Best of Last Year: The top TechXplore articles of 2019

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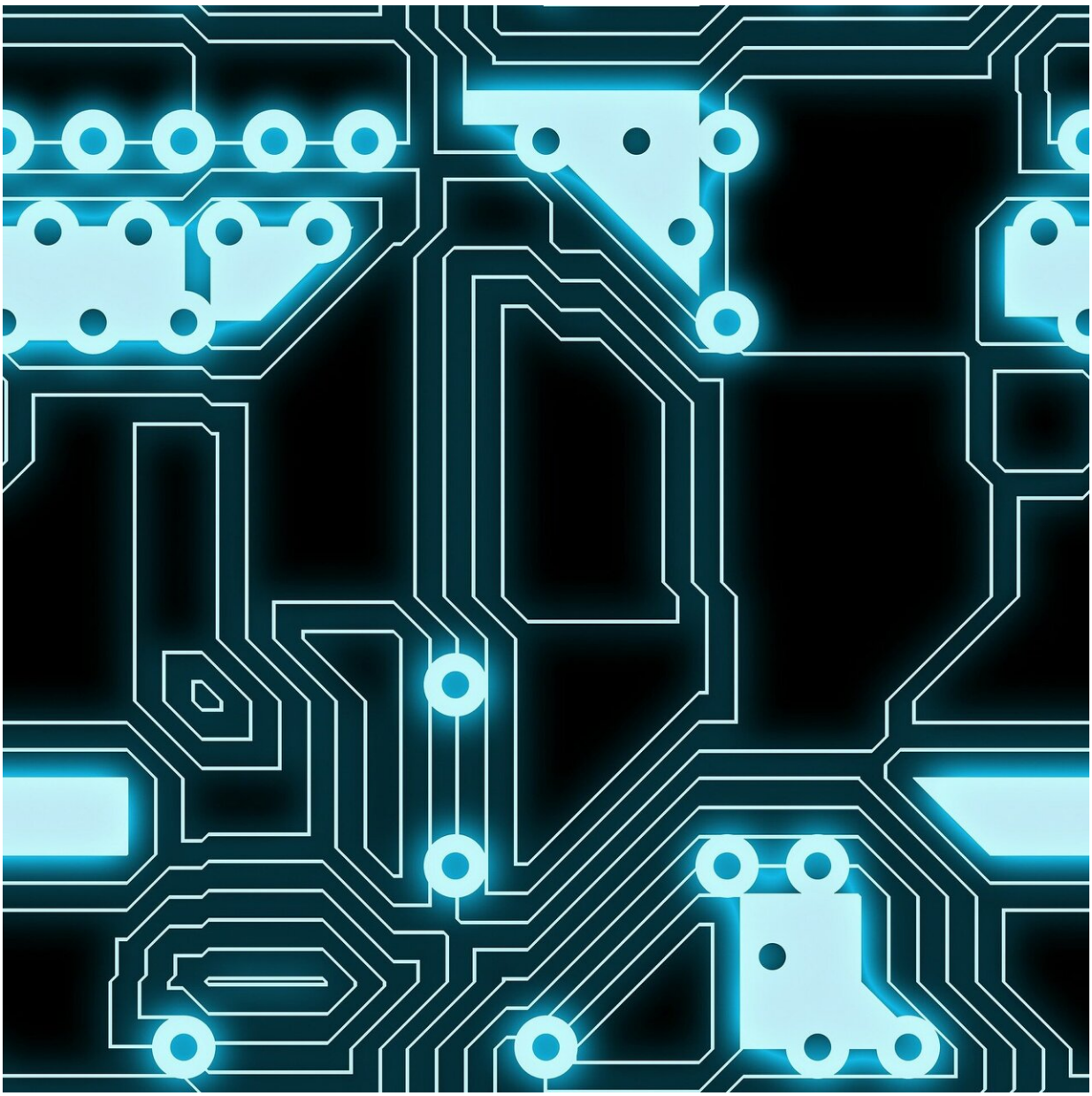

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It was a good year for technology development as a pair of engineers at Iowa State University solved a 50-year-old puzzle in signal processing—they came up with an algorithm to provide a generalization of the inverse fast Fourier transform—they called it the inverse chirp z-transform, and noted that it could be used with exponentially decaying or growing frequency components.

A team at UC Berkeley claimed that drones would fly for days with their new photovoltaic engine—they said that they were testing a novel design with the potential for 50 percent efficiency, developed by applying well-established scientific concepts. They had already broken a record in photovoltaic efficiency by reaching 23 percent and were confident they could do better by adding a highly reflective mirror on the back of their photovoltaic cell.

A team at Pennsylvania State University came up with a lithium ion battery design that can charge an electric vehicle in 10 minutes. Their design involved making charges at an elevated temperature to increase the reaction rate while keeping the cell cool during discharge—a technique that they reported added 200 miles of driving range for an electric car with just a 10-minute charge.

A team of engineers at Columbia University created a system to translate brain signals directly into speech. Their system was developed with speech synthesizers and artificial intelligence with assistance from volunteer epilepsy patients undergoing already scheduled brain surgeries. The system can recognize a sequence of numbers by analyzing brain waves.

And a team at the U.S. Department of Energy's Lawrence Berkeley National Laboratory discovered that with little training, machine-learning algorithms can uncover hidden scientific knowledge. They created a system with an algorithm using no training in materials science that can scan the text of millions of papers to uncover new scientific knowledge—they taught the system with 3.3 million abstracts of published materials science papers.

A team at the University of Michigan found that 3-D printing could be 100 times faster with light. Rather than building up plastic filaments layer by layer, as with conventional printers, their new approach to 3-D printing involved lifting complex shapes from a vat of liquid by solidifying liquid resin using two lights to control where the resin hardened and where it stayed fluid.

And a team of Italian mathematicians found that novel math could bring machine learning to the next level. They showed that artificial vision machines could learn to recognize complex images more quickly by using a mathematical theory developed 25 years ago by one of the team members—the technology involved teaching the network about real-world faces or other objects before training to restrict the set of features it analyzed.

Also, a team at UC Santa Barbara developed a new method of identifying a person through walls from candidate video footage using only WiFi. Their system was able to determine whether a person standing behind a wall was the same individual who appeared in video footage using only a pair of WiFi transceivers outside. The software analyzed and compared the gait of the live person with the video.

A team of researchers from the Karlsruhe Institute of Technology proposed air conditioners as a climate-change remedy. Their idea involved adding hardware to otherwise normal air conditioners that

would pull carbon from the air as they cooled buildings. The carbon and some added water could then be converted into renewable hydrocarbon fuel.

A team at the University of San Francisco came up with the novel idea of using Spotify data to predict which songs will be hits. They trained four machine-learning models on song-related data extracted using the Spotify Web API and then evaluated their performance in predicting which songs would become hits. They found the best one achieved a precision rate of 99.53 percent.

A team with members from the University of Wollongong, Deakin University, Monash University and Kyushu University collaborated on a framework for AI-powered agile project management. The work explored the potential use of AI for agile project management—a means for assisting in the rapid creation and delivery of software using an iterative approach. Their proposed framework included deep learning, reinforcement learning, natural language processing, evolutionary search and intelligent agents.

A team of researchers at Dalhousie University working with Tesla reported the development of a million-mile battery. They used a cathode material from the family of Ni-rich NCM cathode materials because it had a specific capacity 20 percent higher than those used in Li-ion batteries that power mobile electronic devices. They also suggested that such a battery should last at least two decades.

And in an interesting historical challenge, a team of engineers at MIT put Leonardo da Vinci's bridge design to the test. The bridge was originally designed by da Vinci to connect Istanbul with its neighbor city Galata. But it was never built; another designer got the job. To find out if it would have worked, the researchers created small replica blocks from da Vinci's notes and used them to build the bridge. They report that

it worked as planned.

A collaboration between several European universities as part of the ASSISIbf project led to the creation of a robot that enabled bees and fish to talk to each other. The robot was able to get two extremely different animal species located far apart to interact with each other and to reach shared decisions. The bees were located in Austria and the fish in Switzerland—the robot allowed them to send signals back and forth to coordinate their decisions.

And a team at MIT came up with a novel data-compression technique for faster computer programs. They described their effort as the first approach to compress objects across the memory hierarchy rather than moving it in conventionally sized fixed chunks—the new approach could reduce memory usage while improving performance and efficiency.

Beth Parks, a Colgate University researcher working on a Fulbright fellowship in Uganda, along with a group of students, developed a novel way to get a solar panel to follow the sun—the researchers placed a bucket of rocks on the west side of the frame and a bucket of water on the east side. Using a controlled leak from the water bucket, the weight shifted and the panel slowly rotated from east to west throughout the day. Testing showed it captured 30 percent more sunlight than a standalone panel.

And a team of engineers at MIT developed a new way to remove carbon dioxide from the air. The technique was based on passing air through a stack of charged electrochemical plates. The group described it as a large battery that could absorb carbon dioxide as air moved over its electrode during charging. Notably, it could remove carbon even with low concentrations such as that found in the air.

Also, a team from the University of California collaborating with

Solargiga Energy in China found that caffeine could give solar cells an energy boost. They noted that caffeine is an alkaloid compound containing molecular structures that could interact with the precursors of perovskite materials, and therefore, it could be used to improve the thermal stability of the solar cells. Doing so improved efficiency from 17 percent to over 20 percent.

A team at Saule Technologies, led by company founder Olga Malinkiewicz. claimed that "Inkjet' solar panels were poised to revolutionize green energy. The company was developing a novel inkjet processing method for perovskite, used for the current generation of inexpensive solar cells. The company envisions coating the windows of buildings, allowing them to generate their own electricity.

A team at Technion-Israel Institute of Technology announced the development of a new water-splitting technique to generate clean hydrogen. They came up with the idea of separating the oxygen and hydrogen compartments in a PEC cell into two separate cells,so that the oxygen was generated in the solar field and released to the atmosphere, while the hydrogen was generated in a central reactor at the corner of the field.

And a team with members from Stanford University and the SLAC National Accelerator Laboratory announced a new, more user-friendly language for programming supercomputers. The new system is based on a programming language the team developed called Regent. The resulting programming environment allowed researchers to use supercomputers without becoming experts on the computer system.

A team of engineers at the University of Sussex demonstrated the first-ever personalized sound projector using a $12 webcam. The demonstration involved tracking a moving individual and delivering an acoustic message as the individual moved to a high-profile tech and

media conference in L.A. The system worked with in-house face-tracking software that piloted an Arduino-controlled acoustic telescope to focus sound on a moving target.

A team at MIT gave a presentation at the 2019 International Conference on Learning Representations outlining their work on algorithm designs to optimize machine-learning models up to 200 times faster than traditional methods. In their presentation, they described their NAS algorithm that could directly learn specialized convolutional neural networks for target hardware platforms that run on a massive image dataset in only 200 GPU hours, which could enable far broader use of such algorithms.

And finally, a team of researchers at the University of Illinois at Urbana-Champaign built microscopic biohybrid robots propelled by muscles and nerves. The soft robotic devices were driven by neuromuscular tissue that triggered when stimulated by light. The group demonstrated a new generation of two-tailed bots powered by skeletal muscle tissue stimulated by onboard motor neurons. The neurons had optogenetic properties: Upon exposure to light, the neurons fired to actuate the muscles.

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