

ITRI TODAY



Spring Issue 2020



— SILVER JUBILEE EDITION —

Issue 100 Celebration!

In celebration of ITRI TODAY's 100th Issue, we present this special edition. In this issue, you will see the milestones of our publication, cool ITRI techs as chosen and described by our readers, experts' insights on AI and pandemics, tech trends at CES 2020 and the latest ITRI updates.

ITRI TODAY **100** Spring Issue 2020

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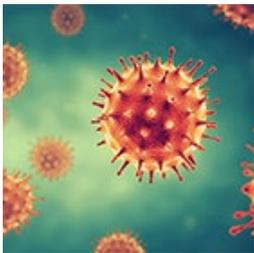


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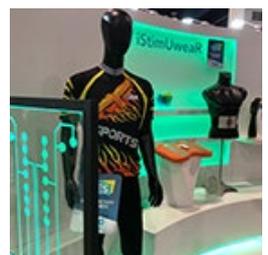
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» Preface

Celebrating the Milestones and Thank You All!

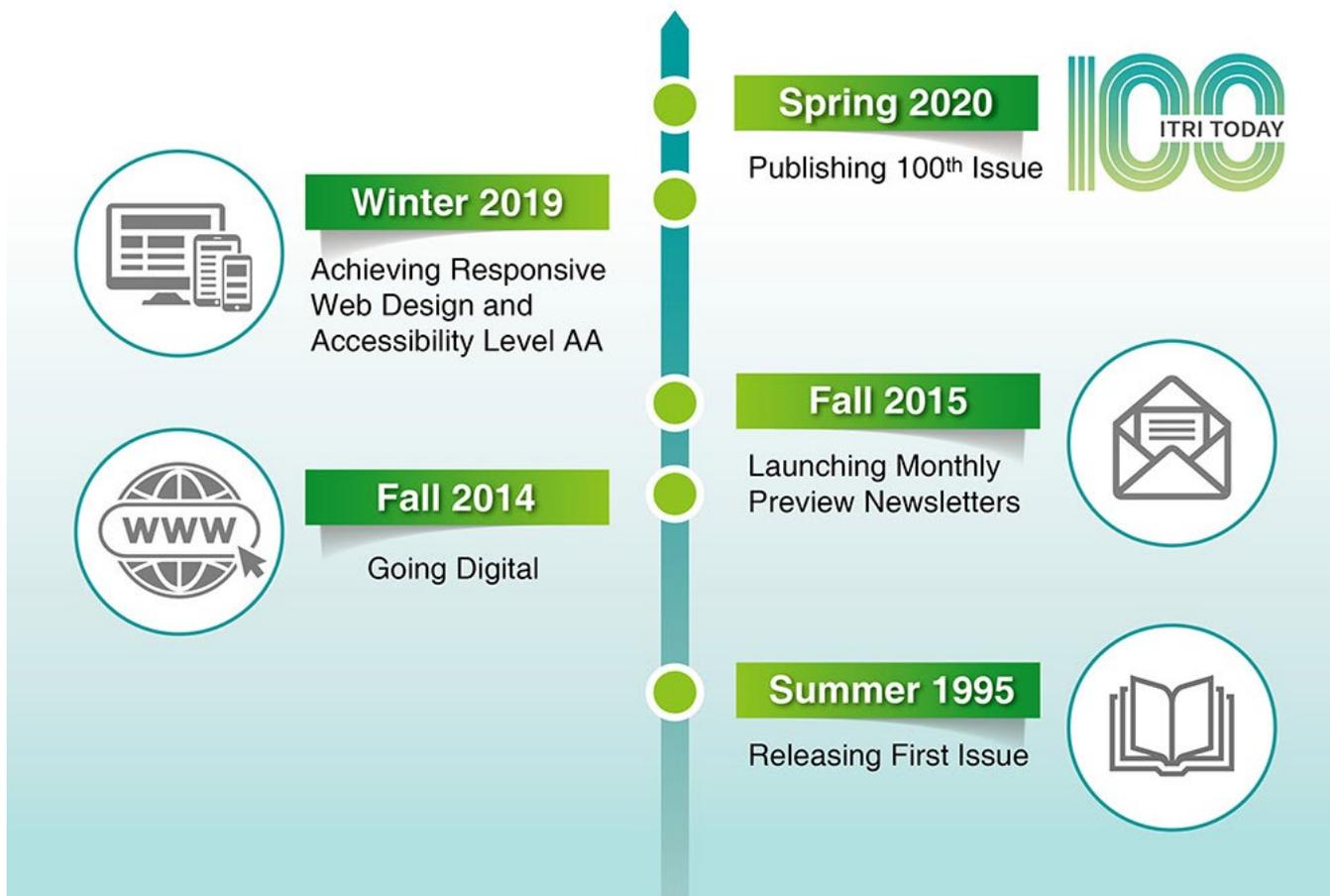
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Video of ITRI TODAY Issue 100 Special Edition.

It's our Issue 100, marking the 25th anniversary of ITRI TODAY! In celebration of our silver jubilee and to thank our readers for your support, here we unveil a special edition for you, where you can learn about impressive ITRI techs from readers' picks, experts' tech insights, CES 2020 trends analysis, and the latest ITRI updates. Hope you enjoy it!

As the only quarterly English publication at ITRI, we have been striving to offer high-quality content to keep readers updated about ITRI. Our goals are simple. We aim to serve as a key bridge, connecting ITRI with the world. We see ourselves as an efficient messenger, delivering ITRI news, latest trends, and brilliant ideas in time to our readers. And we would like to be a reliable partner, one that forges communication and cooperation across different industry sectors and multidisciplinary fields.



Milestones of ITRI TODAY.

It has been a long road to get us here since our first launch in June, 1995. Looking back, there are some milestones we have reached. A turning point was in fall 2014, when we became digitalized and moved beyond the boundaries of hardcopies. This digital transformation helps us save the planet and allows readers to access online more freely. Electronic files can be downloaded or printed out for offline reading only when needed. The new format also enriches the reading experience with more vivid content and flexible sections, including lively videos and photos, on-site interviews, and many more stories to view.

To engage with our readers more frequently, we even started sending monthly preview newsletters in spring 2015. Besides quarterly issues, subscribers can get monthly notice of our latest R&D achievements, current collaboration projects, and every effort we’ve made to innovate a better future. In late 2019, we improved our web design and accessibility to accommodate various reading needs.

ITRI values worldwide resources and global partnerships. ITRI TODAY, for its part, opens a gateway for facilitating international interaction. Our readers range widely, including those from industrial, academic, governmental, and media sectors. Many have explored novelty and opportunities through ITRI TODAY. As ITRI TODAY Publisher and ITRI President Edwin Liu suggests, “ITRI TODAY is becoming even more important in the future. We’d like to continue to use it to build a communication channel with the tech society as well as the markets.”

Finally, we would like to thank all of our readers. It is always thrilling to get feedback from you so that we can know your interest, inquiry and any comment for us to improve upon and become better. Without you, it is unlikely for us to get here today. Going forward, we will work to extend our reach and maximize our impact, hoping to get more people inspired and connected.

So stay tuned with us! Let's grow together while sparking more innovation and collaboration!

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» Readers' Choice

Brilliant ITRI Techs from Readers' Picks

To make ITRI TODAY No. 100 special, we held a Call for Essays event to invite readers to choose a technology developed by ITRI they think is cool and express their thoughts on their pick. This is the first time that we accepted contributed essays and we are grateful for every participant's contribution for this event. Our intention is to boost reader engagement by co-creating a section beyond editors' efforts. Now we are glad to share five selected essays with you.

The selected essays include descriptions and comments on ITRI's R&D advances in smart manufacturing, healthcare and environment sustainability. Through these essays, you can relearn ITRI's tech innovations via others' perspectives. And perhaps you will find something you have never thought about or noticed before.

Can't wait? Read these interesting stories now!

-  Virtual Reality to Enhance Human-Robot Cooperation 
-  An Intuitive and Practical Solution to Sleep Disorder 
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-  Smart Knee Injury Monitoring 
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» Readers' Choice

Virtual Reality to Enhance Human-Robot Cooperation

By Andrés Gaona



VR/AR technology is expected to improve the efficiency and safety of manufacturing processes.

Since their invention, robots have been considered tools that aim to help humans mainly in manufacturing processes. Their employment in factories has increased the production efficiency, and although robots have shown various benefits in terms of human health and safety, their acquisition remains limited.

One reason is that robot owners cannot risk the machine integrity to unsafe manipulation because of its high cost. The second reason is that industrial robots are conceived to automate a repetitive process rather than a customizable task. Thus, if some level of customization is

required, the robot needs to be trained in an exhausting process that not only might take several days but also exposes the robot to failures and damages due to either human inexperience, unexpected robot behavior or unforeseen circumstances.

These issues are often related to the lack of information that goes beyond human senses. For example, it is hard, if not impossible, for an operator to predict the robot trajectory, and it is even more complicated if collision avoidance is considered. In this context, implementing an immersive platform that simulates the robotic cell might be a good solution to minimize risks. Virtual Reality (VR) and Augmented Reality (AR) are technological tools that can be exploited to recreate virtual scenarios as well as enhance human sensory capabilities.

The VR/AR market value reached US\$6 billion in 2019, and this technology is quickly being applied to the robotics field. VR/AR allows people to experience surreal atmospheres indoors such as an industrial environment, but more importantly a robotic cell.

ITRI engineers are working on an immersive environment that emulates not only the functionality of an industrial robotic arm but also the working elements that are invisible to human eyes. For example, inside the VR/AR environment, operators can see the robot's work envelope and check the motion paths. Also, virtual objects can be added to simulate the interaction with the robot. Simulation in the virtual environment reduces the risk of damage to the robot's integrity because several analyses are run before commanding the real robotic arm.

VR/AR technologies are not limited to recreating environments; they also allow innovation in manufacturing processes. An immersive robotic environment can serve as a teaching platform for applications such as painting or polishing, where the operator can easily interact in the virtual environment and create a customized motion path, evaluate a robot's performance in simulation, and carry out troubleshooting. This makes the process more intuitive and aims to reduce robot training time as well as wasted resources. A task that takes hours such as creating the robot path, can be drastically reduced in the virtual environment. VR/AR could also be employed in data collection for artificial intelligence applications. In the era of AI, collecting a considerable amount of reliable data is actually a complex task. The more specific the process is, the harder it would be to get the data. Replicating a process using VR/AR would minimize the investment to acquire this data.

VR/AR technology is expected to improve the efficiency and safety of manufacturing processes while enhancing human sensory capabilities. Its popularity and the trend to become a cheaper technology makes VR/AR one of the options to be considered in future developments of human-robot collaboration.



About the Author



Andrés Gaona is an associate researcher working at ITRI. Raised in Ecuador, he was educated in mechatronics engineering, and moved to Taiwan to study artificial intelligence. His specialities are robot manipulators, deep learning and optimization. When not sitting in the office, Andres enjoys playing soccer, practicing bouldering and going on hikes.



» Readers' Choice

An Intuitive and Practical Solution to Sleep Disorder

By Emmanuel Anios Fils Mompremier



ITRI's WiFi Sleep Apnea Detection System features a non-contact method using a low-power WiFi device to sense the user's respiratory rate.

If your breathing erratically stops and starts during sleep, you snore loudly and feel tired even after a full night's sleep, you may have the symptoms of sleep apnea, a serious sleep disorder and considered as the plausible origin of various health complications. ITRI's WiFi Sleep Apnea Detection System is the most user-friendly technology currently available to help detect and palliate this disorder.

Unlike other commercial technologies, ITRI's system provides convenience and comfort. It does not require the user to wear any device nor to charge any gadgets. In fact, it features a

non-contact method using a low-power WiFi device to sense the user's respiratory rate. This system automatically monitors breathing and is insensitive to sleep positions or blanket types. Therefore, the user sleeps comfortably while his breathing is being monitored. ITRI designed this technology to better one's sleeping experience without additional disruptions.

This sleep apnea detection system presents an intuitive and untroublesome design. An airbag cushion placed under the user's pillow slowly inflates in case breathing is interrupted. The position of the user's head will then slightly increase to keep the airway of the respiratory tract open, ease sleep apnea, and consequently reduce snoring. As the number of breathing interruptions decreases, the inflatable cushion deflates back to its original size. Experimental evidence shows that the user will not notice the subtle changes in the pillow position.

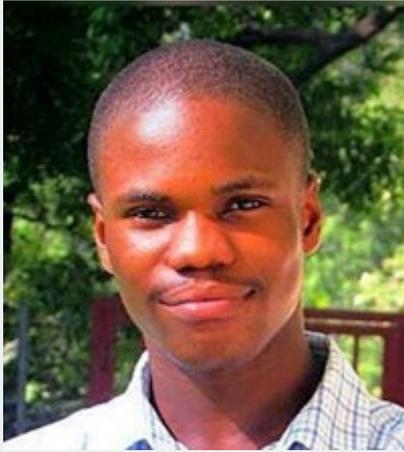
Helpful and practical, this technology suits applications in medical facilities including hospitals, clinics, hospices and regular home usage as well. Health professionals can set up the device in the user's room to detect breathing abnormalities, respond accordingly to help reduce breathing pauses and snoring, and check daily sleep quality through applications installed on smartphones. Furthermore, people who would like to enhance their sleep quality may also use this technology to automatically adjust their head position while sleeping.

I would recommend an advanced version of this technology that can detect and improve one's sleep positions in addition to the adjustment of head position. For instance, wouldn't it be agreeable for a home sleep technology to automatically raise one's head up to alleviate sleep apnea and simultaneously raise/lower the back, hip or feet sections of the mattress to reduce muscle strain and pain?

In terms of technological design, actual effect and user friendliness, ITRI's WiFi Sleep Apnea Detection System appeals to me. Besides its being useful to the well-being of people, with its non-contact breathing and heartbeat detection, it stands as the most intuitive and least intrusive technology available for sleep monitoring.



About the Author



Emmanuel Anios Fils Mompremier grew up in Haiti and is currently studying Mechanical Engineering at National Taiwan University (NTU). His research interests include smart manufacturing, structures and materials.

Emmanuel is also on NTU's soccer team and active in various volunteering projects through which he enjoys sharing his enthusiasm and meeting new people.



» Readers' Choice

HECLOT, an Innovation for Circular Economy

By Yo Hwang



ITRI and Taiwan Cement collaborated to build the world's largest calcium looping pilot plant in 2013.

Greta Thunberg, a 17-year-old Swedish environmental activist on climate change, has awakened us with her world-changing heartbreaking emotion-stirring speech at the U.N.'s Climate Action Summit in New York City on September 23, 2019. Her speech was sobering. My heart sank as I listened to it. How dare we? How dare we steal the future of our children's generation with our selfish ways? How can we still talk about making money as our natural ecosystem is collapsing? How can we still believe in the "fairy tales of eternal economic growth"? How is it that Greta can see the truth while we are blinded by it? Have we lost all hope?

I've always taken pride in working at ITRI, which has a unique pool of talented engineers, researchers, specialists, inventors, entrepreneurs, and everything in between. We have played a vital role in changing Taiwan's economy from a labor-intensive industry to a high-tech one. Industries are moving forward and now look to ITRI for our green technology and solutions for sustainability. Unfailingly, ITRI has developed different technologies to help achieve a circular or zero-waste economy, the key to sustainability. Amongst them, I think HECLLOT (High Efficiency Calcium Looping Technology) is its most significant technological innovation. And I truly believe Greta would agree.

HECLLOT was licensed to Taiwan Cement in 2013 to build the world's largest calcium looping pilot plant, where up to 1 ton of carbon could be captured per hour. The process was expected to achieve a carbon capture cost of less than \$30 per ton of CO₂, which is very cost-competitive when compared to other existing carbon capture technologies. In 2014, ITRI received an R&D 100 Award for this technology breakthrough in the Environmental Technologies category.

Not only does the technology reduce CO₂ emission to near zero, the heat generated in the process can also be recovered and reused. The CaO (calcium oxide) used to capture CO₂ can be reused repeatedly. Further, it can be used as raw material for cement process when it loses its activity during the capture process. Most importantly, the captured CO₂ is prevented from being released into the atmosphere, mitigating the contribution to global warming and ocean acidification. What's more, it can be monetized in value-added products.

Six years have passed since the launch of HECLLOT. If Greta knew about this technology and how it could potentially drastically reduce global carbon emission, I am sure she would advocate the adoption of this technology in every heavy industry. But what about us? What can we do as responsible human beings to change our ways NOW?

We may not be able to give back Greta's childhood, but perhaps we can still give back her dreams of a better future.



About the Author



Yo Hwang was born and raised in Bangkok's expat community. With background in Visual Communication Design, she went on to complete her Masters in Integrated Marketing Communications in Australia. Yo joined ITRI in 2017 as an associate administrator and is now working on startup ecosystem development programs.

» Readers' Choice

Smart Knee Injury Monitoring

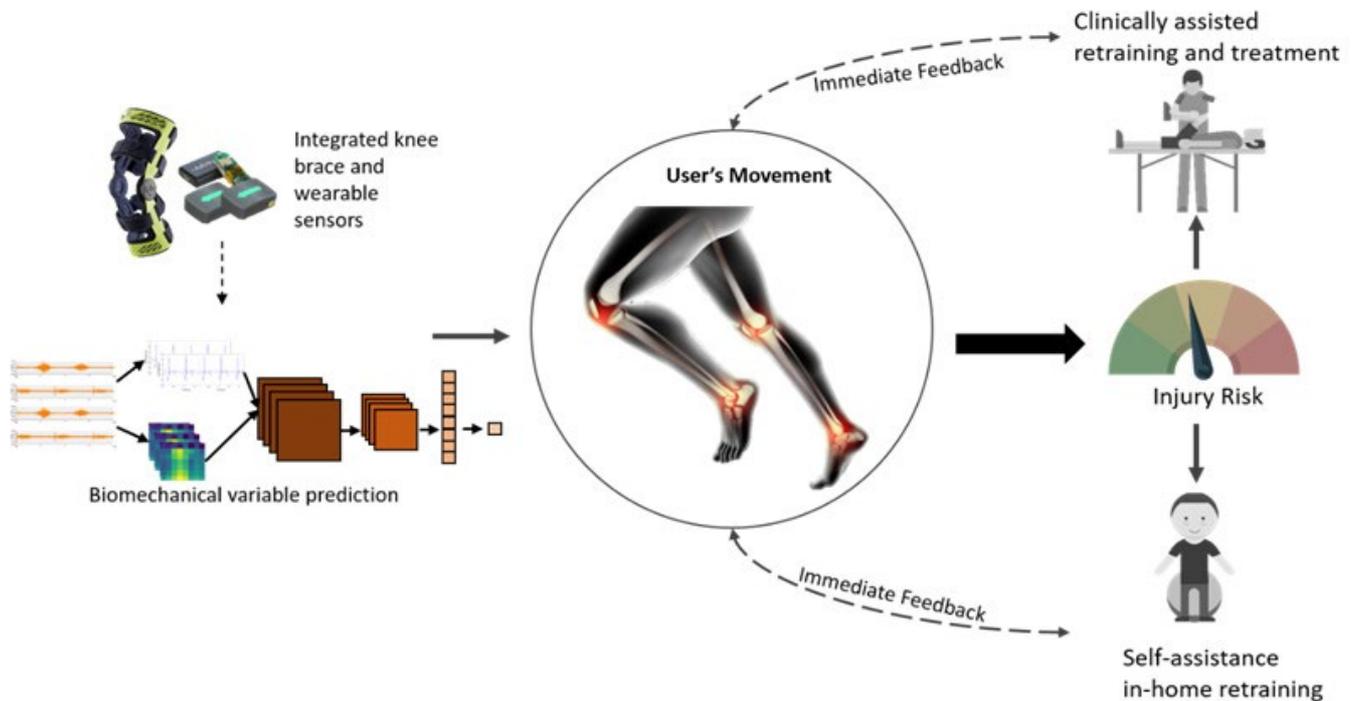
By Tommy Sugiarto

Studies suggest that up to one-third of people in the general population have shown knee joint problems with radiological evidence (G. Peat *et al.*, 2001). Knee osteoarthritis (OA), for example, is the single most common cause of disability in older adults. Current technology used to monitor the development of the injury still relies on complex and expensive 3-Dimensional Motion Capture System (3D-Mocap). Regardless of the precision and the accuracy of the 3D-Mocap, this system has some drawbacks, such as the complexity of the equipment and installation, and the high costs which make this system unaffordable for patient in-home monitoring and rehabilitation.

To address these issues, ITRI collaborated with Graduate Institute of Biomedical Engineering from National Taiwan University of Science and Technology to develop a smart knee brace that can detect abnormal knee alignment and send feedback when the user has an abnormal muscle activity. The smart knee brace consists of an electromyography (EMG) sensor which can record muscle activity and a triaxial accelerometer to record acceleration on the segment. The EMG sensors are placed on Vastus Lateralis and Vastus Medialis muscle to continuously monitor muscle activity. When there is abnormality detected, the system will generate tactile feedback to the designated muscle. This form of feedback is useful to solve the muscle imbalance problem which is common in athletes and may reduce sport injury risks.

Besides providing immediate tactile feedback, collected EMG and accelerometer data will also be used for other analysis, for example, diagnosis on knee alignment problems. With the trained model from Deep Neural Network, the data from sensors can be used to detect knee abnormality. More advanced application will be available in the future for predicting biomechanical variables such as joint movement, or joint loading with a combination of wearable sensor data and deep learning method. In the future, users will be able to know exactly how much loading they put on their knee joint when doing exercise or high risk activities with only using smart knee braces with wearable sensors. Compared with conventional knee braces which only correct the alignment, this solution opens up an opportunity to continuously monitor and record user's data and develop recommendations for better movement strategy or exercise prescription.

In sum, I see much potential for this integrated system developed by ITRI. It can create a smart in-home healthcare monitoring and rehabilitation system which will bring more convenience to patients while providing clinicians simpler tools for knee injury monitoring to enhance the quality of diagnosis and treatment.



Future extended application for in-home healthcare with smart knee brace and wearable sensors.

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About the Author



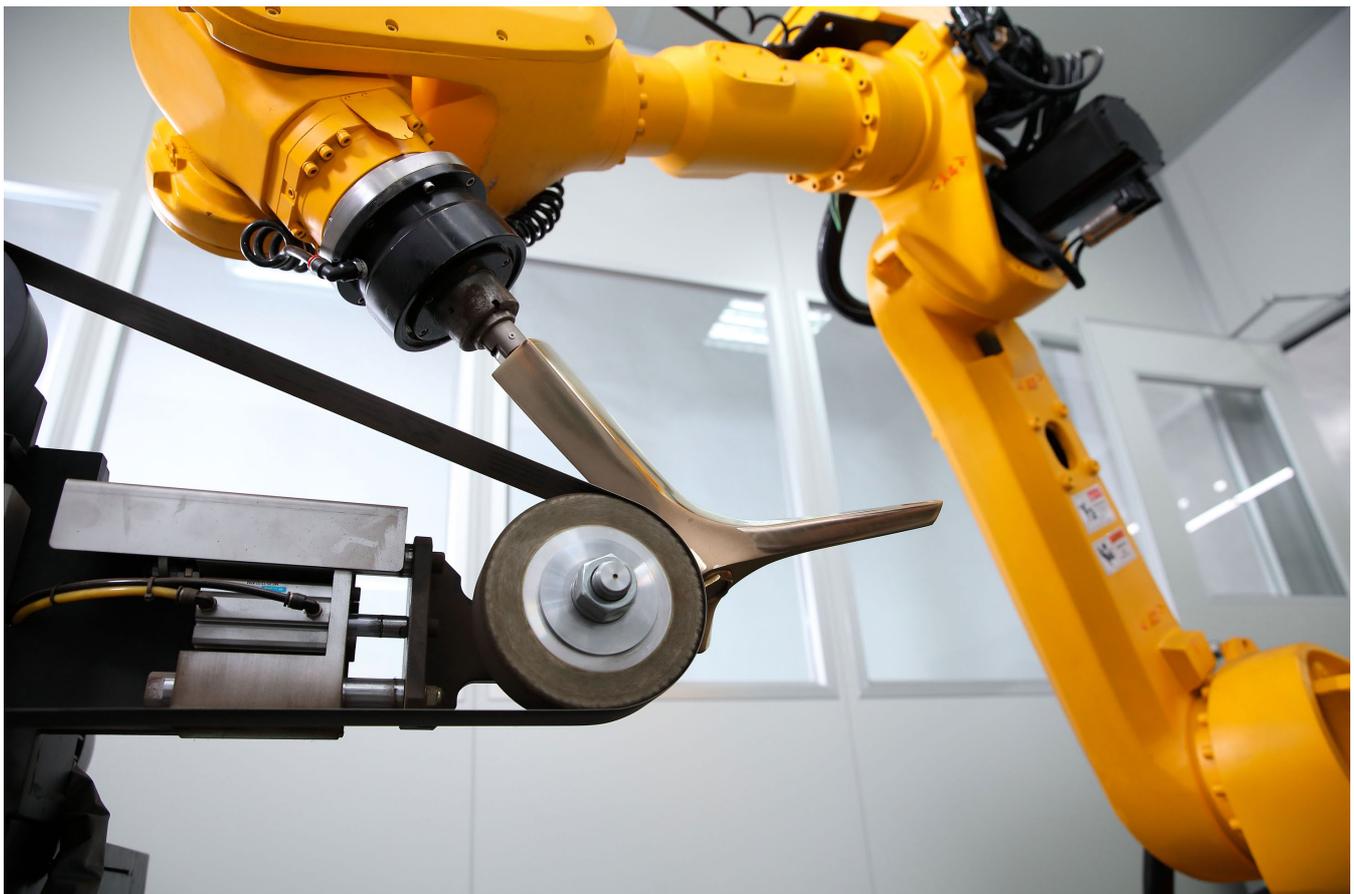
Tommy Sugiarto is an associate engineer working at ITRI. Currently, he is also a PhD candidate in Biomedical Engineering at National Taiwan University of Science and Technology (NTUST). He got his master degree also in the same major and university while his bachelor degree was obtained from Department of Physics, University of Indonesia. His research interest is in Artificial Intelligence especially in biomedical applications.



» Readers' Choice

Polishing and Grinding Robot Cell

By Garcia Liang



The Polishing and Grinding Robot Cell can solve problems such as labor intensiveness, manpower shortage, and the loss of artisanal experience.

Speaking of “polishing” and “grinding”, what image comes first to your mind? To me, I could imagine a hunchbacked grandmaster attentively polishing or grinding metal objects in a dusty and muggy place, and this laborious work makes him suffer from backache.

The scenario above points out two questions: whether there is a way to improve the bad working environment, and what technology can reduce the task overload on the craftsmen or replicate their experience and skills in an intelligent and efficient way. Since “providing breakthrough solutions to existing industrial problems” is one of the missions that ITRI shoulders, I am glad to see ITRI introduce the Polishing and Grinding Robot Cell.

The Polishing and Grinding Robot Cell is a technology that can teach robots to polish a whole work piece, and even complex-shaped objects such as water faucets or golf equipment. When the grandmaster works on the work piece with the robot cell, the robot simultaneously records the moving tracks. That is, the hard-to-track experience can be recorded precisely and systematically. In my view, this technology enlightens a solution to problems such as labor intensiveness, manpower shortage, and the loss of artisanal experience. Also, such an innovation plays a role in Industry 4.0, where manufacturing has moved further toward intelligence, high efficiency, high quality, and circular economy.

With the Polishing and Grinding Robot Cell, Taiwan's robotic arm industry can stride into high-value advanced processing fields, enhance the digital transformation of traditional manufacturing processes, and strengthen the industry's international competitiveness.

To extend the applications of the robot cell, ITRI has also developed a robot arm with the All-in-one Joint, which is lightweight, modularized, and features a high payload ratio and high-precision motion. Such a technology can be applied to anthropomorphic hands other than industrial applications. This Human-like robot hand is able to move all five fingers, helping people with disabilities perform everyday functions such as holding a name card or even a plastic bottle. In addition, it can be used to grasp soft irregularly-shaped objects, which is a great improvement on traditional grippers. The technology is also suitable for loading or unloading goods in factories or stores.

To sum up, robots are designed to help humans, and thus we should take advantage of robot applications. This Polishing and Grinding Robot Cell, I believe, is developed for innovating a better future!



About the Author



Garcia Liang is an associate administrator at ITRI. She received her first degree in Foreign Languages and Applied Linguistics. She is a project manager for Technology Development Program, and Industry-Academia-Research Cooperation. She also works on business promotion and international cooperation for ITRI.

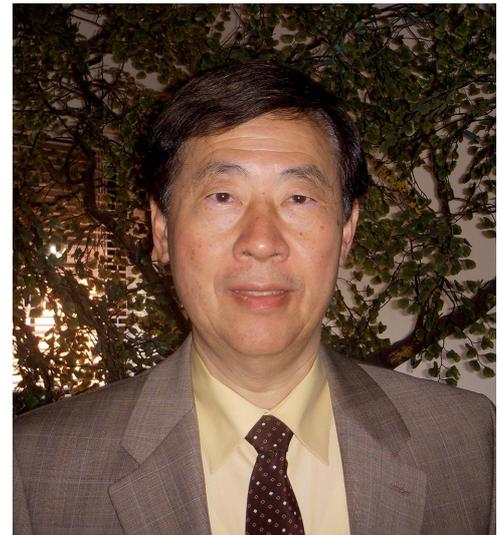
» Tech Insights

Pandemic Viral Infection in the Era of Global Climate Change

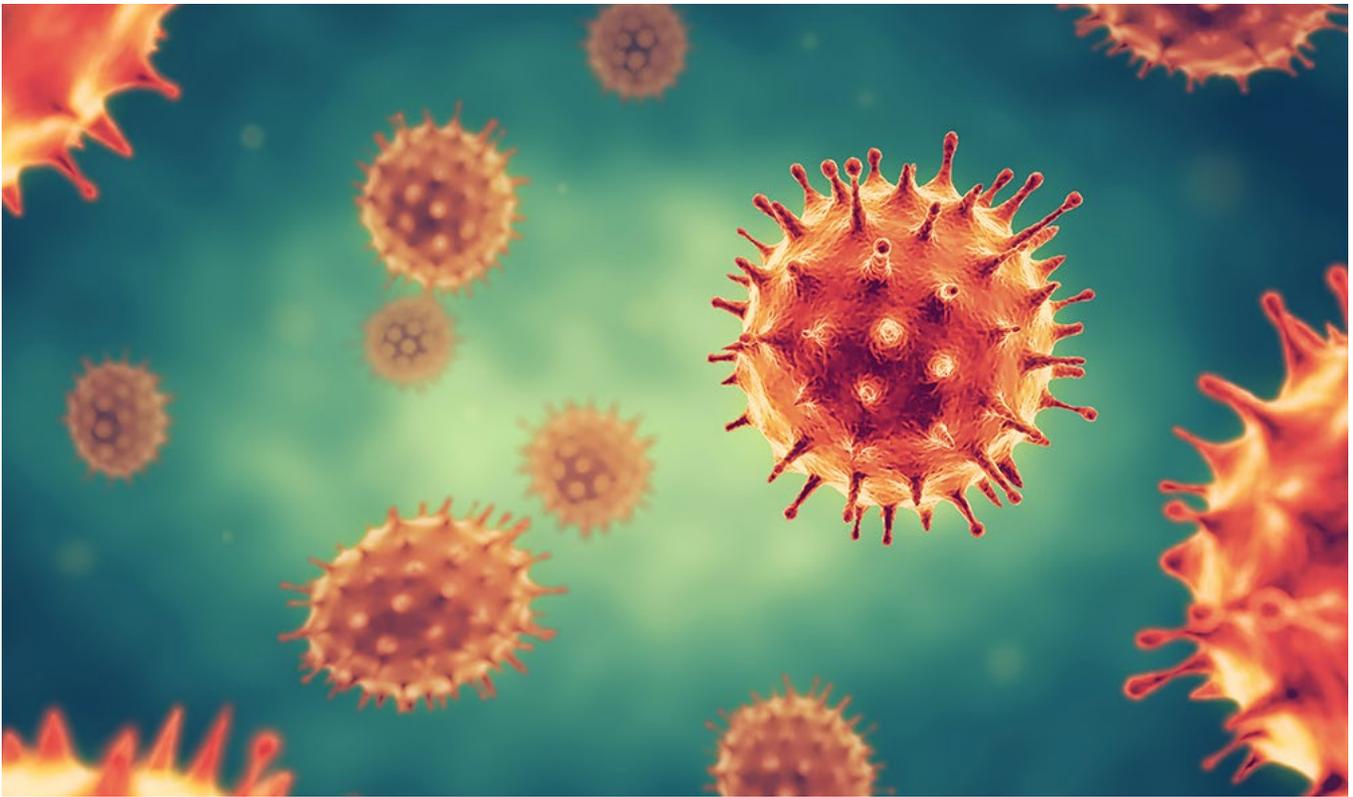
The possibility of pandemics has increased over the past century due to intense global changes including urbanization, land use and climate. Since these trends are likely to intensify, a pandemic is considered a serious subject in public health that can potentially pose a great threat to the human race. Dr. David Ying Chien, the founder and CEO of YingTech Bioscience Consulting Company, recently shared his insight on this issue during a speech at ITRI.

In Dr. Chien's opening remarks, he stated that pandemic tragedy is a clear and present danger, and that the question is not if it will happen, but when, and how. He further pointed out that climate change is an important indicator for the growing chance of a global pandemic. Dr. Chien explained that human activities such as burning fossil fuels that releases CO₂ pollution and livestock farming that produces methane gas all contribute to global warming and alter the ecosystem. This consequently increases the chance of virus occurrence and the distribution of epidemic diseases. In addition, extreme weather events may expose humans to risks where we do not have immune-protection mechanisms against new pathogens in the first place.

"Compared with bacterial infection, virus infection has the tendency to progress to chronic infection. This is due to inadequate immune response from hosts," said Dr. Chien. He further explained that sometimes the virus suppresses the host's inner response and moves into sensory cells like nerve cells. As the immune system cannot reach the viruses, the viruses become latent and stay there for years until the immune system operates. Dr. Chien took HIV or HCV infection for instance. "If you don't treat the patients in the early stage, or the first three months, almost 99% patients become chronic infected for the rest of their life," he stated.



Dr. David Ying Chien shared his view on the associations between climate change and pandemic viral infection.



An illustration of viral cells.

Therefore, it is important to take steps that can manage and mitigate pandemic risks. Dr. Chien proposed three action plans. The first involves getting to know the virus infection and its transmission route. He proposed to work closely with international public health institutions, e.g. the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC). “You need to get the first-hand information as soon as possible. The sooner you know about this infection, the better for us to formulate a strategy to control the virus infection,” stressed Dr. Chien. Also, he added that when a patient recovers from infection, neutralizing anti-sera should be collected (if possible) for future therapeutic treatment.

Yet, how can we effectively control virus infection? Dr. Chien commented that in the second plan, it is crucial to grow virus in the cell culture—known as viral culture—to isolate the virus for direct examination. However, since time is of the essence for pandemic issues, the third plan proposes screening commercially available drugs for viral inhibition in cell culture. Dr. Chien indicated that one way is to use artificial intelligence (AI) for viral structure predictions in finding new anti-viral drugs and developing vaccines based on the sequence result. For example, the development of anti-virus nucleic acid drug like RNA interference (RNAi) or the flu vaccine production scheme are great solutions to inhibit virus replication and control the disease.

These action plans along with quarantine policy are crucial steps to contain the spread of pandemics. Dr. Chien expressed his expectation that ITRI can play a role for pandemic prevention or treatment. Dr. Chii-Wann Lin, ITRI’s Vice President and General Director of Biomedical Technology and Device Research Laboratories responded that regarding vaccine

production scheme, ITRI has the upstream skill set such as using AI to construct data and bioinformatics and conducting bioreactor operations for cell culture. ITRI will continue to enhance its technological competence and collaborate with global partners in developing biomedical and healthcare innovations to combat emerging pandemic viral infections.



» Tech Insights

Physics Assisted AI for Autonomous Vehicles

For the past few years, artificial intelligence (AI) has emerged to play a major role in many areas of scientific research. This trend has affected our lives through common devices like smartphones with built-in smart assistants like Siri, Google Assistant, or Alexa that can understand and complete our requests. Smart homes also continue to get smarter and more sophisticated from learning our behaviors. Meanwhile, AI technology is bringing autonomous vehicles and drone delivery services into reality, leading us to new ways of life we've never imagined before.

However, the term "AI" is not exactly a new technology. It was introduced as "machine learning" in the early 1980s, along with successful methods involved such as data analysis, modeling and backpropagation that enabled AI to spread and be widely used in software and applications.

"AI comes in cycles," noted Dr. Huei Peng, Professor of Mechanical Engineering at University of Michigan and Director of Mcity, during his speech at ITRI. The hype and bust (boom) of AI come in several cycles, he said, explaining there is Boom 1 (known as the good-old fashioned AI, GOFAI), Boom 2 (the so-called "expert system") and Boom 3, where we are right now. Dr. Peng stated the necessity to recognize how the boom will grow and what its outcome would be, because these thoughts will guide us to identify what is new in AI.



Dr. Huei Peng presented his view on the use of physics for AI applications in an invited talk at ITRI.

"There is the need to leverage our traditional knowledge completely," added Dr. Peng. The "traditional knowledge" mentioned here may refer to the methods in physics. Being educated as a mechanical engineering professional, Dr. Peng believes that the enhancement of AI can be done through either the old way of sensing or through a control approach which uses model analysis or mathematics shown in block diagrams. In the meantime, the emerging trend of data/AI-driven approach like new coding paradigms including Python is widely used for all kinds of AI applications.

As the use of AI methods like fast computation, big data, backpropagation and deep learning gains popularity, AI is undoubtedly on an upswing. One of its recent triumph moments is the AlphaGo event in which an AI scored a huge win against the 18-time world GO champion Lee Sedol. Even three decades earlier, IBM's Deep Blue has beaten the world champion chess player, Garry Kasparov. Indeed, AI achievements are impressive enough that even Dr. Peng acknowledges them by saying, "AI does do something that our traditional way doesn't know how to solve."

However, Dr. Peng stressed that there are still many challenges regarding the fragility and slow or erratic convergence problem of AI. To be more specific, he gave an example of the end-to-end autonomous driving results for autonomous vehicles. These test-drives involve recording a period of 20 to 100 hours of actual driving in places like California. The whole scene layout is provided for neural networks to learn through street-view related datasets, yet almost all of these reinforcement learning results show erratic convergence.

To solve this issue, Dr. Peng stated that there is the need to incorporate physics in training deep neural networks (DNNs). The autonomous driving test results can be enhanced by adding approaches like model-enhanced cost function, parallel and polynomial methods to calculate lane curve shape or the number of lane lines. Dr. Peng indicated that the end results in comparison with other benchmarks appear to be a "few percent better." This also implies that sometimes training DNNs doesn't always guarantee better results, or as Dr. Peng commented, "Sometimes they can go horribly wrong or become worse."

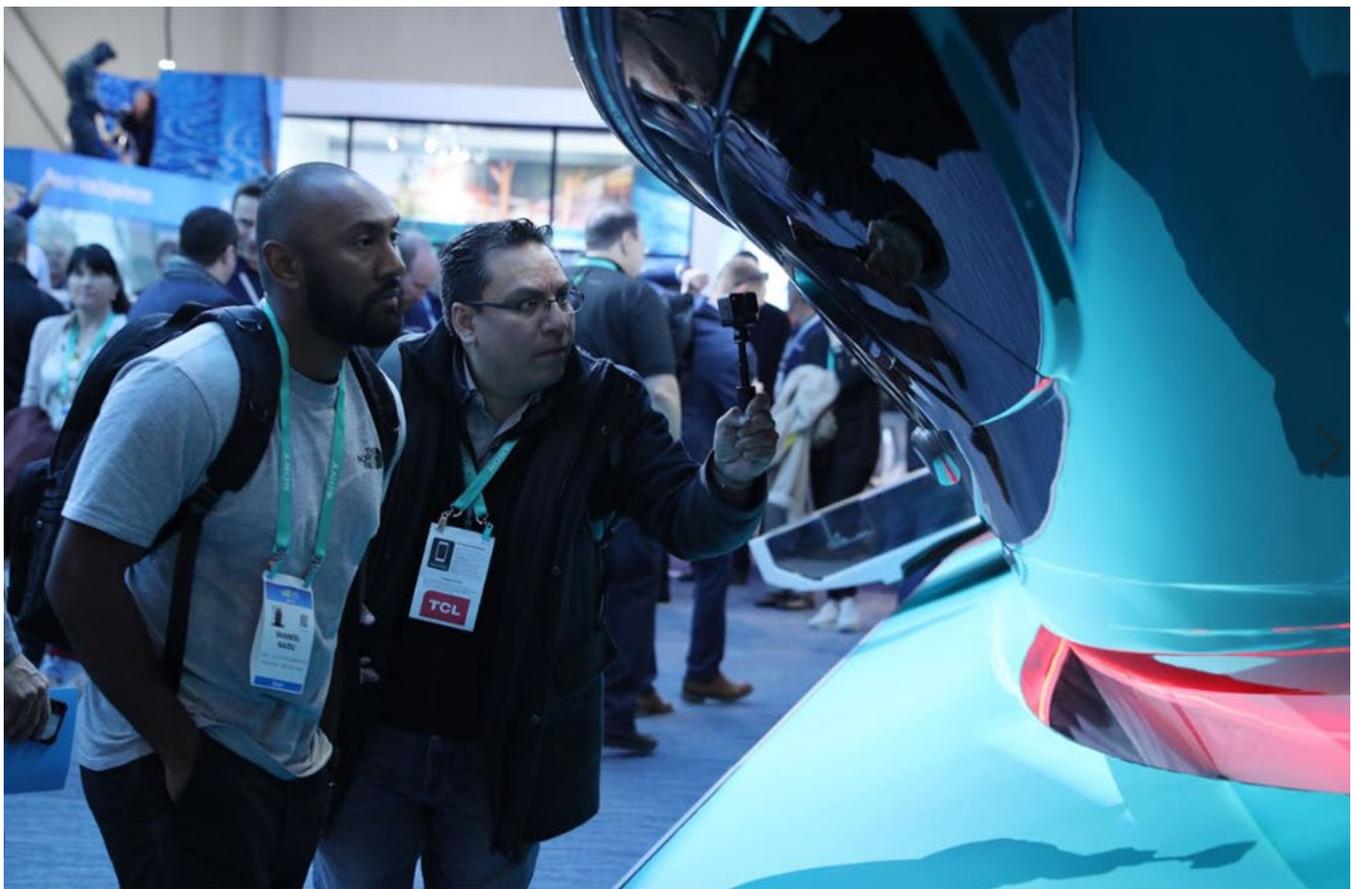
As advancements in AI continue, Dr. Peng concluded that from a mechanical engineer's point of view, one should never just blindly collect big data and claim victory. Rather, he said, "We should always remember the value of the old knowledge and never stop learning new things!"



» Trend Forecast

Trends to Watch at CES 2020: Into the Data Age

CES 2020, the world's biggest consumer electronics show, marks the beginning of a new decade by featuring some of the coolest transformative technologies in the modern era. With more than 4,400 exhibitors and approximately 170,000 attendees, the exhibition showcased over 20,000 products across 11 venues in Las Vegas during January 7-10, 2020, including many innovations in 5G, artificial intelligence (AI), robotics, autonomous vehicles, digital health, smart cities, and augmented and virtual reality (AR/VR).

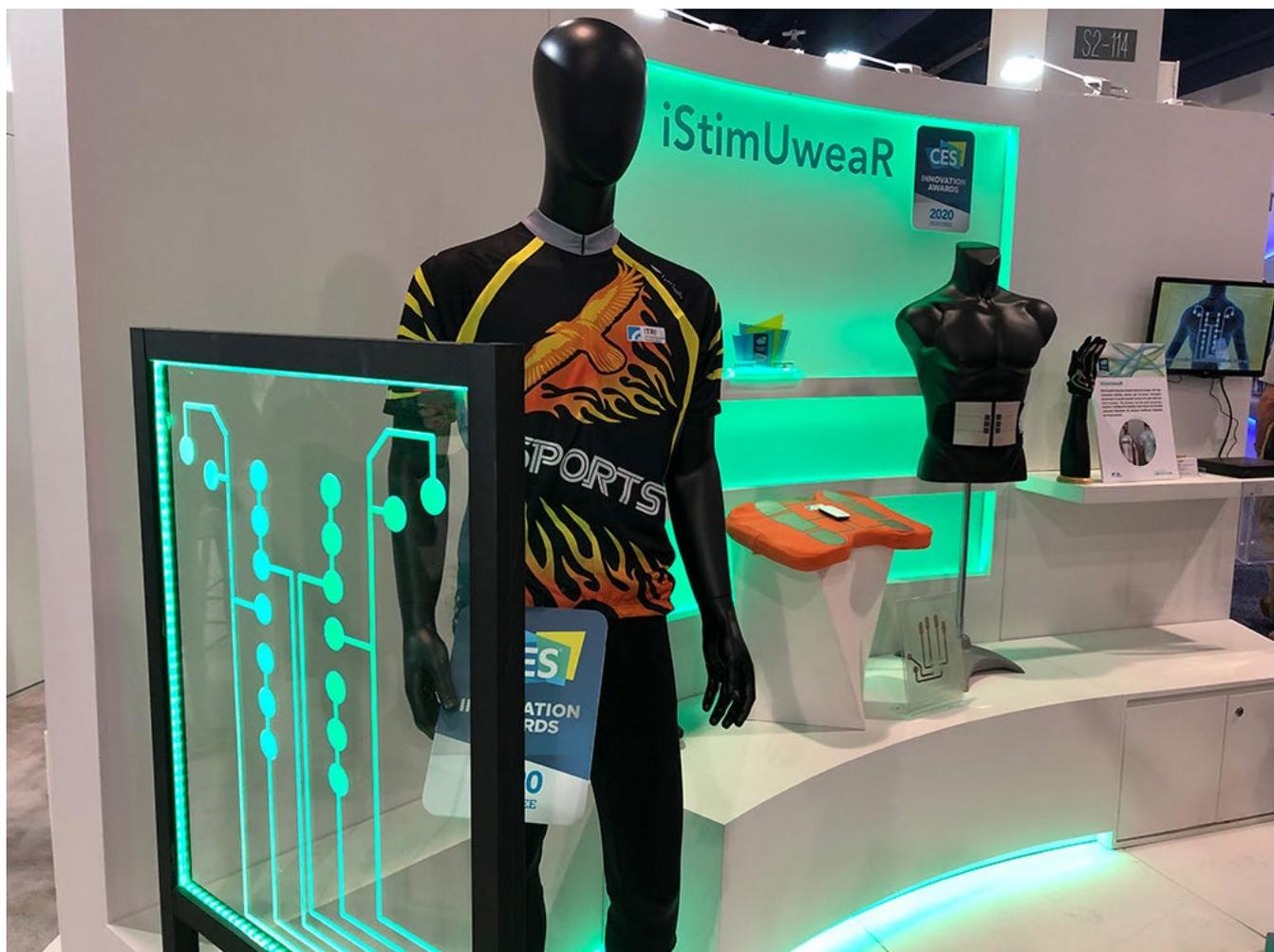


Attendees explore the latest developments in AI and the next generation of intelligent, autonomous machines at CES 2020. (Photo credit: CES)

As IEK Consulting indicated in a seminar early this year, the exhibition reveals a major tech trend of the new “IoT”, or so-called “Intelligence of Things”. The word “Intelligence” here refers to AI, the driving force behind the next generation of technologies and industrial innovations.

“Although AI is not omnipotent, it will be indispensable over the next decade,” said Stephen Su, ITRI’s Vice President and General Director of Industry, Science and Technology International Strategy Center.

Su further explains that application of the new “IoT” already exists in “Things”. For instance, in agriculture where drones can improve crop yields by detecting dry areas for watering, and in wearable technologies like ITRI’s iStimUweaR, a CES Innovation Award 2020 honoree featuring smart washable fabric that can record and evaluate a wearer’s performance for sport/healthcare management. These suggest that AI is permeating our everyday life through gadgets or devices and providing solutions to address global challenges.



ITRI developed smart washable fabric technology for sport/healthcare management.

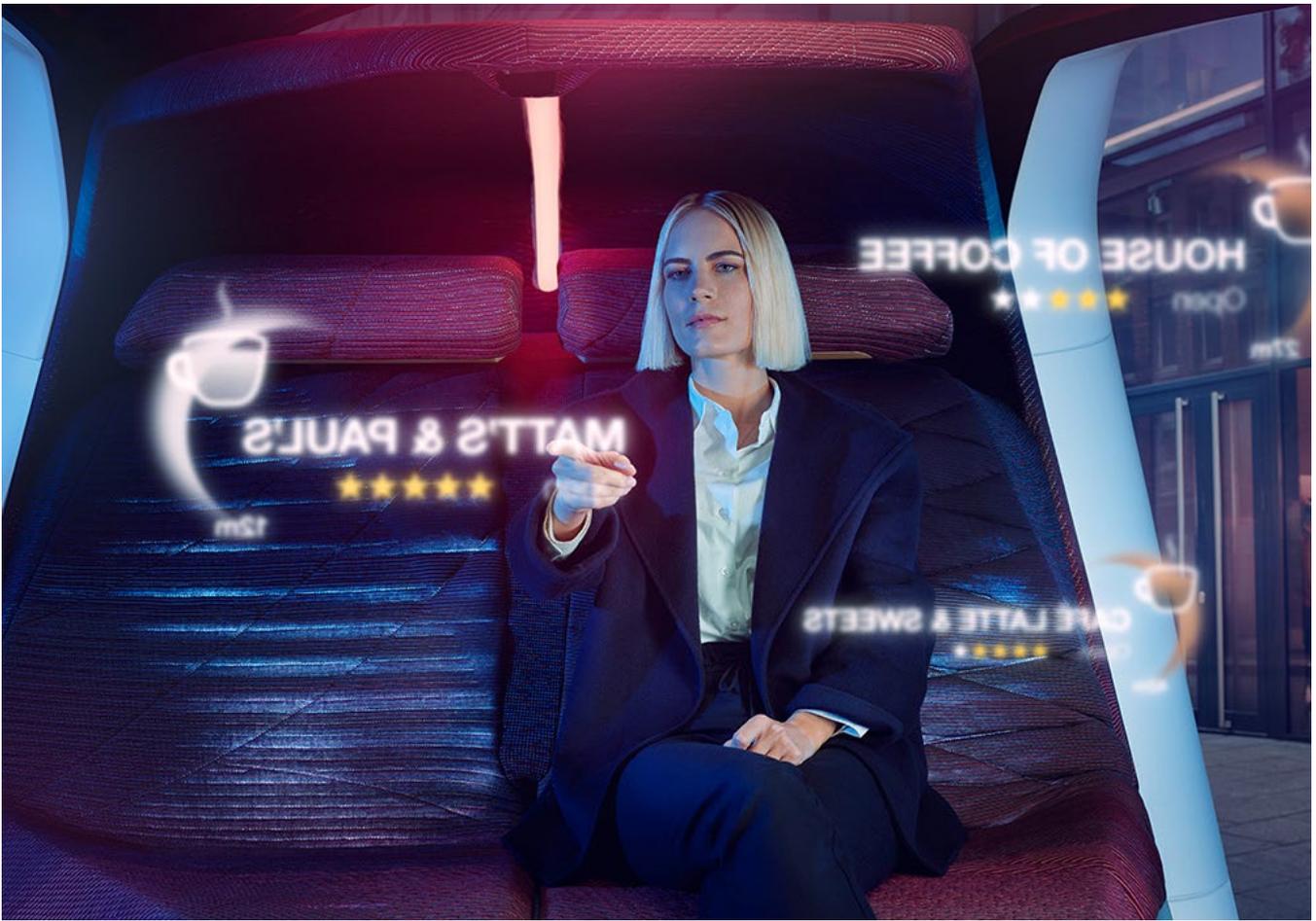
According to IEK Consulting, three key themes were highlighted at CES 2020: Smart Everything, audio/video technology, and autonomous technology.

The so-called “Smart Everything” underscores the confluence of AI, 5G and edge computing. In the data age, the surge of AI-based analysis via the adoption of edge computing and 5G connectivity leads to greater data processing power, supporting 100 times more connected devices.

Tsu-Yu Chao, Division Director of ITRI's Industry, Science and Technology International Strategy Center shared his view on the role and impact of 5G based on his observation at CES 2020. "5G technologies will be a game changer for vertical sectors such as transport and manufacturing," he said. An example is Sony's smart car, which adopts 5G, advanced sensing, and visual technology to detect the concentration and fatigue levels of the driver through facial expression and body movement. This prototype can also automatically adjust cabin temperature based on passengers' conditions for better comfort.

Another key theme to look at is the revolutionary audio/video technology. Big companies like Samsung and LG followed the trend to target smart home innovations including the debut of new 8K TVs. These giant displays utilize the power of AI to optimize resolution, sound settings as well as smart capabilities, for example by placing health and wellness content onto TV for consumers to track their fitness progress. Also, novel ways of mirroring content and controlling home devices are introduced to provide users with a more immersive viewing experience.

Meanwhile, autonomous technology that centers on self-driving vehicles also played a major role at CES. Though fully autonomous cars are not quite ready yet to roam on the streets without human assistance, major tech brands surprised us with some of their concepts and visions. BMW, for instance, demonstrated a mock-up cabin featuring gaze detection, which can track what you are looking at outside of the car and then present relevant information about it, providing users with an immersive experience.



A self-driving car that features a gaze detection system and provides users with an immersive experience. (Photo credit: BMW)

Apart from the three key themes highlighted at the show, Chao noted that CES 2020 definitely shed light on the rise of AI consumerization. He explained, “Fusion AI is like an ‘enabler’ that will boost the use of more AI control for many end devices and services.”

With increasing transformative technologies and emerging trends including self-driving cars and digital health being played out across this year’s show floor, this signals the advent of the data age, where consumers will embrace faster connectivity and advanced intelligence for vital technologies to optimize our everyday life.



» Latest Updates

Arts@ITRI: When Technology Meets Art



Arts@ITRI showcased its results in an exhibition in late 2019, with attending guests including Deputy Minister of Culture Tsung-Huang Hsiao (third right in front row) and ITRI's General Director of Service Systems Technology Center Roger Cheng (third left in front row).

Arts@ITRI, the first-ever residency program launched by the Ministry of Culture and ITRI, unveiled its results in art-technology collaboration in a joint exhibition. This 8-month program selected three groups of artists: Wen-Cheng Lee, Yu-Shen Li and Yi-Ching Liao of Piànn-Tiúnn art group, Chieh-Sen Chiu & Margot Guillemot (C&G Art Group) and Huang Yi (Huang Yi Studio+) to work side by side with ITRI researchers, allowing them to gain access to the world-

class R&D institute for creating their artwork.

Deputy Minister of Culture Tsung-Huang Hsiao commented that he looks forward to seeing more artists collaborate with ITRI for cultural enrichment. ITRI's General Director of Service Systems Technology Center Roger Cheng also responded that this residency program is a win-win solution for technology and art to fully engage with each other as artists and researchers can find new inspirations during the process of exploring what technology can do for art. He indicated that applying innovative technology in art will not only show impressive originality and global impact but also drive the development of the cultural technology industry.

The works from these art groups range from dance performance to cultural landscape artwork and stage management, interacting with ITRI's diverse R&D capabilities in 3D scanning/printing, facial recognition and 3D modeling, and artificial intelligence (AI). Project leader Hsiang-Lan Shih, Deputy Manager of ITRI's Service Systems Technology Center, commented that through this project, team players were able to co-work by sharing their creativity and technological competence and integrating the rational and emotional parts of their brains.

For artist Wen-Cheng Lee of Piànn-Tiûnn, his presentation is known as "Strengthen Tendons and Bones of Deities" project. This artwork features a deity dance performance. "We'd like to present the character of deities in Taiwan's folk religion in a bold way by using a female dance performer," Lee stated. He indicated that the difficulty of this project lies in the weight of the dance costume, which is a huge burden for their female performer, Yi-Ching Liao, to execute dance moves. "ITRI researchers were able to solve this problem by using their medical-grade 3D printing technology to produce a lighter apparel design with excellent flexibility for our performance," said Lee. ITRI engineer Wei Li considered this task an interesting challenge to resolve. "Their requirement for altering the gadget stiffness is different from the demand for designing assistive devices for medical uses, not what we are used to," he said.



Artist Wen-Cheng Lee's team collaborated with ITRI on the deities' costume (left image) by designing a new gadget (right top image) that is light and flexible for dance movement.

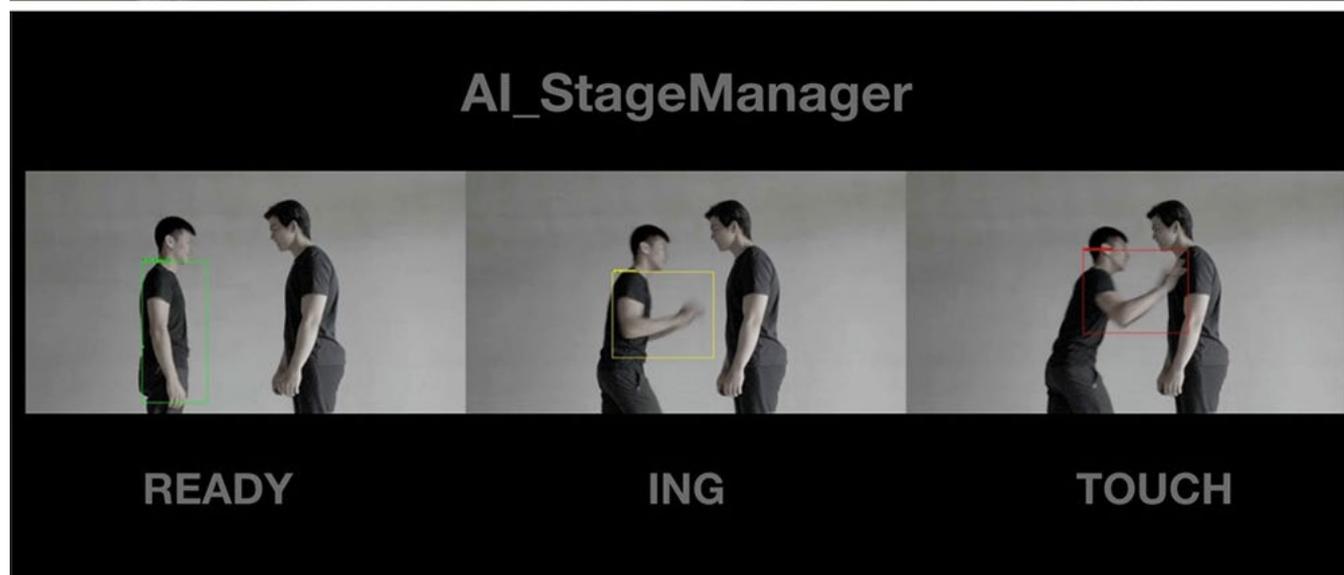
The second art group, Chieh-Sen Chiu & Margot Guillemot (C&G Art Group) created a work called "Borderlands", where they chose Beitou Heart Village as an example to explore the rupture zone between modern people, the environment and life-virtual world through digital technology. C&G Art Group explained that this presentation adopted ITRI's facial recognition technology to digitize all the viewers in front of the camera and convert these data into a constantly flowing image. It is through the collaboration from both sides that this work can present the desert world and interaction with viewers. Additionally, the black and white image of landscape displayed on screen will evolve into color images as the number of viewers increases. ITRI researcher Chun-Ting Lee noted that this work prompted them to be more aware of our social landscape and embrace a novel approach that connects rigid data from sensor technology with landscape images.



In the C&G Art Group work “Borderlands”, the black-and-white image depicting the landscape will gradually shift its colors with the growing number of viewers in front of the camera.

As for Huang Yi, his projects include “Specimen of the Soul” and “AI Stage Manager”, which incorporate ITRI’s expertise in 3D printing and AI. “I want to keep the memory of those close to us by preserving their appearance,” stated Huang Yi. “For Specimen of the Soul, ITRI’s industrial technology with high precision and resolution holds the key to this creation.” He further explained that ITRI’s 3D-printed face portrait of his partner dancer and Huang Yi Studio+ co-founder Hu Chien is so refined that even the facial pores can be seen.

The other project “AI Stage Manager” focuses on teaching AI to recognize dance moves and predict the timing of movement through deep learning. “AI Stage Manager is not created to replace humans, but rather to work with us and do something we are not able to do,” expressed Huang. In the collaboration with ITRI, he was thrilled to see that AI finally can recognize body movement like touch or disengagement. He believes that an AI stage manager will soon be able to monitor the entire stage, helping a human stage manager to call and execute every cue with correct timing during a show. Jerry Wang, Industrialization Deputy Division Director of ITRI’s Electronic and Optoelectronic System Research Laboratories, remarked that this project also inspired his team to apply a similar technology to Metro’s track inspection.



Huang Yi Studio+ and ITRI worked together on the projects “Specimen of the Soul” (top image) and “AI Stage Manager” (bottom image).

To conclude, Arts@ITRI exemplifies successful interdisciplinary collaboration between art and technology. As project participant and Division Director of ITRI’s Service Systems Technology Center Dr. Hong-Dun Lin suggested, this project initiates a remarkable process of cross-sector

communication between qualitative and quantitative approaches, between abstract and concrete thinking. “The purpose is not to turn art into technology, but add value to art through technology,” he stressed.

» Latest Updates

ITRI, Xplova, and Everest Textile Collaborate on Digital Fitness Platform



From left: Director of Xplova Jia-Yan Chen, ITRI President Edwin Liu, ITRI Senior Vice President Jia-Ruey Duann, and Everest Textile VP Eric Wu.

ITRI, Xplova, and Everest Textile signed an MoU (Memorandum of Understanding) on January 7 at CES 2020 in Las Vegas to announce their cooperation on the development of a digital fitness platform. The cooperation will see the three parties team up to develop innovative applications in smart sports and digital health around ITRI's iStimUwearR, a CES 2020 Innovation Awards Honoree. The aim is to promote such applications in the smart sports sector and help firms to gain a competitive edge in the global markets.

The agreement, witnessed by ITRI President Edwin Liu, was signed by ITRI Senior Vice President Jia-Ruey Duann, Director of Xplova Jia-Yan Chen, and Everest Textile VP Eric Wu.

Under the MoU, each party is able to play to their strengths. ITRI, for instance, has a smart wearable system that can be integrated into fabrics for exercise performance evaluation and healthcare improvement. Everest Textile, a major supplier to the world's greatest sports brands including Nike, Decathlon, Lululemon, and The North Face, will produce innovative, high value-added textile products such as smart garments and accessories for cyclists. Xplova, a subsidiary of Acer Inc. that specializes in smart cycling computers, can combine these products with its smart devices and technology platform to collect data and provide cyclists feedback.

“I am glad ITRI can work together with our brilliant industry partners to develop a digital fitness platform and deliver the values of technologies to our society. This strategic cooperation forges a seamless supply chain. It joins the efforts of a technology innovator, a textile manufacturer, and a smart sport training system architect. The MoU enables the three parties to tap into the digital electronics market, promote sports technologies, and seize new business opportunities,” said ITRI President Edwin Liu. “It also reflects ITRI’s commitment to maximizing the impact of its R&D results and helping industries transform and upgrade,” he added.

“With the recent surge of sports technology worldwide, Xplova is moving into the field of smart training that offers a platform for users at home to experience cycling challenges with other online users or simply work out alone. It is our honor to sign the MoU to develop a digital fitness platform with ITRI and Everest Textile. Through this cross-sector cooperation, we hope to provide a perfect solution for consumers from outdoors to indoors and across amateurs to professionals,” commented Director of Xplova Jia-Yan Chen.

“Everest is an R&D oriented and vertically integrated textile company, manufacturing products from yarns to garments. We have an extensive global network, especially our new manufacturing factory here in the United States, in Forest City, North Carolina,” said Everest Textile VP Eric Wu. He is happy with the initial result of the smart clothing products made with ITRI’s iStimUwear, and appreciates the support from and teamwork with ITRI and Xplova. “ITRI and Xplova are the most impressive partners that we have worked with. We look forward to a successful partnership and a promising future!”

ITRI’s iStimUwear is a health-assisting system integrating TENS (transcutaneous electrical nerve stimulation) into fabrics to intelligently evaluate body status and exercise performance and provide optimized stimulation for pain relief, self-massage, and personal healthcare evaluation and improvement.

iStimUweaR



Video of iStimUweaR.



» Latest Updates

Taiwan's Largest Autonomous Vehicle R&D Project Kicks Off



From left: ITRI Executive Vice President Pei-Zen Chang, Director General of DoIT, MOEA Ta-Sheng Lo, and Mobiletron and RAC Electric Vehicles Chairman Kim Tsai.

ITRI and Mobiletron launched the largest autonomous vehicle R&D project in Taiwan, which will see the introduction of ten locally made autonomous electric buses by 2021. The first of the vehicles is expected to roll off the pilot production line in the first quarter of 2020. Local bus operators will also join the project to work on self-driving verification in designated areas. This initiative involves 14 vehicle electronics manufacturers, including those involved in motors, automotive displays, system integration, sensors, geospatial information, and cybersecurity. It is hoped the collaboration will build an autonomous vehicle industry chain and help Taiwan enter the first-tier supply chain for international automakers.

ITRI Executive Vice President Pei-Zen Chang remarked that autonomous vehicles play an essential role in smart transportation and are a key component in ITRI's 2030 Technology Strategies and Roadmap. He stressed that ITRI took the lead in developing the Surrounding Sensing Subsystem (S3). In 2018, it established the S3 Partnership Program and cooperated with Mobiletron in operating a trial shuttle system during the Taichung World Flora Exposition. "ITRI is delighted to sign this autonomous electric bus trial production agreement with Mobiletron," said Dr. Chang. "It is expected that in 2020, we can work with local bus operators to develop commercial operation models that can generate economic value and help to shape a smart futuristic city."

"The cooperation with ITRI is the first initiative setting the foundation for the mass production of autonomous electric buses," said Mobiletron and RAC Electric Vehicles Inc. Chairman Kim Tsai. He pointed out that Mobiletron is the first dedicated maker of automotive electronics in Taiwan and RAC Electric Vehicles is able to produce a highly efficient six-stage automatic transmission drive system and leverage Mobiletron's lithium battery active balance system to complete a Level 3+ self-driving bus production line in 2021. Mobiletron and RAC, he said, will also develop a smart autonomous electric bus platform that integrates ITRI's innovation along with Taiwan's ICT, energy storage, and key automotive components technologies, in order to target the global markets.

Dr. Tzi-Cker Chiueh, ITRI's Vice President and General Director of Information and Communications Research Laboratories, stated that this cooperation combines the strengths of both sides. While Mobiletron is committed to developing smart, green buses, ITRI is steering what is currently Taiwan's largest R&D project for autonomous electric buses and is developing a self-driving sensing subsystem that fits the unique needs of Taiwan and Asia. This system takes into consideration the wide variety of vehicles on Taiwan's roads as well as the long rainy seasons. Moreover, ITRI's V2X road safety solution iRoadSafe can be introduced through this project, setting a successful example of integrating connected vehicle technology with autonomous vehicles.



The initiative joins the forces of 14 vehicle electronics manufacturers to build an autonomous vehicle industry chain in Taiwan.

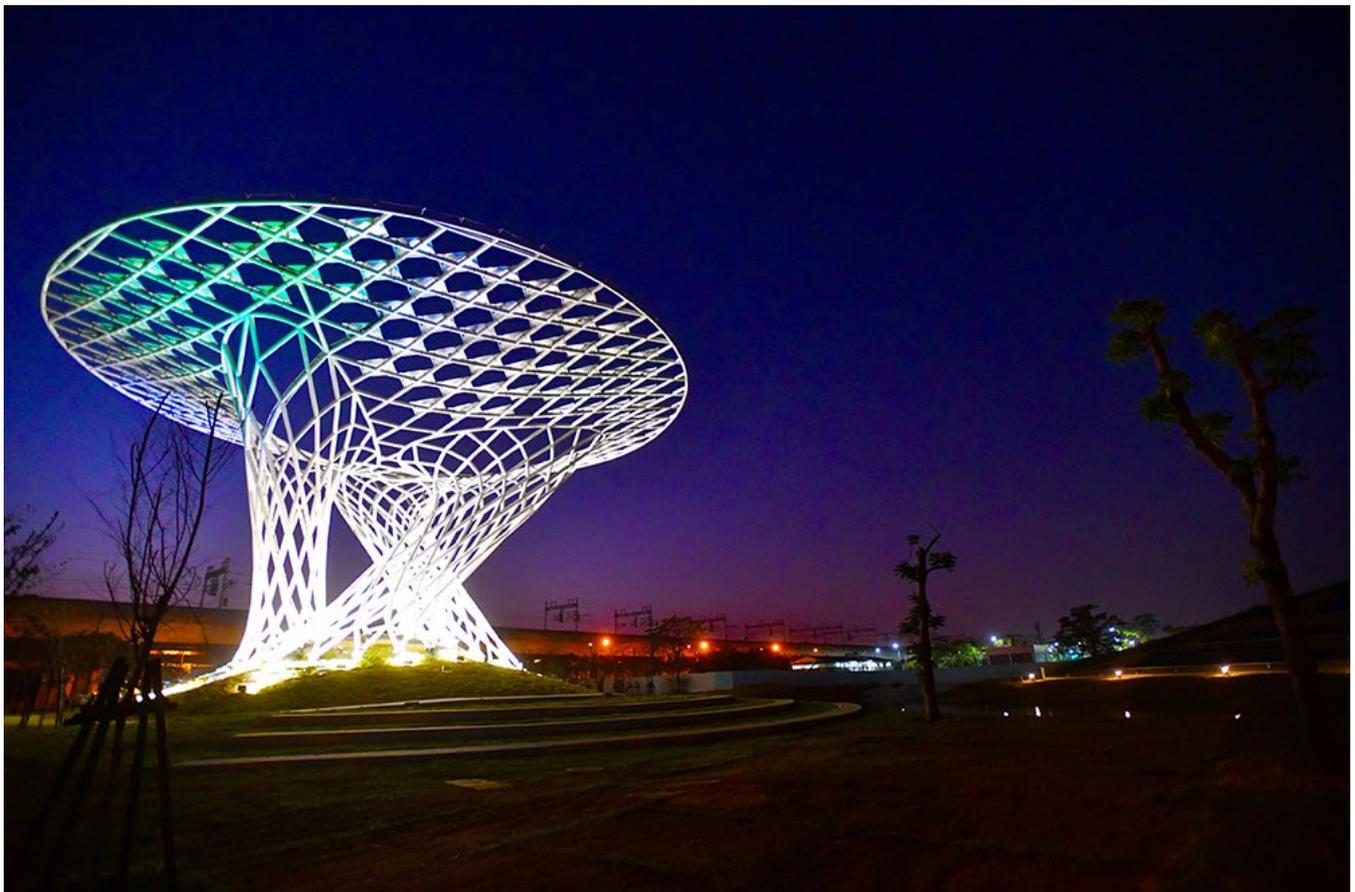
Neousys Technology, a leading manufacturer of rugged embedded wide-temperature industrial PCs, also took part in this project as an official provider of the autonomous driving sensing platform by utilizing its GPU computing platform to construct the S3 system. Other participating companies include Bluestar, Moxa, Unex Technology, Qisda, ANEST IWATA, Alpha Networks, TECO Electric & Machinery, Kingwaytek Technology, Forward Electronics, MaxWin Technology, and Whetron Electronics.



» Latest Updates

Green Energy Technology Demonstration Site Launched

Anchoring the Creation of a Green Economy Cluster



The Green Energy Technology Demonstration Site is expected to form an innovative green energy industrial ecosystem and create a green economy cluster.

The Green Energy Technology Demonstration Site, which is located at the Shalun Smart Green Energy Science City (SGESC), was officially launched in the middle of December 2019. The demonstration site is the first of its kind in Taiwan and will support rapid industrialization of mature green energy technologies. The SGESC, a key component of the government's 5+2 innovative industries plan, will further tie together 30 technology parks and industrial zones within a 45-kilometer radius and provide industries with a field for technology R&D, testing, verification, and matchmaking. The aim is to form an innovative green energy industrial ecosystem and forge a green economy cluster.



Multiple solar photovoltaic generation systems are established in the Shalun Green Energy Technology Demonstration Site.

Besides the Green Energy Technology Demonstration Site, the science city also includes the Joint Research Center for Green Energy Technologies, Southern Campus of Academia Sinica, Taiwan CAR (Connected, Autonomous, Road-test) Lab, the Multifunction Conference and Exhibition Center, and the Smart, Green, and Circular Economic Residential Park. An outlet park will also be built. This will create a comprehensive industrial cluster from R&D and production, to display and marketing, and will provide sufficient amenities to people working and living there. The SGESC is the only locale in Taiwan where the nation's three major research organizations –Academia Sinica, National Applied Research Laboratories, and ITRI– will all have a presence. It is expected that the proximity of these researchers to each other will help to stimulate the development of more innovative and smart green energy technologies.

ITRI Chairman Chih-Kung Lee said he was pleased that the Green Energy Technology Demonstration Site is the first major facility being launched in the science city, and that it is now ready for researchers and companies to use. The demonstration site will not only become a unique landmark in southern Taiwan but also provide a comprehensive system testing and verification ground, along with matchmaking services, for green energy technologies. Dr. Lee added that over 200 ITRI colleagues have begun working at the facility, highlighting ITRI's determination to boost its R&D capacity here and establish an innovative green energy industry ecosystem.



Taiwan Vice President Chien-Jen Chen (7th left) attended the signing ceremony for a number of major companies to enter the Green Energy Technology Demonstration Site on the day of the SGESC launch.

The Green Energy Technology Demonstration Site has also attracted several companies to enter, including Formosa Plastics Group, solar power heavyweight Motech Industries Inc., the world's second largest screw compressor manufacturer Hanbell Precise Machinery Co., Ltd., SolarEdge Technologies, and Dyna Rechi Co., Ltd. This shows the benefit of industrial clustering—creating a strong magnetism for so many important firms to gather. Pilot production lines and testing and verification platforms will be established in this area.



» Latest Updates

ITRI Named a Derwent Top 100 Global Innovator for Fourth Time

Standing Out as the Only Research Institute in Asia on the 2020 List



ITRI received the Derwent Top 100 Global Innovators 2020 award from Clarivate Analytics in early March.

ITRI was again named a Derwent Top 100 Global Innovator by Clarivate Analytics. It is the fourth time and the third consecutive year that ITRI has won a place on this prestigious list, making it the most awarded organization in Taiwan ever. ITRI is also the only research institute in Asia to be named a Top 100 Global Innovator for 2020. Other winners this year include international companies such as Google, Microsoft, Merck, and NTT.

Now in its ninth year, *Derwent Top 100 Global Innovators* identifies the world's most innovative organizations which successfully develop valuable patented inventions that also have strong commercialization potential based on market reach and impact on other downstream inventions. The assessment utilizes editorially enhanced authoritative patent data from [Derwent World Patents Index \(DWPI\)](#) and [Derwent Patent Citations Index \(DPCI\)](#) to

track innovation based on four criteria: volume, success, globalization and influence. Winning this award represents outstanding effort not only in the quantity of filed patents, but also success in obtaining granted patents, breadth of filing of inventions, and external citations. According to Clarivate Analytics, ITRI is particularly excellent in its patent success and influence this year.

“We are really honored to once again be recognized as a Top 100 Global Innovator by Clarivate Analytics. Winning this award for the fourth time is truly a great acknowledgement of our multidisciplinary innovation capability and robust intellectual property (IP) achievements,” stated ITRI President Edwin Liu. “To innovate a better future, ITRI developed the 2030 Technology Strategy and Roadmap that assumes future scenarios for technology and market needs. Following this initiative, we will continue to boost our R&D capacity and build strong IP portfolios. In every effort we make, we are fulfilling our commitment to helping Taiwan’s industry stay competitive, explore new opportunities, and present novel solutions to critical issues.”

“We are pleased to see that ITRI has been nominated again. Its long-term investment and commitment to innovation has also been reflected in our report analysis,” said Nathan Fan, Head of Derwent, Greater China and General Manager of Taiwan, Clarivate Analytics. “For the first time, in 2020, the report’s analysis extends beyond the Top 100 to have a closer look at trends. Today’s modern inventions, from electric vehicles to medical devices, require deeper and broader expertise, as well as collaboration across previously unrelated disciplines. This also implies that working together across boundaries is key to a more thriving future for innovation in Taiwan.”

The Derwent Top 100 Global Innovators 2020 come from three continents and 14 countries/regions. Besides ITRI, there are three other recipients from Taiwan: Foxconn Technology Group, HTC, and Quanta Computer. Amongst the top 100, ITRI, Fraunhofer, the French Alternative Energies and Atomic Energy Commission, and University of California are the only four government-sponsored research institutions to make the list.



About Derwent

Derwent™, a Clarivate Analytics company, powers the innovation lifecycle from idea to commercialization—with trusted patent data, applications and services including Derwent Innovation™, Derwent World Patents Index™, Derwent Patents Citation Index™ and Derwent Data Analyzer™. The company builds solutions for inventors, patent attorneys and licensing specialists at start-ups and the largest global innovators, legal professionals at the leading IP practices, and patent examiners at more than 40 patent offices. Its solutions are used to monitor technology trends and

competitive landscapes, inform FTO opinions, prosecute patents, monetize and license assets and support litigation activities.



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ITRI is one of the world's leading technology R&D institutions aiming to innovate a better future for society. Founded in 1973, ITRI has played a vital role in transforming Taiwan's industries from labor-intensive into innovation-driven. It focuses on the fields of Smart Living, Quality Health, and Sustainable Environment. Over the years, ITRI has incubated over 280 innovative companies, including well-known names such as UMC and TSMC. In addition to its headquarters in Taiwan, ITRI has branch offices in the U.S., Europe, and Japan in an effort to extend its R&D scope and promote opportunities for international cooperation around the world.

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