ISSN 2599-7920

#103
JUNE 2021

European Commission

Research*eu

BRINGING YOU THE RESULTS OF EU RESEARCH AND INNOVATION

A 1-hour test to diagnose children with fever

High-voltage storage could soon move from the margins to the mainstream

Eyes and ears everywhere to protect Europe's ports

SPECIAL FEATURE

READY PLAYER... YOU?
WELCOME TO THE VIRTUAL REALITY REVOLUTION

Editorial

Immerse yourself in a Virtual Reality revolution, a sustainable outdoor toilet that's flushed with success and a board game that lets you win the ultimate prize imaginable – a Nobel Prize!

Welcome to this month's Research*eu magazine

Your editor loves to travel – for 2 years, he had been planning a trip to Japan, a country that utterly fascinates him. It has been postponed twice, in 2020 due of course to the pandemic and in 2019, due to a freak roller skating accident that led to a double-fractured ankle. Your editor is also a keen gamer and has thus spent much of his free time over the past year and a half exploring virtual worlds on his TV screen to try and scratch the travelling itch, some of them beautiful fantasy lands, others based on real-life environments, including one video game that allowed him to thoroughly explore downtown Tokyo. Only a few weeks before writing this editorial, your editor got to experience a Virtual Reality (VR) headset for the very first time and took part in a space battle dogfight set in a particular galaxy far far away... and the sense of immersion was genuinely awe-inspiring and mind-blowing.

Now, VR is still a technology in its relative infancy, but it has come leaps and bounds over the past few years and innovation in the field is exciting and rapidly expanding. It's a new technology that doesn't quite cause the same level of unease regarding possible negative impacts on society as other emerging technologies do, such as Artificial Intelligence (AI) and robotic automation. Part of this may be down to the fact that VR is often viewed as a tool for entertainment and pleasure and indeed, a lot of the exciting VR developments are coming out of the global video games industry, itself a massive economic juggernaut now bigger than the film industry in terms of total revenue.

But this is only part of the story. VR may be chiefly associated in the popular consciousness with immersive, escapist entertainment but there are also an enormous number of practical benefits to VR that researchers and companies are eagerly exploring and that could change all our lives for the better – some examples include VR's use as a tool in education, training and even social reconciliation and conflict resolution. Suffice to say, the ongoing VR revolution isn't just about fun and games but nonetheless it is incredibly thrilling, as the Horizon 2020-funded projects in this month's special feature wonderfully show.

Meanwhile, in **Project of the Month**, we highlight an absolutely delightful product coming from the **GEARING ROLES** project, a project heavily focused on gender roles and fostering gender equality. What is this product, you ask? It's a board game that gives players the task of winning a Nobel Prize and along the way you can get tips and assistance from some of the world's most prominent and inspiring female Nobel laureates. Suffice to say, your editor is also a big board game fan and can't wait to get his hands on a copy for himself!

Then in **Life After**, we sit down with the innovative French SME WeCo that has pioneered a sustainable circular economy-compatible outdoor toilet through the EU-funded **RecycLoo** project and find out about their progress since the formal end of the project. Finally, **EU Agenda** provides details on some of the (still mostly online) events taking place across Europe and the world that may be of interest to our readers.

And that just about does it for this issue of Research*eu – as always, if you have any queries, questions or suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu.

Published on behalf of the European Commission by the Community Research and Development Information Service (CORDIS) at the Publications Office of the European Union
2, rue Mercier
L-2985 Luxembourg
LUXEMBOURG
cordis@publications.europa.eu

Editorial coordination
Birgit Alice BEN YEDDER

Research*eu is free of charge.

For all issues of the magazine you can:
— browse the web edition in six languages;
— download the PDF version;
— order single print copies;
— subscribe to have every issue posted to you worldwide.

Go to cordis.europa.eu/research-eu

ISSN 2599-7912 (Printed version)
ISSN 2599-7920 (PDF)
ISSN 2599-7939 (HTML)
Catalogue No ZZ-AG-21-005-EN-C (Printed version)
Catalogue No ZZ-AG-21-005-EN-N (PDF)
Catalogue No ZZ-AG-21-005-EN-Q (HTML)

Luxembourg: Publications Office of the European Union, 2021

Contents

#103
JUNE 2021

HEALTH

A 1-hour test to diagnose children with fever

Imagine a test that identifies the exact cause of fever in children within an hour. No more waiting, going back to the hospital after an inaccurate diagnosis, or unnecessary antibiotics. This is what the PERFORM project has been working on thanks to RNA sequencing and protein analysis.

Nothing leaves parents with a feeling of dread like a baby or a young child with unreasonably high fever. In such scenarios, there is but one choice: heading straight to the hospital so that clinicians can distinguish mild, self-resolving viral infections from severe bacterial ones. But methods currently used in hospitals are far from 100 % reliable.

With PERFORM (Personalised Risk assessment in febrile illness to Optimise Real-life Management across the European Union), project partners aimed to solve the three main problems posed by these methods: the high number of children unnecessarily treated with antibiotics; the fact that some severe bacterial infections are still missed; and the long time required to get test results.

"The vast majority of children admitted to emergency departments have trivial illnesses that do not require any treatment. But amongst them are also a small number of bacterial infections that can progress into life-threatening conditions like septicaemia, meningitis, pneumonia, osteomyelitis and septic arthritis," says Michel Levin, coordinator of PERFORM and professor of Paediatrics and International Child Health at Imperial College London. Doctors need to rule out such scenarios, but the go-to solution – bacteria culture that can take 24 to 48 hours – can't be applied to difficult-to-access sites like the lungs. The result? Too many children still undergo unnecessary treatment with broad spectrum antibiotics simply because the presence of bacteria couldn't be ruled out or get sent home without treatment only to come back with aggravated symptoms.

FROM GENES AND PROTEINS TO RAPID TESTING

The PERFORM consortium faces this challenge head-on by tapping into the potential of a new technique called blood

© Aleksandra Suzi, Shutterstock

RNA sequencing. "Instead of culturing the bacteria or using molecular methods to identify the pathogen, we propose to identify bacterial infection by using the child's immune response to this pathogen," Levin explains. "The fundamental concept is that identifying the specific host response to bacteria can help us distinguish bacterial from trivial viral infections."

Doctors and researchers from across Europe tested two distinct methods on blood samples from 6 000 children: one detecting the genes being switched in response to bacteria or viruses, and one detecting the proteins produced in response to the two types of infections. "Not only did we show that the pattern of RNA expressed in a blood sample can accurately distinguish bacterial from viral infection, but we also found that only three to five genes were needed to do so. The same goes with proteins: we only need a small number," Levin adds.

This wasn't an easy process. Each patient studied generated millions of RNA or peptide sequences. Bringing these down to a very small number required sophisticated computational methods, and there is still the challenge of turning these genes into a rapid test that can deliver results in 1 hour. Biotechnology company bioMérieux is already hard at work developing a prototype device.

Besides this groundbreaking testing method, the project also generated large amounts of data on the patterns and cases of febrile illness. The team notably found that many children suffering from severe and life-threatening bacterial infections also have viruses in their nose or throat. "This suggests that bacterial infection and viral infection are not two distinct conditions. Viral infections may in fact alter the child's resistance or response to infection, which in turn allows bacterial infections to develop. This shows how the presence of a virus in a child's nose or throat does not exclude the possibility of a severe bacterial infection," Levin notes.

"Not only did we show that the pattern of RNA expressed in a blood sample can accurately distinguish bacterial from viral infection, but we also found that only three to five genes were needed to do so."

PERFORM is set for completiOn in June 2021, but a follow-up project – DIAMONDS – is already under way. The new project will investigate the hypothesis that all infectious and inflammatory diseases can be diagnosed rapidly and accurately with gene signatures. Eventually, both projects should help ease parents' and clinicians' concerns while avoiding inappropriate use of antibiotics in children.

PERFORM

- Coordinated by Imperial College London in the United Kingdom
- Funded under Horizon 2020-HEALTH
- cordis.europa.eu/project/id/668303
- Project website: perform2020.org

HEALTH

An injectable polymer for the fast track delivery of pain medication

If not properly treated, acute pain can become chronic, leading to significant lifelong disability. For the effective treatment of chronic pain, European researchers have developed an injectable solution for localised and controlled release of pain medications.

Current products in the market do not prevent chronic pain but are palliative, relieving symptoms temporarily. Multimodal pharmacological injection strategies combine opioids with non-steroidal anti-inflammatory drugs (NSAIDs) and other

© HENADZI KILENT, Shutterstock

drugs to prevent the transition from acute to chronic pain. However, they require high doses which leads to significant side effects, toxicity and low efficacy.

A BIOCOMPATIBLE CARRIER FOR LOCALISED DRUG DELIVERY

Undertaken with the support of the Marie Skłodowska-Curie Actions programme, the project TherGelFas (Novel nanometrically structured therapeutic hydrogel as injectable for fascial tissues surrounding the nerves intended for preventive treatment of chronic pain) developed an injectable product to improve current interventions that inhibit nerves during and after surgery. "Our goal was to combine advanced materials to generate a product that can release NSAIDs and other drugs in a controlled manner and thus prevent acute pain from becoming chronic," explains project coordinator and CEO of i+Med, Manu Muñoz.

The TherGelFas solution consists of a nanostructured hydrogel based on hyaluronic acid and has the capacity to immobilise and release different drugs. The polymer is biocompatible and biodegradable, and has antiseptic properties. Its main advantage is that it releases the drugs at the target site in a controlled manner. This extends the therapeutic effect and lowers the drug concentration achieved with conventional methods. It also improves the pharmacokinetic profile of drugs which translates to lower toxicity and fewer side effects. "Our approach essentially offers existing drugs the opportunity to perform more effectively at lower doses," notes Muñoz.

Researchers synthesised new formulations of hydrogels and tested their capacity to carry and release active drugs. Hydrogel nanoparticles suitably functionalised

"Our goal was to combine advanced materials to generate a product that can release NSAIDs and other drugs in a controlled manner and thus prevent acute pain from becoming chronic."

were additionally tested for better drug control. The different TherGelFas hydrogel formulations underwent physicochemical testing to ensure correct viscosity, suitable mechanical properties, stability and biodegradability. Safety screening *in vitro* and *in vivo* has generated encouraging results for evaluating the product further for efficacy in clinical studies.

TOWARDS IMPROVED PAIN MANAGEMENT

It is widely accepted that to prevent chronic pain, it is paramount to initiate anti-pain medication early on during or after surgery. "By combining several technologies and advanced biomaterials, we obtained an industrially scalable medicinal product, ready to be tested and certified for effective pain management," adds Muñoz. Importantly, the TherGelFas injectable polymer can be employed in 'fast track' recovery methodologies where a combination of commonly used medications is applied. The correct spatiotemporal release of drugs on nerves overcomes random spreading and ensures greater efficacy.

The researchers are currently in the process of producing the injectable hydrogel under good manufacturing practice (GMP) conditions, ready to be tested in the clinic following regulatory approval. A business plan analysis and a feasibility study have already been performed for commercialisation and marketing of the product.

Considering that chronic pain conditions pose a significant socio-economic burden and may lead to disability retirement, the TherGelFas drug administration strategy has the potential to reduce treatment and healthcare costs. Most importantly, it can contribute to the prevention of chronic pain, improving the quality of life of afflicted individuals.

THERGELFAS

- Coordinated by i+Med in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/795417
- Project website: bit.ly/3ao2jI6

Innovative approach to protecting women's rights during childbirth

Doctors and midwives frequently fail to treat women as rational citizens during childbirth, inflicting trauma and violence on them, finds new research led by Oxford University.

Women frequently have their rights breached during childbirth and even suffer violence at the hands of European health professionals because, during childbirth, they are not considered to be rational, new research finds.

With the support of the Marie Skłodowska-Curie Actions programme, the VOICEs (Controversies in Childbirth: from Epistemology to Practices) project used the tools of philosophy to probe why doctors and midwives are failing their patients despite their best intentions.

"Simply telling health professionals to do more listening, to have women involved, to ensure that all women are heard, will not work," says Stella Villarmea, professor of Philosophy who led the research at the University of Oxford. "We need to know why this happens before we can fix it effectively."

Villarmea concluded philosophers, lawyers and health workers are influenced by age-old stereotypes about childbirth, allowing violence in the labour ward to be considered normal. "Unnecessary episiotomies or caesareans, vaginal examinations conducted without a woman's consent – all are examples of routine violence in countries considered to have some of the best health systems in the world," she explains.

She argued in the Spanish newspaper El País article, 'When does a woman lose her right to decide when to give birth?', that a woman's rights were also breached when a hospital secured a court order to forcibly induce a pregnant woman during her 42nd week of pregnancy despite no immediate risk to the baby.

> *Philosophy can use its scalpel to open up the theories and practices which still oppress and denigrate women's bodies.*

COMMONPLACE VIOLENCE

The United Nations considers obstetric violence a problem worldwide, as outlined in 'A human rights-based approach to mistreatment and violence against women in reproductive health services with a focus on childbirth and obstetric violence'.

The Council of Europe in Resolution 2306 (2019) concluded: "Obstetrical and gynaecological violence is a form of violence that has long been hidden and is still too often ignored."

"Pregnant women should not be so obviously deprived of their full capacity just because they enter the maternity ward," states Villarmea, explaining in detail why that happens in her book 'Women's birthing bodies and the law: unauthorised intimate examinations, power and vulnerability'.

Western philosophy has traditionally focused little on birth, compared to death and mortality, and underestimated the capacity of a woman in labour to be rational, she argues. Women in popular culture are depicted as crying out during labour due to a loss of control whereas, in fact, antenatal classes teach them guttural sounds can open up the birth canal.

"Nature documentaries show chimpanzees piling up boxes to reach bananas as proof of a cognitive learning process but the decisions a woman takes to get into a good birthing position are considered to be just following her animal instincts," notes Villarmea.

During her research, Villarmea collaborated with health professionals and academics at the Values-based Practice in Health and Social Care at St Catherine's College, in Oxford, the School of Community Health and Midwifery – UCLan, based at the University of Central Lancashire and the University of Southampton, making the tools of philosophy accessible to practitioners in several papers including 'Barriers to establishing shared decision-making in childbirth: Unveiling epistemic stereotypes about women in labour', in the 'Journal of Evaluation in Clinical Practice'.

"Philosophy, which Plato called the 'medicine of the soul', can use its scalpel to open up the theories and practices which still oppress and denigrate women's bodies," she says.

VOICES

- Coordinated by the University of Oxford in the United Kingdom
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/787646

Now you've read the articles, why not download our **CORDIS**covery podcast episode on the future of European healthcare?

- bit.ly/CORDIScovery_healthcare

SOCIETY

How do international courts develop international criminal law?

The number of international courts has increased significantly over the past three decades and international judges have begun to develop law through their decisions, especially in international criminal law. How were international criminal courts able to develop law so substantially, and with what consequences?

International judges have been updating or clarifying the legal meaning of specific provisions. In international criminal law, a particularly prominent example, international judges repeatedly describe the development of law as one of their main achievements.

How far do judicial interpretations matter in global governance? How were international courts, required to remain within the boundaries of existing law, able to develop law so substantially, and with what consequences?

The EU-funded EaRL (Expert Rule? Judges, Lawyers, and the Practices of Interpretation in International Criminal Law) project addressed these questions by looking into the broader relevance of the decisions rendered by international criminal courts as they've faced increasing

© Roman Yanushevsky, Shutterstock

> *I examined three reasons for judicial discretion articulated in legal theory: possible 'gaps' within legal provisions as unforeseen circumstances arise; types of legal provisions that provide more room for discretion such as customary law; and the process of legal reasoning in which legal provisions are applied to factual situations that are themselves often inconclusive.*

pressure. "I examined three reasons for judicial discretion articulated in legal theory: possible 'gaps' within legal provisions as unforeseen circumstances arise; types of legal provisions that provide more room for discretion such as customary law; and the process of legal reasoning in which legal provisions are applied to factual situations that are themselves often inconclusive," says Nora Stappert, Marie Skłodowska-Curie fellow.

Legal theory is reflected in the professional convictions lawyers hold about how to interpret international law. According to Stappert: "In international criminal law, one of the assumptions widespread among judges and legal officers was that international courts should be careful not to overstep their responsibilities, which as a result curbed the potential for creativity and change in legal interpretation."

INTERNATIONAL CRIMINAL COURT ESTABLISHED

Since the end of the Cold War, the number of international courts has increased considerably. One example is the international criminal tribunals established by the UN Security Council in the early 1990s to focus on Rwanda and the former Yugoslavia. This led to the 1998 treaty establishing the International Criminal Court (ICC) as the first permanent international court to hold individuals accountable for genocide, war crimes, and crimes against humanity.

International criminal courts started to produce a growing body of case law whose decisions not only addressed case facts, but untangled difficult legal questions. Consequently, they decided how the questions apply to the case at hand (e.g. how to interpret the law of command responsibility, a form of liability that holds military commanders responsible for offences committed by their subordinates).

DEVELOPING INTERNATIONAL CRIMINAL LAW

When addressing legal questions, international courts may develop international law. In many legal systems, judges develop law as they specify a rule's meaning when applying it to a new case, which can become a precedent referred to in future decisions. The difference is that in international criminal law, international courts have developed law particularly rapidly.

The EaRL project used legal theory and social research methods to understand how such developments are possible despite a strong requirement to root legal interpretations in existing law.

Examining how international courts function is important as several international courts have come under increasing pressure. The ICC faced accusations of bias against Africans, and some states threatened and withdrew from the court. In December 2019, an Independent Expert Review was formally established to improve the work of the court.

Stappert's investigations yielded important results that explored how the practices of legal interpretation can develop legal meaning along with a methodological toolbox for studying the practices of legal interpretation in international law empirically.

EARL

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/748114

Slavery in the Mediterranean region during the Early Modern Age

Although Naples and Valencia were important slave markets during the 16th and 17th centuries, little is known about the slaves themselves. But new research is using archival sources to shed light not only on who these slaves were and where they came from, but also on the dynamics of the Mediterranean slave trade of the Early Modern Age.

During the 16th and 17th centuries, Naples and Valencia were two of the most important trading cities in the Spanish Empire. But with commerce being largely driven by forced slave labour, these two cities were, in general, also important slave markets in the Mediterranean region.

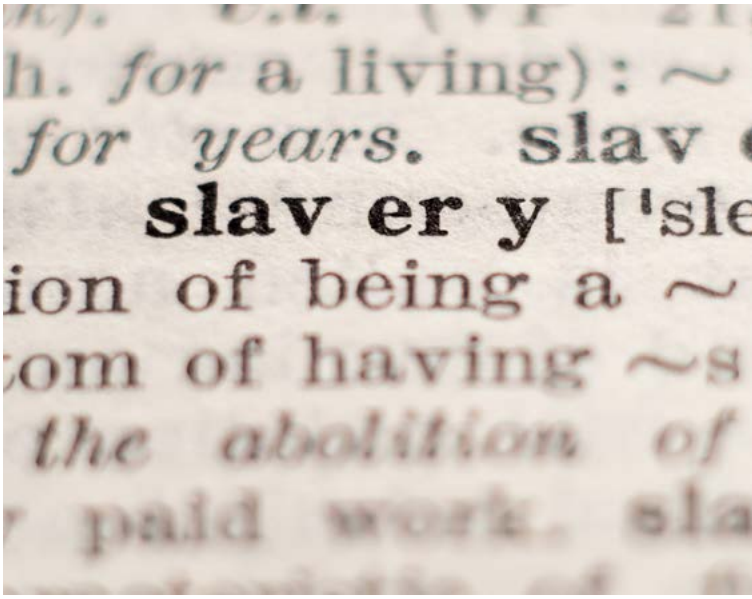
Despite the essential role that slaves played during the Early Modern Age, little is known about the slave trade or the slaves themselves. Now, thanks to new research being done as part of the EU-funded project Men of Value (How much is a man worth? Slavery and market of individual identities in early modern Naples and Valencia), this is starting to change.

"This project was born and developed with the intention of studying the slave markets of Valencia and Naples, not only from the perspective of supply and demand, but also by analysing the social and institutional relations that influenced the price of slaves and prisoners," says Fabrizio Filioli, a researcher at the University of Valencia and Men of Value project coordinator.

This research was undertaken with the support of the Marie Skłodowska-Curie Actions.

INTERESTING INSIGHTS

Using archival sources, the project began reconstructing the biographies of some of the period's slaves, learning where they came from, their ages, religions, and what jobs they were required to perform. "Answering these questions opened the door to better understanding the dynamics that governed their selling price," notes Filioli.



© Vitezslav Vylicil, Shutterstock

For example, from this work, Filioli concluded that a slave's value was the result of not only such local issues as the need for low-cost labour, but also the more abstract geopolitical issues existing well beyond the cities' walls.

"Because of alliances and globalisation, slaves were traded from port to port, making their way to Europe," explains Filioli. "As a result of this complex, global network, we see slaves in Valencia and Naples coming not only from nearby sub-Saharan Africa, but also from as far away as Goa."

Filioli also uncovered some interesting insight on the cost of slaves and how their exchange rate was determined. For instance, by studying the case of the oarsmen who

filled the galleys of Naples' substantial fleet, Filioli found that a prisoner's ransom, or 'exchange value', was significantly higher than his value as an oarsman.

"Such variables as the amount of money that his family was determined to spend to redeem him and his social status prior to capture had a profound impact on the cost of ransom," adds Filioli.

NEW OPPORTUNITIES AHEAD

Filioli says his research has led to numerous new opportunities. "This project would simply not have been possible without the support of international experts and the exchange of scientific reports."

He feels being able to work in the archives of Valencia, Naples, Madrid and Rome, and having the opportunity to participate in various international conferences, allowed him to build a truly important trajectory of study.

Having secured a fellowship at the Bonn Center for Dependency and Slavery Studies, Filioli plans to expand on the work he began during the Men of Value project.

> *"This project was born and developed with the intention of studying the slave markets of Valencia and Naples, not only from the perspective of supply and demand, but also by analysing the social and institutional relations that influenced the price of slaves and prisoners."*

"This is a very prestigious postdoc fellowship that allows me to continue my investigations on slavery in the Mediterranean," he concludes. "I'm excited to see what new insights we will unlock in the coming months."

MEN OF VALUE

- Coordinated by the University of Valencia in Spain
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/792668
- Project website: mediterraneanslavery.com

SOCIETY

How children learn language in complex social settings

Language learning differs during the different phases of human development. Through mathematical modelling backed by behavioural data, an EU-funded project sheds new light on how children integrate different information sources during word learning.

Language is intrinsically polysemantic. The social-contextual tools that help us elucidate the ambiguity of each language utterance form what we call 'common ground', a safe territory of mutual agreement between the people taking part in the dialogue.

How do we use this common ground though? Tracing the psychological foundation of language in children's mechanisms of language acquisition can help us understand this process. The EU-funded ModelingCommonGround project merged developmental and computational approaches to focus on this topic. The research was undertaken with the support of the Marie Skłodowska-Curie programme.

UNDERSTANDING HOW CHILDREN ACQUIRE LANGUAGE

Children learn language in a rather complex environment that is abounding in dissimilar – and at times conflicting – information sources of what words mean. A common

© peterschreibermedia, Shutterstock

approach in research on children's language learning is to isolate one of these information sources and test if children can use it. ModelingCommonGround emphasised a different rationale. "Our goal was to study multiple information sources at the same time. Furthermore, we wanted not just to see if children use multiple information sources, but also to specify how they do this," says research fellow Manuel Bohn.

To describe how children integrate different information sources during word learning, ModelingCommonGround used a computational cognitive model. In contrast to a verbal theory, such a model specifies the hypothetical computations that underlie word learning. Furthermore, it enables quantitative predictions about how children behave in new conditions.

The project put this model in a dialogue with data from behavioural experiments. More specifically, it used experiments to measure children's developing sensitivity to individual information sources and then used the model to predict what should happen if these separate sources were combined. The next step was to compare these predictions to new data from behavioural experiments in which multiple information sources were manipulated at one time.

"We assume that there is a general way in which children integrate information during word learning. This process, we think, is stable and does not change over time. What we believe is changing is children's sensitivity to each information source," explains Bohn. "Instead of thinking of development as progressing through different stages or phases, we believe it is a continuous process that unfolds over time."

"We assume that there is a general way in which children integrate information during word learning. This process, we think, is stable and does not change over time. What we believe is changing is children's sensitivity to each information source."

PROGRESS THROUGH TRIAL AND ERROR

After the project model was tested with adults, the same experimental designs were used with children. However, they did not work. "Children did not find them interesting and showed no signs of understanding what was going on. It took us a couple of months to implement the basic experimental design in a child-friendly way," notes Bohn.

So far, the model has enabled predictions about a group of children. The next focus will be on studying individual differences through the same successful approach.

"I hope that our findings will be seen as a model for studying the complexity of children's learning environment. Since the beginning, we have made sure that we document and report everything we do transparently. Furthermore, all materials, data and scripts are publicly available. All our designs and analysis were preregistered. I hope that other researchers can use our work and build on it," says Bohn.

MODELINGCOMMONGROUND

- Coordinated by Leipzig University in Germany
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/749229
- Project website: bit.ly/3su4ZKG

How a wonderfully original board game aims to promote gender equality and encourage a new generation of researchers

We feature the GEARING ROLES project as our Project of the Month due to its intrepid work in the field of gender roles and gender equality in the research and innovation sectors. In particular, we're highlighting their wonderful board game, 'Nobel Run', which tasks players with winning a Nobel Prize – with some help along the way from some of Europe (and the world's) most prominent female scientists!

> *"We become women by internalising gender roles that often limit us and discourage us from questioning our social identity and our position in society. Learning that a different way of being women is possible can be done through gaming: In the game we can play – literally – different social roles and learn the best ways to possibly win a Nobel Prize and pursue an academic career."*
>
> Maria Silvestre, GEARING ROLES coordinator

Despite efforts to eliminate gender disparities in research and innovation, women continue to be under-represented in this field. When considering all disciplines, only a third of researchers in the EU are women and only 15% in the STEM subjects of science, technology, engineering and mathematics. Women also represent less than 10% of patent holders and founded only 8% of European start-ups. Furthermore, only 25% of European start-ups were founded by a team that included at least one woman.

Enter 'Nobel Run', a deck-building board game, developed through the EU-funded project GEARING ROLES (Gender Equality Actions in Research Institutions to traNsform Gender ROLES), with an innovative approach to tackling the issue of gender stereotypes and inequality in science. By racing to win a Nobel Prize, players need to manage a research team, hire predoctoral, postdoctoral and senior researchers, publish articles and get funding through international projects. To aid in these endeavours, players can call on renowned female Nobel laureates, such as Marie Curie, Austrian-Swedish physicist Lise Meitner and Jocelyn Bell Burnell, an Irish astrophysicist.

We at CORDIS absolutely adore this entire idea and we can't wait to give it a go ourselves and try our luck at winning a Nobel Prize! If you think this could be a great gift for your budding young (or even older) aspiring researcher, the game will be available by May 2021.

For more information, please see the project website: gearingroles.eu/nobel-run/

GEARING ROLES

- Coordinated by the University of Deusto in Spain
- Funded under Horizon 2020-Science with and for Society
- cordis.europa.eu/project/id/824536
- Project website: gearingroles.eu
- bit.ly/GearingRoles

If you are interested in having your project featured in 'Project of the Month' in an upcoming issue, please send us an email to editorial@cordis.europa.eu and tell us why!

ENERGY

High-voltage storage could soon move from the margins to the mainstream

Billed as the most cost-efficient battery for high-voltage storage, Tesvolt's new system acts as a big 'electricity warehouse' for renewable integration. The technology took a page out of the electric vehicle playbook for faster progress in curbing carbon emissions.

Battery storage systems serve as an interface between intermittent renewable power and the benefits of all-time reliable, clean energy supply. They allow power to be stored when usage is low and released into the network at times of peak demand, help meet peak demand and flatten the duck curve, and keep grid frequency within preset limits.

"Increased energy capacities, faster recharge time, enhanced safety and low costs are crucial to the success of battery storage systems. In particular, value for money was cited as the number one barrier to impeding market penetration of battery storage systems by 49% of respondents in a survey conducted by trend:research," notes Daniel Hannemann, co-founder of Tesvolt and coordinator of the EU-funded project HiVOLT (HIGH-VOLTAGE LITHIUM STORAGE – secure + efficient battery storage solution of the next generation).

RISING FROM OBSCURITY TO THE MASS MARKET

Tesvolt unveiled a new stationary battery storage system that tears down the barriers that chronically impede large-scale renewable power. The grassroots innovation behind Tesvolt's new solution relies on a technology called high-voltage storage, a first of its kind in the renewable energy field that also demonstrates unprecedented cost-efficiency.

© TESVOLT

"High-voltage storage technology has hitherto been reserved for use in a luxury class of electric vehicles. The high performance-to-cost ratio of our solution extends the realm of the technology's possible applications to a wider mass market, including the renewable energy sector. Our goal is to reduce battery storage costs for energy applications to EUR 0.07/kWh," explains Hannemann.

BATTERY INNOVATION IS THRIVING

Unlike state-of-the-art systems that languish at low-voltage modes, Tesvolt's high-voltage storage system eliminates the need for expensive and heavy transformers for power transmission. "Transformerless power supplies slash costs related to power electronics by more than 50 % compared to existing systems. Instead, a boost converter helps the system step up output voltages. There is no limit to the output voltage our system can adapt to. Our battery is also compatible with any commercial low- or high-voltage inverter. This enables us to break the link between battery and power electronics development once and for all," adds Hannemann.

Tesvolt's battery storage system is highly flexible thanks to its modular design. Additional cells can quickly and easily fit to each other in the module. The system can also be expanded with further battery modules.

The company is using Samsung SDI's new prismatic lithium cells, which a renowned carmaker has recently introduced in its electric cars to expand their range. It is combining the new cells with an active battery optimiser – a special battery management system – to ensure active cell balancing between all cells in the battery module. This enables the battery storage system to complete around 8 000 full charge cycles with a depth of discharge of 100 %.

> *"Value for money was cited as the number one barrier to impeding market penetration of battery storage systems by 49 % of respondents in a survey conducted by trend:research."*

Ultimately, the system features a static switch far more efficient in managing power than existing technologies. Put together, all these advances make Tesvolt's high-voltage storage system more affordable, energy-efficient and longer-lasting than competitive technologies.

"Our main goal is to make future lithium batteries for high-voltage storage so affordable that renewable energy will be consistently more profitable than fossil fuels. Our solution can be connected to all types of renewable sources, such as solar, wind, hydro, biogas and combined heat and power systems, whether on-grid or off-grid," concludes Hannemann.

HIVOLT

- Coordinated by Tesvolt in Germany
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/829877
- Project website: high-volt.eu

ENERGY

The story of added value to storage in distribution systems

Energy storage can bring added value to a flexible, secure and sustainable energy system. An EU-funded project researched new energy storage technologies and their benefits in distribution systems, involving 18 partner institutions in eight different European countries.

The growing need for clean and inexhaustible sources of energy is becoming a global priority. Yet, increasing the share of renewable energy sources entails many challenges, the main one being the temporal mismatch between energy demand and renewable energy availability, which has an intermittent nature. Energy storage enables decoupling demand and supply and adds flexibility to the system.

> *The small- and medium-sized energy storages studied in STORY can indeed give valuable support to the grid, but a careful cost-benefit analysis needs to be carried out, with analysis of sensitivity to different changes. The constant changes in regulations may undermine the assumptions in these analyses.*

The EU-funded STORY (Added value of STORage in distribution sYstems) project investigated six demonstration cases with different local or small-scale storage concepts and technologies, ranging from neighbourhood residential storage to multi energy grid in industrial areas. "The case studies had indeed very different goals, but some common goals can be mentioned: increased use of local renewable energy, reduction of CO_2 emissions and limiting the negative effects on the grid," says project coordinator Mia Ala-Juusela.

AN AMBITIOUS AND DEMANDING APPROACH

The focus of the project was on electricity storage, but thermal storage was also included in some of the demos. One essential aspect was the control strategies developed for the different cases to reach their goals, contributing to the formulation of policy recommendations based on the experiences from the demos.

During the project, acquiring the storage systems was not always an easy endeavour. Despite the tenders received during the preparation phase, some systems were not available at all, while in other demos, the suppliers withdrew their offers. Moreover, maintenance proved to be a key aspect, as very few of the systems worked reliably from beginning to end.

© Marjan Jerele

"One thing that was also not anticipated was the low level of interoperability," notes Ala-Juusela. "We knew that there are challenges in this field, and we developed solutions to mitigate this, such as the digital twins and the interoperability platform. Still, it was surprising for us to discover how little interest there seemed to be among the component developers to make the products compatible with other parts of the system, or even inside their own system."

VALUABLE CONCLUSIONS FOR FUTURE STORAGE APPLICATIONS

Among other issues, STORY investigated the interrelations between technologies and stakeholders as well as the impact of policy and regulations on the business opportunities of the storage-related industry. "The small- and medium-sized energy storages studied in STORY can indeed give valuable support to the grid, but a careful cost-benefit analysis needs to be carried out, with analysis of sensitivity to different changes," explains Ala-Juusela. "The constant changes in regulations may undermine the assumptions in these analyses."

One surprising result of the large-scale analyses was that, to reach the level where the environmental effects of storage installation are on the positive side, high penetration of renewables is imperative. The storage reduces the need to curtail the renewable energy and increases the share of CO_2-free energy in the system.

The renewable energy and the energy grid/market branches are the sectors that will benefit the most from the project's findings. The STORY consortium continues the development of the solutions, both in public-funded and commercial projects. "The new projects are related to positive energy buildings, energy communities, digital twins, data platform, flexibility market, life-cycle assessments and simulation models, to mention a few," adds Ala-Juusela.

STORY

- Coordinated by the VTT Technical Research Centre in Finland
- Funded under Horizon 2020-ENERGY
- cordis.europa.eu/project/id/646426
- Project website: horizon2020-story.eu
- bit.ly/STORY-video-final

ENERGY

The winds of change are bringing automation to turbine blade inspection

Wind energy is important to Europe's energy supply and economy, so keeping its skyscraper-like windmills whirring along is critical. The first-ever 24/7 structural health monitoring technology could soon be replacing dated, sporadic visual inspection.

Converting wind's kinetic energy to electricity is an economical, sustainable way to drive human progress, and Europe is leading the way. Last year alone, wind accounted for more than 40 % of all new power installations in Europe and now provides about 15 % of Europe's electricity. Europe is also home to three of the five largest turbine manufacturers and has a combined global market share of 40 % of wind turbine sales.

According to data based on reported insurance claims in the United States in 2012, approximately 4 in 10 insurance claims relate to blade damage. There is currently no technology on the market to catch defects before they become failures. All this is about to change thanks to EU funding of the BladeSave (Risk Based Technology for Blade Structural Assessment) project and its embeddable structural health monitoring system for new and retrofit applications.

LARGE AND POWERFUL WINDMILLS: MORE TO GAIN AND MORE TO LOSE

A lot has changed in the millennium since the earliest known clay and wood windmills were first used to process grain in Persia. Large, modern wind turbines can have blades over 50 m in length, with the world's largest now longer than a football field, and the loads they bear can take a toll on composite blade integrity.

Blade inspection and maintenance still rely on visual inspection to determine risks. Years can pass between inspections, increasing the possibility of development and propagation of a defect and even catastrophic failure in the meantime. Even if a defect is noted, increasingly smaller budgets for operations and repairs often lead the owner/operator to repair only the worst defects. Eventually, this may lead to replacement, rather than repair, and turbine downtime or replacement lead time can be 12 months or more. The BladeSave project has successfully addressed this problem.

HIGH-TECH WINDMILLS GET THE HIGH-TECH SUPPORT THEY DESERVE

BladeSave™, a 24/7 structural health monitoring system with automated risk assessment and reporting, is a highly attractive alternative to archaic, costly and inefficient visual inspection. BladeSave™ utilises fibre-optic sensors embedded in the composite blade's internal surface. The fibre Bragg grating technology offers multiple sensing capabilities, including acoustic emissions. The sensors are automatically tuned to detect the signature frequencies associated with defect formation and propagation. BladeSave™'s onboard computer preprocesses the data and sends it via the cloud for further analysis and risk

Wind provides about 15% of Europe's electricity

categorisation. A simple traffic light display on the user's dashboard informs the end user of the current risk and provides recommendations for action.

Project coordinator Benn Faulkner from Renewable Advice summarises the step change in capabilities: "BladeSave™ correlates the acoustic emissions frequencies in the blades with specific fault types including matrix cracking, delamination and fibre breakages during operation. Automatic localisation of the defects expedites investigation and repair. A fatigue life-cycle evaluation supports improved evaluation of long-term operation and turbine life extension." Faulkner notes that without EU support for the BladeSave project, the undertaking would have been deemed too risky by the consortium

> *BladeSave™ correlates the acoustic emissions frequencies in the blades with specific fault types including matrix cracking, delamination and fibre breakages during operation. Automatic localisation of the defects expedites investigation and repair. A fatigue life-cycle evaluation supports improved evaluation of long-term operation and turbine life extension.*

partners. Now, the system is near commercialisation and has been developed to be equally applicable for installation on new blades or retrofitted to existing ones. It will certainly come in handy as the EU looks to double wind energy capacity by 2030 compared to its 2016 contribution and use it to meet 30% of the EU's power demand.

BLADESAVE

- Coordinated by Renewable Advice Ltd in the United Kingdom
- Funded under Horizon 2020-Societal Challenges and Horizon 2020-Industrial Leadership
- cordis.europa.eu/project/id/760353
- Project website: bladesave.eu
- bit.ly/Bladesave-video

RURAL INNOVATION: DEVELOPING REAL SOLUTIONS FOR SMART AND RESILIENT RURAL AREAS IN EUROPE

Whilst all too often the cities and other urban areas are touted as the bastions of innovation with rural areas being consigned to the background, this is in fact far from the truth. Rural innovation potential is actually high and powered by a strong natural resource base and community spirit, a smart utilisation of tacit knowledge and the use of cooperation and social innovation to overcome barriers, such as weaker infrastructures and services.

Rural areas have a crucial role to play in ensuring the stewardship of natural resources, as well as mitigating the effects of climate change, all ultimately enabling the transition to a truly green and sustainable Europe. For rural people to play their part, rural communities need to be smart, resilient and attractive places to live, work and visit.

Many EU-funded projects under the Horizon 2020 programme have been applying their skills and expertise to address the issues faced by rural areas outlined above and enhance their potential to seize opportunities and contribute to Europe's future.

To find out more, browse, download or order a physical copy of the Results Pack here: cordis.europa.eu/article/id/428970

CLIMATE CHANGE AND ENVIRONMENT

Bridging the climate innovation gap

European climate adaptation innovations are not reaching the intended markets. BRIGAID is bridging the gap between innovators and the communities that stand to benefit the most from them.

Recent studies by the Intergovernmental Panel on Climate Change indicate that Europe faces increased risks of floods and droughts, which would result in water restrictions and damage caused by extreme weather events such as heat and wildfires. These studies also highlight a gap between the research and innovations aimed at reducing these climate change risks and the markets they are intended for.

"Europe is prone to natural disasters due to climate change," says coordinator of the EU-funded BRIGAID (BRIdges the GAp for Innovations in Disaster resilience) project Bas Jonkman. "Innovations will be key to climate adaptation, but many innovations fail to reach the market because of a lack of insight into and attention to technical readiness and impacts, social acceptance and business aspects."

The researchers set out to consider the geographical and economic variability of climate-related hazards in Europe. They also examined the structural hurdles that would need to be surpassed to implement the many innovative solutions European industry has to offer.

BRIGAID built a network of 120 innovators, many of which are in the green sector, and showcased them in the online Climate Innovation Window. The project has supported these innovators to advance their technical and social readiness and business preparation.

COMMUNITIES OF INNOVATION

The researchers facilitated the development of the innovations using expertise in addition to the small testing and support budgets. The team further helped to build up some local communities of innovation specific to

© Melanie Hobson, Shutterstock

certain regions, such as drought innovations in Spain and innovations for flood defence in Romania.

"We had the success story of a smart green roof in Antwerp (Belgium) which had some neighbourhood involvement and a lot of sharing of information with the public," adds Jonkman. "Another success story is Flood Proof Romania, a new test site we opened near Bucharest."

The smart green roof in Antwerp demonstrates a water retention system that makes use of modular trays via remote control to store and dissipate rainwater on a roof. The Flood Proof system in Romania is a downstream dam 13 metres high used as a platform to test flood prevention structures designed to stop high-speed water found in mountainous areas.

FROM INNOVATION TO ENTREPRENEURSHIP

The project organised innovation fairs in Italy, the Netherlands, Romania and Spain that brought together end users and innovators. In addition, the researchers facilitated knowledge transfer between regions regarding innovations that they anticipate will become more valuable in the future.

Jonkman warns that existing climate change specific to some regions will become more widely spread over Europe, such as the drought and wildfires in southern Europe that will be a problem everywhere. For this reason, BRIGAID is providing long-term support for innovations particularly in the climate adaptation market in which many of the clients are government agencies.

> *"Innovations will be key to climate adaptation, but many innovations fail to reach the market because of a lack of insight into and attention to technical readiness and impacts, social acceptance and business aspects."*

For the future, BRIGAID has established the BRIGAID Connect platform as a sustainable independent entity that transforms innovators into entrepreneurs. The researchers hope to use this platform to connect innovators to end users and technical experts, to ultimately deliver adaptation innovations that improve European climate resilience.

BRIGAID

- Coordinated by Delft University of Technology in the Netherlands
- Funded under Horizon 2020-ENVIRONMENT and Horizon 2020-SECURITY
- cordis.europa.eu/project/id/700699
- Project website: brigaid.eu
- bit.ly/brigaid-video

CLIMATE CHANGE AND ENVIRONMENT

Tiny material, big problem: assessing the impact of nanocomposite pollutants

Engineered nanomaterials crop up in clothes, food packaging and make-up. SAFEnano project researchers have begun assessing the effects of their complex structures on the environment.

An increasing number of engineered nanomaterials (ENMs) are being created with the goal of improving ordinary daily products such as clothes and food packaging. Some of these materials occur as complex structures known as nanocomposites.

© Irina Kozorog, Shutterstock

"When nanocomposites get into our waste water, little is known about their effect on the environment", warns researcher Patryk Oleszczuk, head of the Radiochemistry and Environmental Chemistry Department at Maria Curie-Skłodowska University.

The project SAFEnano (Effect of water and wastewater treatment on the properties of engineered nanomaterials (ENMs) in context of their fate, toxicity and interaction with other contaminants) set out to remedy that gap in research, showing the properties of nanocomposites change during water purification processes, and determining the way they behave and interact with other pollutants.

"Different contaminants that were previously weakly bound can be bound more tightly or more weakly as a result of the modification, which means the ENMs could act as a Trojan Horse for these contaminants," says Oleszczuk, whose work was supported by the Marie Skłodowska-Curie Actions programme.

NEW MATERIALS, NEW RISKS

He worked with an interdisciplinary team to investigate the physicochemical and ecotoxicological properties of ENMs as well as their interaction with other pollutants.

Previous research has tended to focus on single issues or on ENMs as nano-sized pure elements, investigating their effects when they are released into water during clothes washing, or into food.

> *"The number of nanocomposites created is massive and new ones are being created every year."*

"But increasingly, ENMs occur as more complex structures and there is an influx of them in sewage, meaning risk research needs to move beyond pure ENMs", notes Oleszczuk.

"Our research has shown you cannot assess environmental risk based purely on pristine ENM," he explains. "You also need to take into account processes that can change ENM properties, which may affect their behaviour and toxicity."

Environmental nanotechnology is a growing field, but efforts and funding often go to those focused on developing new materials for applications such as energy production and storage or agriculture.

A GROWING PROBLEM

Oleszczuk believes society is in danger of forgetting the importance of evaluating the consequences of those materials once they get into the environment. "There is still a lack of researchers, and especially research, addressing the issue," he says.

SAFEnano's work is just a first step towards evaluating the environmental risk from the way ENMs are modified during environmental processes with other pollutants.

"The number of nanocomposites created is massive and new ones are being created every year," adds Oleszczuk. "A lot of work awaits us to maintain the safe use of ENMs."

SAFENANO

- Coordinated by the Maria Curie-Skłodowska University in Poland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/699794
- Project website: bit.ly/SafeNano

SPECIAL FEATURE

READY PLAYER... YOU? WELCOME TO THE VIRTUAL REALITY REVOLUTION

Editorial

"Just as a microscope and a telescope extended our senses, so could VR" – Howard Rheingold, American critic, writer and academic

The potential of Virtual Reality (VR) symbolises many of the most positive perceptions of the future. The idea of fully immersive, realistic digital environments that can allow you to get completely lost in another world or a gripping narrative (or both) is incredibly enticing. In popular culture, probably the most famous example is the 'Star Trek' holodeck. Whilst a couple of episodes did explore the potential negative impacts of such technology (the notion of 'holo addiction'), the holodeck was seen overall as a positive technological development, in line with that classic show's generally utopian view of the future. Of course, there are some cultural works that have expressed a more cautious tone to VR or even a dire dystopian warning alarm, again the most famous example probably being 1999's seminal film 'The Matrix'. But VR technology doesn't seem to cause as much unease amongst the general population in terms of possible negative impacts on human society as other emerging technologies do, such as Artificial Intelligence (AI) or widespread robotic automation.

In the minds of many, VR is closely associated with entertainment, in particular video gaming. Most of the major gaming/computing giants, as well as many smaller gaming SMEs, have experimented with VR technologies over the past decade, some with more success than others. Admittedly, the technology is still in its infancy – VR games today make up a small percentage of game releases and in no way can VR be considered 'mainstream' yet. As the gaming industry is now larger than the film industry in terms of total revenue, innovation will definitely still come from this sector over the next few years. Companies and researchers are looking to develop tools that will make VR even more enticing, immersive, attractive, accessible and – importantly – cost-effective for players, such as smaller, less clunky headsets and completely new devices that could allow for a real sense of touch to be introduced to VR environments.

But we must also emphasise strongly that VR and its technological siblings, Augmented Reality (AR) and Extended Reality (XR), offer extremely practical real-world benefits that could enhance our lives in more ways than simply entertaining us. From trainee surgeons learning to do open-heart surgery in a completely safe VR environment, to virtual exhibitions that have helped museums ride out the pandemic, and realistic VR avatars that help us to do our online shopping, the possibilities are endless. The idea that VR isn't just a technology that solely caters to individual whims but can also have valuable social benefits on a wider scale is also being explored by researchers – for example, VR environments could be used as a neutral staging ground to build intergroup trust and reconciliation following conflict or deep political polarisation.

The projects showcased in this month's special feature have all been funded through the EU's Horizon 2020 programme and they highlight both the entertainment and practical sides of the VR coin. The EU strongly supports the growth of a world-class European VR sector, due to its potential to really transform our lives and the exciting employment and growth opportunities it offers. Already there are numerous 'VR hubs' across Europe where innovative companies are making their mark. The next decade promises major innovation and we very much look forward to seeing how the VR landscape – virtual and otherwise – will grow and evolve over that time.

We look forward to receiving your feedback. You can send questions or suggestions to editorial@cordis.europa.eu.

Contents

SPECIAL FEATURE

READY PLAYER… YOU? WELCOME TO THE VIRTUAL REALITY REVOLUTION

Photorealistic avatars for more immersive VR experiences

Anyone familiar with 'The Sims' video games would have had a feeling of déjà vu *when they tried social Virtual Reality for the first time. But whilst the cartoonish characters came across as a breath of fresh air way back in 2000, they can't help but feel a bit awkward when ported to wannabe immersive Virtual Reality experiences. Is it time for a photorealistic approach to social Virtual Reality?*

Immersive is easily the first term that comes to mind when you think about Virtual Reality (VR). But there is a second one not too far behind: social. As the recent boom of social VR apps shows, immersion goes hand-in-hand with the capacity of users to interact just like they would in the real world.

The EU-funded project VRTogether (An end-to-end system for the production and delivery of photorealistic social immersive virtual reality experiences) stands at this much-coveted crossroads between immersive and social VR. The project promises groundbreaking VR experiences built around 'social photorealistic immersive content', at an affordable cost. To cut a long story short, VRTogether wants VR users to just forget about the avatars they've had to deal with so far, and rather enter VR experiences looking exactly as they do in the real world.

"We have focused our work on the creation of the tools necessary to take multiple users, capture them in real time as volumetric videos, and bring them in virtual environments. We now have an end-to-end lightweight holo-conferencing platform that pushes technological boundaries to seamlessly integrate people – or rather a digital version of themselves – in VR or Extended Reality (XR) environments," Sergi Fernandez, Media and Internet director at i2CAT and coordinator of VRTogether, summarises.

On the path to their photorealistic avatars, the project team left no stones unturned. "A platform, per se, is composed of multiple components that can both be used individually and add value to specific parts of the chain. We have generated tools for capture, streaming and communication between multiple users using volumetric video. These components may also serve for other purposes like pure volumetric video streaming for the next-generation contents or realistic

© View Apart, Shutterstock

capture of characters, to be later post-produced as VFX," says Fernandez.

Beyond the 3D capture and reconstruction of users as a point cloud, the consortium also developed: solutions to ensure low latency; a new compression format to save bandwidth; media orchestration to create consistent and synchronised experiences for all users; the capacity to broadcast content in real time; and protocols to make object interactions more worldly. Icing on the cake: the support of home usage with a low entry burden for users. The technology can be compared to that used in Hollywood CGI blockbusters, only at a fraction of the cost.

FROM GAMING TO DATING APPLICATIONS

Potential applications are legion. In Fernandez' own words, "VRTogether is the seed for the next generation of communication and collaboration tools where the boundaries between real and digital become blurred. Our technology can be applied to content watching, gaming, training, education, culture, industry, or anything in which human collaboration in hybrid or virtual environments requires a higher quality of experience than what current framed video calls offer."

To ensure these experiences will eventually come to life, the project team has developed three content pilots to demonstrate the technology and attract potential customers. In these pilots, the users can participate in a murder investigation. "It's a threefold story with one chapter per pilot," Fernandez explains. "Users have to discover the perpetrator of a crime and collaborate in groups of two to six to interrogate suspects at a police station, participate in a TV show, and inspect a crime scene."

"VRTogether is the seed for the next generation of communication and collaboration tools where the boundaries between real and digital become blurred."

Collaboration with partners interested in applying VRTogether technology to specific use cases has already begun, and the team expects first product commercialisation as early as 2022. Meanwhile, project partners have started working on project follow-ups. i2CAT for instance is developing two virtual escape rooms, as well as a watch-together-in-VR experience for a broadcaster. All in all, VRTogether brings us closer to live-like experiences in VR, where realism is pushed to the extreme.

VRTOGETHER

- Coordinated by i2CAT in Spain
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/762111
- Project website: vrtogether.eu
- bit.ly/VRTogether

Hand-to-object interaction reaches new heights thanks to VirtualGrasp

Interacting with objects is crucial to immersive and realistic Virtual Reality environments, but accurate depictions of these interactions have proved very difficult to achieve. The VirtualGrasp project has come forward with an Artificial Intelligence-based solution that can automate this process.

One of the main challenges facing Virtual Reality (VR) application developers is hand-to-object interaction. Sure, VR headsets do a great job of immersing us into realistic virtual worlds. They have even become a must for professional training, especially amidst this unprecedented pandemic. But in both cases – just like in other VR application fields – hand-to-object interaction is far from feeling as natural as it does in the real world.

Jakob Way, CEO of VR and robotics start-up Gleechi, summarises the current state of play: "VR training participants primarily use handheld controllers. They must be able to experience natural hand interaction to develop new skills and have the confidence to apply them in the real world. Meanwhile, although VR game players can already interact with objects, manually creating and animating hand interaction has so far proven impossible due to the time needed to manually animate many different grasps for all different objects."

The latter is key to understanding the current limitations of hand-to-object interaction. For each possible interaction, developers currently must define how an object can be grasped before manually animating these grasps. This inherently limits interaction: Objects can only be used in predetermined ways, and getting to these mixed results is very time-consuming.

ALGORITHM-BASED INTERACTION BUILDER

This is where VirtualGrasp (Speeding up the virtual reality revolution with realistic & real-time animation of hand-to-object interaction) comes into its own. By combining machine learning and predictive algorithms, Gleechi provides VR users with complete freedom of interaction.

VirtualGrasp is particularly applicable in three distinct fields of applications: training, games and stroke rehabilitation. For training, the team developed an in-depth understanding of how each object is held and used, which is vital to providing a truly immersive learning experience. For VR games, VirtualGrasp manages to automate the creation of interactions between hands and 3D objects. Finally, for stroke patients, the system can predict patient grasps and convert them into VR interactions. Way explains: "Patients have been able to conduct rehabilitation exercises in a VR environment where they would perform motivating tasks such as playing games or planting flowers. However, due to limited mobility in the patient's hands and fingers, they often struggle to perform the required precision grasps. By predicting these grasps, we hope to accelerate the rehabilitation process through visual amplification."

© pickingpok, Shutterstock

Trial results in these three fields have been very encouraging, but COVID-19 lockdowns resulted in an increased focus on commercial applications in the field of training. There, VirtualGrasp was proved to enhance the impact of VR training and significantly simplify the creation of VR training applications. After they observed a 50 % increase in knowledge retention for VR training participants, Gleechi expedited the development of self-service tooling to enable industrial companies to create their own VR training.

"SAAB Aeronautics is actively testing VirtualGrasp for advanced VR training where participants learn to use specialised tools and equipment during the assembly process," Way says. "The natural interaction makes it

> *VR training participants primarily use handheld controllers. They must be able to experience natural hand interaction to develop new skills and have the confidence to apply them in the real world.*

possible for SAAB Aeronautics to deliver remote training while retaining exceptionally high standards of quality."

Likewise, YrkesAkademin – a major provider of labour market training – has been using VirtualGrasp to rapidly provide vital skills to healthcare workers with a focus on working in sterile environments. "The training requires careful handling of complex medical tools and equipment where following procedures is essential to maintain a sterile environment. By being able to interact naturally, it becomes possible for participants to develop practical experience where access to real-world sterile environments for training purposes is problematic," Way notes.

Gleechi has raised EUR 2.4 million in funding to start commercialising its software for VR training, and R&D work will continue thanks to an additional grant project aiming to test the same interaction technology in the field of robotics.

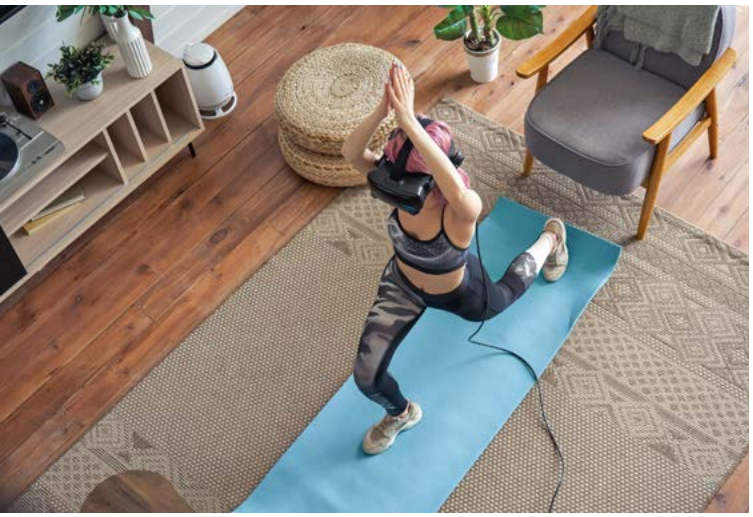
VIRTUALGRASP

- Coordinated by Gleechi in Sweden
- Funded under Horizon 2020-SME, Horizon 2020-LEIT and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/829467
- Project website: gleechi.com

How wearables could lead the way for more immersive Virtual Reality experiences

In movies using computer-generated imagery, actors perform in front of a green screen and wear so-called mocap (motion capture) suits recording their every move. The WEARTUAL project wants to take a similar direction to more immersive Virtual Reality, in which wearable devices could be used to track full body movements, turn bodies into interfaces, or even generate semi-virtual clothes.

Virtual Reality (VR) experiences so far tend to revolve around two technologies: head-mounted displays (HMDs) and controllers. If we're moving anything else than our head or hands, this simply won't be reflected in the virtual world. But this might change soon thanks to reflections and prototypes brought by the EU-funded project WEARTUAL (Designing and Developing Wearables for Virtual Reality Environments with a Research Through Design Process).



© insta_photos, Shutterstock

Oğuz Buruk, Marie Skłodowska-Curie fellow at Tampere University, has been investigating ways to integrate wearables into VR experiences to make them more immersive. He accepted our invitation to provide an early glimpse of his findings, as well as discuss the wearable prototypes he's been working on.

How did you come up with the idea of combining wearables with VR headsets? What benefits did you foresee for such combinations?

Oğuz Buruk: I had already been working on playful wearables for 5 years when I decided to explore wearable design for Extended Reality (XR) environments. Headsets for VR, Augmented Reality (AR) and Mixed Reality (MR) are developing rapidly, and we have seen many other accessories being commercialised such as haptic gloves or 360° treadmills.

Being an expert on playful wearables, I knew they could really provide transformative experiences and enhanced social interaction. They can cover a wide variety of interaction modalities beyond haptic feedback, such as tangible or bioadaptive modalities.

Although these aspects were explored to some extent in the playful wearables field, there was not much work done in the XR field. The relationship between physical and virtual layers also added another challenge to the design of such wearables, so I wanted to explore how their strengths would manifest themselves in the virtual world.

Can you tell us more about the prototypes you developed? What makes them particularly innovative?

Our prototypes are still under development. We're focusing on three different areas. In one of our concepts, we explore how our bodies can be used as a scaffold to create dangling, floating and tangible interfaces providing more realistic and immersive experiences. The idea is to leverage the different interaction modalities wearables can introduce by using the body as a support point. Other concepts focus on the use of wearables in semi-virtual clothing and costumes, as well as the utilisation of bioadaptive cues in different social contexts.

WEARTUAL is a research-through-design project, and we innovate by inventing new use cases rather than creating technical advancements. All concepts were created with the help of users, students and stakeholders with different backgrounds. The design directions we put forth, along with many different XR wearable concepts proposed by different stakeholders, were published at the CHI 2021 conference – which is one of the most prestigious venues for human-computer interaction.

How did you proceed to test these prototypes?

Unfortunately, we could not test them with users due to COVID-19 restrictions. We are currently considering alternative paths to disseminate our artefacts to different audiences.

What would you say are the project's most important results so far?

Our project has been very productive in all foreseen topics. We could create the likes of frameworks or design recommendations, design methods, and critical and speculative design outcomes for playful wearables, bodily integrated technologies, and XR environments.

Oğuz Buruk
WEARTUAL MSCA fellow
© Oğuz Buruk

> *Being an expert on playful wearables, I knew they could really provide transformative experiences and enhanced social interaction.*

One of the most impactful outcomes of the project is the Design Framework for Playful Wearables which we developed in collaboration with Katherine Isbister from the University of California, Santa Cruz and Theresa Jean Tanenbaum from the University of California, Irvine. This framework is the starting point of current design concepts in WEARTUAL and will be helpful to playful wearable designers working in any kind of interactive environment, including XR. Based on this framework, we have organised participatory design workshops with different stakeholders and created comprehensive design directions and concepts for gaming wearables and XR environments.

By collaborating with other Marie Skłodowska-Curie fellows in the Gamification Group, we also developed the Transurban framework which combines bodily technologies and transhumanism with smart city design (with Mattia Thibault) and the gamification of online conferences with alternate reality games (with Mattia Thibault and Zampeta Legaki) in COVID-19 times.

All these outcomes point to new directions for the design of bodily integrated technologies such as wearables. These will guide researchers and designers of wearables and XR developers alike.

What are the next steps you plan to take?

Our current objective is to finish the development of the prototypes to create polished experiences and disseminate our results to a wide population. We want to pursue the implementation of our prototypes in public spaces such as museums as soon as the effects of the pandemic ease off.

Do you have any specific plans that would get you closer to market-ready applications?

The Gamification Group is used to acquiring funding for the commercialisation of research projects' outcomes. We will definitely look into creating market-ready applications for end users as well, by pursuing further

funding opportunities such as Research to Business funding of Business Finland or Digital Grants from the European Institute of Innovation and Technology.

Could you provide one or two concrete examples of such applications?

Currently, hand tracking and free-hand interaction are the main interaction modalities in VR and AR headsets. However, for more complex interactions, buttons and tangible interfaces are still needed. This is where the utilisation of wearables shows promise. In this context, I believe that the fruits of our research will lead to the creation of mainstream and common XR interfaces in wearable forms.

Another concrete application is virtual clothes and there are already several fashion houses selling clothes that can be worn in virtual environments. Understanding the user experiences created by virtual garments and their effects on self-expression and identity is crucial for virtual fashion, and is one of the purposes of our project.

WEARTUAL

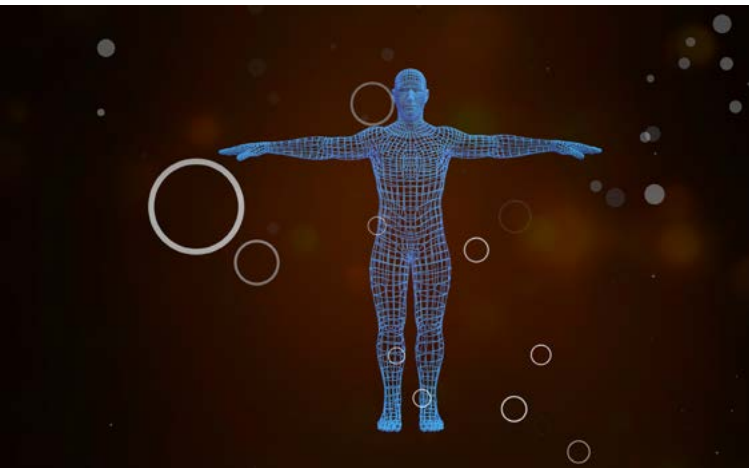
- Coordinated by Tampere University in Finland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/833731
- Project website: bit.ly/WEARTUAL_project

The realistic avatar we've all been waiting for

Having a virtual self that looks exactly like we do could come in handy in a world increasingly resorting to the virtual territory for all kinds of purposes. Didimo has devised a new system to create these digital counterparts in just 90 seconds, from a simple photo.

Imagine a digital human that looks just like you and can convey the same emotions as you do in the real world. Based in Portugal, Didimo, the company behind the EU-funded project bearing the same name, Didimo (Humanity in Digital Communication), specialises in the creation of such high-fidelity digital humans in a field otherwise dominated by avatars that often lack authenticity and nuance.

The company specifically looked into the issues of virtual shopping and virtual meetings. "In virtual (clothes) shopping, consumers usually need to answer two questions: does this look good on me and does this fit me? Virtual try-on applications could have been a solution, but they failed because of two trade-offs. Firstly, consumers are instructed to make an avatar that looks like them but often misses or oversimplifies important personal attributes. Secondly, very few systems can accurately gauge user-specific body size, shape and nuance, which means that consumers can only select the generic body shape that's the closest to their own," says Jim Franzen, director of Marketing at Didimo.



© VFX video, Shutterstock

Users of avatar-based virtual meetings don't fare any better. Not only do the usually cartoonish avatars look nothing like the real person, but these systems don't offer high-fidelity facial and emotional representation of the user despite it being key to fruitful human interaction. As Franzen notes: "If I want to show that I am happy, I have to make my character jump up and down. Or do the boogie. But in real life, I have never done those things at a real business meeting!"

A SELFIE AND YOU'RE ALL SET

Convinced that more realistic and emotionally accurate digital representations would be much more effective and engaging, Didimo created a Cloud-based platform and support tools to generate lifelike digital humans. Using this platform, anyone can generate a fully 3D representation of themselves – a didimo – from a photo or selfie in just 90 seconds.

"This is a real breakthrough," Veronica Orvalho, CEO and founder of Didimo, explains. "No more arbitrary choices or

> *No more arbitrary choices or generic options to choose from: users automatically receive an avatar that looks just like them.*

generic options to choose from: users automatically receive an avatar that looks just like them. We are already excellent at generating faces and heads and we are working on bodies, trying to bring high accuracy to 1:1 digital human generation."

EU support under the SME instrument helped the company establish their ethics and responsibility policies, which can hardly be ignored when creating a technology that builds digital humans. The grant also helped the technical team in the development of Didimo's core patented API technology, retail and mobile product. "Support under Horizon 2020 has helped strengthen our brand and commercialisation process. We could build complex use cases and test the potential of the technology with early adopters," says Franzen.

As they aimed to build a scalable solution for various situations, Didimo worked closely with the likes of Amazon, Sony, Altice, Ceek, Soliel, Atom Republic and others to create robust solutions for their needs.

"As a B2B provider, we want to provide our customers with a turnkey solution. We offer a cloud-based platform with API, SDKs, documentation and other support services to make this easy for them. Didimo's core services are fully scalable and designed to be embedded in an ongoing business application or site. We are particularly focusing on the gaming, fashion retail, communications and XR industries," Franzen adds.

Didimo has secured two patents in the United States and has more pending approval. With COVID-19 skyrocketing digital adoption rates to heights not even the most optimistic projections could have seen coming – or at least not so suddenly – the technology certainly presents a huge potential for growth. More importantly, it finally addresses a basic human need that is often missing from digital interactions today: authentic human expression and connection.

DIDIMO

- Coordinated by Didimo in Portugal
- Funded under Horizon 2020-SME, Horizon 2020-LEIT and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/873511
- Project website: didimo.co
- bit.ly/Didimo

Code-free app design in immersive environments

Designing apps without developer skills – that means involving people with many different profiles in the creative process and delivering prototypes quickly and easily. By enabling code-free development for Extended Reality applications, the Justinmind platform is opening the way for massive adoption of these technologies.

How close are we to turning Virtual Reality (VR) applications into everyday tools used on a large scale to learn, collaborate, play, or receive healthcare? According to the Justinmind team, this revolution could be imminent. The key? Killer apps that will drive massive adoption – and tools enabling us to involve a much broader range of professionals in the creative process that will deliver them.

Justinmind could be a stepping stone in this process. The successful platform, which currently has 2 million users, offers user interface (UI) design tools for the creation of web and mobile app prototypes without any coding skills. Thanks to the EU-funded JUSTINMIND-XR (The First Code-Free Rapid Prototyping Platform for eXtended Reality (VR/AR/MR) and Spatial Computing) project, the team is now taking this idea one step further into the realm of Extended Reality (XR), which includes Virtual, Augmented and Mixed Reality technologies.

"With Justinmind XR, users will be able to prototype software applications that can be visualised and experienced in an immersive environment," explains Xavier Renom, Justinmind CEO and co-founder.

While Augmented Reality (AR) adds digital elements to physical environments, VR creates a fully digital 360° experience. App development projects in both areas still face several hurdles: Lack of standardisation and high technical knowledge requirements often make it difficult to bring the right people on board.

> *Our objective is to democratise the design of any type of computer application, making it easy to prototype and validate complex programmes.*

© XR_SeventyFour, Shutterstock

ZERO-CODE DESIGN

The Justinmind team set out to resolve this issue by offering AR and VR design software accessible to anyone. "Our objective is to democratise the design of any type of computer application, making it easy to prototype and validate complex programmes. That is why our platform is completely code-free: you don't need to know any programming language to use it," Renom says.

To get started with Justinmind XR, users will need to download the programme. Building the prototype involving various profiles and teams can then easily be done online thanks to the tools' remote collaboration features using cloud services.

"You can look at Justinmind XR as a testing tool," Renom adds. "Usually, the problem with testing is that it occurs when the app is already built: any design error discovered has huge budget implications. With our approach, you can test the project early, reducing the risk of costly rework and project failure."

The team has also taken the cost factor into account regarding the equipment required for experiencing the VR or AR simulations. While high-end devices are supported, smartphone-based headsets provide an affordable, fully functional alternative further lowering the threshold for large-scale adoption.

XRGONOMICS

XR application areas span virtually all sectors of society, from education and public services to manufacturing and healthcare.

As physical and virtual worlds are increasingly intertwined, Justinmind's developers believe it is becoming increasingly important to create tools and processes for testing experiences spanning the physical and the digital world. To cater to this need, they have developed the concept of XRgonomics testing. "XRgonomics capture the physical and digital interaction together. For example, this makes sense for automotive applications or medical devices with a physical and a digital part."

Justinmind XR is scheduled to launch in October 2021 as an update of the existing Justinmind platform, just before the formal end of the JUSTINMIND-XR project at the end of October.

JUSTINMIND-XR

- Coordinated by Justinmind in Spain
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/873537
- Project website: justinmind.com

Making contact in cyberspace: could Virtual Reality help foster a common sense of identity?

The Troubles may have ended, but Northern Irish society is still marked by deep divisions. From separate schools to walls and fences closing off neighbourhoods, Catholic and Protestant communities remain largely segregated. The recent eruption of violence has been a stark reminder of the divisions that continue to exist to this day.

Opportunities offered by Virtual Reality (VR) applications for creating new connections are being explored by the EU-funded project contactVIRT (Intergroup Contact in Virtual Reality: Comparative Effects of Two Contact Strategies on Reducing Prejudice and Increasing Trust Between Catholics and Protestants in Northern Ireland). While intergroup contact is widely recognised as an effective means to improve relations between social groups, there is little data available yet on the potential of virtual interactions.

© Iensfield, Shutterstock

By creating a safe online space through which members of both communities can connect, the team aims to identify concrete approaches for fostering a shared sense of identity. VR test sessions with volunteers will be organised to test different strategies.

CROSSING DIVIDING LINES

Through a questionnaire, participants were asked to pick a social group of which they identify as a member – the so-called 'in-group', as opposed to the 'out-group'. Surprisingly, the selected groups do not simply reflect the Catholic-Protestant division: "Members of both communities noted that the Nationalist/Catholic/Republican and Protestant/Unionist/Loyalist labels do not reflect their real intercommunity identities. Some of them feel more threatened by members of their own community than by outsiders," explains Salvador Alvídrez, Marie Skłodowska-Curie research fellow at Queen's University Belfast, which hosted the project. He notes that Brexit may also have contributed to a more uniform Northern Irish identity.

During the VR sessions, volunteers will be placed in a virtual space together with members of a different social group. A virtual moderator will provide them with instructions for working together on simple tasks such as describing pictures or filling out blank spaces in sentences.

Visual cues will be added to avatars indicating community background and membership of a wider virtual group. "For instance, if a Catholic participant thinks of Protestants as the out-group, their respective avatars are dressed in the traditional colours of each community, green and orange. But both carry a token over their heads indicating membership of the same virtual group," Alvídrez outlines. Through this strategy, known as 'recategorisation', the researchers will seek to strengthen a sense of belonging to a common group.

NEW CONTACT STRATEGIES

The results of contactVIRT's work will inform policymaking, shaping concrete contact strategies supported by technology in education and community work. With the support of the Community Relations Council (CRC) of Northern Ireland, the team has already collected valuable insights from community and peacebuilding organisations with a view to developing technological tools for intercommunity dialogue.

They are also in talks with the CRC to organise activities with end users such as practitioners, community workers, mediators and volunteers. "The collaborative relationship with the CRC has represented a great opportunity to take our research 'out of the lab' and to learn directly from the people who will benefit from our studies," Alvídrez notes.

He is currently building an Irish-British network exploring the use of technology for intergroup contact, bringing together researchers from fields including social psychology, education, computer science and political science: "The network is intended to be a space for exchanging knowledge and resources around new uses of technology to improve intergroup relations, particularly in a post-pandemic context."

CONTACTVIRT

- Coordinated by Queen's University Belfast in the United Kingdom
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/832662
- Project website: bit.ly/contactVIRT-project
- bit.ly/contactVIRT

A stronger European XR community is shaping up

How can European actors in the Extended Reality market find their place in the sun? This question was at the heart of the XR4ALL project, which aimed to strengthen industry by means of a community platform and funding for innovative start-ups.

As popular as it may be in very specific markets, the concept of Extended Reality (XR) – which encompasses Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) – is still alien to most consumers. An

Oliver Schreer
XR4ALL project coordinator
© Oliver Schreer

> *This is a sector set for a bright future as long as it can secure funding, especially for start-ups and early-stage companies.*

international race is on to create not only the most immersive experiences possible, but also a new generation of devices that consumers are willing to buy and don't find too complicated to use. The trouble is Europe is still a long shot from being in the lead.

To strengthen the European XR industry, the European Commission has been funding the XR4ALL (eXtended Reality for All) project. The initiative has been lending innovative start-ups a helping hand as well as cementing a strong XR community in an otherwise highly fragmented sector.

Oliver Schreer, head of the Immersive Media & Communication Group at the Fraunhofer Heinrich Hertz Institute (HHI) and coordinator of XR4ALL, discusses how the project helped build a stronger XR community and will continue to do so in the foreseeable future.

Your project is called 'eXtended Reality for All'. Aside from a few niche applications, it seems like industry has yet to find the products that will make XR truly mainstream. What do you think is currently missing to get there?

Oliver Schreer: XR is widely used in Industry 4.0 in sectors such as maintenance, repair, design assembly and quality assurance, as well as in the medical sector where it provides training or for pre-, intra- and post-operative use. However, it is true that the consumer mass market has not matured in the same way. From a technological point of view, tracking and sensing need to be further improved if we are to make AR applications more acceptable and easier to use. Glasses need to be more lightweight and cheaper to reach the mass market. Another major issue is the lack of interoperability for wide-scale technology adoption and for a healthy ecosystem with a diverse range of technology providers.

Why does the United States perform better when it comes to overcoming these barriers?

The United States and also Asian companies are currently leading the hardware sector. This is particularly true for the head-mounted device (HMD) market, with all major devices being manufactured in these regions. However, VARIO in Norway is currently entering the HMD market with promising high-quality devices.

How can a united XR community help Europe catch up?

When we analyse the European XR landscape, we see severe fragmentation of policies and technology development along with a lack of funding. Even though XR technologies are not quite mainstream yet, we're talking about an industry with hundreds of companies, tens of thousands of employees, and over EUR 4 billion in investments to date. This is a sector set for a bright future as long as it can secure funding, especially for start-ups and early-stage companies.

Other European strengths are creativity, skills and cultural diversity. This is why we are convinced that offering a central access point for employment exchange between companies and academia on the one hand and young talents, developers and creatives on the other hand will help to improve job-skills matching.

Can you tell us more about this platform and how it works?

The XR4ALL project is designed to forge a competitive, sustainable XR-tech ecosystem in Europe. We aim to create a pan-European XR-tech community, discover existing EU XR technology, develop a research agenda, award grants to innovative technology projects, and increase investments and tech transfers to help products reach the market.

Where do you stand with the funding of interesting ideas?

We selected 50 projects for XR4ALL. They all went through a first phase with corresponding funding of EUR 10 000 in which the company was asked to validate the technical feasibility of their solution and its business potential. Following this first phase, 25 projects were selected to continue to phase 2 with corresponding funding of EUR 40 000.

The projects were organised in three cohorts. The first cohort is completed and eight projects have already brought their solution to market. The second and third cohorts are still running, with an additional 17 projects expected to reach market stage soon.

© dotshock, Shutterstock

Overall, what would you say are the project's most important outcomes so far?

After 2.5 years, XR4ALL has been able to create a unique European brand which brings the major stakeholders in the XR community together. Over 1 000 individual experts have registered as members of the XR4ALL community, while 17 organisations and associations have become associated members.

Within the community itself, a set of Ambassadors and Special Interest Groups (SIGs) have been set up around specific themes. More than 50 influential people have been approached and 30 have agreed to become Ambassadors. They now form and lead 14 SIGs joined by XR4ALL members, where they interact and discuss through channels set up for this purpose. We also organised two XR4ALL annual events and two tech venture forums to bring the members of the community together and link start-ups with investors.

Finally, the project launched our open call to attract, select and provide financial support to third parties in the development of new XR solutions. These include, for instance: plug-ins for game engines such as Unity; and low-level components based on open APIs, standards and frameworks such as SolAR.

What do you still need to achieve before the end of the project?

One major task is to make all the efforts of XR4ALL sustainable. In a few weeks, we will launch with a number of other founding members a new umbrella organisation called XR4Europe. The consortium will put all its energy and creativity into making this new non-profit organisation a successful continuation of XR4ALL.

XR4ALL

- Coordinated by the Fraunhofer Society in Germany
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/825545
- Project website: xr4all.eu
- bit.ly/XR4ALL-helsinki

If you enjoyed this special feature, don't forget to check out the **CORDIS**covery podcast that dives even deeper into the issues raised here – download at Spotify, Apple Podcast, Google Podcasts, Anchor.fm!

→ anchor.fm/cordiscovery

FOOD AND NATURAL RESOURCES

Digitising Europe's forests with the help of satellites

Through a virtual platform and portfolio of services based on remote sensing technology, MySustainableForest provides up-to-date data to support sustainable forest management.

Forests offer a range of ecological, societal and economic benefits. They store carbon and maintain the water cycle, sustain rural populations through silvicultural practices, and provide raw materials for construction.

But forests are fragile, and with long growing cycles recovery from damage takes time. Destruction can come from sudden events such as fires, or long-term issues such as climate change. These changes impact livelihoods and drive rural depopulation and the loss of traditions.

The EU-funded MySustainableForest (Operational sustainable forestry with satellite-based remote sensing) project developed Earth observation-based solutions for more sustainable forest management and conservation.

"Our MySustainableForest platform provides accurate and up-to-date information to support decision-making in forestry operations," says project coordinator Julia Yagüe from the technological business group GMV, the project host.

GLOBAL OVERVIEW

Despite forests representing over 42 % of EU land and being economically vital, forest managers lack accurate, up-to-date data. Traditional national forest inventories are expensive and typically performed only every 5 to 10 years. Given the rate at which forests change, sustainable management requires annual monitoring.

"As forests evolve and mature, each stage requires specific site characterisation – of soil, terrain and climate – for effective maintenance, reforestation or regeneration," explains Yagüe.

To achieve this, the project assessed the data needs of a range of forestry stakeholders, from paper industries to national authorities. The 508 requirements identified

© Anton Mazaev, Shutterstock

were then matched to remote observation solutions. The result was a portfolio of 21 geoinformation products available through the MySustainableForest platform.

For each product, users select the desired data set, and define the geographical area of interest and the monitoring or analysis period. Data sets can then be previewed, visualised or analysed on the platform's digital map viewer or downloaded to another one. All files contain metadata and the platform is hosted on a hybrid public/private cloud infrastructure for enhanced data protection.

The products are supplied by GMV, föra forest technologies, MADERA+ and the European Forest Institute (EFI), with the remote sensing data derived from satellites Copernicus Sentinel and Landsat, as well as LiDAR, meteorological and sonic wood fibre data, and customised models.

"Users can evaluate biomass volume, produce wood quality maps and develop strategies to mitigate forest decay caused by droughts and pests in locations impacted by climate change, among other benefits," adds Yagüe.

Platform prototypes were field-tested with specialist forestry stakeholders, including the Forest and Paper Research Institute, French National Forest Ownership Centre, Croatian Forest Research Institute, Navarra Forestry Association in Spain and Forest Owners Association of Lithuania. Testing resulted in 331 validated sample products and 580000 hectares of forests assessed across 16 locales.

DRONES AND ADOPTION

The team developed a roadmap for future initiatives, showcasing the strengths and limitations of six services: Forest Site Characterisation, Wood Characterisation,

Forests represent over 42% of EU land

Volume, Biomass and CO_2 Stocks, Forest Condition, Ecosystem Vulnerabilities and Forestry Accounting.

Key future actions were also highlighted in the road map, including the expansion of data set categories, improved prediction and validation accuracy using machine learning, addition of UAVs for increased coverage, and analyses of more land cover types to detect ecosystem vulnerabilities.

"We have demonstrated that our product saves time and money," says Yagüe. "Now that it is available for use, we just need to persuade foresters, who are more used to visual inspections *in situ*, to adopt it."

MYSUSTAINABLEFOREST

- Coordinated by GMV Aerospace and Defence in Spain
- Funded under Horizon 2020-LEIT-SPACE
- cordis.europa.eu/project/id/776045
- Project website: mysustainableforest.com
- bit.ly/MySustainableForest-video

FOOD AND NATURAL RESOURCES

Plenty more fish in the sea?

A statistical model for predicting fish populations takes into account predator-prey dynamics and environmental factors such as rising sea surface temperatures. This could lead to more sustainable fishing quotas, and more concerted action to protect our precious marine resources.

Estimating the evolution of global fish stocks is not a simple task. Mathematical models that attempt to represent what is happening under the sea have to be built on data carefully collected by scientific surveys.

"In our line of work – ecology – we are not predicting the amounts of fish that will be caught, but rather how fish stocks are changing over time," explains SPITFIRE (SPatial variability and Implications of the Timing of FIsh Responses

to the Environment) project coordinator Joël Durant, a senior researcher at the University of Oslo's Centre for Ecological and Evolutionary Synthesis in Norway.

"These predictions are given as advice to governments, and used to negotiate quotas that will determine the amounts of fish to be harvested." This information is therefore critical to ensuring the sustainability of marine ecosystems, and can significantly influence the future operations of fishing fleets.

In recent years, greater attention has been paid to the need for an ecosystem approach to fisheries management. This means taking into account not just the target fish stock, but also all the other organisms that share the environment.

Relationships between predator and prey for example are key to understanding population trends. In particular, the match-mismatch hypothesis seeks to explain why fish stocks sometimes fail to produce young, by comparing the timing of certain seasonal activities like spawning across a range of species, including both predator and prey.

MATCH-MISMATCH HYPOTHESIS

The SPITFIRE project, which was undertaken with the support of the Marie Skłodowska-Curie Actions programme, sought to apply the match-mismatch hypothesis to develop a model that could more accurately predict certain harvested fish populations. The project also sought to link changes in sea surface temperatures to predator-prey dynamics.

"The first step was to collect a huge of amount of data," says Durant. "To develop an effective metric, we needed

© DoublePHOTO studio, Shutterstock

"By linking rising sea surface temperatures to predator-prey dynamics, we were able to demonstrate how climate change greatly affects marine ecosystems."

data stretching over several years and even decades, covering not only young fish but also prey and other species. This work required a great deal of time, research and exchange involving the Marie Skłodowska-Curie fellow Sofia A. Ferreira."

Data collected from the Norwegian-Barents Sea system was first analysed and applied to a mathematical model that Durant had developed previously. "It was only then that we were able to really test and evaluate the explanatory power of the match-mismatch hypothesis," he adds. "Our results were published, and we were then able to feed data from other sea systems into the model."

VAST GLOBAL DATABASE

A key result of SPITFIRE has been the development of a vast database, stretching across global regions and time. Data was gathered from across the Atlantic and Pacific, as well as the Norwegian-Barents Sea system, the North Sea and the Gulf of Saint Lawrence.

With this data, Durant and Ferreira were able to develop the robust predator-prey metric they were looking for. "This can now be used by the scientific community at large," notes Durant.

"By linking rising sea surface temperatures to predator-prey dynamics, we were able to demonstrate how climate change greatly affects marine ecosystems. We hope this will promote ecosystem approaches to fishery management, which will help to better manage both fish stocks and marine biodiversity."

The success of the project also enabled Ferreira to secure a research position within the Centre for Ecological and Evolutionary Synthesis. This will help ensure that the knowledge gleaned from the SPITFIRE project will continue to be built upon.

SPITFIRE

- Coordinated by the University of Oslo in Norway
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/794301
- Project website: asofiaaferreira.com/spitfire

INDUSTRIAL TECHNOLOGIES

New microwave microscopy platform spurs development of high-quality semiconductor materials

EU-funded researchers developed a microwave microscopy platform that can probe material properties across all scales: from elusive processes that take place at semiconductor interfaces to macroscale electric and magnetic behaviour.

Nanotechnology is rapidly expanding and quietly worming its way into more products. Advances in the field open up a variety of new applications outside of the technology's core area of microchips, such as in medicine, energy, batteries, fuels and chemical sensors. Successful manufacture of nanotechnology products requires better understanding of how matter behaves at the atomic scale.

"The quality and performance of the manufactured products strongly depend on the chemical, electrical, electronic and optical properties of materials at the nanoscale. Precise control over performance may be accomplished through modifying material interfaces," notes Kamel Haddadi, coordinator of the EU-funded MMAMA (Microwave Microscopy for Advanced and Efficient Materials Analysis and Production) project. "Deep insight into the interface properties is crucial as they often mask or superimpose the properties of bulk semiconductors, rendering product design challenging."

ELUSIVE PROPERTIES COMING INTO VIEW

MMAMA developed a new imaging platform integrating instruments and modelling tools that allows close analysis of these interfaces and modelling of their properties. "Our microwave microscopy platform enables advanced analysis of semiconductor materials used in solar cells and electronic circuits," adds Haddadi.

Scanning microwave microscopy offers a non-invasive way to explore important phenomena occurring at the scale of billionths of a metre. To give a broad outline, a near-field microwave microscopy set-up combines the exceptional spatial resolution of an atomic force microscope with the excellent electrical measurement capabilities of a vector network analyser. The atomic force microscope tip scans the sample at a distance of a few nanometres above the surface, emitting a microwave signal that is scattered by the material. Microwaves are much larger than the nanomaterial surfaces they are watching. But when emitted from a minuscule distance away, near-field microwaves reflect a surprisingly detailed image from the sample.

"MMAMA demonstrated that state-of-the-art scanning microwave microscopy technology can be further improved in terms of sensitivity and spatial and temporal resolution, supporting different types of microwave probes such as tuning fork-based tips," says Haddadi. "Our platform integrates scanning microwave microscopy tools, free-space radar imaging, impedance spectroscopy, a dielectric resonator and simulation models." The newly developed split-post dielectric resonator operating at 10 GHz was mounted on a portable channel scanner for characterising material properties, such as the dielectric constant, at the macroscale. Cross-checking amongst different instruments and simulation models proved indispensable for obtaining reliable measurement results.

> *"Our microwave microscopy platform enables advanced analysis of semiconductor materials used in solar cells and electronic circuits."*

© Konstantin Kolosov, Shutterstock

TECHNOLOGY APPLICATIONS

In the realm of third-generation solar cells, scanning microwave microscopy can capture charges moving from layer to layer through interfaces and selectively collecting at electrodes. "Scanning microwave microscopy measurements allow for characterising the electrical properties of nanostructured organic or hybrid semiconductors used in next-generation solar cells. They help predict performance in the early stage of prototype development, thereby accelerating the market launch of high-efficiency solar cells. Translating insights from microscopy measurements, a dielectric resonator could be directly integrated into the photovoltaic production lines for monitoring thin-film deposition processes," explains Haddadi.

MMAMA's advanced multiscale microwave microscopy platform also has implications for conventional electronic chips based on p-n junctions, interfaces between semiconductors carrying positive and negative charges. Integrating instruments, software, calibration and modelling tools, the new microwave platform should enable faster development of new semiconductor materials and nanodevices.

MMAMA

- Coordinated by the University of Lille in France
- Funded under Horizon 2020-LEIT-ADVMAT
- cordis.europa.eu/project/id/761036
- Project website: mmama.eu

Novel exoskeleton chair supports factory workers

Workers no longer have to stand all day. A new chair straps to the body and is available for support as needed.

Workers in manufacturing and other industries routinely work long hours in a standing position. Standard office chairs may not be permitted because they can dangerously impede workers and machinery.

Although occasionally working standing up benefits health, standing for entire shifts has the opposite effect. Specifically, it can cause injury, various kinds of strain including lower back pain, and hypertension. Furthermore, demographic and social changes mean that an increasing proportion of factory workers are of an older age group, especially unsuited to standing all day.

To combat these problems, the EU-funded project Chairless Chair (The worldwide first exoskeleton for the creation of ergonomic, age-neutral and low-fatigue workplaces in industry and for the reduction of physical strains in the ageing workforce) developed an exoskeleton chair. Conventional industrial exoskeletons are worn on the upper body and augment workers' strength. The Chairless Chair is the first designed to be worn on the lower body to support workers' weight.

WORKERS MOVE AS NORMAL

Wearing the chair like a garment, workers move about as normal, supporting their weight with their own legs. Whenever workers need a rest, the exoskeleton can support their weight without interfering with factory operations.

"The Chairless Chair can be worn the entire workday, as it does not interfere with walking or standing," explains project coordinator Katrin Hoffmann. "It adapts to all movements. Workers can switch between standing, sitting and walking in a matter of seconds." The support redirects 64 % of the user's body weight through the exoskeleton, relieving strain on workers' backs and joints, helping to avoid injuries and health problems. It also promotes 'active sitting', which helps strengthen muscles.

"It consists of two skeletal legs made of fibreglass-reinforced plastic and corresponding joints," adds Hoffmann. "At the top are the seating surfaces, and the strap which attaches to the hips. Two other attachment points are straps on the thighs, and click-sliders on the work shoes." The chair has rubber, non-slip feet to provide a secure footing. The product features a stepless adjustment, making it suitable for workers of virtually any height or proportions. It also comes with an optional chest harness to improve weight distribution and ergonomics.

PRODUCT DEVELOPMENT AND FINALISATION

The current version, Chairless Chair 2.0, is actually the third product generation. It has been refined in collaboration with automobile manufacturers. The refinement has reduced the weight by more than 25 %, extended the height adjustment from 1.5 to 2 metres, and slimmed the

> *The Chairless Chair can be worn the entire workday, as it does not interfere with walking or standing. It adapts to all movements. Workers can switch between standing, sitting and walking in a matter of seconds.*

design. The product has been optimised for fit. The newer version is safer and offers more freedom of movement. The straps, vest and seat pads have been redesigned and feature new textile materials. Such changes make the product more comfortable and durable.

The team has established the Chairless Chair as a well-known brand, especially among German car manufacturers. Next, researchers will be further refining the product in subsequent versions, while also seeking new markets.

The product benefits older workers but is not intended for them exclusively. It will benefit any worker having to stand all day, reducing the health consequences and lost productivity resulting from this mode of work.

CHAIRLESS CHAIR

- Coordinated by noonee in Germany
- Funded under Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT
- cordis.europa.eu/project/id/822096
- Project website: noonee.com
- bit.ly/chairless-chair-video

INDUSTRIAL TECHNOLOGIES

Soft hands help to solve a hard problem in robotics

Researchers find factory robots can work faster, smarter and more robustly when given pliable manipulators.

Factory robots can easily pick and place regular objects that are presented to them in an orderly fashion. However, grasping and manipulating irregular objects, such as jumbled parts in container bins, raw food and waste sorting, has proven to be a difficult problem to solve.

The EU-funded SoftHandler (Commercial feasibility of an integrated soft robotic system for industrial handling) project sought to build a commercially viable prototype of an industrial system, one that works with pliable manipulators which conform to objects of different size, shape, weight and strength.

"Our idea was to prove whether it was possible to have an industrial gripper exploit the idea of softness for doing operations in an industrial environment, especially where you need to pick and move objects randomly placed on a tray, and put them in another box or tray. This is something that happens very often in producers and warehouses," says project coordinator Antonio Bicchi.

REDUCIBLE COMPLEXITY

The project stems from previous work carried out by Bicchi and his team. "In the original grant, SOFT HANDS, the idea was to address a problem in the design of artificial hands," he explains.

This work focused on resolving a difficult problem in prosthetics and robotic manipulators: how to mimic the complexity and dexterity of a human hand, which has 19 degrees of freedom, while keeping the part robust and simple to operate.

"For many years, people in the community tried to design hands that were able to approximate what a human hand could do," notes Bicchi. "Notwithstanding, we had very

© industryviews, Shutterstock

few if any artificial hands that were used in the real world, either in industrial applications or in prosthetics."

In industrial settings, highly articulated manipulators need to be reprogrammed for each new application, in accordance with the object they'll be interacting with. Bicchi says this is costly and prevents these manipulators from being more widely adopted.

Part of Bicchi's solution was to focus on movement primitives: groups of muscles that work in concert, producing complex action through simple impulses. "If you use those primitives, you can do 90 % of grasping operations with only one or two controls," observes Bicchi.

SOFTER, BETTER, FASTER, STRONGER

Bicchi and his colleagues at the Italian Institute of Technology then sought to build on this success with soft manipulators. "The human body is compliant, it takes in part the shape of the environment," explains Bicchi.

Their system builds models of the objects to be grasped, which are compared to the object as it is felt by the manipulator. The more the model differs from the reality, the tighter the manipulator grasps the object.

This improves upon existing systems which use machine vision to categorise objects, as these struggle in

"We had very few if any artificial hands that were used in the real world, either in industrial applications or in prosthetics."

suboptimal lighting conditions and with heterogenous objects. The soft manipulators are also more robust than complex mechanical grippers. "We proved it is possible to manipulate objects much faster with our method," says Bicchi.

The work was supported by the European Research Council. "This was absolutely crucial and gave me the freedom to venture in a new direction, very different from what most other groups were doing, and from what we had done for 20 years," adds Bicchi. The work has since been spun out into a commercial firm, qbrobotics, which aims to produce hands for industrial robots based on these principles and designs.

SOFTHANDLER

- Hosted by the Italian Institute of Technology in Italy
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/840446
- Project website: bit.ly/qb-softhand-research
- bit.ly/3tw6pWb

Catching up with RecycLoo: A sustainable public toilet solution is flushed with success due to exciting worldwide commercial opportunities

*In the June 2020 issue of Research*eu we featured an article on the RecycLoo project, undertaken by French start-up company WeCo, that has designed and built a new type of sustainable public toilet. With exciting expansion plans in Europe and Africa, we find out how they've been doing, arranging a discussion with WeCo CEO and founder, Cécile Dekeuwer.*

© Fred Furgol

What makes the WeCo toilet, made possible through the EU-funded RecycLoo (The water recycling bio toilets) project and which to the casual user looks like any other public toilet, so unique is that a combination of bacteria, sedimentation and an electrochemical reaction allows for previously dirty flushed water to be completely treated, made clean, and usable again for another flush. This has the great benefit of saving water and is an excellent example of the concept of the circular economy in action.

Opportunities in COVID times

COVID-19 has caused a change in how people perceive hygiene in the public space – specifically, the idea that public toilets could be a major infection risk. Yet the fact remains that one could be caught short whilst out-and-about, and with restaurants and other non-essential businesses closed, the need for public restrooms, even in COVID times, has provided opportunities for WeCo.

With a priority focus on France, WeCo has recently installed their toilets in the municipality of Grigny (near Paris), and at the beginning of 2021 the French towns of Blois and Rennes also became WeCo customers.

"We've also strengthened our team with multilingual sales experts who are exploring opportunities for WeCo in Germany, where we are prioritising raising our brand awareness and asserting our presence there," Dekeuwer explains. "And we expect to see the payoff of these efforts by the end of 2021."

New commercial opportunities abound

Alongside their growing French customer base and push into Germany, WeCo also recently began new partnerships with an industry leader in sewered flush toilets, a 'grey water' recycling company and their main industrial partner. "New orders are increasing, and we are now concentrating on developing our first sales in a client-partnership mindset, focusing on sustainable cities and B2B projects where our off-grid sustainable toilets are needed," adds Dekeuwer.

WeCo also hasn't given up on its plans to penetrate African markets. "Thanks to further funding through the INNOWWIDE – EUREKA Prize and Water Europe's Innovation Award, as well as through the Seal of Excellence from the EIC Accelerator, we have begun a partnership with Senegalese company Delvic Sanitation Services, a key actor in the valorisation of faecal sludges," she continues. "This allows us to understand the specific needs of West Africa and to help contribute to building the sustainable African cities of tomorrow!"

From our catch-up interview, it's clear that Dekeuwer and her team are extremely proud of their sustainable and reliable toilet solution – and they're absolutely confident that WeCo will make its mark in Europe, Africa and, one day, Asia as well.

RECYCLOO

- Coordinated by WeCo in France
- Funded under Horizon 2020-SME, Horizon 2020-LEIT and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/867076
- Project website: en.weco-toilet.com

Cécile Dekeuwer
WeCo CEO and founder
© Fred Furgol

"New orders are increasing, and we are now concentrating on developing our first sales in a client-partnership mindset, focusing on sustainable cities and B2B projects where our off-grid sustainable toilets are needed."

DIGITAL ECONOMY

Deep learning transcends the edges of our imagination

Imagine the ability to bring the processing power of today's supercomputers and data centres to virtually any device at the network's edge with a tiny chip. EU-funded research has made it a reality with an unprecedented embedded Artificial Intelligence processor.

The explosive growth in mobile connectivity – from cell phones and tablets to the expanding internet of things (IoT) and Industry 4.0 – is driving demand for increased speed, decreased latency and power consumption, and enhanced functionality of connected devices. To meet this demand, embedded sensors and edge computing (processing close to the edge of the network rather than centrally) are playing an increasingly important role relative to centralised data processing and cloud-based services. The EU-funded project Hailo-8 (End-to-end hardware implementation of Artificial Neural Networks for Edge Computing in Autonomous Vehicles) is preparing a step change in edge computing. Its pioneering embedded Hailo-8™ Artificial Intelligence (AI) processor brings deep learning to AI-based edge devices with a focus on processing of vision sensor data.

DEEP LEARNING, BROAD REACH

Deep learning leverages a brain-inspired, multilayered, artificial neural network architecture that, like the brain, can learn without a priori rules, hardwired instructions or human supervision. Further, it can deduce structure in raw data. Hailo-8™'s AI hardware architecture unleashes the power of deep learning to support edge devices in advanced applications. The processor delivers unparalleled AI performance with low power consumption and compact size.

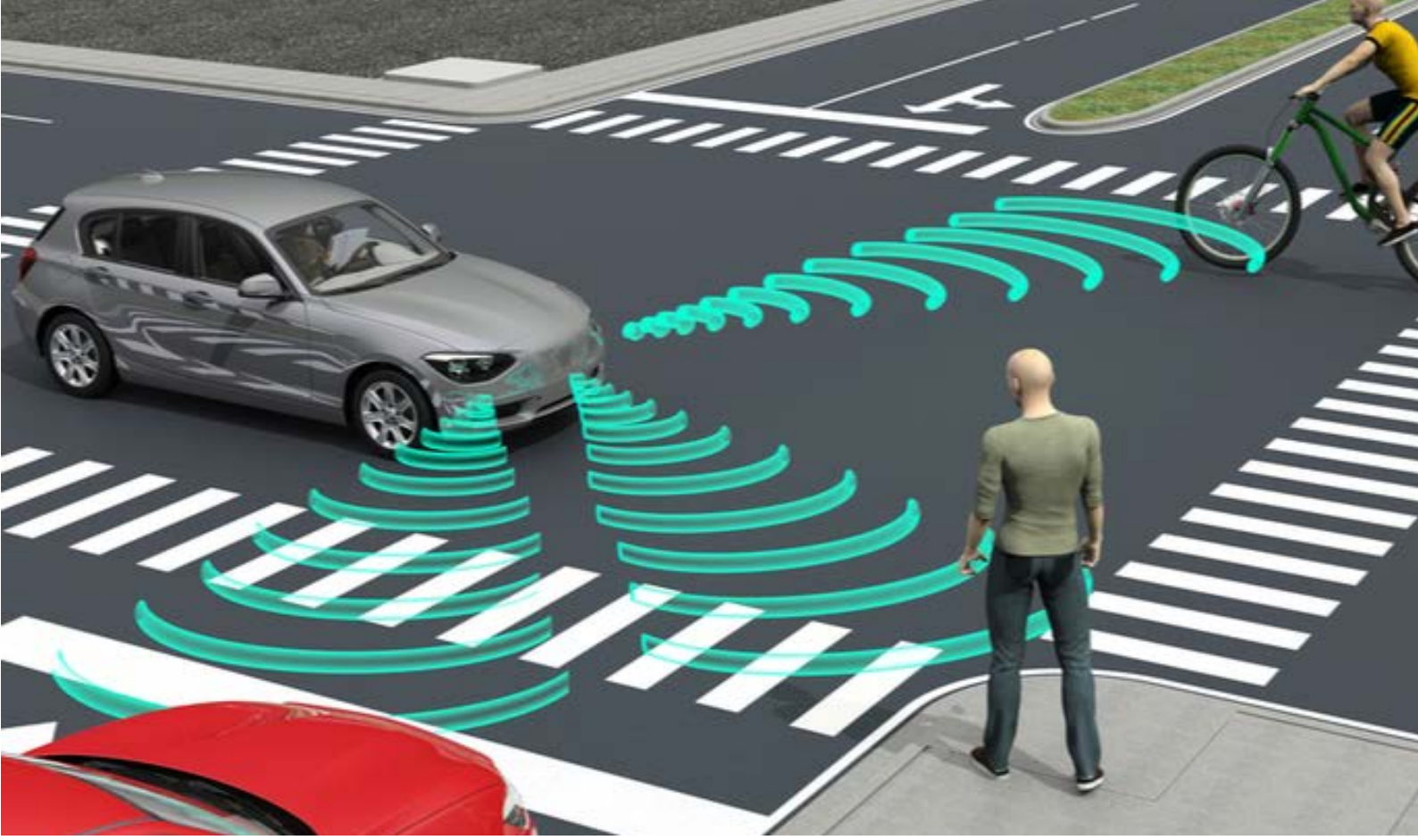
Extremely high processing resolution harnesses the full potential of advanced sensors. The processor's fully programmable AI accelerator chip and its comprehensive software development kit support numerous neural network types, enhancing the flexibility of programming. The software seamlessly fuses with existing machine language development frameworks to streamline integration in products.

Avi Baum, chief technology officer at Israeli SME Hailo Technologies and project coordinator, explains the potential: "As an embedded AI processor, the Hailo-8™ is a perfect fit for a wide variety of embedded computing platforms ranging from automotive and heavy industries to consumer electronics. Given its automotive and industrial grade qualifications and functional safety attributes designed into the product to address automotive needs, it is uniquely positioned for industrial applications in an IoT-4.0 context as well as smart mobility, public safety and other IoT applications."

HEADING TO THE EDGE

The Hailo-8 project focused on two aspects. On the engineering side, the team built the capacity for mass production and design for testability and manufacturability. On the business side, the company targeted product promotion and customer engagement. The project launched an early access evaluation programme to gain market traction. It attracted more than a dozen potential customers seeking early access to the technology, including several automotive suppliers and original equipment manufacturers. In fact, Baum reflects, "the overwhelming interest from new markets that we were not directly targeting was quite exciting and led to many more business opportunities than we originally anticipated. With the Hailo-8™ AI processor now in volume production and ready for deployment, we already have over 30 potential customers in the sales pipeline."

"As an embedded AI processor, the Hailo-8™ is a perfect fit for a wide variety of embedded computing platforms ranging from automotive and heavy industries to consumer electronics."



© Hailo Ltd.

Hailo-8™'s comprehensive and flexible software will facilitate ease of use and rapid deployment. Baum concludes: "Not only have we lowered the barrier for introducing deep learning to embedded platforms, but we have also delivered the most efficient AI processor for edge devices available today. Its unparalleled processing capabilities will unleash the awesome potential of edge computing."

HAILO-8

- Coordinated by Hailo Technologies Ltd in Israel
- Funded under Horizon 2020-LEIT, Horizon 2020-SME and Horizon 2020-Societal Challenges
- cordis.europa.eu/project/id/849921
- Project website: hailo.ai

DIGITAL ECONOMY

Novel platform helping to achieve work-life balance

EU-funded researchers harnessed the potential of new technologies and social networks to help working families balance professional commitments and childcare needs.

Insufficient and unaffordable childcare services, augmented workloads and increased working hours are some of the reasons why many Europeans over the last decade have found it increasingly challenging to balance work and family life. On top of this, the COVID-19 pandemic has made it hard for many families to achieve this balance.

Addressing these challenges, the EU-funded Families_Share (Socializing and sharing time for work/life balance through digital and social innovation) project created a bottom-up solution – a childcare model – and co-designed an open-source platform with organisational and networking functionalities that supports families in self-organising childcare activities. Agostino Cortesi, project coordinator and professor at Ca' Foscari University of Venice, explains: "We have built on current practices that are already leveraging on mutual help and support amongst families, such as time banks and social streets, and we have exploited the potential of ICT networks and mobile technologies to increase the effectiveness of participatory innovation."

© Fondazione Bruno Kessler

CONNECTING WORKING PARENTS

The project, developed in seven City Labs, involved the parents of children aged 3-11 years, living in the same neighbourhoods. Cortesi notes: "Taking into account children's privacy and safety, parents co-designed a platform where they can take turns organising recreational activities for their children." They can engage in various activities, such as share learning sources and agree on timesharing schemes for mutual support in childcare and after-school activities. This helps to improve work-life balance as well as increase the quality of learning opportunities for their children.

With over 2 000 registered users, the platform has also paved the way for new neighbourhood-based communities. "It has helped strengthen bonds with existing local communities and, due to its affordability and inclusive nature, has enabled the participation of vulnerable families," adds Cortesi. The platform can also be easily adopted by NGOs, municipalities and companies in different contexts.

Cortesi acknowledges one thing: "While the COVID-19 outbreak had a dramatic impact on the project's activities, most City Labs engaged parents in collaborative homework and games among small groups of families. Workshops, talks and information sessions were organised to support parents towards a new work-life balance." The project also provided supportive guidelines for organising summer activities that complied with the restrictions imposed at different levels of government. "A sense of community has emerged in all City Labs, especially during the pandemic where families share a strong need for socialisation."

TOOLKITS SUPPORTING DIFFERENT CONTEXTS

The project has received positive feedback from families, with many expressing their willingness to continue using the platform. It is expected that Families_Share's dissemination activities will result in extensive adoption of the project's solution around Europe.

Foreseeing this, the project designed and delivered toolkits for parents, NGOs, companies, municipalities and developers (for the app deployment) in five languages: English, Italian, Greek, Dutch and Hungarian. "These toolkits contain all you need to replicate the Families_Share solution to different contexts. The technical support to the platform will be provided by the consortium partner ViLabs for another 2 years. A deployment guide for developers to install the platform and a user guide are part of the toolkits," concludes Cortesi.

The work of Families_Share, through the socialisation of childcare, has helped parents find a balance between work and private life. It has positively increased community building as well as child and parent well-being, and has enabled the social inclusion of vulnerable groups.

FAMILIES_SHARE

- Coordinated by Ca' Foscari University of Venice in Italy
- Funded under Horizon 2020-LEIT-ICT
- cordis.europa.eu/project/id/780783
- Project website: bit.ly/Families_Share_archive

SECURITY

Eyes and ears everywhere to protect Europe's ports

A research project has developed a solution for protecting EU ports targeting terrorist threats on the ground, in cyberspace and those combining both modes of operation.

Millions of passengers and billions of tonnes of goods transit through European ports every year, making them both a key asset to protect and a potential target for criminal attacks.

The EU-funded SAURON (Scalable multidimensionAl sitUation awaReness sOlution for protectiNg european ports) project designed a new concept helping port authorities to deal with increasingly sophisticated threats targeting people or infrastructure as well as computer systems and often combining physical- and cyberattacks.

"To protect EU ports, which are among the main critical infrastructures in Europe, the SAURON project proposes a single software solution offering physical, cyber and hybrid situation awareness and an emergency population warning system," explains Rafael Company, director of Safety and Security at the Valenciaport Foundation, and SAURON project coordinator.

"Together, these four components help port security staff prevent and mitigate incidents by making them aware of any potential risk and providing information they can use to protect the general population in the vicinity."

360° AND BEYOND

How does the system work in practice? SAURON builds on existing port security tools such as cameras, sensors and fire alarms, and complements these with cutting-edge security technology equipped with new sensors, such as drone-mounted cameras and facial recognition.

The system uses an IT platform monitoring and analysing data from multiple sources and generating alerts when anomalies are detected, whether in the 'real world' or in cyberspace.

> *Although the system has been proven in port and maritime environments, all its components are easily adaptable to critical infrastructure in other industries such as energy, water or communications.*

New visualisation techniques such as 3D models and Virtual Reality scenarios enable operators to view and evaluate on- and offline threats in real time, thereby supporting quick decision-making.

In dangerous situations, the early warning system can be triggered to alert authorities and the public.

EFFECTIVE THREAT DETECTION

During the pilot phase, SAURON was deployed in four European ports where cyber, physical and hybrid terrorist attacks were simulated to test the concept. At the Port of Sagunto in Spain, for instance, a drone was used to monitor a truck with dangerous goods inside the port. "We were able to detect and manage the incident through the system, and to send the port police to handle it," Company notes.

During another simulation, this time at the Port of Piraeus in Greece, the system was used to foil a staged terror plot in which the computer of the port security officer was compromised with a view to targeting passengers at a cruise terminal. In this case also, SAURON effectively enabled the trial participants to detect and prevent the attack.

BROAD PROSPECTS

Based on these successful trials, four potential end users have already expressed an interest in deploying SAURON in the future.

While the project has focused on European ports, the concept developed has the potential to provide improved security in other areas.

"Although the system has been proven in port and maritime environments, all its components are easily adaptable to critical infrastructure in other industries such as energy, water or communications," says Company.

The project team has just been awarded EU funding for a new project which will enable it to further enhance the system and explore opportunities for broadening its scope.

SAURON

- Coordinated by the Valenciaport Foundation in Spain
- Funded under Horizon 2020-SECURITY
- cordis.europa.eu/project/id/740477
- Project website: bit.ly/Sauron_archive
- bit.ly/sauron-video

SECURITY

Using your fingerprint as a password

Tired of trying to remember passwords and PINs? Soon, you may no longer have to. That's because one EU-funded tech company is developing a biometric, secure smart card system that can be accessed using only your fingerprint.

Every day, more and more people turn towards online services and cashless transactions. And while this trend provides a range of conveniences to users, it also creates new opportunities for identity and data theft by hackers.

"Despite rapid advances in online commerce and digital services, data protection hasn't evolved much past PINs and passwords – both of which are incredibly easy for hackers to access," says Frank Sandeløv, CEO of CardLab,

a Danish company that creates high-security card systems. "The challenge is making data dynamic while simultaneously providing unique user identification and full privacy protection."

With the support of the EU-funded QuardCard (Powered smart card with a biometric one time password system) project, CardLab is developing a groundbreaking biometric smart card with a fingerprint sensor, display, multiple interfaces and back-end authentication system. "This innovative technology creates the unbreakable link between the physical and digital identity, and also provides full privacy protection and is both GDPR and PSD 2 compliant," adds Sandeløv.

BETTER DIGITAL SECURITY

QuardCard is a highly secure smart card developed for the access, government ID, blockchain and payments markets. The card is a first in that it combines the smart card concept with the latest in biometrics.

According to Sandeløv, all the data is kept inside the card, with only a tokenised identity being released. The card stores a biometric fingerprint algorithm, which is highly accurate and impossible to copy. "Using your fingerprint, the system creates a token/one-time password, or OTP," he explains. "Because the card only works with the rightful owner's fingerprint, it drastically improves the security of online and physical transactions."

QuardCard generates the OTP using a standard OATH algorithm, meaning the back-end verification server, accessed via an API, can act as an authentication gateway to any existing application regardless of operating system, data model or architecture. "The API-based solution effortlessly integrates three-factor security in a cost-effective manner and with minimal impact on existing infrastructure and operations," remarks Sandeløv.

This versatility means the QuardCard can be used for a wide range of electronic security applications, including remote access, government ID systems, drivers' licences, digital wallets, medical cards, and student and employee IDs – to name only a few.

"The project provides a solution that spans well beyond only facilitating online payments," explains Sandeløv. "As the first secure biometric solution that stores data in a card and offline, the QuardCard overcomes a number of security and data protection risks that all companies face."

TECHNOLOGY AND MARKET ENTRY

Despite COVID-19-related delays and issues with suppliers, the project succeeded in developing a biometric platform for building different versions of the QuardCard. This includes a primary cell-powered card with a normal lifespan of 2.5-5 years and a card with a rechargeable battery for an extended lifespan. The project also developed a battery-less energy-harvesting version, which is ideal for extended lifetime use applications like national ID cards, medical insurance cards and drivers' licences.

"In addition to enabling these electronic card applications, the QuardCard solution is a very efficient cybersecurity tool," concludes Sandeløv. "Companies investing in the solution can get an almost immediate return on investment, along with many other benefits and administrative savings."

The company is currently in a funding round to ramp up its sales and marketing efforts and production. The research team is correcting a few minor bugs identified during user testing, and the first large-scale pilot programme is expected to begin in spring 2021.

QUARDCARD

- Coordinated by CardLab Innovation in Denmark
- Funded under Horizon 2020-SECURITY and Horizon 2020-SME
- cordis.europa.eu/project/id/757096
- Project website: quardlock.com

FUNDAMENTAL RESEARCH

Measuring and understanding the Earth's wobble with greater accuracy

For millennia we have steered our way by the stars, and we still do – with ever greater accuracy. Global Positioning Systems, atomic clocks and many other tools we take for granted depend on our ability to measure Earth's movements, but current models could be improved.

Global Navigation Satellite Systems (GNSS), such as Global Positioning Systems (GPS), receive data sent by orbiting satellites to provide precise positioning. The receivers, fixed relative to the Earth and rotating synchronously with the planet, track signals from satellites that are moving in space. In order to be precise, we need to know how the Earth is rotating and shifting beneath the satellites.

The European Research Council's RotaNut (Rotation and Nutation of a wobbly Earth) project managed to model the Earth's nutation to within a few millimetres, so providing information that can boost the accuracy of tools based on atomic clocks and GPS.

Such tools are based on two frames of reference: the terrestrial frame, fixed relative to the Earth and rotating synchronously with the planet, and the celestial frame, which is immobile in space, where the artificial satellites such as those of GPS are moving.

As principal investigator Véronique Dehant explains: "The relationship between these frames is complicated

by the fact that the rotation and orientation of the Earth are subject to irregularities induced by global mass redistributions with time and external forcing, such as the gravitational pull of the Sun and the Moon."

The RotaNut project set out to improve modelling of the Earth's rotation, and to better understand the role and nature of the Earth's interior.

"Current modelling doesn't fully take into account the Earth's complexities. In particular, the atmospheric and oceanic contribution to the Earth's orientation is not perfectly modelled. It's also the case that the coupling mechanisms at the boundaries between the inner core, the liquid outer core, and the mantle are not yet understood enough to be properly modelled," adds Dehant.

SMALL SHIFTS, BIG IMPACT

The rotation axis of the Earth is moving in space at the rate of 1.5 km a year due to precession and has periodic variations at the rate of 600 metres, as seen from space in a plane tangent to the pole. The present observations of quasars from Earth-fixed antennas, using Very Long Baseline Interferometry, allow scientists to measure these at the centimetre level.

The term 'precession' describes the long-term trend of the orientation of the axis of spin, while 'nutation' is the name given to shorter-term periodic variations. The RotaNut project focused on the latter.

By measuring nutation at the sub-centimetre level, scientists can identify what elements of the physics of the Earth's interior need to be taken into account when modelling the planet's orientation. These include the coupling mechanisms at the boundary between the liquid core and the viscoelastic mantle.

UNCOVERING WHAT'S GOING ON IN THE EARTH'S CORE

Dehant, who conducted her research at the Royal Observatory of Belgium, feels it is an exciting time to be working in the field: "Technological advances are making it possible for geodesists and geophysicists to identify the causes and magnitude of the changes to the Earth's orientation."

"Our results are important. They allow us to better describe what is going on in the core when modelling nutations. I am very pleased with what the project managed to achieve because motions and dissipation in the core could explain the observation."

The project demonstrated that the dynamics in the liquid core have to be considered if one wants to describe the Earth's orientation precisely.

"It's important to factor in the inertial waves in rotating fluids, coupled with rotational global motions, when studying nutations inside the core," says Dehant.

Using a fully coupled core-mantle model, the RotaNut team managed to analyse the coupling at the core-mantle boundary which they deduced from the observed nutation.

"Our results are important. They allow us to better describe what is going on in the core when modelling nutations. I am very pleased with what the project managed to achieve because motions and dissipation in the core could explain the observation."

The project's findings are available on the RotaNut website.

ROTANUT

- Hosted by the Royal Observatory of Belgium
- Funded under Horizon 2020-ERC
- cordis.europa.eu/project/id/670874
- Project website: rotanut.oma.be

Genome study on small fishes reveals the underlying forces that drive repeated evolution

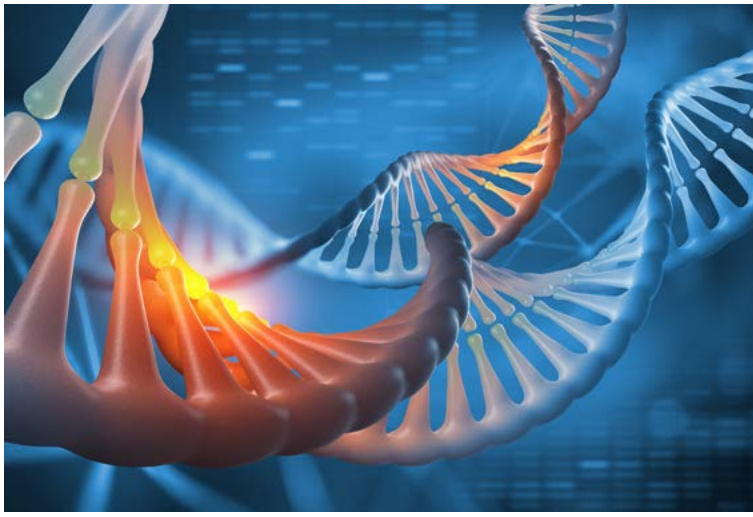
Genetic analyses of three-spined sticklebacks show that isolated populations evolve 'in parallel' in response to similar conditions. But the specific mechanisms that account for the repeated genome-wide patterns of genetic parallelism and divergence differ from currently held theory.

How predictable is evolution? If we could rewind the tape of life with the same environmental constraints at work, would evolution result in the same outcome? These questions have long fascinated evolutionary biologists who strive to delineate the role of random events versus deterministic processes in the evolutionary history of organisms.

"Peering into how organisms evolved over time and adapted in response to similar environmental changes could help researchers predict how bacteria or viruses might adapt to drug therapies. Evolutionary approaches could therefore be useful for improving antibiotic therapies," explains Catherine Peichel, coordinator of PLEVOCON (Pleiotropy and Evolutionary Constraint), a Marie Skłodowska-Curie project.

A TESTBED FOR NATURAL EVOLUTIONARY EXPERIMENTS

The three-spined stickleback, a finger-sized fish distributed across the northern hemisphere, is a textbook model species in evolutionary biology. With the melt of Greenland's ice sheets at the end of the Last Glacial Maximum, sticklebacks evolved from living in seawater to freshwater in just 15 000 years. Upon colonising in new freshwater environments across different regions, they exhibited similarities in their phenotype, a phenomenon known as parallel evolution.



© Yurchanka Siarhei, Shutterstock

Three-spined stickleback populations found in large lakes tend to have short and slender bodies, large eyes, and adjusted structures for feeding in surface waters on zooplankton. Unlike their limnetic (lake-living) counterparts, benthic populations that reside in streams often have longer and deeper bodies and smaller eyes.

"These divergent patterns of lake and stream sticklebacks keep repeating themselves in geographically isolated populations," notes Peichel. If these repeating phenotypic traits emerged in several evolutionary lines independently of each other, this denotes that evolution responded to similar

> *"Evolution is not always the product of random processes. It also follows deterministic processes, arriving at the same solution over and over again."*

environmental conditions using the same mechanisms. "Evolution is not always the product of random processes. It also follows deterministic processes, arriving at the same solution over and over again," adds Peichel.

REVEALING THE UNDERLYING GENETIC BASIS FOR REPEATED EVOLUTION

PLEVOCON did not just rely on the surface, identifying repeating patterns of parallel evolution in the fishes' genome, but rather sought to investigate what drives these repetitions. Are the same genes (or loci) and genetic mechanisms triggered each time to produce the divergent patterns we see in organisms that look similar?

Researchers conducted a whole genome sequencing study of 16 stream-lake stickleback pairs living in the freshwaters of Vancouver Island, Canada, and found that about 30 % of highly differentiated genomic regions evolved in parallel. Comparative studies showed the mutation and recombination rates between parallel and non-parallel sliding windows did not differ significantly. But what they did find was that parallel genomic regions contained a larger number of pleiotropic genes – genes contributing to multiple phenotypic traits.

The team used two different methods for investigating the relationship between pleiotropy and parallel evolution. First, they scoured large genetic databases for quantitative trait loci – specific regions in the genome where genes interact to form complex phenotypic traits – and found that parallel windows hosted a larger number of such regions. Second, they used RNA sequencing data derived from previous studies on sticklebacks to scan for gene co-expression patterns. Results showed parallel windows acted as a hotspot for highly correlated genes, which serve as a proxy for pleiotropy.

"Our findings run counter to predictions holding that non-pleiotropic genes are freer to evolve in parallel. Genes with very high levels of pleiotropy could indeed delay adaptation, but genes with limited pleiotropy tend to favour adaptation," concludes Peichel.

PLEVOCON

- Coordinated by the University of Bern in Switzerland
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/794277
- Project website: bit.ly/plevocon-webpage

FUNDAMENTAL RESEARCH

How birds navigate barriers to long-distance migration

Advances in small-scale tracking technologies can reveal secrets about the vast migrations undertaken across the globe each year.

Every year, millions of birds migrate around the world. In doing so, they must overcome certain ecological barriers in the landscapes, such as oceans and deserts. The success of a bird's migration, and therefore its ability to survive, depends on the behaviour it uses to cross these difficult terrains.

How songbirds do this has been debated for a long time. Songbirds usually fly during the day and rest at night, and it was unclear whether they change their behaviour.

The BIRDBARRIER (The Importance of Barriers to Bird Migration) project, undertaken with the support of the Marie Skłodowska-Curie Actions, has been using groundbreaking tracking technology to investigate this issue.

"This project aimed at describing in detail the behavioural changes birds show when crossing barriers," says Sissel Sjöberg, a postdoc at the University of Copenhagen and BIRDBARRIER project lead.

This project aimed at describing in detail the behavioural changes birds show when crossing barriers.

TRACKING ADVANCES

Until recently, studying the behaviour of small animals such as songbirds throughout migration has been particularly difficult. Either the tracking technology was too large to be carried, or the resolution of the data was too small to draw accurate or firm conclusions.

The BIRDBARRIER team has been involved in the development of a new technology which makes this sort of tracking possible.

These are miniaturised multisensor dataloggers that, as long as they stay on a bird, continue to record data. These loggers are customisable, and changing the sensors attached to the device alters which information it can gather.

"The dataloggers we have used have recorded acceleration with a resolution of 5 min, which we translate into activity. This makes it possible for us to calculate, for example, exact flight times and durations. We also have a barometric sensor which gives us hourly information on flight altitude, interpreted from air pressure and temperature," Sjöberg explains.

The dataloggers used by the BIRDBARRIER team also have attached light sensors, which can gather information on sun hours, and approximate the position of the bird.

"We can say where the birds are, at least during stationary periods, along with how much time they have spent on migratory flights. We can tell when they flew and how the birds have regulated flight altitude throughout the flights," adds Sjöberg.

BEHAVIOURAL CHANGES?

Preliminary data from the project reveals that birds do behave differently at barrier segments compared to other migratory segments.

"Nocturnally migrating species shift behaviour when crossing inhospitable areas, and sometimes instead fly both at night and during the day to get over the area as fast as possible," says Sjöberg.

The next step is to continue to publish the large amount of data that has been collected by the project, and also to try and understand the reason for, and importance of, the completely new behaviours that have been described through the project.

In the long term, the team wants to continue the research, investigating how flexible these new behaviours are and how they might be adapted to a changing environment in the years to come.

TEAM COLLABORATION

Sjöberg concludes: "Being allowed to work with data when we for the first time get insight into how individual birds behave throughout the annual cycle, and during their amazing journeys, is extremely fascinating, and everyone involved in the project has been amazed by the data we managed to get."

BIRDBARRIER

- Coordinated by the University of Copenhagen in Denmark
- Funded under Horizon 2020-MSCA-IF
- cordis.europa.eu/project/id/751692

AGENDA

JULY 2021

28 JUNE → 2 JULY

ONLINE
IEEE International Conference on Network Softwarization
⇢ netsoft2021.ieee-netsoft.org

7→9 JULY

ONLINE
International Symposium on Geofluids
⇢ geofluids2021.hu

11 JULY

WORLDWIDE
⇢ World Population Day

14→16 JULY

ONLINE
Wireless Sensors & Drones in IoT (Wi-DroIT 2021)
⇢ widroit2021.github.io

15 JULY

WORLDWIDE
⇢ World Youth Skills Day

29→31 JULY

SINGAPORE & ONLINE
SIGDIAL 2021
⇢ bit.ly/SIGDIAL2021

3–10 JULY

THESSALONIKI, GREECE & ONLINE

NANOTEXNOLOGY 2021

NANOTEXNOLOGY explores the opportunities in the emerging fields of Nanotechnologies, Organic & Printed Electronics and Nanomedicine. NANOTEXNOLOGY brings together over 2 000 researchers, scientists, engineers, business, technical and policy professionals to promote research and industrial collaborations, identify priorities and strengthen the innovation ecosystem.

⇢ nanotexnology.com

Whilst at the time of writing all of these events were scheduled to take place, we advise all of our readers to regularly check the status of each event due to the continued uncertainty caused by the novel coronavirus epidemic in Europe – events may be cancelled, rescheduled or reformulated (e.g. switched to being a digital event only) at any time.

Publications Office
of the European Union

For a free magazine subscription and more go to:
cordis.europa.eu/research-eu

Follow us on social media too!
facebook.com/EUresearchResults
twitter.com/CORDIS_EU
youtube.com/CORDISdotEU
instagram.com/eu_science

EN