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ERCIM NEWS

Special theme:

Assistive Technologies for a More Accessible and Inclusive Society

Also in this issue

Research and Innovation: Taste Before Tasting: Development of a Virtual Tongue to Characterise the Organoleptic Profiles of Mediterranean Ingredients

Editorial Information

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 6,000 printed copies and is also available online ,at https://ercim-news@ercim.eu.

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July 2022: Assistive and Inclusive Technologies

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JOINT ERCIM ACTIONS

SPECIAL THEME

The special theme “” has been coordinated by the guest editors Christine Azevedo Coste (Inria) and Barbara Leporini (ISTI-CNR)

RESARCH AND INNOVATION

ANNOUNCEMENTS / IN BRIEF

ERCIM "Alain Bensoussan" Fellowship Programme

The ERCIM PhD Fellowship Programme has been established as one of the premier activities of ERCIM. The programme is open to young researchers from all over the world. It focuses on a broad range of fields in Computer Science and Applied Mathematics.

The fellowship scheme also helps young scientists to improve their knowledge of European research structures and networks and to gain more insight into the working conditions of leading European research institutions. The fellowships are of 12 months duration (with a possible extension), spent in one of the ERCIM member institutes. Fellows can apply for second year in a different institute.

Why to apply for an ERCIM Fellowship?

The Fellowship Programme enables bright young scientists to work on a challenging problem as fellows of leading European research centers.An ERCIM fellowship helps widen and intensify the network of personal relations among scientists.

The programme offers the opportunity to ERCIM fellows:

- to work with internationally recognized experts;
- to improve knowledge about European research structures and networks;
- to become familiarized with working conditions in European research centres;
- to promote cross-fertilization and cooperation, through the fellowships, between research groups working in similar areas in different laboratories.

Conditions

Candidates must:

- have obtained a PhD degree during the last eight years (prior to the year of the application deadline) or be in the last year of the thesis work;
- be fluent in English;
- have completed their PhD before starting the grant.

The fellows are appointed either by a stipend (an agreement for a research training programme) or a working contract. The type of contract and the monthly allowance/salary depends on the hosting institute.

Application deadlines

Deadlines for applications are currently 30 April and 30 September each year.

Since its inception in 1991, over 750 fellows have passed through the programme. In 2021, 26 young scientists commenced an ERCIM PhD fellowship and 54 fellows have been hosted during the year. Since 2005, the Fellowship Programme is named in honour of Alain Bensoussan, former president of Inria, one of the three ERCIM founding institutes.

http://fellowship.ercim.eu

Beyond Compliance - Digital Ethics in Research

Paris, 17-18 October 2022

The ERCIM Ethics Working Group organises a workshop in Paris on 17 and 18 October, targeted at researchers and Research Ethics Boards (REBs). The event will consist of keynotes, presentations, tutorials and interactive sessions, and will provide ample time for open discussions.

Researchers in digital sciences face tough ethical questions in their daily activity for which there are not yet consensual answers among the research community. The forum "Beyond Compliance" aims at advancing the discussion about those issues. The outcomes of the workshop will provide input for policy makers.

Preliminary programme

Day 1: Monday, 17 October 2022

- 09:00-09:15: Welcome
- 09:15-10:00: General overview, from Belmont to Menlo to what now?
- 10:15-12:15: Session 1: Strengthening research ethics review and oversight
- 14:00-16:00: Session 2: Research ethics in a cross-disciplinary and cross-cultural setting
- 16:15-18:15: Session 3 Research ethics in the era of big data and AI

Day 2: Tuesday, 18 October 2022

- 08:30-10:30: Session 4: Tutorial
- 10:45-12:45: Session 5: Raising awareness, fostering responsible research and identifying best practices
- 14:30-16:30: Session 6: New horizons, new challenges
- 16:30-17:00: Closing remarks.

If you are interested to participate or if you would like to receive more information, please contact the organisers at beyondcompliance@ercim.eu

Link:
https://kwz.me/hjU

Support for Ukraine

Russia's invasion of Ukraine has brought incredible suffering to the Ukrainian people and has affected the scientific community. ERCIM institutes feel for all Ukrainians and especially for Ukrainian staff and colleagues who have family and friends in Ukraine, and express solidarity with them as well as with our Russian colleagues and staff who are suffering from this conflict.

Many initiatives have been launched to help Ukrainian scientists. Here are a few examples from the Netherlands and Italy and France.

Suspension of partnerships with Russia and Belarus

The Dutch Research Council (NWO), including our Dutch member CWI, and other Dutch knowledge institutions such as universities, university hospitals, universities of applied sciences, the Royal Netherlands Academy of Arts and Sciences and others, have decided to suspend all formal and institutional partnerships with educational and knowledge institutions in the Russian Federation and Belarus with immediate effect [L1]. Similarly, the French Ministry of Higher Education and Research suspended on 28 February 2022 all new bilateral collaborations with Russia. This applies to all higher education institutions and research institutes in France, including Inria.

Employment of Ukrainian researchers

From the beginning of the conflict, the entire scientific network of the Italian National Research Council (CNR) was mobilised to support and welcome students, researchers and lecturers, but also to contribute to socio-political analysis and reinforce the message that science is the bearer of peace, friendship and cooperation.

CNR has already awarded 66 scholarships to Ukrainian graduates, professors and researchers who have faced serious difficulties due to the conflict. Calls for applications are published by the research institutes and are available at [L2, L3] along with full details.

Inria has set up a dedicated team to deal with any difficulties that Ukranian and Russian researchers may encounter. Solutions are offered to overcome the personal situation, from financial help to psychological support in English via a special hotline. This applies to researchers as well as students and support staff. The information is updated on the Inria intranet site on a dedicated page.

Financial support

In the Netherlands, the Governing Board of NWO has set up an emergency fund of €1 million. First, the fund is intended to support Ukrainian, Russian and Belarusian staff working at the NWO. The board wants to use it to help them if they run into acute financial problems because of the war.

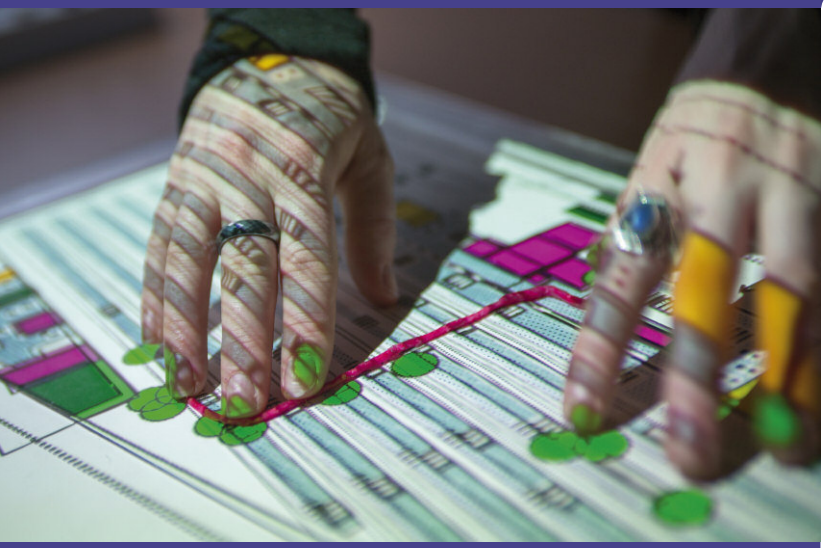
Second, the fund is intended to support Ukrainian researchers who have fled from their home country to The Netherlands. NWO believes that these refugees should have a safe (working) place. NWO would also like to make a concrete contribution to the Young Academy's initiative for a national coordinating body. The aim is to provide practical support to refugee researchers, lecturers and students as quickly as possible so that they can continue their research and studies at a Dutch knowledge institution, for example through the Foundation for Refugee Students (UAF).

In France, financial support within the Ukraine Solidarity emergency fund is available, including a six-month program together with the French national research funding agency ANR, to help Ukrainian researchers within the frame of the “PAUSE-ARN Ukraine” programme [L4, L5] that supports scientists and artists in exile by facilitating their reception in higher education and research institutions.

At the European level, the European Union, its Member States and Europeans across the continent are committed to helping people fleeing the war in Ukraine through the ERA4Ukraine [L6] initiative. "We are working on all fronts to support Ukraine with aid, humanitarian assistance and disaster response," says the Euraxess website. This particular initiative aims to support researchers in Ukraine by giving them an overview of all existing measures at the European and national level.

Links:

[L1] https://www.cwi.nl/news/2022/nwo-and-cwi-condemn-russian-attack-on-ukraine-preparing-measures (March 2022)
[L2] https://www.urp.cnr.it/pagina.php?id=6
[L3] https://www.cnr.it/en/war-in-ukraine
[L4] https://kwz.me/hjV
[L5] https://kwz.me/hjW
[L6] https://euraxess.ec.europa.eu/ukraine



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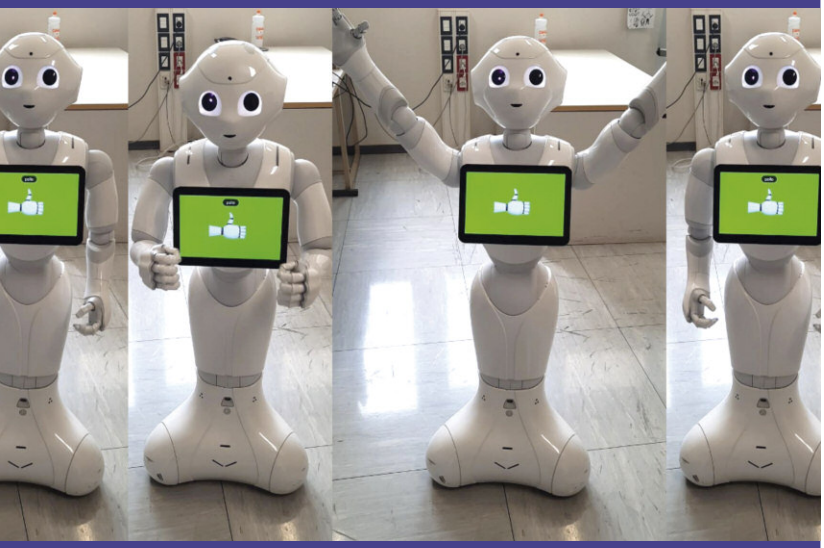

Photo: ISTO-CNR

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Introduction to the special theme

Assistive Technologies for a More Accessible and Inclusive Society

by the guest editors Christine Azevedo Coste (Inria) and Barbara Leporini (ISTI-CNR)

People with disabilities and special needs may encounter difficulties in performing activities of daily living (ADLs), which affects their quality of life. Therefore, they have always sought alternative solutions and ways to be as autonomous as possible in performing activities of daily living in different areas such as education, work and even leisure and entertainment. Technology has opened up previously unthinkable scenarios by providing software and hardware that can compensate for the possible limitations of people with disabilities. There would be many examples we could cite for many categories of users.

When we refer to technologies that are designed to compensate for the difficulties of people with disabilities, we talk about assistive technologies. These include applications, software and digital tools, as well as robotic aids such as mobility aids for motion impaired people, screen readers and magnifiers for visually impaired users, applications for reading aloud, cognitive maps, etc. In addition, assistive technologies are understood as all digital and technological tools that in some way enable analysis or the provision of services that are useful to move forward in identifying problems and solutions to support people with difficulties. For this reason, research continues to address assistive technologies and proposes many studies and prototypes that represent progress in the field.

The field is very multidisciplinary and has a strong social impact, which explains the interest of different scientific communities. The keyword "assistive technology" is mentioned in 1086 articles on pubmed.org in 2021, compared to 584 in 2011. However, many scientific papers refer to assistive technologies, although they do not list "assistive technologies" among the keywords, but words like "accessibility" "autonomy" or specific words like "screen reader". It is therefore difficult to grasp how many papers there actually are in the literature.

Certainly on the topic of assistive technologies there is a lot of interest and a growing body of work. There has been considerable development in the area of accessibility of user interfaces and of software in general for a variety of reasons (education, everyday activities, entertainment, etc.), to the

use of devices, sensors and robotics to develop hardware assistive technologies that can overcome many limitations.

Conferences offer workshops and special sessions on this topic (IEEE Engineering in Medicine and Biology Society 2022, International Conference on Intelligent Robots and Systems IROS 2021, IEEE International Conference on Intelligent Systems 2020, etc). For Human-Computer Interaction (HCI) conferences, accessibility and assistive technologies are also among the accepted workshops and topics. These include annual or biennial conferences such as ACM Computer Human-Interaction (CHI), ACM Assets, Springer ICCHP, PETRA and so on. Technology challenge events such as Cybathlon [L1], Lyon Cyber Days, EPFL and Assistive Technologies Challenge are organised to promote these technologies and drive development.

Furthermore, over the years we have moved from the more specific concept of "accessibility" and "assistive technologies" that enable people with disabilities to perform certain activities, to the broader concept of "inclusion" that envisages the use of products and systems by all and not only by certain categories. This is also thanks to the contribution of Europe, which a few years ago started to talk about digital inclusion as a goal to be achieved in order to open up services to all and thus promote a more inclusive society. This has radically changed the perspective, also on the part of researchers, because there is a tendency to stop thinking about individual categories of users and start thinking about how to make a product and service truly usable for all, regardless of the difficulties and limitations that different people may have. In a way, this was a turning point in research and development.

So important is the contribution of Europe, which has put forward specific European directives in the field of accessibility and inclusion in terms of services and products open to all, such as EU Directives EU/2016/2102 and EU/2019/882, which provide for the use of products and services in an inclusive manner. This is undoubtedly a good sign of openness to inclusion, and this also has an impact on the world of research, the public and private sectors.

We therefore expect that in the coming years the different sectors, including research, will explore and propose new solutions that will support the implementation of the EU Directives in order to create an increasingly inclusive society.

This special issue aims to represent a further step in this field by presenting numerous contributions with studies in the field of assistive technology with different and complementary approaches. The papers presented deal with a variety of disabilities and special needs in different fields.

They range from looking at the collaboration of people with disabilities as an added value in finding solutions, to proposing useful services in the field of accessibility and digital innovation for all in the use of museum content, access to content and news, including internet accessibility.

Two papers address the problem of access to science content, astronomy and geology, for people with visual impairments or people who may have problems due to mobility issues.

Several contributions deal with applications for people with cognitive difficulties, e.g. serious games, or with software solutions for the inclusion of people with autism spectrum disorders in the world of work.

Also using software solutions, prototypes are proposed to help blind or visually impaired people perceive content useful for orientation or access to popular or scientific information.

Some contributions address the problem of movement support and therapy for people with motor difficulties.

Finally, a contribution based on the use of text-to-speech addresses people with severe hearing problems.

Links:
[L1] https://cybathlon.ethz.ch/en
[L2] https://ants-asso.com/en/lyon-cyber-days-en/
[L3] https://kwz.me/hjX

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Humanlab: Innovating for and with End-users with Disabilities

by Christine Azevedo Coste (Inria) and Roger Pissard-Gibollet (Inria)

A model of a frugal, replicable and open-source technological innovation approach to improve the quality of life of people with disabilities by developing technical aids for an individual and making them accessible to the greatest number.

Humanlab Inria (HLI)

Humanlabs are collaborative digital fabrication spaces. The operating principle is similar to that of Fab Labs, a concept created at MIT by Neil Gershenfeld in the late 1990s: places of learning and innovation that offer access to an environment, skills and technologies to enable the manufacture of technical objects.

Humanlabs are Fab Labs dedicated to people with disabilities to help them realise a project related to their situation and to enable them to appropriate technology for their own use. These are not medical equipment centres, and the developed homemade prototypes are not medical devices. It is a complementary approach to complete or customise commercial devices at the margin. For simple needs, it can also replace expensive or non-existent devices. The realised devices can be, for example, a new joystick for an electric wheelchair or a motorised thumb orthosis with a control unit. The disabled person becomes a project leader by expressing his or her needs or ideas for realisation.

The first Humanlab, MyHumanKit, was created in 2017 in France [L1]. Inria joined the Humanlab network in 2021 [L2, L3] to help meet the needs expressed by people with disabilities. The Humanlab Inria (HLI) action is part of a frugal, reproducible and open-source innovation approach that aims to implement the scientific and technological know-how of Inria to meet specific needs. Unlike other Humanlabs, HLI does not receive any visitors but contributes to the development of projects for its partners.

Humanlabs regularly organise Hackathon-type days, where multidisciplinary teams are formed around the project owner and work for several days on a project. MyHumanKit has organised several events of this type (Fabrikariums) with the company Ariane Group. Employees of the company with disabilities propose the projects [L4].

Exofinger

We propose to illustrate our approach and our activity around a flagship project: Exofinger, a motorised finger orthosis for Bastien, who suffers from tetraplegia and has difficulty holding objects. His thumb has little strength but has active extension. Bastien chose a simple task for the project, which was to hold a pen to sign a document. This was one of the Fabrikarium 2020 projects, to which MyHumanKit, Inria, Humanlab Saint Pierre [L5] and ArianeGroup contributed.

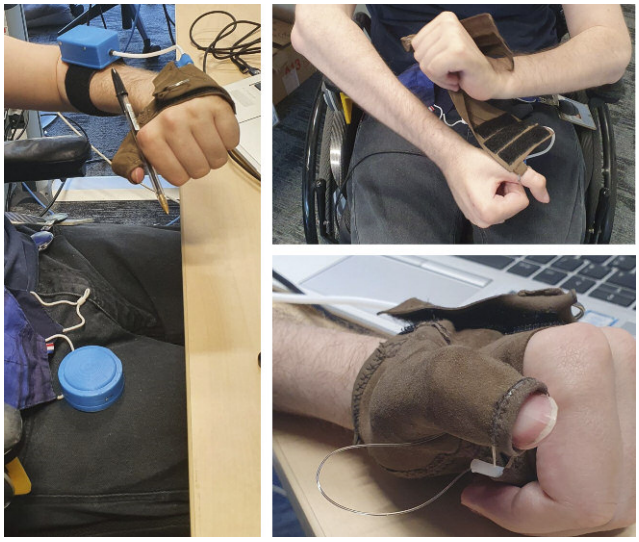

Figure 1: Use of the Exofinger system by a user with tetraplegia.

After discussion and exploration of several hypotheses, the retained principle was that of a glove guiding cables pulled by a motor located on the forearm to apply the pulp of the thumb on the lateral edge of the index finger (key grip) to clamp an object [L6].

The HLI Inria team worked from the prototype produced at Fabrikarium 2020 to propose an advanced version of the device. A control unit positioned on the arm, containing the motor with reduction gearbox and an Adafruit feather nrf52840 microcontroller, pulls a cable that runs inside a glove. The cable is wound and unwound on a spool. We also developed a wireless button using another Adafruit feather that communicates with the control unit via Bluetooth Low Energy (BLE). This wireless button activates the motor and winds the cable to bring the thumb closer to the rest of the hand. The button is also used to stop the motor, allowing the thumb to return to its resting position (see Figure 1).

The glove is based on the principle of protecting the hands when propelling a wheelchair, by which the user can put the glove on independently by wrapping it around the hand instead of slipping it on.

A glove pattern generator has been developed to enable adaptation to individual morphology. All that is required is to enter a few characteristic dimensions of the hand and fingers to generate a printable pattern necessary for the production of the glove (leather cutting and sewing).

A phone app has been developed to trigger the activation of the motor in the same way as the wireless button. It also allows the user to obtain the battery status of the motor housing and to set the clamping range.

An experimental validation will be carried out in the coming months to assess the interest of the solution to various user profiles who have difficulty grasping objects.

Used tools

In order to be reproducible by the general public, we use open-source design software, for example Kicad for electronics or Freecad for mechanics. The machines used for manufacturing

are found in common Fab Labs and include 3D printers, laser-cutting machines, sewing machines, etc. The chosen hardware is also accessible, e.g., Arduino or RaspberryPi for controllers. Sensors and actuators can be connected to these controllers to interact with the environment.

What guides us

In the Humanlab approach, the process of realisation is as important, if not more important, than the realisation of the object itself. By guiding the whole realisation process, the project owner becomes familiar with the custom-made technical aid developed. This is fundamental to Humanlabs' ways for two main reasons: to be able to understand the functioning of the technical aid in order to fix it or make it evolve if necessary, and to see his or her own disability and technical aid differently. A Humanlab project is made up of different people: disabled, volunteers, technical or medical specialists, who collaborate to create a device. It is a space of socialisation and reappropriation of the stakes of the handicap. To facilitate this, the objects must be duplicable, modifiable and reusable; one way to ensure this is the open-source approach.

For G. Simondon, a French philosopher, the alienation of humans from technical objects is due to the misunderstanding of the mode of existence of technical objects [1] and of their internal functioning. This idea leads to proposals made by the author in the sense of a pedagogy and technical culture, and of a democratisation of technical knowledge. This is what drives HLI.

We are also convinced that meeting individual needs with less-complex devices must generate new research problems. From a simple homemade system, we can try to generalise it to answer a class of needs, to measure its technical and clinical effectiveness. Moreover, it allows us to think about the tension between the complexity of a device and the degree of satisfaction of a need; In a way, we are in the low-tech movement [L7] where simple technology is opposed to the obsession of high technology.

Links:

[L1] https://myhumankit.org/le-humanlab/
[L2] https://project.inria.fr/humanlabinria/
[L3] https://myhumankit.org/en/network/
[L4] https://kwz.me/hj7
[L5] https://www.humanlabsaintpierre.org/
[L6] https://kwz.me/hj6
[L7] https://solar.lowtechmagazine.com/

Reference:

[1] G. Simondon: "Du mode d'existence des objets techniques", Paris, Aubier, 1958.

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Social Inclusion, Health and Content

by Markus Tauber, Benedikt Gollan (Research Studios Austria FG), Christoph Schmittner (Austrian Institute of Technology GmbH) and Thomas Ballhausen (University Mozarteum Salzburg)

In this paper we propose an approach to use assistive technologies beyond traditional Ambient Assisting Living Setups for a more accessible and inclusive society. This supports including and involving elderly people via sharing of cultural content and linking it to individual biographies and supporting the work of caregivers who require this information to support their patients more adequately.

Elderly woman using immersive technologies for training and recreation.

Europe is currently experiencing the emergence of an increasingly ageing society. According to the WHO, there is "little evidence to suggest that older people today are experiencing their later years in better health than their parents" [L1]. Older people prefer to stay in the comfort of their own homes, to age in place [1]. It very much seems like traditional forms of assisted living, such as living in institutional residences or facilities, have fallen out of favour. In such cases, mostly professional nurses treat patients. The nursing profession involves a range of activities that demand a great deal of strength from nurses, both mentally and physically. The current COVID-19 situation increases the effort required in a caregiver's daily routine due to various safety regulations and spacing requirements. Monitoring vital signs and performing important activities is combined with a lot of effort in an already challenging nursing job.

The consideration of Internet of Things (IoT) sensors, third-party cloud services and other Ambient or Active Assisted Living (AAL) related technologies has been shown [L2] [2] [3] to be of significant use in collecting information regarding the vital conditions of patients automatically and hence has potential to ease the work of caregivers. Furthermore, it allows elderly people to remain in their homes.

Additionally, we see a positive effect of arts and music on people [L3], which, especially if related to personal experiences, e.g., in the patient's individual biography, will have a positive impact on the conditions of the people who receive treatment and those who provide it. Careful and informed selection of content and the monitoring of related vital signs will support caregivers in keeping their patients active but also supports them in identifying requirements for improved treatment and, most importantly, improves the lives of the people receiving care.

We outline here a concept of how an invigorated understanding of culture tech can be combined with technology beyond what is commonly known as AAL to improve the life and caregiving for elderly people and prevent social exclusion.

To realise such a concept, we consider three conceptual building blocks – technology, beyond traditional AAL, culture tech and the compliance with existing security, safety and ethical standards.

Technology:

- Quantified Self – Wearable devices are becoming less intrusive and more intuitive, enabling the continuous assessment of vital signs and enabling the notifications in emergency situations but also for regular monitoring over a longer period.
- Infrastructural Assistance Technologies, and physical assistance devices – Smart home automation technologies can also substantially support elderly people to live at home. Recent advances in IOT enable devices to be automatically configured and controlled via explicit (consciously controlled processes) or implicit interaction (e.g., presence, behaviour analysis). This will make the use of the technology for collecting information about patients even more attractive.
- Edutainment – Immersive technologies can also be used for gamification approaches to (i) avoid the cultural and social disconnect of elderly people (contact to relatives, participation in cultural experiences, maybe also linked to their biography) and (ii) contribute to physical and mental health (e.g., serious games as a physical rehabilitation measure or to present cognitive challenges and prevent dementia).

Content, Curatorship, Culture Tech:

- Such content-driven support, inclusion and care of elderly people will strongly benefit from the availability of cultural content in a free and structured manner such as in Europeana or Historiana. Next to the open access of carefully curated digitised artefacts, the advantages of enriched metadata, narrativity and interconnectedness within the respective collection will allow sensible and serious use of the repositories in question.
- This use of digitised cultural heritage will be particularly successful if culture itself is the basis of all relevant development steps and work processes. We therefore aim at a renewed understanding of culture tech to ensure an intertwinedness of culture and technology that transcends the concept of a mere toolbox to help distribute or market content. That also includes a broader and more informed understanding of cultural heritage that is not only material for the worst-case stress test of technological developments, but rather at the core of all described endeavours.

Security, Safety, Ethics:

- Using technology in support of giving care to elderly people also requires reliable and available properties of the components, as delayed response time between any of the modules might be dangerous, especially if timely correlation of the monitoring data is important. This is a safety aspect that will be considered during the design of an architecture to ensure using the technologies that are suitable for real-time data processing and will require revisiting the correspondent methodologies in this setup.
- The technology must be trustworthy for patients and caregivers alike. This can be achieved by designing corresponding feedback and explainability approaches. Trust, ethical and legal norms related to such technology may mean different things depending on the type of stakeholder it concerns. A structure and role-based approach is required to document and assess the technology and services used. This should be inspired by existing work like the EC HLEG publication "Ethics Guidelines for Trustworthy AI" (Final report April 2019, HLEG AI).

Overall, the availability of content, technology and guidelines for how to use them in a secure, safe and ethical manner has great potential for improving the life of elderly people and the entire caregiving process. Our investigation of supporting topics and existing work shows great potential for related research in upcoming projects.

Links:

[L1] https://doi.org/10.2471/blt.19.246801 .
[L2] http://mytactile.eu/
[L3] https://kwz.me/hjj

References:

[1] J. H. Johnson, S. J. Appold: "US older adults: Demographics, living arrangements, and barriers to aging in place", Kenan Institute, 2017.
[2] M. El Kamali, et al.: "Towards the NESTORE e-Coach: a tangible and embodied conversational agent for older adults", in Proc. of the 2018 ACM Int. Joint Conf. and 2018 Int. Symposium on Pervasive and Ubiquitous Computing and Wearable Computers, ACM (2018), pp. 1656-1663.
[3] N. Van den Berg, et al: "AGnES: supporting general practitioners with qualified medical practice personnel: model project evaluation regarding quality and acceptance" Deutsches Ärzteblatt Int., 106 (1–2) (2009), p. 3.

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Supporting Trust Related to Health News Through Artificial Intelligence

by Paul Isaris (SciFY PNPC), George Giannakopoulos (SciFY PNPC), Alexandros Tzoumas (SciFY PNPC)

Health-related news articles have become increasingly significant during the past few years, especially in crisis times. Their impact can be significant, to communicate critical knowledge, but also to bend the truth and provoke unwanted reactions from the public, or even reduce the efficacy of large-scale health efforts. However, Artificial Intelligence can support the reader when evaluating news items related to health by summarising different views on the same subject into a single, non-redundant summary. Such tools can change the way we interact with health news sources, help us build trust, and empower our verification capacity.

Artificial Intelligence (AI) changes the way we work, get informed, and interact with our community. An increasing number of news websites now operate with the help of AI in order to offer rapid and evidence-based journalism.

However, in the era of real-time information and rapid news coverage, one needs to verify the integrity of the news they read, and more so when it concerns health news streams. AI can support the user in such tasks, related to the trustworthiness of an article. On the other hand, the fact that news agencies rely significantly on automation and AI in order to produce news articles has led to a situation where the quantity of news articles battles the quality of the information offered. In health-related news, this is of great importance, since readers may pick a free online article over an expensive and time-costly appointment with the doctor. Thus, in such cases, evidence and science-backed content are critical.

Ideally, a health news article should list its source scientific publications, or surveys, or be verified by a human with a specialty in the related health sector. "Fake news", i.e. false, or misleading information presented as news, can often (mis)lead readers to believe something that has not been backed by evidence or that is damaging to another person or a cause. This is especially true for people with reduced digital literacy since they are not usually able to do their own research on what they read. Integrity and truth are of great importance, especially in an era when thousands of news articles are being published every hour, and the number of news sources is excessive.

In such a setting, we can use AI to identify, across many sources, clusters of news items about the same topic, and use automatic summarisation techniques to create summaries that offer all the viewpoints, without redundancy, keeping the links to the original sources. This keeps the human in the communication loop, allowing them to correct and filter out any misleading information, while using computers to speed up the collection of news items, searching for similar texts, and providing a holistic view for the human to evaluate.

NewSum is a news summarisation app for Android devices [F1]. It is the first application to automatically create news summaries from multiple sources, based on multilingual summarisation research [1,2]. Offered in Greek and English, the app [L1] outlines the main points provided by the different news sources, without redundancy, facilitating the reader. Another demonstration of NewSum relates to the Social Web Observatory Project [L2], which overviews the trends of news sites and social media.

Thousands of users have used it on a daily basis for real-time, multilateral news reading. By using a simple yet intuitive user interface, NewSum is applicable also to users with little-to-no familiarity with technology. This allows NewSum to act not only as a useful news summarisation mobile app, but also as an entry-level technological path for people with little-to-no experience with mobile apps and technology.

SHAPES (Smart and Health Ageing through People Engaging in Supportive Systems) [3] is an Innovation Action funded by the European Union's Horizon 2020 programme involving 36 partners from a total of 14 European countries. It aims at creating an integrated IT platform that will bring together a wide

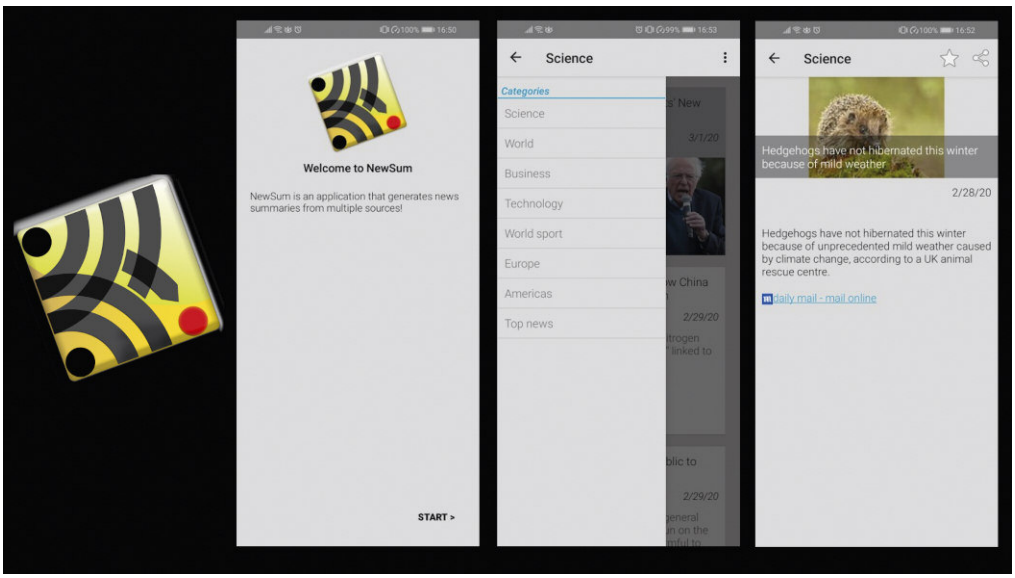

Figure 1: Newsum offers a wide variety of news articles, automatically summarised into cohesive texts.

range of digital solutions focused on improving the health, wellbeing, and independence of people as they get older. Sustaining longer and healthy lives requires solutions that minimise risks of injury, frailty, and long-term chronic diseases. These solutions also relate to how the ageing population will adapt to the information flux from online sources. This is where NewSum comes in.

NewSum participates as a Digital Solution in the "LLM CARE Healthcare System for Cognitive and Physical training / Improving In-Home and Community-based Care" Pilot, which will run in three countries. This pilot includes, among other outcomes, several non-pharmaceutical interventions against cognitive deterioration, but also an increased connection of the elderly to the wider community and environment. The contribution of NewSum relates to facilitating health news reading and connecting the elderly to the wider world, through news. It is also expected to help the reader retain critical evaluation capacity and access trustworthy health news. To this end, NewSum emphasizes multi-lateral viewpoints. It also provides links back to the sources allowing validation of the claims and enables holistic updates, reducing the effect of "information bubbles" that strongly bias the reader. The above points, coupled with appropriate inclusive user interfaces, remove technology skill and age barriers and support trust-building and equal information access across societal and age strata. This, in turn, builds a common ground for discussion with peers, allows information processing and related high cognitive functions to be retained through daily interaction, and forms a non-intrusive (information) accessibility solution.

Links:

[L1] https://kwz.me/hj9

[L2] https://socialwebobservatory.iit.demokritos.gr/#/about

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Digitally Enhanced Museum Accessibility in Post-COVID Era

by Christophe Ponsard (CETIC) and Ward Desmet (Computer Museum NAM-IP)

Museums play a key cultural role through the immersive experience they provide. Their accessibility for all was threatened by the COVID-19 lockdowns. In response, many museums, including our Computer Museum, have accelerated their digital transformation for improved online or hybrid experiences, with benefits for accessibility but also possibly new barriers to address.

Museums preserve cultural artefacts and make them accessible to present and future generations, through an immersive access to public. They rely on exhibitions and specific events such as conferences and workshops, which can target a specific audience. Museums remain essentially "brick-and-mortar" spaces and as such they must meet legal physical accessibility requirements with specific standards, regulations, assessments and tools for supporting this process. However, the COVID-19 pandemic has triggered many digital initiatives in museums [L1], including in our Computer Museum located in Belgium [L2].

All museums have to manage multiple interactions with a varied public from kids to seniors and mobility-impaired people. It is also a workplace for curators, experts, animators, etc. Such audiences can be characterised through archetypal descriptions embodying their user stories, called personas [1]. The following personas cover important accessibility goals:

- Alice, an animator with young kids, would like to regularly work remotely in full collaboration with her colleagues to keep a good balance in her work/private life.
- David, a deaf visitor, would like to register online, benefit from subtitling in videos and possibly specific signed language tours.
- Frank, a foreign visitor, would like to enjoy the exhibition in his native language or English.
- Walter, a wheelchair-using visitor, would like to prepare his visit through a virtual tour and consult information in an accessible way for an optimal experience.

Digital technologies can provide support for those user stories but the whole personas have to be kept in mind in order to identify emerging accessibility threats. For example, web forms enable remote access for David but must be accessible according to web standards like WCAG. This also applies to the nice virtual tour of the IN2P3 Computer Museum [L3] depicted in Figure 1 – while it may help Walter, it may also be more difficult to reach good digital accessibility given the complex multimedia navigation interface. Many museums also propose a mobile application either on a specific terminal or to install. Figure 2 depicts an example developed in our museum. It will help Frank, given the multilingual support, and David, through the subtitling features, but at the same time may prove difficult to use for Walter, given the need to swipe on a timeline while moving his wheelchair. Finally, the ease of information access for Alice from home may vary depending

Figure 1: Virtual tour of the IN2P3 Computer Museum.

Figure 2: Mobile app of the NAM-IP Computer museum.

on the mix of online collaborative tools, off-line files, email and possibly available VPN access.

From the user experience, it is interesting to analyse how advanced technologies such as the development of virtual tours or mobile applications really support the museum scenography. Different approaches exist from the basic transposition of the physical experience, e.g., video of a guided tour or paper guide made available online. The virtual museum is a more complex case. It might involve unusual controls that need to be validated for accessibility and regarding the learning curve, e.g., through a tutorial or possibly through a virtual guide (avatar). The pure transposition of the physical world into a digital one is interesting for hybrid experiences (preparation before arrival) but it might also overload the user with uninteresting information/actions (corridor pictures, the need to point in the right direction). It is interesting to consider a more conceptual level stated with goals and narratives [2]. This led us to develop our mobile application depicted in Figure 2, which can relate various artefacts, people, organisations and technologies through a timeline mechanism, enabling the support of a physical visit but also the exploration of other relationships beyond what is "hard coded" in the physical exhibition [3]. Another interesting and possibly complementary approach is gamification; it allows the user (not only kids) to engage more deeply with the content.

To summarise, new online channels can help to reach a larger and multilingual audience. Consequently, emerging threats relate to online accessibility or the interconnection between the physical and digital worlds. Some web accessibility problems are well known but others are less common and require more attention, e.g., virtual navigation or mobile apps. The use of personas, possibly reflecting user preferences and abilities or disabilities, is efficient in discovering such barriers and mitigating them. We are currently reconsidering them from a more global perspective, integrating a more immersive on-site and online user experience.

Links:
[L1] https://pro.europeana.eu/post/mapping-museum-digital-initiatives-during-covid-19
[L2] https://www.nam-ip.be
[L3] https://musee.cc.in2p3.fr

References:
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[2] M. Mason: "The elements of visitor experience in post-digital museum design", Design Principles and Practices, 2020.
[3] C. Ponsard, A. Masson and W. Desmet: "Historical Knowledge Modelling and Analysis through Ontologies and Timeline Extraction Operators: Application to Computing Heritage", MODELSWARD 2022.

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An Open Virtual Reality Toolbox for Accessible News Reading

by Hui-Yin Wu (Centre Inria d'Université Côte d'Azur, France), Aurélie Calabrèse (Aix-Marseille Univ, CNRS, LPC, France), and Pierre Kornprobst (Centre Inria d'Université Côte d'Azur, France)

The Inria Biovision team has been working on designing accessible news-reading experiences in virtual reality (VR) for low-vision patients. We present the advantages of VR as well as design principles based on clinical studies of low-vision reading and newspaper design. This is realised through a novel VR toolbox that can be customised to create a personalised and accessible news-reading environment.

Low-vision conditions generally refer to visual impairments that cannot be corrected or cured, resulting in a loss of visual acuity, which most notably impacts reading activities. Newspapers pose a unique challenge due to their unpredictable layout, timely nature, and condensed formatting, making them visually complex for low-vision audiences, and a challenge for news publishers to create accessible versions. News reading is an essential activity affording social connection, entertainment, and learning in modern society. With an estimated 180

million people suffering from low vision worldwide and rapidly rising, there is a strong need for accessible news-reading platforms.

Our Project

The Inria Biovision team [L1] has been tackling this problem since 2017 through virtual reality (VR) technology. The introduction of budget headsets such as Google Cardboard©, or Oculus©, has made VR available to the general public. With the freedom to fully customise a 360° visual space, VR solutions have already been studied and developed in the context of low vision for rehabilitation, architecture design, public awareness, and more.

For low-vision reading, VR allows the user to personalise the look and feel of the reading content. However, the development of reading applications in VR is still in its early stages. That is why our team took on this challenge to propose a novel toolbox for creating accessible news-reading experiences for low vision.

Design Principles for Low-Vision Reading in VR

We surveyed eight existing reading applications on the market for VR headsets and studied news journal design guidelines, and recommendations of low-vision scientists on how to make text accessible for patients. From this we identified five important principles to designing reading applications for low vision:

- *Global and local navigation*. The large visual space in VR can be properly used to design intuitive navigation both globally, between different articles and pages, and locally on line-to-line navigation by parsing and enlarging text.
- *Adjustable print and text layout*. Adjustable variables for print should include (1) size: reasonably up to 100 times the size of newsprint, (2) fonts: those such as Tiresias and Eido have been developed with accessibility in mind, and (3) spacing: between words and lines. Ideally, text should conform to medical standards for measuring visual acuity using visual degrees, and defining line width on the number of characters.
- *Smart text contrasting*. Intelligent color adjustments can increase the polarity of text, including white text on a black background and yellow on blue without affecting non-text media. Previous studies indicate an improvement of 10-40% in reading speed.
- Image enhancement. Integrating image-enhancement techniques to sharpen text and media content for better visibility.
- *Accessibility Menu*. Everyone has different preferences. These principles should be implemented as options to allow personalisation of the reading space. Enabling voice commands would further facilitate interaction, avoiding crowded interfaces of buttons, and simplifying the user experience.

An Open VR Toolbox for Accessible Reading Design

These design principles were implemented as an open toolbox [L2]. We chose to use WebGL technology, which runs on most VR browsers. The interface view space is composed of the page view, text view, media view, and accessibility menu (Figure 1), all of which can be flexibly moved around, hidden, or summoned at the user's preference.

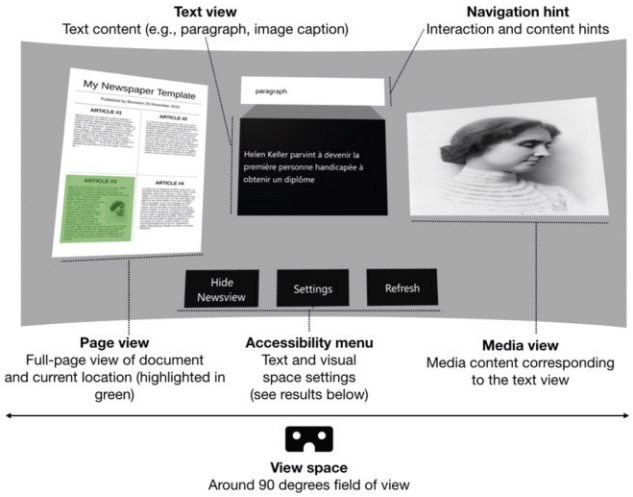

Figure 1: The interface of our toolbox is composed of four components: (1) a page view to highlight global reading position, (2) a text view presenting augmented text content along with the content type in the navigation hint, (3) a media view for associate visual media content, and (4) the accessibility menu to adjust visual parameters.

The page view displays the current page image with a global navigation indicator that highlights the part that is currently displayed in the text and media views to help the user immediately identify their reading position.

Text view in the middle of the visual space shows headings, captions, paragraphs, or other text content. Text is presented using a card-deck navigation metaphor, with a remote go-to next or previous cards and select cards (e.g., an article) for in-depth reading. Print size and color can be adjusted through the accessibility menu (Figure 2).

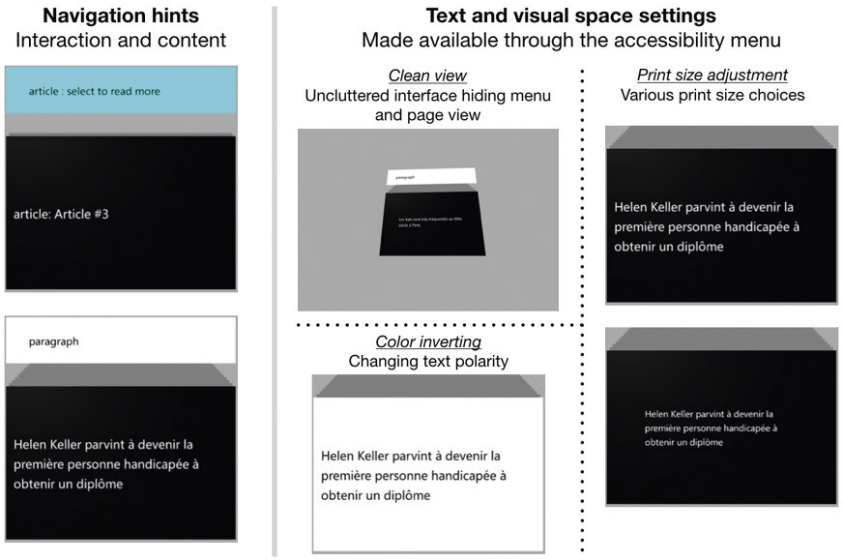

Figure 2: The toolbox offers various customisation of accessibility parameters such as navigation hints to indicate what text content is being shown and if more content is linked to a card (left), and print size, interface decluttering, and colour options (right).

Media view shows any media content associated with the current text view, with alternative text support.

Navigation hint indicates to the reader what type of content is currently being displayed in the text and media views.

To Reading Accessibility and Beyond!

Our project highlights the high potential of immersive technologies to facilitate accessible media experiences far beyond simple magnification or image enhancement of classical assistive technologies. Their potential is supported by clinical proofs of concept, suggesting that smart augmentation principles might be beneficially implemented in VR [2], with the flexibility and full control over visual variables in a 3D environment, personalised to patients' needs. However, to leverage the VR/AR to design novel e-health systems, we need rigorous scientific, medical, and ergonomic evaluation of these systems.

This calls for translational research and cross-disciplinary approaches that implicate the vision science community to study fundamental and clinical vision science. An immediate challenge to confront here is the high technical barrier to create VR experiments. Existing packages like PsychoPy have successfully tackled this difficulty to generate stimuli on 2D monitors through a script programming interface. With the same ambition as PsychoPy, our team is currently working on the development of the Perception Toolbox for Virtual Reality (PTVR) package [L3], which proposes a scripting interface to design stimuli in virtual reality and is developed under an Open Science framework. This work is carried out in collaboration with E. Castet (Aix Marseille Univ, CNRS, LPC) in the context of ANR DEVISE [L4]. With the democratisation of immersive technologies and research-grounded solutions, our vision is that immersive technologies can soon be deployed on a larger scale to meet various patients' needs.

Links:

[L1] https://team.inria.fr/biovision/
[L2] https://team.inria.fr/biovision/cardnews3d/
[L3] https://ptvr.inria.fr/
[L4] https://anr.fr/Projet-ANR-20-CE19-0018

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Speech-to-Text Technology for Hard-of-Hearing People

by Manuela Hürlimann (Centre for Artificial Intelligence, Zurich University of Applied Sciences), Jolanda Galbier (Pro Audito Schweiz) and Mark Cieliebak (Centre for Artificial Intelligence, Zurich University of Applied Sciences)

Hard-of-hearing people face challenges in daily interactions that involve spoken language, such as meetings or doctor's visits. Automatic speech recognition technology can support them by providing a written transcript of the conversation. Pro Audito Schweiz, the Swiss federation of hard-of-hearing people, and the Centre for Artificial Intelligence (CAI) at the Zurich University of Applied Sciences (ZHAW) conducted a preliminary study into the use of Speech-to-Text (STT) for this target group. Our survey among the members of Pro Audito found that there is large interest in using automated solutions for better understanding in everyday situations. We now propose to take the next step and develop an application which uses ZHAW's high-quality STT models.

Figure 1: A group discussion – this is a situation in which the proposed application could support hard-of-hearing people (Photo: colourbox.de).

The average person holds more than 25 conversations per day, which can be very challenging for people with hearing loss, as their auditory perception of spoken language is limited. Pro Audito provides an interpreting service ("Schriftdolmetschen"), where a trained human interpreter accompanies the hard-of-hearing person and creates a written transcript of the interaction on the fly. While this is highly appreciated with 1,800 hours of speech transcribed each year, the financial compensation by the Swiss disability insurance is currently limited to professional and educational settings and the cost is capped [L1]. We received an Innovation Cheque from Innosuisse to run a preliminary study consisting of a needs analysis and market research. Our goal was to find out how STT could be used to create an offer for people with hearing loss that provides more flexibility and independence.

Needs analysis

The needs analysis was conducted via a detailed survey among the members of Pro Audito, which was answered by 166 respondents, of which 87% have moderate or severe hearing loss. We found that 28% already use technical support to facilitate understanding, which consists mostly of external microphones, headsets or rerouting sound to their hearing aid via Bluetooth (e.g., when watching TV). Some people already use

STT apps, where the most frequently named use cases are appointments at the doctor or optometrist, meetings (both online and on-site, see Figure 1) and conversations in crowded spaces with background noise (such as restaurants). 57% of our respondents can imagine using STT technology to facilitate their understanding – the most frequently named languages are Standard German, Swiss German, French and English. They were also asked what would be important features of an STT application: it should be as easy as possible to use and provide high-quality recognition (e.g., accuracy, robustness to noise, specialised vocabulary) with minimum latency. Many of our respondents would be willing to pay for a STT solution, either as a one-off purchase or on a monthly subscription basis. Most people would be willing to pay between 50 and 150 CHF one-off or 10 CHF per month.

Market Research

We reviewed existing STT solutions for people with hearing loss and found that currently no single solution ticks all the boxes – some have good recognition accuracy but a poor user interface, others are very easy to use but quickly become unstable when tested in real-life conditions. We are currently developing STT models for various languages at ZHAW. We believe that the best way forward is to develop a dedicated application for hard-of-hearing people and integrate our models for the following reasons:

- Latency: For real-time STT, latency needs to be minimised as much as possible. This means that ideally the model runs on-device, since using external cloud providers introduces an additional time-lag. Creating STT models which are small enough to run on a device such as a smartphone yet have high prediction accuracy is an important challenge.
- Privacy: Users will in some cases want to transcribe sensitive information, such as a conversation with a doctor. With a local model, privacy can be guaranteed.
- Customisation: The use cases from our survey offer significant challenges such as a large number of speakers, spontaneous speech, and background noise. If we use our own STT models, we have full control over their customisation.

Furthermore, it is important that this application can run on an inexpensive device to be accessible to as many users as possible; this is a further argument in favour of a smartphone app.

Future Activities

We propose to develop an application for hard-of-hearing people based on our STT models, which will use a high-precision microphone to record audio – either from the hearing aid itself, a partner microphone, or a wireless lapel microphone. The audio is then transmitted via Bluetooth to the user's smartphone. For minimum latency as well as maximum privacy and customisation, the transcription will be carried out on-device and will be displayed in an easy-to-use interface.

Pro Audito and ZHAW are now looking for partners interested in jointly developing and operating this application - if you are interested, please refer to the contact information below.

Link: [L1] https://kwz.me/hjf

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Improving Accessibility for Deep Sky Observation

by Olivier Parisot, Pierrick Bruneau, Patrik Hitzelberger (Luxembourg Institute of Science and Technology), Gilles Krebs and Christophe Destruel (Vaonis)

Electronically Assisted Astronomy allows near-real-time generation of enhanced views of deep sky objects like nebulae and galaxies. This approach is ideal for people who have difficulty with direct observation through a telescope, especially those who have poor visual acuity or physical difficulties with positioning oneself correctly in front of the instrument.

Electronically Assisted Astronomy is widely applied today by astronomers to observe planets and deep faint sky objects like nebulae, galaxies, or globular clusters. By capturing images directly from a telescope coupled to a camera, this approach allows generation of enhanced views of observed targets that can be displayed in near real-time. While astrophotography aims at producing detailed and visually appealing images after numerous hours of post-processing of long exposure images [1], Electronically Assisted Astronomy aims at quickly getting images by stacking on-the-fly raw images in order to accumulate the (faint) signal (and then reduce the inherent noise). All this is made possible by the fact that recent CMOS/CCD cameras are extremely sensitive and have a very low read noise (i.e., amount of noise generated by electronics) [2], which makes it possible to obtain already satisfactory results with lightweight image processing.

By comparing with direct visual observation through an eyepiece and an instrument (refractor or reflector), this approach

Figure 1: Live session of Electronically Assisted Astronomy on the night of 14 May 2022 from a village in the northeast of France.

Figure 2: Image of the M5 globular cluster (distance from Earth: 24,460 light years), as seen on the night of 9 May 2022 from a village in the northeast of France. 125 raw images of 10s exposure-time were stacked in near real-time to obtain this result.

has definite advantages for people who have physical constraints preventing them from enjoying astronomy to the fullest: poor eyesight requiring the wearing of glasses (in particular for people with astigmatism), difficulties in positioning to look through the eyepiece of a telescope, etc. Not to mention the fact that most people cannot see colours during visual observations (with a few exceptions, the light from deep sky objects is too weak for the colour to be visible), making deep sky observing sessions frustrating for a novice.

Electronically Assisted Astronomy also makes it possible to observe in difficult outdoor conditions, for example in places heavily impacted by light pollution. Deep sky objects almost invisible in the eyepiece of an urban or suburban sky become impressive and detailed.

Nevertheless, the practical implementation is not straightforward. Electronically Assisted Astronomy requires a complex hardware setup [L1]: motorised alt-azimuthal or equatorial mount for tracking targets (with respect to the Earth's rotation), refractor/reflector with good-quality lens, CMOS/CCD dedicated cameras, pollution filters, etc. Depending on the size of the targets, a Barlow lens (for planets and planetary nebulae) or a focal length reducer (for large nebulae) is also required. Moreover, dedicated software like Sharpcap or AstroDMX are needed to control the camera and then deliver the live images on a display device [L1].

The easiest way to get rid of these difficulties to observe the deep sky is to use a remote telescope. Using a simple web interface, it is possible to control telescopes located at the other end of the planet (which can be interesting for viewing deep sky objects only visible from another hemisphere) [L2]. Nevertheless, this mechanism is not very suitable for live observation – the idea being rather to retrieve the images a few hours later.

During the MILAN research project (MachIne Learning for AstroNomy), funded by Luxembourg National Research Fund, we use instruments provided by our partner VAONIS [L3] to collect images of deep sky objects. VAONIS provide fully automated telescopes that are controlled via smartphones and tablets. With these telescopes, all the critical steps are automatised and transparent for the end user: tracking, focus, capture, lightweight image processing, and then display.

Electronically Assisted Astronomy allows us to plan and organise observation sessions without most of the technical barriers mentioned earlier. For the time being, we can capture and visualise live images in different conditions (e.g., low or high light pollution) and with different parameters (exposure time and gain for each unit shot) to build a collection of images while controlling the results. In the near future, we plan to participate in events for the general public in Luxembourg and in the Greater Region in order to allow young and old to discover the beauties of the deep sky.

Links:
[L1] https://kwz.me/hj8
[L2] https://telescope.live
[L3] https://www.vaonis.com

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Accessible Natural Sciences for the Visually Impaired and the Disabled

by Andreas Papalambrou, Christos Palaiologos and John Gialelis (University of Patras)

A team at University of Patras developed a software that gives students and educators, with special emphasis on the disabled and the visually impaired, the opportunity to enjoy the beauty of the natural sciences such as astronomy and geology.

Studying the natural sciences is more accessible than ever to groups such as the visually impaired or the disabled, with old or new technologies such as braille, text to speech, audiobooks and others. However, members of such groups cannot fully experience all aspects of the natural sciences. For instance, they may not be able to visually enjoy the magnificence of astronomical objects and the universe or an on-site visit to a geological site. Our work aims to bridge that gap by introducing inexpensive and unobtrusive means to the visually impaired and the disabled to experience astronomy [L1] and geology [L2]. A virtual assistance module has been developed for achieving this goal.

Figure 1: Original picture of a petrified tree, its outline and interest heat map.

The first application transforms astronomical images (such as planets and galaxies) and geological evidence (such as fossils, rocks or petrified trees) into sound. When this happens, a visually impaired person can touch a touchscreen and "feel", according to the sound changes, the shape of the astronomical object or geological evidence. An algorithm divides the object image in blocks and recognises its different parts (Figure 1). In the first stage, the user feels the image shape through vibration. After assessing the requirements of the users, we concluded that it will be easier to recognise the shape if it is cut off from the process of recognising the colours by reproducing the sound. Each photo examined in the application is accompanied by its contour, created algorithmically by tracing the edges of objects. Users feel the touch device vibrate when they touch the image borders. Proceeding to colour mode, when the user touches the screen, an algorithm detects on which of these blocks the coordinates of the finger belong. Then, the mean RGB value of this area is algebraically calculated, stored in a matrix and translated through the Harbisson's Sonochromatic Scale [1] into hue, lightness and saturation. These values are used to generate the frequency and the volume of the sinewave, which is created and played in combination with the level of interest each part of the image has (foreground, main object, background) through an interest heat map. This process is repeated every time the user touches a different area of the image. A "train" mode is included, in which the user familiarises himself with the recognition of shapes through the vibration of the device and the recognition of colours through sounds.

The second application is a mapping and navigation application with special features for the disabled and the visually impaired. With this mapping application, a visitor in a geological site is assisted in their path. Predetermined routes are calculated for the disability types supported and sites that are accessible for them are proposed. When a user actually goes near a geosite, the previous sound application can be called to translate the current view into sound.

The navigational functions of the software will soon include special functionality that aims at providing an easy and effective visiting experience for people who are visually impaired or disabled, but will also be usable for people with no disability. The software functions both with aural instructions as well as with visual instructions, so it can be used by the visually impaired, the disabled, as well as people with no disability. The simultaneous use by all users is useful for when a disabled person is accompanied by a guide, as well as for social inclusion and the simultaneous use by disabled and non-disabled.

Current applications will soon have extra abilities such as user uploading of images, photos, videos and information related to points of interest in the geopark. This will be extra useful for a real or a virtual visitor but also will be very educative for teachers who wish to provide their students with a multimedia lesson on a geological monument. Apart from this, a person with disabilities that cannot access a geopark can thus accomplish a sort of virtual visit.

Being strong supporters of open data, a publicly accessible website will be created, which will include the information gathered in the application development. In detail, the website will contain maps of the geoparks, details on the selected points of interest with photos and descriptions, suggested routes for visiting the geoparks and audio-visual content gathered in all intellectual outputs and connections to the map.

Links:

[L1] https://www.a4bd.eu/

[L2] https://www.g4vid.eu/

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Augmented Contents as Assistive Technology to Make More Inclusive Everyday Objects for Visually Impaired People

by Barbara Leporini (ISTI-CNR & I.Ri.Fo.R.), Marina Buzzi (IIT-CNR) and Luca Baldini (Editoriale Campi)

This study investigates how to exploit technologies for making society more inclusive by increasing the usability of artefacts that may be not accessible to people with disabilities. Accessing everyday objects can be a challenge for blind and visually impaired people. Although digital calendars are available, a tangible paper-based calendar can be more suitable or preferred by users, in specific contexts. Such a calendar should be as inclusive as possible. This paper shares the experience of designing an inclusive paper-based calendar conceived in codesign sessions with blind and visually impaired users.

One of the most popular everyday objects are calendars, both paper based or in electronic formats as digital date pickers or interactive calendars. The aim of this study is to design an inclusive paper-based calendar enabling multimodal and multimedia content in an accessible format. The Italian most famous lunar calendar is the Barbanera Calendar, which has been printed since 1762 [L1] (see Figure 1). It offers information about moon phases linked to the stages of cultivation (sowing, caring, harvesting), horoscopes, and suggestions. Main features printed on the calendar include: a) Cover information, b) Contents of the month, c) The phases of the moon, and d) The information of the day.

The main contribution of this work is the proposal of a participatory design methodology that can be applied in other fields, such as in education and other goods and services based on paper formats to be augmented with multimedia and multimodal contents.

Figure 1: Barbanera calendar – Cover page.

Figure 2: Page of month.

Related Work

Previous research investigated the problem of audio access to calendars by designing a non-visual interface for selecting dates on web-based forms, in order to provide audio access to date selection while automating the formatting of dates. The proposed calendar date entry system reduced errors about date format when a user has to insert a date [1]. Nowadays several date pickers and calendar applications are available on touchscreen devices. Google Calendar, one of the most popular, offers support for usage with a screen reader, and provides Application Programming Interfaces (APIs) that make it possible to incorporate its calendar functions in customised apps.

In addition, as technology rapidly evolves, people with special needs like blind and visually impaired people can benefit from using voice assistants such as Siri or Alexa, thanks to the vocal interaction and the audio information. Voice assistants are considered helpful, in particular in everyday-life practical tasks like checking calendar entries [2]. However, to the best of the author's knowledge, a tangible augmented calendar accessible to blind and visually impaired people has not yet been described.

Participatory Design and Suggestions

The design teams included an accessibility expert (researcher), the Barbanera Calendar design teams, and visually impaired end users. Seven users with visual impairments took part in the participatory design: 5 men and 2 women aged 32 to 67; 5 blind users, 2 visually impaired users. The members were recruited by the Italian Association for the Blind and Visually Impaired.

After analysing the first draft prepared by the design team, the working group proposed a set of suggestions to design a more inclusive format:

- *Tactile cues*. Braille letters are easily recognisable by touch. Exploit Braille to localise QR code points. The tactile dots allow the user to correctly identify the QR codes. It is important that for each QR code, the tactile dot is always inserted in the same position in order to allow the blind person to know where exactly the QR code is located (see Figure 2).
- *Tangible icons*. If the icons relating to the lunar state are inserted (full moon, first quarter, etc.), in order to make moon phases tactfully perceivable, the outline of the moon icon can be marked in relief. In the case of a full moon, the same could be highlighted with a full circle, while in the case of a black moon, the circle could be empty.
- *QR codes*. Having QR codes too close on the page may pose difficulties since the camera triggers the description for the first detected code as soon as the user moves the camera focus over the dates of the days. To overcome this issue, a digital solution can be exploited: only one QR code can be used to refer to a single digital page showing a list of the days that can be selected by the user through a smartphone/computer and an assistive technology. When the day is selected in the page, the user can listen to / read the associated information (audio files in mp3 format). Various technical design solutions can be applied: e.g., using a link or a button referred to each day, or alternatively a combo-

box or a dropdown menu where the user can edit (or select from the list) the desired day. For the day's info, specific written or audio content about the day can be assigned and so triggered. In the accessible calendar, the QR codes are placed at the bottom of the page for horoscope and agriculture information related to the moon phases (see Figure 2). The QR code in the top-right corner activates the day mp3 file. The QR code in the top-right corner brings the users in a web page navigable with flick-left and flick-right screen gestures enabling the listening and the navigation of all the month's audio files (one for each day) (see Figure 3).

- Calendar format. The standard format with a single list of days placed one under the other would make available much more space to write information that is more visible even for visually impaired people. The more compact grid format requires an app to enrich content and information not only for the blind but also for the visually impaired (see Figure 2).

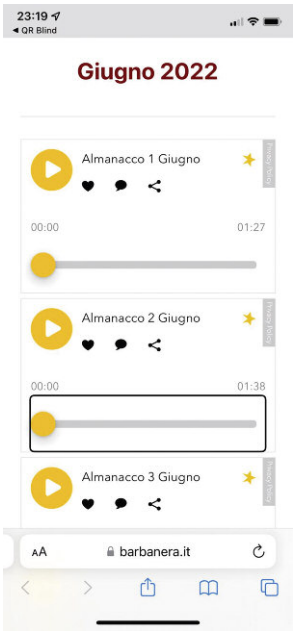

Figure 3: Web page for the audio contents.

Conclusions

In summary, the proposed solution combines tangible references with digital tools (app or web) to make a paper-based object more accessible. The solution proposed here is meant to be an example of how simple tools – if well exploited – can become assistive technologies for a more inclusive society.

Link:

[L1] https://www.barbanera.it/

References:

[1] A. Brown, C. Jay, S. Harper, S.: "Audio access to calendars", in Proc. of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A) (pp. 1-10), 2010.

[2] Y. Mehta, et al.: "Accessibility of date picker for touchscreens", in Proc. of the 8th Indian Conference on Human Computer Interaction (pp. 64-69), 2016.

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Using Haptic Feedback to Support Cognitive Mapping in Mobile Applications for Orientation and Mobility

by Maria Teresa Paratore (ISTI-CNR) and Barbara Leporini (ISTI-CNR)

The aim of this study, which is currently underway, is to investigate how the haptic channel can be effectively exploited in a mobile app devoted to visually impaired users, for the preliminary exploration of a complex indoor environment, such as a shopping mall.

Navigation apps have proven to be effective assistive solutions for persons with visual impairments, helping them achieve better social inclusion and autonomy [1]. Navigation apps can be used to get real-time information about users' actual position in a physical environment, route planning, and accessibility warnings. A mobile app can also be used to help users build a cognitive map (i.e. a mental representation) of the spatial environment before physically accessing it. An effective cognitive map allows a subject to localise and orient themselves in the space in relation to the landmarks and elaborate a route to reach a given point in the environment [2]. For a visually impaired person, this is particularly useful before physically accessing a complex, unknown or rarely visited environment [1]. The goal of our study is to investigate the potentialities of vibration patterns to enhance the learning rate of a cognitive map. Our idea is to adopt the haptic channel in order to provide not only spatial cognition and directional hints, but also an overview of the functional areas of the environment, also known as Points of Interest (POIs). Almost every public building nowadays provides visitors with aids for navigation (paper maps, digital signage, websites or mobile apps); however these aids are generally not accessible for visually impaired users. In the following, we describe a mobile Android application we designed and developed for testing purposes, with the aid of two experienced visually impaired users.

The Test Application

Our test application provides users with a simple audio-vibration map. Seven functional categories were identified, which are typical of a shopping mall, and each category was associated to a different vibration pattern. The map is composed of two layers, one of which is invisible, and is responsible for the haptic and audio rendering. The hidden layer is formed by a set of coloured areas, each corresponding to a POI. RGB (red, green, and blue) colour encoding was exploited to identify each POI; predefined couples of red and green levels were associated with many functional categories in the building. The blue component, on the other hand, was used to precisely identify each single POI. While the user explores the touchscreen with their finger, the app checks the colour of the underlying coordinates. Whenever a couple of red and green components is detected, which corresponds to a POI category, the matching vibration pattern is triggered, and if the user lifts their finger, the blue component will be considered to announce the matching descriptive label through the TTS engine. Vibration

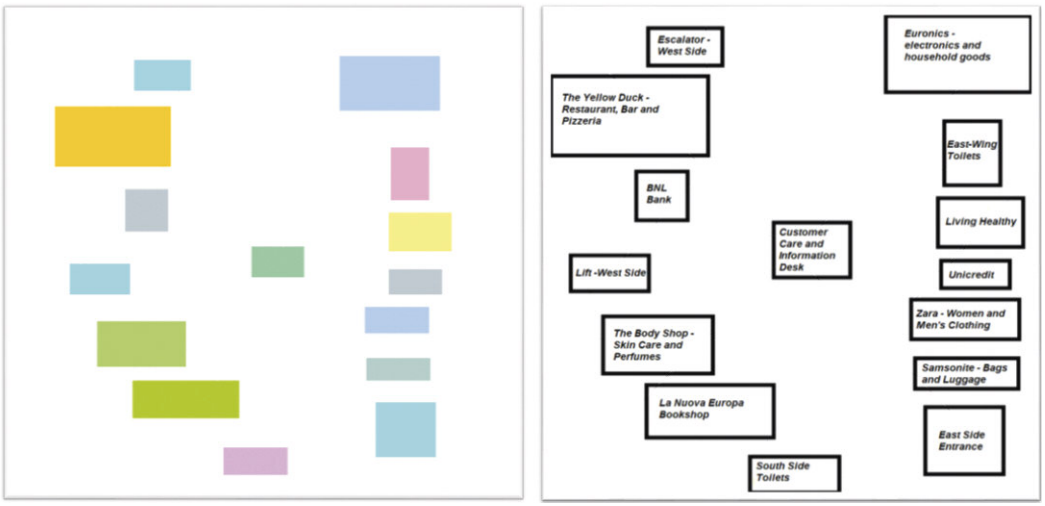

Figure 1: The coloured image used to recognise the different areas on the map, and the visible version of the map.

```
<color name="pharmacy">#FFFF80</color>
<color name="info_box">#80D8A8</color>
<color name="stairs_elevator">#89DAE5</color>
<color name="shop">#ABCCF6</color>
<color name="atm">#BCC8CE</color>
<color name="bar_restaurant">#FFC90E</color>
<color name="toilettes">#F7B0C8</color>
```

```
//POI types
public static final int POI_TYPE_PHARMACY = 0;
public static final int POI_TYPE_INFOBOX = 1;
public static final int POI_TYPE_STAIRSELEVATOR = 2;
public static final int POI_TYPE_SHOP = 3;
public static final int POI_TYPE_TOILETTE = 4;
public static final int POI_TYPE_ATM = 5;
public static final int POI_TYPE_RESTAURANT = 6;

public static final int SHORT_VIB = 100;
public static final int LONG_VIB = 200;
public static final int LONGER_VIB = 300;
public static final int PAUSE = 100;

//pattern values in msecs
public static long[] PATTERN_PHARMACY = new long[]{0,LONG_VIB,PAUSE,SHORT_VIB,PAUSE,SHORT_VIB};
public static long[] PATTERN_INFOBOX = new long[]{0,LONGER_VIB,PAUSE,LONG_VIB,PAUSE,LONGER_VIB};
public static long[] PATTERN_STAIRSELEVATOR = new long[]{0,SHORT_VIB,PAUSE,SHORT_VIB,PAUSE,SHORT_VIB};
public static long[] PATTERN_SHOP = new long[]{0,SHORT_VIB};
public static long[] PATTERN_TOILETTE= new long[]{0,LONGER_VIB,PAUSE,LONG_VIB};
public static long[] PATTERN_ATM = new long[]{0,SHORT_VIB,PAUSE,LONGER_VIB};
public static long[] PATTERN_RESTAURANT = new long[]{0,LONGER_VIB};
```

Figure 2: Colour encoding adopted to identify the different categories of POIs and the associated vibration patterns, as they are encoded according to the Android/Java formalism.

patterns were designed in such a way as to make the POI categories as distinguishable as possible, while keeping a low level of intrusiveness. Concern arose that the cognitive load may become too heavy in certain conditions or for certain categories of users, such as the elderly. A "filter by category" function was therefore introduced.

Experimental Results

The app was provided with three alternative modalities of feedback: audio only, vibration only, audio and vibration. Trials were carried out in which users were asked to build a cognitive map of a shopping mall in each of the three modalities of interaction. We found that, when only haptic feedbacks were enabled, users were able to get an idea of the arrangement of the POIs within the space and had no difficulty in recalling the location of specific POIs, as well as the total number of shops or entrances and stairs. The task of finding a given shop on the map was also successfully accomplished. Worse results were achieved when the exploration

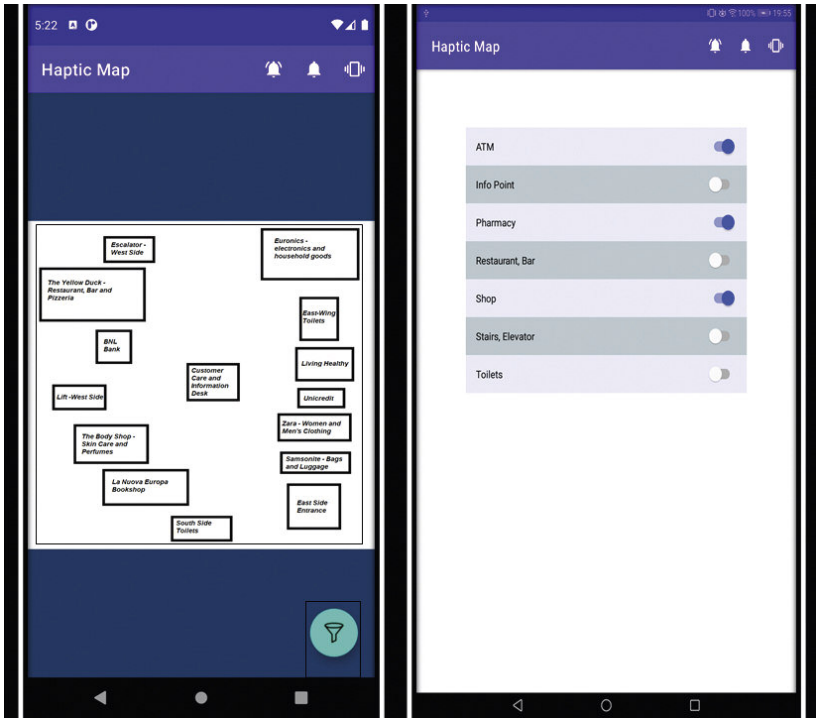

Figure 3: Two screenshots of our test application: the map to be explored with the feedback and filter controls and the filtering switches.

was only supported via auditory feedback. Using both the auditory and the haptic channels to announce the POI category was perceived as overwhelming, even though this modality was appreciated for a training phase, when correspondences between vibration patterns and POI categories had to be learned. Problems were occasionally reported, related to synchronisation of the TTS announcements. We are confident to solve these issues during the next phase of our study, when integration with Android's accessibility service will be better exploited.

Future Work

Our aim is to integrate the described approach into traditional maps provided by services such as GoogleMaps [L1] and OpenStreetMap [L2]. To achieve this goal, further ad hoc trials will be carried out, focusing on specific aspects such as the maximum number of patterns that can be used at the same time and the most effective pause and vibration configurations, also in relation to users' demographic data.

Links:

[L1] https://developers.google.com/maps?hl=en
[L2] https://www.openstreetmap.org/about

References:

[1] A. Khan, S. Khusro: "An insight into smartphone-based assistive solutions for visually impaired and blind people: issues, challenges and opportunities", Universal Access in the Information Society. 1-34 (2020). https://doi.org/10.1007/s10209-020-00733-8
[2] R.A. Epstein, et al.: "The cognitive map in humans: spatial navigation and beyond", Nature Neuroscience, 20, 1504-1513. (2017). https://doi.org/10.1038/nn.4656

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PlayToPickUp: Customisable Serious Games for Children with cognitive disorders

by Letizia Angileri, Marco Manca, Fabio Paternò, Carmen Santoro (ISTI-CNR)

PlayToPickUp is a serious game that stimulates children in the relevant cognitive aspects (attention, planning task and error monitoring) while performing tasks that replicate the activities of daily life, such as preparing the backpack, recognising money or emotions.

Cognitive developmental disorders are common in children and affect the language or attention area, such as attention deficit and hyperactivity. In these cases, the individual is unable to engage and interact effectively with the environment, resulting in difficulties in learning and autonomously carrying out daily activities. For these reasons, this work proposes a solution that aims to stimulate children in the relevant cognitive aspects, which are attention, planning tasks and error monitoring. The proposed solution is PlayToPickUp, a serious game that supports tasks that replicate the activities of daily life, such as preparing the backpack, recognising money or emotions.

Previous work on serious games to cognitively stimulate young people includes a proposal by Fontana et al. [1] who put forward Train Brain, a serious game for selective attention training, based on memorising images in one or more contexts using coloured circles. However, in general, previous work lacks proposals to support children in their daily routines, so we thought it would be interesting to address this aspect in a new solution, which also takes into account emotional-related aspects of the target population.

Design

The serious games design and implementation was driven by aspects and requirements gathered in state-of-the-art analysis, interviews, empathy maps and personas. For example, it was found that these children have low self-esteem as they tend to maximise their weaknesses and minimise their strengths, isolate themselves for fear of rejection and seek attention with cocky attitudes.

The PlayToPickUp game [L2] has been designed to reproduce some scenarios that children may encounter in their daily life: preparing the backpack, recognising money or emotion representations, stimulating sustained attention, planning skills and error monitoring. The objective of this game is to help the main character (a robot) to collect some target objects (school- or money- or emotion-related). The game is a responsive web-based application, therefore available on different platforms (tablet, smartphone, PC) and has four difficulty levels that automatically increase as the game progresses. Each difficulty level has three sub-levels where dynamic objects move, respectively, in the following ways: vertical, horizontal, and vertical with the initial position of the elements set randomly. When objects appear, the user has to collect those elements

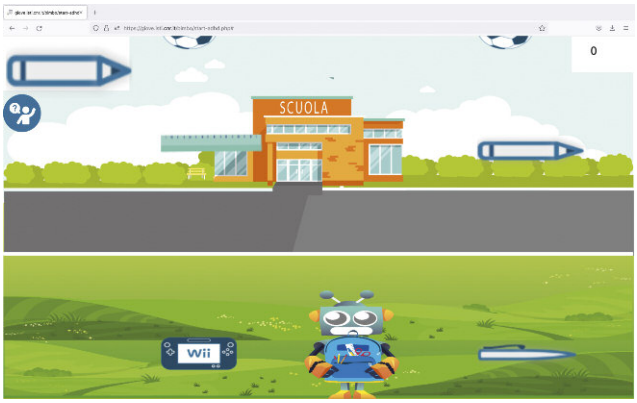

Figure 1: PlayToPickUp – School scenario – collection of relevant objects.

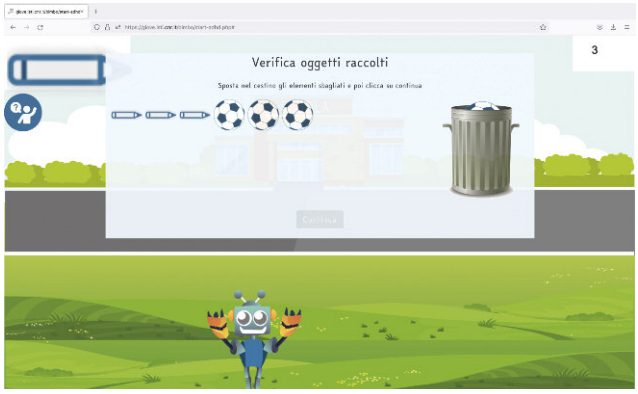

Figure 2: PlayToPickUp – School scenario – Final phase.

that are relevant (targets) by moving the character, while not being distracted by other non-relevant elements (distractors).

At the end of the game, for each sub-level, the child has to check the objects that have collected and drag those not relevant into a basket (in the school scenario) or an "emotion suitcase" (emotions scenario), or to the corresponding textual description (money scenario).

Depending on the characteristics of the child, the operator can customise the game by configuring some parameters, such as the speed of falling of the elements and the scenario. Thus, the game offers a range of options to provide a training that best fits with the skills of the child, thus limiting the possibility of being received as repetitive.

Trial

A trial has been carried out. The participants are children with cognitive impairment followed by the PAIM Social Cooperative of Pisa. 27 children, aged between 8 and 12, are participating in the study. The tests have been conducted by the PAIM operators during one/two weekly meetings over two months.

In the trial, three questionnaires have been proposed: the first, administered before the start, aimed at collecting information on the user's digital skills; the second and the third ones, administered after using the game, respectively to the child and the operator, to collect information about the user's experience of the game.

Preliminary results have shown positive feedback from the children, as 12 out of 17 children felt happy after playing serious games. In addition, the data collected indicate that the majority of the children tended to make fewer errors over time during the training sessions, especially at some levels of difficulty of the game. Also, the operators have provided positive feedback, as in their view the children perceive the exercise as a playful activity, albeit with the primary objective of cognitive training, such as attention, and to transfer playful activities into everyday life, such as recognising money and preparing the backpack.

Conclusions

This study stems from the consideration and awareness that studies and research on innovative interactive applications for children with cognitive disorders are necessary and important.

To this end we offer PlayToPickUp, a serious game designed for children with cognitive disorders, and the implemented game has been used by a group of children aiming to improve their cognitive abilities. The results of the users' tests were encouraging; the structure of serious games seems to be suited to their needs for fun and ease of interaction, and to their cognitive stimulation.

We plan to extend the user study with other groups of children that can benefit from the approach proposed.

Links:

[L1] https://hiis.isti.cnr.it/lab/home
[L2] https://giove.isti.cnr.it/bimbo/index.html

Reference:

[1] E. Fontana, et al.: "Trainbrain: a serious game for attention training", Int. J. of Computer Applications 160, 4, 2017.

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Play with me! A Serious Game for Cognitive Stimulation of Older Adults with a Humanoid Robot

by Eleonora Zedda (University of Pisa and ISTI-CNR), Marco Manca and Fabio Paternò (ISTI-CNR)

Serious games in humanoid robots have an interesting potential to help older adults with cognitive stimulation in non-pharmacological treatments. Additionally, exploiting the multimodal possibilities of the humanoid robots in such a way to provide them with a personality can be suitable to improve users' engagement, and thus their potential participation in cognitive training programs.

The number of people aged 65 or older is projected to grow by nearly 1.5 billion by 2050. Ageing has a considerable impact on the health of older adults in terms of cognitive and physical impairments, which influence the abilities to complete and perform basic activities of daily living, such as cooking, shopping, managing the home, bathing, and dressing. Additionally, given the high healthcare expenditure at older ages, and effect on family caregivers, new technologies to assist older adults with cognitive impairments are urgently needed.

In recent years, humanoid robots have increased their similarity to human behaviour thanks to their ability to perform gestures and facial expressions, interact vocally and move. These capabilities are essential to creating social and emotional interaction with the users to increase their acceptability and engagement, which may increase the possibility of reaching the goal of the assistance in less time and with better results. Furthermore, serious games can provide positive results in stimulating older adults and helping them improve their cognitive abilities with respect to traditional training.

This study aims to design and implement a serious game for a humanoid robot able to show different personalities through different multimodal interactions to provide a more engaging interaction and obtain better results in terms of cognitive improvements.

At the HIIS Laboratory of CNR-ISTI [L1] we design serious games that stimulate multiple cognitive domains for reducing the risk of cognitive decline and build more powerful cognitive resources [1]. In this study, we chose to design a cooking game requiring users to recognise the recipe ingredients' chronological sequence, the typology of the ingredients, and their weight. It aims to stimulate working memory, visual memory, and verbal memory. During the game, the robot shows and vocally synthesises the ingredients for the selected recipe. Then, it starts the quizzes, during which the user should use visual memory and verbal memory to recognise the right ingredients and select them over other options. In this game, the types of interaction supported are vocal, graphical and touching the robot sensors. The robot that we use in our project is Pepper Robot developed by Softbank's Robotics (a 1.2-m-tall wheeled humanoid robot, with 17 joints for expressive body language). During the user's interaction, the robot can show two different types of personality traits: a calm and introverted personality, and an extroverted and active personality. We based the implementation of these personalities according to the Big Five-Factor Model [2]. In summary, the extrovert personality is shown through a more joyful and active interaction while the introvert with a more neutral and calm interaction. Both personalities are designed to modulate different parameters related to the verbal and non-verbal channels. In particular, for the verbal channel, we modulate the robot's intonation, pitch, volume rate and speech rate while for the non-verbal channel we modulate the robot's gestures, movements speed, motor trajectories and motor orientation.

The sessions are structured into three main phases: introduction, play and results. In each phase, the robot shows the personality chosen modulating the parameters identified for that personality. For example, when the robot asks the question regarding the chronological sequence of the ingredients, at the same time it displays and vocally renders the question and generates some animations. After the user answers the question, reinforcing feedback is provided by Pepper in the form of vocal feedback. Nonverbal feedback is combined with verbal and visual feedback, for example in the extrovert personality, Pepper raises the right arm and moves its elbow up and down, and simultaneously it nods its head twice (see Figure 1). During all the sessions, the robot provides different animations and vocal and visual feedback for various aims: to stimulate the user to focus on the game, create more engagement and stimulate attention in the user, and create a more natural interaction and communication.

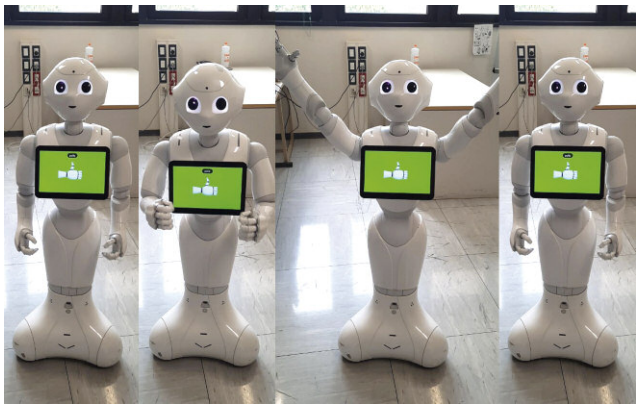

Figure 1:Animation for positive answer in extravert personality.

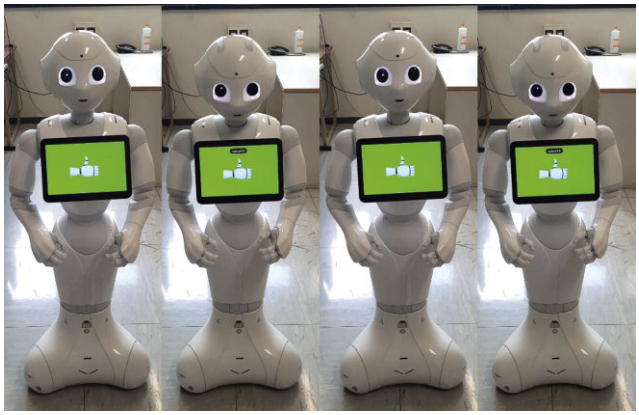

Figure 2: Animation for positive answer in introvert personality.

We performed a first validation of the game design with seven experts in psychology, who played the game and provided positive feedback and found the game as a helpful tool for cognitive stimulation. Indeed, the combination of the game and the robot stimulate multiple cognitive domains and are useful in the cognitive context because they improve engagement and attention. For what concerns the evaluation of the robot personalities, the two personalities were found well distinguished and representative of both conditions, and the users were satisfied with the interaction with the robot performing both. In future work, we plan to assess the engagement and usefulness of cognitive assistance provided by a humanoid robot performing two personalities with older adults in the serious game.

Link:

[L1] https://giove.isti.cnr.it/lab/home

References:

[1] M. Manca, et al.: " The impact of serious games with humanoid robots on mild cognitive impairment older adults", International Journal of Human-Computer Studies 145 (2021): 102509.

[2] O. P. John, et al.. "The Big Five Trait Taxonomy: History, measurement, and theoretical perspectives." Handbook of personality: Theory and research, 2nd ed., pp. 102–138 (1999).

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Aïana: An Accessible MOOC Player for Supporting e-Learning of Individuals with Cognitive Impairments

by Hélène Sauzéon, Pascal Guitton and Pierre-Antoine Cinquin (Inria)

For an equal access to education and more particularly since the COVID crisis, there is a huge need for accessible Massive Open Online Course (MOOC) players for people with cognitive impairment. Aïana is a new accessible MOOC player, which has been co-designed by the stakeholders (learners with cognitive impairment, teachers, accessibility designers, etc) and assessed with a field study without an equivalent in the literature, including learners with and without disabilities. Early interactions (with accessibility features), participation, learning and learner experience supported our contribution to designing a more inclusive e-learning environment.

Aïana is a web media player [L1] meant to consume massive open online course (MOOC) resources [L2]. It started as a research project at Inria Bordeaux in the POTIOC team [L3] in collaboration with the FLOWERS team and the Inria Learning Lab (from 2016 to 2021). Its aim is to propose new design principles for MOOCs in order to let people with disabilities (PWD) (cognitive and non-cognitive impairments) have a better experience when consuming the contents.

In order to contribute to the fight against the digital divide in access to education and then to employment, our objective was to design and to assess a digital online teaching system accessible to People With Disabilities (PWD), particularly of cognitive origin, by adopting a truly inclusive approach:

- No "PWD-specific" response but instead open to all;
- No focus on a specific pathology, but rather on cognitive function disorders (attention, memory, emotions, etc.);
- Strong involvement of people with disabilities upstream for the design and downstream to validate the design choices.

Participatory design of Aïana

As there was no complete state-of-the art model of digital systems for inclusive education, we started by carrying out a systematic study [1] that validated the absence of a suitable response both in terms of research and software solutions.

We then decided to develop a MOOC player (Aïana) and in order to develop a really efficient and used tool, stakeholders (PWD students, experts) were involved from the beginning of the conception via individual interviews (collection of obstacles and needs, paper mock-up of GUIs). This allowed us to define several principles [2] (Figure 1):

- Separation of information flows (video, slides, comments) in order to facilitate their interpretation and to allow the use of adapted tools;
- Complete individualisation of the interface configuration (choice of displayed streams, location and size of their displays) in order to provide an environment adapted to the wishes and capacities of a user;
- Possibility to display an additional information in the form of short texts and icons to explain abbreviations or teacher's feelings in order to externalise implicit elements of teaching;
- Content Structuring into chapters to reinforce acquisition through semantic navigation;
- Addition of markers (like Post-It notes in a handout) to sequences to optimise information processing (live and recorded);
- Choice between different views of the speaker to avoid face-to-face interaction or to promote joint attention.

In order to validate our concepts, we built the MOOC, "Digital Accessibility", using the Aïana reader, and broadcasted on the FUN platform (French national MOOC platform), which counted more than 13,000 registrants of 60 nationalities. In order to be able to evaluate the choices made in real conditions, we asked the participants for their opinion via questionnaires (usability, satisfaction, free comments, suggestions) and measured their use of the tool by monitoring the functions used. These surveys were carried out in a totally anonymous way and were validated by the COERLE (Inria's ethics committee).

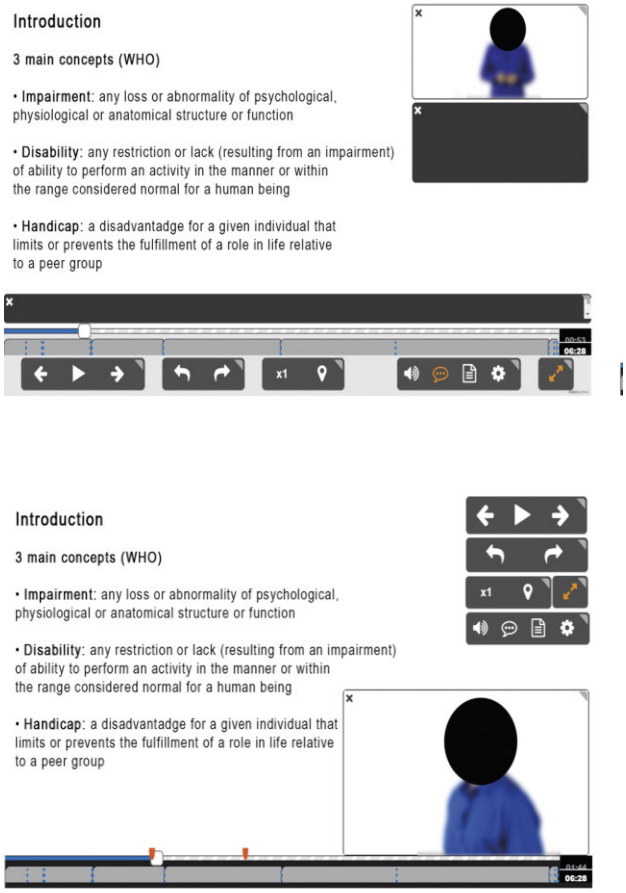

Figure 1: Two configurations of AÏANA.

Results

The very large number of participants (n= 546) allowed for a large-scale preliminary study whose main results demonstrate the benefits of using Aïana:

- Almost 16.3% of students who have fully completed the MOOC, are PWD, one third more than the average reported in other MOOC platforms
- The average module completion rate was 90.4% for PWDs and 90.5% for typical students, and an equivalent attrition rate (dropouts) is observed for PWD and non-disabled persons
- All learners obtained very good results (average 89%), although the acquisition time was a little longer for PWD
- Learners reported a good level of satisfaction (average 75%, USE questionnaire standard), and above all consider that Aïana gives them a high level of feeling of competence and autonomy.

Conclusion

The outcomes of the field study support the positive impact of our design decisions and provide positive feedback about the benefits of Aïana for PWDs to engage in a MOOC, in particular with regard to people with cognitive impairments that are often insufficiently addressed. More research efforts and legal obligations are needed to narrow the digital divide between ordinary and extra-ordinary learners.

Links:

[L1] https://kwz.me/hj5
[L2] https://github.com/INRIA/aiana-player
[L3] https://team.inria.fr/potioc/research-topics/aiana/

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[2] P. A. Cinquin, P. Guitton, H. Sauzéon: "Designing accessible MOOCs to expand educational opportunities for persons with cognitive impairments", Behaviour & Information Technology, 40(11), 1101-1119, 2021.
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Designing Universally Accessible Interactions in Intelligent Environments

by Constantine Stephanidis, Stavroula Ntoa, George Margetis and Margherita Antona (FORTH-ICS)

The advent of intelligent environments brings several challenges for the design of universally accessible interactions; however, it also bears novel opportunities. Given the importance of inclusive intelligent environments, we propose a methodology for designing interactions in such environments that are universally accessible.

Universal accessibility refers to the provision of interactive applications and services that are accessible by the broadest possible end-user population, depending not only on their characteristics, but also on the changing nature of human activities, the variety of contexts of use, and the diversity of technological platforms [1]. Simply put, it means that everyone should be able to use an interactive system regardless of their physical, mental, or psychological characteristics, the device they are using, or the conditions under which they are using it. Although this sounds fair, ethical, and obvious, it is certainly not simple, and – apparently – in many cases, this has not been achieved so far.

The concept was initially advocated as the "Design for All" approach, proposing solutions for technological products and services accommodating diversity, and being accessible by people with disabilities [1]. Since then, several advancements have been achieved, be they technical, legal, or societal. As new technologies come into play, new tasks and user goals flesh out, and new contexts of interaction emerge, it is remarkable that universal accessibility not only carries through but actually prospers at the end of the day. For example, consider that not all workstations are equipped with assistive technology solutions for people with disabilities, yet all smartphones come with such features embedded and readily available to consumers.

Our everyday devices have become smarter and interconnected, paving the way for the materialisation of intelligent environments. Even though technological complexity increases, the enhanced capabilities of the new technological environments bring along several benefits for universal accessibility [2]. Intelligent environments are expected to be inherently multimodal, thus accommodating a wide variety of interaction preferences. At the same time, the interconnectivity of devices can be a great asset for achieving personalisation and adaptation to the needs and preferences of each user interacting in the intelligent environment. However, apart from the technological readiness and infrastructure capabilities, there are several challenges that need to be addressed to create universally accessible intelligent environments [3]. In a nutshell, appropriate modelling approaches need to be developed, capturing and correlating user and application characteristics for diverse contexts of use, as well as ready-to-use accessibility solutions, and suitable design tools. Furthermore, as intelligent environments advance toward Artificial Intelligence (AI)-enabled environments, a concrete methodological approach for Human-Centred AI should be framed [4], paying particular attention to how universal accessibility methods, processes, and tools are incorporated.

Our approach to designing universally accessible intelligent environments, applied in the context of the FORTH-ICS Ambient Intelligence Programme [L1] is rooted in the principles of Human-Centred Design, adhering to iterative design organised in four main phases (Figure 1). However, acknowledging that Intelligent Environments inherently employ AI, the proposed approach is enhanced with activities pertaining to the design and development of the AI components as well. Furthermore, for each entailed activity, our approach considers key points that should be addressed for achieving universally accessible solutions.

In the phase of understanding the context of use the overall goal is to comprehend who are the users/inhabitants of the Intelligent Environment, which are the activities that they will realise therein, as well as what are the attributes of the technological, physical, but also the social environment. Important attributes that are specified include user characteristics (e.g. age, physical and cognitive capabilities, psychological attributes, skills, etc.); the envisioned system functionalities and user tasks in the intelligent environment; the available devices, interaction modalities, and assistive technologies; Internet of Things (IoT) and IoT data collected; the auditory, visual, and thermal environment, as well as space and furniture; and also attributes with regard to social interactions in the environment (e.g. social norms, people co-presence, etc.) and application-domain specific goals. The outcome of this activity entails a user model and a context model, which are reusable and extensible.

In the requirements specification phase, appropriate methods are applied to involve in the process representative end-users (e.g., persons with disabilities) in order to create a detailed specification of user requirements in relation to the intended context of use and objectives of the designed system or environment. As such, functional and non-functional requirements are elicited regarding users' interaction needs and preferences, assistive technologies employed, information needs and preferences, space requirements for approaching and reaching interactive systems, as well as safety and privacy requirements. An update of the devised user and context model is also carried out after this phase.

Informed by the preceding stages, the phase of designing and producing solutions creates the universally accessible solution aiming at the same time to achieve an optimal User Experience. In the context of this phase, the data that will be used to train the system is collected, with particular emphasis on employing datasets that will not lead to exclusion of the target users. Data for AI systems are a recognised factor of exclusion since they often stem from who is thought of as the "average" user, leading to systems that are trained with biased datasets, thus affecting their decision-making. In the same phase, the design of the AI and reasoning process over the devised user-context model takes place, paying attention to universal accessibility aspects and addressing the reactions and information that should be provided by the environment toward anticipating users' interaction activities. Finally, the user interface design is also a major activity, catering to information and interaction design that is accessible and adheres to the principles of "Design for All" [1].

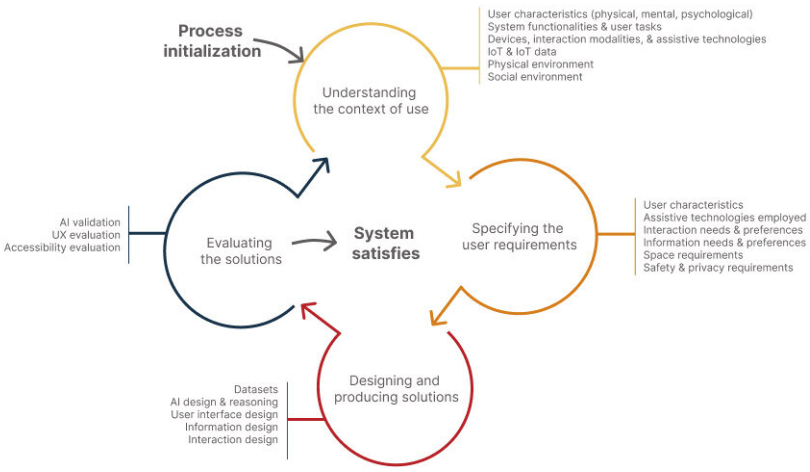

Figure 1: Methodological approach to designing universally accessible intelligent interactions in intelligent environments.

Last, the phase of evaluation is performed covering aspects of User Experience evaluation, accessibility evaluation, and AI validation, employing automated and semi-automated tools, expert reviews, and, cardinally, user testing.

The overall process is iterative and scalable; it can be applied to the design of entire Intelligent Environments (such as a smart home), sub-spaces of Intelligent Environments (such as a particular room of a smart home), or particular interactive artefacts (such as a smart table). The work is ongoing to further extend the process in order to indicate appropriate methods and tools for each phase and provide templates for the documentation of each phase, resulting in a pool of use case examples that can be valuable to the research community.

Link:

[L1] https://ami.ics.forth.gr/

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Introducing People with Autism to Inclusive Digital Work using Microtask Fingerprinting

by Dennis Paulino (INESC TEC and University of Trás-os Montes e Alto Douro), João Barroso (INESC TEC and University of Trás-os Montes e Alto Douro) and Hugo Paredes (INESC TEC and University of Trás-os Montes e Alto Douro)

This article discusses the potential of including people with autism in digital work, giving them an opportunity to have personalised and remunerated work. The authors of this article are working in cognitive personalisation of microtasks (a simple form of digital work) so it can be adapted the digital work's assumptions to the worker abilities. A planned case study will include people with autism, whereby their digital interactions in the microtasks will be recorded and used for the cognitive personalisation.

Social exclusion can be defined as individuals who are unable to obtain various human rights or realities that are often available to another group of individuals [L1]. People with disabilities are unfortunately targets of prejudice in the workplace, as a result of stereotypes [L2] [L3]. Autism is defined by the American Psychiatric Association as "a disorder in the development of a person, characterized by difficulties in social interaction, communication, and restrictive and repetitive behaviors" [1]. It is estimated that there are around 25 million people with autism worldwide [L4]. Autistic individuals have several limitations in their social interactions, including in the actions they perform in their daily lives [L5] [L6]. Social limitations result in increased isolation, which in turn is related to the deterioration of quality of life [L7]. Working helps to combat the effects of isolation [L8]. A study conducted by Müller and Schuler [L9] identified social difficulties from the perspective of individuals with autism, and revealed that most participants would like to be able to contribute to improving the environment that surrounds them.

Given the various possibilities of overcoming cultural and social barriers, digital work provides the opportunity for people with autism to have financial compensation and helps them to feel fulfilled. Crowdsourcing is a new reality of digital work, which mostly consists of microtasks, which are tasks with a low level of complexity that can be carried out in a short time [L10]. Microtasks broaden the spectrum of people who can access the digital job market; however, it was identified in a study that for microtasks, work assumptions and workers' capabilities are misaligned [L11].

The correct mapping allows a significant increase in the quality of work performed, as well as the motivation of workers. Cognitive personalisation has the potential to adapt microtasks to workers, thus allowing for increased accessibility and inclusion of people with disabilities and people with autism. In crowdsourcing, there is already research work done at the dis-

tribution level with the mapping of microtasks [2]. There is still a need to explore the cognitive personalisation of microtasks in its design. This will allow that, regardless of the published micro-tasks, as well as the worker who will perform them, the tasks can be adapted to the individual's capabilities. Cognitive personalisation can be done by applying cognitive tests to assess capabilities or using microtask fingerprinting. The former is used by adapting psychometric tests into short microtasks. The latter comprises assessing the digital worker's behaviour while performing the microtasks, such as the key presses, number of clicks or even the click details [3]. This method of microtask fingerprinting develops prediction models based on Machine Learning, to identify behavioural traits of workers.

The authors of this article propose that microtask fingerprinting, including the application of digital cognitive tests, can have the potential to include people with autism, upkeeping their motivation, introducing them to the digital work marketplace, and allowing that the work performed can have good quality.

To accomplish this, an architecture and a system for cognitive personalisation applied to the design of microtasks in crowdsourcing is proposed. The architecture includes an ontology, built from other existing ontologies, for the representation of knowledge including the concepts of microtasks, cognitive abilities and types of adaptation in order to customise the interface to the worker. The ontology incorporates an existing ontology called ACCESIBILITIC [L12], which represents knowledge about accessibility and activity-centred design to support usage of technologies, and includes a taxonomy of concepts of cognition from the International Classification of Functioning, Disability and Health (ICF) [L13]. The proposed system contains a backend and a frontend that serve as an intermediary layer between the microtask platforms and workers. The ongoing work contains results from 130 microtask workers, including their performance on prototypical microtasks and cognitive tests. In both microtasks and cognitive tests, we recorded the digital worker behaviour, namely the key presses, click movements and click details, which can be used for predicting the digital work quality and thus be used for optimizing personalisation. For future work, it is intended to test this system and the proposed method on people with autism and verify the potential to include them in the microtask marketplace.

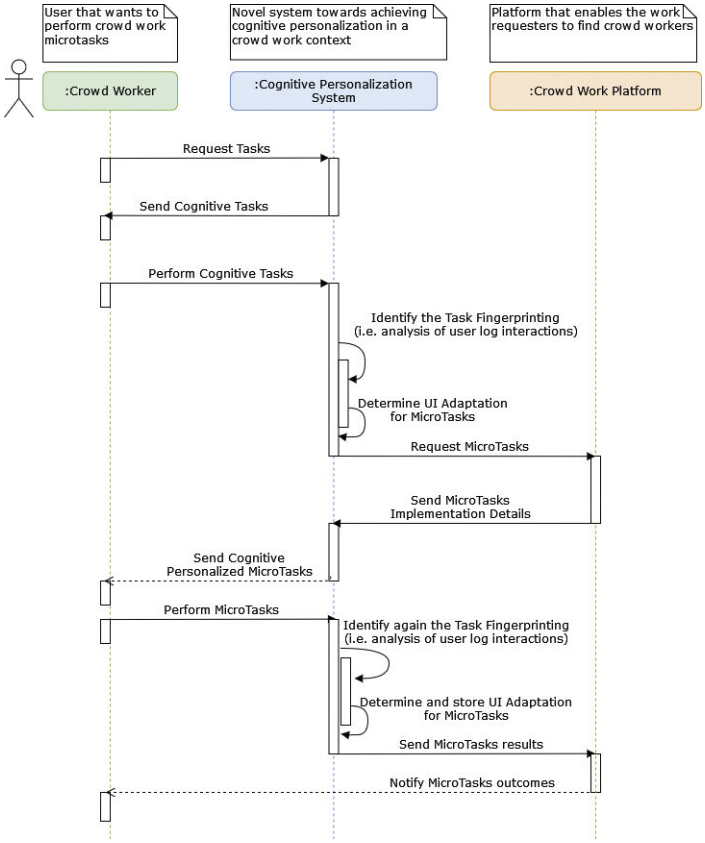

Figure 1: UML Sequence Diagram of the proposed cognitive personalization system in a crowd work context.

This research is part of the scope of a doctoral thesis that is hosted by INESC TEC and University of Trás-os Montes e Alto Douro in Vila Real (Portugal), with funding from FCT – Fundação para a Ciência e a Tecnologia (Portuguese Foundation for Science and Technology) with research grant SFRH/BD/148991/2019. The authors also recognise support from the European Social Fund of the North Portugal Regional Operational Programme.

Links:

[L1] https://kwz.me/hjx
[L2] https://kwz.me/hjz
[L3] https://kwz.me/hjA
[L4] https://kwz.me/hjD
[L5] https://kwz.me/hjF
[L6] https://pubmed.ncbi.nlm.nih.gov/34855725/
[L7] https://pubmed.ncbi.nlm.nih.gov/25910392/
[L8] https://kwz.me/hjG
[L9] https://kwz.me/hjI
[L10] https://kwz.me/hjJ
[L11] https://dl.acm.org/doi/abs/10.1145/2675133.2675158
[L12] https://kwz.me/hjM
[L13] https://kwz.me/hjQ

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Harmonised Web Accessibility Testing

by Wilco Fiers (Deque Systems Europe)

Web accessibility is a hot topic these days. The EU's Web Accessibility Directive requires governments throughout the EU to build websites and apps that are accessible for people with disabilities. Over the next few years, the European Accessibility Act will mean similar requirements will apply to private businesses as well.

All this accessibility legislation is based on the same international standard; the Web Content Accessibility Guidelines (WCAG) [L1]. WCAG is developed and maintained by the World Wide Web Consortium (W3C). WCAG 2.0 is internationally recognised as an ISO standard, and WCAG 2.1 was incorporated in the EN 301 549. One of WCAG's biggest strengths is that it is written in a technology-neutral language. This allows it to apply to technologies that came out after WCAG was published. It also makes it useful for non-web technologies. Even though WCAG was not written to comprehensively apply to mobile apps, the EU's guidelines for mobile app accessibility are largely from WCAG.

Transposing Web Accessibility

Taking the technology-neutral language of WCAG and working out what it means for specific technologies requires a transposition. For example the term "text alternative" in WCAG is something called "accessible name" in the lingo of web pages. As anyone who speaks more than one language knows, there are often different ways you can transpose something. This is also the case when translating WCAG and applying it to a particular technology.

There are different ways to explain how WCAG should be applied to specific technologies. These differences are small and get into nuances of how specific technologies work. These differences show up when you start comparing accessibility tests done with different tools [1], or by accessibility experts from different organisations [2].

With different countries introducing their own legislation on web and mobile accessibility, even though they all use the same WCAG requirements, because of these transpositions, there are subtle differences in what regulators in different countries consider a compliant website. For companies that work internationally, this creates some uncertainty about the compliance of their website across different countries. When it comes to knowing your organisation complies with legislation, "probably" is not a satisfactory answer.

Harmonised Web Accessibility

To try and address this challenge, the W3C has developed rules and examples that document how WCAG should be applied to particular technologies. These are known as Accessibility Conformance Testing (ACT) Rules [3, L2], or more specifically, WCAG Test Rules when it comes to rules and examples written for WCAG.

The Web Accessibility Initiative (WAI) is an initiative of the W3C. As part of the WAI-Tools project [L3], co-funded by the European Commission (EC), a partnership led by the W3C developed 95 rules, and more than 1,000 examples of how to apply WCAG to HTML. This covers many of the most common types of accessibility problems. Most of those rules are focused on bringing greater consistency in the way automated accessibility tools recognise issues. Various popular accessibility tool vendors have started to apply these rules already. However, it has been difficult to track how consistently this has been done.

Another common challenge in web accessibility is knowing what different accessibility tools are capable of testing, and understanding their differences. The Web Accessibility Initiative - Communities of Practice (WAI-CooP) project, another EU funded project, aims to bring clarity to this topic.

ACT Implementation Matrix

WAI-CooP [L4] is a Coordination and Support Action project, co-funded by the European Commission (EC). WAI-CooP is a project led by the ERCIM, host of W3C Europe, which supports implementation of the international standards for digital accessibility. WAI-CooP:

- establishes international vendor-neutral overviews on available training, tools, and resources
- analyses technological advancements and coordinates with relevant research and development
- provides opportunities for key stakeholders to share resources and to exchange best practices.

Part of WAI-CooP's vendor-neutral overview includes creating an implementation matrix for accessibility tools and methodologies that have implemented ACT rules. Vendors can run their tools and methodologies on the 1,000+ examples and post their results online. This implementation matrix groups tools and methodologies into three categories:

- Evaluation methodologies: Step-by-step instructions on how to test accessibility
- Semi-automated tools: Tools that combine user input and automated testing to test accessibility
- Automated tools: Tools that automatically test accessibility.

It is worth noting that this ACT implementation matrix is only designed to track the consistency of accessibility tools and methodologies with ACT rules. ACT rules are not exhaustive though. Tools and methodologies may, and likely do include tests that either aren't covered by ACT, or where the transposition of WCAG differs from that of the ACT rules.

The ACT implementation matrix is not an endorsement of any particular accessibility tool or methodology by the W3C. It is based on data published by accessibility vendors. That is why vendors that have not published detailed test results are not part of the ACT implementation matrix. The data is taken as-is, and often cannot be verified by the W3C.

ACT Rules in Action

You can find information about which vendor has implemented which rule on the WCAG 2 test rules pages on the W3C website [L5]. A general overview per tool and methodology is also under development. It is expected to go live in the second quarter of 2022. This overview will also include a

high-level summary of the number of rules each tool and methodology has implemented.

Links:
[L1] https://www.w3.org/WAI/standards-guidelines/wcag/
[L2] https://www.w3.org/WAI/standards-guidelines/act/
[L3] https://www.w3.org/WAI/about/projects/wai-tools/
[L4] https://www.w3.org/WAI/about/projects/wai-coop/
[L5] https://www.w3.org/WAI/standards-guidelines/act/rules/

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Supporting Autonomous Access to the Sea for People with Kinetic Disabilities

by Christos Alexakos (Industrial Systems Institute/ATHENA RC), Ignatios Fotiou (TOBEA) and Panagiotis Konstantinopoulos (Computer Technology Institute and Press "Diophantus")

Modern technology achievements, such as the rail-based infrastructure of SEATRAC© allow people with kinetic disabilities to enjoy access to the sea. In the project SMART SEATRAC, we empowered the existing supporting autonomous access to the sea infrastructure with an embedded data aggregation system, connected with various sensors to collect and transmit information to the end-users, presenting them, in near real-time, the conditions on the beach to assist them in their decision.

Over the past decade, engineering evolution has allowed the development of technological solutions permitting people with kinetic disabilities to have access to the sea easily and without major assistance from third persons. One of these solutions, the SEATRAC© [L1] is a mechanical construction comprising a sheet on a railway and a motor, and it can be used by people with disabilities to safely manoeuvre themselves into and out of the sea. In the project SMART SEATRAC[L2], TOBEA – the company that designs and produces SEATRAC© – in co-operation with Computer Technology Institute and Press "Diophantus" and University of Patras, aimed to enhance the beach installation with smart sensors that collect data from the environment and store them to the cloud. This information will be analysed and properly published for people with disabilities to assist them in their decision to visit a beach that supports their needs. The scope is to minimise unnecessary movements and to give the opportunity to people with kinetic disabilities to enjoy safely swimming at sea.

The next generation of SEATRAC© installations are empowered with a new embedded device that is based on a Raspberry Pi 2 Model B small single-board computer, which acts as the main data aggregation unit (Figure 1). A series of sensors for water temperature, air temperature, humidity, and UV radiation, and an anemometer are connected to a breadboard that contains an analog-to-digital signal converter wired to the digital inputs of the Raspberry Pi board. Further, a set of IP cameras are set in a panoramic position on the top of the installation, and through Ethernet are connected to the aggregation unit. The images from the camera are processed in the aggregation unit by a script that identifies human faces and bodies. The detected human parts are blurred, and the original images are deleted to protect the privacy of the visitors of the beach. In addition, in the cases where there are parking lots especially for people with disabilities, parking lot sensors transmitting through LoRa network can detect if there are free parking spaces. A LoRa gateway is installed in the SEATRAC© installation to receive data from the parking sensors. Both the aggregation unit and LoRa gateway are connected to a 4G Lte router that connects them with the internet for transmitting data to the cloud.

The SMART SEATRAC cloud platform consists of two major systems: the Data Storage and Analysis Platform and the Public Portal. The Data Storage and Analysis Platform is based on the ThingsBoard opensource platform, a platform widely used in IoT systems [1]. The platform gathers data from all the SEATRAC© installations and stores it in a NoSQL database. Further, it provides a set of graphic tools for data analysis as well as real-time monitoring, as depicted in Figure 2.

The Public Portal is a web portal tailored to people with disabilities, and it is designed to offer them all the necessary information for their choices to visit the sea. The portal has been designed to be easily used on both PCs and small devices (tablets and smartphones). The visitors to the portal can see in an interactive digital map the beaches where there are installations of SEATRAC©. If they permit their device to locate their position, the portal can focus on the nearest beaches. Further, the portal presents information about the operational status of each installation, i.e., if it is working, or if it is temporarily out of order or under maintenance. Additional information about the supporting facilities is also available, such as the existence of changing rooms, showers, and parking for people with disabilities. In the case of parking, the visitors can see the available parking spaces. Apart from the information regarding the SEATRAC installation, the visitors are informed of the environmental conditions of the beach. They can see the temperature of the water and the air, the humidity, and the wind speed.

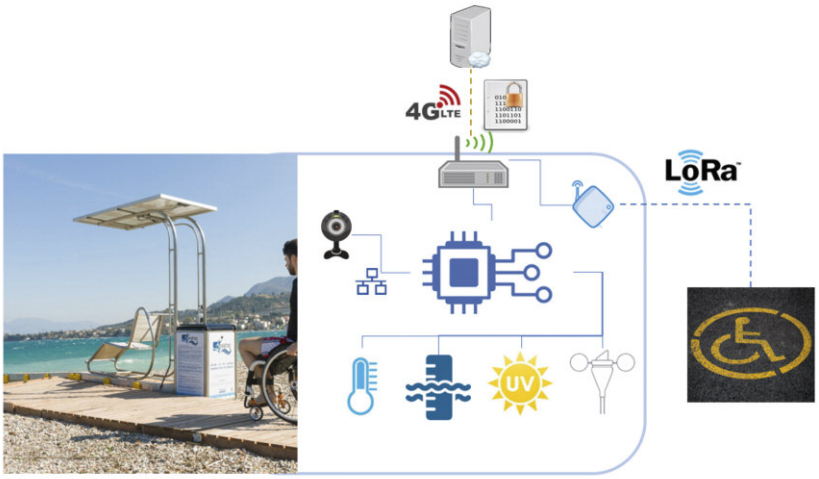

Figure 1: SMART SEATRAC component architecture.

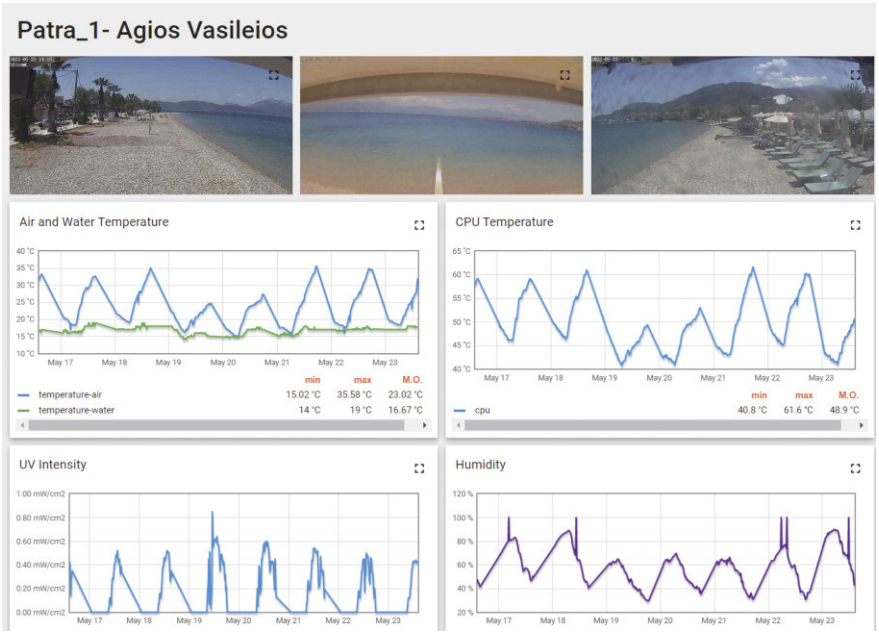

Figure 2: Real-time monitoring and visual analysis of the aggregated environmental data.

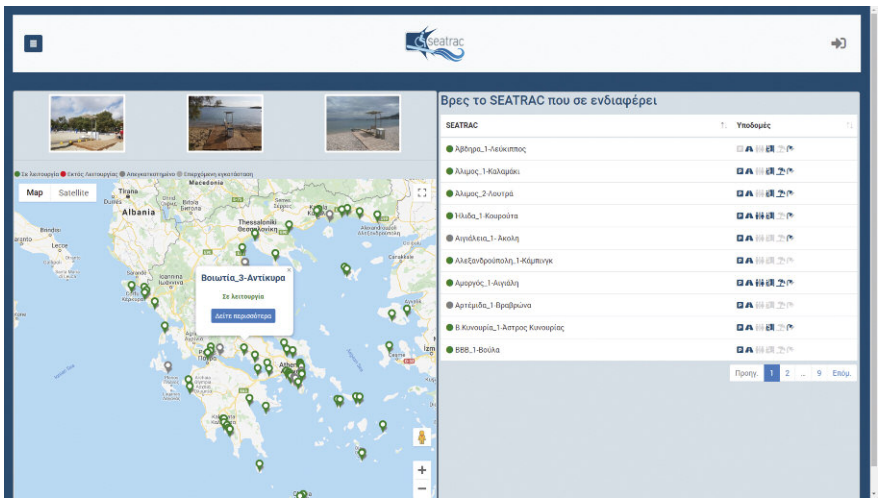

Figure 3: SMART SEATRAC Public Portal interactive map with installations at Greek beaches.

For the protection from UV radiation, the simplifying scale of the UV index is used, informing the visitors about the danger of staying for long time in the sun unprotected. The images from the beach also provide useful information to the visitors as the can see in near real-time the condition of the sea, the height of the waves, and how crowded is the beach.

The SMART SEATRAC project focused on taking advantage of an installation near the beach for gathering useful information for people with kinetic disabilities. People can be informed about the operational status of the infrastructure of the SEATRAC at the beach, supporting infrastructure (showers, parking lots, etc.), the environmental conditions, and the number of visitors on the beach. For the evaluation of this approach, the system was deployed and operated for three months during the summer of 2021 at four beaches in Greece. The next steps include the addition of a novel sensor that detects viruses and bacteria in sea waters and evaluation of the public portal from the end-users. This article presents research work that was implemented in the context of the "Smart SEATRAC" project, which was partly funded by the Greek State and the European Union, in the framework of Action "I Research – Create – Innovate" of the Operational Programme COMPETITIVENESS – ENTREPRENEURSHIP – INNOVATION 2014-2020.

Links:

[L1] https://seatrac.gr/en/
[L2] https://smartseatrac.tobea.gr
[L3] https://thingsboard.io/

Reference:

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Interfacing Brain with Assistive Devices and Reality

by Cristina Farmaki, Matthew Pediaditis, and Vangelis Sakkalis (ICS-FORTH)

Unlocking the true potential of assistive rehabilitation technologies heavily depends on their adaptive potential to match the special needs and abilities of people in need. Previous attempts in advancing brain-computer interfacing (BCI) technologies promise an alternative communication path, but do they actually contribute towards social inclusion or are they for demonstration purposes only?

The i-AMA project's goal is to develop complete closed-loop BCI applications including low-cost hardware and software for navigation purposes, in order to assist patients suffering from severe paralysis to gain a sense of autonomy and initiative.

Brainstem stroke, spinal cord injury and neurodegenerative diseases such as amyotrophic lateral sclerosis (ALS) are only some of the conditions that could lead to paralysis, quadriplegia, or even locked-in syndrome (LIS), where patients lose control of the majority of their muscles, while their cognitive state remains intact. The development of assistive systems that move beyond the typical means of control are of paramount importance for these individuals, as their brain signals are their only way of communicating with their environment. Patients suffering from the aforementioned conditions can greatly benefit from assistive BCI technologies, since such systems are solely based on brain signals to control external devices, without the use of peripheral nerves and muscles. Typically, BCIs take advantage of the excellent time resolution, portability, affordability and non-intrusiveness of electroencephalographic (EEG) recordings to use as control signals in real-time tasks. More specifically, an EEG-based BCI analyses the user's EEG signals and decodes specific brain patterns into control commands, relative to the devices to be controlled.

The iAMA project [L1] stemmed from the collaboration of FORTH-ICS, in Crete (GR), with the rehabilitation and recovery centre, ANIMUS, in Larisa (GR), and WHEEL (GR), a company in Salonica that specialises in manufacturing wheelchairs. iAMA research, running from 2018 to 2022, is supported by the European Union and Greek national funds through the call RESEARCH CREATE INNOVATE (project code: T1EDK- 01675.) In the iAMA project, we focused on navigation-oriented applications and we chose to use the Steady-State Visually Evoked Potentials (SSVEPs) stimuli protocol, which employs specific visual targets, flickering at different frequencies. When someone focuses their gaze at a flickering stimulus, the same frequency can be detected by sophisticated signal processing algorithms at their visual cortex. Thus, each distinct frequency can be assigned to a different movement control command in a navigation system. SSVEPs have been proven to be ideal for such applications, due to their high Information Transfer Rate (ITR) and fast response time, and the minimal training time they require.

Figure 1: Evaluation of the SSVEP-based BCI for wheelchair navigation at ANIMUS Rehabilitation Center.

The initial application our team developed was an SSVEP-based BCI for the navigation of a telepresence robotic car, which has already been successfully evaluated and presented [1,2]. The evolution of navigating a telepresence robotic car was naturally the independent movement of the patients themselves. To this end, we applied the principles of the developed BCI to the control of an electric wheelchair. In order to establish communication between the BCI and the wheelchair, we developed an electric wheelchair controller (EWC), which replaces the standard joystick module and achieves both wireless and wired communication with the BCI. Thus, the BCI system can directly send the detected user's commands to the EWC and control the wheelchair's direction. The wheelchair's battery has large capacity and can power the EWC and the computer system responsible for the interface presentation, the signal processing and the machine learning modules, thus creating an autonomous system. The SSVEP-based BCI uses a three-target scheme: three red–black checkerboards reverse their pattern at three different frequencies, on a laptop screen. The three targets correspond to the movement commands FORWARD and SELF-ROTATION TO RIGHT-LEFT, while the STOP command is detected when the user focuses their gaze at the centre of the screen or even off-centre, where no flickering occurs. An EEG device records the user's brain signals at all times and the developed algorithms analyse and decode them in real-time into movement commands, which are forwarded to the wheelchair controller.

The BCI-based wheelchair navigation system has been tested on both indoor and outdoor conditions on able-bodied subjects [3], exhibiting high accuracy, robustness and ease of use. The latest version of the system, including distance sensors of high sensitivity for collision avoidance, is being tested on patients suffering from various neuromuscular dysfunctions, in the rehabilitation centre, ANIMUS (Figure 1). The application of an assistive system to real patients is always a challenging task, as each patient suffers from a different disease with distinct characteristics, which affect the effectiveness of the system to different extents. Robust brain signals captured from able-bodied users can be well-characterised and the BCI outcome is really promising, but in many cases cannot be directly applied to

patients. i-AMA focuses its efforts on personalising the overall system according to each patient's specific needs and limitations. Our research expands beyond able-bodied test users to account for real-world application difficulties, i.e., dealing with excessive motion artifacts and people not able to maintain focus, including the widely complex children application domain.

Our future goals include grouping specific disorders according to their specific traits, in order to develop various user-tailored initialisations of the system. An important insight from the evaluation of patients is the necessity for a user-friendly, cost-effective, highly adaptive system that requires minimal preparation and training. Hence, we exploit dry electrodes that require no preparation time, different interface schemes and pre-trained models for the machine learning algorithms, as well as low cost EEG hardware. All these considerations have the potential to enable the development of assistive interfaces that can be integrated into the daily life of patients, build social trust and pave the way towards a more accessible and inclusive society.

Link:
[L1] https://i-ama.gr/

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Enabling Data-Driven Robotic Physical Therapy

by Christian Thomay and Benedikt Gollan (Research Studios Austria FG) and Erich Heil (tech2people)

The physical therapy centre of the future contains a variety of robotic assistance systems, allowing an increasing range of patients access to individualised rehabilitation therapy. However, novel, holistic approaches are needed to combine heterogeneous data from such different devices into a consistent digital twin that encompasses a patient's circumstances and needs. tech2people and the Research Studios Austria FG aim to realise such a data-driven, digital therapy centre where data is combined and analysed using Big Data and AI methods, allowing for precise insight into, and forecast of, therapy progress for both therapists and patients.

"Get up and walk every day. Something that most of us take for granted, but for people who suffer from neurological diseases and are in a wheelchair, it is probably what they want most." Gregor Demblin (Co-Founder of tech2people) is paralysed from the waist down; he has been in a wheelchair since a swimming accident in 1995. Walking and training with robotic assistive technology systems has given him a new degree of freedom and changed his life: he hardly needs to take any medication; bladder infections and abrasions on the body have become fewer; and after "sitting for 20 years" he now feels "like a new person". Studies have shown [1] that his personal experience is measurable. Motivated by these results he founded tech2people, with the goal to set up the most modern physical therapy centre in Central Europe and specialise in data-driven robot-assisted therapies for everyone.

In past studies, exoskeletons and other robotic assistive systems have been shown to contribute to recovery of body functionality, increasing recovery speed and therapy effectiveness [2]. An additional advantage of robotic therapy is the wealth of data that the assistive systems generate, for instance, an Eksobionics EksoNR robotic exoskeleton [L1] records data from hip and knee angle sensors, pressure sensors on toes and heels, and assistive motor force at a rate of up to 500 Hz. Similarly, other advanced assistive systems such as the Hocoma Lokomat [L2] – a robot-assisted treadmill system – and a range of devices from Tyromotion [L3] – which target different regions of the body such as upper extremities, finger/hand, and arm/shoulder – allow for detailed insight into the therapy process and the state of the patient.

However, much of this bounty of data is either not fully utilised yet – or not utilised at all. While data interfaces exist and feedback may be given to patients, there is no holistic methodology that allows for cross-examining the data between different devices and therapy types, thereby enabling a detailed analysis of this data towards studying a patient's progress on their journey to rehabilitation. The need for such multimodal fusion has been concluded in studies into the effectiveness of exoskeleton therapy [3], as well as the need for therapy individualisation, but such systems have not been realised yet.

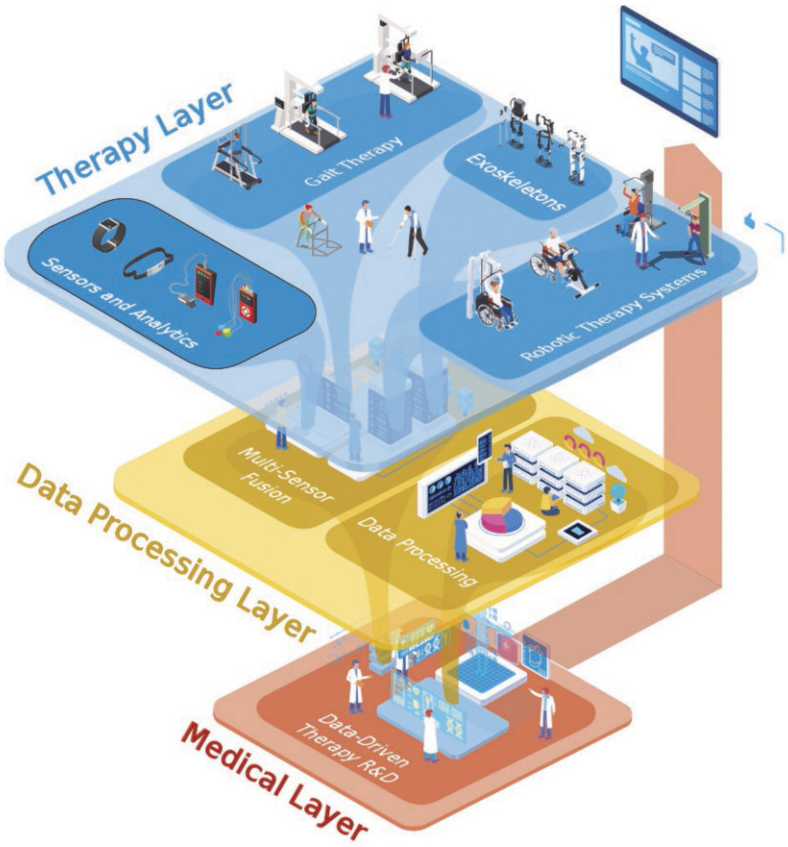

Figure 1: Data-driven therapy is supported by different devices, combining the data to allow for individualised approaches.

tech2people, in a scientific cooperation with the Research Studios Austria FG (RSA FG), intends to change that. Fig. 1 illustrates the vision of the therapy centre of the future: the aim is to realise a fully digital therapy environment where different assistive systems and sensor technologies are all running on a shared platform, allowing for a holistic view of the patients and their therapies. This heterogenous data is processed using multi-sensor fusion, culminating in a digital twin model of the patient. This digital twin represents the state of relevant parts of the patient's body and is constructed from data obtained from different sensor devices and assistive systems.

Such a digital twin serves two main purposes. It offers the therapists detailed insight into the patient's progress and individual requirements, allowing the therapists to create customised therapy schemes tailor-made for individual patients, and to adjust therapy schemes over time. The digital twin also allows for an intuitive visualisation of their progress for the patients themselves: summarising complex information in accessible 3D models and colour schemes, patients can see how they did in a given therapy session, making the process more transparent and engaging.

However, visualising and evaluating the data on a session-to-session basis is only the first step. By deriving generalised metrics that offer insight into relevant parts of the rehabilitation process, therapy progress can be evaluated over time, showing trends and long-term developments that individual session data might not reveal. Furthermore, the wealth of information created throughout all therapy sessions comes together in an incrementally growing knowledge base. Together, these aspects form the foundation for predictive modelling: using Big Data and AI-based methods, therapy forecasts can be given, contributing to an optimal choice of therapy for each individual patient.

Due to the sensitive nature of confidential patient data, data security and privacy are of utmost importance. To that end, data encryption and anonymisation schemes will be applied, ensuring no outside access to patient data or identification of individuals. Furthermore, it is a key priority that the patient themselves always remain the focus; all results derived from the data will form the basis of recommendations to the therapists, but decisions will only be made in a dialogue between patient and therapist, ensuring a respectful usage of their data.

tech2people is currently working on realising its vision for the therapy centre of the future, located in Vienna, Austria. The ongoing research endeavour in partnership with RSA FG aims to establish the methodology to evaluate data from a range of assistive systems, creating a digital twin of the patient that allows both therapists and patients detailed insight into the rehabilitation process. These analyses of heterogeneous data are founded on the therapy expertise of tech2people, together with the data science and sensor fusion know-how of RSA FG, which in combination will contribute to making robotic physical therapy more effective, transparent, and user-friendly. The therapy centre aims to offer access to advanced therapy technology that was previously not available, increasing the range and accessibility of rehabilitation for patients that might otherwise not have access to it, and offering better, and more individual, therapy for anyone who requires it.

Links:

[L1] https://eksobionics.com/eksonr/
[L2] https://www.hocoma.com/solutions/lokomat/
[L3] https://tyromotion.com/en/product-overview/

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Increasing the Independence of People with Disabilities Using Bio-signals, Computer Vision and Wearable Devices

by Ioulietta Lazarou, Lampros Mpaltadoros, Fotis Kalaganis, Kostas Georgiadis, Spiros Nikolopoulos, Ioannis (Yiannis) Kompatsiaris (Centre for Research & Technology Hellas – Information Technologies Institute - CERTH-ITI)

Recent advancements in the fields of bio-signal processing, computer vision and wearables empower the independence of people with physical and cognitive disabilities.

The Activities of Daily Living (ADLs) rely on a very broad spectrum of physical and cognitive functions that need to perform adequately for ensuring an acceptable level of independence. Therefore, people's independence can be affected by different types of disabilities that, in turn, may require different types of assistive technologies, such as those shown in Figure 1, to alleviate the negative effects. In this article, we describe how the use of bio-signals have allowed people with neuromuscular disorders to operate a computer using their eyes and mind; how the use of computer vision has enabled the visually impaired to do their groceries, visit a public service office or perform a recreation activity; and, finally, how the use of wearable devices has allowed reliable monitoring of elderly people and people with chronic illnesses, leading to more effective remote care, and self-management of illnesses.

Loss of voluntary muscular control while preserving cognitive function is a common symptom of neuromuscular diseases, leading to a variety of functional deficits, including the ability to operate software applications that require the use of conventional interfaces like mouse, keyboard, or touchscreens. As a result, the affected individuals are marginalised and unable to keep up with the rest of society in a digitised world. In the context of our research project MAMEM [L1], we have allowed people with neuromuscular disorders to reintegrate into society by endowing them with the skill of operating a computer using their eyes and mind. More specifically, we have produced a mature software system enabling the basic functionalities of human computer interaction through the use of eye-gaze and mental commands [1]. Although solutions for supporting the disabled have been around for some time, the output of MAMEM is among the few solutions that nicely integrate eye-tracking with brain commands, which is also designed for home use. This system was installed at the home of 30 patients with neuromuscular disorders, and was used autonomously for one month to perform social media interaction and other online activities. In addition, our technical solution has gained the attention of relevant user communities and independent users requesting to use the system for their own benefit of improved communication and digital empowerment. Following their request, five systems are now installed in the home of patients with locked-in syndrome, helping them to operate a computer through eye movements and mental commands, helping to make these people feel less marginalised and to become more integrated with the rest of society, reflecting very positively on their mental health.

The autonomy of the visually impaired, expressed by their ability to accomplish everyday tasks on their own when help from others is not available, is of paramount importance. Our goal in the context of the research project e-Vision [L2] has been to leverage the latest advancements in computer vision, with the aim to improve the autonomy of people with visual impairment at both practical and emotional levels. The system developed for this purpose consists of a pair of eyeglasses integrating a camera and a mobile application that encapsulates computer vision algorithms capable of enhancing several daily

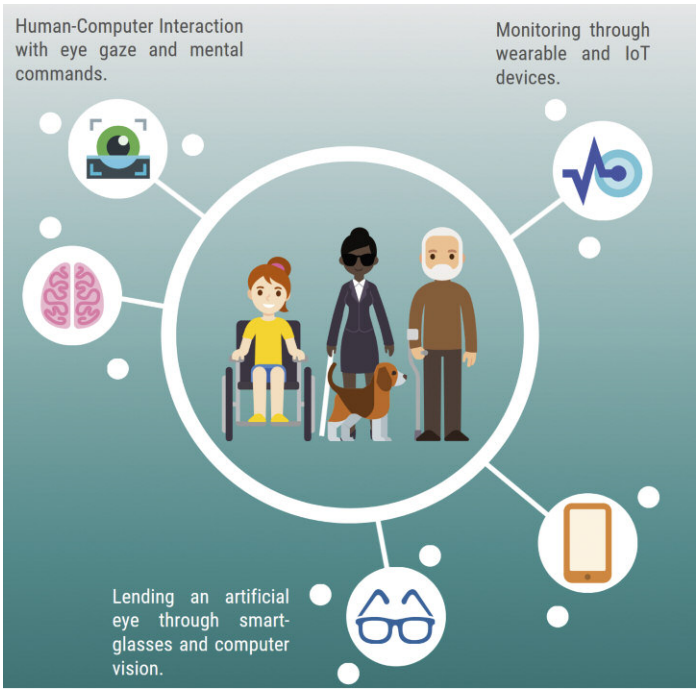

Figure 1: Brain computer interfaces, computer vision glasses, wearables and IoT devices for increasing the independence of people with physical and cognitive disabilities.

living tasks for the visually impaired [2]. It is a context-aware solution and builds upon three important day-to-day activities: visiting a supermarket, going on an outdoor walk, and visiting a public administration building for handling a certain case. e-Vision also caters for social inclusion by providing social context and it enhances overall experience by adopting soundscapes that allow users to perceive selected points of interest in an immersive acoustic way. This particular aspect, i.e., the emphasis on the social rather than the strictly practical aspects of autonomy, is what differentiates eVision for similar solutions designed for the visually impaired.

The increasingly aging global population is causing an upsurge in ailments related to old age, primarily dementia and Alzheimer's disease, frailty, Parkinson's, and cardiovascular disease, but also a need for general eldercare as well as active and healthy aging. In turn, there is a need for constant monitoring and assistance, intervention, and support, causing a considerable financial and human burden on individuals and their caregivers. Interconnected sensing technology, such as IoT wearables and devices, present a promising solution for objective, reliable, and remote monitoring, assessment, and support through ambient assisted living [3]. In the context of our research project support2Live [L3] we have developed a platform based on intelligent collection and interpretation of IoT devices, to reliably monitor elderly and people with chronic illnesses, leading to more effective, more economical and more accessible remote care, harvesting multiple social and economic benefits. Performing a longitudinal study with wearables and IoT devices being installed in patient homes before and after specialized interventions, can be considered as the most significant contribution of our work.

Links:

[L1] https://www.mamem.eu/
[L2] https://evision-project.gr/en/
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Restoring Grasping Functions of Paralysed Hands

by Christine Azevedo Coste (Inria), David Guiraud (NEURINNOV) and Charles Fattal (Centre Bouffard-Vercelli, USSAP)

The objective of our research is to provide different hand movements using only two epineural electrodes implanted above the elbow in individuals with hand paralysis. Each multi-contact cuff electrode can be configured to electrically stimulate different fascicles of the nerve, eliciting the contraction of different muscles. The user controls the neuroprosthesis by executing stereotyped movements or activating muscle contractions that are interpreted by the piloting interface as orders to trigger the stimulation. Two participants with complete tetraplegia were implanted with two electrodes for 28 days and were able to grasp different types of objects for the first time since their spinal cord injury.

People with complete tetraplegia are dependent on caregivers for activities of daily living (bathing, dressing, eating, self-care, etc.). In some situations, functional surgery can partially restore hand and wrist movements to produce useful but limited functions. Functional Electrical Stimulation (FES) can activate muscles with intact motor neurons located below the spinal cord injury by applying electrical pulses of current to excitable tissue. FES can be applied using surface, percutaneous or implanted electrodes. As the forearm muscles are small and sometimes deep, implanted stimulation was considered relevant to restore hand function. To date, the proposed solutions require the insertion of an electrode in each muscle involved in the movement to be restored. A commercial device was available decades ago: the Freehand system (Neurocontrol). It has been implanted in more than 250 people (Keith et al, 1989). Up to 12 intramuscular electrodes were inserted in the arm muscles and various movements could be induced. Despite the benefits reported by users, marketing was stopped in 2001 for mainly economic reasons. One of the disadvantages of the device was the high number of electrodes and cables implanted in the body as well as a surgical procedure lasting about six hours.

In a previous study, we investigated the possibility of activating different muscle groups innervated by the same nerve using a multi-contact cuff electrode wrapped around the median or radial nerves (Tigra et al., 2020). We designed mathematical models of the nerve–electrode interface and extracted from simulation results the most selective electrode configurations. We developed an electrical stimulator capable of controlling multichannel electrodes. After acceptance of the protocol by the ethics committee and the national competent authority, 10 participants with complete tetraplegia accepted our intervention during a scheduled functional musculotendinous surgery. During surgery, under anaesthesia, the median nerve (flexion movements) or the radial nerve (extension movements) was exposed and an electrode positioned. We systematically scanned different pre-programmed electrode configu-

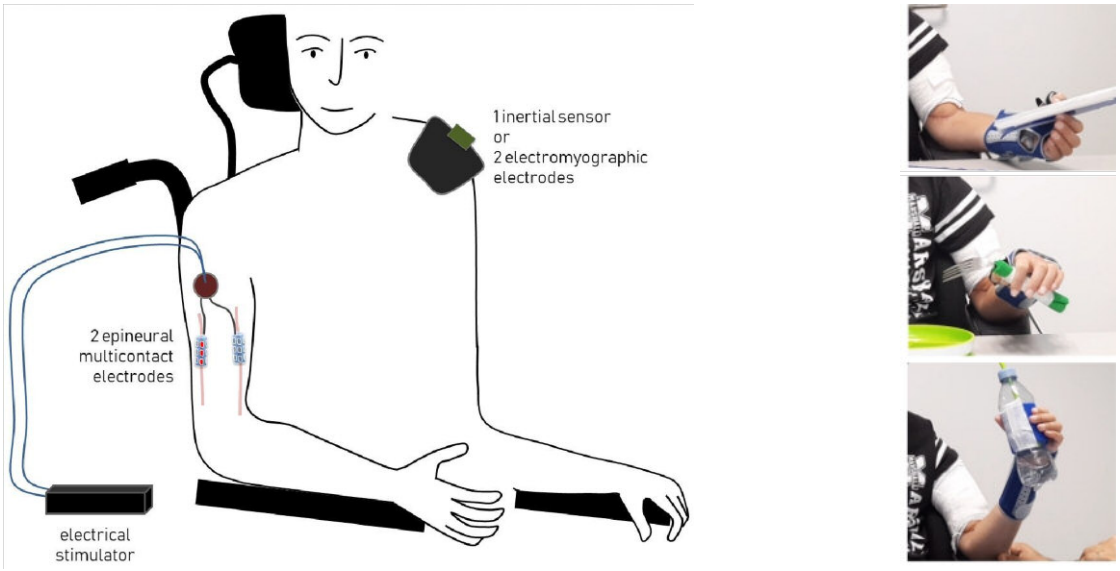

Figure 1: Left: AGILIS solution: two multi-contact neural stimulation electrodes are wrapped around medial and radial nerves. The user mobilises his/her sus-lesional muscles to send orders to the controller of the electrical stimulator to activate the corresponding electrode configuration and induce the intended hand action. Right: Examples of object grasping.

rations (contact arrangement and electrical stimuli parameters) and observed the induced movements. The electrode was then removed, and the surgical procedure continued. The analysis of the movements induced by the different configurations confirmed the possibility of activating different muscles with a single electrode. Based on these results, we launched a new project: AGILIS [L1]. AGILIS proposes to use only two neural electrodes to drive the extension and flexion movements of the hand: multi-contact electrodes placed around the median and radial nerves to activate different muscles depending on the contact configuration and the stimulation parameters. These neural electrodes were implanted for 28 days in two volunteers with tetraplegia. During this period, the configuration of the electrodes could be individually optimised and the progression of performance evaluated longitudinally. An intuitive interface was designed to allow the user to control the assistive device and to increase the embodiment of the technology.

The electrodes were placed during a first surgical procedure and explantation performed 28 days later during a second surgical procedure. The complete device consisted of two multi-contact electrodes (CorTec GmbH Freiburg Germany) with their individual percutaneous cable and extracorporeal connector, two extracorporeal cables, and one multi-source external stimulator (STIMEP, Inria, Montpellier) connected to a computer. Wireless sensors (Delsys, Natick, MA) were placed on the skin to measure voluntary muscle signals (electromyography (EMG)) and voluntary movements (inertial measurement units (IMU)). These signals were processed to detect the user's steering commands. Users could autonomously trigger stimulation using their contralateral limb: stereotyped shoulder movements or muscle contractions of muscles above the spinal cord lesion. A finite state machine (FSM) was defined to associate user commands (detection of muscle activation thresholds or recognition of a predefined movement) with actions.

It was possible to generate various functional movements in the two participants, allowing them to grasp various objects of everyday life [3]. Our study suggests that multi-contact cuff electrodes combined with multi-source electrical stimulation offers the possibility of selectively activating nerve fascicles in a reproducible manner. Multipolar neural electrical stimulation of the median nerve and radial nerve allowed for useful grasp and release in both participants. Future studies will consolidate this proof of concept by expanding the number of participants.

Link:

[L1] https://www.eithealth.eu/agilis

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Taste Before Tasting: Development of a Virtual Tongue to Characterise the Organoleptic Profiles of Mediterranean Ingredients

by Lorenzo Pallante (Politecnico di Torino), Athanasios Kalogeras (Athena Research Center, Industrial Systems Institute), Marco Agostino Deriu (Politecnico di Torino)

The EU-funded VIRTUOUS project is dedicated to the development of an integrated computational platform working as a virtual tongue able to predict the taste and the organoleptic profile of Mediterranean ingredients. VIRTUOUS integrates mechanistic modelling approaches, machine learning classifiers, algorithms for big data, and cloud computing, all fed by experimental data to predict food taste, knowing its chemical composition.

The Mediterranean diet is often associated with a reduced risk of developing diseases and an increased life expectancy. Several clinical trials highlighted the beneficial effects of the Mediterranean diet in the primary and secondary prevention of cardiovascular diseases, diabetes, and even cancer. In this connection, a rational analysis focused on the chemical compound content of food interacting with specific targets in the human body might be a crucial breakthrough to provide insight into complex biological mechanisms that make the Mediterranean diet result in long-term favourable effects on human homeostasis, which is preserved firstly by taste receptors and driven by nuclear receptors.

In this connection, nature has developed fascinating screening mechanisms to detect healthy or dangerous chemical compounds contained in food. One of the most important control systems for food and drink intake is called "taste", a sensory modality to evaluate the nutrition content of food and preventing the ingestion of toxic substances. Five basic types of taste are in general accounted: salty, sour, bitter, sweet and umami (by many authors, fat is also considered as a sixth taste). Each taste represents a different nutritional or physiological need.

The common experience is that taste sensation suddenly arises when food hits our tongue. More in depth, tastants primarily interact with taste-specific proteins, i.e. the taste receptors. The interactions between food chemical compounds and relative taste receptors trigger a subsequent cascade of events involving receptor cells linked to the nervous system, ultimately resulting in the perception of a specific taste. Understanding complex relationships that, from the chemical composition of food, drive towards both its organoleptic profile and its long-term impact on human homeostasis, is a crucial breakthrough oriented to future improvements in applied research targeting health, the market of nutrition supplements, and diet. From the molecular point of view, structural molecular modelling has been recognised as a promising tool for the study of structure-activity relationships and the accurate integration of in silico and experimental methods has provided an up-to-date understanding of the intricate aspects of intermolecular recognition [1]. Moving from structure to function, recently the interest is converging toward promising machine learning, recognised as a powerful approach with yet unexplored capabilities applied to the treatment of large-scale data analysis for efficient extraction of patterns and associations between various types of regions of interest. Several scientific advances have been made in recent years in the field of taste prediction, which should be of paramount importance not only for the food industry but also for the medicine, pharmaceutical and biotechnology sectors [2].

To face the complexity of the taste-perception process, it is necessary to employ multidisciplinary competencies to develop computational models in a multiscale/multiphysics fashion, moving from chemistry to structure, and from structure to function. This vision is embraced by the EU-supported

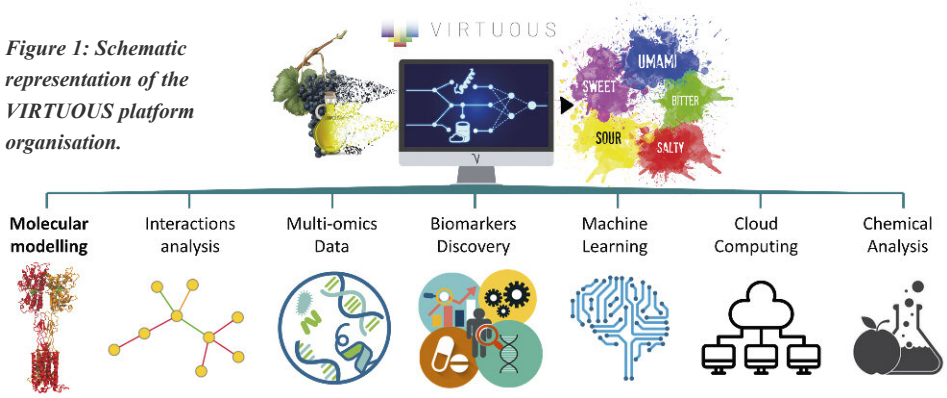

Figure 1: Schematic representation of the VIRTUOUS platform organisation.

research actions, namely VIRTUOUS [L1], which aims at developing a user-friendly computational platform able to predict the taste of a food, starting from its chemical composition. VIRTUOUS integrates mechanistic modelling approaches, machine learning classifiers, algorithms for big data, cloud computing, continuously fed and validated by experimental data. (Figure 1).

The idea a taste predictor applied to European food products will boost and widen the European food market at a global level, also enhancing Europe's attractiveness as a leading destination. A virtual tongue will allow to "taste" a food even thousands of kilometres away. In this project, the specific application cases will be focused on wine and oil, but the research can be easily extended to any other type of fresh food.

The VIRTUOUS tongue may be also thought to have a "food computer-aided design tool" for EU food technology. For example, based on taste prediction, the VIRTUOUS platform may be used in the future to predict the results of a specific grape graft, and propose what grafting strategy to use to obtain a specific taste or aftertaste. In the same way, all food processing procedures can be optimised and refined through the VIRTUOUS tongue, allowing to obtain different flavours and/or different effects on homeostasis.

The VIRTUOUS research also links taste receptors' activation to the activity of nuclear receptors, by classifying food molecules based on their ability to interact with specific targets. This aspect will have a great impact on the EU and the global medical field concerning for example immunological disease or cardiovascular pathologies, where a correct diet is commonly complemented by drug therapy. Therefore, the development of a VIRTUOUS tongue has the potential to become a tool to help clinicians in preparing a diet to target specific cell receptors and cell functions and maintain high patient quality of life.

VIRTUOUS embraces a disruptive paradigm concerning modelling physiological and pathological phenomena. The VIRTUOUS vision promises to support a better understanding of the mechanisms underlying the functioning of our physiological and pathological functions and an in-depth understanding of the effects on our bodies of diet, food supplements, drug therapies, or combinations thereof.

All project events and results are also described in the VIRTUOUS official website [L1].

Links: [L1] https://virtuoush2020.com/

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Challenges in Artificial Intelligence for Smart Forestry

by Andreas Holzinger, Karl Stampfer, Arne Nothdurft, Christoph Gollob (University of Natural Resources and Life Sciences Vienna) and Peter Kieseberg (University of Applied Sciences, St.Poelten)

New challenges, especially due to climate change, warrant rethinking classical forestry in many ways, ranging from neophytes and overspread of pests to drought and fires, previously rare in many places like middle Europe. Digital transformation in future smart agriculture and forestry requires a human-centred artificial intelligence (HCAI) approach, incorporating sociological, ethical and legal issues. Human intelligence should be augmented – not replaced – by artificial intelligence, like "power steering for the brain".

Especially in the case of small-scale forestry, many forest owners work in their own forests and much of the work is done manually. But digital and intelligent tools are spreading in this area, for example, forest owners can be shown individual tree information via head-up displays in their helmets or VR glasses. In addition, assistance can be provided for value-optimised logging to increase efficiency and yield. Conversely, the AI can learn from the forestry workers' expertise and concrete actions at any time during the work process. A first step towards autonomous practice is to temporally decouple the collection of environmental data from a forest machine and its AI-controlled functions. For example, 3D scanners can be used to create digital twins of the forest (this often takes place as part of the forest inventory anyway) and autonomous, automated or even augmented processes can be integrated into the forest machine on the basis of the digital twin. This saves the time-consuming mapping and navigation of the environment during operation. Robots (e.g., quadrupeds, see Figure 1) are already affordable and offer a good opportunity to test such a process. Throughout the process, the forester needs to be specifically involved in making decisions.

The introduction of AI can be a game changer in many current environmental issues surrounding forestry; one example is the analysis of forest fires. Major research efforts have been spent on the detection and classification of forest fires, especially in cases of large, isolated places in the countryside. Classification of forest fires is required in order to discern wanted fires (fires native to the ecology) from unwanted fires. Still, there are several questions that require additional attention by the academic world. Intelligent methods could be used to target the following key research issues: (i) the automated detection of fire nests, (ii) the modelling of risks for fires based on forestry data, (iii) the setup and development of low-cost sensors for data gathering and actual fire detection. One key takeaway from the fires in Lower Austria in 2020 was the fact that the actual detection was not a problem in such a densely populated area. Still, the topology of the area had a severe impact on the actual control of the fire: extinction was often done from airplanes, thus putting out the fires was not the key problem. The key issue was that the fires were re-igniting constantly from

Figure 1: While the hardware is working, the software needs additional capabilities – experts in the loop can provide the solution [1].

fire nests. Combating these nests was a key problem, as the area was very karstic and thus firefighters needed to climb up to the potential locations for fire nests – a tedious and dangerous task that required a lot of manual effort and time. Thus, the detection of fire nests from airborne drones would be very important in order to increase the effectiveness of combating fires.

Still, while detection is certainly important in combatting fires, the reasons why fires break out need to be understood as does whether data can show which areas (i) are especially prone to fires and (ii) increase the growth of a fire at a disproportionate rate. Information from previous fires and also sensors targeting new parameters need to be developed, not only for pure environmental factors like temperature and humidity, but also for man-made issues like highways (glass and smoking hazards). A low-cost infrastructure based on low-energy sensor and communication equipment needs to be developed and applied.

The previous example regarding forest fires is just one of many aspects where data and the respectively generated digital twins could add great value, with respect to increased sustainability of forestry, as well as security and safety concerns [2]. Still, generating good digital twins requires a lot of research efforts: what data is required to be collected at what granularity and what error variables exist. In addition, the collection of such parameters is very different from tradition digital twins in industrial operational technology (OT) systems. One solution lies in the application of flying drones combined with (inexpensive) ground sensors, as outlined in the forest fire example above. Still, the dense coverage with foil and trees provides a lot of problems for most current low-cost, low-energy communication techniques. Furthermore, energy consumption is a problem for many potential solutions in smart forestry, as well as the unsure ground to navigate. Compared to questions in smart farming, the wide variety of different plants requires advanced decision making on the software side in order to make ground-based robots fully navigable and operable without them stalling – again, decisions that cannot be made at design time, but require a human in the loop. A human expert (e.g., forester, farmer) has a wealth of practical experiential knowledge that needs to be fed to the robot to enhance their operations, combining "natural intelligence" with "artificial intelligence" [3].

To this end, we propose three pioneering research areas (see Figure 2) that we have identified as the most important and promising research areas for the coming years, based on our experience, namely (1) Intelligent sensor information fusion, (2) Robotics and embodied intelligence, and (3) Augmentation, explanation, and verification. The results of this research will not only enhance efficiency in forestry, but will also allow the development of new technologies. Furthermore, we also see ample opportunities for enhancing forest workers' safety by outsourcing dangerous tasks to robots.

Link:

[L1] https://human-centered.ai

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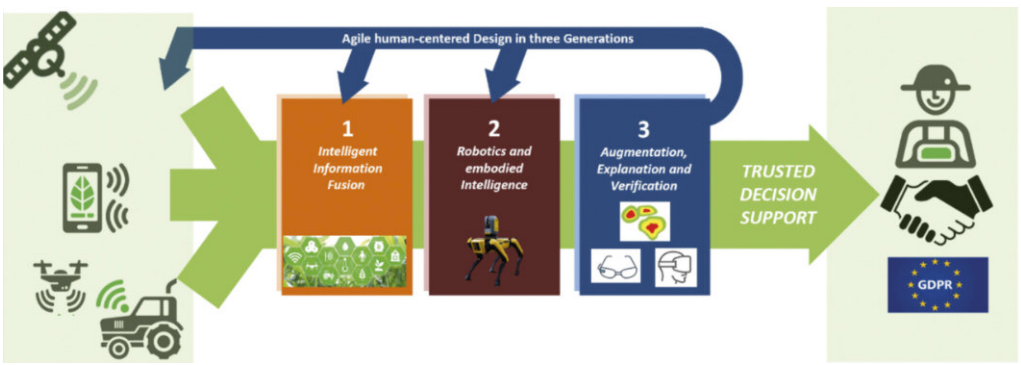

Figure 2: Three frontier research areas with agile human-centred design [1].

Personalised Medicine and Gender Analysis: A Hint at the Problem for More Inclusive Technologies

by Emanuela Tangari and Carmela Occhipinti (CyberEthics Lab.)

The use of Artificial Intelligence can be a vital resource for the development of precision medicine. Nonetheless, it is crucial to conduct a gender analysis of this technology for increasing its inclusiveness and democratic nature.

In the field of assistive technologies, an interesting project started two years ago, financed by the European Union (EU) under the Horizon 2020 (H2020) programme, which aims to support the follow-up of cancer survivors and to improve the diagnostic decisions of clinicians involved in the treatment of these cancers (with the perspective of extending the process to other fields of application). The PERSIST project (Patients-centred Survivorship care plan after Cancer treatments based on Big Data and Artificial Intelligence technologies) [L1] is based on Artificial Intelligence (AI), the use of Big Data and the detection of circulating tumour cells (liquid biopsy) to implement and refine a real-time and remote patient monitoring system, and at the same time to improve medical analyses and decisions regarding the prognosis and treatment of patients, targeting and supporting so-called "precision medicine". The 13 partners (hospitals, companies and technology centres from 10 countries) and the 160 patient volunteers involved cooperate in the development of this assistive technology through the use of a smartwatch connected to a platform, to monitor and record patient-specific biomedical data (heart rate, blood pressure, sleep quality, etc.), and indicators concerning the patient's quality of life.

Precision medicine, which makes use of AI, is the way to improve the management of both prevention and follow-up of patients, e.g., to promote faster recovery and more effective reintegration into the social, work, and relational spheres. In PERSIST, in addition to the use of AI and Big Data, a system is being developed based on an algorithm that allows the constant measurement of circulating tumour cells in order to detect possible metastases at an early stage. This type of monitoring, along with all the processes that have always been performed by technicians, requires longer analysis times; the technologies currently under development can therefore also help to significantly reduce the diagnostic treatment time, thus making therapies and discoveries much more effective.

On the one hand, AI aims towards coding by experts, who make use of their own knowledge; on the other hand, machine learning algorithms aim to build models from labelled classification cases. The common goal is to achieve an ever-increasing predictive capacity (also for the algorithm and Deep Learning); it is a matter of perfecting more and more such "labels" on which the data are structured. Machine learning then identifies itself as a continuous process with a great capacity for defining patterns that are not included in the training phase.

The challenge for such assistive and medical technologies, however, is to ensure that data-driven research models go hand in hand with good clinical practice, and that important ethical standards are considered and maintained in them. Among these, one of the most decisive issues – also for the very structuring of the learning models on which the algorithm drives – is certainly that of gender analysis.

There is a gender discrimination that precedes the results of medical research. The many studies on this subject [1] point out how already at the screening stage certain values are not adequately taken into account, for example the psychological distress of women with regard to their sense of family responsibility (which affects the decisions they make for their own care plan) or the under-representation of women in medical research [2]; or even the difficulty of particular groups of people in obtaining (for geographical or economic reasons) treatment. These forms of discrimination do not move over an immediately identifiable field, but are often underestimated due to unconscious patterns and a cultural (including clinical) tradition that increases inequality between social groups.

Figure 1: Infographics of a gender-sensitive communication.

It is crucial, in referring to gender analysis, that it is not conceived in the sense of male–female difference. We have noted that gender also includes all socio-economic factors; the need then arises for an 'intersectional' analysis capable of showing how gender has to do with other social parameters, in order to raise awareness of prejudices (and thus actions) that drive analyses and studies.

Then there are the large and numerous gender-related problems due both to access to information resources (and thus to information, to the news people can obtain) and to media communication (Figure 1) (according to which, in a large number of cases, we see represented male doctors and female nurses, for example). A "personalised" medicine needs therefore to consider these and numerous other issues, first and foremost by working on individual and collective awareness (e.g., through staff training) [3], decision-making policies and research and diagnostic methodologies.

Conclusions

An appropriate analysis of the data, combined with a broad cultural system consistent with the complexity of reality and human beings, capable of recognising and resolving gender bias and adopting differentiated good practices, can allow the building of a democratic and inclusive approach (for a cultural and a technology education). On the other hand, it can allow the implementation of increasingly reliable and accurate technologies tailored to individual needs and characteristics. "Precision medicine" must therefore have as its perspective not only to be clinically reliable, but to become a medicine "for everyone", able to leave no one behind and to start conceiving gender in its complex and important meaning of human gender.

"This document is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 875406".

Links:

[L1] https://www.projectpersist.com/
[L2] https://www.cyberethicslab.com

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Paving the Way Towards a Complete Integration of Data and Model-driven Methods for Structural Health Monitoring

by Alessia Amelio, Roberto Boccagna, Maurizio Bottini (University of Chieti-Pescara "G. D'Annunzio") and Massimo Petracca (ASDEA srl)

We present a comprehensive strategy for assessing structural health conditions that we believe could become the standard procedure. The proposed solution covers the entire structural health monitoring (SHM) process, from data recording to damage management. The key innovation of our approach is through the elaboration of a logical workflow reinforced by the use of integrated high-performance devices and hardware/software components designed by ASDEA srl specifically for use in this context.

Artificial Intelligence (AI) has definitively changed perspectives on data analysis and prediction making due to the reliability of AI-based algorithms and the enhanced performance of the currently available processors, which ensure large amounts of data can be analysed in near real-time. These aspects have made AI popular in the fields of civil and structural engineering, where Machine Learning (ML) and Deep Learning (DL) techniques are being used to classify signals acquired by sensor networks permanently installed on structures being monitored. The data recorded undergo a pre-processing step in which noise reduction algorithms are applied before extracting relevant features to be fed into the true AI step. Then, an algorithm establishes if the incoming data are anomalous compared to a baseline of healthy data, indicating whether the structure has undergone a change. This automated approach to assessing the health of (typically) large structures is replacing more traditional (and usually more expensive) in-situ inspections, although periodic surveys are still recommended. Nevertheless, AI has the distinct capability to catch inner changes not otherwise apparent, allowing fast repair operations before damages grow, preventing catastrophes.

Despite the clear advantages offered by AI in diagnosing structural damage, a precise procedure has not yet been established. The literature [1] shows how various tools have been employed for accomplishing the tasks involved in the SHM sequence, i.e., data acquisition, pre-processing, anomaly detection, damage classification, and decision making. However, these approaches vary wildly in the way they gather and process data, and the lack of a unified and integrated system means that information gained is often incomplete or ineffective. For example, looking at just the first stage of the SHM process, the data acquisition phase, the choice of hardware conditions the functionality of the whole approach. The instrumentation quality alone demonstrates how simple choices condition the rest of the analysis as different sensors measure physical quantities with different sampling rates. Moreover, each sensor has an inherent noise level depending on the hard-

ware components and the way single devices are connected. Even the placement of sensors is critical for obtaining meaningful outputs.

The next salient issue after data pre-processing regards the choice of the algorithm used for damage detection. With reference to the literature [1], many solutions have been adopted for the task with varying levels of success, spanning from classical multivariate statistic techniques to more complex (and generally costly) algorithms involving artificial neural networks. Nowadays, dedicated libraries written in the most popular programming languages contain many AI-based black boxes that can be easily trained for classification issues. However, these obscure many subtleties that must be considered, especially regarding the establishment of relevant features from data, i.e., the engineering parameters most sensitive to small structural variations and a coherent geometry for the chosen classifier.

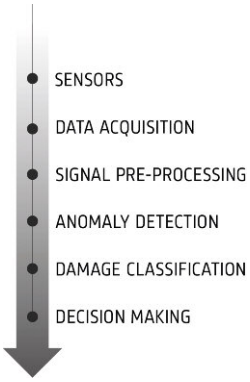

Figure 1: The sequence defining the SHM process.

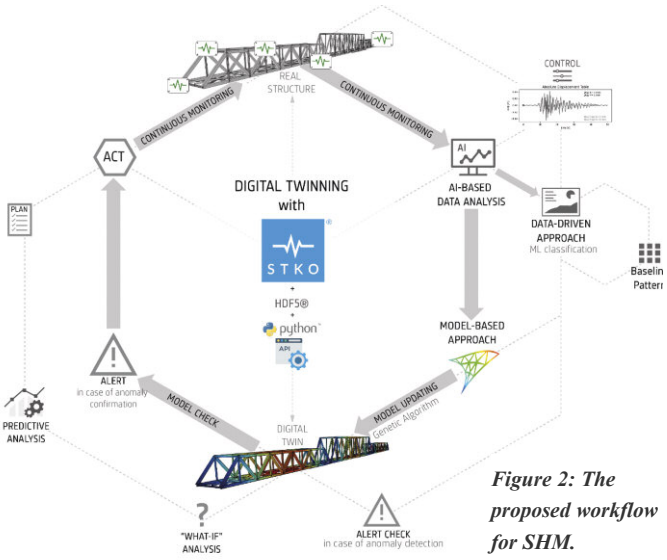

Figure 2: The proposed workflow for SHM.

Furthermore, what makes most solutions implemented so far for SHM unfit is the heterogeneity of data produced in the various stages, as described in Figure 1, and the lack of a common framework for analysis as the software programs used in each stage are typically furnished by different suppliers. Format incompatibilities represent a serious issue, and many problems arise in managing such large, heterogeneous datasets, including a slowdown of the algorithm and, more critically, data loss.

We propose a robust solution that overcomes these problems and manages the whole SHM process in a simple but powerful way through a holistic approach that looks at the system as a whole, instead of the individual parts, aiming at optimal compatibility. The key aspects of our proposed paradigm are as follows:

- A network of optimally placed, high-performance MonStr sensors [L1] for signal acquisition;
- A common environment for analysis provided by the STKO (The Scientific ToolKit for OpenSees) software [L2];
- The adoption of Python 3 as the unique programming language for each part of the algorithm needed to accomplish the flow of operations described in Figure 1;
- The adoption of HDF5 as the only data format.

STKO was initially created to offer a user-friendly interface for the extremely powerful solvers OpenSees provides for Finite Element Method (FEM) analysis [2]. Beyond that, the software leaves room for customisation, as users can insert Python scripts for special purposes, meaning the entire algorithm for damage detection can be fully integrated within this framework. The environment is already able to construct a digital twin of the structure. Alarms emitted by the data-driven algorithm can be checked immediately by running dynamic simulations, using corresponding recorded data as boundary conditions for the analysis, preventing the emission of false alarms and helping classify damages by location and extension if present. Notice that in this logical framework, no compatibility issues arise; all the I/O operations are managed using the same HDF5 data format, and each component of the software is designed to perfectly match the others to obtain a coherent anomaly detection machine. The entire workflow is described in Figure 2.

Within this carefully thought-through workflow, one can integrate any classifier desired by writing a specific code or borrowing any ML tool Python makes available, such as Python's Tensorflow library or Apache Spark, for which GPU programming is easily accessible to speed up computations. These libraries provide many variants of artificial neural networks, which at present are the most promising for this task, beating all other AI techniques.

Our integrated system offers an elegant solution to the most pressing problems in structural health monitoring. We believe it will pave the way toward a standard paradigm for Artificial Intelligence-based SHM [3].

Links:

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Smart Railway Infrastructures: Efficiency, Reliability and Safety

by Alessio Bechini (University of Pisa), Giulio Masetti (ISTI-CNR), Giorgio O. Spagnolo (ISTI-CNR), and Carlo Vallati (University of Pisa)

SmaRIERS (Smart Railway Infrastructures: Efficiency, Reliability and Safety) is a technology transfer project financed by the Tuscany Region. The project partners include ECM s.p.a. (Progress Rail of the multinational Caterpillar Inc. group), a Pistoia-based company and leader in the railway sector that develops solutions and technologies for the safety and control of railway infrastructure, and the Formal Methods and Tools (FMT) and Software Engineering and Dependable Computing (SEDC) research labs of ISTI-CNR. The project is conducted in strong collaboration with the Department of Information Engineering of the University of Pisa.

A railway infrastructure is a highly complex system that includes several interconnected and co-operating devices, components, and subsystems. In SmaRIERS, we focus on the study of Uninterruptible Power Supply (UPS). UPS is a modular system that ensures the uninterruptible power supply of signalling systems. The main components of such signalling systems are control logic devices and so-called "yard devices" installed along the railway infrastructure (switches, train detection elements, light signals, etc.) that perform the signalling tasks – vital elements for the safety of people and property that therefore require an uninterruptible power supply. The project idea is to equip the UPS with a "SMART" diagnostic system capable of becoming proactive, i.e., capable of preventing critical situations or future problems, so as to allow the operator to plan appropriate actions in advance, through the analysis of plant diagnostic data. SmaRIERS also includes studies of measurements related to system availability by means of stochastic modelling, as a support to the design of innovative station power systems.

The aforementioned UPS systems are equipped with a communication port and support a standardised protocol according to the IS01 standard published by the Italian national railway infrastructure manager (RFI). In SmaRIERS, we design a new communication protocol that allows collection of the data of UPS sensors in a simple and efficient way. The idea is to exploit the advantages offered by the so-called MQTT protocol for transporting UPS data to the database. MQTT is an ISO standard publish-subscribe type protocol, which can manage message dispatching in a simple way. The data of UPS sensors are thus published and made available via the MQTT broker. Figure 1 depicts the system architecture, with the UPS data given as input on the left. The data published in the MQTT broker is read and decoded in the JSON format to be stored in the Time Series Database (TSDB). Such a TSDB is exploited by a Web application to monitor the sensor values via a dashboard that allows the data to be monitored interactively. The system will also allow generation of alerts, via email and Telegram messages, to inform the plant managers about anomalies and errors.

Furthermore, we study predictive maintenance algorithms for improving the system maintenance as well as algorithms to recommend actions for improving the system's availability (prescriptive analytics), starting from the data collected as mentioned above. To allow a better training of the machine-learning systems, it is of particular importance to be able to use a set of field data. To this aim, we plan to use data from apparatuses already employed in current railway stations, available to ECM; even if they concern less innovative systems than those proposed in SmaRIERS, they still represent a reasonable knowledge base that can provide added value. At the same time, a preliminary analysis of the power supply system is carried out to identify the availability characteristics of the station power systems, also in relation to power consumption characteristics. We study measures representative of availability and energy consumption through stochastic modelling, to support innovative design of the station power systems. The planned

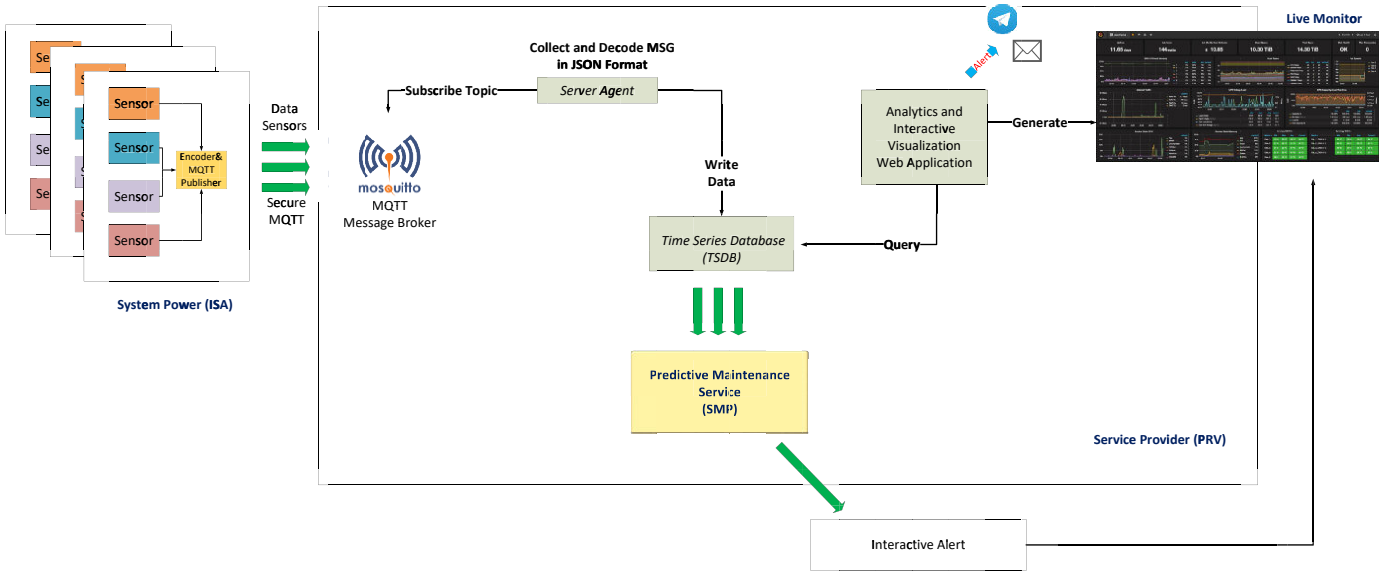

Figure 1: SmaRIERS system architecture.

case studies are useful for achieving, among others, the following goals:

- Identify critical elements of the existing configuration;
- Identify the degree of redundancy of particularly critical system elements;
- Identify the optimal charge level of the batteries, trading between costs and availability.

SmaRIERS lasts for two years and is coordinated by ECM.

Link: https://smariers.isti.cnr.it/

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Call for Participation

SAFECOMP 2022 and the DECSoS 2022 Workshop

Munich and online, 6-9 September 2022,

SAFECOM has contributed since 1979 to the progress of the state-of-the-art in dependable application of computers in safety-related and safety-critical systems. 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 2022 will take place on 6-9 September 2022 at Fraunhofer AISEC and the Galileo Science Technology Park in Munich Garching.

DECOS Workshop

The 17th International Workshop on Dependable Smart Embedded Cyber-Physical Systems and Systems-of-System (DECOS) was created by the ERCIM Dependable Embedded Systems Working Group. Topics cover a large scope in context of dependable, trustworthy systems. It is collocated with SAFECOMP as one of the seven workshops on 6 September at the same venue,. Online participation is possible (hybrid). For details see [L1]. It is also possible to attend only for the workshop at a reduced fee.

IDIMIT 2022

IDIMT 2022, the 30th Interdisciplinary Information Management Talks, is held in Prague as joint Central European event of the University of Economics, Prague, and the Johannes-Kepler University, Linz, Austria, from 7-9 September 2022. The session "Smart Technologies for a Sustainable Green World", is organized by the chair of the ERCIM DES Working Group, who is also the keynote speaker. For details see [L2] .

Link

[L1] https://safecomp22.iks.fraunhofer.de/
[L2] https://idimt.org/ .

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SCHLOSS DAGSTUHL
Leibniz-Zentrum für Informatik

Call for Proposals

Dagstuhl Seminars and Perspectives Workshops

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is accepting proposals for scientific seminars/workshops in all areas of computer science, in particular also in connection with other fields.

If accepted, the event will be hosted in the seclusion of Dagstuhl's well known, own, dedicated facilities in Wadern on the western fringe of Germany. Moreover, the Dagstuhl office will assume most of the organisational/ administrative work, and the Dagstuhl scientific staff will support the organizers in preparing, running, and documenting the event. Thanks to subsidies the costs are very low for participants.

Dagstuhl events are typically proposed by a group of three to four outstanding researchers of different affiliations. This organizer team should represent a range of research communities and reflect Dagstuhl's international orientation. More information, in particular details about event form and setup, as well as the proposal form and the proposing process, can be found on

https://www.dagstuhl.de/dsproposal

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is funded by the German federal and state government. It pursues a mission of furthering world class research in computer science by facilitating communication and interaction between researchers.

Important Dates

- *Next submission period:*
  October 15 to November 1, 2022
  Seminar dates: In 2023/2024.

Female Science Students Wanted for CWI's Constance van Eeden PhD Fellowship

To stimulate the recruitment of female PhD candidates, CWI launches the Constance van Eeden PhD Fellowship. The fellowship offers a PhD position to a talented young female student in mathematics or computer science or a related field of science at CWI. It is named after Constance van Eeden (1927-2021), who worked at CWI from 1954 to 1960 and was one of the first female PhD students in statistics in the Netherlands.

The number of female researchers in mathematics and computer science and related fields of science is lagging behind for many years already. CWI wants to address this problem and create more awareness with the launch of the Constance van Eeden Fellowship, aimed at talented female researchers that want to pursue a career in science. CWI had 20% female researchers and in 2021. CWI is aiming for a 30% of female staff however.

A tribute to Constance van Eeden

As one of the first female PhD students ('avant la lettre') at CWI, Constance van Eeden was an inspiration to and an example for many women that aimed to pursue an academic career in mathematics and computer science. She became a world-renowned researcher in statistics. She won the Gold Medal from the Statistical Society of Canada in 1990 and many other prizes for her outstanding contributions and was, among others, honorary member of the Netherlands Society for Statistics and Operations Research (VVSOR). She was the first woman in the Netherlands to obtain a PhD in Statistics, and it would take many years for the next woman to follow in her footsteps.

On the occasion of this special PhD position, CWI has produced a video series about Constance van Eeden, the Fellowship and the necessity of female role models. In this series Constance van Eeden's daughter Kari, reflects on her mothers career: "My mother would have really loved this Fellowship that will bear her name. She would have found it very honourable."

About the Constance van Eeden PhD Fellowship

In order to create more awareness for the position of female researchers and to attract talented female researchers in fields not immediately within CWI's scope, CWI offers this special position for talented female researchers at the start of their academic career as of 2022. Students from a related field of study such as chemistry, biology, ICT physics, econometrics, other engineering studies are also cordially invited to apply for this position. Candidates will have the freedom to choose their own research topic within CWI's focus areas Algorithms, Data & Intelligent Systems, Cryptology & Security, and Quantum Computing, and will be mentored by a female role model from CWI. A residency at a prestigious foreign institute/university for 6 months and generous budget for training and travel are a part of the Fellowship as well.

More information:
https://www.cwi.nl/jobs/vacancies/932972

Judy Brewer received the ACM Policy Award

Judy Brewer has been recognized by the ACM for service to the computing community through her leadership at W3C of the Web Accessibility Initiative (WAI) work. This work includes development of multiple web accessibility standards which have been adopted globally and have improved accessibility for millions worldwide.

The ACM noted: "In the late 1990s, although web design was flourishing, accessibility was not. Millions of new users uploaded image maps, frames, and other features that proved problematic at best and prohibitive at worst for users with auditory, cognitive, motor, neurological, physical, speech and visual disabilities. Under Brewer's direction, WAI develops the Web Content Accessibility Guidelines (WCAG), which provide developers with a set of criteria to judge the accessibility of the sites they are building. WCAG has also inspired the development of numerous evaluation tools capable of reviewing web pages to identify potential barriers such as non-navigable menu structures and images without alternative textual descriptions. The WCAG specifications and these tools provide a baseline for accessible web design, and for accessibility of web-based technologies such as real-time communications and virtual reality."

ERCIM is the host of W3C Europe and coordinator of two EU-funded projects led by Judy Brewer: WAI-CooP - Web Accessibility Initiative – Communities of Practice and WAI-GUIDE - Authoritative Implementation Guidance and International Cooperation to Support Training, Awareness Raising, and Capacity Building.

More information:
https://kwz.me/hjR
https://www.w3.org/WAI/about/projects/wai-guide/
https://www.w3.org/WAI/about/projects/wai-coop/

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 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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