ASIA-PACIFIC

AUSTRALIA

The 3D printing process offers energy storage design options

University of New South Wales (UNSW) engineers have developed a process to print solid-state polymer electrolytes into any shape desired for use in energy storage. The research team from the School of Chemical Engineering led by Professor Cyrille Boyer, including Dr. Nathaniel Corrigan and Kenny Lee, states that the 3D printing process of such material could be particularly useful in future medical devices where small, intricately designed energy storage offers a number of benefits.

Solid-state electrolytes are a key component in solid-state batteries, although traditionally, they have suffered from poor performance due to low ionic conductivities or poor mechanical properties. However, in a paper published in Advanced Materials, the team from UNSW reports that their 3D printed solid polymer electrolyte (SPE) offers high conductivity as well as robust strength. This means the solid-state electrolytes can potentially be used as the actual structure of a device, creating a range of conceivable design opportunities, particularly for future medical products.

Although the SPE developed by the UNSW team is regarded as a high-performance material, the researchers say it can be manufactured using inexpensive and commercially available 3D printers rather than sophisticated engineering equipment.

The SPE described in the paper is composed of nanoscale ion-conducting channels embedded in a rigid crosslinked polymer matrix. It is produced via a process known as polymerization-induced microphase separation (PIMS). The researchers used 3D printing to have an intricate map of Australia, which was later tested as an energy storage device to demonstrate the material's versatility.

"One of the other benefits of this SPE in energy storage devices is the fact it increases the cycling stability - that is the number of charging and discharging cycles until its capacity is reduced to a certain .amount," says Dr. Corrigan. "In our paper, we show that this material is very stable and has the ability to charge and discharge over thousands of cycles. After 3000 cycles there was only roughly a 10 percent drop."

Researchers claim that 3D printing also reduces wastage compared to other traditional forms of manufacturing and reduces costs since the same machine can be used to produce a variety of differently shaped materials. In the future, they say product designers could use their SPE to create items with a much higher energy storage density.

https://www.printedelectronicsworld.com

CHINA

Machine learning to predict municipal solid waste generation

Machine prediction models with high accuracy, which can obtain new complex data and mine them in depth, are increasingly used to create short-, medium-, and long-term predictions for municipal solid waste (MSW) generation. Among them, algorithms such as artificial neural network (ANN), support vector machine (SVM), and gradient boost regression tree (GBRT) have been employed to forecast MSW generation. However, the lack of a high-accuracy model based on large-scale data collection and a wide range of influence variables limits the broad applicability of the model.

To meet the needs of the large-scale comprehensive treatment and realize the short-term MSW generation prediction, Professor Weijing Lu from Tinghua University and team members have worked jointly and used a wide range of data (countrywide, city-based) from 130 cities across China, and multilevel feature variables (e.g., socioeconomic factors, natural conditions, and internal conditions) to establish a machine learning multicity model of MSW generation with high accuracy. Their work analyzed and explored the waste management models of two typical large cities (Beijing and Shenzhen) in China. This study, titled "Development of machine learning multicity model for municipal solid waste generation prediction,» was published online in *Frontiers of Environmental Science & Engineering*.

This study constructed a database of MSW generation and feature variables covering 130 cities across China. Based on the database, an advanced machine learning (GBRT) algorithm was adopted to build the waste generation prediction model (WGMod). In the model development process, the main influencing factors on MSW generation were identified by weighted analysis. The selected key influencing factors were annual precipitation, population density, and annual mean temperature with weights of 13%, 11%, and 10%, respectively.

The WGMod showed good performance with $R^2 = 0.939$. Model prediction on MSW generation in Beijing and Shenzhen indicates that waste generation in Beijing would increase gradually in the next 3-5 years, while in Shenzhen it would grow rapidly in the next 3 years. The difference between the two is predominately driven by the different trends of population growth.

This study established a database of MSW generation and feature variables with 1012 data sets covering 130 cities across China. The developed WGMod performs reasonably well and is very suitable for predicting MSW generation in China. This study provided scientific methods and a basic data for multicity model development for MSW generation.

https://techxplore.com

3D printing sodium-ion micro batteries

Chinese researchers have developed a prototype of planar and flexible 3D printed sodium-ion micro batteries (NIMBs) with ultra-high areal capacity and boosted rate capability, according to a research article recently published in the journal Advanced Materials. Planar NIMBs are a promising new micro-power source because of their rich sodium resources, low cost, and fast sodium ion transmission. But they are hindered by low areal capacity owing to the thin microelectrodes.

The researchers from the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences developed 3D printable inks with appropriate viscosities and high conductivity. The material allows the multilayer printing of NIMB microelectrodes to reach a very high thickness of about 1,200 micrometers while maintaining effective ion and electron-transfer pathways.

The 3D-printed NIMBs deliver a superior areal capacity of 4.5 mAh per square centimeter at a low current density of 2 mA per square centimeter, outperforming the state-of-the-art printed micro batteries, said the research article.

The new NIMBs show enhanced rate capability with 3.6 mAh per square centimeter at a high current density of 40 mA per square centimeter and robust long-term cycle life of up to 6,000 cycles.

Furthermore, the planar NIMB microelectrodes exhibit decent mechanical flexibility under various bending conditions.

http://english.news.cn

Robotic fish to "eat" microplastics

Chinese scientists have developed a robotic fish that can remove microplastic particles from water environments. Researchers working on the project say the robots could help clean up plastic pollution in oceans around the world. The robotic swimmers are about 1.3 centimeters long. They are made of a soft chemical compound. The robots are designed to absorb microplastics while moving through the water.

The project was launched by a team at Sichuan University in southwestern China. The researchers said the robots have already performed well in shallow water, and they plan to carry out more tests in deeper waters. The scientists reported their findings in a new study in *Nano Letters*. The publication comes from the American Chemical Society, a non-profit organization supported by the U.S. Congress.

The robotic fish was built to target microplastic particles smaller than 5 millimeters. Studies have confirmed that microplastic pollution has been discovered in many natural environments. The material comes from the breakdown of manufactured plastic products and industrial waste. The team said that the robots can be controlled by light. Turning "a near-infrared light laser" on and off causes the fish's tail to move back and forth, the American Chemical Society said. The robotic fish can swim up to 2.76 body lengths per second. The researchers said this is faster than most similar soft robots.

Wang Yuyan was a member of Sichuan University's research team. She told the Reuters news agency that the small, lightweight robot is currently being used to collect microplastics for research purposes. But Wang added that the team plans to expand that use so the robot fish can remove larger amounts of microplastic waste from deep ocean areas.

The researchers said that the fish can take in different kinds of microplastics and even repair itself when damaged. And if a robot fish is accidentally eaten by a real fish, it could safely digest the material, the team added. Wang said similar robots could be developed to be placed inside the human body to remove unwanted materials or diseases.

https://learningenglish.voanews.com

INDIA

Indigenous metal 3D Printer

Indian Institute of Technology (IIT) Jodhpur researchers have indigenously developed a metal 3D printer based on the Direct Energy Deposition (DED) technology. All the components of this metal 3D printer, except the laser and robot systems, are designed and manufactured in India. The project›s main objective is to reduce the cost of metal 3D printers and attract a broader range of users.

Despite the fact that metal 3D printing technology started a few years after the launch of polymer 3D printing, it is yet to experience the tremendous growth that the polymer 3D industry has achieved, especially in India. The high price of the product and the more expensive proprietary metal powders imported from abroad are some of the reasons for the limited growth of metal 3D printers.

The printer developed is suitable for repairing and adding additional material to existing components. Hence, it is ideal for printing fully functional parts for a range of industries, like aerospace, defense, automotive, oil and gas, and general engineering, to name a few. This machine can print 3D parts with metal powders made in India. In addition, India's first state-of-the-art variable spot size laser optics, without compromising on laser beam homogeneity for laser cladding and additive manufacturing process, is available in this machine. The team at IIT Jodhpur has developed this machine's tool path planning software and coaxial nozzle. It also has in-situ monitoring technologies that constantly monitor the melt pool temperature and clad thickness during the additive manufacturing process.

The research team from IIT Jodhpur involved in this project are Ravi K.R., Associate Professor, Department of Metallurgical and Materials Engineering; V. Narayanan, Associate Professor, Department of Physics; Abir Bhattacharyya, Assistant Professor, Department of Metallurgical and Materials Engineering; Sumit Kalra, Assistant Professor, Department of Computer Science and Engineering; Rahul Chhibber, Associate Professor, Department of Mechanical Engineering, and Hardik Kothadia, Assistant Professor, Department of Mechanical Engineering.

Regarding this indigenously developed 3D printer, Ravi K said, «The small success of this research has given great hope to our team to undertake new endeavours. Moreover, it will further strengthen the trust placed on our team and organization by the funding agencies and industry that are assisting our current research and will be assisting us in the future.»

He added, "Our study results show that if all the parts needed to make a metal printing machine could be manufactured indigenously, the cost of a metal 3D printing machine could be reduced by two to three times. Moreover, such an initiative would further strengthen the policy decisions of the Government of India under the 'Atmanirbhar Bharat' initiative."

The project has been funded by the Technology Development and Transfer (TDT) Division, Department of Science and Technology (DST). Other academic and industrial collaborating partners are PSG College of Technology, Coimbatore; PSG Industrial Institute, Coimbatore; and VectraForm Engineering Solutions, Coimbatore.

Metal 3D printing technology, which has been slowly advancing over the past three decades, is poised to grow rapidly over the next decade due to the astounding progress that has taken place recently in sensors, artificial intelligence (AI), and machine learning (ML) technologies. The future scope of this research will be to transform the current metal 3D printing machine into a "smart metal 3D printer" by creating the infrastructure, expertise, team, etc., needed to participate in this race.

https://www.telegraphindia.com

AI tool for personalized cancer diagnosis

Researchers at IIT Madras have developed an AI-based tool, "PIVOT" that can predict cancer-causing genes in an individual. The tool is designed to help devise personalized cancer treatment strategies. Their work has been published in a reputed peer-reviewed journal, *Frontiers in Genetics*.

PIVOT, an AI tool, is designed to predict genes that are responsible for causing cancer in an individual. The prediction is based on a model that uses information on mutations, expression of genes, and copy number variation in genes and perturbations in the biological network due to an altered gene expression.

Dr. Karthik Raman, a core member of the Robert Bosch Centre for Data Science and Artificial Intelligence (RBCDSAI), and Malvika Sudhakar, a research scholar, at IIT Madras, explained that "in this tool, we are trying to use the available wealth of genomic sequences, we understand what are the mutations triggering this disease in terms of Driver versus passenger mutations."

"With PIVOT, we try to understand mutations that occur in a personalised manner. We have looked further into the Driver genes, wherein the tool can classify genes as tumour suppressor genes, oncogenes or neutral genes. The tool was able to successfully predict both the existing oncogenes and tumour-suppressor genes like TP53, PIK3CA etc. and new cancer-related genes such as PRKCA, SOX9 and PSMD4. The model learns from the data of known driver genes of the patient and then protects it from any unknown mutations you throw at it," says Ms. Malvika Sudhakar, a researcher on the team.

PIVOT is an AI that will collect and study data to identify personalized cancer genes. This would amass a large number of individual data, Dr. Karthik explains if that could be a potential challenge.

https://newsonair.com

Intelligence system and health monitoring solution for EVs

A new complete vehicle intelligence system and health monitoring solution for electric vehicles (EVs) can ensure safe and high EV performance, which will occupy a major part of the next-generation transportation system. The system can help in estimating the accurate state of health and state of charge of the battery pack, help fleet operators in their control, and facilitate seamless communication. The unavailability of such vehicle intelligence modules for the different components of EVs serves as a roadblock in their efficiency.

Delhi-based Vecmocon Technologies developed the vehicle intelligence system with critical battery data collection and monitoring, such as cell voltages, temperature, and the current health of the battery. Vecmocon, incubated at FITT-IIT Delhi, with seed support from the Department of Science and Technology, also provides solutions for intelligent vehicles, including keyless entry, preventive and predictive maintenance, user-adaptive algorithms, remote diagnostics, fleet management, and so on. It can cater to the entire ecosystem of EVs, such as motor power controllers, battery management systems, vehicle intelligence modules, cloud connectivity, etc., with specialized components for high-performance vehicles.

The patented technology at Technology Readiness Level 9 costs around 20-22k for the entire kit (battery management system - 4-5K, vehicle intelligence module - 6-8K, fast chargers - 4-5K, instrument cluster - 2-3K, motor controller - 4-5K) and is being used by more than 15 EV manufacturers as well as original equipment manufacturers (OEMs).

"While others are focused on 2 wheelers, 3 wheelers as a product in the Market, we at Vecmocon are building the ecosystem for electric vehicles to happen in India at a very faster pace. We design and develop core components for electric vehicles like Battery Management System, Motor Controller, Vehicle Intelligence Module, Chargers, and the whole of the cloud architecture for Data Analysis, Machine Learning, and Artificial Intelligence," said Peeyush Asati, one of the founders of the company.

Adarshkumar Balaraman, the other founder, acknowledged DST's support during the company's initial stages.

Vecmocon provides battery packs with all thermal and structural considerations, battery management systems, and machine learning (ML) algorithms for battery management design of computationally in-expensive system-local ML algorithms, which run on ₹100 microcontrollers. It has generated a revenue of ₹5 crore so far.

https://pib.gov.in

Wireless powering and communication technology for IoT applications

Researchers at the Indian Institute of Technology, Mandi, are working toward developing efficient remote powering and communication technology for futuristic Internet of Things applications. The findings of this study were published in the *Wireless Networks*.

The study was led by Dr. Siddhartha Sarma, Assistant Professor, School of Computing and Electrical Engineering, IIT Mandi, and co-authored by his student Mr. Shivam Gujral, Ph.D. Scholar, School of Computing and Electrical Engineering, IIT Mandi. The Internet of Things (IoT) is a collection of objects (things) that can exchange data with each other through the Internet. IoT devices range from ordinary household appliances in a "smart" home to sophisticated industrial and scientific tools.

These smart things are equipped with sensors, chips, and software that must be powered and stay in communication with other devices at all times. Simplistic power sources such as batteries may be unsuitable for such applications because of the constancy of power required, and because some of these "things" may be embedded or hidden, which makes changing batteries difficult. There is thus worldwide research in combining remote communication technology with remote powering options.

Highlighting his research, Mr. Shivam Gujral, Ph.D. Scholar, School of Computing and Electrical Engineering, IIT Mandi, said, "We have developed a cooperative model, in which, backscatter communication and radiofrequency energy harvesting (RF-EH) devices act together to optimally allocate the resources such as time and antenna weights."

The team performed research on two such powering options—radiofrequency energy harvesting (RF-EH) and backscatter communication. In RF-EH, energy is transmitted by a dedicated transmitter to the IoT device through radio waves, the same kind of waves that are used in mobile phones for communication. In backscatter communication, as before, power is transmitted via radio waves, but with/without the need for a dedicated transmitter. Instead, RF signals available in the vicinity, such as WiFi, cell phone signals, etc., are harnessed through reflection and backscatter to power the IoT objects.

The RF-EH and backscatter devices have their own strengths and drawbacks. For example, while the latter is associated with considerable energy savings compared to the former, it suffers from reduced data rate and a shorter transmission range.

The IIT Mandi team has leveraged the complementary nature of these two technologies and judiciously combined them to achieve the desired quality of service (QoS) and efficiency using the power allotted to the system. Going into the technical aspects of this work, Dr. Siddhartha Sarma, Assistant Professor, IIT Mandi, mentioned, "We used a dedicated power transmitter for the two devices, in which the backscatter device transferred information through a monostatic configuration and the RFEH device through the HTT protocol. The team used extensive numerical simulations to establish the superiority of the proposed cooperative scheme over existing schemes. In these simulations, key parameters were varied to analyze the performance of the model."

Researchers plan to implement the joint radiofrequency energy harvesting backscatter communication system in realtime to analyze system performance. This would include working on the hardware aspects of the two complementary technologies. The potential of the proposed system is vast and includes, in addition to IoT devices, applications such as battery-free wireless cameras, wireless monitors, sensors, skin-attachable sensing platforms, contact lenses, machine-to-machine communication, and human-to-machine interactions.

https://www.iitmandi.ac.in

JAPAN

3D printed electrodes for batteries

Researchers from the Tohoku University in Sendai, Japan, recently announced the discovery of a new procedure in which high-performance carbon microlattice electrodes could be 3D printed for batteries. The newly introduced method that was published as a research article in the science journal, *Small,* could soon become an alternative way to produce cheaper and better-performing batteries. The effort may also be able to make the production and use of batteries less harmful to the environment.

By 3D printing carbon micro lattice electrodes for new, high-performance, low-cost batteries, Tohoku University materials scientist Akira Kudo and his colleagues recently introduced a procedure that might be the answer to the ongoing problem. The goal of this new approach is to increase the loaded number of active materials that are used to make a battery into a single battery cell by maximizing their potential and capability. This desired increase in loaded materials would reduce the inactive materials. While these inactive materials are responsible for binding multiple cells together, the battery would require thicker electrodes instead, which would restrict ion movement and the electric charge within the battery.

In their new attempt, Akira Kudo and his team used stereolithography (SLA) to create micro lattice structures from resin, which are then shrunk by carbonizing them via a process called pyrolysis. The resulting hard carbon anodes are able to transport energy-generating ions faster and have a finer lattice structure, which increases the anode's performance altogether. Kudo also states that "As 3D printers gain increasing resolution, sodium-ion batteries could eventually outperform lithium-ion ones." Although the new discovery is a major breakthrough for Kudo and his team, the scientists are still working toward their ultimate goal, which is to further develop the process and soon use these finely architected electrodes to make high-performing, cost-effective sodium-ion batteries.

https://www.3dnatives.com

Robot that can peel bananas

Researchers in Japan have developed a robot capable of **peeling** a banana without crushing the fruit inside. While the two-armed machine is only successful

57 percent of the time, banana peeling points to a future where machines could do more sensitive, skillful kinds of work. A video from researchers at the University of Tokyo showed the robot pick up and peel a banana with both hands in about three minutes.

Researchers Heecheol Kim, Yoshiyuki Ohmura, and Yasuo Kuniyoshi trained the robot using a "deep imitation learning" process. In this training, they showed the banana-peeling action hundreds of times to the robot to produce enough data for the robot to learn the actions and copy them. In this case, the banana reached its success rate after more than 13 hours of training.

While the experiment requires more testing, Kuniyoshi believes his method can teach robots to do different simple "human" tasks. He hopes the better-trained robots can help with Japan's labor shortage problems, particularly in food-processing factories that currently depend on human workers.

https://learningenglish.voanews.com

REPUBLIC OF KOREA

AI-based precision medicine technology

A team of researchers at the Pohang University of Science and Technology (POSTECH) has improved the accuracy of predicting patient response to immune checkpoint inhibitors (ICIs) by using network-based machine learning. The research team discovered new network-based biomarkers by analyzing the clinical results of more than 700 patients with three different cancers (melanoma, gastric cancer, and bladder cancer) and the transcriptome data of the patients' cancer tissues. By using the network-based biomarkers, the team successfully developed artificial intelligence (AI) that could predict the response to anticancer treatment.

The team further proved that the treatment response prediction based on the newly discovered biomarkers was superior to that based on conventional anticancer treatment biomarkers, including immunotherapy targets and tumor microenvironment markers. This study helps detect patients who will respond to immunotherapy in advance and establish treatment plans, resulting in customized precision medicine with more patients to benefit from cancer treatments.

https://www.biospectrumasia.com

SINGAPORE

Assistive robot to prevent falls for the elderly

Researchers at Nanyang Technological University, Singapore (NTU Singapore) and Tan Tock Seng Hospital (TTSH) have developed a wearable assistive robot that can detect and prevent a fall before it happens, reducing the user's risk of sustaining injuries.

The development of the robot, which can also be used to aid patients' rehabilitation from their injuries, was catalyzed by the National Robotics Program, a multiagency national program that looks at the end-to-end development of differentiating robotics enablers and solutions in Singapore, from funding R&D to facilitating partnerships for translation and adoption to maximize socioeconomic impact.

Called the Mobile Robotic Balance Assistant or MRBA (pronounced Mister-Bah), the robot uses its inbuilt sensors to instantaneously detect a loss of balance and catches the user with its attached safety harness, which is worn around the user's hips. The device would also help users who have difficulty in walking and balancing to stand up safely from a seated position, and to sit down safely from a standing position. It also uses a depth-sensing camera to observe the user's movements, while its machine learning algorithms estimate the balance state of the user in real time to better predict any future imbalances or falls.

The human balance control system degenerates with age. This is exacerbated by conditions such as neurological diseases and injuries, musculoskeletal problems like ankle sprains, scoliosis, or missing limbs as well as vertigo. This loss of balance control often results in falls, especially in the elderly.

MRBA was co-developed by a team of researchers, engineers, and data specialists at the Rehabilitation Research Institute of Singapore (RRIS), alongside clinicians and researchers at TTSH. RRIS, which is hosted at NTU's Lee Kong Chian School of Medicine, was founded in 2016 by NTU Singapore, the Agency for Science, Technology, and Research (A*STAR), and the National Healthcare Group (NHG).

In clinical trials involving 29 participants, including patients who suffered from stroke, traumatic brain injuries, and spinal cord injuries, the researchers found that MRBA was successful in aiding them with sitting, standing, and walking as well as assisting in tasks like fetching water. No falls were recorded in the trials, which spanned three days per participant.

The technology presents an improved tool to help in the care of Singapore's aging population, reflecting both NTU's and TTSH's commitment to using technology and innovation to respond to the needs and challenges of healthy living and aging, which is one of four humanity's grand challenges that the university seeks to address through its NTU 2025 strategic plan.

Associate Professor Ang Wei Tech, Executive Director of RRIS, who supervised the project's development, says that "MRBA could prove to be an invaluable resource for older adult users, and help promote independent living and aging. The development of the robot was a result of a fruitful collaboration with TTSH, blending our expertise in engineering and machine learning with their strengths in rehabilitation and medicine." Associate Professor Ang is also from NTU's School of Mechanical and Aerospace Engineering.

MRBA comes in three models. The first model caters to users that weigh up to 80 kilograms, while the second assists those who weigh up to 120 kilograms. The third version, the Agile model, supports more dexterous movements. In addition to assisting users in daily living, the robot can also support physiotherapy consultations by assisting those recovering from injuries to carry out key rehabilitation exercises, such as side stepping, balancing on a rocker board, and standing on one leg. In providing such balance support, users feel more confident in going about their daily activities, including sports, such as bouncing and throwing a basketball, kicking a soccer ball, and even playing badminton.

https://medicalxpress.com

AI-based method to identify cancer mutations

A*STAR scientists have developed a novel AI-based method, named Variant Network (VarNet), that can inspect and identify cancer mutations (variants) in the millions of DNA fragments inside a tumor sample.

Scientists from A*STAR's Genome Institute of Singapore (GIS) have developed a novel AI-based method, named Variant Network (VarNet), that can inspect and identify cancer mutations (variants) in the millions of DNA fragments inside a tumor sample. It will serve as a key compass in steering personalized treatment strategies in the fight against cancer. VarNet can be used in both clinical as well as research settings to analyze mutations to tailor treatment strategies or better understand cancer. The research was published in *Nature Communications* on July 22, 2022.

Cancer is a genetic disease caused by mutations acquired during an individual's lifetime. Identifying these mutations has been a longstanding challenge that must be solved in order to develop personalized treatment strategies—providing the right treatment to the right patient at the right time. This research was developed to address that challenge.

VarNet uses deep learning, an AI approach, to detect cancer mutations without any specialized knowledge of cancer and genomics. VarNet was trained on vast amounts of cancer sequencing data from both Singapore and international databases. When evaluated on real tumor benchmarks, VarNet often exceeds existing mutation identification algorithms in terms of accuracy. The accurate identification of mutations in tumors affects downstream analyses that could have an impact on research outcomes as well as treatment decisions in the clinic.

Dr. Anders Skanderup, Group Leader of the Laboratory of Computational Cancer Genomics and corresponding author of the study said, "We have been working on machine learning methods for some time to improve detection of cancer mutations. During this work, we learned that human experts were often involved in the process to validate selected high confidence cancer mutations. Such human experts make decisions by inspecting images of DNA reads overlapping the potential mutations. However, while a human can only do this for a couple of mutations in a limited amount of time, an AI-approach could potentially perform the same task across the entire 3 billion nucleotides in the human genome. This inspired us to leverage deep learning approaches that learn patterns in images, and develop a pure AI-based method for identifying mutations in cancer."

Kiran Krishnamachari, a PhD candidate and A*STAR Computing and Information Science scholar affiliated with GIS who is the first author of the study, noted that the system learnt to detect mutations from the raw data in a manner that a human expert would do when manually inspecting potential mutations. He remarked, "This gave us the confidence that the system can learn relevant mutational features when trained on vast sequencing datasets, using our weak-supervision strategy that does not require excessive manual labelling."

Professor Patrick Tan, Executive Director of GIS, said, "Identifying cancer mutation is a critical step in developing precision medicine. VarNet demonstrates that deep machine learning can detect cancer mutations with an accuracy often exceeding existing state-of-the-art methods."

https://www.eurekalert.org

EUROPE

Flying 3D printing drones to create and repair buildings

A team led by scientists at Imperial College London and Empa—the Swiss Federal Laboratories of Materials Science and Technology—claims the lab-tested system could be used for manufacturing and building in difficult-to-access or dangerous locations, such as high-rise buildings, or help with post-disaster relief construction. The researchers have trailed the flying, 3D printing robots using "collective building methods inspired by natural builders like bees and wasps who work together to create large, intricate structures."

According to the team, the drones in the Aerial Additive Manufacturing (Aerial-AM) fleet work co-operatively from a "single blueprint, adapting their techniques as they go." Although fully autonomous while flying, they are monitored by a human controller who checks progress and intervenes, if necessary, based on the information provided by the drones.

Aerial-AM uses both a 3D printing and path-planning framework to help the drones adapt to variations in the geometry of the structure as the build progresses. The fleet consists of BuilDrones, which deposit materials during flight, and quality-controlling ScanDrones that continually measure the BuilDrones' output, informing their next manufacturing steps.

To test this concept, the researchers developed four different cementitious mixtures for the drones to build with. Throughout the construction, the drones assessed the printed geometry in real time and adapted their behavior to ensure they met the build specifications. The researchers said the drones achieved a manufacturing accuracy of 5 mm.

The team's proof-of-concept prints included a 2.05 m-high cylinder (72 layers) with a polyurethane-based foam material and a 0.18 m-high cylinder (28 layers) with a custom-designed structural cementitious material.

https://www.architectsjournal.co.uk

SWITZERLAND

Preparing for future COVID variants using AI

Researchers led by Professor Sai Reddy from the Department of Biosystems Science and Engineering at ETH Zurich in

Basel have now developed a way of using artificial intelligence to answer such questions, potentially even in real time immediately after a new variant emerges. The new method takes a comprehensive approach: for each variant in this multitude of potential viral variants, it predicts whether or not it is capable of infecting human cells and if it will be neutralized by antibodies produced by the immune system found in vaccinated and recovered persons. It is highly likely that hidden among all these potential variants is the one that will dominate the next stage of the COVID-19 pandemic.

To establish their method, Reddy and his team used laboratory experiments to generate a large collection of mutated variants of the SARS-CoV-2 spike protein. The scientists did not produce or work with live virus, rather they produced only a part of the spike protein, and therefore there was no danger of a laboratory leak.

The spike protein interacts with the angiotensin-converting enzyme 2 (ACE2) protein in human cells for infection, and antibodies from vaccination, infection, or antibody therapy work by blocking this mechanism. Many of the mutations in SARS-CoV-2 variants occur in this region, which allows the virus to evade the immune system and continue to spread. Although the collection of mutant variants the researchers have examined only comprises a small fraction of the several billion theoretically possible variants, which would be difficult to examine in a laboratory setting, it does contain a million such variants. These carry different mutations or combinations of mutations.

By performing high-throughput experiments and sequencing the DNA from these million variants, the researchers determined how successfully these variants interact with the ACE2 protein and with existing antibody therapies. This indicates how well the individual potential variants could infect human cells and how well they could escape from antibodies.

The researchers used the collected data to train machine learning models, which are able to identify complex patterns and when given only the DNA sequence of a new variant could accurately predict whether it can bind to ACE2 for infection and escape from neutralizing antibodies. The final machine learning models can now be used to make these predictions for tens of billions of theoretically possible variants with single and combinatorial mutations and going far beyond the million that were tested in the laboratory.

The new method will help develop the next generation of antibody therapies. Several of such antibody drugs were developed to treat the original SARS-CoV-2 virus and approved for use in the United States and Europe. Among these, five antibody drugs were removed from clinical use, and many others under clinical development were discontinued because they could no longer neutralize the Omicron variant. To address this challenge, the new method may be applied to identify which antibodies have the broadest activity.

"Machine learning could support antibody drug development by enabling researchers to identify which antibodies have the potential to be most effective against current and future variants," says Reddy. The researchers are already working with biotechnology companies that are developing next-generation COVID-19 antibody therapies.

Additionally, the method developed at ETH Zurich could be applied to support the development of next-generation COVID-19 vaccines. The focus here is to identify virus variants that still bind to the ACE2 protein, and can therefore infect human cells, but cannot be neutralized by the antibodies present in the vaccinated and recovered people. In other words, variants that can escape the human immune response. This was indeed the case with the Omicron variant that escaped from most antibodies, and resulted in many breakthrough infections in vaccinated and previously infected people. Therefore, similar to antibody therapies, it would be a major advantage if vaccines could induce antibodies that provide protection against potential future viral variants.

https://www.eurekalert.org

UK

Machine learning algorithm predicts EV battery life

Researchers have developed a machine learning algorithm that could help reduce charging times and prolong battery life in electric vehicles by predicting how different driving patterns affect battery performance, improving safety and reliability. The researchers from the University of Cambridge, say that their algorithm could help drivers, manufacturers, and businesses get the most out of the batteries that power electric vehicles by suggesting routes and driving patterns that minimize battery degradation and charging times.

The team developed a non-invasive way to probe batteries and get a holistic view of battery health. These results were then fed into a machine learning algorithm that can predict how different driving patterns will affect the future health of the battery.

If developed commercially, the algorithm could be used to recommend routes which get drivers from point to point in the shortest time without degrading the battery, for example, or recommend the fastest way to charge the battery without causing it to degrade. The results are reported in the journal *Nature Communications*.

The health of a battery, whether it's in a smartphone or a car, is far more complex than a single number on a screen. "Battery health, like human health, is a multidimensional thing, and it can degrade in lots of different ways," said first author Penelope Jones, from Cambridge's Cavendish Laboratory. "Most methods of monitoring battery health assume that a battery is always used in the same way. But that's not how we use batteries in real life. If I'm streaming a TV show on my phone, it's going to run down the battery a whole lot faster than if I'm using it for messaging. It's the same with electric cars – how you drive will affect how the battery degrades."

The researchers developed a non-invasive probe that sends high-dimensional electrical pulses into a battery and measures the response, providing a series of "biomarkers" of battery health. This method is gentle on the battery and does not cause it to degrade any further. The electrical signals from the battery were converted into a description of the battery's state, which was fed into a machine learning algorithm. The algorithm was able to predict how the battery would respond in the next charge-discharge cycle, depending on how quickly the battery was charged and how fast the car would be going the next time it was on the road. Tests with 88 commercial batteries showed that the algorithm did not require any information about the previous usage of the battery to make an accurate prediction.

The experiment focused on lithium cobalt oxide (LCO) cells, which are widely used in rechargeable batteries, but the method is generalizable across the different types of battery chemistries used in electric vehicles today.

The researchers are now working with battery manufacturers to accelerate the development of safer, longer lasting next-generation batteries. They are also exploring how their framework could be used to develop optimal fast charging protocols to reduce electric vehicle charging times without causing degradation. The research was supported by the Winton Programme for the Physics of Sustainability, the Ernest Oppenheimer Fund, the Alan Turing Institute, and the Royal Society.

https://www.eurekalert.org

NORTH AMERICA

CANADA

Machine learning to keep drinking water safe

Waterborne illness is one of the leading causes of infectious disease outbreaks in refugee and internally displaced persons (IDP) settlements, but a team led by York University has developed a new technique to keep drinking safe water using machine learning, and it could be a game changer. The research is published in the journal *PLOS Water*.

"When water is stored in a container in a dwelling it is at high risk of being exposed to contaminants, so it's imperative there is enough free residual chlorine to kill any pathogens," says Ph.D. student Michael De Santi from Lassonde School of Engineering, who is part of York's Dahdaleh Institute for Global Health Research, and who led the research.

Recontamination of previously safe drinking water during its collection, transport, and storage has been a major factor in outbreaks of cholera, hepatitis E, and shigellosis in refugee and IDP settlements in Kenya, Malawi, Sudan, South Sudan, and Uganda.

"A variety of factors can affect chlorine decay in stored water. You can have safe water at that collection point, but once you bring it home and store it, sometimes up to 24 hours, you can lose that residual chlorine, pathogens can thrive and illness can spread,» says Lassonde Adjunct Professor Syed Imran Ali, a Research Fellow at York›s Dahdaleh Institute for Global Health Research, who has firsthand experience working in a settlement in South Sudan.

Using machine learning, the research team—including Associate Professor Usman Khan, also of Lassonde—has developed a new way to predict the probability that enough chlorine will remain until the last glass is consumed. They used an artificial neural network (ANN) along with ensemble forecasting systems (EFS), something that is not typically done. EFS is a probabilistic model commonly used to predict the probability of precipitation in weather forecasts.

"ANN-EFS can generate forecasts at the time of consumption that take a variety of factors into consideration that affect the level of residual chlorine, unlike the typically used models. This new probabilistic modeling is replacing the currently used universal guideline for chlorine use, which has been shown to be ineffective," says Ali.

Factors such as local temperature, how the water is stored and handled from home to home, the type and quality of the water pipes, water quality, and whether a child dipped their hand in the water container can all play a role in how safe the water is to drink.

"However, it's really important that these probabilistic models be trained on data at a specific settlement as each one is as unique as a snowflake," says De Santi. "Two people could collect the same water on the same day, both store it for six hours, and one could still have all the chlorine remaining in the water and the other could have almost none of it left. Another 10 people could have varying ranges of chlorine."

The Safe Water Optimization Tool Project provided the researchers with data on routine water quality monitoring from two refugee camps in Tanzania and Bangladesh. In Bangladesh, the data was collected from 2,130 samples by Médecins Sans Frontières from Camp 1 of the Kutupalong-Balukhali Extension Site, Cox's Bazaar between June and December 2019 when it hosted 83,000 Rohingya refugees from neighboring Myanmar.

Determining how to teach the ANN-EFS to come up with realistic probability forecasts with the smallest possible error required out-of-the-box thinking. "How that error is measured is key as it determines how the model behaves in the context of probabilistic modeling," says De Santi. "Using cost-sensitive learning, a tool that morphs the cost function toward a targeted behavior when using machine learning, we found it could improve probabilistic forecasts and reliability. We are not aware of this being done before in this context."

For example, this model can say that under certain conditions at the tap with a particular amount of free residual chlorine in the water, there is a 90 percent chance that the remaining chlorine in the stored water after 15 hours will be below the safety level for drinking.

https://phys.org

USA

AI-based screening method for drug discovery

Using a technique that models drug and target protein interactions using natural language, researchers achieved up to 97% accuracy in identifying promising drug candidates. Developing life-saving medicines can take billions of dollars and decades, but the University of Central Florida researchers are aiming to speed up this process with a new artificial intelligence-based drug screening process they've developed.

Using a method that models drug and target protein interactions using natural language processing techniques, the researchers achieved up to 97% accuracy in identifying promising drug candidates. The results were published recently in the journal *Briefings in Bioinformatics*.

The technique represents drug–protein interactions through words for each protein binding site and uses deep learning to extract the features that govern the complex interactions between the two. "With AI becoming more available, this has become something that AI can tackle," says study co-author Ozlem Garibay, an Assistant Professor in UCF's Department of Industrial Engineering and Management Systems. "You can try out so many variations of proteins and drug interactions and find out which are more likely to bind or not."

The model they have developed, known as AttentionSiteDTI, is the first to be interpretable using the language of protein binding sites. The work is important because it will help drug designers identify critical protein binding sites along with their functional properties, which is key to determining if a drug will be effective.

The researchers made the achievement by devising a self-attention mechanism that makes the model learn which parts of the protein interact with the drug compounds while achieving state-of-the-art prediction performance. The mechanism's self-attention ability works by selectively focusing on the most relevant parts of the protein.

The researchers validated their model using in-lab experiments that measured binding interactions between compounds and proteins and then compared the results with the ones their model computationally predicted. As drugs to treat COVID are still of interest, the experiments also included testing and validating drug compounds that would bind to a spike protein of the SARS-CoV2 virus.

https://www.ucf.edu

Robots and AI to help develop better batteries

Carnegie Mellon researchers used a robotic system to run dozens of experiments designed to generate electrolytes that could enable lithium-ion batteries to charge faster, addressing one of the major obstacles to the widespread adoption of electric vehicles. The system of automated pumps, valves, and instruments, known as Clio, mixed various solvents, salts, and other chemicals together, then measured how the solution performed on critical battery benchmarks. Those results were then fed into a machine learning system, known as Dragonfly that used the data to propose different chemical combinations that might work even better.

In the end, the system produced six electrolyte solutions that outperformed a standard one when the Carnegie researchers placed them into small test cells, according to a new paper in *Nature Communications*. The best one showed a 13% improvement over the top-performing baseline battery cell.

Developing better electrolytes is crucial for improving the performance, safety, and cost of batteries. Faster-charging batteries are especially important for making electric cars and trucks more appealing, as they can ease the annoyance of long delays at charging stations.

In recent years, research labs have increasingly coupled automated systems with machine learning software that identifies data patterns to improve at designated tasks to develop materials ideally suited to particular applications. Scientists have tapped into these methods to identify promising materials for solid-state electrolytes, solar photovoltaic cells, and electrochemical catalysts. Several startups have emerged to commercialize the approach as well, including Chemify and Aionics. Alán Aspuru-Guzik is using AI, robots, and even quantum computing to create the new materials that we will need to fight climate change.

In the case of electrolyte ingredients, "you can mix and match them in billions of ways," says Venkat Viswanathan, an Associate Professor at Carnegie Mellon, a co-author of the Nature Communications paper, and a cofounder and chief scientist at Aionics. He collaborated with Jay Whitacre, director of the university's Wilton E. Scott Institute for Energy Innovation and the co-principal investigator on the project, along with other Carnegie researchers, to explore how robotics and machine learning could help.

The promise of a system like Clio and Dragonfly is that it can rapidly work through a wider array of possibilities than human researchers can and apply what it learns in a systematic way.

In the case of battery experiments, the Carnegie Mellon team was looking for an electrolyte that would speed up the recharging time for batteries. The electrolyte solution helps shuttle ions—or atoms with a net charge due to the loss or gain of an electron—between the two electrodes in a battery. During discharge, lithium ions are created at the negative electrode, known as the anode, and flow through the solution toward the positive electrode, the cathode, where they gain electrons. During charging, that process is reversed. One of the key metrics Clio measured and sought to optimize is "ionic conductivity," or how readily ions flow through the solution, which directly affects how quickly a battery can recharge.

https://www.technologyreview.com

Affordable 3D printed plasma sensors for climate change monitoring

Researchers at the Massachusetts Institute of Technology (MIT) have used 3D printing to create unique plasma sensors with the potential to help scientists better understand the impact of climate change.

Compared to traditional weather-monitoring sensors, the team's laser-cut and 3D-printed alternative can be produced outside of cleanroom conditions, reducing its lead time from weeks to just a few days. This, alongside their relatively low manufacturing cost, could make the devices ideal for fitting to CubeSats, where they can monitor temperature fluctuations in Low Earth Orbit (LEO).

At the core of the team's redesigned sensor is a laser-cut, five-electrode stack inside a 3D printed glass-ceramic electrode housing and CNC-machined shroud. In practice, the housing is designed to spatially distribute electrodes using a set of grooves that interact with a set of deflection springs. That said, the researchers actually explored two different stack designs, one in which all apertures were of the same size, and another, where clusters were matched to a single aperture in a "floating grid" formation.

Both were made using a Tethon 3D Bison 1000 system and Vitrolite, a durable pigmented glass capable of withstanding temperatures of up to 800°C, and designed with hexagonally packed apertures, to maximize the number that could be fitted in. For each RPA design, the aperture size was also optimized via finite element analyses, in an attempt to achieve optimal ion transmission across the device's grid.

Once ready, the team subjected their prototypes to ion energy distribution simulations and practical testing via electron impact ionizer and helicon plasma testing. In the former, both designs proved able to estimate the average energy of ions accurately, but in practical evaluations, the devices showed potential in different application areas.

In practice, the uniform grid design was especially effective at measuring a wide range of plasmas, similar to those that a satellite would ordinarily encounter in orbit. However, the other, featuring a floating grid alignment, proved better-suited to sensing dense and cold plasmas, at an accuracy of just 50 µm, the likes of which are usually only measurable using ultra-precise semiconductor devices.

Given that testing had revealed their devices could "perform at par with state of the art," the researchers concluded them to have significant potential to facilitate accessible weather monitoring. Moving forward, the team believes that binder jet 3D printing could be used to produce even more of the RPA's parts, in a way that could reduce its mass and improve its performance.

Additive manufacturing continues to find widespread satellite applications, not just in the creation of ancillaries but also in the casings of the devices. ROBOZE, for instance, has partnered with the University of Colorado Boulder to 3D print a weather-monitoring CubeSat designed to analyze the electromagnetic waves caused by lightning strikes.

Alongside Alba Orbital and Mini-Cubes, CRP Technology has also continually used its Windform XT 2.0 material to 3D print pocket satellites and deployers. Working with the former, the firm previously deployed the technology and its carbon fiber composite to reduce the weight of the "Alba 2" PocketQube deployers by 60%.

On a more commercial level, Franco-Italian aerospace manufacturer Thales Alenia Space continues to use 3D printing in the series production of satellites.

https://3dprintingindustry.com

AI-engineered plastic-eating enzyme

Researchers at the University of Texas (UT) at Austin used a new machine learning (ML) algorithm to create a new variant of enzymes that could potentially degrade plastic. Hal Alper is a lead researcher of the engineering biology team in the McKetta Department of Chemical Engineering at UT at Austin. He is also a professor and fellow of the Les and Sherri Stuewer Professorship in Chemical Engineering at UT. Alper and his team of engineers and scientists created a variant of an enzyme called hydrolase using an ML algorithm. The enzyme is capable of breaking down polyethylene terephthalate (PET), one of the most common plastics used today, into its component molecules.

Once PET plastic waste breaks down, it can be reused to create entirely new PET materials, essentially leading to a circular plastics economy. In the past, attempts in enzymatic degradation were unsuccessful, mainly due to a lack of robustness to acidity (pH), temperature ranges, and slow reaction rates.

During the project, Alper and the team at UT Austin found that the novel plastic-eating enzyme, referred to as FAST-PETase (functional, active, stable, and tolerant PETase), can break down plastics at a much faster rate than other PET hydrolases used in previous studies. It is also capable of degrading both mixed-colour and clear PET plastic products.

Untreated, post-consumer PET from 51 different products was almost completely degraded by the new FAST-PETase enzyme in only one week. At 50°C, the team reported that portions of an entire thermally pretreated water bottle and a commercial water bottle could also be broken down. Because this new enzyme can break down plastics so quickly and on a large scale, it will have virtually limitless potential to assist many industries in their waste reduction efforts.

For many environmental cleanup activities, controlling the outdoor temperature is a major challenge.

The plastic-eating enzyme is sensitive to changes in temperature, rendering enzymatic degradation ineffective. Since the FAST-PETase enzyme degrades plastic and handles variations in temperature simultaneously, it would be effective in non-laboratory conditions. This new discovery could be a major advantage to environmental organizations and other agencies focused on cleaning the environment.

With enough quantity, the enzyme can clean up landfills, waste plants, and other sites that are negatively affected by plastic pollution. The plastic-eating enzyme is affordable, portable, and can be applied extensively. The role of ML in this research is critical. Without the model developed by UT's researchers, the new enzyme discovery might not have been possible.

https://earth.org