

Technology Scan

Focus: 4IR technologies for healthcare

ASIA-PACIFIC

CHINA

AI-powered drug discovery framework

Ping An Insurance (Group) Company of China has reported that its researchers have come up with a deep learning framework for drug discovery. A research team from Ping An Healthcare Technology Research Institute and Beijing's Tsinghua University developed the said framework; its findings were published in the peer-reviewed journal *Briefings in Bioinformatics*.

The researchers created a new AI-driven framework for drug discovery called MPG that learns molecular representations from large volumes of unlabelled molecules. They also made their own graph neural networks (GNN) model called MolGNet for modeling molecular graphs.

Ping An said drug discovery can take between 10 to 15 years. AI technologies have been employed to speed up the process, particularly in molecule drug design, drug-drug interaction, and drug-target interaction predictions. Yet, molecular designing remained a challenge given the dearth of labeled data for training data sets. To this end, the research team worked with GNN technology, a model that can be pre-trained with unlabelled data instead of relying on labeled data.

In their research, the team crafted a self-supervised pre-training strategy named Pairwise Half-graph Discrimination. It found that after pre-training the MolGNet on 11 million unlabelled molecules, it captured "meaningful" patterns of molecules to produce an interpretable representation.

<https://www.mobihealthnews.com>

AI-steered platform for COVID-19 prevention and control

Chinese researchers developed a big data and artificial intelligence (AI)-steered model in a bid to reduce economical cost while carrying out accurate COVID-19 prevention and control work. The

model, developed by a task force from the Department of Computer Science and Engineering at Southern University of Science and Technology, is able to complete deduction based on the model's simulation. Such model facilitated the establishment of a platform which has provided reference for the government to combat the virus.

The platform started its demonstration experiment in Shenzhen at the beginning of the year and finished the data analysis in May, Song Xuan, leader of the team and also a researcher at the department, told the *China Science and Technology Daily*.

The platform has applied for more than 40 Chinese and international patents, the researcher noted. Working together with Shenzhen disease control and prevention center and Smartcity Tech, the team worked out the platform by integrating, processing, and analyzing a variety of people's mobility and travel data. With AI technology, the platform can provide predictions and simulations of virus transmission based on the model.

<https://www.globaltimes.cn>

INDIA

Wearable devices with IoT, ML

The Indian Institute of Technology Madras (IIT-M) researchers are enhancing already developed wearable devices with latest technologies that will assist people with hearing impairment and motor disabilities to communicate independently and enhance their quality of life. These wearable sensors will include the latest sensor technologies used in the Internet of Things and Machine Learning (ML). The devices are being developed by the Centre for Rehabilitation Engineering and Assistive Technology (CREATE), a multidisciplinary translational research and educational initiative of IIT Madras. It was conceived as the researchers began interacting with NGOs and inclusive schools.

"Due to the non-availability of affordable and sustainable assistive devices and systems, the hearing-impaired are excluded from the mainstream and inclusive edu-

cation. Also, the imported devices cannot be afforded by most people," said Prof Anil Prabhakar, Head, CREATE and Faculty, Department of Electrical Engineering, IIT Madras, in a statement. "The cost of the product is kept low and to be less than INR 5000 so that it is an affordable device for its basic functionality. The advance of technology and the advent and availability of low-cost microcontrollers and sensors allows us to come up with this unique low-cost device," Prabhakar said.

The two major projects being developed by CREATE are "Vibe" and "iGest" for the hearing impaired and for persons with motor disabilities, respectively. Both devices will be embedded systems that will bring the latest developments from IoT and ML to wearable assistive devices. Such wearable devices will have rechargeable batteries and communicate with a mobile phone over Bluetooth.

Vibe is a wearable device that vibrates for acoustic sounds around a person with hearing impairment. Vibe features a multitude of sound patterns that are recognized using a microphone and voice recognition modules. The device, compact and wearable as a watch, will alert the hearing impaired about a specific sound such as a doorbell, alarm, or a crying child. It is a simple way of providing vibration input for the pre-identified surrounding sounds, with each such sound corresponding to a specific vibration and blinking LEDs to alert the user.

iGest will function as an alternative and augmentative communication device for persons with cerebral palsy. It will recognize the gestures of those with limited motor skills and convert them into audio output through a smartphone. It aims to address issues of speech impairment and motor impairment faced by persons with cerebral palsy.

iGest, which borrows on commercially available fitness sensors, will be designed using an inertial motion unit. For persons with cerebral palsy, movements can be much slower than normal people and also less repetitive. Hence, iGest will be designed around available Edge ML

microcontrollers that provide ML capabilities to IoT devices.

<https://www.english.lokmat.com>

Nano robot for rapid cancer diagnosis

Maharashtra Institute of Medical Education and Research (MIMER), Pune has developed a nano robot that is programmed to capture and isolate circulating tumor cells. The tool is expected to lead to a new rapid and accurate diagnostic method for cancer, said Dr Shashwat Banerjee, Scientist at MIMER Medical College at Talegaon Dabhade in Pune.

“In search of better cancer diagnostics, scientists from MIMER, Pune, synthesized multi-functional nanorobot using magnesium-iron oxide Janus nanoparticles. The reported nano robot tested on blood containing a low number of cancer cells exhibited ~100% capture efficiency in less than 5 minutes. The nano robot was further clinically validated by testing it on a cancer patient’s blood samples and it exhibited rapid and efficient circulating tumor cells (CTC) capture ability,” Dr Banerjee said in a statement.

The findings were published recently in the peer-reviewed journal *Communications Chemistry* under the title “Water-Powered Self-Propelled Magnetic Nanobot for Rapid and Highly Efficient Capture of Circulating Tumor Cells.” This new nano robot-based diagnostic tool may help in improving cancer treatments, allow for better treatment control, enable early interventions and change decision-making from reactive actions towards more predictive early interventions, he added.

According to a recently released report by the Indian Council of Medical Research (ICMR) and the National Centre for Disease Informatics and Research (NCDIR), the number of cancer cases in the country will rise to 15.6 lakh by 2025. This will be an increase of 12% from the current estimated cases. With this rising global burden, prevention and cure of cancer is one of the most important public health challenges of the 21st century.

<https://www.indianexpress.com>

ISRAEL

AI-based technology to identify patients at risk

A new technology developed at Tel Aviv University will make it possible, using artificial intelligence, to identify patients who are at risk of serious illness as a result of blood infections. The researchers trained the AI program to study the electronic medical records of about 8,000 patients at Tel Aviv’s Ichilov Hospital who were found to be positive for blood infections. These records included demographic data, blood test results, medical history, and diagnosis. After studying each patient’s data and medical history, the program was able to automatically identify medical files’ risk factors with an accuracy of 82%. According to the researchers, in the future this model could even serve as an early warning system for doctors, by enabling them to rank patients based on their risk of serious disease.

Behind this groundbreaking research with the potential to save many lives are students Yazeed Zoabi and Dan Lahav from the laboratory of Prof. Noam Shomron of Tel Aviv University’s Sackler Faculty of Medicine, in collaboration with Dr. Ahuva Weiss Meilik, head of the I-Metadata AI Center at Ichilov Hospital, Prof. Amos Adler, and Dr. Orli Kehat. The results of the study were published in the journal *Scientific Reports*.

The researchers explain that blood infections are one of the leading causes of morbidity and mortality in the world, so it is very important to identify the risk factors for developing serious illness at the early stage of infection with a bacterium or fungus. Most of the time, the blood system is a sterile one, but infection with a bacterium or fungus can occur during surgery, or as the result of complications from other infections, such as pneumonia or meningitis. The diagnosis of infection is made by taking a blood culture and transferring it to a growth medium for bacteria and fungi. The body’s immunological response to the infection can cause sepsis or shock, dangerous conditions that have high mortality rates.

To the researchers’ satisfaction, following their training the AI reached an accuracy level of 82% in predicting the course of the disease, even when ignoring obvious factors such as the age of the patients and the number of hospitalizations they had endured. After the researchers entered the patient’s data, the algorithm knew how to predict the course of the disease, which suggests that in the future it will be possible to rank patients in terms of the danger posed to their health—ahead of time.

<https://www.news-medical.net>

MALAYSIA

App to detect Covid-19 through cough patterns

The government is in the midst of introducing a mobile phone application that detects Covid-19 through users’ cough sound patterns. The Ministry of Science, Technology and Innovation (MOSTI), through the Sandbox Innovation and National Technology (NTIS) secretariat, is assisting a local company, Serba Dinamik IT Solutions Sdn Bhd, to develop the Covid-19 initial screening product.

“Based on the concept of ‘plug-and-play’, users only need to download the application and record the sound of ‘coughing’ three times in a row,” Science, Technology and Innovation Minister Dr Adham Baba mentioned in a written Dewan Rakyat reply. “For verification purposes, this application is also equipped with a ‘facial recognition’ system to identify the user’s identity.”

According to MOSTI, Covid-19 screening results using this application can be received within 30 seconds. The positively identified users will then be required to undergo RT-PCR or RTK-Ag tests to confirm the presence of the coronavirus. Besides that, MOSTI—through the National Nanotechnology Center (NNC) and the National Institute of Biotechnology Malaysia (NIBM)—has helped a research team from Universiti Teknologi Malaysia (UTM) to identify a simpler, cheaper, and faster Covid-19 screening method.

<https://codeblue.galencentre.org>

REPUBLIC OF KOREA

Automated system surgical robot

The Ministry of Food and Drug Safety said it designated “Soft Ureteroscopy Automated System Surgical Robot” as the nation’s 17th innovative medical device. A surgeon can remove kidney stones using the device by inserting a thin, soft, and flexible ureteroscope and remotely controlling it. The device has an automatic driving function to remember the location of stones and an automatic stone extraction function, making it easy to control and improving surgical accuracy. In addition, the device reduced the risk of ureter damage when removing bulky stones by allowing a surgeon to check the size of the stones during surgery. Also, the device shortened the surgery time and reduced radiation exposure, which helped raise the convenience and safety for both doctors and patients, the ministry said.

The government recognized it as an innovative medical device because it was the first homegrown automated surgical robot for lithotomy. A surgeon had to insert a ureteroscope directly and shoot an X-ray to check and remove stones in the past. This took a much longer surgery time, and the patient was exposed to radiation excessively. As the Soft Ureteroscopy Automated System Surgical Robot is being commercialized, the MFDS will support swift approval for the device, the ministry said.

<https://www.koreabiomed.com>

SINGAPORE

Smart bandage for chronic wounds

Researchers at the National University of Singapore have developed the world’s first smart bandage. The scientists, in collaboration with Singapore General Hospital, created VeCare, a bandage with a wearable sensor that can conduct real-time, point-of-care assessment of chronic wounds via an app. It uses sensor technology that can detect temperature, pH, bacteria type and inflammatory factors specific to chronic wounds within 15 minutes.

It’s estimated that about 1% to 2% of people in developed countries will experience a chronic wound in their lifetime. VeCare could be particularly useful for people with diabetes who have foot ulcers. “The VeCare platform is easily scalable and customizable to accommodate different panels of biomarkers to monitor various types of wounds,” said Lim Chwee Teck, director of the Institute for Health Innovation and Technology (iHealthtech) at the National University of Singapore.

The healing process of chronic wounds can be interrupted by infection and repeated trauma, which causes more pain and stress for the patient. In diabetic patients with foot ulcers, this can lead to more severe outcomes like amputation.

VeCare is the first wound assessment platform that can detect bacteria type and probe inflammatory factors within a single 15-minute test. The smart bandage enables rapid assessment of the wound’s microenvironment, inflammation, and infection state by detecting multiple chronic wound-specific biomarkers from wound fluid using an electrochemical system. A wound-fluid collector directs the fluid to the sensor. Then, the chip that is connected to the sensor transmits data wirelessly to an app, providing real-time wound assessment and analysis onsite. The chip component, which is powered with a rechargeable battery, can be reused.

<https://www.amp.dw.com>

EUROPE

DENMARK

AI tool to combat COVID variants

While considerable advances have been achieved in our battle against the coronavirus, new mutations of COVID-19 continue to emerge and could threaten public health. To prevent further severe pandemics, researchers from the University of Copenhagen and the immunotherapy company Evaxion have teamed up to develop a new AI tool that can more quickly and effectively predict how different protein elements can be assembled

to increase the likelihood of coronavirus protection. Their tool, BIFROST, is a computer model that uses algorithms to put together virus proteins that are most likely to be included in a vaccine, explains Christian Thygesen, an industrial Ph.D.

Thygesen has developed the model together with Evaxion and Associate Professor Thomas Hamelryck in the Deep Probabilistic Programming group at the University of Copenhagen’s Department of Computer Science. “For a vaccine to be effective, the body must be able to produce antibodies against viruses. It does so if it recognizes dangerous proteins—such as coronavirus spike proteins. With BIFROST, we use algorithms to prioritize the parts of viral proteins that we already know can stimulate an immune response, so that we can assemble them in a way that is most likely to work in a vaccine,” says Christian Thygesen.

BIFROST uses data on amino acid chains—the building blocks of proteins—to predict how various proteins look and behave. In the future, this knowledge will allow researchers to design “super proteins” that elicit the desired response to viruses in the immune system, with few side effects.

BIFROST has numerous advantages over other models, according to a new study conducted by the three researchers. Until now, researchers have used a computer model called Rosetta to learn about the shape and behavior of proteins. But as Christian Thygesen explains, the Rosetta method has significant shortcomings. “Our new method has the major advantage of running on special hardware that allows us to get answers in seconds rather than waiting hours for results. It saves time and thus money.”

BIFROST has another unique attribute that makes it more efficient than Rosetta. “Where, based on a single amino acid chain, Rosetta can only provide one estimate of the protein in question, our tool uses algorithms to calculate the probability of several possible proteins. One piece of an amino acid chain doesn’t have to result in exactly the same proteins every time,” explains Thygesen.

Thus, BIFROST is equipped to provide us with more suggestions about potential protein shapes and behaviors. This is important when trying to develop a vaccine that needs to be able to recognize many new variants of, for example, coronavirus spike proteins.

<https://www.medicalxpress.com>

GERMANY

AI for early detection and treatment of illnesses

Artificial intelligence (AI) will fundamentally change medicine and healthcare: Diagnostic patient data, e.g., from ECG, EEG, or X-ray images, can be analyzed with the help of machine learning, so that diseases can be detected at a very early stage based on subtle changes. However, implanting AI within the human body is still a major technical challenge. TU Dresden scientists at the Chair of Optoelectronics have now succeeded for the first time in developing a bio-compatible implantable AI platform that classifies in real-time healthy and pathological patterns in biological signals such as heartbeats. It detects pathological changes even without medical supervision. The research results have now been published in the journal *Science Advances*.

In this work, the research team led by Prof. Karl Leo, Dr. Hans Kleemann, and Matteo Cucchi demonstrates an approach for real-time classification of healthy and diseased bio-signals based on a biocompatible AI chip. They used polymer-based fiber networks that structurally resemble the human brain and enable the neuro-morphic AI principle of reservoir computing. The random arrangement of polymer fibers forms a so-called “recurrent network,” which allows it to process data, analogous to the human brain. The nonlinearity of these networks enables to amplify even the smallest signal changes, which—in the case of the heartbeat, for example—are often difficult for doctors to evaluate. However, the nonlinear transformation using the polymer network makes this possible without any problems.

In trials, the AI was able to differentiate between healthy heartbeats from three common arrhythmias with an 88% accuracy rate. In the process, the polymer network consumed less energy than a pacemaker. The potential applications for implantable AI systems are manifold: For example, they could be used to monitor cardiac arrhythmias or complications after surgery and report them to both doctors and patients via smartphone, allowing for swift medical assistance.

<https://www.sciencedaily.com>

SPAIN

Autonomous robot designed for Covid-safe communications

A “telepresence” robot has been designed to enable Covid-19 sufferers to talk to their loved ones without putting them at risk. Designed by University of Malaga researchers, the robot has Covid-specific design functions in order to adapt it to the pandemic needs and aims to facilitate the work of professionals in nursing homes and hospitals. “We have enabled people that are isolated in a room to have a video call with relatives and friends without risks and regardless of their ability to use new technologies,” said researcher Juan Pedro Bandera.

Patients are able to book an hour for a video call by using a simple web interface, after which the robot boots up autonomously and goes to the counter to be disinfected. It then travels to their room and starts the video call at the scheduled time. When finished, it is disinfected again and goes back to charge. Just over a meter high, with a cylindrical or pedestal-shaped body, this robot also has simple expressive abilities, audio-visual communication capacity and is able to move around autonomously.

The team also envisages it being used in homes for the elderly as an announcer or offering residents the ability to share and view photos. “A social robot that crosses continuously between two people talking, that gets too close to them when moving around, that moves too fast or abruptly or stops in a corridor blocking their way will not be accepted and, therefore, will not be useful,” Bandera said.

His team also studied the movement of robots, determining that “smoother” paths tend to decrease energy consumption and increase social acceptability. However, they also show that other critical factors need to be considered, such as keeping an adequate distance from people:

<https://eandt.theiet.org/>

NORTH AMERICA

CANADA

AI could help predict the necessity of ICU admission

New technology could help doctors make the most of limited resources during the COVID-19 pandemic by identifying patients who require intensive care unit (ICU) treatment. The system, developed by researchers at the University of Waterloo and DarwinAI, an alumni-founded startup company, uses artificial intelligence (AI) to predict the necessity of ICU admission based on more than 200 clinical data points, including vital signs, blood test results, and medical history.

The new AI software was trained using data from almost 400 cases at Hospital Sirio-Libanés in Sao Paulo, Brazil, in which doctors had decided if COVID patients should be admitted for intensive care. Based on lessons learned from that known data, the neural network developed by researchers can predict the need for ICU admission in new COVID cases with greater than 95% accuracy. It also identifies the key factors that drive its predictions to help give clinicians confidence in them.

Rather than replacing doctors, the technology is meant to arm them with a new tool to make faster, more informed decisions and ensure the patients most in need of intensive care receive it. “The goal is to help clinicians make faster, more consistent decisions based on past patient cases and outcomes,” said Wong, a director of the Vision and Image Processing (VIP) Lab at Waterloo. “It’s all about augmenting their expertise to optimize the use of medical resources and individualize patient care.”

USA

Researchers have made the technology freely available so engineers and scientists around the world can work to help improve it. They are now incorporating it into a larger clinical decision support system, developed in their ongoing COVID-Net open-source initiative, that also helps doctors detect COVID and determine its severity using AI analysis of medical images.

<https://www.news-medical.net>

3D printed medical implant

Health Canada, the government arm that deals with national health, has approved its first Canadian-made 3D printed medical implant. The 3D printed device is a customizable mandibular (lower jaw) plate for use in facial reconstruction surgery, predominantly for patients with oral cancer. It can also be used in conjunction with surgical guides for cutting and drilling operations.

Named the Specifit 3D mandibular plate, the implant was developed by the 3D Anatomical Construction Laboratory (LARA 3D) in Quebec City. LARA 3D is a part of Investissement Québec (CRIQ), an organization providing product development services for new enterprises. The creation of the implant was also supported by the university hospital CHU de Québec-Université Laval, orthopedic screw manufacturer Alkom Digital, and metal powder firm AP&C (a GE Additive company).

For patients that have been diagnosed with oral cancer, the removal of a section of the lower jaw is sometimes a necessary procedure. In these cases, mandibular reconstruction surgery is often used to normalize the lower facial contour, regain architectural support, and improve the relationships between any affected teeth. The procedure can give patients greater functionality when it comes to both speaking and chewing, vastly improving their quality of life.

To enable mandibular reconstruction surgery, a mandibular plate is necessary. The device serves to align and stabilize the several pieces of bone that go into a

reconstruction surgery, all while promoting healing and long-term bone fusion.

Bernier adds, “Not only will it improve patients’ quality of life; but thanks to optimized, guided, and personalized surgery; it will also enable the development of a 3D medical equipment center of expertise at Centre de recherche du CHU de Québec – Université Laval. We are convinced the approval of this technology marks only the start of innovation, research, and development in 3D medical printing at LARA 3D.”

<https://3dprintingindustry.com>

Robot autonomously performs needle-less vaccinations

It goes without saying that a *lot* of people are receiving the COVID-19 vaccine these days, and will continue to do so for some time. A new robot is designed to help streamline the process, by autonomously—and needle-lessy—vaccinating human patients. Known as Cobi, the device was developed by Canadian startup Cobionix, a University of Waterloo spinoff company. It’s claimed to be the first robot to ever successfully perform an intramuscular injection, and it did so without using a hypodermic needle. The idea is that after pre-registering for a vaccination online, patients will show up at a clinic or other location that’s utilizing a Cobi robot, then display a piece of identification to a camera on the unit’s touchscreen interface. As they arrive, multiple 3D depth sensors detect their presence.

Once their ID has been verified, the Cobi robotic arm retrieves a vial of vaccine from a built-in storage area. A LiDAR sensor on the «hand» of that arm is then used to create a 3D digital map of the patient’s body, which is analyzed via AI-based software to determine the optimal injection site. Utilizing a third-party needle-less technology, the vaccine itself is subsequently injected in the form of a high-pressure jet of fluid that passes through a human-hair-width orifice. The company is unable to provide more details at this time.

<https://newatlas.com>

AI-based healthcare tools for hospitals

Chipmaker NVIDIA announced the launch of FLARE (Federated Learning Application Runtime Environment), an open-source software platform offering a common computing foundation designed to improve collaboration on AI model development in healthcare. The Flare platform can integrate with existing AI initiatives, including the open-source MONAI framework for medical imaging, using a server-client technique, according to NVIDIA. With this setup, learned model parameters from each participant are sent to a common server and aggregated into a global model.

The Netherlands Cancer Institute (NKI) research and treatment centers currently uses NVIDIA’s AI Enterprise software suite to test AI workloads on higher-precision 3D cancer scans than are commonly used today. The higher memory capacity afforded by AI Enterprise, allows researchers to use high-resolution images for training, which in turn helps clinicians better target the size and location of a tumor every time a patient receives treatment.

<https://www.healthcarefinancenews.com>

AI-powered computer model predicts disease progression

Using artificial intelligence, a team of UB researchers has developed a novel system that models the progression of chronic diseases as patients age. Published in October in the *Journal of Pharmacokinetics and Pharmacodynamics*, the model assesses metabolic and cardiovascular biomarkers—measurable biological processes such as cholesterol levels, body mass index, glucose, and blood pressure—to calculate health status and disease risks across a patient’s lifespan. The findings are critical due to the increased risk of developing metabolic and cardiovascular diseases with aging, a process that has adverse effects on cellular, psychological, and behavioral processes.

"There is an unmet need for scalable approaches that can provide guidance for pharmaceutical care across the life-span in the presence of aging and chronic comorbidities," says lead author Murali Ramanathan, professor of pharmaceutical sciences, School of Pharmacy and Pharmaceutical Sciences. "This knowledge gap may be potentially bridged by innovative disease-progression modeling." The model could facilitate the assessment of long-term chronic drug therapies, and help clinicians monitor treatment responses for conditions such as diabetes, high cholesterol, and high blood pressure, which become more frequent with age, says Ramanathan.

The research examined data from three case studies within the third National Health and Nutrition Examination Survey (NHANES) that assessed the metabolic and cardiovascular biomarkers of nearly 40,000 people in the United States. Biomarkers, which also include measurements such as temperature, body weight, and height, are used to diagnose, treat, and monitor overall health and numerous diseases. The researchers examined seven metabolic biomarkers: body mass index, waist-to-hip ratio, total cholesterol, high-density lipoprotein cholesterol, triglycerides, glucose, and glycohemoglobin. The cardiovascular biomarkers examined include systolic and diastolic blood pressure, pulse rate, and homocysteine.

By analyzing changes in metabolic and cardiovascular biomarkers, the model "learns" how aging affects these measurements. With machine learning, the system uses a memory of previous biomarker levels to predict future measurements, which ultimately reveal how metabolic and cardiovascular diseases progress over time.

<http://www.buffalo.edu>

Wireless networks allow brain circuits to be controlled remotely

A new study shows that researchers can remotely control the brain circuits of numerous animals simultaneously and independently through the internet. The scientists believe this newly developed technology can speed up brain research and various neuroscience studies to uncover basic brain functions as well as the underpinnings of various neuropsychiatric and neurological disorders.

A multidisciplinary team of researchers at KAIST, Washington University in St. Louis, and the University of Colorado, Boulder, created a wireless ecosystem with its own wireless implantable devices and Internet of Things (IoT) infrastructure to enable high-throughput neuroscience experiments over the internet. This innovative technology could enable scientists to manipulate the brains of animals from anywhere around the world. The study was published in the journal *Nature Biomedical Engineering* on November 25.

"This novel technology is highly versatile and adaptive. It can remotely control numerous neural implants and laboratory tools in real-time or in a scheduled way without direct human interactions," said Professor Jae-Woong Jeong of the School of Electrical Engineering at KAIST and a senior author of the study. "These wireless neural devices and equipment integrated with IoT technology have enormous potential for science and medicine."

The wireless ecosystem only requires a mini-computer that can be purchased for under \$45, which connects to the internet and communicates with wireless multi-

functional brain probes or other types of conventional laboratory equipment using IoT control modules. By optimally integrating the versatility and modular construction of both unique IoT hardware and software within a single ecosystem, this wireless technology offers new applications that have not been demonstrated before by a single stand-alone technology. This includes, but is not limited to minimalist hardware, global remote access, selective and scheduled experiments, customizable automation, and high-throughput scalability.

"As long as researchers have internet access, they are able to trigger, customize, stop, validate, and store the outcomes of large experiments at any time and from anywhere in the world. They can remotely perform large-scale neuroscience experiments in animals deployed in multiple countries," said one of the lead authors, Dr. Raza Qazi, a researcher with KAIST and the University of Colorado, Boulder. "The low cost of this system allows it to be easily adopted and can further fuel innovation across many laboratories," Dr. Qazi added.

One of the significant advantages of this IoT neurotechnology is its ability to be mass deployed across the globe due to its minimalistic hardware, low setup cost, ease of use, and customizable versatility. Scientists across the world can quickly implement this technology within their existing laboratories with minimal budget concerns to achieve globally remote access, scalable experimental automation, or both, thus potentially reducing the time needed to unravel various neuroscientific challenges such as those associated with intractable neurological conditions.

<https://www.eurekalert.org>