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Special theme:

Intelligent and Cognitive Systems

Also in this issue:

ERCIM News is the magazine of ERCIM. Published quarterly, it reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology and Applied Mathematics. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. This issue has a circulation of about 9,000 copies. The printed version of ERCIM News has a production cost of €8 per copy. Subscription is currently available free of charge.

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Keynote

"Cognitive Systems and Robotics" in the ICT Programme of the European Commission

The speed at which European robot manufacturers are diversifying their product portfolios and entering new markets critically depends on contributions from research in diverse disciplines. Hard scientific problems still have to be worked on in order to make robotic devices fit for rendering meaningful services to people.

In 2009, EUROP, the European Robotics Platform[1] , issued a Strategic Research Agenda (SRA), extrapolating from current trends. According to this agenda, by 2020 robots should for instance be programmable by learning (eg, from observation or imitation), they should be able to predict failure states in their operating environment and their own bodies (and take remedial action), detect operator intention, plan complex tasks, avoid collision with non-cooperative obstacles, achieve beyond-human-level dexterity and manipulation skills; they will increasingly rely on new materials incorporating a multitude of sensors and allowing for physical compliance; they will be equipped with fast processors (with new architectures, including neuromorphic) and ultra-high capacity on-board memory, for sensor fusion, controlling perception and action, and episodic memory.

Systems operating in largely non-deterministic environments, and close to people, will regularly be confronted with novelty, uncertainty and change. To work robustly and adaptively, they not only have to be able to extract information from their environment but also to reason and learn about it. At least limited autonomy will be important for certain kinds of robotic devices (including all sorts of vehicles). In order to control their own actions such artificial systems have to be endowed with capabilities that can with good justification be called "cognitive".

Elementary cognitive capabilities include mechanisms for establishing and recognising patterns in sensor-generated data; they are prerequisites for higher level operations like conceptualisation, reasoning, planning, intelligent control and complex goal-oriented behaviour. Learning is essential at all levels.

Typical robot functionalities and the underlying structures can, to a certain degree, be understood and modelled in terms of those of living entities. The growing body of knowledge (for instance in the neuro- and behavioural sciences) about natural cognitive systems may therefore help fuel technical developments, for instance by informing the design of control architectures for multi-component and multi-degree-of-freedom artificial systems.

Under the 7th RTD Framework Programme of the European Commission, as of this writing, 75 grant agreements, falling in the remit of the ICT Challenge "Cognitive systems and robotics", have been or will shortly be concluded. Projects[2] address:

- issues pertaining to endowing artificial systems with cognitive capabilities, including: object / scene - detection / recognition / analysis / classification / categorisation / interpretation; learning and adaptation, reasoning and planning;
- issues specifically related to the design of robots of all sorts, including: roving and navigation, manipulation and grasping, human-robot interaction (especially safety), and robot-robot interaction.

Our work programme[3] acknowledges the fact that intelligent and cognitive systems research is, by the very nature of its subject matter, open-ended. There are no "final" results. But we do expect results that not only advance our knowledge in relevant areas but also enable engineers to build ever more viable systems with features such as safety, robustness, efficiency, ease of use, and (where needed) autonomy. Proposers are therefore asked to motivate, guide and validate their research through suitable scenarios of their choice, relating to industrial and service applications (for instance, industrial/service/medical robotics, exploration, logistics, maintenance and repair, search and rescue, monitoring and control, cognitive assistance, etc.).

In order to achieve impact, be it scientific, economic or societal, it is equally important for a project to actually demonstrate that it makes a significant contribution towards advancing the state of the art. Whether or not this demonstration can be based on agreed measures and, if so, what measures apply, depends on the type and scope of the project concerned.

A popular way of determining the quality of results is "benchmarking" which is suitable for instance for research focussing on improving the performance in carrying out a given task (such as recognising and classifying a given range of objects, assembling or disassembling objects, reaching a particular goal, etc.). Cognitive systems and robotics projects are expected to develop and publish benchmarks whenever possible. Another popular approach, especially with roboticists, to comparing technical achievements is through competitions. Our current work programme includes a measure to accommodate pertinent contests.

For our programme to live up to the inherent economic challenge, the participation of new players, notably from the robotics industry, is greatly encouraged. It is important for these companies (mostly small and medium-size enterprises) to formulate their research needs and meet them in collaboration with academic partners. Our ECHORD (European Clearing House for Open Robotics Development)[4] project is making promising moves towards this objective. In addition, the coordination action (CA) euRobotics[5], jointly with the above mentioned European Robotics Platform, provides an open forum for considerably widening the scope of this kind of activity.

Hans-Georg Stork
European Commission,
Information Society and Media Directorate General,
Unit E5 "Cognitive Systems,Interaction, Robotics"

The wider cognitive systems research communities are currently being served, on the basis of individual memberships, by EUCogII[6], the "2nd European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics", an EC supported coordination action that continues a similar FP6 initiative.

With preparations for FP8, the next RTD Framework Programme, still at the very beginning, it is too early to give concrete indications as to the extent, depth and emphases of future EU support to intelligent and cognitive systems research, the results of which will, after all, most likely continue to bring about considerable economic and societal benefits.

Hans Georg Stork

The views expressed in this article are the sole responsibility of the author and in no way represent the view of the European Commission and its services.

Links:

1) http://www.robotics-platform.eu/
2) http://cordis.europa.eu/fp7/ict/cognition/projects_en.html
3) For 2011-2012, http://cordis.europa.eu/fp7/ict/cognition/docs/workprogramme2011-2012.pdf, p. 37-39
4) http://www.echord.info/
5) http://www.eurobotics-project.eu/
6) http://www.eucognition.org/

RESEARCH AND INNOVATION

This section features news about research activities and innovative developments from European research institutes

EVENTS

IN BRIEF

ERCIM "Alain Bensoussan" Fellowship Programme co-funded by the European Commission

by Peter Kunz

The "ERCIM Alain Bensoussan Fellowship Programme" is now supported by the FP7 Marie Curie Actions - People, Co-funding of Regional, National and International Programmes (COFUND) of the European Commission. This support is for an initial period of four years. With the support from the European Commission, ERCIM plans to co-fund more than 150 fellows in a four year period which started in September 2010. With the "COFUND" action, the Commission recognizes ERCIM's successful and long-lasting fellowship programme.

The Marie Curie co-funding action is a new way of implementing individual fellowships. It aims to increase the transnational mobility for training and career development of experienced researchers, in line with the objectives set out in the activity heading "Life-long training and career development" of the "People" Work Programme. The co-funding is expected to result in a considerable increase in the number of ERCIM fellows, with the current average of 20 ERCIM fellowships per year almost doubling. Also, the fellowship's duration has been extended and applicants can now benefit from one or two periods of twelve months spent in one or two ERCIM member institutes.

Additionally, employment conditions are now more flexible, with the option of signing a working contract instead of a stipend agreement (an agreement for a research training programme) in some of our institutions. The type of contract as well as the monthly allowance (for stipends) or salary (for working contracts) depend on the host institution. Another novelty is the yearly "ABCDE seminar" where fellows will have the opportunity to benefit from specific training on a range of non-scientific skills. The first seminar is planned in June 2011 and could cover topics such as personal development courses, IPR issues, communication, presentation and mentoring techniques and career development.

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ERCIM Fellowship Programme

Who can apply?
The fellowships are available for PhD holders from all over the world.

What is the duration?
Fellowships are generally of 24 months duration, spent in two of the ERCIM institutes. A fellowship of 12 months duration spent in one institute might also be offered.

Application deadlines:
Twice per year: 30 April and 30 September.

How to apply?
Only online applications are accepted.
The application form will be online one month prior to the application deadline.

Which topics/disciplines?
Topics cover most disciplines in computer science, information technology, and applied mathematics.

Where are the fellows hosted?
Only at ERCIM member institutes (the current ERCIM member institutes are listed on the back page of this issue). When an ERCIM member is a consortium (AARIT, CRCIM, IUA, PEG, PLERCIM, SARIT, SpaRCIM) the hosting institute might be any of the consortium's members. When an ERCIM Member is a funding organisation (FNR, FWO/FNRS), the hosting institute might be any of their affiliates.

What are the conditions?
- have obtained a PhD degree during the last eight years (prior to the application deadline) or be in the last year of the thesis work
- be fluent in English
- be discharged or get deferment from military service
- the fellowship is restricted to two terms (one reselection possible)
- have completed the PhD before starting the grant.
- a member institute will not be eligible to host a candidate of the same nationality
- a candidate cannot be hosted by a member institute, if by the start of the fellowship, he or she has already worked in this institute for a total of six months or more, during the last three years.

How are the fellows selected?
Each application is reviewed by scientists, and the criteria for selection are:
- scientific expertise of the applicant
- quality of scientific publications
- relevance of the fellow's research agenda
- interest/added-value for the ERCIM consortium
- previous mobility / professional experiences.

The number of available positions depends on the needs of the member institutes and their available funding.

More information: http://fellowship.ercim.eu/

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Michel Cosnard, President of ERCIM.

Michel Cosnard elected President of ERCIM

Michel Cosnard, President of INRIA was elected President of ERCIM at the last ERCIM Board of Directors, held in Brno, Czech Republic, 4 November 2010. Michel Cosnard took office as ERCIM president 1st January 2011 for a two-year term. Michel succeeds Keith Jeffery who served as ERCIM President from January 2005.

For some time, the Strategy Task Group (an elected subset of the Board of Directors) has been discussing the future of ERCIM. Indeed there is some pressure from more organisations to join ERCIM (the current construction is one member per country) and the current structure of an EEIG (European Economic Interest Grouping) of seven members plus thirteen associates is now inappropriate for the mission and objectives of ERCIM.

"ERCIM - the European Research Consortium for Informatics and Mathematics - aims to foster collaborative work within the European research community and to increase co-operation with European industry. For more than 20 years, ERCIM has a leadership position for cooperating for excellence in research and is a recognized expert in Information and Communication Technologies which are now a worldwide research and innovation priority", said Michel. "Its impact on society is tremendous and the number of key players has increased exponentially. To maintain its position, remain THE recognized expert in Europe, and increase its impact on European strategy and policy, ERCIM has to evolve in particular its membership by attracting the best research performing organizations."

"ERCIM has been also the European host of the World Wide Web Consortium (W3C). The evolution of Web standards is key to maintain an open Web and to lead it to its full potential. Transforming the consortium into a more long term international standardization organization is a challenging objective".

At the recent Board of Directors meeting the following plan was approved:

- form a non-profit association open to any suitable organisation based on criteria of excellence and with an executive elected from the membership;
- retain the EEIG of seven members to look after the W3C Europe host and office with legacy project responsibilities at least for some years.

Three new Vice Presidents (VPs) were also nominated:

- Jan Karel Lenstra, General Director, Centrum voor Wiskunde en Informatica (CWI), The Netherlands becomes Vice President with responsibility to advance the activity for the creation of the non-profit association.
- Andreas Rauber, Professor at Vienna University of Technology, Department of Software Technology and Interactive Systems and President of the Austrian Association for Research in IT (AARIT), Austria becomes Vice President with responsibility for attracting new members.
- Keith Jeffery, Director IT and International Strategy of the Science and Technology Facilities Council, UK becomes Vice President for external relations.

The plan is to form the association by June 2011 when there will be elections for the President and VPs for the new organisation. At this time the relationship of the EEIG to the new ERCIM will also be determined.

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ICT Solutions benefitting India and Europe

by Juanita Kakoty and Nicholas Ferguson

Euro-India SPIRIT and SYNCHRONISER two EU-funded projects dedicated to synergising and strengthening EU-India relations in ICT research and innovation organised a joint ICT Policy Workshop on 10 November 2010 in India.

Modern healthcare is becoming more and more reliant on Information and Communication Technologies (ICT) which offer a variety of benefits such as increased efficiency, a decrease in overall healthcare costs and improvements in patient safety. The growth of ICT solutions for healthcare is a global trend that is reflected in India, where the technology is seen as a key enabler in scaling up and managing networks of hospitals as the market for affordable healthcare in India grows. The social significance and possible implications of this is widespread and could reach underprivileged and rural sectors of Indian society for who affordable healthcare is often not yet a reality.

The topic of ICT for healthcare and the broader issue of how ICT can address Societal Challenges were just two of the issues discussed at the Euro-India SPIRIT and Synchroniser ICT policy joint workshop held on 10 November at

SurajKund Delhi NCR. The event enabled ICT experts and stakeholders from Europe and India to discuss and deliberate upon issues that have direct bearing on ICT policies formulated in the two regions. The insights that emerged outline a roadmap of thematic concerns for future collaborative research, and pronounce the strong need to engage the respective governments and industry practitioners in an active ICT policy dialogue.

In the build up to the workshop an intensive meeting of Euro-India SPIRIT experts took place the day before focusing on shaping EU-Indian ICT policy in three main areas ICT Addressing Societal Challenges, AudioVisual Media and Internet, and Emerging Technologies and eInfrastructures. The group consolidated the findings and results of previous

Participants of the joint ICT Policy Workshop.

meetings to leverage joint cooperation between EU and India in areas that offer mutual benefits for both sides. Areas recommended for future collaborative research include: boosting e-Healthcare capacities; investing in secure and dependable ICT infrastructures; broadband research capacities pertinent to both EU and India; ICT applications in disaster management; e-Services like multi-lingual content and cloud computing; data acquisition, dissemination, storage and management; issues of security and trust; and empowering end users.

Comprehensive discussions on policy measures to fund and promote research kept the experts' discussions animated, as did the talks that stressed the importance of addressing a validation scenario right at the stage of formulating research proposals. The importance of adding local depth to a global infrastructure was also repeatedly highlighted during the course of the meeting.

The ICT joint Workshop itself welcomed over 50 participants including key stakeholders from the Indian Government, European Commission, academia, industry, civil society. Researchers and practitioners discussed and reflected upon joint research possibilities in the domain of ICT for Development between the European Union (EU) and India. With a keynote presentation on Indian ICT Policy Issues from Dr. G Narendra Kumar, Joint Secretary Performance Management Division, Cabinet Secretariat, the exclusive invitation-only forum aimed to maximise the effects and benefits of policy dialoguing among stakeholders and experts from EU and India. Alvis Ancans, International Relations Officer, European Commission, highlighted the structure of FP7, including a breakdown of funding areas focusing on ICT; by outlining the various types of support that the European Union offers for international collaboration; and by listing the Indian organisations that have been successful so far in FP7 ICT Calls such as FICCI, IBM India, CDAC , EIRC and IIT Delhi and Bombay.

Participants from elaborate discussions that dwelt upon how societal challenges in India could be applied to the Seventh Framework Program (FP7). They also took back home practical ways to transform research ideas into EU-funded projects.

As an outcome of the two-day intensive exercise, Euro-India SPIRIT re-aligns its priority to drawing expertise and knowledge from the industry practitioners. This would allow real use case scenarios to be discussed, showcasing benefits and pinpointing real challenges on the ground.

In the coming year SYNCHRONISER will publish and promote the long term research perspectives and trends study in India that has been identified by the Indian high level visionaries while Euro-India SPIRIT will issue a policy recommendations document from the experts findings.

Both projects will actively participate in a series of ICT events to be hosted in India in 2011. Working Group experts will interact with stakeholders from the government, industry, academia and civil society on issues pertaining to ICT societal challenges in the country, technology application concerns, application of European research results, and ICT policy matters.

The two projects will then consolidate the identified priority research themes between India and Europe to create an enduring collaborative R&D framework between the two regions. Policy recommendations will be submitted to the Ministry of Communications and Information Technology, Government of India and to the Directorate General for Information Society and Media, European Commission. The document will highlight themes for joint EU-India research collaborations and innovation in the field of ICT for development.

The Euro-India SPIRIT project is coordinated by ERCIM.

Links:
http://www.euroindia-ict.org
http://www.synchroniser.org

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Participants of the GEO-RECAP kick-off meeting. From left: Giorgi Mumladze (IC), George Giorgobiani (MICM), George Goguadze (DFKI), Vakhtang Kvaratskhelia (MICM), Jérôme Chailloux (ERCIM), Andrey Girenko (GIRAF), Andrea Loesch (GIRAF) and Givi Kochoradze (ICARTI).

Supporting Georgia in Enhancing the Cooperation Capacities of its ICT Research Centres

A new two-year project entitled "Re-creation and building of capacities in Georgian ICT Research Institutes" (GEO-RECAP) was launched with a kick-off meeting in Tbilisi on 23 November 2010. GEO-RECAP is designed to support Georgia in enhancing the cooperative capacity of its ICT research centres and facilitate scientific cooperation between these centres and the European research area (ERA).

Georgia is currently in a period of reform. Analysis shows that the current weaknesses in the country's research system are:
- a high diversification and division of research institutes
- a weak focus on research commercialization and links to industry
- a weak impact on the socio-economic conditions.

In this respect it is very important to improve the structure and profile of scientific research institutions, to develop strategies to reorganize the research institutes into "European style organizations" and to elaborate new funding models in particular with regard to international programmes and projects.

Two Georgian ICT research centres, N. Muskhelishvili Institute of Computational Mathematics (MICM) and Institute of Cybernetics (IC), members of the GEO-RECAP consortium, possess strong potential in ICT and applied mathematics. Aside from the fundamental research, which has always been a strong suit for both institutes, they were also involved in solving the socio-economic problems. Well-known political events in the former USSR in the nineties negatively influenced the scientific life of the country. During the last decades, due to the lack of funding and of commercialization, research has been rarely implemented in practice.

However, the imminence of reform, together with the increasingly pragmatic attitude of Georgian authorities to the future development of the country motivates us to intensify applied research and to increase our focus on innovative information communication technologies. We believe that GEO-RECAP's main objective, the provision of support to MICM and IC, is achievable owing to collaboration with European partners such as the German Research Centre for Artificial Intelligence (DFKI) and GIRAF PM Services GmbH (both from Germany). Furthermore, ERCIM has excellent institutions in the ICT fields, and the local partner, International Centre for Advancement of Research, Technology & Innovation (ICARTI), has made substantial efforts to raise awareness of Georgian scientists about the 7th Framework Programme and other collaboration facilities with the ERA.

The main objectives of GEO-RECAP will be achieved through two networking and training events: The first networking event will be held in Budapest on 4-6 May 2011, and will coincide with the FET11, the European Future Technologies Conference and Exhibition. A second event will be organized in Tbilisi in 2012. Two training events will be held in Tbilisi in 2011 and 2012.

GEO-RECAP Expectations

The expected outcome of the project is the following:
- RTD capacity building in Georgia
- enhanced participation of the country in the 7th Framework Programme
- increased scope of MICM and IC with increased linkage with the economic and social environment
- increased job opportunities in the country for young scientists
- increased scientific cooperation between the ERA and Georgian ICT centres.

GEO-RECAP is supported by the EU FP7 Capacities Work programme 2010; Activity 7.6. Integrating Europe's neighbours into the ERA; Area INCO.2010-6.1: Eastern Europe and South Caucasus. ERCIM is a partner in the project.

Link: http://www.georecap.eu (under construction)

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ERCIM at ECCV 2010

by Antonis Argyros and Panos Trahanias

ERCIM sponsored the 11th European Conference on Computer Vision, ECCV, which took place on 4-11 September 2010 at Heraklion, Crete, Greece. Almost 800 participants from 38 countries attended and contributed to the main conference, workshops, tutorials, demonstrations and special sessions. The conference was organized by FORTH-ICS.

ECCV is a highly selective, single track conference comprising the highest quality previously unpublished papers on any aspect of Computer Vision. The 11th ECCV had an exciting programme dealing with fiel ds such as object and scene recognition, segmentation and grouping, motion and tracking, statistical models and visual learning, matching, registration, computational imaging, multi-view geometry, video and event characterization, shape representation and recognition, and more. ECCV received a record number of 1174 submissions of which 40 oral and 285 poster presentations were accepted.

The first day of the conference was dedicated to eight tutorials. This was followed by the main conference that lasted four days. Finally, the last two days were dedicated to eleven specialized workshops. Several computer vision related enterprises contributed to the conference as exhibitors. The conference program was additionally enriched by 25 research demonstrations.

The 2010 edition of ECCV coincided with the 20th anniversary of the event. In the context of this occasion, the first ECCV organizer, Prof. Olivier Faugeras, gave an exciting invited talk.

ECCV 2010 granted the following paper awards:

- Best Paper Award, presented to L. Laticky, C. Russell, P. Kohli and P.H.S. Torr for their paper entitled “Graph Cut based Inference with Co-occurrence Statistics”
- Runner-Up Paper Award, presented to A. Gupta, A. Efros and M. Hebert for their paper entitled “Blocks World Revisited: Image Understanding Using Qualitative Geometry and Mechanics”
- Best Student Paper Award, presented to T. Pätz and T. Preusser for their paper entitled “Ambrosio-Tortorelli Segmentation of Stochastic Images”
- Koenderink Prize 2010, jointly presented to H. Sidenbladh, M.J. Black and D.J. Fleet, for their ECCV’2000 paper entitled “Stochastic Tracking of 3D Human Figures Using 2D Image Motion” and to M. Weber, M. Welling and P. Perona, for their ECCV’2000 paper entitled “Unsupervised Learning of Models for Recognition”.

Two special ECCV’2010 sessions were organized. The first, "Vision and Industry" aimed to bring academic researchers into closer contact with leading industrial labs and firms that translate computer vision into a profitable business. R&D managers and scientists from half a dozen highly recognized enterprises delivered talks about the current and future state of computer vision products and projects. The second special session, on "Research Funding for Vision", featured invited talks from Dr. Jie Yang (IIS Division, NSF) and Dr. Cécile Huet (European Commission - Directorate-General Information Society and Media) who presented opportunities for research funding in the area of Computer Vision, Robotics and Cognitive Systems in US and EU, respectively. Besides ERCIM, the list of ECCV’2010 sponsors included organizations and companies such as INRIA, Technicolor, Microsoft Research, Google, Point Grey, Adobe, IBM Research, Siemens, GE, Dynavox Mayer Johnson, Johnson Controls and University of Houston.

The proceedings of ECCV’2010 are published by Springer in the Lecture Notes in Computer Science series 6311- 6316. The next edition of the conference - ECCV 2012 - will be held in Florence, Italy, 7-13 October 2012.

Links:
ECCV’2010: http://www.ics.forth.gr/eccv2010
ECCV’2012: http://eccv2012.unifi.it/

CSCLP 2010 - Annual ERCIM Workshop on Constraint Solving and Constraint Logic Programming

by Barry O’Sullivan

The 2010 annual workshop of the ERCIM Working Group on Constraints was held on 25-26 November 2010 in Berlin, at Fraunhofer Institute for Computer Architecture and Software Technology FIRST. The workshop series on Constraint Solving and Constraint Logic Programming is now in its fifteenth year. This year's workshop chairs were Armin Wolf (Fraunhofer FIRST) and Barry O'Sullivan (4C, University College Cork, Ireland).

The first session of the two half-day event began with an invited talk given by J. Christopher Beck (University of Toronto) on a tour "From Constraint Programming to Logic-Based Benders Decomposition (and back!)". This was an illustrative and educational presentation of experiences with decomposition methods for solving hard combinatorial optimisation problems. This was followed by a report of a practical application on “Solving the Rotation Assignment Problem for Airlines Using Constraint Programming” - a piece of work undertaken by Son Tung Nguyen and Roman Barták from the Charles University in Prague. A more theoretical piece of work on “An Adaptation of Path Consistency for Boolean Satisfiability” was presented by Pavel Surynek, also from the Charles University. The final talk of the first workshop day was given by Rémy Haemmerlé, Universidad Politécnica de Madrid on “(Co)inductive Semantics for Constraint Handling Rules”.

The second day of the workshop began with an overview by Armin Wolf of a number of CP applications developed at Fraunhofer FIRST. These applications ranged from areas

such as production scheduling, workload distribution in maintenance, and energy management to partition scheduling for multi-core architectures. This overview was followed by two presentations of some scientific work performed at 4C at University College Cork (an ERCIM member institution) on "Almost Square Packing" by Helmut Simonis and Barry O'Sullivan, showing the influence of effective problem modelling on the solution process. The other work on "Creating Tests for a Family of Cost Aware Resource Constraints" was by Tarik Hadzic and Helmut Simonis, and addressed a new family of cost constraints that are very relevant in energy management with time and consumption dependent costs.

The participants of the workshop were from Canada, Czech Republic, Germany, Ireland, Luxemburg, and Spain. The proceedings of the workshop and some presentations are available on the CSCLP 2010 website. The 2011 CSCLP Workshop will be held at the University of York in April 2011, and will be chaired by Alan Frisch and Barry O'Sullivan.

Link: http://www.constraint-programming.de/csclp2010/

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15th ERCIM Workshop on Formal Methods for Industrial Critical Systems

by Stefan Kowalewski and Marco Roveri

The 15th ERCIM Formal Methods for Industrial Critical Systems (FMICS) workshop was held in Antwerp, Belgium, on 20-21 September 2010. It was co-located with the 25th IEEE/ACM International Conference on Automated Software Engineering (ASE).

The aim of the FMICS workshop series, organized annually by the ERCIM FMICS Working Group, is to provide a forum for researchers who are interested in the development and application of formal methods in industry. In particular, these workshops are intended to bring together scientists and engineers who are active in the area of formal methods and are interested in exchanging their experiences in the industrial usage of these methods. These workshops also strive to promote research and development for the improvement of formal methods and tools for industrial applications.The topics chosen for FMICS 2010 included:

- design, specification, code generation and testing based on formal methods
- methods, techniques and tools to support automated analysis, certification, debugging, learning, optimization and transformation of complex, distributed, real-time systems and embedded systems
- verification and validation methods that address shortcomings of existing methods with respect to their industrial applicability (eg, scalability and usability issues)
- tools for the development of formal design descriptions
- case studies and experience reports on industrial applications of formal methods, focusing on lessons learned or identification of new research directions.
- impact of the adoption of formal methods on the development process and associated costs
- application of formal methods in standardization and industrial forums.

FMICS 2010 received 30 submissions from 19 countries, 14 of which have been selected after a thorough reviewing process. Each paper was reviewed by at least four program committee members or external referees that selected the papers basing their choice on the paper scientific quality, originality and relevance to the workshop. The presentations covered a wide range of topics, mostly focusing on applying model checking and abstract interpretation to reason about software. In addition to the regular talks, FMICS featured four invited talks by Stephan Tobies (Microsoft European Innovation Center), Axel Simon (Technical University of Munich), Aarti Gupta (NEC Labs), and Bert van Beek (Technical University of Eindhoven). The resulting program offered the participants a complete landscape of the recent advances in this area. On-site proceedings were published by Springer-Verlag as volume 6371 of Lecture Notes in Computer Science.

From left: Marco Roveri, Alessandro Fantechi, and Stefan Kowalewski.

Best paper award

Following a tradition established over the past few years, the European Association of Software Science and Technology (EASST) offered an award to the best FMICS paper. This year, the award was given to Alessandro Fantechi for the paper "The Metrô Rio ATP Case Study" (http://www.springerlink.com/content/vh0734j73j8q5002/), written together with Alessio Ferrari, Daniele Grasso, Gianluca Magnani, and Matteo Tempestini. The award was presented by Stefan Kowalewski and Marco Roveri, PC co-chair of FMICS 2010 (see photo).

Links:
http://es.fbk.eu/events/fmics2010
http://www.inrialpes.fr/vasy/fmics
http://www.easst.org/, http://soft.vub.ac.be/ase2010/

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Introduction to the Special Theme

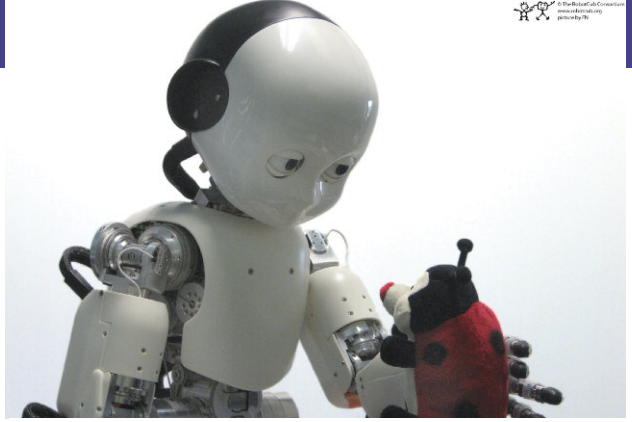
by Rüdiger Dillmann, Tamim Asfour and Antonis Argyros

Truly intelligent technical cognitive systems should be able to operate autonomously, interact naturally with their environment and the humans therein, and be adaptive to changing situations and contexts, including the user's preferences and needs. Currently, an encouraging spectrum of many isolated elements in the area of cognitive systems is realizable, including vision, speech, learning, decision making, planning and motor control. Nevertheless, the focus of these developments is mainly on performance in well defined, narrow domains. Successful attempts in building artificial, intelligent cognitive systems are still mostly restricted to systems designed for 'sunshine' environments having limited scope and performing simple tasks. The transferability of the developed skills and abilities to varying contexts and tasks without costly redesign of specific, ad hoc solutions is still impossible. In the future, research efforts must be devoted to rich cognitive challenges which are measurable and scalable in open ended scenarios under changing conditions, and to the development of measures, metrics and benchmarks that highlight and focus on both transferability and performance.

Challenges

Current challenges in the area of intelligent cognitive systems can be summarized as follows:

- Methodologies supporting the development of systems that explore their own sensorimotor primitives, body morphology, the environment and their effective interaction with it. Systems must be able to predict body dynamics and the physics of the world and, thus, develop ability to reason about it.
- Methodologies supporting the learning of new skills, adaptation of existing skills and the ability to switch between different learning modalities. Combination as well as context-dependent switching among multiple forms of learning should be possible. The relevant methodologies and frameworks should allow for competence learning as well as autonomous and interactive skill and strategy transfer to varying contexts and tasks.
- Architectures and models for the representation and organization of huge bodies of knowledge for sophisticated sensory-motor control, choice and combination of actions for coping even with common everyday situations.
- Cognitive architectures that allow the integration of perception, action, reasoning, learning and communication components.
- Methodologies supporting learning, recognition and classification of objects and events (eg associative memories, stochastic computing etc).
- Technology for soft sensors, massive connections and soft flexible tissues (tendon-like, skin-like, bone-like) which allow the realization of adaptive, flexible and robust artificial cognitive systems and provide safe interaction with humans.
- Common/shared complex platforms with standard/common/open software, which allow researchers from different fields to evaluate their theories and simultaneously provide a framework for the benchmarking of different algorithms.



iCub, a humanoid robot of the Italian Institute of Technology (IIT) developed by the European Project RobotCub, funded by the European Commission, to support community research on embodied cognition.

Research Themes

New approaches are needed to cognitive system development, focusing more on understanding processes that lead to autonomous growth and development than on system development. Semantics will arise from the interaction of an agent with its environment and with other agents.

Processes and representations for emergence

An important aspect for future cognitive systems is the definition of morphogenetic processes (processes that cause an organism to develop its shape) for information processing. This takes into account cooperation, stabilization, consolidation, focusing, categorization and mode selection. Autonomous, interactive and incremental learning and co-developmental approaches will be a key element in the development of processes for emergence. For this purpose, one has to study how sensorimotor experiences can be organized into appropriate data structures that allow sensorimotor learning at different levels of abstraction. Sensorimotor knowledge is gained by humans from childhood on, when children start to explore the space around them with seemingly random movements. This type of learning is the focus of developmental approaches, which have gained a lot of attention in robotics in recent years.

Emergent cooperation

Cooperation between agents must be based on the principles of alignment, entrainment, imitation, sharing, anticipation and proactive interaction. Guiding principles of cooperative decision making and role assignment in cognitive ensembles must be investigated to bootstrap natural communication and language generation. New theories of interaction should be developed to enable human-robot, human-human, robot-robot and other forms of interaction. The goal is to develop autonomous, interactive agents that operate within human environments and play a beneficial role in the daily lives of people. A key aspect in this field is multimodal interface technology, which allows humans and their environments to be 'observed' by recruiting signals from multiple audio-visual sensors.

Embodiment for guiding design

The development and emergence of cognition relies on artificial embodiments having rich perceptual and motor capabilities. Biologically inspired robot systems with such capabilities therefore represent the most suitable experimental platform for studying cognition. Body morphology of artificial cognitive systems should be inspired by biological systems, and the cognitive system should be able to learn its own body schema and cope with morphological changes arising through

ARMAR-III, a humanoid robot of the Karlsruhe Institute of Technology developed by the Collaborative Research Center on humanoid robots (SFB 588), funded by the German Research Foundation (DFG), as assistance robot in human-centered environments.

physical interaction with the environment. The following technologies need to be further developed to achieve these goals: artificial skin, soft and compliant mechanisms, new sensors, new energy-efficient actuation methods and on-chip multi-core systems. Humanoid personal robots are examples of artificial cognitive systems and a key growth industry of the 21st century. The big challenge is the advancement of robotic technology to the point where interactions between humans and robots run smoothly and robots are able to fulfill roles in the human living space.

The challenges for the development of humanoid robots also hold for robot ensembles. The vision of multiple, inexpensive robots operating in concert to solve complex and dynamically changing tasks has not yet been achieved. From a scientific/technological perspective, the two major challenges consist of developing efficient and general models of collective operation and conceiving hardware for disposable and collective operation. Although many models of collective operation (swarm intelligence) exist, they tend to be applicable only to specific robotic hardware and tasks. The big challenge is to capture principles of collective operation, such as altruistic cooperation, dynamic division of labor and emerging communication that are applicable to a wide set of robotic platforms and tasks. Existing models in the biological literature are not easily applicable to a real robot. For example, a model often used to explain division of labor in insect societies implies an updated and global knowledge of the needs of the colony, which is not realistic for a robot with only imprecise and local sensory information. It is therefore necessary to bring together scientists from biology, control theory and robotics to develop principles and algorithms that hold in the reality of specific robots and animals; and at the same time are general enough to be easily applicable to novel platforms.

Architectures and principled benchmarks

In addition to studying representations and processes, investigations are necessary on cognitive system architectures, which should allow for the integration of perception, action, reasoning, learning and communication and should provide an integrative framework for modeling, validation, and benchmarking of complete cognitive systems. New architectures should allow the use of emergent representations and substitute the modeling of cognitive systems based on the study of isolated, representation-rich, symbol manipulation systems with the study of the dynamics of agents and their environments.

Apart from theories of cognition, special emphasis must be put on experimental studies, approaches for comparison, analysis, and synthesis of various cognition paradigms. Additionally, shared complex platforms with standard/open software are required which on the one hand allow researchers from different fields to evaluate their theories and on the other hand provide a framework for benchmarking of different algorithms. Despite its fundamental importance, systematic benchmarking is still extremely difficult. Experimental studies of intelligent cognitive systems need test-beds that allow the evaluation of behaviors and results at system level rather than focusing on the performance of single component algorithms. Such test-beds together with common repositories must be provided for use by the research community. Key research activities in the future should be devoted to the definition of rich cognitive challenges which are measurable and scalable in open-ended scenarios under changing conditions and to the development of measures, metrics and benchmarks that highlight and focus on transferability as well as performance.

Integrative Studies of Cognitive Systems

Europe has the potential to play a leading role in the analysis and modeling of cognitive systems due to the leading position of European research in many fields such as computer vision, neuroscience, cognitive science and robotics. In Europe we are in particular able to gather the required critical mass of leading scientists in interdisciplinary consortia, thus making it possible to address challenges of scientific as well as commercial relevance. However, the existing expertise in information theory, neuroscience and social sciences can be more strongly bundled to provide better theoretical foundations towards understanding the processes and underlying mechanisms on which cognition builds. It is hoped that through extensive international collaboration, a fruitful cross-fertilization will emerge, giving technical oriented scientists new inspiration from biology and providing cognitive scientists with new ways to prove and evaluate their biological models. Clearly, significant progress can only be made through a more intensive dialogue among researchers from the fields of natural and artificial cognitive systems.

Within this context, ERCIM has run the FET “InterLink” project (Oct 2006 - May 2009, http://interlink.ics.forth.gr/) which aimed at advancing knowledge in Europe in three strategic areas, including Intelligent and Cognitive Systems. Interlink has formulated the research priorities that will create the scientific basis for concrete new technologies to be developed in the long run. Its recommendations are based on a sound cross-disciplinary perspective and, importantly, they transcend the European dimension towards global international collaboration. The visions exposed in this preface are essentially part of the InterLink project results. They vividly show the need to build new bridges across disciplines, so that next generations of researchers will be able to evolve in the more challenging, but so much more enriching and rewarding landscape of interdisciplinary work.

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Invited article

Cognitive Systems – From Internet to Robotics

by Henrik I Christensen

Over the last two decades the Internet has been a game changer. It has changed how we interact with people, the world is becoming flat in the sense that we can easily access people and resources across the world. It is, however, characteristic that so far the internet has primarily been used for exchange of information. The premise here is that the next revolution will happen when the internet is connected to the physical world, as typically is seen in robotics.

Robot systems are composed of three components: actuation, perception and cognition. Actuation is the physical generation of motion in the environment. Perception is about the estimation of the state of the environment and agents within it. Finally, cognition is acquisition of information about the environment and use of such information to reason about past, current and future events. If we consider the components of perception, actuation and cognition to span a 3-dimensional space as shown in Figure 1. More than 10,000,000 robots are used industrially but less than 5% of them have sensors in the outer control loop. That is, the motion is primarily pre-programmed. There is thus a need to move away from the actuation axis and into the green plane where perception/sensing is integrated into the control loop to provide increased flexibility and adaptability to changes in the environment. We are starting to see such integration of sensing for example for visual servoingas part of assembly operations as illustrated in Figure 3. In this example assembly of a car door is studied. Robot assembly of a car door represents one of the most challenging tasks in car manufacturing and it thus represents a suitable benchmark. In the space of perception and cognition there has been a rich body of research on activity recognition, intelligent home environments and smart diagnostics. In the actuation-cognition plane there has been a number of new efforts on intelligent search and planning such as smart motion planning and exploration strategies. It is, however, characteristic that there has been relatively few efforts to deploy systems that integrate all 3 aspects into system beyond the toy domains or outside of the research laboratory.

As important aspect of design of next generation robot systems is integration of effective user interfaces. Traditionally robots can only be utilized after a multi-day training course or the functionality is simple enough to allow use of very basic interface modalities such as playing sound patterns to indicate different states. As more and more functionality is integrated into systems there is a need to provide richer modalities for interaction. We have already started to see voice dialog systems on smart phones and when integrated with methods for gaze estimation, gesture interpretation it is possible to provide comprehensive interfaces. People have traditionally developed interaction patterns for pets, toys, etc. It is no surprise that more than 50% of all Roomba owners name their robot! Leveraging the fact that people bond with pets and popular technologies such as GPS units, computer game characters, and smart robots it is possible to consider a new generation of robot systems. One such example is the use of humanoid type robots for interaction with people without a need for extensive training. One such example is the robot Simon that has been developed by Prof. Andrea Thomaz at Georgia Institute of Technology. The robot is shown in Figure 4. Through use of an articulated interface that has facilities for speech, gesture and gaze interaction it is possible to design rich interfaces that can be used for non-expert users such as kids. Typically there is no need to train people prior to deployment of the system for

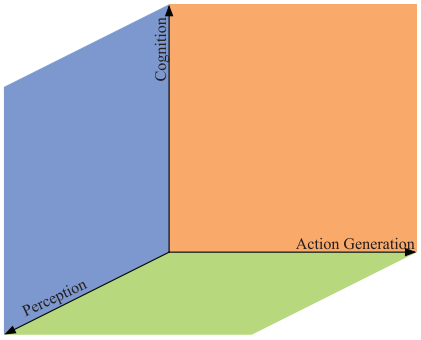


Figure 1: The space spanned by perception, actuation and cognition.

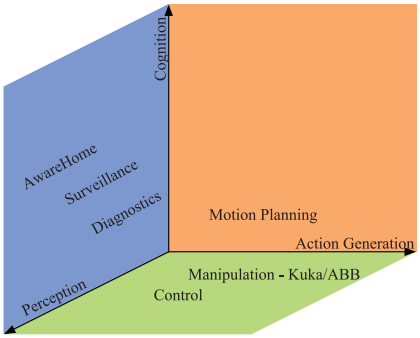
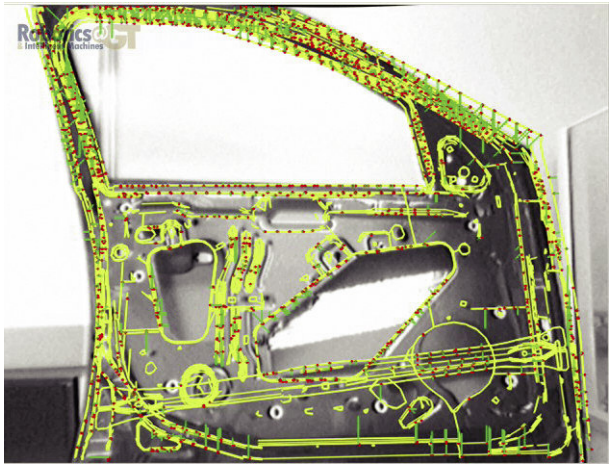


Figure 2: Example applications in the robotics space.

Figure 3: Example of using vision to drive a robot as part of assembly operations.



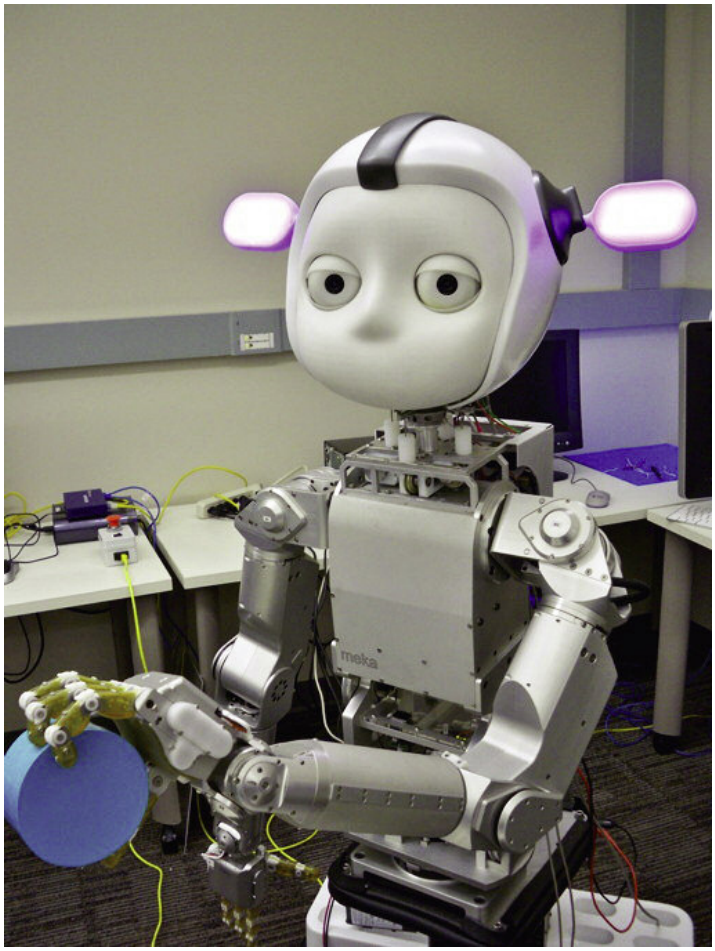


Figure 4: The robot Simon used for social HRI studies (Courtesy of Prof. A. Thomaz, RIM@GT).

Figure 5: The robot E-LE developed at Georgia Tech for studies of assistance to elderly/disabled people (Courtesy of Prof. C. Kemp, RIM@GT).

kids play, training of assembly actions for manufacturing and elderly care. For cognitive systems that are to be deployed in general scenarios it is particularly important to consider use of embodied interfaces that lower the bar for adoption.

There is a tremendous need for utilization of robot systems as part of providing assistance to elderly and disabled people. As an example there are more than 400,000 stroke victims in the US and many of them could live independently if they had a little help. An example would be delivery of food, pick up of items from the floor, recovery of lost items such as glasses, remote control, etc. Today people can request assistance from canines or trained monkeys. Clearly many of the required functions could also be achieved with a robot system. The challenge is here to provide a robust system that can be operated after a minimum of training. One such example is the robot E-Le developed by Prof. Charlie Kemp at Georgia Tech. The robot is shown in Figure 5. It has been developed for basic delivery tasks and to pickup and delivery of medicine to a person that is mobility impaired. The robot has been tested in field trials for adoption by real client with great success. The current challenge is consideration if it can be commercialized at a cost of less than $10,000 to be competitive with competing approaches.

Robots endowed with cognitive capabilities that enable communication, interaction and recovery are without doubt the next wave. The confluence of interface technology, cheap actuations and affordable computing with new methods in learning and reasoning will pave the way for a new generation of systems that move away from the factory floor and in the daily lives of citizens across cultures, age and needs. This is an exciting time.

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The Cognitive Robotics behind Human-Robot Interaction

by Tony Belpaeme

Currently, most cognitive and social robots only operate in the here and now, but the ALIZ-E project aims to change this, moving human-robot interaction from the range of minutes to the range of days. The project develops the theory and practice behind embodied cognitive robots capable of maintaining social interactions with a young user over an extended period of time.

Social robots are robots that interact and engage with people directly, using a range of communication channels, such as gestures, sounds, and speech. Social robotics is a young but fast-growing research field, with results mainly being generated in academic institutions and only recently finding their way into commercial products. One of the pillars of social robotics is the fact that humans have evolved to be gregarious, group-living animals and, as such, are very adept at social interaction. We generate and are sensitive to a wide range of conscious and unconscious signals that we use to operate as social beings. Of all such signals, language is the most complex communication channel and a uniquely human capacity. The study of social robots is important to enable us to build robots (and technology in general) that can interact with us on a more inter-subjective level in environments where naturalistic social interaction between people and technology is desired.

The ALIZ-E project specifically explores robot-child interaction, capitalizing on children's open and imaginative responses to artificial 'creatures'. Promising future applications include the development of educational companion robots for child users. The project will innovate in taking robots out of the lab and putting them to the test in a health education role, with young diabetic patients, in a busy paediatric department at the Ospedale San Raffaele in Milan.

Technical and scientific challenges are rife. Available Automated Speech Recognition (ASR) typically handles only adult speech so recognising children's speech requires novel ASR approaches. After speech has been recognised, it is passed to the Natural Language Processing (NLP). Currently NLP is only robust in closed and well-controlled dialogue contexts. The project studies how NLP can be ported to a robot in a semi-open real-world setting and how the Human-Robot Interaction experience can be tailored so failures in NLP or elements feeding into it go unnoticed by the young user. The robot's perception needs to handle audio and video stream captured from onboard cameras and microphones and needs to return a high-level interpretation of gestures, expressions and various other social markers. Most existing algorithms work on carefully collected datasets, the challenge here is to adapt these to function on audiovisual streams captured by a small robot, thereby having a very different viewpoint than typical training databases, operating in a real-world environment.

The robots will learn online through unstructured interactions in dynamic environments and a number of different machine learning approaches will be integrated to facilitate this functionality. This requires that robots should have the

Aldebaran Nao robot.

capacity to store and recall experiences, to learn from them and to adapt their social behaviour on the basis of their previous experiences. A distributed "switch board" model, in which memory provides the substrate through which other cognitive modalities interact, will be used to provide socially coherent, long-term patterns of behaviour.

To orchestrate the robot's behaviour we rely on URBI by Gostai, which serves as a middleware and as a common language for the different partners in the project. As all processing is computationally expensive, much of it will be off-loaded from the robot. For this we rely on Gostai's cloud computing solution, GostaiNet, where URBI transparently calls code on remote servers, effectively using the robot as an input/output device, with computation and storage being remote. The computer on the robot only runs reactive and time-critical code, any other expensive processes - for example ASR, NLP or vision - are passed to the cloud.

ALIZ-E will use Aldebaran Nao robots as an implementation platform. The Nao being a small, autonomous, humanoid robot to which children respond very well. The project, coordinated by the University of Plymouth, involves a consortium of seven academic partners further comprising the Vrije Universiteit Brussel (Belgium), the Deutsches Forschungzentrum für Künstliche Intelligenz (Germany), Imperial College (UK), the University of Hertfordshire (UK), the National Research Council - Padova (Italy) and the Netherlands Organization for Applied Scientific Research (The Netherlands) plus commercial partners Gostai (France) and Fondazione Centro San Raffaele del Monte Tabor (Italy). Funded under the European Commission 7th Framework Programme the ALIZ-E project began in April 2010 and will run for a total of four and a half years.

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R3-COP - Resilient Reasoning Robotic Co-operating Systems

by Wolfgang Herzner and Erwin Schoitsch

The ARTEMIS-project R3-COP will provide European industry with new leading-edge methodology and technologies to enable production of advanced robust and safe cognitive, reasoning autonomous and co-operative robotic systems at reduced cost in terms of time and money in different application domains. It will establish an environment for their design, development, assessment and validation and develop a high-performance and fault-tolerant processing platform. R3-COP is the first ARTEMIS project addressing this area.

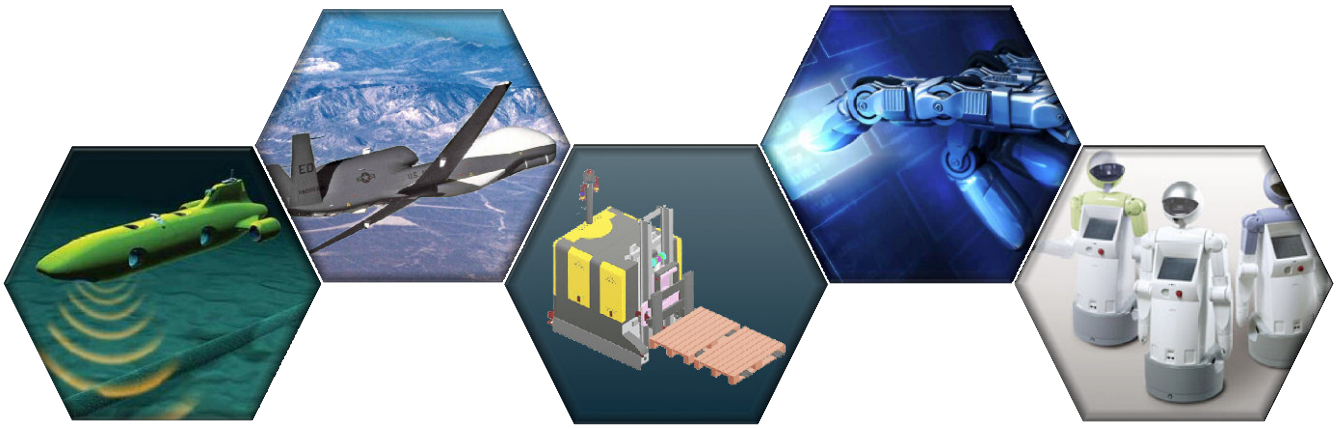
The project is a joint effort of about 35 partners from industry and research, from 12 countries all over Europe, comprising about 1,800 person months at a cost of €18.3 million. Its planned duration is three years (1st May 2010 – 30th April 2013).

Safe and robust autonomous systems are one of the key tangible manifestations of embedded systems simply because the application domains are so diverse, from rescue over industrial automation to home care and entertainment. Such systems increasingly share space, and even cooperate closely, with humans, so an urgent need exists to assert and guarantee their dependability, especially in terms of safety and robustness.

The major goals of R3-COP are to overcome this fragmentation of the market, to reduce the cost of system design and development considerably by facilitating composability and reducing re-validation and re-certification effort. R3-COP aims at cross-domain reuse of components and creation of a generic framework of tools and methods for specific reference platform instantiations, being thus in-line with the ARTEMIS ("Advanced Research and Technology in Embedded Intelligence and Systems") strategy. ARTEMIS-IA is an industry-driven European Technology Platform with more than 200 members from large corporations, SMEs and research organizations. The ARTEMIS Joint Undertaking is a PPP (Public-Private Partnership) of ARTEMIS-IA, the EC and the ARTEMIS member states. It is a Joint Technology Initiative (JTI), a new mechanism within the 7th Framework Programme. ARTEMIS develops its own industry-driven work programme with annual updates and an open call each year. Whereas the Framework Programmes aims at more long- and mid-term research, ARTEMIS targets research results closer to the market (timeline to market 3-5 years). R3-COP is one of the 13 projects selected in the 2nd Call (2009).

R3-COP is also in-line with the European Robotics SRA (Strategic Research Agenda), covering the general embedded systems technologies, system architecture, software and system engineering tools, validation and verification, safety, planning, modelling and communication,

Today, a large number of different approaches and platforms exist, rendering an economic realization of such systems currently unrealistic (except in the manufacturing domain, where robots are already industrially exploited). Simultaneously, as such systems increasingly share space – and even closely cooperate – with humans, there is an urgent need for providing every possible means and measures to assert and guarantee their dependability, in particular safety and robustness. R3-COP will progress autonomous systems



Multi-domain coverage of R3-COP technology (underwater, ground-based, airborne, manufacturing, home appliances).

in two directions: technology and methodology. The following obstacles and open issues hampering the broad and economic application of autonomous robotic systems in new, demanding domains and applications are addressed by R3-COP:

- lack of a uniform platform that would provide a flexible framework to integrate components from various technology providers
- lack of appropriate verification and testing means for autonomous systems with complex behaviour in realistic environments
- the current robotic systems lack a "broader" sense to understand the environment and sufficient reasoning capabilities
- unavailability of high-performance computational embedded platforms
- unavailability of integrated components for advanced image recognition/processing and other perception/recognition/reasoning capabilities.

As mentioned, R3-COP will progress autonomous systems in two directions: technology and methodology.

- *Technology:* R3-COP will develop a fault-tolerant high-performance processing platform, based on a multi-core architecture, as well as innovative system components for robust perception of the environment including sensor fusion, and for reasoning and reliable action control, communication, positioning and navigation, and mission planning.

- *Methodology:* a methodology-based development framework with an underlying knowledge base will enable economic development of reference platforms for various robotic applications as well as dedicated solutions. A tool platform will allow for guarded application of the design methodology, including new test strategies and V&V tools especially suited to test autonomous systems for suitability and safety when to be applied in complex real-world environments.

A common architectural approach (framework), the development of a high performance extendable processing platform and of innovative system components for advanced perception and sensing, together with the methodologies for advanced validation and verification as prerequisite for certification will meet the objectives of the ARTEMIS 2009 Call, namely to:

- Reduce the cost of system design from 2005 levels by 15% by 2013 (R3-COP expects at least 20% while at the same time enabling faster time-to-market).
- Achieve 15% reduction in development cycles, especially in sectors requiring qualification or certification by 2013.
- Manage a complexity increase of 25% with 10% effort reduction by 2013, by composition of domain/application specific systems from a knowledge-base of components, methods and tools (embedded HW, sensors, perception).
- Reduce re-validation and re-certification effort and time by 15% by 2013.
- Achieve cross-sectoral reusability, by developing and implementing a rather generic framework and platform with domain-specific instantiation, and use of multi-purpose computing platform.

The outcomes will be applied in a series of demonstrators from ground-based (industrial (co-operating fork lift, manufacturing) and domestic (intelligent home-cleaning module, domestic indoor and outdoor robot platform), airborne (co-operating with unmanned ground-based systems) and underwater domains (co-operation among autonomous and/or remote-controlled vehicles).

Links:

http://www.ida.ing.tu-bs.de/en/research/projects/r3_cop/
http://svn.inf-ra.uni-jena.de/trac/r3-cop
https://www.artemis-ju.eu/projects
https://www.artemis-ju.eu/project_news
http://www.ait.ac.at/departments/safety-security/?L=1

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AIsoy 1: A Robot that Perceives, Feels and Makes Decisions

by D. García, C. Pallardó, D.Ríos Insua and R. Moreno, A. Redchuk

We have recently developed AIsoy 1, a robot that is capable of inferring the current state of its environment and what its user is doing, through voice, vision and a system of sensors. As a consequence, it modifies its emotional state and makes decisions aimed at attaining its objectives. With numerous functionalities, AIsoy 1 is a social emotional bot with enormous potentiality as an edutainment tool, as a cognitive personal assistant and as a therapeutic means.

Affective computing and affective decision-making constitute two areas of growing interest in relation to intelligent and cognitive systems. One of their key applications refers to the development of bots which are capable of interacting intelligently and emotionally with their users and other bots. They are mainly used for education and entertainment purposes.

With such a background, we have developed AIsoy 1, a social emotional robot that perceives the environment surrounding it and the actions performed by its users. As a consequence, it will modify its emotional state and make decisions. AIsoy 1 has emerged as a result of a project from AIsoy Robotics, with the cooperation of researchers from the Rey Juan Carlos University, and supported by the Spanish CDTI.

At the core of AIsoy 1, there is a decision analytic model which guides the robot's decision making. It is based on a built-in multiobjective utility function which takes into account as objectives, in order of importance: the bot's own safety, the bot's energy level, how nicely its user is treating it, its own entertainment and its requirement to be properly updated. These have a clear reminiscence of Maslow's hierarchy of needs. It also maintains several learning and forecasting models which allow it to forecast how the user will react and the environment will evolve, given the bot's potential action, and the recent past history of user's actions and environmental states. These forecasting models are then mixed. They are combined with the utility function to approximate the expected utilities of various actions. The alternative is chosen randomly with probabilities proportional to the expected utilities. This increases unpredictability of the bot's choices under similar circumstances. The bot's actions include Talk, Sing, Tell a joke, Do nothing or Ask to be charged, among others. This decision making mechanism will be fired synchronously unless an exception happens, in which case the bot has built in reactive rules.

Emotions play a central role in AIsoy 1's artificial life. We have opted for an emotional model which uses basic emotions (such as happy, sad, angry) and mixes them to provide more complex emotions. The evolution of emotions takes into account the values, expectations and built in standards within our bot, as well as previous emotions. They influence forecasts and utility evaluations and, thus, influence the decisions made. Emotions are shown through the expression of our bot (given its ability to move its neck, eyebrows and eyelids, and illuminate its mouth, which includes seventy minileds facilitating the display of numbers, letters and signs) and the colour of its chest. Emotions are expressed also through our bot's voice pitch, speed and volume.

AIsoy 1 robot.

The voice interface is a very powerful component of AIsoy 1. It includes an ASR based on a BNF grammar which helps in identifying the conversation topic. Then, it deduces appropriate responses with a dialogue manager and, finally, through a TTS, it synthesises the required sentences. This scheme aids AIsoy 1 in maintaining a reasonably intelligent conversation with a user. It also facilitates user recognition through voice. Currently, AIsoy 1 only speaks and understands Spanish, but English and Catalan versions will soon be available. AIsoy 1 also incorporates a powerful visual recognition system that facilitates face detection, user recognition, object tracking and character recognition, thus permitting reading in a sufficiently stable environment.

AIsoy 1 is based on an ARM Cortex-A8 microprocessor, with our own operating system AIROS, based on LINUX. It includes sensors for temperature, inclination, touch, light and strength. It has an integrated camera as well as an integrated audio system. It may communicate with other AIsoy 1 bots through a private radio protocol.

The built in functionalities permits AIsoy 1 to be described as a revolutionary edutainment bot, which may serve as a cognitive personal assistant, may be used with kids for educational, recreational and therapeutic uses and with elderly people for companion purposes. It facilitates also communication through social networks like Facebook or Twitter.

AIsoy 1 is available at the AIsoy web page. Several videos of AIsoy 1 in action may be seen in YouTube.

Links:
http://www.aisoy.es/
http://www.estamoscreandovida.com/
http://www.youtube.com/watch?v=No7MqxUONRs

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Long-term Evaluation of a Mobile Remote Presence Robot for the Elderly

by Amedeo Cesta, Gabriella Cortellessa, Lorenza Tiberio

We are currently working on a project, named ExCITE, the goal of which is to intensively evaluate a tele-presence robot against a wide spectrum of requirements of the elderly. This work is at the intersection of two emerging fields, Human-Robot Interaction (HRI) and Ambient Assisted Living (AAL), and involves both long term and cross-cultural user evaluation.

The Planning and Scheduling Team (PST) at the Institute for Cognitive Science and Technology (ISTC-CNR) is currently working within an AAL project called ExCITE whose goal is to adapt an existing tele-presence robotic platform to support the participation of elderly people in social life. The sense of isolation associated with increasing age is a very relevant issue for the elderly. Retirement, living far from family members and reduced physical ability may limit their ability to be socially engaged, which in turn may augment the risk of occurrence of cognitive deficits. The challenge of ExCITE is to carry out a set of fielded experiments with the elderly in their living environment, exploring the ability of the robot to reduce the sense of social isolation by bridging distances, facilitating interaction and communication.

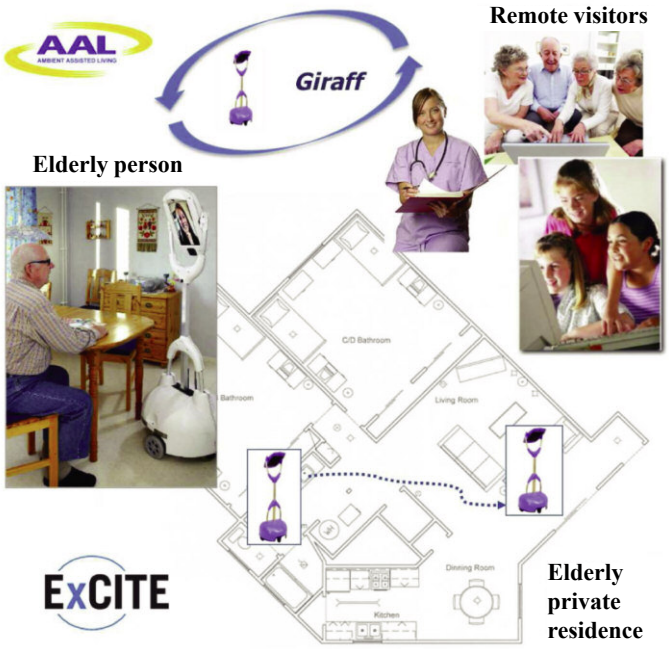
The project reference platform is the mobile presence robot Giraff. The robot is a remotely controlled mobile, physical avatar, of human-height, integrated with a videoconferencing system (including a camera, display, speaker and microphone). Giraff is accessed and controlled via a standard computer/laptop over the Internet, using an application, called "the pilot", downloadable for free. From a remote location, a person with quite limited computer training can "visit" a home and intuitively navigate Giraff in the environment.

ExCITE aims to allow the elderly to remain in their home environments, enabling loved ones and caregivers to maintain a higher level of communication and interaction with them. A number of individual, personal health and lifestyle factors may influence perceptions, expectations and acceptance of the Giraff robot. From the HRI point of view, ExCITE addresses a very difficult challenge: the challenge of moving laboratory experiments to real life settings involving real people. Most of the known experimental results have been either video-based or obtained in restricted and controlled laboratory settings. In contrast, Giraff, with its ease of use and technical robustness, makes possible a long-term fielded evaluation, unusual in robotic research. This scenario highlights an almost unique perspective offered by the project, but also underscores the potential difficulties that may be encountered given the high variability of experimental settings and the possible risk of technology abandonment after a first period of curiosity driven utilization.

We are responsible for the design and implementation of the field tests. We have selected qualitative and quantitative research techniques for the assessment of attitudes and individual perceptions of Giraff. The aim of the evaluation is twofold: to measure the usability of the interface from the pilot side, and also to assess acceptance, improvement of social isolation/loneliness, perceived usefulness, and engagement by the end-user.

Two different scenarios have been chosen as test cases in Italy: (i) a private home and (ii) a rehabilitation centre. In the first case, the Giraff is being placed in an elderly woman's house for several months in order to assess its impact on daily routine in terms of improvement of social isolation/loneliness. The lady has a reduced mobility capability, lives with a caregiver and spends much of her time at home receiving weekly visits from her only daughter who lives in the same city. The woman has two other sons who live far away and Giraff would offer the possibility of increasing the frequency of contact with them through "virtual visits".

The aim of the second test case is to validate the use of the Giraff robot as a tool for cognitive rehabilitation. This scenario poses even more challenging prob-



Giraff allows remote visitors (healthcare professionals and/or relatives and friends) to visit end-users in their living environment thus contributing to maintain social relationships and enabling home assistance to frail older adults.

lems. For instance, before assessing the use of Giraff as a device for "remote cognitive rehabilitation" a preliminary assessment is needed in order to understand how patients with cognitive impairments feel about their interactions with the robot ("Are they scared? Would they accept it"?). The main objective of the clinical trial is to observe patient's physiological stress response during interaction with the robot.

The ExCITE partners come from Italy, Spain and Sweden: Örebro University (coordinator), University of Malaga and CNR (research centres), Giraff AB (the robot manufacturers), RatioConsulta SpA (a software company), and the Örebro City Council as end-user representative. An additional project goal is to analyse the cross-cultural aspects involved in the use of this technology.

Links:
http://www.excite-project.eu
http://pst.istc.cnr.it
http://www.giraff.org

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Designing an Air to Ground Robot Team using Agent-based Technology

by Cai Luo and Alessandro De Gloria

Robot team work is typically a collaborative activity. Organising a robot team to undertake a search and rescue mission is an important and complex task. Agent-based technology provides a solution. We present preliminary work aimed at developing distribution strategies for a robot team using an agent-based model (ABM).

In urban environments, the deployment of multi-robot teams can be a challenge because communication between ground robots is difficult and GPS measurements may be unavailable. We believe that the cooperation of air and ground robot teams can provide better results in such situations. This is one of the reasons why robot collaboration is an exciting research topic and the distributed control of a group of robots has been the focus of much recent research. These robots can interact or cooperate through a communication network to accomplish certain complex tasks or sets of tasks. They can be considered as the extension of a person's sense organs, such as their ears, eyes, or hands.

We present current work at the ELIOS Lab, Dept. of Biophysical and Electronic Engineering, University of Genoa aimed at deploying agent-based technology when developing air to ground robot distribution strategies. We are testing our system by simulating a search and rescue mission. For our ground-robot, we use two LEGO mindstorms NXT (Figure 1). The NXT bricks have a 64KB RAM main processor and a co-processor with 512 Byte RAM. NXT bricks come with multiple sensors, for example, touch, light, colour, compass and ultrasonic sensors. We design special NXT robots for different tasks which means our NXT robots are built on the basis of the role they play in the mission. This plasticity can increase our effectiveness in the tasks.

Figure 1: Lego mindstorms NXT.

For the air-robot, we use a quadrotor helicopter(Figure 2) equipped with multiple sensors: one front camera with 15 fps video frequency, one vertical camera with 60 fps video frequency and an embedded computer with 468MHz processor.

Figure 2: Quadrotor helicopter.

The reasons why we chose the quadrotors are:

1. Simple design and low maintenance time. Unlike normal helicopters, quadrotors do not need mechanical linkages to verify the rotor blade pitch angle.
2. Smaller rotor diameter. Requires less kinetic energy stored during flight.
3. High manoeuvrability. Owing to their small size, quadrotors can easily fly indoors and outdoors.

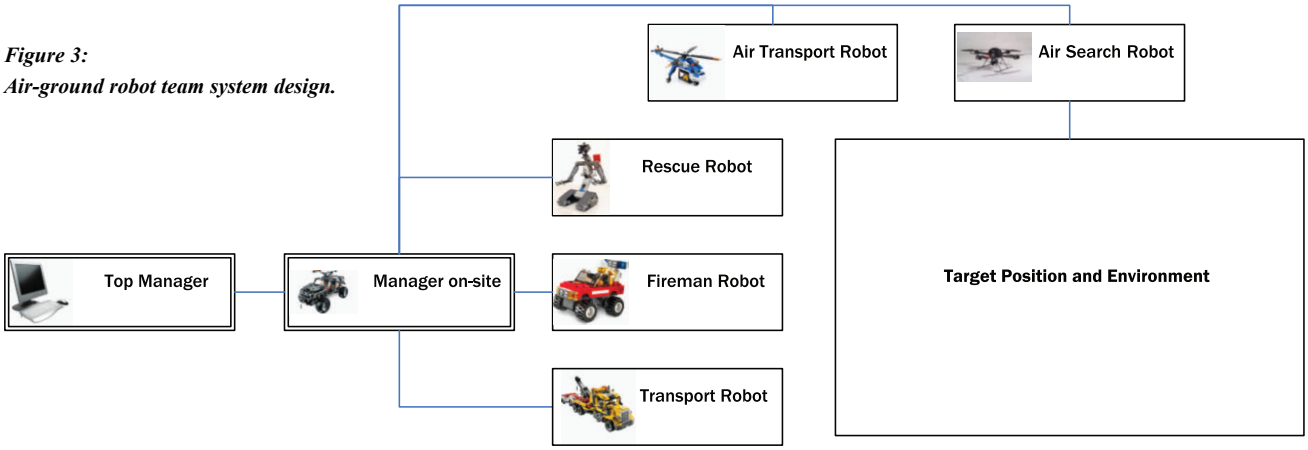

Figure 3:
Air-ground robot team system design.

The reason why we chose to use an air-ground robot team is because both micro aerial vehicles (MAVs) and micro ground vehicles (MGVs) are limited in their ability to search and transport objects or complete complex missions. The payload of MAVs is relatively small and they have difficulty in transporting objects; the speed of MGVs is relatively slow for performing rescue missions. We overcome this limitation by using the cooperation between the MAVs and MGVs, ie we use the speed of the MAVs and the payload of the MGVs to accomplish the tasks in our system (Figure 3). In order to make the system robust against robot failure, the robots will backup the data by using a broadcast protocol to send it to the on-site manager, a ground station with more powerful processors.

A mission runs as follows: First, the MAVs will be sent out to search for the objects. They will send the path information back to the manager on-site. This information will be useful to plan the paths of later missions. Meanwhile the processor on the MAVs will compute the path for collision avoidance with other objects or other MAVs. After finding a suspect object, the MAVs will make the first check based on its colour and shape. The manager will confirm the object on the basis of the images and data sent back by the MAVs and decide which MGVs should then be sent out. Similarly, the MGVs will proceed to the objects, sending the path information back to the base and avoiding potential collisions. On arrival at the location of the object, the MGVs will complete the task using their agent-based design. All the information and data will then be sent to a top manager by the on-site manager. The top manager can change decisions taken by the on-site manager if necessary.

Future research will be in two main directions. First, we want to enrich our set of ground and aerial robots. The actual five robots are too few to allow the team to split into sub-teams for the accomplishment of more difficult tasks. Furthermore, we want to develop a web protocol in order to let the top manager control more than one on-site manager in different locations.

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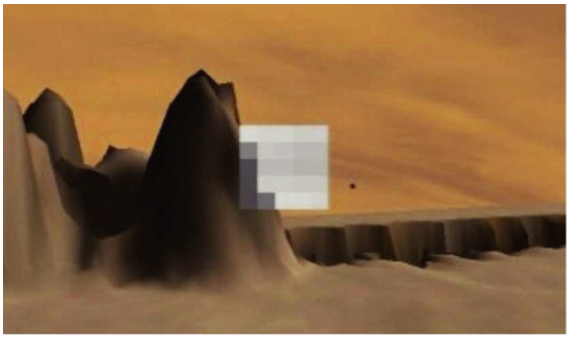
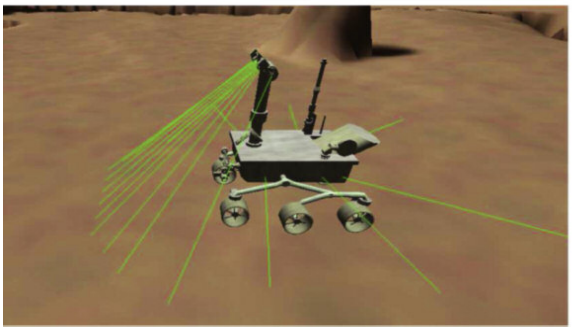
Evolving Autonomous Mars Rovers

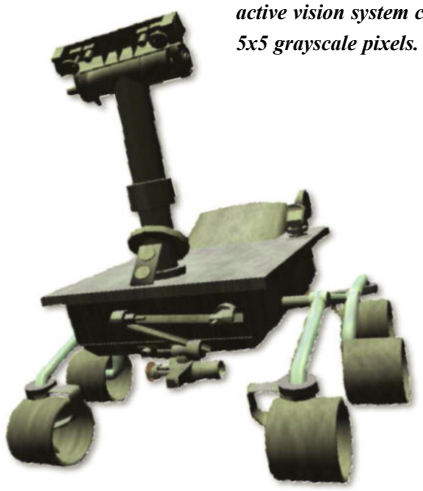
by Angelo Cangelosi, Christos Ampatzis and Dario Izzo

The innovative contribution of this collaborative project between the University of Plymouth Robotics groups and the ESA Advanced Concepts Team was to successfully test the hypothesis that the island model paradigm permits the autonomous design of complex controllers for Mars rover robots, for navigation and active vision strategies, thus overcoming some of the current limitations of evolutionary robotics.

The Centre for Robotics and Neural Systems of the University of Plymouth (CRNS-Plymouth) and the Advanced Concepts Team of the European Space Agency ESTEC laboratories in Nordwijk (ACT-ESA) have joined forces in an innovative project on evolutionary robotics techniques applied to a Mars Rover. The scientific and technological rationale of this project was to integrate the methodological approach and expertise on evolutionary robotics and cognitive robotics of the CRNS-Plymouth team with the island evolution approach developed at ACT-ESA. The main aim was to demonstrate how such an integrated system enhances the automatic design of robust controllers for Rovers' navigation tasks, including application to a complex problem demanding the integration of basic sensory capabilities with active vision. This project was funded by the ESA Ariadna programme, and was carried out between October 2009 and July 2010. The staff involved in the project were Angelo Cangelosi, Davide Marocco, Martin Peniak and Barry Bentley, from CRNS-Plymouth, and Christos Ampatzis, Dario Izzo and Francesco Biscani, from ESA-ACT.







3D physics model of the rover (right), the position and orientation of the camera and infrared sensors (bottom-left) and fovea of the active vision system consisting of a matrix of 5x5 grayscale pixels.

Evolutionary Robotics promises the automatic design of neuro-controller for autonomous robots, but it barely copes with increasing task complexity, failing to deliver good solutions in a reasonable time. The innovative focus of this project was to test the hypothesis that the "island model" paradigm can complement evolutionary robotics techniques allowing for the design of complex robot controllers, thus overcoming some of the current limitations of these techniques. The island model is based on the theory of punctuated equilibria, and corresponds to a coarse-grained parallelization approach to genetic algorithms. Initially isolated populations, while evolving in parallel, exchange genetic material at a certain rate through migration of individuals (genotype), thus interacting with each other. As a result, not only do populations evolve faster, but their final performance is also improved.

To proceed with the above outlined experimentation, a new software tool integrating the island evolution model (PaGMO libraries – an open source software platform for Parallel Global Multiobjective Optimization) with the physics simulator model of the rover was designed. Three sets of simulation experiments were then carried during the project. The first was a benchmark comparisons study between island versus standard genetic algorithm experiments for an autonomous navigation task. The second study systematically varied the type and properties of the environment and navigation tasks to test the robustness of solutions evolved. In the third set of experiments, a complex navigation task based on active vision was investigated. Active vision experiments involved a simple camera whose directionality and focus the robot can actively control, and focussed on the integration of sensing of both local information (eg perception of sand/icy/standard ground surfaces through infrared sensors) and distal landmark information (active and autonomous control of the robot camera to identify relevant features).

This project led to a series of methodological and scientific results. One contribution was the extension and integration of the Mars Rover Simulator with the PaGMO library for the development and dissemination of an open source application on robotic island experiments. The study demonstrated the robustness/efficiency of the island approach to evolve controllers for autonomous rover navigation. Comparisons between island model and single population model on different tasks show the island model's performance to be statistically better, producing improved results in terms of computational performance (island model is faster) and quality of the evolved controllers. This is an important step towards obtaining a functional and reliable tool to automatically generate intelligent controllers. The active vision experiments also show the feasibility of the proposed methodological approach for complex tasks and controllers. Evolved solution for active vision experiments led to robot's neural controllers that autonomously orientate the robot's camera to identify distal landmarks and local obstacles.

The results obtained in this study, and the methodological advances through the PaGMO/Rover simulator software tool, have the potential to lead to promising new research developments. One of the first directions of future work might regard the adaptation and testing of the autonomous navigation methodology to the physical rover robot platform. Further experiments on the active vision setup can lead to the design of autonomous navigation to a goal complemented with intelligent obstacle avoidance behaviour.

Links:
http://www.esa.int/gsp/ACT/ai/op/roboticislands.html

http://sourceforge.net/projects/marsroversim/

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Next Generation Bio-inspired Vision

by Christoph Posch

At AIT, the Austrian Institute of Technology, we have developed the next generation of biomimetic, frame-free vision and image sensors. Based on the seminal research on neuromorphic electronics at CalTech in the 1990's and further developed in collaboration with the Institute of Neuroinformatics at the ETH Zürich, ATIS is the first optical sensor to combine several functionalities of the biological 'where'- and 'what'-systems of the human visual system. Following its biological role model, this sensor processes the visual information in a massively parallel fashion using energy-efficient, asynchronous event-driven methods.

Neuromorphic Systems

Biological sensory and information processing systems still outperform the most powerful computers in routine functions involving perception, sensing and motor control, and are, most strikingly, orders of magnitude more energy-efficient. The reasons for the superior performance of biological systems are still only partly understood, but it is apparent that the hardware architecture and the style of computation in nervous systems are fundamentally different from those applied in artificial synchronous information processing.

In the late 1980s it was demonstrated that modern semiconductor VLSI technology is able to implement electrical circuits that mimic biological neural functions and allow the construction of neuromorphic systems, which – like the biological systems they model – process information using energy-efficient, asynchronous, event-driven methods. The greatest successes of neuromorphic systems to date have been in the emulation of peripheral sensory transduction, most notably in vision.

Learning from Nature

Conventional image sensors acquire the visual information time-quantized at a predetermined frame rate. Each frame carries the information from all pixels, regardless of whether or not this information has changed since the last frame had been acquired. If future artificial vision systems are to succeed in demanding applications such as autonomous robot navigation, high-speed motor control and visual feedback loops, they must exploit the power of the asynchronous, frame-free, biomimetic approach. This means leaving behind the unnatural limitation of frames: Systems must be driven and controlled by events happening within the scene in view, and not by artificially created timing and control signals that have no relation whatsoever to the source of the visual information: the world. Translating the frameless paradigm of biological vision to artificial imaging systems implies that control over visual information acquisition is no longer being imposed externally to an array of pixels but the decision making is transferred to the single pixel that handles its own information individually. The notion of a frame has completely disappeared and is replaced by a spatio-temporal volume of luminance-driven, asynchronous events.

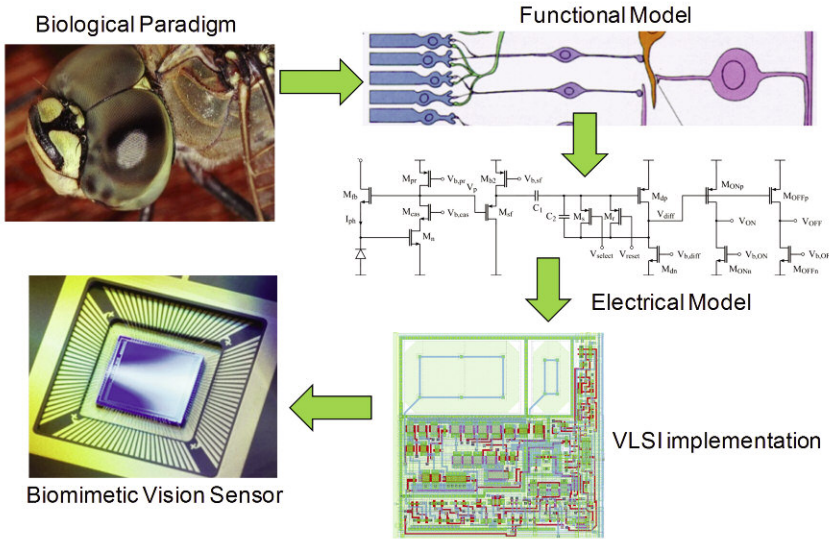

Figure 1. Biology guides vision and image sensor development.

In studying biological vision, it has been discovered that there exist two types of retina-brain pathways in the human visual system: The transient Magno-cellular pathway and the sustained Parvo-cellular pathway. The Magno-system is sensitive to changes and movements. Its biological role is demonstrated for instance, by our ability to detect dangers that arise in the peripheral vision. It is referred to as the "where" system. Once an object is detected, the detailed visual information (spatial details, color, etc.) seems to be carried primarily by the Parvo-system which is known as the "what" system. Practically all conventional image sensors can be attributed to the "what" system side; they completely neglect the dynamic information provided by the natural scene and perceived in nature by the 'where'-system.

Biomimetic Vision Sensors

Modelling of the Magno-cellular pathway has recently led to the first generation of real-world deployable biomimetic, asynchronous vision devices, known as 'dynamic vision sensor' (DVS), which respond autonomously to temporal contrast in the scene. Computer vision systems based on these sensors already show remarkable performance in various applications.

Taking further inspiration from the fundamental concepts of biological vision, it is clear that a combination of the 'where' and 'what'-system functionalities could have the potential to open up a whole new level of sensor functionality and performance, and inspire new approaches to image data processing. A first step towards this goal is ATIS

Figure 2. Temporal contrast change events, change-triggered exposure data starting from an empty image, and continuous-time video stream. The event-based video contains the same information as standard frame-based video at data rates reduced by orders of magnitude.

(Asynchronous, Time-based Image Sensor), the first visual sensor that combines functionalities of the biological 'where' and 'what' systems by employing multiple bio-inspired approaches like pulse modulation imaging, temporal contrast dynamic vision and asynchronous, 'spike'-based neural information encoding and data communication.

In each ATIS pixel, a change detector initiates a pixel-individual exposure, the measurement of a new illumination value, only after a change has been detected in the field of view of the respective pixel. Such a pixel independently and asynchronously requests output bandwidth only when it has a new illumination value to communicate. In addition, the asynchronous operation avoids the time quantization of frame-based acquisition. In standard terms, this operation principle results in highly efficient video compression through temporal redundancy suppression at the focal-plane while the asynchronous, time-based exposure encoding yields exceptional dynamic range, improved signal-to-noise ratio and high temporal resolution.

The target applications for this device include high-speed dynamic machine vision systems that take advantage of the real-time change information and frame-free continuous-time image data, as well as low-data rate video as required for instance, by wireless or TCP based applications. Wide dynamic range, high quality, high-temporal resolution, imaging and video for scientific tasks are at the other end of the application spectrum.

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Bioinspired Robot Homing using ALV and Visual Features

by Arnau Ramisa, Alex Goldhoorn, David Aldavert, Ricardo Toledo and Ramon Lopez de Mantaras

There is significant research in robotic navigation using methods based on animal navigation techniques. For example, some work has drawn inspiration from biological studies of the navigation techniques of the ant species Cataglyphis. The main advantage of such techniques is that they use simple sensors and are also computationally simple, which makes them applicable to inexpensive robots.

The Average Landmark Vector (ALV) has been suggested as a way to model animal navigation techniques. This model assumes that the animal stores an average landmark vector of a place, where landmarks can be (simple) features like edges. The direction to the destination is then the difference of the ALV at the destination and the ALV at the current location.

This approach has been investigated in robot homing research, but mainly using artificial landmarks as features. This is a strong limitation, as it requires setting up the environment beforehand. Instead, in our work the goal is to create a simple homing method that can be used without having to rely on artificial landmarks. For this we propose the combination of the ALV homing technique with visual invariant feature detectors. This project is funded by the Generalitat de Catalunya's support to groups of excellence, referenced under number 2009-SGR-1434.

Local visual invariant features can be points or regions of an image which correspond to a local extrema function over it. The main interest of these features is that they are detectable under several transformations and illumination changes, which makes them suitable for the purpose of matching and recognition. Moreover, representations made with such local features are robust to partial occlusions and background clutter. Finally, extracting local features from an image reduces the dimensionality of the data to handle and adds robustness against noise, aliasing and acquisition conditions.

From the multiple local feature detection techniques available in the literature, we have used the Maximally Stable Extremal Regions (MSER) and

Differences of Gaussians (DoG) visual invariant feature detectors for the homing method. These local feature points possess qualities which make them interesting for the ALV. One advantage is that they are fast to compute (and even faster hardware-based approaches are being built) and yet robust, and another is that many high-level processes are based on information from these interesting regions.

Experiments with the ALV homing method were first done in simulation and because the results were promising, experiments were conducted using a real robot in an office environment, namely in three different rooms at the IIIA research centre. Additionally, experiments with artificial landmarks were done for comparison purposes.

One important prerequisite of the ALV is that it is necessary to have the panoramic images aligned to an external compass reference before computing the homing direction. As a way to solve the constant orientation prerequisite, in our work all test panoramic images have been acquired with the robot facing a constant direction, as is common practice in similar works. In order to apply the ALV method in a navigation experiment, a magnetic compass, or another system to acquire the global orientation, is required to align the panoramas.

The locations at which the robot acquired the panoramas were measured manually and used to calculate the ground truth homing directions, which were then used to verify the homing method results. The panoramas were created with the camera on a pan tilt unit which rotates around a fixed point to get images from all directions. Next, these images were combined to create the final panorama. Feature points from these images were extracted to be used by the homing method, and only the horizontal location of the feature points was used (ie the cylindrical angle, and not height, nor depth).

The ALV homing was found to be a good working method, however the method performed worse in rooms where the width and length differ greatly. This has been explained by the way the feature points are projected on the panorama and by the "equal distance assumption".

We have also evaluated the proposed method in the Bielefeld panorama dataset, where omnidirectional images were acquired with a camera pointing to a parabolic mirror. The advantage of creating a panorama like this is the speed of acquisition, in contrast with our initial method where images from several angles had to be retrieved first and then stitched to create a high resolution panorama. Its main drawback is a significantly lower resolution. In order to compare both methods of panorama acquisition, additional experiments using the Bielefeld dataset were conducted.

When comparing the results of IIIA dataset and Bielefeld dataset, we can see that the ALV homing method performs slightly better on the IIIA panoramas, but the difference is not significant. Given these results, it seems favorable to use an omnidirectional camera for ALV, as the speed of acquisition is more relevant than the slightly better performance.

Regarding the feature types, in our experiments MSER significantly outperformed DoG, which is consistent with previous studies which have reported MSER to be one of the most robust feature detectors. In the additional experiments with artificial landmarks, the results were significantly better with the artificial landmarks than with the invariant feature points as was expected, since they are less affected by occlusions and viewpoint changes. However, using the MSER detector only represented an additional error of seven degrees in orientation, which seems low enough to justify the applicability of the presented homing method as it can be used in unprepared environments.

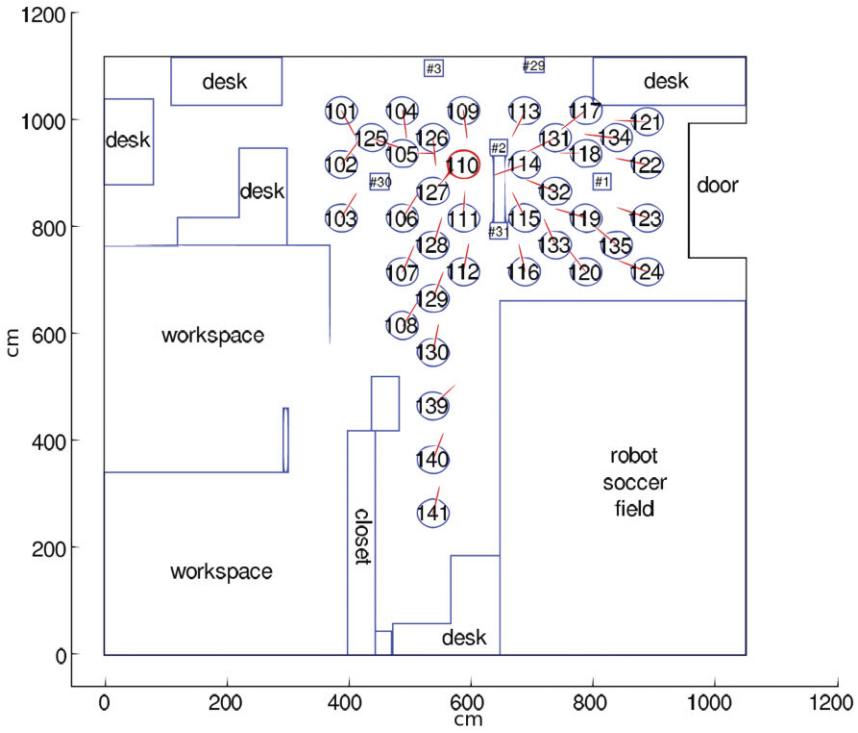

Figure 1: ALV Homing results using MSER visual features.

Links:
Bielefeld panorama database:
http://www.ti.uni-bielefeld.de/html/research/databases/

IIIA ALV panorama database:
http://www.iiia.csic.es/~aramisa/datasets/iiia_alv.html

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Time, Language and Action - A Unified Long-Term Memory Model for Sensory-Motor Chains and Word Schemata

by Fabian Chersi, Marcello Ferro, Giovanni Pezzulo and Vito Pirrelli

Action and language are known to be organized as closely-related brain subsystems. An Italian CNR project implemented a computational neural model where the ability to form chains of goal-directed actions and chains of linguistic units relies on a unified memory architecture obeying the same organizing principles.

Recent advances in cognitive psychology and neuroscience emphasize that action and language are not organized as insulated brain subsystems. Rather, language processing elicits perceptual and motor processes/responses that are tightly coupled with the referents of what is heard or read. Rizzolatti and Arbib (1998) proposed that linguistic abilities developed phylogenetically on top of action control abilities, on the basis of a common brain substrate where the mirror neuron system plays a key role. Accordingly, area F5 of the monkey brain (where mirror neurons are located) is a precursor of human Broca's area (devoted to language processing), and language could have inherited the "grammatical" and combinatorial structure of actions. An Italian CNR project is currently exploring the related hypothesis that the ability to form chains of goal-directed actions (ie, action sequences leading to a distal result) and chains of linguistic units (eg, sequences of phonemes, morphemes or words forming a sentence) may rely on the same neural architecture obeying a common pool of organizing principles.

Motor chains and lexical chains

Fogassi and colleagues (2005) have shown that motor and mirror neurons in the monkey inferior parietal lobule code single motor acts (eg "reaching" or "grasping") belonging to an action sequence and that their discharge reflects the intended goal of the whole action (eg "grasping to eat" versus "grasping to place"). On this empirical basis, it has been hypothesized (Fogassi et al. 2005; Chersi et al. 2005) that this brain area contains highly ordered neural structures, where each goal-directed action sequence is represented by a separate chain of pools of neurons. Elements in one chain are not interchangeable with elements of other chains even if they code the same motor

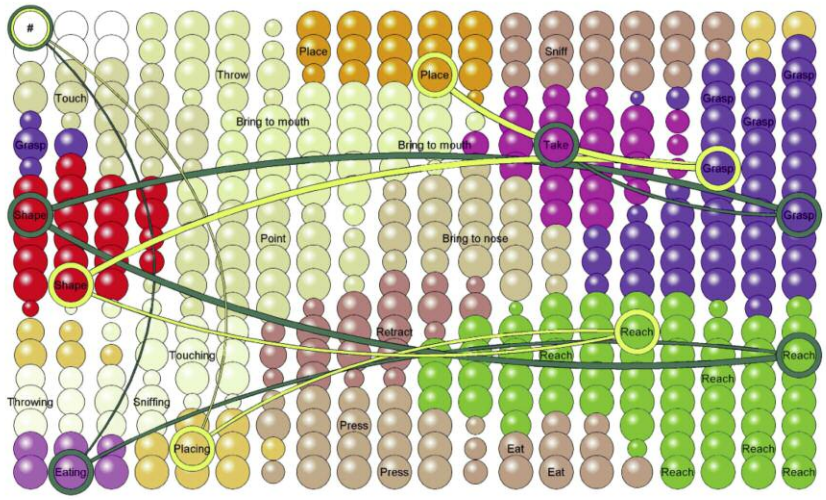

Figure 1: A 400 node T²HSOM trained on sequences of goal-action patterns. Topological clustering is highlighted by colour shades, showing specialization of different areas for different goals (eg "Eating", "Placing", "Throwing" etc., bottom left corner) and actions (eg "Reach", "Shape", "Bring to mouth" etc.). The temporal response of the map for two input patterns (<#, Eating, Reach, Shape, Grasp, Take> and <#, Placing, Reach, Shape, Grasp, Place>) is shown through circles (highlighting BMUs) and clockwise oriented arcs, representing temporal transitions between consecutively-activated BMUs, ie chains of goal-directed actions. The "#" symbol is the "start of sequence" marker.

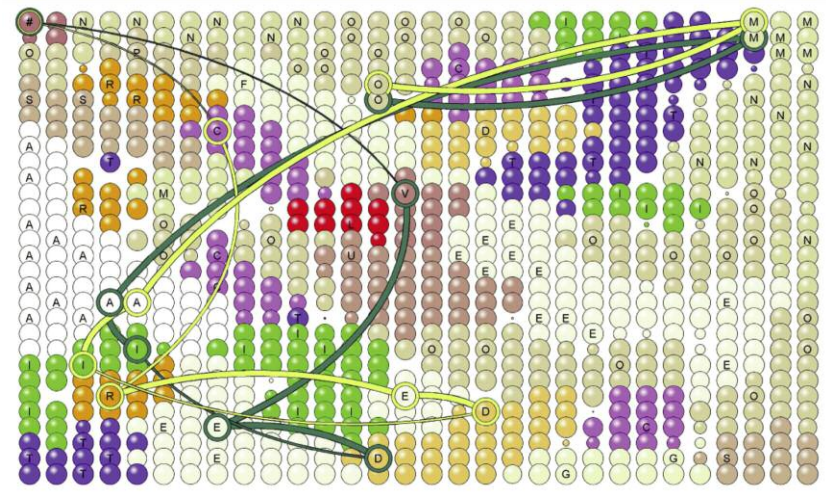

Figure 2: A 900 node T²HSOM trained on Italian verb forms. BMU chains are shown for "vediamo" ("we see") and "crediamo" ("we believe"). Although the two forms share the common ending "-iamo", the fact that the roots "cred-" and "ved-" are different produces the activation of BMU chains independently running through the map at a short topological distance (green and yellow trajectories). The "#" symbol is the "start of sequence" marker. The result shows node sensitivity to morphological structure.

act. Execution and recognition of an action is achieved through the activation of the appropriate chain and thus to the pre-selection of specific neurons.

Results from joint behavioural and functional neuro-imaging studies on the mental lexicon demonstrate the existence of a whole-word level of brain coding (Baayen 2007). Word forms are stored in full, organized into hierarchically-structured chains of sub-lexical units (eg letters or phonological segments), where units in one lexical chain are coded differently from the same units in another lexical chain. Whole-word memory structures account for i) development of dedicated chains of linguistic units, enhancing predictive linguistic behaviour (Ferro et al. 2010); ii) frequency-based competition between inflected forms of a word (eg "bring" and "bringing") (Pirrelli et al., in press); iii) simultaneous activation of false morphological friends (eg "broth" and "brother").

The analogy between action and word memory structures persuaded us to investigate the hypothesis that they can both be served by the same memory mechanisms for serial order, modelled as Topological Temporal Hebbian Self-Organizing Maps (T^2HSOMs, Ferro et al. 2010). T^2HSOMs are time-sensitive SOMs (Kohonen 2002, Koutnik 2007) whose nodes are fully connected through an add-on weighted temporal Hebbian layer. Upon presentation of a stimulus, all map nodes are activated synchronously, with the most highly-activated node (or Best Matching Unit, BMU) winning the competition. Through training, nodes are made more sensitive to particular classes of stimuli occurring in specific spatio-temporal contexts, with inter-node Hebbian connections being attuned to transition probabilities between temporally adjacent stimuli, thus affording predictive processing.

Results and future developments

Figures 1 and 2 illustrate chains of BMUs in two T^2HSOMs activated by action chains and word forms respectively. The effect is achieved with a "predictive drive", making the network maximize prediction accuracy in perception, and effortless memory access of order information in production (note that the same network supports both perception and production). As a result, highly-ordered neural structures emerge as a response to repeated action patterns and word schemata.

Besides unravelling some fundamental mechanisms underlying the processing of time-ordered series, the model shows that apparently unrelated evidence on the neural coding of motor chains and word schemata is accounted for by the dynamic interaction of common principles of topological self-organization and time-bound prediction. This dynamic is key to modelling pervasive aspects of synchronization of multimodal sequences in both linguistic (eg reading) and extra-linguistic (eg visuo-motor coordination) tasks.

Link:
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Challenges for the Design of Intelligent and Multimodal Cognitive Systems

by José Rouillard, Jean-Claude Tarby, Xavier Le Pallec and Raphaël Marvie

With the MINY (Multimodality Is Nice for You!) project, our goal is to propose some novel possibilities to take many modalities of interaction into account. Using a model-driven engineering approach we present some suggestions in order to tackle the challenges around the design of intelligent and multimodal cognitive systems.

Technology's evolution is an unstoppable process. Consider the regular release of new devices such as smart-phones or the multi-touch tabletop: each new version is more powerful and more interconnected than the previous one. Home automation is an example of improved communication: Washing machines can run Android and be remotely driven by a smartphone or computer. While such interaction is easy to implement, most of these systems offer a single modality of interaction: the Wii only support movement based interactions. Games are at the more complex end of the scale, relying on two modalities such as Mouse / Keyboard and voice.

Multimodality is the ability to combine different modalities of interaction (voice, gesture, touch, etc) as input and/or output, such as the historical "Put that there" from Bolt in 1980. Our goal is the design and implementation of intelligent multimodal systems. By intelligent, we mean the ability to make decisions, to request additional information from outside (eg the user or other applications), and to learn (from mistakes, from the user actions, etc).

Our approach is top-down and is very concerned about the heterogeneity of the material covered. It begins with the specification of tasks that the system can achieve. Then we choose the best suited materials to enable the realization of these tasks. This allows code generation supporting the interaction with the system and associated materials (eg X10 home automation, but also smartphones, webcams etc).

To support this top-down approach, we use a model-driven engineering approach (MDE). A first reason for this choice is that we are designing applications for various domains (such as home automation, botany, tourism). While the modalities are always the same, their implementations change from one application to another.

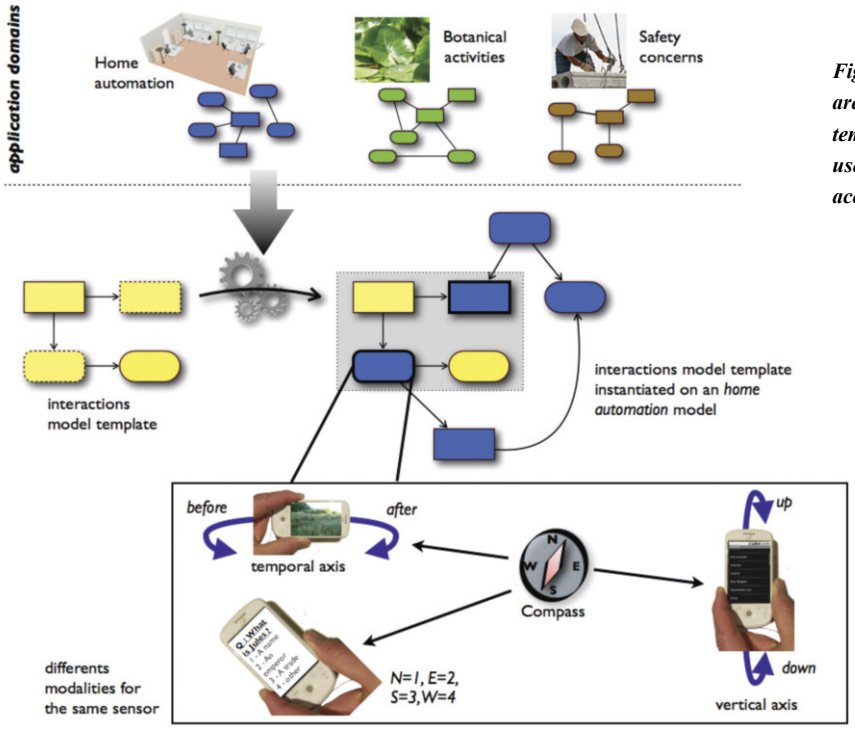

Figure 1: Models of application domains are integrated in an interactions model template. A compass, for example, can be used in different manners (input/output) according to a particular context.

A second reason is that our work addresses both the design and the execution. At the design level, systems should not only be designed by computer experts but also by domain experts such as a botanist. During the execution, end users should be able to adapt their applications to their context of use (and its constraints). A tactile modality, for instance, is not practical when the temperature requires wearing gloves. In this situation one should be able to switch to a vocal modality on the fly.

The MDE approach provides us with interesting tools. Meta-modelling and separation of concerns (or aspects) help support multiple domains while capitalizing recurrent aspects. Model transformation and code generation ease the support of similar modalities for different domains while providing a tailored implementation every time.

We face three major challenges in our research:

1. The modelling of modalities.
This must be done at an abstract level in order to facilitate modelling in different domains. For example, a compass in a smartphone can be seen as many kinds of information sources. As we can see in Figure 1, it can be used:

- as an output, to give a direction to the user
- as an input selector among four positions (North, South, East, West)
- as a chronological switcher (past, present and future, according to movement toward a particular direction)
- as a digital switch (for instance according to a financial budget, from the cheapest to the most expensive, user will visualize the lining of a roof with slate, tile, etc.)
- as a metal detector.

The difficulty lies in modelling these possibilities of interaction, without any application domain in mind.

2. Managing the heterogeneity of the devices and components that can be used in a system.
In the context of MDE, our main proposition is to design systems in an abstract and generic way in order to allow the generation of code (with multimodal capabilities, for instance) according to a particular context. To do so, we use the concept of "model template" in order to dynamically generate some suitable scripts and code software.

3. The intelligence of the system.
In the context of ambient intelligence, for example, it's not easy for supposed cognitive and intelligent systems to detect particular situations or users' behaviours (danger, help or more information needed, etc.). Ideally the system would understand some specific situations, learn during interactions, and offer appropriate suggestions, by making inferences based on elements within the operating context.

Our future work will focus on three issues:

- multimodality composition: How to allow the usage of "synergical" multimodality rather than only "alternate" multimodality ?
- MDE: How to use generic models (template models) in order to support our approach?
- the intelligence and cognitive abilities of the systems.

Since the beginning of the project, we have been using workflow mechanisms for the reasoning base. Currently, we are experimenting with multi-agent systems in order to provide the user with information and decisions based on more flexible, intelligent and autonomous behaviours.

Link:
http://www.lifl.fr/miny/

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DECKT: Epistemic Reasoning for Ambient Intelligence

by Theodore Patkos and Dimitris Plexousakis

The intriguing objective of AI - to create intelligent autonomous agents that exhibit commonsense behavior in the real world - forces research to go beyond many deep-rooted simplistic assumptions and to acknowledge the restrictions and complexity of our surroundings. The nascent field of Ambient Intelligence (AmI), that formulates current trends and challenges in Europe, opens new avenues of research for AI. Intelligent and usable computing devices need to prove their cognitive skills in environments that involve dynamically changing context, where information quickly becomes obsolete as a result of context-dependent occurrences or actions performed by users. Reasoning under partial knowledge is intended to promote run-time decision-making based on knowledge about the effects of events and their ramifications and on causal relationships among different components of the world, even when information about the components is incomplete.

A unifying formal framework providing the substrate on which to devise techniques addressing the aforementioned issues is currently missing. To this end, we have developed DECKT (Discrete Event Calculus Knowledge Theory), a formal framework for automated epistemic, temporal and causal reasoning for dynamic, uncertain and partially known domains. The theory enables the integration of cognitive capabilities to the mental state of reasoning agents by coupling the temporal aspect of knowledge with the causal description of a domain and the actions performed by entities that operate and change it. A multitude of commonsense phenomena can be represented: they range from knowledge about direct effects and complex ramifications of context-dependent actions or physically triggered events, to knowledge-producing actions and loss of knowledge, continuous change, temporary knowledge and delayed knowledge effects.

DECKT adopts a representation for knowledge that does not employ the commonly used possible worlds semantics, which dominate the formal characterization of various manifestations of epistemic concepts. A major impediment is the computationally intensive reasoning required under this semantics which, in effect, is making the task of producing performant practical implementations very difficult. Instead, our theory's efficiency stems from establishing a sound and complete translation of possible worlds into a generic form of implication rules, called hidden causal dependencies, that are treated as ordinary epistemic concepts and are more conveniently axiomatized.

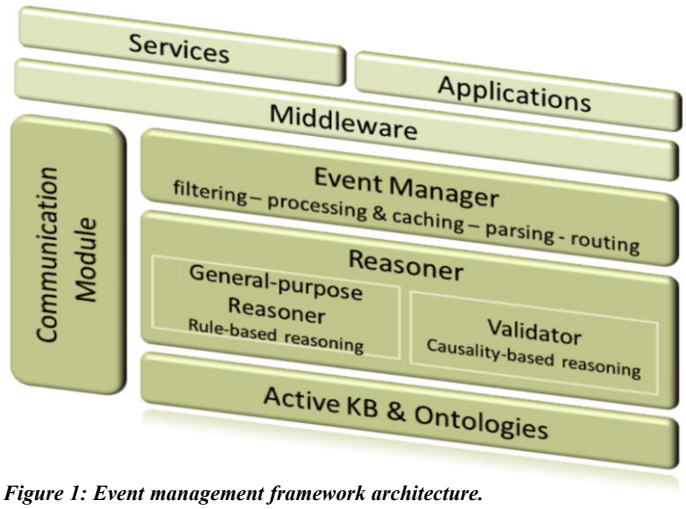

Figure 1: Event management framework architecture.

The approach builds on contemporary progress in the field of cognitive robotics; even so, its application is being tested on different scenarios of commonsense reasoning for AmI. DECKT forms part of a reasoning framework that is being employed in a large-scale AmI-related project conducted at FORTH-ICS. The goal of this project is to provide efficient representation, monitoring and dissemination of any low- or high-level contextual information, as well as to support a number of general-purpose and domain-specific inference tasks for smart devises. The framework couples methodologies from the Semantic Web and the Action Theories domains and deploys the hybrid event-based reasoning architecture shown in Figure 1. Causality-based reasoning and DECKT contribute in verifying that the specifications of the applications that are implemented by different research groups in the project are in compliance with the overall system restrictions, as specified by services, thus detecting errors early at the development phase. In addition to this task that is accomplished in isolation at design-time, action validation, performed at run-time, considers the potentially partially known current state of the system, as well as the conflicts that might arise with other applications that share the same resources.

Furthermore, DECKT is also used to provide reasoning capabilities to mobile and resource-constrained devices that inhabit smart spaces. PDAs, smart phones and other autonomous devices, capable of executing commonsense tasks, constitute the core of the AmI vision, as these devices play a lead role in the realization of domains such as ambient assisted living for the support of individuals with cognitive or physical impairments. For user assistive applications and personal agents hosted on these devices, reasoning under partial knowledge is an essential prerequisite, as such devices experience substantial restrictions not only in storing relevant contextual information, but also in accessing it. DECKT-enabled agents

can promote the execution of different types of tasks:

- they can be instructed to proactively or reactively devise ways to accomplish user objectives that comply with the user's needs, given the specifications of the smart space (planning)
- they may assist users while performing certain tasks and explain the behaviour of the system in response to their actions (postdiction and model finding)
- they can foresee the result of actions by predicting the user's intentions and provide relevant assistance, eg suggestions or warnings (projection).

The agents can take advantage of the facilities of the smart space, i.e., sensors, services and devices, based on certain privacy policies. Nevertheless we should expect that their knowledge about the environment for executing reasoning is neither complete nor constantly updated.

Conclusions

As the emphasis is now placed on supporting humans with problems of everyday life while lessening their cognitive load on dealing with technology, intelligent computing systems need to become more cognitive and usable. DECKT, as a tool for automated epistemic reasoning for a wide range of phenomena, aims to help agents to understand their environment, whilst taking into account their own capabilities and limitations, in order to achieve more accurate commonsense inference.

Links:
FORTH-ICS AmI programme:
http://www.ics.forth.gr/ami/index.html
DECKT implementation:
http://www.csd.uoc.gr/~patkos/deckt.htm

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Comparative Cognition: Animals and Robots

by Vicente Matellán

One of the major scientific contributions of CompCog has been to provide a unified system to collate research methods and results across various animal species, including humans, and also artificial creatures (robots). The systematic collection of data produced by different research groups would enhance the study of social cognition in an operationally comparative way. In the project an on-line video tagging system has been developed. Another contribution has been the use of mobile robots to test the abilities of ethologists.

Cognitive sciences and computer science - artificial intelligence and robotics in particular - have been close related since the appearance of computers. Cross-fertilization between the two fields has been particularly beneficial for robotics, which has gained much from the cognitive sciences. There are many examples of robotic architectures based on cognitive science, starting from the very first robot, The Tortoise, built by Dr Walter in 1949.

On the other hand, robotics has helped cognitive scientists in a much more limited way. Robots have been used to test only a small number of theories, for instance verifying limited effects of joint attention, demonstrating such abilities as gazing at the person who is talking, etc. More recently, work on androids by Prof. Ishiguro has gained much attention, especially in the mass media. Ishiguro claims that contributions from robotics to cognitive science have not been significant because robots to date, have been robot-like, and appearance and behav iour cannot be uncoupled. He hypothesizes that using androids - robots that have an identical appearance to human subjects - will solve this problem.

Nowadays, robotic engineers could program robots to be able to pass any ethologist-designed test relating to visual attention, gaze following, joint attention, etc., providing the details of the test are known in advance. This is what computer scientists have been doing in recent decades. One can find "artificial multitudes" in any movie, which to viewers, are indistinguishable from real actors, artificial characters in any computer game that would pass the Turing test in that domain, even robotics pets that mimic real pets. But these robots are incapable of real "cognition": They are simply programmed to mimic the external behavior of humans, pets, etc.

CompCog is a Research Networking Programme funded by the European Science Foundation, whose full title is "The Evolution of Social Cognition: Comparisons and integration across a wide range of human and non-human animal species". This programme brings together 28 laboratories from eleven countries, and runs for five years from May 2008 to April 2013.

Its general objective is to develop "real" comparative cognition across a wide range of animal species (including humans) with a coherent theoretical background, unified terminology and standard methods, and to make it transparent for and integrated with other fields, like social sciences, genetics, physiology, animal welfare and robotics.

Its goals are also: to assist in training a new generation of researchers who are already endowed with the knowledge and experience that is needed for designing real comparative studies, to establish a unified, user-friendly depository database for the available comparative results, and consequently to make the field more transparent to, and integrated into, the main stream of biological research aimed at understanding the mind at various levels of biological organization ranging from genetics to neuroscience, and to make it accessible and informative to other disciplines such as robotics and social sciences by providing a comprehensive approach.

In the CompCog environment, we think that robotics could help cognitive science, not in testing a particular topic, but in verifying its research methodologies.

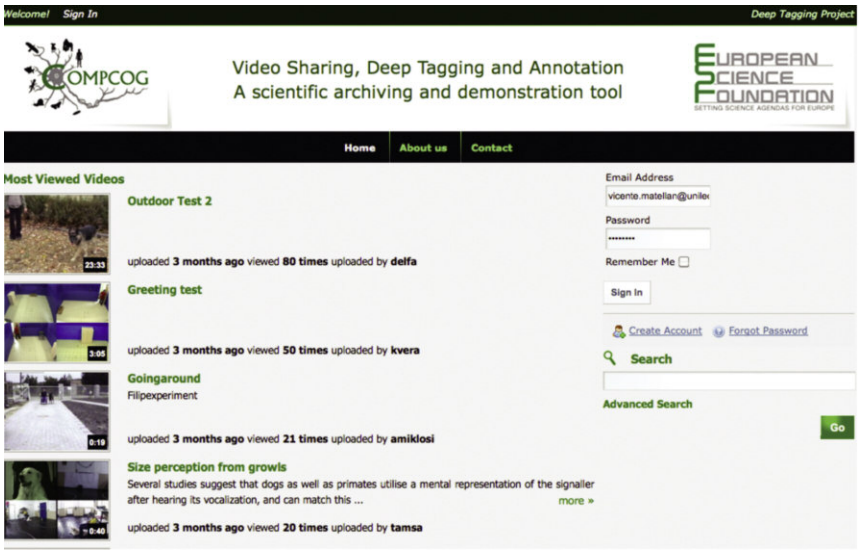

Figure 1: Comparative Mind DataBase (CMDB).

In this way we propose to challenge ethologists to test their observational abilities to infer the internal organization, motivations, etc. of robots, and also their ability to design experiments.

The idea is to show a set of videos of a "pack of robots" in their "environment", for instance a RoboCup team playing robotic soccer, and ask ethologists about the robots' behavior:

- Are there internal "states" in the robots?
- A theory of mind? Any social organization?
- Is there any "internal representation" in the robots? Is it symbolic or subsymbolic?
- Do the robots possess learning ability?
- Do the robots have roles, if so, how many?
- What are the motivations of the robots?
- What is the robots' goal? Is there only one?
- Are the robots communicating?

This has been usual in the training on animal behavior; students have to watch animal behaviour on videos and infer the organization of their behaviours. In this context, robotics videos can be included in the comparative mind database. In this case, programmers can provide the real internal organization, motivations, roles, etc. of the robots. These videos have been included in the Comparative Mind DataBase (CMDB) (see Figure 1).

CMDB is a module of the CompCog project that supports the inquiry using innovative, advanced information technologies and methods from philosophy of science, statistics, experimental design and data/text mining. Components include: data acquisition and description methods, data and text mining for conceptual analysis, ontologies for animal cognition, integrated tools for the design and analysis of experiments, and work towards the standards of experiments, their communication and evaluation concepts.

The problem of cross-comparisons and different markers points towards the necessity of a formal, flexible representation of animal data currently supported by ICT methods commonly called ontologies. Developing an ontology could also support and standardize many statistical comparisons

Links:
http://www.compcog.org
http://www.cmdbase.org
http://robotica.unileon.es

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Executive Control in Artificial Agents

by Michail Maniadakis and Panos Trahanias

Self-referential cognitive control is a fundamental capacity of animals and humans. Ongoing research in FORTH-ICS focuses on implementing this high-order cognitive skill in the domain of artificial autonomous agents, aiming to accomplish an important milestone for the development of the seamless integration of robots into human societies.

The long-term goal of human-robot symbiosis requires equipping artificial agents with the capacity to autonomously control their thought and behaviour. The meta-level mental processes which are responsible for controlling cognitive activities are referred to as executive control functions. Research in FORTH-ICS focuses on implementing such meta-level processes in artificial agents, investigating the dynamics of their interaction with the cognitive activities under control. Interestingly, besides the high potential of implementing cognitive systems with executive control capacity in developing truly autonomous and intelligent robots, such systems may formulate novel explanations on the working principles of the human brain.

A well-known experiment used for investigating executive control functions in the human brain is the Wisconsin Card Sorting Test (WCST), where a subject is asked to discover and apply a card sorting rule based on reward and punishment feedback. In unpredictable times during the task, the rule is changed by the experimenter and must be re-discovered by the subject. The ordinary WCST can be further enriched with the option of betting on behavioral outcomes (ie, success or failure of sorting), testing the capacity of subjects to monitor and implement

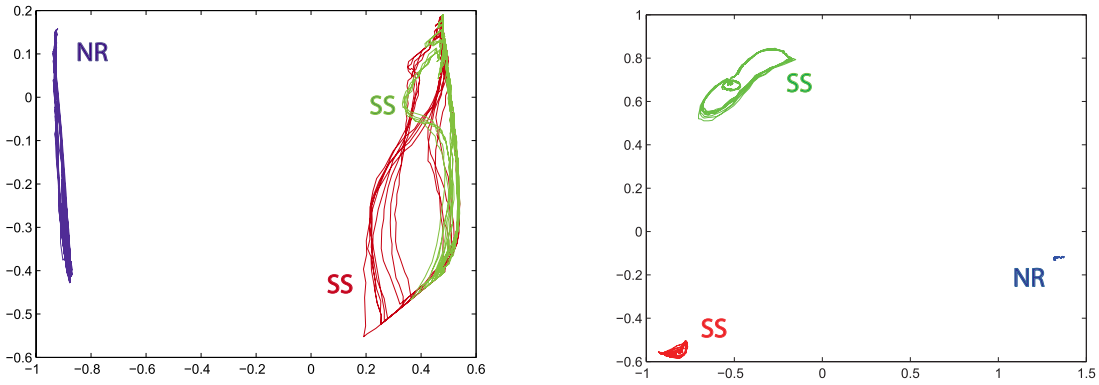

Figure 1: Phase plots of the first two principal components of neural activity for the Type-A (left) and Type-B (right) CTRNNs.

confidence about the currently adopted rule.

We have designed a mobile-robot task that resembles WCST-with-Betting task, investigating rule switching in a sample-response paradigm. The agent has to learn three sample-response rules, selecting, applying and re-selecting each one of them, as indicated by reward and punishment signals provided by the experimenter. The task is based on three response rules named Same Side (SS), Opposite Side (OS) and No Response (NR), guiding robot behaviour in a T-shaped environment. According to the SS rule, the agent must navigate towards the left wing if the light source appeared at its left side, and it must navigate towards the right wing if the light source appeared at its right side. According to the OS rule, the robot has to turn to the opposite direction of the light side, i.e. right when light appears to the left, and left when light appears to the right. In the case of the NR rule, the robot should ignore the side of light staying close to the starting position. The rule following and rule switching capacity of the robot is evaluated for a large sequence of trials examining all possible combinations. At the beginning of trials, the agent bets for the success of the forthcoming response, having the opportunity to gain some profit. Overall, the underlying task requires the coordination of a range of different cognitive skills that include generating motor commands that efficiently drive the robot, maintaining working memory for the currently followed rule, examining conflicts between the adopted rule and the reward or punishment feedback, self-monitoring for confidence development and betting decisions on the basis of the selected rule.

The exploration of executive control mechanisms implemented into a two-level Continuous Time Recurrent Neural Network (CTRNN) is based on an evolutionary approach. We have run several statistically independent evolutionary processes that revealed two basic mechanisms for the solution of the underlying problem, named Type-A and Type-B. This is illustrated in the Figure 1, which shows the phase plots of the first two principal components of CTRNN activity (each rule is presented with a different color).

In the case of Type-A, there is a partial overlap between the trajectories encoding rules SS and OS (i.e. trajectories shown in red and green) while NR is represented by a distinct attractor (i.e. blue trajectory). The overlap of SS and OS suggests their encoding as subclusters of a larger cluster separating them from NR. This is a reasonable organization since both SS and OS ask the agent to navigate in the environment, while NR asks the agent to ignore cue stimulus and stay close to the starting position. On the contrary, the plot corresponding to Type-B solution shows three attractors akin to three different fixed points. This corresponds to clearly distinct representations for the rules SS, OS and NR. Such a rule encoding is also reasonable, given that the three rules are actually independent from one another. Further investigation of the executive control mechanisms self-organized in the CTRNN revealed that:

- Rule switching is achieved through the destabilization of attractor-following neurodynamics that is caused by the lack of positive rewards, therefore making neural activity jump on a different attractor (representing another rule).
- Betting strategy is affected by a self monitoring procedure making the agent place high bets for the more stable rules.

The obtained results have additionally shown that the implementation of rule switching and betting mechanisms is affected by the characteristics of the rule encoding scheme (i.e. either Type-A or Type-B). Interpreting this observation into the framework of biological cognition, we may say that prior experience, and the way a task is understood by a subject is likely to affect the development of the relevant dynamics in his brain. In other words, if two subjects understand a given problem in different ways, then they may use their brains in different ways when solving the problem. Such a subjective view on cognition is particularly relevant with high level skills because they are not directly linked with the phylogenetically strict characteristics of the low-level sensory-motor system.

Ongoing research activities in FORTH-ICS capitalize on the above mentioned results, investigating issues which are based on executive control, such as risk undertaking by artificial agents.

Link:
http://www.ics.forth.gr/cvrl

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Conscious-like Bot wins the 2K BotPrize

by Raúl Arrabales and Jorge Muñoz

CCBot-2, a software agent based on the CERA-CRANIUM cognitive architecture, was the winner of this year's edition of the BotPrize. This contest is an adaptation of the Turing test for a first person shooter video game. Although CCBot-2 could not pass the Turing test, she narrowed the gap with human players, being considered the most human bot, and achieving a humanness ratio of almost 32% (while the "less human" human player scored around 35%).

Creating believable bots has become a new area of interest over the last years. Game development companies are looking for new ways to improve their games and increase the believability of their bots – or non-player characters (NPC) – using new Artificial Intelligence techniques. However, current approaches do not seem to meet the high standards required by hardcore gamers. Artificial characters in video games are often considered either too predictable or too skilled, which inevitably results in frustration for the player, who usually ends up looking for other human players online. The background problem is that current game bots lack the ability to generate engaging human-like behaviour. With this in mind, a new competition was introduced in 2008: the 2K BotPrize [1]. This contest is an adaptation of the Turing test for a first person shooter video game called Unreal Tournament 2004. During the competition, both human and artificial players enter a deathmatch game anonymously, where the objective is to kill as many opponents as possible during a given period of time. Human players are able to observe and judge other opponents, tagging them as humans or bots (see Figure 1). The bot more frequently rated as human is the winner; furthermore, if a bot is wrongly identified as human on more than 50% of the judgements, it is considered to pass the Turing test (no bot has passed this Turing test to date).

CCBot-2 was the winner of the 2010 edition of the BotPrize competition, which was held last August in Copenhagen at the IEEE Conference on Computational Intelligence and Games. In contrast with classical AI approaches, CCBot-2 is based on a novel Machine Consciousness approach [2]. Specifically, the bot is controlled by a cognitive architecture called CERA-CRANIUM, which is modelled after several theories of consciousness such as the Global Workspace Theory.

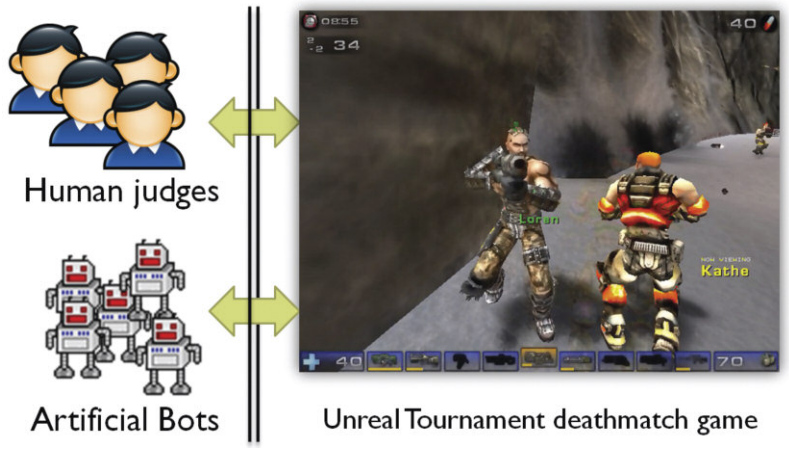

Figure 1: BotPrize judging protocol. Both human and artificial players can connect remotely to the game and are assigned random names to preserve anonymity.

CERA-CRANIUM consists of two main components: CRANIUM is a runtime environment for the creation and management of numerous parallel processes in shared memory spaces (known as Cranium Workspaces). These workspaces can be seen as particular implementations of a pandemonium or a blackboard system, where the daemons (or specialized processors) compete and collaborate with each other for activation. CERA is a four-layer architecture designed to provide a flexible control system for autonomous agents. Lower layers of CERA deal with raw sensory information, while higher layers generate more abstract meaning and behaviours:

- The sensory-motor services layer is the interface between the cognitive architecture and sensors and actuators of a particular agent.
- Physical layer uses a Cranium workspace and is in charge of the low level representation of both sensory information and actuators commands.
- Mission layer also hosts a Cranium workspace and produces and manages elaborated sensory-motor con-

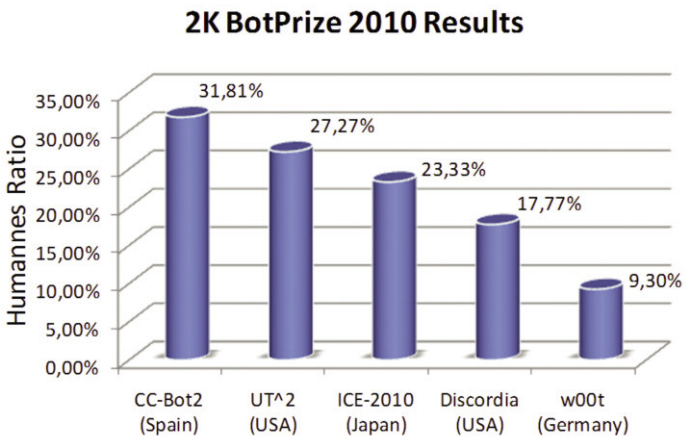

Figure 2: BotPrize 2010 results including five best entries.

tent related with agent's complex behaviors and its current missions.
- Finally, the core layer is the highest control level that generates an internal control signal used to modulate the way in which lower layers work.

Behaviours generated by the bot emerge as a result of the combination of most active processors running in the Cranium workspaces. Generally, specialized processors are rather simple and carry out relatively uncomplicated tasks (like determining if another player is an enemy or calculating the relative position of most dangerous enemy).

CERA-CRANIUM does not only try to decide what the next action should be (as in classical control architectures), but also what specific content should be the focus of conscious attention. We argue that addressing the latter issue is required in order to successfully cope with the action selection problem in a human-like fashion. This mechanism inspired by consciousness was the main difference between CCBot-2 and other BotPrize entries. CCBot-2 achieved a humanness ratio of 31.82% in the competition, still far from the 50% required to pass the Turing test (see Figure 2), however it was close to the "least human" human player, who scored 35% humanness.

Much work still needs to be done in order to pass the Turing test; we plan to enhance future generations of CCBot agents with additional cognitive features like episodic memory, a model of the self, and different learning techniques. We will follow the roadmap implicit in ConsScale [3], a cognitive scale designed to assess the level of consciousness of artificial agents.

Links:
[1] http://www.botprize.org/
[2] http://www.conscious-robots.com
[3] http://www.consscale.com

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An Intelligent System for Decision Support in Bioinformatics

by Antonino Fiannaca, Massimo La Rosa, Daniele Peri and Riccardo Rizzo

The enormous array of computational techniques and data available due to today's use of high-throughput technologies can be quite overwhelming for researchers investigating biological problems. For any problem, there are many possible models and algorithms giving different results. We present a new Intelligent System that supports the selection, configuration and operation of strategies and tools in the bioinformatics domain.

The Institute for High Performance Computing and Networking (ICAR-CNR) and the University of Palermo are developing an intelligent system that supports bioinformatics research. The system guides the researcher in building a data analysis workflow and acts as an interface by rendering transparent details regarding the implementation of the tools proposed or the configuration of on-line services.

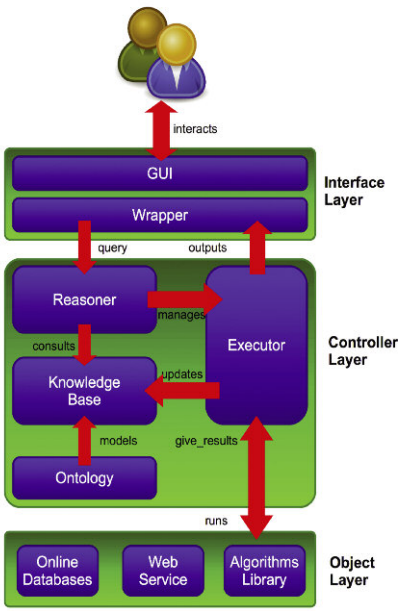

Figure 1: System three-level architecture.

The system is thus a crossover between classical decision support systems (DSS) and recent workflow management systems (WFMS). It provides both the tools/services needed to resolve a problem, and also the knowledge necessary to justify the choice of specific strategies. This knowledge comprises expertise on the application domain, which is composed of heuristics and strategies derived from bioinformatics literature and experiments and/or provided by one or more human experts.

Architecture

Our system is structured in a three-layer architecture, as shown in Figure 1.

The Interface layer is responsible for interactions between the system and the user. It accepts user queries and returns first suggestions, intermediate and final results. This layer consists of a Graphical User Interface (GUI) and a wrapper module for communication between the GUI and the rest of the system.

The Controller layer contains the knowledge of the system on the application domain. This knowledge, built on an ontology, contains problem definitions, using pieces of information called facts, and the necessary skills to solve them, using rules in the form IF <pre-condition is true> THEN <do action>. The controller layer contains the Reasoner component, an inference engine implemented in Java using the Jess engine. The Reasoner makes decisions (inferences) by consulting the knowledge base.

The Executor module is a scheduling agenda whose task is to run the tools and software selected by the Reasoner. The Executor has access to the Object layer (see below), and can update the knowledge base with new facts derived from intermediate results of processing operations.

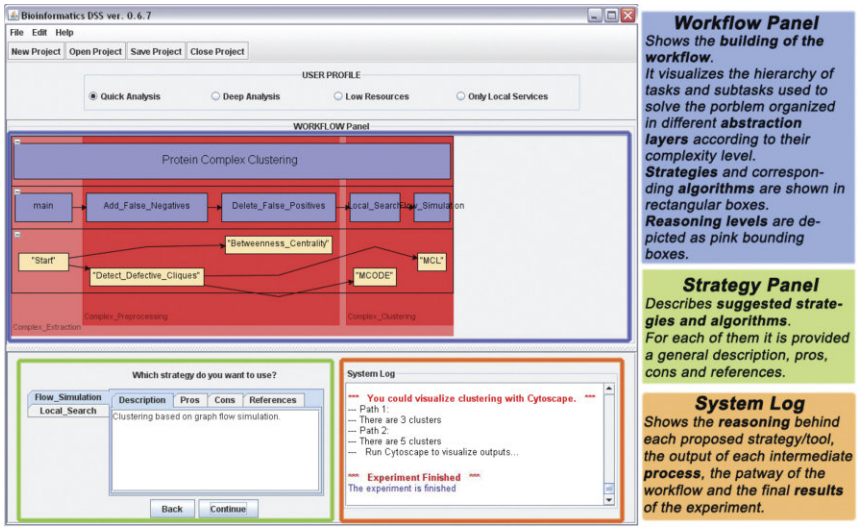

Figure 2: Screenshot of execution of Scenario 1.

The Object layer includes information and links to all the instruments the system could use in order to accomplish the user's request. The components of the Object layer, typically algorithms, web services, online databases and so on, are not part of the system itself: in other words the Object layer offers access to the external tools the system could run.

Decision Making

The decision-making activity of the system is based on an organization of functional modules inside the knowledge base. Each module has its own group of facts and rules, takes care of a specific part of the reasoning process, and is responsible for making decisions about a well defined task. Modules are structured into a hierarchy of levels of reasoning where, at each level, the reasoning is focused on "what to do" and not "how to do". The highest level is focused on general strategies and directives for solving the user's request; lower levels in the hierarchy focus on more specialized tasks; the lowest level makes decisions concerning the choice of proper algorithm or service. This hierarchy is set up as a tree, where parent modules manage the activation of children modules when they need a more specific expertise in order to solve the main goal.

Use Cases

We have implemented two simple scenarios to test the system: (1) protein complex extraction from a protein-protein interaction network and (2) reverse engineering gene regularity network.

We collected strategies and heuristics from more than 50 scientific papers and coded them as rules into the knowledge base. These strategies use more than 20 different tools represented in the Object Layer. The system can thus help the researcher to obtain a correct workflow for these scenarios, according to input data and user preferences.

Figure 2 shows a screenshot taken during an execution of the first scenario.

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Learning from Experience to Anticipate Domestic Needs

by Vittorio Miori, Dario Russo and Alessandro Pulidori

With the increasing influence of technology on our lives, it is becoming ever more important to offer new ambient intelligence solutions which enable humans to adapt and organize their lives around computational technologies and technologies that adapt to meet user behaviour. We apply machine learning techniques to demonstrate how user needs can be satisfied and anticipated by adding Ambient Intelligence solutions to any environment equipped with well-established commercial domotic systems.

Ambient Intelligence (AmI) denotes the presence of a digital environment that is sensitive, adaptive and responsive to the presence of people. We have applied a data mining approach of association rule learning and statistical algorithms in the development of a system prototype that learns from the experience and habits of people in their domestic environments. As shown in Figure 1, the first step in the life cycle of our AmI-based system is the acquisition of information about the users and their environment by means of a monitoring service software module. The data is then analysed and processed by the information manager module. A decision making software application uses this processed information to identify the actions to be performed. Decisions are translated into commands and are sent to the recipient actors (ie people or devices).

These concepts are applied within a home environment equipped with domotics, ie, modern technologies that are used to control and manage all our domestic installations. Our approach uses the DomoNet framework developed by our Domotics Laboratory of the

Ambient Intelligence solutions are sensitive, adaptive and responsive to the presence of people.

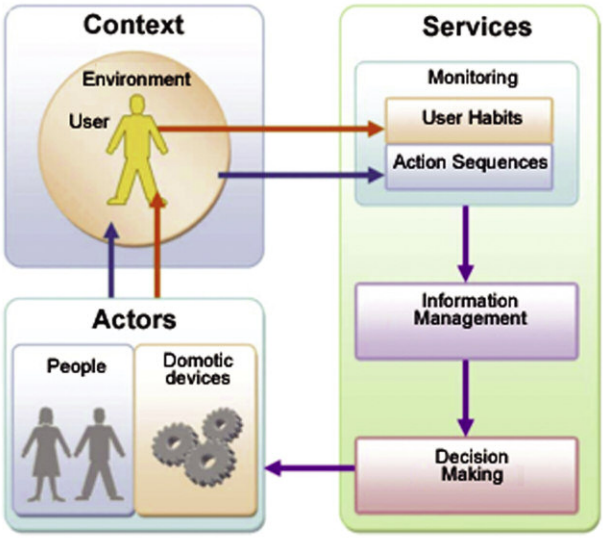

Figure 1: Life-cycle of the AmI-based System.

Institute of Information Science and Technologies (ISTI) of the National Research Council of Italy (CNR) in Pisa. The solution is a semantic DomoNet component based on the action sequence concept. In our context, an action sequence is a set of undefined number of normal interactions with domotic appliances, where the order of their execution is not relevant.

Our prototype includes two complementary and interoperable machine learning modules:

- Association rules manager: this module applies a data mining paradigm. It learns action sequences that represent user habits, considering all action sequences that occur within a fixed short temporal gap or that are executed with systematic periodicity (ie each day at the same time). These action sequences are learnt using the association rule learning technique with the constraint of the Apriori algorithm to select the relevant rules. In the literature many other machine learning approaches exist to cope with this problem (such as neural networks or some variant of Bayesan classifiers or Markov models) but our choice facilitates the management of a non-ordered action list and requires a lower computational time.
- Statistic rules manager: the second module is designed to learn scenarios related to the domestic preferences of the user, such as temperature and lighting levels for a favorite room, or scenarios related to the identification of anomalies which do not comply with the preference rules. For this purpose, the module creates a user profile obtained using a statistical approach by analysing the frequency and percentage of use of the appliances. This data is obtained by monitoring DomoNet activities according to the preferences learnt from experience. This statistical inference is performed at preset intervals during the entire day.

The entire system learns rules in real time and is able to modify its operational mode when user habits change.

The prototype was developed and tested at the ISTI Domotics Laboratory where the DomoNet framework is running. Three volunteer colleagues with no knowledge about the functionalities of the prototype tested it for a period of one month.

The parameters (confidence, support, window size and correlation threshold percentage use of the device) were obtained empirically by testing and cross-validation on datasets incremented dynamically during the use of the system. The support parameter was decreased each day, and reached zero when the dataset was sufficiently large.

This methodology made it possible to avoid learning uncorrected action sequences during the first phase of the process (when the dataset does not contain sufficient information).Once the dataset has been "warmed-up" (ie is sufficiently large), the learning process can add new habits as new rules by decreasing the support parameters. We found that by setting initial support at 10%, confidence at 90%, the correlation window at 30 seconds and the percentage threshold at 80%, we obtained the best results. In fact, 90% of the action sequences were identified.

At the end of the learning period, the system was able to recognize the habits of two of the three volunteers. The first was accustomed to taking a shower around 7 a.m. and to watching TV with soft lighting. The system learnt to warm the bathroom at the right time in the morning and to switch on the TV and the light of the living room at the desired intensity while switching off all lights in the other rooms. The second user was accustomed to returning home from work in the evening and first relaxing in the bedroom while listening to music and then taking a shower. The system has learnt to play the user's favourite music while it warms the bathroom in the evening when the user switches on the bedroom light.

Links:

Domotics Lab Home Page:
http://www.isti.cnr.it/research/unit.php?unit=HA

DomoNet Home Page:
http://sourceforge.net/projects/domonet/

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A Self-Healing Approach to Risk Management in Work Environments

by MariaGrazia Fugini and Claudia Raibulet

A significant number of accidents still occur in the work-place. We describe the WIRI project which investigates how such accidents can be prevented by the employment of user-friendly IT technologies aimed at identifying risky situations.

Many accidents in the work-place are the result of risky situations which could well have been identified by the employment of appropriate IT technologies. The main objective of WIRI (Wearable Instruments for Risk Intervention) is to apply IT technology such as sensors, service-oriented software, web technologies and hardware-software co-design methods in the work-place, in order to detect risks and address them before they become emergencies. We have studied both the social and technological aspects of this challenge, focusing on if and how wearable garments and services can be employed in working environments. In order to do this, we have tried to understand the nature of a risk or a risky situation to enable us to model and simulate such situations. In particular, we have investigated whether Web-based technologies can be used and have identified which of the available architectural styles and patterns are most suitable, Finally, we have experimented with a prototype self-healing system capable of diagnosing and analysing risks, and of executing self-managed intervention strategies for preventing or dealing with them.

When designing solutions for risk identification and management in the work-place, we have encountered a number of challenges. These challenges have to be studied before we can address more complex issues such as prevention, analysis of the impact of combined risks, or investigation of the effectiveness of the strategies currently adopted.

These issues are summarized as follows:

- How can risks and risk prevention strategies be defined and how should risks be addressed at run time?
- How can the level of danger of a risk and the likelihood that it will lead to an emergency be identified dynamically?
- How can complex risks, which are generated when two or more simple risks occur simultaneously, be identified?
- What architecture is most suitable as a solution for risk management in working environments?

Our approach to risk management uses the Monitoring, Analysing, Planning, Executing (MAPE) loop typical of control systems and currently used in the engineering of self-adaptive and self-managing systems (see the Figure 1). This loop observes the environment, detects anomalies by analysing the data collected during the monitoring stage, identifies risky situations and decides on necessary changes, and executes planned modifications in the work environment. This solution can be exploited to address both risky situations through preventive strategies, as well as emergencies through corrective strategies.

One research problem is the standardization of the data collected from different sensors and ambient devices. We believe that a service-oriented approach should be adopted, acquiring all the data in a uniform format, eg XML, in order to facilitate device and system interoperability.

A second research question relates to testing the practicability of a (web) service approach to risk management. So far we have no practical results showing the performance required for such applications from (web) services, thus we are developing a prototype that can simulate risky situations starting from a risk map of the workplace, showing the people and machines in movement. Such situations can be monitored for a given period of time in order to analyse the causes of risky situations and to generate reports showing system compliance with safety regulations and norms. We are also now working on producing a prototype that can be used in seminars and courses on risk prevention.

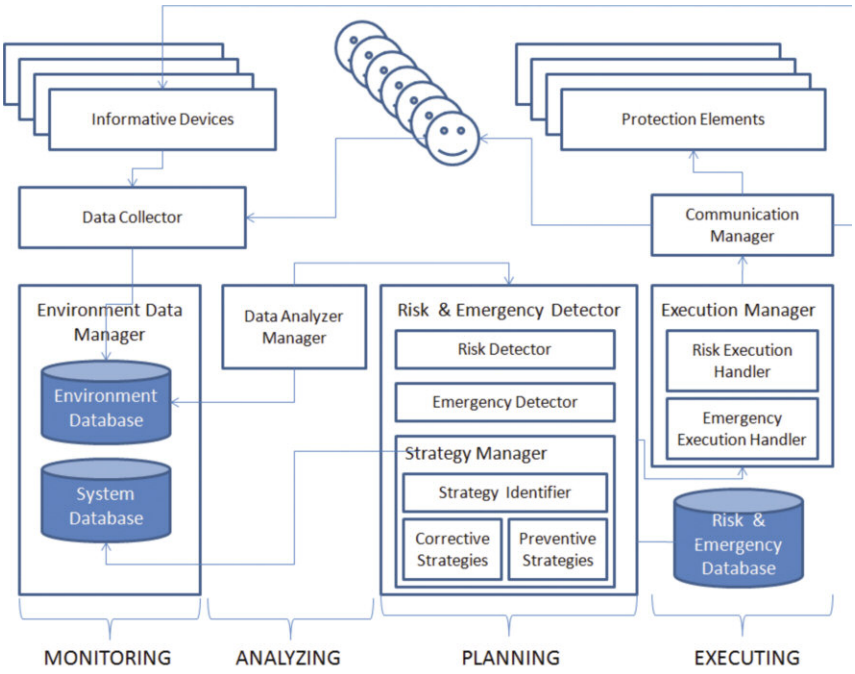

Figure 1: The Architecture of Our Risk Management System.

The project begun by the Politecnico di Milano in collaboration with the University of Milano-Bicocca at the beginning of 2009. It is partly funded by the EC 7th Framework Program under the Network of Excellence S-Cube – Grant Agreement no. 215483 and by the Italian TEKNE Project. Luigi Ubezio and Filippo Ramoni have actively contributed to the system design and prototyping. A number of SMEs in Lombardy, including the Carlo Gavazzi S.p.A. have supplied valuable input in the form of both software and sensors, and have provided feedback on the usage of smart textiles in risky environments. This research is also conducted with the INDACO Dept. of Design and the Dept. of Management Engineering of Politecnico di Milano with respect to the usability of wearable services and to norms and regulations concerning safety in the work-place.

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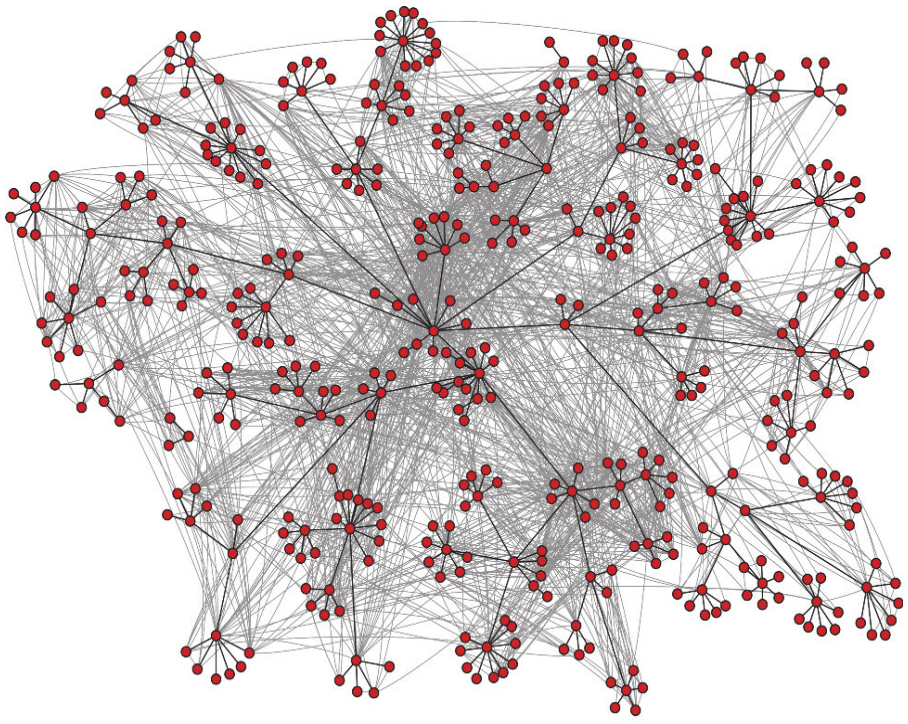
Knowledge and Interaction in Social and Economic Networks

by Jan van Eijck and Floor Sietsma

When you send an email message to more than one address using the Cc: field, all recipients see the same message, including the To: and Cc: fields. Sending a message to undisclosed recipients (using Bcc) has a quite different communicative effect: no common knowledge about the recipient list is created. If a communication network is complex and lots of messages pass through it, it becomes a real challenge to trace who has learnt what from the communication. This challenge is taken up in a project at CWI that started recently.

Social interaction protocols are specifications for carrying out tasks with specific social goals, such as fair division of desirable goods, rational decision making in groups, voting, creation of common knowledge, and so on. Perhaps the simplest fair division mechanism is the well known 'Cut and Choose' protocol. Two agents are dividing a set of items X, and they agree to let one of them divide X into two subsets A and B, and next leave the choice between A and B to the other agent. In general, the two agents will value the items in X differently. Indeed, as was already observed by H. Steinhaus in 1948, if the two parties have different estimations, then there exists a division that gives both parties more than their due part; "this fact disproves the common opinion that differences in estimation make fair division difficult".



Email communication between employees of HP Research Lab.

Issues of knowledge and ignorance are relevant in such protocols. Take 'Cut and Choose', and suppose both parties are ignorant about the valuation of the other party. Then the party that chooses has the advantage over the party that makes the cut. For since the one who makes the cut does not know which items the other person values most, the best she can do is make equal piles according to her own valuation. Although issues of knowledge and ignorance are crucial for analysis of fair division protocols, in traditional studies of 'cake cutting algorithms' the role of knowledge is not taken into account.

CWI is developing a general framework for studying interaction in social and economic networks, building on epistemic logic and theoretical computer science. As a first step, we are studying the epistemic effects on email message exchanges, including the subtle logical differences between cc and bcc of mes-

sages. In follow-up research, we will address the influence of communication links and knowledge of communication links on communication protocols. The nature of the communication links matters to the outcome of a protocol. Consider the decision making process for taking social action. Everyone communicates to their neighbours: "I promise to join the action on condition that I know for sure that at least two others are going to do so as well". Now it depends on the direct communication links between the agents whether collective social action will result or not.

The effects of email communication may seem trivial: if I send you an email, the result will be that you know the information contained in it. But there are more complicated things going on here: I also know that you got this information, and you consider it possible that I sent a BCC of this message to any other person I know. If I do send such a BCC, the third recipient will know that you know, but that you do not know that the third recipient knows. Additionally, I know all this, and the third recipient knows I know this... etcetera.

People intuitively understand all these different levels of knowledge but to express them in a logic is harder than it may seem. This all becomes even more interesting when the number of emails becomes very large. Suppose the director of Google finds out that one of his employees secretly works for Facebook, and he wants to know which information this person can have leaked to the competitor. He could go through all emails this person received one by one in order to determine this, but it would be much more efficient if we could let the computer do this. One of the long-term goals of the research is to automatically visualize information streams within a company, making clear who has which information about basic facts but also about the knowledge of others.

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Safe, Sound and Ethical: Rolling Out the Intelligent Systems of the Future

by John Fox

As with stocks, shares and the gold market the perceived value of Artificial Intelligence (AI) waxes and wanes. Stanley Kubrick's '2001 a space odyssey' captured everyone's imagination in 1968; the Japanese 5th Generation created an enthusiastic bubble in the early 70s, to be punctured in the 80s; the defeat of world chess champion Garry Kasparov by the supercomputer 'Deep Thought' and the extended operation of NASA's 'Deep Space 1' probe by an "autonomous agent" regenerated funders' interest, and Spielberg's 'A.I. Artificial Intelligence' renewed public appetite, and expectations. As with all markets however AI bulls and AI bears tell the most convincing stories by turns. The bears who say we are far from constructing anything truly intelligent seem presently in the ascendant, pointing out that few automata are truly autonomous and most "robots" are largely pre-programmed or remotely controlled. Avatar, the film which most recently captured the public imagination as 'A.I.' did a decade before, focused on devices that project and amplify human capabilities rather than act independently.

Yet, as with markets, the swing of short-term sentiment between bulls and bears isn't the whole story; despite constant turbulence the long-term trends in the gold price and AI are solidly "up". In the world of stocks and shares we are seeing the emergence of autonomous systems in high frequency (and in some cases predatory) trading which are already reputed to be making serious money in global markets. A rather different domain for AI applications is healthcare (see Link 1). In the 'Safe and Sound' project we demonstrated how AI systems could populate the future digital economy in healthcare, demonstrated in a video which shows a benign future of human and artificial agents cooperating for the benefit of patients, clinicians and medical research (see Link 2).

The narrative follows a fictitious patient through her cancer "journey" showing how many different tasks and medical services can be automated and choreographed using AI technologies. A key station on this journey is the multi-disciplinary meeting, where all the members of the clinical team discuss each patient to decide what to recommend. The photograph below shows a multi-disciplinary meeting at the Royal Free Hospital in London where the team reviews each patient's history, imaging and lab results and so on. The screens in the meeting room show a system called MATE which summarises the data and assists in most decisions (eg diagnosis, risk assessment and prognosis, test selection and treatment recommendation) taken by the team. (The MATE system was developed by my col-

The MATE clinical decision support system in use in the breast cancer multidisciplinary meeting at the Royal Free Hospital, London (thanks to Mr. M Keshtgar and colleagues for use of the photograph).

leagues Vivek Patkar MRCS and Dionisio Acosta PhD working with Mo Keshtgar FRCS who leads the breast cancer team at the RFH. We are grateful to Mr. Keshtgar for his enthusiastic support for this project and for his leadership in organising the first clinical trial anywhere of this kind of AI technology.)

MATE does not operate autonomously. For obvious professional and ethical reasons all decisions remain the responsibility of the clinical team. However, it uses the same AI technology (see Link 3) developed in the Safe and Sound project, so that with little more than a "flick of a switch" any decision, or care plan, or even the whole system, could operate without human supervision. The simplicity of this change deserves attention.

Looking after cancer patients demands a large slice of every healthcare budget, and multi-disciplinary meetings require the time and expertise of a lot of highly paid professionals as is evident from the picture. If evidence emerges that decision-making and care planning could be run without human supervision, yet effectively and safely, the pressure to deploy them in this way would surely grow. (The idea that responsibility for landing a plane full of people could be delegated to an automated system was once outrageous; today we take autolanders for granted, not least because they can get aircraft down safely in conditions that human pilots might not.) The ethical implications of this are obvious.

Safe, sound and ethical?

Medical decision-making has been an important setting for the discussion of ethical questions in professional practice, in which the following are taken as axiomatic:

- Beneficence: do good.
- Non-maleficence: do no harm.
- Distributive justice: be fair.
- Patient autonomy: respect patient self-direction.

If systems like MATE could be rolled out in an autonomous mode should they? If not, why not? As we develop the autonomous systems of the future we are likely to consider questions like those traditionally discussed in medicine. However additional ethical principles are also likely to be needed before the possibility of widely rolling out such systems would be considered. For example:

- Personalisation: a system must be able to engage in natural and cooperative interactions with its users and accommodate the user's personal goals and preferences.

- Accountability: an understandable rationale must be available for all recommendations, at whatever level of detail the user may reasonably require.

- Controllability: the user must be able to modify the system's assumptions and goals, and the system must adapt appropriately and safely to such changes.

If autonomous systems are rolled out without considering such issues then, as with automated markets, those without technical skills will be excluded from many benefits and the potential for disastrous failures and abuse will grow.

Links:

[1] Drawing on a long-term R&D programme on the application of AI in safety-critical applications starting with the RED project http://www.comp.lancs.ac.uk/computing/resources/scs/App-A.pdf (p22) and culminating in Safe and Sound: Artificial Intelligence in Hazardous Applications, J Fox and S Das, AAAI and MIT Press, 2000.)

[2] Safe and Sound http://www.clinicalfutures.org.uk was a collaboration between Oxford University, Edinburgh University, Imperial College/St. Mary's Healthcare and UCL/Royal Free Hospital, video at http://www.clinicalfutures.org.uk/video/final

[3] PROforma agent modelling language (Das et al, JETAI, 1997; Fox et al, AI Communications 2003; Sutton and Fox, J Am. Med. Informatics 2003) and the Tallis application development platform: http://www.cossac.org/technologies/proforma http://www.openclinical.org/gmm_proforma.html

COSSAC - Interdisciplinary Research Collaboration in Cognitive Science & Systems Engineering: http://www.cossac.org

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Probabilistic Modelling of Drug Dissolution

by Marija Bezbradica, Martin Crane and Heather J. Ruskin

The project at Dublin City University aims to establish new computational models for drug dissolution systems, specifically for sustained release drugs used in the gastro-intestinal tract. It seeks to improve existing algorithms and develop improved ones to predict the release curves of active substances. High-performance computing and cellular automata are used to investigate probabilistic drug dissolution phenomena. The project is an ongoing collaboration with industrial partner, Sigmoid Pharma Ltd.

Pharmaceutical companies today face a growing demand for more complex drug design for targeted dose delivery. Targeted drug delivery systems (DDS) have the primary objective of achieving drug release at a sustained rate at the targeted site. Modern drug design processes require collaboration between pharmacists, bioengineers and computer scientists. Thus, the computational modelling of DDS is a constantly developing field with the potential to become an integral part of pharmaceutical research. In silico modelling addresses the main problems of drug development through (1) reducing experimental cost, (implicit in large amount of in vitro testing), (2) accelerating time for drug progression to market, (3) better understanding of drug transport processes and (4) converting the existing approach from a descriptive to a predictive one.

The researchers within the Centre for Scientific Computing and Complex Systems Modelling, (Sci-Sym), at Dublin City University are using high performance computing to develop computational and mathematical models for complex systems in multi-disciplinary areas, including engineering and the natural and applied sciences. Drug dissolution modelling, an ongoing project building on work by Dr Ana Barat and Dr Niall McMahon has involved both probabilistic and deterministic models and numerical simulation. Current work is expanding on these efforts by investigating the importance of various microscopic effects to system evolution over time. This research is funded by the Irish Research Council for Science, Engineering and Technology and is an ongoing collaboration with Sigmoid Pharma Ltd.

The project aims at simulation of coated drugs for targeted delivery and addresses the difficulty of understanding how the molecular-level interactions between coating and environment affect characteristic behaviour. Controlled, targeted, release is achieved by using polymers with different dissolution characteristics, making polymer dissolution one of the most important phenomena to be modelled. The model validation is performed against in vitro pharmaceutical data for a drug targeting the gastro-intestinal (GI) tract, with ethylcellulose as the polymer coating of the microspherical drug particle geometry. The novelty in this work is the effort to mimic non-homogeneous dispersion of the drug which improves the realism of the model for this complex system.

The first step in modelling the dissolution is to determine the in vitro dissolution rate under various external conditions, which mimic metabolic processes. Common USP II apparatuses are used for collecting experimental data provided by colleagues at Sigmoid Pharma Ltd. The model results are evaluated against these experimental data.

Applying a bottom-up approach to observe the probabilistic behaviour of individual particles in the system has an advantage over the top-down approach, as it has the potential to yield better predictions while requiring less initial information. Monte Carlo is used as a framework for the cellular automata modelling. The system is represented as a matrix of agents where each agent has defined rules of behaviour and transitions. Microscopic features of the model can be investigated through transitions between agent states. A dimensional analysis approach is used to fine tune model precision. Using high performance computing facilities, provided by the Irish Centre for High-End Computing

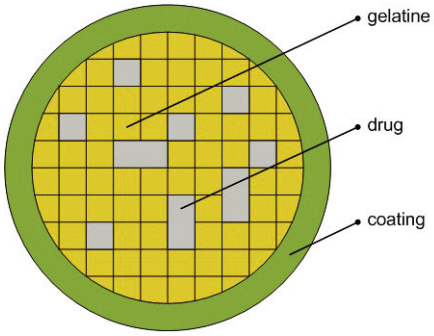

Figure 1: Design of modelled drug.

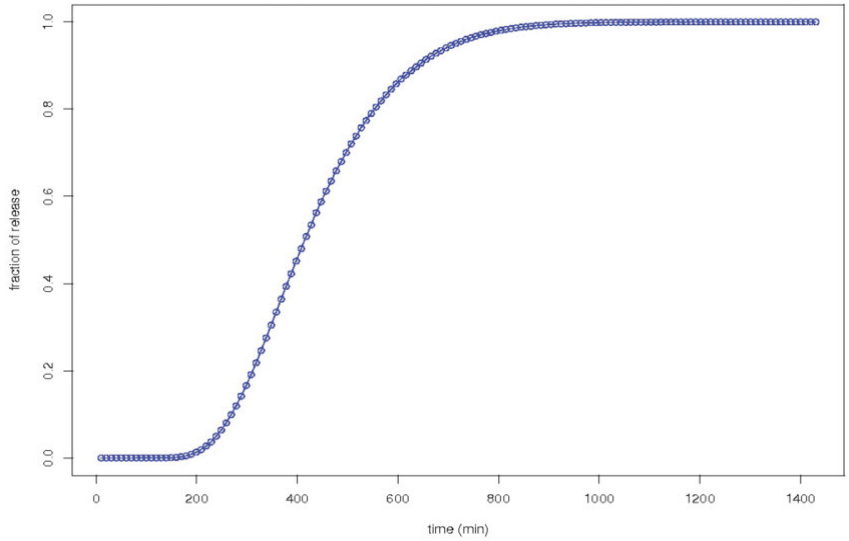

Figure 2: Typical release curve (sigmoidal shape) - No release within first two hours and initial burst effect due to environment transition after two hours.

(ICHEC), we are parallelising the model for large-scale short simulation times. Parallelisation is implemented using OpenMP. Algorithms are coded using the C++ language and OpenGL libraries for graphic representation where the latter is useful, in particular, for the development and liaison stage.

Preliminary results, which include erosion as a main transport mechanism, give a qualitative match to characteristic release profiles with typical "biphasic" release. A future focus is incorporation, into the model, of additional phenomena, caused by additives to the coating structure. Furthermore, model augmentation will include the effect of different polymer coatings and different media surrounding the drug, in order to simulate different stages of the GI tract environment. The deduction of unknown parameters from the experimental release curves, using reverse engineering and inverse Monte Carlo methods, is a long-term aim. Nevertheless, the approach to date has enabled comparison of a set of simulated and experimental release curves, allowing us to determine key parameters for this novel formulation and to reproduce qualitative behaviour.

Acknowledgements
Authors would like to acknowledge the financial support from the Irish Research Council for Science, Engineering and Technology (IRCSET), under the Enterprise Partnership Scheme, grant number P07669 and access to ICHEC (Irish Centre for High-End Computing) facilities.

Links:
http://sci-sym.dcu.ie/
http://www.computing.dcu.ie/~msc/
http://sigmoidpharma.com/dynamicdata/default.asp

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Computational Geometry meets Material Science

by Marco Attene and Giulio Ottonello

Computational geometry is not just a tool for computer graphics - its applications in Material Science are opening unexpected possibilities and exciting new research challenges.

The ability to predict the properties of new materials is of great importance in the study of natural processes such as the evolution of magma bodies and volcanic eruptions. In October 2009, the Institute for Applied Mathematics and Information Technologies (IMATI) of the Italian National Research Council began a collaboration with the Earth Science Department (Dip.Te.Ris.) of the University of Genova (Italy).The objective of this collaboration was to develop new tools for the visualization of the so-called "descent lines" that describe the crystallization of molten materials subject to heat loss. During this research, the Shape Modelling Group at IMATI also applied its expertise in computational geometry to several other applications in the field, going far beyond the original intentions.

A number of the models used to study materials are characterized by variables that turn the investigation into a multi-dimensional problem. It is common practice in Material Science to treat multi-dimensional problems using numerical techniques, performing the analysis on a finite set of samples (input data). IMATI and Dip.Te.Ris., however, have developed alternative approaches that have proved to be more robust, more efficient and, most importantly, more scalable than traditional techniques. Until now, only the behaviour of mixtures consisting of no more than three pure components could be comprehensively simulated. Using these new approaches, mixtures of any number of components can be treated, which makes it possible to simulate complex materials such as magma bodies.

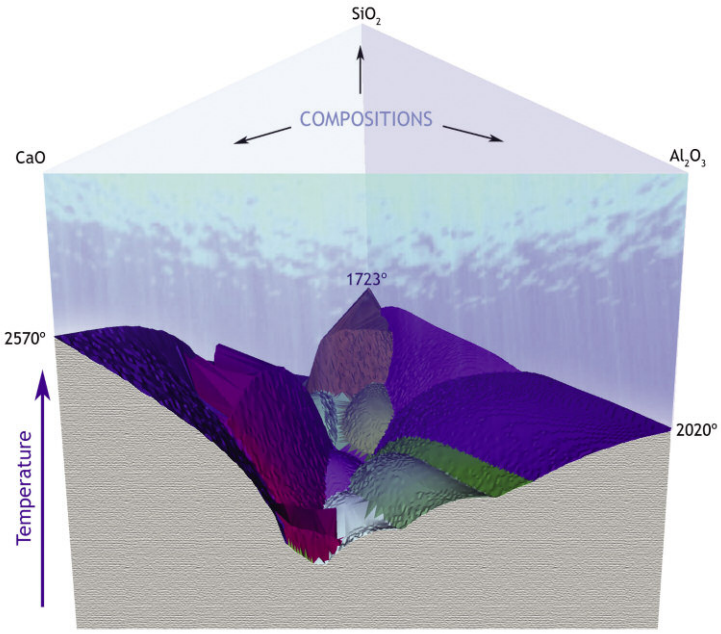

Figure 1: The liquidus of a mixture of three pure components (CaO, Al_2O_3, SiO_2) as computed by the algorithms developed during the project.

Many interesting materials studied today are mixtures of several pure components. Typically, in Material Research the absolute amount of pure components constituting a complex material is not very important, it is much more interesting to know their relative amount. For example, "pseudowollastonite" is always composed of 50 % calcium oxide and 50 % silicon dioxide in molar proportions, independently of the bulk amount of the substance. In many cases, the characteristics of a mixture can be derived from the characteristics of its components, their relative amount, and a number of other variables such as the temperature or pressure. It is often useful to know, for example, the minimum temperature at which a given material begins to melt. On the contrary, when lowering the temperature, it is useful to know at which point a liquid

substance begins to crystallize (eg at sea level, water becomes ice at zero degrees). The temperature for incipient crystallization depends on the crystallization temperature of the constituting pure components, but this dependence is not necessarily a linear combination. The mathematical function which associates each possible mixture of a given set of components to its crystallization temperature is called the "liquidus".

The study of computer algorithms to model and analyse geometric information (i.e. computational geometry) is clearly useful to understand the liquidus which is, in mathematical terms, a "hypersurface". In Computer Graphics, the surface of a 3D object is typically represented by a mesh of triangles, and a number of theories and algorithms exist to deal with such a geometric model. Analogously, the liquidus is a hypersurface in a space of N dimensions and, as such, can be described as a "simplicial mesh", which is a generalized version of the triangle mesh. On the basis of this representation, IMATI and Dip.Te.Ris. are now studying methods both to compute the liquidus itself and to analyse it, independently of the dimension of the space.

In particular, each possible composition of N pure components is represented as a point within an (N-1)-dimensional simplex (ie a triangle when N=3, a tetrahedron when N=4, …). In such a simplex, convex hulls are used to derive samples of the liquidus which are then interpolated through a lifted Delaunay triangulation. The triangulation is made of simplexes of dimensions ranging from 0 to N-1, and each of them is associated with a vector specifying the direction that a line of descent must follow when passing through that simplex. On this dimension-independent model it is possible to robustly compute descent lines describing the crystallization path induced by heat loss for any initial composition.

Due to the promising results of this first year of activity, IMATI and Dip.Te.Ris. plan to keep collaborating with the objective of developing new computational tools and software libraries to support the analysis of complex materials using strongly-established geometric techniques and novel advanced shape analysis tools.

The research is expected to have a significant impact in particular in Earth Sciences, where a complex problem such as the evolution of magma bodies subjected to ascent dynamics within the Earth's mantle becomes manageable.

Links:
Shape Modeling Group at IMATI:
http://www.ge.imati.cnr.it/ima/smg/home.html
Geochemistry Lab at Dip.Te.Ris:
http://www.dipteris.unige.it/geochimica/indexen.html

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Intelligent Guideline-driven Approach in Remote Monitoring of Cardiac Implants

by Asuman Dogac, Gokce Laleci and Catherine Chronaki

The guideline-driven approach of iCARDEA (An Intelligent Platform for Personalized Remote Monitoring of the Cardiac Patients with Electronic Implant Devices) capitalizes on interoperability standards to semi-automatically process patient data from hospital-based health records, remotely monitored implants and personal health records, and promote context-aware personalized and participatory care through the intelligent management of patient information. At the same time it targets reduction of unnecessary in-patient follow-up visits, increased quality of life and patient safety.

A recent consensus statement by the Heart Rhythm Society and the European Heart Rhythm Association reports more than 800,000 patients in Europe have Cardiovascular Implantable Electronic Devices (CIEDs) for the treatment or secondary prevention of cardiac arrhythmias [1]. With current guidelines dictating in-patient follow-up every 3-6 months, the current estimate of 5.8 million visits per year in the EU can only increase, thus increasing the burden on the healthcare system.

While remote monitoring of implants offers a potential solution, many cardiac implantation centres have not yet established work protocols to deal with remote monitoring data, the newest addition to a long list of disparate sources of patient-related information. The integrated guideline-driven approach of iCARDEA builds on interoperability standards to contribute to quality-driven, time- and cost-effective healthcare processes that uphold patient safety, deliver high quality care, and save physicians' precious time.

iCARDEA, a project cofounded by the European Commission for 2010-13 [2], develops an intelligent platform that aims to semi-automate the follow-up of CIED patients through context-aware adaptable computer interpretable guideline models. The models incorporate information from CIED implants, Electronic Health Records (EHRs) and Personal Health Records (PHRs), reducing in-patient visits and providing decision support to health professionals within the chain of care whilst promoting patient safety and reaping the benefits of collaborative and participatory care. iCARDEA exposes the CIED interfaces using health information technology standards developed by HL7 and ISO/IEEE 11073, through appropriate IHE IDCO, CM, and XDS integration profiles [3]. The IHE Exchange of Personal Health Record Content (XPHR) Profile is being implemented in iCARDEA for PHR-EHR interoperability.

iCARDEA has designed a component based architecture that may be adapted for different health care settings. The basic components shown in Figure 1 are:

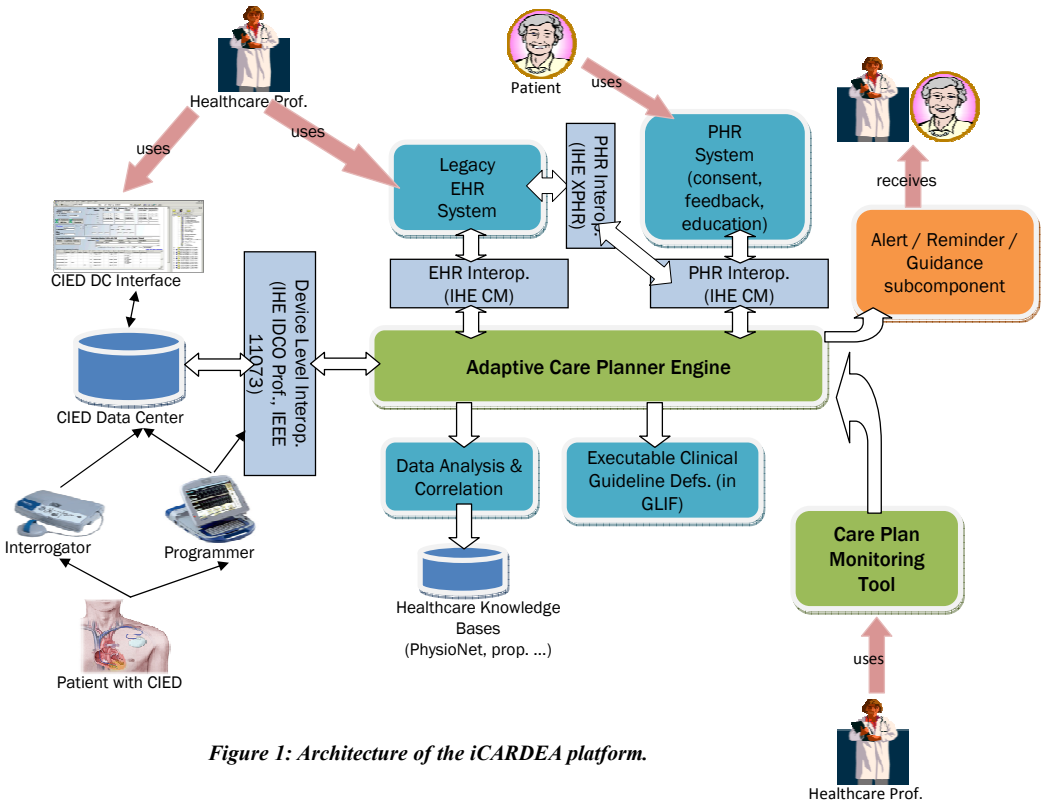

Figure 1: Architecture of the iCARDEA platform.

- *CIED data exposure service (led by OFFIS, Germany):* The CIED data exposure services are based on the IHE IDCO profile based on HL7 v2.5/6 to retrieve remote monitoring reports from CIEDs from two major manufacturers, namely, Medtronic and St. Jude Medical, who are participating in the project.
- *Adaptive Care Planner and Patient Monitor (led by SRDC, Turkey):* In iCARDEA, the remote follow-up of CIED patients is coordinated through the Adaptive Care Planner component. The care processes are defined as care pathways using "computer interpretable clinical guideline models". Using the information obtained from CIEDs, EHRs and PHRs of the patient, clinical guidelines interact with modular healthcare processes to perform various functions, for instance to invoke a service to assess critical situations for early diagnosis to prevent health complications. So far, SRDC, Turkey with the active support of clinical partners (SALK in Austria and Barcelona Clinics in Spain) have developed a semi-automated guideline for Atrial Fibrillation [3], while additional guideline models for ventricular tachycardia are currently been studied.
- EHR Interoperability Framework (led by FORTH-ICS, Greece): The EHR interoperability framework is a toolbox that enables patient related information referenced in guidelines to be seamlessly and intelligently retrieved and used in a dynamic personalized and adaptable workflow for clinical follow-up. This toolbox exposes legacy EHR systems through standard interfaces dictated by established IHE profiles for Patient Care Coordination and Care Management, and Cross Enterprise Document Sharing. In addition the HL7 CTS 2 service is used to leverage differences in terminology and a security layer supports the local security policy.
- *Patient Empowerment Platform and Consent Editor (led by Salzburg Research, Austria):* The Patient Empowerment platform aims to provide feedback, education on patients' cardiac problems and communication with the care givers. In this way, iCARDEA provides feedback and education to the patients through a Personal Health Record (PHR) component so that they can gain the benefits of having their healthcare records and CIED data in a format easily accessible to them. The PHR system also supports patient privacy by having the patient consent on the type of data about him or her to be collected and the way in which the data will be used. Thus, the consent editor nurtures patient empowerment by enabling the dynamic definition of privacy preserving rules that build trust and confidence.

Validation of iCARDEA results

The iCARDEA services will be validated through pilot deployment activities in Austria in the latter part of 2011/12 to confirm that remote monitoring of CIEDs as an integral part of collaborative patient care requires investment in interoperability and process re-engineering, but can lead to significant savings in physicians' time, while contributing to improved patient comfort, safety, and quality of life.

Links:
[1] http://www.hrsonline.org/policy/clinicalguidelines/cieds_consensus.cfm
[2] http://www.srdc.com.tr/icardea
[3] http://www.ihe.net/profiles/index.cfm

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Intelligent Transport Systems on the Road - Lane-Sensitive Navigation with NAV-CAR

by Egbert Althammer, Reinhard Kloibhofer, Roland Spielhofer and Erwin Schoitsch

The goals of the project NAV-CAR are to enable lane-sensitive navigation for cars on motorways and to increase robustness for high precision positioning in specific environments such as urban canyons where satellite based navigation systems may fail. The challenge of the project is the technical realization of the accuracy vs. costs, which is met by using sensor fusion technologies and stepwise integration of car specific data.

Current satellite based vehicle information, navigation and tolling systems rely on a minimum number of satellites that are both visible and well distributed to compute geo-reference data at the accuracy promised by the operators.

Nevertheless, specific environments such as urban canyons, woodlands and mountainous regions, very often do not fulfil the requirements for a continuous and reliable satellite connection of the navigation system, leading either to wrong positional data or no data at all.

The goals of the NAV-CAR project are to increase robustness, improve accuracy and to enhance reliability in comparison to existing solutions in order to enable lane-sensitive navigation.

In NAV-CAR, positional information from navigational satellites is augmented by data collected by an in-car sensor network and combined with high precision map data in order to determine the actual lane in which the car is moving. This in-vehicle process will not only allow the correction of the signal provided by the navigation satellites but can also, to a certain extent, substitute missing signals, as may occur in tunnels, urban canyons and mountainous areas (see Figure 1).

Applications for NAV-CAR

Several European Research Projects develop and test ITS services dealing with the targeted improvement of safety and efficiency on European Roads (eg COOPERS, CVIS; SafeSpot). These projects integrate GPS, GLONASS and GALILEO as source for satellite navigation and positioning. In these projects a number of services were identified which are based on lane-dependent information. Some of these will be used in NAV-CAR in order to demonstrate the benefit of lane-sensitive navigation. The services selected for NAV-CAR are as follows:

- generation and updating of maps
- road charging to influence demand (scenario: motorway interchange)
- lane-specific advice (such as lane specific speed advice, opening/closing of hard shoulders, etc)
- accident localization.

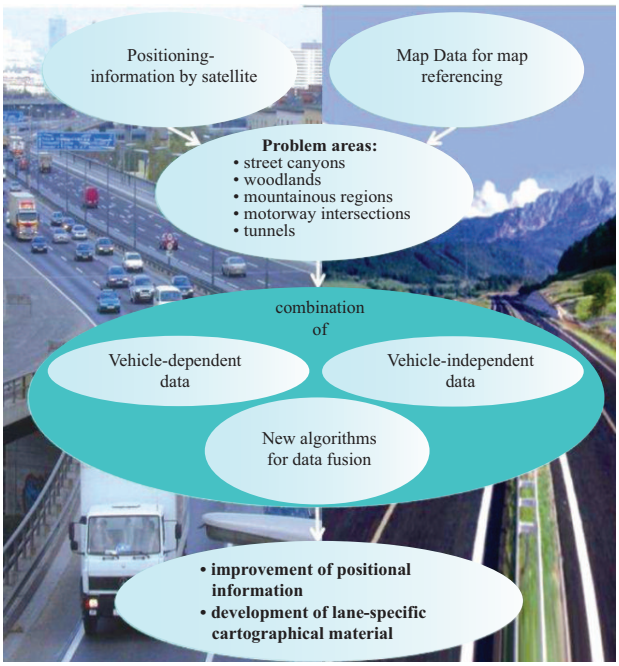

Figure 1: Focus of the project.

Requirements

In order to gain lane-sensitive navigation the following precision requirements have to be met (see Figure 2):

- *Transversal position accuracy: max. +/-1m*
  The width of a lane on an Austrian motorway is 3.50 or 3.75 m. If precise road maps are available, the used lane should be detected with the accuracy described above. If the detected position is within 1 m of the boundary of two lanes or on the boundary of the street, the position should be interpreted as "between two lanes" or "off road" respectively.
- *Longitudinal position accuracy: max. +/-30m*
  This accuracy of the longitudinal position is sufficient for road charging applications and for critical sections such as on-ramp, exit or intersections. For the creation of precise maps, the accuracy of the longitudinal information should be improved to the level of transversal position accuracy.
- *Vertical position accuracy: +/-3m*
  In urban regions sometimes street sections are running in parallel or crossing at a very acute angle on different vertical positions (bridges). For a road charging application it is important to distinguish between a toll road from other non-toll roads which are situated below or above.

Challenges

The challenge in NAV-CAR is the technical realization of the project. The approach we selected is based on multiple sensors using different levels of car integration (see Figure 3). OBUs (on-board units) could receive relevant data from the vehicle itself (ie the CAN BUS), but these data are not standardized across the car industry as a whole. Thus, the inte-

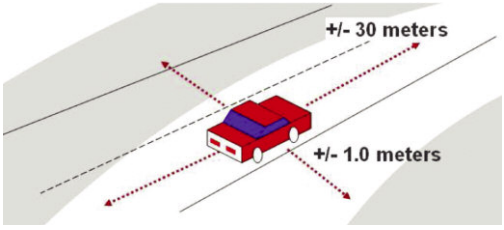

Figure 2: Lane sensitive navigation.

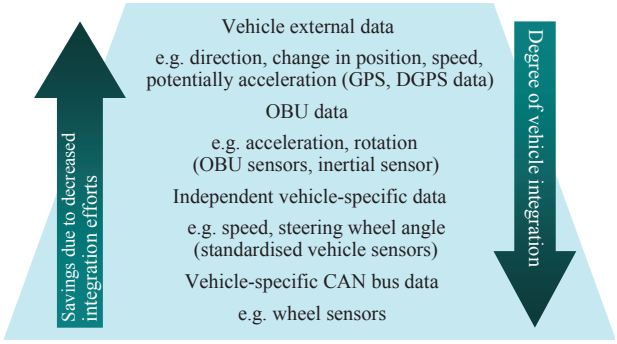

Figure 3: Different levels of car integration.

gration of the OBU with each brand and type of car available is a timely and costly undertaking.

Therefore one objective is to improve the OBU performance by means of data that require no or minor vehicle integration (vehicle independent data), such as acceleration sensors, positioning via WLAN, Infrared, GPS and UMTS cells, etc., and to compare the results achieved with those to be achievable including vehicle-dependent data.

In NAV-CAR different sensors are used to gain both the required navigation accuracy and to guarantee the robustness of data in case of GPS failure, for instance. The sensors used in NAV-CAR are the following:

- GPS receiver data (GPS data)
- Inertial sensor data (acceleration and gyro)
- Altimeter data (height)
- Vehicle CAN data (eg wheel speed).

The data from these sensors is combined using sensor fusion and then compared with precise map data in order to determine the actual lane.

Status and Next Steps

The sensor platform which contains the sensors mentioned above has been accomplished and first test runs have been performed successfully. The next steps will be the evaluation of the sensor fusion software which is based on third party MatLab toolboxes. The sensor platform will be used to perform measurement drives in the car using (1) on an urban and (2) on an alpine motorway. The test data of these measurement drives will be evaluated using the software in order to calculate the gained navigation precision and the robustness of the system. One concrete result could be that the lane specific navigation is guaranteed for one or two kilometres in case GPS fails. Another interesting result is the gain of accuracy for different levels of car integration.

Links:

NAV-CAR project: http://www.nav-car.at/
COOPERS project: http://www.coopers-ip.eu/
SafeSpot project: http://www.safespot-eu.org
CVIS project: http://www.cvisproject.org

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Smart Sensors for Smart Homes

by Joakim Eriksson

Smart Grids is a popular concept and there has been much discussion about the revolution that will be needed to cope with the construction of smart electrical grids. SICS has developed a comprehensive picture of what is required by the private end user who represents the end of the line. In a three-year project financed by the Swedish Energy Agency, SICS is investigating the possibility of "smart houses" from an energy-saving perspective.

This project was initiated less than a year ago and by summer a demonstration house with functioning systems for smart energy savings was already complete. The project's name is rather dull – "System-wide IT network for increased energy efficiency in housing" – but the content is very exciting. It concerns the future of energy regulation at the end consumer level; that is to say, to the benefit of everybody.

The name "system-wide" describes the opening up of different subsystems so they can share and use information with each other. With current technology it is not possible for an alarm to affect the temperature control system, nor is it possible to read the indoor temperature on one's TV-screen as these devices use different protocols to communicate. This has now been solved in an elegant way:

To avoid managing all these protocols, we have chosen to use IP throughout. This means that in certain cases, we have to adapt devices that still do not handle IP, but most of the time we try to find alternatives that already support IP. The advantage with IP is that there is support for IP in all programming environments, there are good support tools and all users and developers already use it, for example for the Internet, IP-TV or IP-telephony.

Today, IPv4 is mainly used for data traffic over the Internet, even though this standard is under-dimensioned and the addresses are simply running out. The new alternative, IPv6, was developed over ten years ago, but it has not really made a breakthrough. Calculations show that as little as 1% of all Internet traffic uses IPv6. The system being developed by SICS communicates directly via IPv4 as well as IPv6.

Since the Western world has already commandeered nearly all the IPv4 addresses, it is mainly the developing countries that have a greater share of IPv6 traffic today. With IPv6, there are in practice an infinite number of addresses available, which means that our system is well prepared for broad utilization and expansion in many different ways.

SICS forecasts a future in which all electronic equipment in the home, such as TV, stereo, cooker, fridge, and freezer will have their own IP address. In the demonstration house, small sensor nodes were used that measured parameters such as energy consumption, temperature and light, and thereby a

The smart house demo setup with a mini-PC for controlling lighting and heating.

The smart house demo consists of several sensor nodes measuring temperature, light and power consumption. This data is used as input to the control system. All sensor data is collected over an IPv6 network.

regulation system for the whole house's functions could be demonstrated.

The basic concept behind the SICS system is that it will include a certain level of automation. Today, there are plenty of solutions that only consist of a display showing the energy consumption. It is up to the user to change his or her behaviour. Such systems, according to some studies, can reduce energy consumption by as much as 25%. However, this assumes the user is active and continues to steer his or her consumption, something that is not at all certain. As a rule, it is difficult to show how much is really saved and the commitment often diminishes after a while. Moreover, if you do not have direct resistive electric heating, then the heating is not included in such a system.

Heating is crucial for energy consumption; heating and hot water consume most of the energy in a household and has to be controlled irrespective of type. To optimize the consumption and create permanent improvements more than visualization is required. In the model with which SICS is working, all information is collected - even that related to the heating - and thereafter the equipment is controlled automatically.

The next step for the work group at SICS, together with the project partner SUST (Sustainable Innovation), is to carry out a number of pilot installations of fully functioning systems in normal homes. The technology has been developed and is functional, and now the extensive work with testing and evaluation remains.

We are out early with test runs of this type of system. The IP standard creates the preconditions for more accessible and less expensive equipment. In time, our aim is for totally automatic, intelligent systems that do not just help us reduce energy consumption but also improve the dwelling environment.

Link:
http://www.sics.se/projects/smartpower

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PROMISE: Advancing the Evaluation of Multilingual and Multimedia Information Systems

by Nicola Ferro

Measuring is a key to scientific progress. This is particularly true for research concerning complex systems, whether natural or human-built. PROMISE will provide a virtual laboratory for conducting participative research and experimentation to carry out, advance and bring automation into the evaluation and benchmarking of complex multilingual and multimedia information systems.

With a population of over 500 million in its 27 states in which more than 80 indigenous and many more immigrant languages are found, the citizens and companies of the EU demand information systems that allow them to interact with the culturally and politically diverse content that surrounds them in multiple media. Moreover, with the advance of broadband access and the evolution of both wired and wireless connection modes, users are now not only information consumers, but also information producers: language and media barriers are no longer seen as inviolable and they are constantly crossed and mixed to provide content that can be accessed on a global scale within a multicultural and multilingual setting.

The technology and research behind multilingual and multimedia information systems are, today, in the position of intercepting these emerging trends but their design and development is becoming increasingly complex and needs proper means for ensuring that they meet the expected user requirements and provide the desired effectiveness.

Objectives

We consider experimental evaluation – both laboratory and interactive – a key means for supporting and fostering the development of multilingual and multimedia information systems in order to ensure that they meet new and evolving user requirements, provide the desired effectiveness and efficiency, guarantee the required robustness and reliability, and operate with the necessary scalability.

PROMISE (Participative Research labOratory for Multimedia and Multilingual Information Systems Evaluation) aims at advancing the experimental evaluation of complex multimedia and multilingual information systems in order to support individuals, commercial entities, and communities who design, develop, employ, and improve such complex systems. The overall goal of PROMISE is to deliver a unified environment collecting data, knowledge, tools, methodologies, and the user community which are involved in the experimental evaluation.

PROMISE is a network of excellence (contract n. 258191), funded in the 7th Framework Programme of the European Commission, with 10 academic and industrial partners, who are leaders in the field: University of Padua, Italy (coordinator); SICS, Sweden; ; University of Amsterdam, The Netherlands; Sapienza University of Rome, Italy; University of Applied Sciences Western Switzerland, Switzerland; Information Retrieval Facility (IRF), Austria; Zurich University of Applied Sciences, Switzerland; Humboldt-Universität zu Berlin, Germany; Evaluations and Language resources Distribution Agency (ELDA), France; Centre for the Evaluation of Language Communication Technologies (CELCT), Italy. The PROMISE project lasts three years, starting from September 2010 and ending in August 2013.

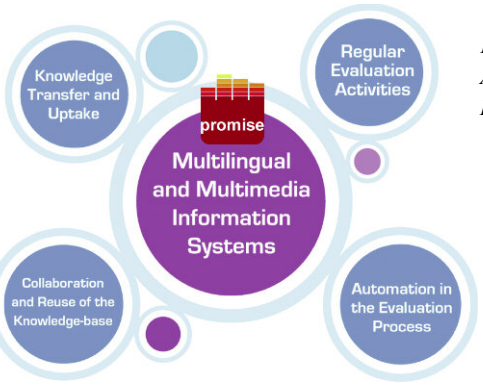

Figure 1: Activities of PROMISE.

Actvities

To achieve its goals, PROMISE will pursue the following activites:

- Foster the adoption of regular and thorough experimental evaluation activities: PROMISE will carry on the successful and renowned CLEF (Cross-Language Evaluation Forum) evaluation campagins futher pushing the evaluation exercises to tackle realistic tasks, use cases, and data sets;
- Bring automation into the experimental evaluation process: PROMISE will propose methods and provide software infrastructure to create larger experimental collections; increase the number and size of the experiments conducted; and develop distributed, asynchronous, and loosely-coupled evaluation protocols, moving experimental evaluation from handcraft process to a mostly automatic one.
- Promote collaboration and re-use over the acquired knowledge-base: PROMISE will curate, preserve, and enrich the collected experimental data; provide the means for an easy comparison with and a meaningful interpretation and visualisation of the experimental results; and facilitate the discussion and collaboration among all the interested stakeholders.
- Stimulate knowledge transfer and uptake: PROMISE will disseminate know-how, tools, and best practices about multilingual and multimedia information systems; facilitate uptake and participation by commercial entities and industries; and give rise to multidisciplinary competencies and expertises.

Links:

PROMISE: http://www.promise-noe.eu/
CLEF 2010: http://www.clef2010.org/
CLEF 2011: http://www.clef2011.org/
CLEF: http://www.clef-campaign.org/

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3D Space Control via Mobile Phone

by Tamás Kifor and Tibor Gottdank

3D visualization and communication devices are developing rapidly. A current project at SZTAKI introduces these innovative technologies to telemanipulation and communication. The main goal is to offer a novel tool for people working on a common task and enable them to cooperate in a common intelligent virtual 3D environment.

The first implementation of this effort is Mouse3D. This program facilitates the use of a mobile device (currently Apple iPhone and Apple iPod Touch) as a spatial computer mouse acting as a 3D controller.

With Mouse3D we can control applications (eg PowerPoint presentations, virtual 3D world applications) on our PC with our mobile device. It is especially handy if we want to carry out control a few steps away from our PC screen, walking freely around a room and don't want to be bound to the keyboard and mouse.

Mouse3D (for VIRCA - SZTAKI 3D Virtual Collaboration Arena application) has been developed within HUNOROB, a Hungarian–Norwegian research based innovation project. It enables the user to control their computer with a smart mobile device from a short distance. Distance parameters and some control mechanisms are similar to Wii. Smart mobile devices include PDAs or smartphones equipped with a touch screen, and an accelerometer/giroscope. Unlike Wii, such controllers are always in the user's pocket and don't need any special hardware. It is also possible to use several mobile devices simultaneously to control an application. This solution increases freedom of control (eg a user may have an iPhone in their right hand and an iPod Touch in their left) and makes possible a more complex control involving more people at the same time (eg multiplayer games).

Practically any application can make use of this controller provided it has an adapter for Mouse3D.

In our implementation there is a standalone client application on the mobile device and a "Mouse3D driver" on the controlled computer. There is also an optional web application component for secure authentication (we call this a domain server).

Within the framework of the project we have created an iPhone controller for VirCA. More recently, we have been working on setting up an open API (Application Program Interface) for Mouse3D adapters and implementing sample adapters to SecondLife, Lego NXJ Robot and PowerPoint applications.

Discovery, authentication, security and control (discussed below) are the major challenges for this approach. The Graphical User Interface (GUI) on the mobile device has been kept as simple as possible to allow users to focus on the controlled application (the computer screen or the controlled robot) rather than the mobile device.

- *Discovery:* The mobile client can search for controllable computers on the local network (by IP address) with a broadcast message and the user can choose from a list of computer names.

- *Authentication:* This is an optional feature, which can be made mandatory by the computer user. There are two ways for authentication: either using LDAP (Lightweight Directory Access Protocol) or using a password.

- *Security:* The biggest issue of security in this application is that the mobile device and the controlled computer don't trust one another. In case of LDAP authentication we use a domain server component (a web application) for the authentication trusted by both the mobile device and the

Figure 1: Using Mouse3D in SecondLife application.

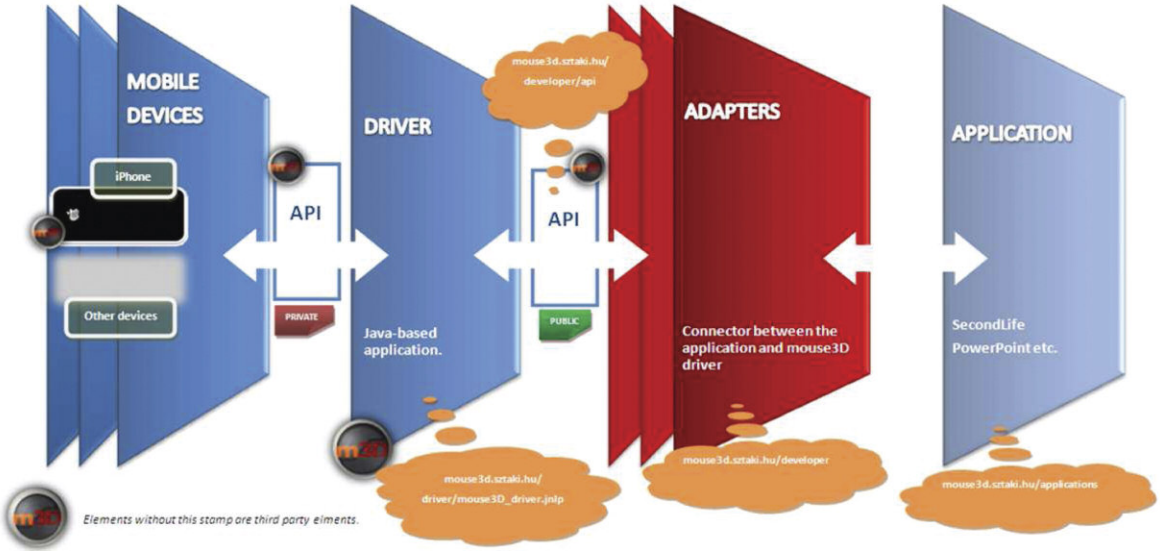

Figure 2: An overview of Mouse3D architecture.

computer. With the combination of authentication, security code and connection confirmation, the user can define the proper security level for this computer.

- *Control:* In order to implement the control features, we have to match possible mobile functions (eg tap, tilt or swipe) with the application functions (eg walk forward, zoom in or go to the next page). Some mobile functions have number values that have to be transformed to an application function value (eg tilting the device at 30 degrees means walk at 6 km/h).

A traditional mouse is an input-only device. A PDA however, can be considered as an input-output device. Controlled applications can send output events to their controller. Such output events are vibration, playing sound, showing images and messages. Input events are tap, tilt, swipe, drag, shake, pinch and screen rotation.

After the completion of the first development, we decided to make an open API for adapters between the Mouse3D driver and a controlled application. This is a platform independent Java API but adapters can use platform-specific libraries, as well (eg Windows DLLs).

The advantage of this API is that developers don't have to implement a controller client on one or more mobile devices, bothering with communication between the mobile client and the computer, implementing authentication and security methods. They only have to implement the Java API and communication between their adapter and the controlled application.

The Mouse3D technology represents the potential of next generation PC tools. Beyond the traditional PC peripherials (keyboard, traditional mouse etc.) Mouse3D, as a feature of mobile devices, would be the general 3D tool for various purposes (eg for presentations, games, research, web shopping).

We plan to extend the availability of Mouse3D in the near future. We want either to implement Mouse3D mobile clients on other mobile platforms (probably Android and WinPhone7) or to make an open API for Mouse3D mobile clients as well.

Links:
Mouse3D website: http://mouse3d.sztaki.hu/

HUNOROB project:
http://www.itm-lab.org/academic-research-and-r-d-programs/hunorob-program

System Development Department of SZTAKI:
http://www.sztaki.hu/department/RFO/

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Immersive Space "Gouraud-Phong" at INRIA Sophia Antipolis – Méditerranée open for Collaboration

by Jean-Christophe Lombardo and David Rey

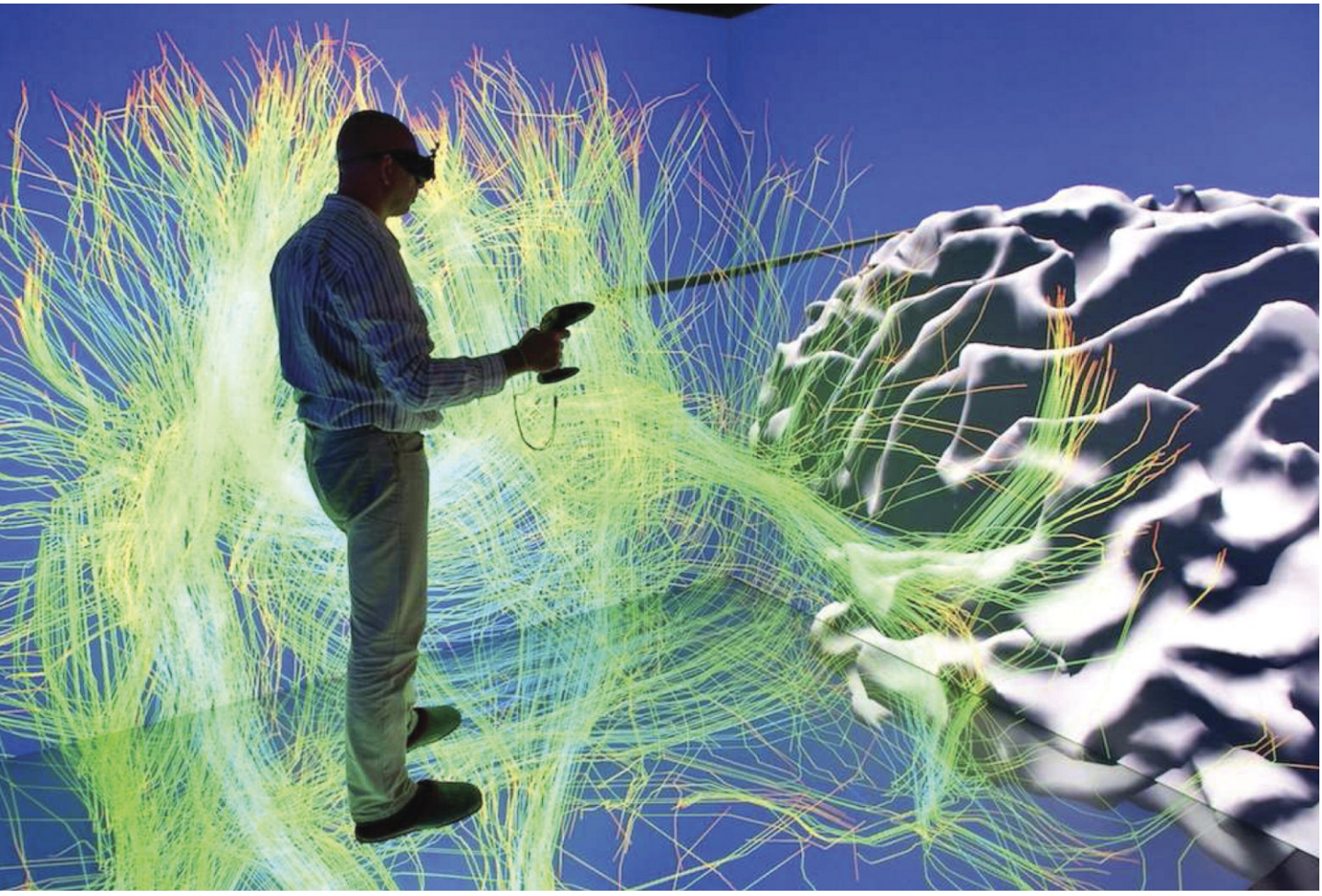
Virtual Reality (VR) is a major area of research at INRIA's research centre, Sophia Antipolis – Méditerranée (CRISAM). To complement this research activity and to stay at the forefront of VR research, CRISAM recently inaugurated its new VR facility: the "immersive space Gouraud-Phong". The space is designed to prototype, test, and run VR applications in various fields including 3D interaction and immersion, scientific visualization, numerical simulation and medical imaging. This platform, located in Sophia Antipolis (France), is open to research collaborations, either with academic or industrial partners.

The immersive space Gouraud-Phong comprises two distinct workspaces: CadWall, an image wall (powerwall) and iSpace, a CAVE-like environment (an immersive cube) offering both high resolution stereo rendering and spatial audio rendering on loudspeakers or with headphones, as well as optical tracking. Furthermore, a dedicated engineering support team is available to help users migrate software applications to the platform, transforming the application from a simple visualization program to a highly immersive one.

The platform has been designed to cover three main aspects:
- Visualization: for 2D, 3D, and multi-D data and results
- Immersion: users have to feel immersed in the virtual environment
- Interaction: users interact with data, results, and even algorithms, as intuitively as possible.

The space has the following technical specifications:
- back projection on each screen
- optical tracking
- infitec stereo
- spatialized audio
- iSpace workspace: 4 screens (front, left, right, floor); 3,2m x 3,2m x 2,4m
- CadWall screen size: 4,1m x 1,4m
- high bandwidth, low latency Infiniband local network
- possible simultaneous use of both sets of equipment
- high bandwidth network connection to external PC clusters.

Figure 1: Immersive interaction with brain fibers and cortex reconstruted from MR Images.



Who can use the platform?

Although this platform is intended for VR experts, it has been designed to be accessible by any researcher who manipulates data and to ease their progression from simple visualization toward fully immersive VR experiments.

The immersive space Gouraud-Phong based in Sophia Antipolis (France) is a shared research platform co-funded by the European Regional Development Fund (ERDF), the French Provence-Alpes-Côte d'Azur region and the French ministry of higher education and research via the agreement State-Region project Telius (CPER). Thus it is not only accessible to INRIA researchers, but to any research partnership, academic or industrial.

Furthermore, this platform has to ease cross-fertilization between scientific and technological results, knowledge and practices, in the field of virtual reality and its applications, by facilitating:

- The integration of users' work/experiments over time within the platform to allow further developments;
- The networking of platforms in this domain to share experiences and practices across the board from the regional to the European scale.

Research application fields

The platform is firstly dedicated to the virtual reality and 3D interaction communities: it makes it possible to study and experiment with future improvements on this type of equipment (eg computer graphics algorithms, intuitive interaction modes, etc.).

Additionally, it is available for use as a research tool for scientists in other fields, for instance:

- scientific computation and visualization: numerical simulation (eg CFD, electromagnetism), computational geometry, etc.
- generation and use of 3D, multi-D, or large scale data: network and graph topologies, large databases, data from sensors, robotics environment, etc.
- immersive studies or tools used by designers, architects, doctors, psychologists, etc.
- collaborative applications.

Technical steps to utilize VR facilities

Starting by using the CadWall as a plug and play external screen to enjoy the display size, users can incrementally modify their software to enable it to handle stereoscopic rendering and head and gesture tracking. The user then implements multi-display capacity on a multi-GPU computer and switches to iSpace. The final step is to parallelize the software, running it on the graphical cluster to profit from the equipment's maximal performance.

A step by step approach to VR:

- *step 1:* plug your computer into the CadWall to enjoy the large screen
- *step 2:* recompile your software on one of the facility's computers (Linux or Windows) to benefit from stereoscopic rendering
- *step 3:* implement tracking:
  - head tracking will provide the 1st immersion sensations, and allow to feel the presence of virtual objects
  - gesture tracking allows natural interaction
- *step 4:* implement a multi-display version of your software on a multi-GPU computer, so you can use the iSpace and experience the large field of view immersion
- *step 5:* implement parallelism and switch to the graphical cluster to enhance performance.

Figure 2: Bimanual interaction with realtime volume rendering.

Further steps might involve using the external PC cluster to compute interactive simulations or to use both pieces of equipment at once to setup collaborative VR experiments.

A dedicated engineer helps researchers setup hardware and middleware and to develop software to get the most out of the platform. His role is also to ensure code re-usability so people can benefit from previous experiments.

Links:
http://www.inria.fr
http://www.inria.fr/sophia
http://www.inria.fr/sophia/dream
http://www.inria.fr/centres-de-recherche-inria/sophia-antipolis-mediterranee/innovation/plateformes-technologiques2

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Feature Selection Software to Improve Accuracy and Reduce Cost in Automated Recognition Systems

by Petr Somol

A specialized software library that helps identify the most informative measurements used in automated recognition systems has been made available to the public by researchers from the Institute of Information Theory and Automation of the Czech Academy of Sciences.

Pattern recognition systems are becoming increasingly important as the variety of scenarios in which they can help reveal important (but otherwise inaccessible) information grows. The increasing role of such systems is made possible partly by the ever-growing performance and proliferation of computers as well as by advances in theory. Pattern recognition is applicable in a vast variety of fields, including:

- Medicine (eg diagnostic systems, gene search)
- Finance (eg trend evaluation, credit scoring)
- Governmental planning (eg analysis of remote sensing data)
- Text processing (eg keyword extraction, document categorization)
- Security (eg face or fingerprint recognition)
- Military (eg target spotting)
- Industry (eg defect detection).

Traditionally, one of the key issues in pattern recognition system design has been the identification of a set of distinctive pattern properties, referred to as features (also known as variables or attributes), that can be used as a basis for pattern discrimination. Such features are selected from among a set of available measurements by mathematical tools which allow the designer to measure the discriminatory content of a feature set.

When building automatic decision systems the commonly followed practice is to first collect as many types of measurement as possible to ensure that no potentially useful information is omitted. Then a dimensionality reduction technique is usually applied to automatically identify which combination of measurements actually contains the maximum discriminatory information. In many situations only a fraction of the originally considered measurements is identified to contain all the useful information. (Note that even seemingly unimportant measurements may prove important in combination with others.) Restricting the final number of various types of measurement not only saves measurement acquisition cost in application phase, it may even help to improve recognition accuracy as it reduces the influence of noise and other unwanted "curse-of-dimensionality" effects.

The theoretical framework of dimensionality reduction now covers a vast range of approaches, some of which have been implemented as supplemental tools in several machine learning software packages (Weka or PRTools being among the better known ones). Nevertheless, many powerful feature selection techniques haven't been generally available so-far except in research papers.

The recently published Feature Selection Toolbox 3 (FST3) library written in C++ narrows several gaps in this area. It contains a selection of highly efficient feature selection algorithms as well as various supportive tools. It enables application of non-trivial subset search techniques even to commonly encountered very high-dimensional (and thus computationally expensive) problems, for instance, in text categorization or gene searches. To tackle the potentially high computational complexity of a feature selection task, the library provides workarounds of both a technical (parallelization) and conceptual nature (fast deterministic and/or non-deterministic techniques of gradual result improvement, etc.). Various anti-over-fitting techniques help to prevent degradation of final system recognition performance on new, previously unseen data.

The library has been developed within the Pattern Recognition Group at the Institute of Information Theory and Automation as part of long-term research activity in the field of statistical pattern recognition. The current 3rd installment of the software package follows an earlier development started in 1999. In addition to the current FST3, the dedicated web (see Figure 1) now also provides the former FST1 as a tool which is less powerful but more suitable for quick experimenting and educational purposes. In addition to FST software a wealth of related informational resources is provided, with the aim of creating a comprehensive portal of interest to any R&D practitioner dealing with pattern recognition problems.

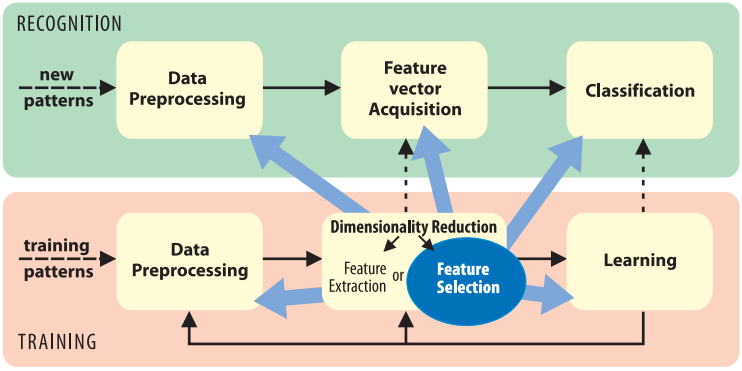

Figure 1: Feature Selection Toolbox 3 software library provides a selection of advanced tools focused primarily on solving the feature selection form of the dimensionality reduction problem, and also addressing and interacting with all other stages of the machine learning and recognition process.

The work has been supported by grants from the Czech Ministry of Education No. 1M0572 DAR and No. 2C06019 ZIMOLEZ.

Link:
http://fst.utia.cz

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Fostering Innovation in ICT – a Toolbox for Technology Transfer Professionals

by Céline Serrano and Katarzyna Kucharczyk

The European project FITT has developed a toolbox for technology transfer (TT) practitioners who work in support of innovation in information and communication technologies (ICT). The motivation is clear: efficient technology transfer is an essential element to transform innovative ideas and research results into new products and services. However, it is a complex job that requires specific tools and a high level of professionalism.

The diversity of tasks performed by technology transfer officers (TTO) often makes their work challenging and far from routine. The scarcity of codified knowledge and standardized processes means that often, the only way to improve one's performance is through learning from experience. The FITT Toolbox (available online on www.fitt-for-innovation.eu) provides a selection of practices from seven partner organizations, which evaluated the solutions fitting the most common needs of TTOs. The idea was to share our know-how and experience in order to build tools for use by TT offices which may have to deal with the same kind of problems. In a situation that requires starting from scratch, it may be particularly useful to try solutions which have already worked well somewhere else. Officers may also benefit from the opportunity to compare the methods of others with their own and to pick up some "lessons learned".

The variety of partners' profiles meant that a broad scope of experience and complementary skills were brought into the Toolbox. Groups involved in the project – which lasted from 2008 to 2011 – included research institutes, university networks, research-industry interface organizations, business schools and innovation agencies from five EU countries: Luxembourg, France, Germany, Belgium and UK (for details see: http://www.fitt-for-innovation.eu/index.php?id=3812). The project is funded under North-West Europe INTERREG IVB programme priority one: capitalizing on innovation. The innovations issued from ICT (meanwhile recognized as a key factor for advancement of industry and cutting-edge research) generally have some specificity in areas of science, law or economics, and these are included in our ICT-oriented tools.

The practical dimension of the Toolbox is reflected by its structure: it is divided into five main activities which cover the entire valorisation chain, from detection of transfer opportunity, intellectual property protection and evaluation of market potential to attracting the interest of future investors. The user can quickly go through the content and find information according to one's needs. Composed of several layers – the more detailed containing practices and case studies elaborated by FITT partners – the toolbox also gives insights on impact, lessons learned, tips and ideas for possible improvements.

FITT project team.

We have designed the FITT Toolbox as a support tool for the day to day work of a TTO, so one of the priorities was to make it useful for the maximum possible number of practitioners across Europe. While the first version is already available online, a number of practices are currently being tested by FITT partners in order to check their relevance to different conditions and facility of adaptation to each organization's environment. This should result in improvements and upgrade of the toolbox content towards greater usability and flexibility.

Philippe Laurent, expert in intellectual property law and ICT from the University of Namur, received a positive first impression of the toolbox: "I've been impressed by the structure and the extensive character of its content. One notices immediately that it has been created on the basis of a real and in-depth sharing of knowledge and know-how (...)."

Furthermore, the practices and use cases integrated in the Toolbox will be used as a part of a transnational TT training programme created within the FITT project, the pilots of which will be launched in 2011. In order to receive feedback and keep improving the Toolbox and the training programme, as well as to share experience and ideas between professionals, a Community of Practice has been started on LinkedIn (http://www.linkedin.com/groups?home=&gid=2808204&trk=anet_ug_hm). The position paper containing recommendations for ICT technology transfer and the FITT Bibliography with selected "must-reads" will be available soon.

Link: http://www.fitt-for-innovation.eu

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Event Report

AARIT Convention 2010

by Erwin Schoitsch

The Austrian Association for Research in IT (AARIT), the Austrian member of ERCIM, acts as sub-organization under the umbrella of the Austrian Computer Society (OCG), and brings together members whom together account for a significant amount of Austria's expertise in Informatics and Mathematics. In order to increase awareness of and collaboration among the Austrian research community, AARIT organized a well attended and appreciated event, the AARIT Convention, on 16 November 2010 at TechGate, a science and technology park near the UNO-City, Vienna.

After a welcome by the OCG president Gerald Futschek, Mag. Lisbeth Mosnik of the Federal Ministry of Transport, Innovation and Technology (BMVIT) (which supports the AARIT initiative in Austria, the AARIT Convention, with a statement on its commitment to research and technology), opened the convention and gave an overview of the Austrian initiatives and success stories in context of the European Framework Programme. Andreas Rauber, the president of AARIT, then discussed ERCIM, AARIT and the AARIT activities within ERCIM.

The event was accompanied by an exhibition of about 16 Austrian Research Institutions, AARIT members as well as others, presenting their research work at exhibition booths. ERCIM was also represented with a separate booth).

Twelve research organizations took the chance to present their activities, plans and expectations concerning the Austrian and European research scenarios in the plenum, discussing chances, challenges, and barriers. This presentation was guided and moderated in interview style by Karl Fröschl, which proved an interesting experience for both presenter and audience.

The keynote in the afternoon was held by ERCIM Vice President Prof. Dr. Matthias Jarke from the Fraunhofer-Institute for Applied Information Technology (FIT), who

Panel discussion at the AARIT convention.

discussed the situation of applied research in Europe, from his institute's as well as from the ERCIM point of view.

The Austrian Research Promoting Agency and the Austrian Science Fund (FFG and FWF) presented their funding concepts and support of national and European projects and programmes (initiatives) in a "service block" in the afternoon.

A panel discussion on "The Future of Austrian Research in the European Context" moderated by Erich Prem, with a highly qualified panel of seven experts from research organizations, the Research Council, an Incubator, the Austrian Science Fund and the Federal Ministry BMVIT, and AARIT, concluded the event. The discussion covered strategy (which routes to take: focus on strengths or include niches?), education and training (how to secure the work force for future challenges?), sustainability of research and competence building (long term continuity beyond individual projects?), and innovation (how to achieve market impact?).

There was full agreement at the end that national and international networking - a task facilitated by organizations like AARIT in the European context - is a basic requirement for researchers, especially for a smaller country. Because of the success of the event it was decided to organize the next AARIT Convention in 2011.

Link: http://aarit-konvent2010.ocg.at/ (in German).

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Co-organised by ERCIM

fet[11] - The European Future Technologies Conference and Exhibition

The European Future Technologies (FET) Conference and Exhibition aims to be the European forum for facilitating international cross-disciplinary dialogue and discussion on visions and challenges for frontier research in future and emerging information technologies.

Deadlines:
Call for sessions: 15th January 2011
Call for exhibits: 15th January 2011
Call for posters: 15th February 2011

Keynote speakers:
- Neelie Kroes, Vice President of the European Commission
- Artur Ekert, University of Oxford
- Claire Tomlin, UC Berkeley
- Gabor Proszeky, Morphologic
- Josh Bongard, University of Vermont
- Jean-Philippe Bouchaud, ESPCI Paris tech
- John Pendry, Imperial College

More information:
http://www.fet11.eu

ICIP 2011 BRUSSELS
IEEE INTERNATIONAL CONFERENCE ON IMAGE PROCESSING
September 11 - 14, 2011 • Square Brussels Meeting Center, Brussels, Belgium

Leading scientists in image processing from around the world will attend

ICIP 2011 - The 18th IEEE International Conference on Image Processing

Brussels, 11-14 September 2011

The 18th IEEE International Conference on Image Processing is the best opportunity to present their technological advances and research results in the fields of theoretical, experimental and applied image and video processing.

Topics include but are not limited to:

- Image/video coding and transmission: Still image coding, video coding, stereoscopic and 3-D coding, distributed source coding, image/video transmission over wireless networks
- Image/video processing: Image filtering, restoration and enhancement, image segmentation, video segmentation and tracking, morphological processing, stereoscopic and 3-D processing, feature extraction and analysis, interpolation and super-resolution, motion detection and estimation, implementation and systems
- Image formation: Biomedical imaging, remote sensing, geophysical and seismic imaging, optimal imaging, synthetic-natural hybrid image systems
- Image scanning, display, and printing: Scanning and sampling, quantization and halftoning, color reproduction, image representation and rendering, display and printing systems, image quality assessment
- Image/video storage, retrieval, and authentication: Image and video databases, image indexing and retrieval, video indexing, retrieval and editing, multimodality image/video indexing and retrieval, authentication and watermarking
- Applications: Biomedical sciences, geosciences and remote sensing, document image processing and analysis, other applications

Special Themes for ICIP 2011:

- Astronomy
- Cultural Heritage
- Human Media Interaction

Submission deadline: 14 January 2011

ICIP 2011 is supported by INRIA

A little about the conference venue:
SQUARE – Brussels Meeting Centre is located in the heart of Brussels and is housed in the extensive former Palais des Congrés, an elegant, architecturally significant building originally constructed for the 1958 World Expo. Many of the original features, including expansive murals by Paul Delvaux, René Magritte and Louis van Lint, have been carefully restored and are now juxtaposed with contemporary design conceived by a team of leading European designers.

With it being situated in the vibrant Mont des Arts cultural quarter in the heart of Brussels. It sits easily among the city's major museums and art galleries, including the recently opened Magritte Museum, devoted to the country's master of surrealism. SQUARE is also located in front of the Central Station, handy for the international airport and train connections.

Photos © M. Van Hulst (left), © Brussels international (right).

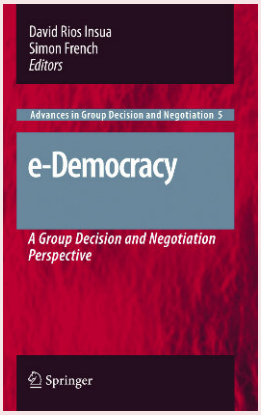
Vues of Brussels.

More information:
http://www.icip2011.org

New Book

David Rios Insua and Simon French (eds)

e-Democracy: A Group Decision and Negotiation Perspective



This is the first comprehensive review of e-participation and e-democracy. Web based interactions to support participation and deliberative democracy are coming, and coming fast. In some instances, the Internet is already permeating politics. However, it is far from clear if the processes involved in these interactions are meaningful and valid, and most of the research in the field has focused largely on technologies to facilitate or automate the standard democratic instruments involved, such as e-voting and e-debating. This book, though, uses the point of view of the Group Decision and Negotiation approach to thoroughly discuss how web-based decision support tools can be used for public policy decision making.

Springer, 2010 (364 pp., ISBN 978-90-481-9044-7)
http://www.springer.com/business+%26+management/operations+research/book/978-90-481-9044-7

International Academy of Systems and Cybernetic Sciences founded

On April 7, 2010 the International Academy of Systems and Cybernetic Sciences (IASCYS) was founded upon an initiative of the International Federation for Systems Research (IFSR). It is based in Vienna with IFSR.

While the traditional disciplines of science tend to have a restricted and narrow focus on their own particular specialized area, theories and practices in Systems and Cybernetics deal with a holistic and interdisciplinary worldwide viewpoint and thus attempt to span the gaps between individual (and often not cooperating) traditional sciences.

One of the main objectives of the Academy is to honour outstanding scientists in the field of Systems and Cybernetics and to build a platform of high-level interaction between them.

On October 25-27, 2010 the IASCYS held its first General Assembly together with a workshop conference at the University of Sichuan in Chengdu, China.

The meeting confirmed the first 25 members of the Academy representing 14 countries on five continents (Argentina, Australia, Austria, Belgium, Canada, Chile, France, Great Britain, Ireland, Japan, Poland, China, Slovenia and USA).

First general assembly of the International Academy of Systems and Cybernetic Sciences.

In the course of the conference essential issues of System Sciences and Cybernetics were discussed from various points of view and future steps were considered, especially with respect to increasing the visibility of this important field.

The current Executive Committee of the IASCYS consists of Prof. M. Mulej, Slovenia (President), Prof. Jifa Gu, China (Vice-president), Prof. Ranulph Glanville, Great Britain, Vice-president), and Prof. Pierre Bricage, France (Secretary General).

More information:
http://ifsr.ocg.at/world/node/68

SAFECOMP 2011 - 30th International Conference on Computer Safety, Reliability and Security

Naples, Italy, 19 - 21 September 2011

Key theme 2011: Safety and security of computer-based systems and infrastructures: from risk assessment to threat mitigation

SAFECOMP is an annual event covering the state-of-the-art, experience and new trends in the areas of safety, security and reliability of critical computer applications. SAFECOMP provides ample opportunity to exchange insights and experience on emerging methods, approaches and practical solutions. It is a one-stream conference without parallel sessions, allowing easy networking.

ERCIM and the ERCIM Working Group on Dependable Embedded Software-Intensive Systems are scientific co-sponsor of SAFECOMP 2011 and plan to organize again a workshop on 'Dependable Embedded Systems' as at the last SAFECOMPs (workshop chairs: Erwin Schoitsch, and Amund Skavhaug)

Scope of the conference:
Papers are invited in application and industrial sectors as well as research areas. Topics of interest include, but are not limited to:

- *Application and Industrial Sectors:* control, networking & telecommunication, railways,robotics and autonomous systems in general, medical devices and systems, e-health, off-shore technology, ship building, power systems, critical infrastructures, security of safety-critical systems, safety guidelines and standards, education & training. Especially papers on industrial experience and practice are encouraged.
- *Research Areas:* safety & security risk assessment, design for dependability, diversity, fault tolerance, verification & validation, testing, qualification and certification, modelling and simulation, human factors, dependability analysis, networked (distributed) embedded systems, safety-critical computer systems, resilient (robust) systems, physical and cyber threats, vulnerability analysis, dependency and interdependency modelling and metrication, cascading effects.

All papers are subject to thorough reviews by at least three reviewers, the reviews deciding about final acceptance are performed on basis of full papers only.

Important dates:
Abstract submission: 27 February 2011
Full paper submission: 21 March 2011
Tutorial/Workshop proposal submission: 15 April 2011
Notification of acceptance: 9 May 2011
Camera-ready submission: 13 June 201

More information: http://www.safecomp2011.unina.it

ERC Grant for Provable Security against Physical Attacks

Krzysztof Pietrzak from CWI was awarded an ERC Starting Grant of € 1.1 million from the European Research Council for his proposal 'Provable Security for Physical Cryptography'. In this project he will develop methods to design cryptographic schemes which are *provably* secure against all types of physical attacks, such as side-channel attacks, where an adversary exploits information leakage from the physical implementation of a cryptosystem, eg by measuring the power-consumption of a smart-card. Even modern security notions do not take physical attacks into account, and as a consequence many 'provably secure' schemes get broken once an adversary can attack their physical implementation. In the future the 'leakage-resilient' schemes developed in this project can be used on lightweight cryptosystems, such as smart cards, RFID tokens or mobile phones, which are particularly susceptible to physical attacks. The grant, which started November 2010 and runs for five years, pays for two postdoc positions and two PhD students.
http://homepages.cwi.nl/~pietrzak/PSPC.html

Six new ERC Grants hosted at INRIA in 2010

In 2010, six new ERC grant winners will be hosted at INRIA. In the "starting grants" category, Axel Hutt ("Mathematical modelling of anaesthetic action"), Paola Goatin ("Traffic Management by Macroscopic Models"), Pierre Alliez ("Robust Geometry Processing"), Kartikeyan Bhargavan ("Collaborative Cryptographic Security Proofs for Programs"), have received funding to form research teams. In the "advanced grants" category, Jean Ponce (Modeling, interpreting and manipulating digital video) and André Seznec ("Defying Amdahl's Law") are among the winners and have chosen INRIA as their host research institution.

Two other "starting grant"winners are members of INRIA teams, jointly with other academic partners: Véronique Cortier ("Provably secure systems: foundations, design, and modularity"), hosted at CNRS, and Nikos Paragios ("Discrete Bioimaging Perception for Longitudinal Organ Modelling and Computer-Aided Diagnosis"), hosted at Ecole Centrale Paris.

Anja Feldmann awarded € 2.5 million Leibnitz Prize 2011

Anja Feldmann from TU Berlin is one of the ten winners of Germany's most prestigious research prize. The Joint Committee of the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) named ten researchers, four women and six men, as the winners of the 2011 Leibniz Prize on 2 December 2010. The award winners were selected by the Nominations Committee from among 152 nominees. Anja Feldmann is the scientific expert on the internet in Germany and a leading figure in the international internet research community. Her work on internet routing, traffic analysis and modelling has advanced basic research and played a decisive role in the ongoing development of the Internet. Feldmann's studies of the potentials and limits of web proxy caching have shaped the business decisions of countless internet services, and technologies for compressing and sending web page updates based on her findings have become ubiquitous elements in internet browsers and servers. Her recent work has focused on technologies for detecting and defending high speed networks against malicious attacks, as well as new Web applications and forms of internet usage.
See also her recent article "Network Virtualization - An Enabler for Overcoming Ossification" in ERCIM News No. 71, p. 21.

José Duato Winner of the Spanish National Research Award "Julio Rey Pastor"

The Ministry of Science and Innovation has awarded to José Duato the Spanish National Research Award "Julio Rey Pastor" 2009 for the area of Mathematics and Information and Communication Technologies.

José Duato.

The National Research Awards, which are granted in ten categories or scientific areas, were established in 2001. The purpose of these awards is to recognize the merit of those Spanish researchers who are doing outstanding work in scientific fields of international importance and who contribute to the advancement of science, to the best knowledge of man and their coexistence, to the transfer of technology and to the progress of mankind.

José Duato is a full Professor in the area of Computer Architecture and Technology at the Polytechnic University of Valencia and head of the Parallel Architectures Group (GAP). He coordinates ACCA (http://www.acca-group.info) one of the first research projects granted in the Consolider-Ingenio 2010 national programme, comprising a consolidated team of over 100 researchers from different Spanish universities. Currently, Jose Duato leads the Advanced Technology Group in the HyperTransport Consortium, which developed the High Node Count HyperTransport Specification 1.0 to extend the device addressing capabilities of HyperTransport in several orders of magnitude.

His most notable work is the promotion and development of research activities in various areas related to the architecture of computers, multiprocessor architectures, supercomputers and interconnection networks. His research results have been transfered to various companies, namely Cray, Compaq, IBM, Mellanox, and Sun Microsystems.

ERCIM
European Research Consortium for Informatics and Mathematics

ERCIM – the European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in information technology and applied mathematics. Its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.

ERCIM is the European Host of the World Wide Web Consortium.

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