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Compiled by:-
Bharti Ghildiyal,Aniket Bharti
Atif Ali(MCA 2nd sem)

Designed by:-
Sujeet Pratap Singh
(MCA Dept.)

Coordinated by:-
Ms. Shalika Arora
(Asst. Prof.,MCA)

Akhilesh Mourya
Senior Software Engineer
Oracle

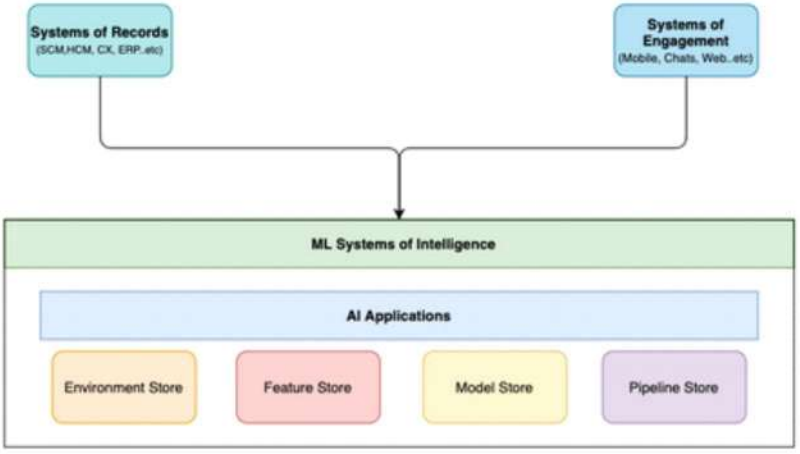
Systems of Intelligence (SOI) - Building Moats for Artificial

to be continued...

In medieval times, moats were built across the castle which served the first line of defense. In the world of machine learning world, the moats are of infrastructure where in there is a stable environment where in the machine models that are developed doesn't have inconsistencies w.r.t model environments, migrating from one environment to another is seamless, maintenance and monitoring of the environments are self-sustainable. In today's world, to build a sustainable and profitable business, you need strong defensive moats around your company. This also serves the purposes of developing and deploying machine models at economies of scale and has "Network effects" with the customers.

Different Components of System of Intelligence

The system of intelligence is a process to extract value from machine learning models for SaaS apps customers and more generally for OCI customers using the AI platform.
The objectives of building such a system is to automatically harvest the key information from system of records (SOR) data, generate re-usable features that can be utilized to train, test, deploy, manage, and monitor by data scientists, machine learning engineers and apps developers alike and consumed by alike Apps. The SOI Apps provide a centralized store where resources related to machine models such as machine model environment parameters, features, machine learning models, and machine learning model metrics can define monitored, shared, re-used across applications, and use cases. These SOI store can be categorized as follows:



1. Environment Store

In today's world data scientists and machine learning engineers deal with many open-source projects, especially in the Python ecosystem. ML engineers and data scientists use a variety of libraries and tools that need to be baked into environments that are available to AI applications and runtime model infrastructures.
Some of the challenges that they face for example are inconsistencies in the python packages, different python versions, which leads to incompatibilities when migrating the machine learning models from one environment to another. The environment store will provide an API to manage the lifecycle of images that contain first- and third-party libraries that are needed to run the AI applications and models in production. The value of the environment store is to provide a simple, easy to use CI/CD tool for data scientists to build, document, version, share, and store those environments for doing data transformation, feature engineering, model training or for model deployment. AI applications can leverage pre-built images or create its own. The environments API will integrate with each Data Science workload resource API (Notebook Sessions, Jobs, Model Deployments, perhaps ML Pipelines) as needed so that the configuration of the workload environments is completed by the user through the Environments API, rather than custom environment variables of runtime.yaml configuration as it is today.

2. Feature Store

In machine learning and pattern recognition, a feature is an individual measurable property or characteristic of a phenomenon. In machine learning, features are individual independent variables that act like an input in your system. While making the predictions, models use such features to make the predictions. And using the feature engineering process, new features can also be obtained from old features in machine learning. The key issues for data scientists when developing a machine learning model is that they expect a consistent feature behavior in while training and as well as serving (inferencing). Many a times data scientists will encounter inconsistencies with respect to features getting changed from training to Serving / inferencing, which is known as "data leakage" or training-serving skew. One of the methods to avoid data leakage is to develop a warehouse which can create feature sets, update, monitor feature sets for data leakage and can be shared and re-used by other Data Scientists and Machine learning engineers.

Features are not the same as raw data. Features are created from raw data for machine learning or explanatory purposes. The feature store is a flexible storage system designed to store features, entities, and embeddings for machine learning purposes. The feature store is a full resource on its own with its own control plan and API. AI applications and data scientists can create features, version them, pull them for training or inference purposes, verify their integrity (e.g., flag missing or anomalous values). Data scientists can share, document, and search through available features to build better models. Main benefits of a feature store are around efficiency, consistency, and scalability. Feature stores foster true collaboration among data scientists in large organizations.

Creating features is expensive. Many data scientists in large orgs are unaware of the features that are being designed for other projects and there is frequent duplication of work. When data scientists can share their efforts via a common, centralized "library" of features, you minimize the amount of duplication and wasted efforts. This is true for data scientists and for their customers. The system of intelligence allows AI applications to populate the feature store with machine features. Those features can be detected and reused by other AI applications and by our customers' data scientists. Feature stores also enable consistency between the data used when training models and serving model predictions.

3. Model Store

The model store contains the model artifact itself as well as all the relevant metadata about the model. OCI Data Science already has an initial version of a model store (model catalog). The model store includes a superset of the current capabilities of the model catalog. The model store will allow AI applications to store, pull, version, compare, and promote different models for deployment. The model store will contain detailed information about the provenance of each model (lineage, version, resource that created the model, environment, code), its performance metrics, metadata about the structure of the model itself (hyperparameters, structure, problem class, etc.), information about the features used to train and validate the model.

AI applications will be able to bank on models in the model store and apply, for example, transfer learning techniques to tailor a model for a particular use case, or create a new, improved version of that model. Perhaps a model that does automated field extraction from an invoice statement could be trained to do extract fields on a bill of sale. Another core problem that the model store will solve is ensuring model reproducibility which is a requirement for deploying ML models in most regulated industries.

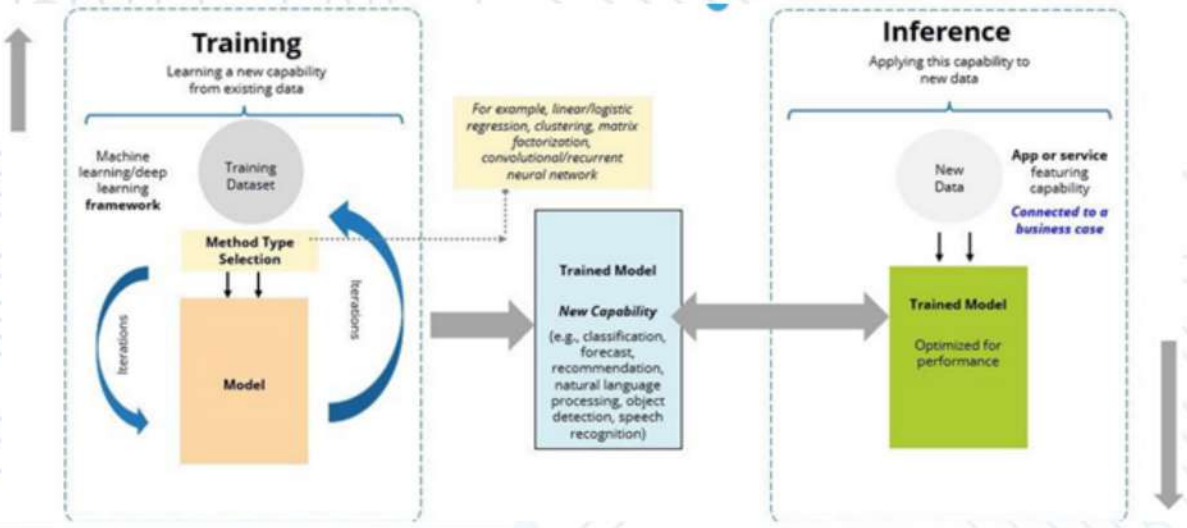
How this will Benefit the Data Scientists and ML Engineers

In 2015 a team of engineers from Google presented a paper titled "Hidden cost of technical Debt". About 90% of machine learning models that are developed will never get deployed into production path. This paper highlights the problems faced by data scientists in machine learning models deployment such as hidden feedback loops, boundary erosion, entanglement of features, undeclared customers, data issues and configuration issues. Effectively applying machine learning for business benefit requires:

- ML training - ML training consists of the steps required to build the ML model and can include model generation, model build, and model fit.
- ML inference - ML inference (i.e., prediction, scoring, or model serve) generates the insights that need to be integrated into a business use case, creating an ML business application that ultimately generates customer value.

ML training and ML inference do not exist in isolation. There is always a cycle that connects them (see Figure below). Models generated by ML training need to be sent to ML inference, and immediately or eventually, the experiences of live data must be used to further optimize the model in the next round of ML training. ML inference is integrated into the business use case, creating an application that

generates customer value. The tighter the execution of this cycle, the quicker the business can respond to changing circumstances. For example, by quickly learning a user's immediate shopping pattern and correlating it to notable events of the day, a business can generate better shopping recommendations and drive more sales. Many other examples of the value of quick adaptation exist. As more businesses adopt ML, competitiveness will be determined by not just whether you adopt ML but whether you can turn this cycle around and adapt your ML faster than your competitor.



It will help Data Scientists effectively collaborate with their Ops counterparts, offloading much of the burden of day-to-day model management. MLOps allows data scientists to focus on what's important — discovering new use cases to tackle, working on feature discovery, and building more in-depth business expertise. Data scientists should not be wasting time maintaining models or reviewing their performance manually. No more manual testing, monitoring, and validation.

How SOI will benefit customers and partners

Today, we expect the software we build our business on to be scalable, reliable, and efficient. And if we want to reap the benefits of AI, we'll need the same to be true of the models that increasingly drive business decisions to our customers. For years, we've optimized the way we build, run, and maintain software through DevOps, and now it's time to do the same for machine learning. Many areas within AI and machine learning are unchartered territories for customers but use of Systems of intelligence (SOI) your business derives the most value from your investments in machine learning.

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Meta builds AI models that provide realistic sounds in VR settings

Meta (formerly Facebook) has built three new artificial intelligence (AI) models designed to make sound more realistic in mixed and virtual reality experiences.

The three AL models – Visual-Acoustic Matching, Visually-Informed Dereverberation and VisualVoice – focus on human speech and sounds in video and are designed to push "us toward a more immersive reality at a faster rate," the company said in a statement.

"Acoustics play a role in how sound will be experienced in the metaverse, and we believe AI will be core to delivering realistic sound quality," said Meta's AI researchers and audio specialists from its Reality Labs team. They built the AI models in collaboration with researchers from the University of Texas at Austin and are making these models for audio-visual understanding open to developers.

The self-supervised Visual-Acoustic Matching model, called AViTAR, adjusts audio to match the space of a target image.

The self-supervised training objective learns acoustic matching from in-the-wild web videos, despite their lack of acoustically mismatched audio and unlabelled data, informed Meta.
VisualVoice learns in a way that's similar to how people master new skills, by learning visual and auditory cues from unlabelled videos to achieve audio-visual speech separation.

For example, imagine being able to attend a group meeting in the metaverse with colleagues from around the world, but instead of people having fewer conversations and talking over one another, the reverberation and acoustics would adjust accordingly as they moved around the virtual space and joined smaller groups.

MIT engineers boost signals from fluorescent sensors – offering unique glimpse inside living cells

MIT engineers found a way to dramatically improve the signal emitted by fluorescing nanosenors. The researchers showed they could implant sensors as deep as 5.5 centimetres in tissue and still get a strong signal.

Engineering advance allows particles to be placed deeper within biological tissue, which could aid with cancer diagnosis or monitoring.

Fluorescent sensors, which can be used to label and image a wide variety of molecules, provide a unique glimpse inside living cells. However, they typically can only be used in cells grown in a lab dish or in tissues close to the body's surface, since their signal is lost when they are implanted too deeply.

MIT engineers have now devised a solution to overcome that limitation. Using a novel photonic technique, they invented for exciting any fluorescent sensor, they were able to significantly improve the fluorescent signal. With this approach, the scientists showed they could implant sensors as deep as 5.5 centimeters (2.2 inches) in tissue and still get a strong signal.

According to the researchers, this type of technology might allow fluorescent sensors to be used to track specific molecules inside the brain or other tissues deep within the body, for medical diagnosis or monitoring drug effects.

"If you have a fluorescent sensor that can probe biochemical information in cell culture, or in thin tissue layers, this technology allows you to translate all of those fluorescent dyes and probes into thick tissue," says Volodymyr Koman, an MIT research scientist and one of the lead authors of the new study.

Enhanced fluorescence

Scientists use many different kinds of fluorescent sensors, including quantum dots, carbon nanotubes, and fluorescent proteins, to label molecules inside cells. These sensors' fluorescence can be seen by shining laser light on them. However, this doesn't work in thick, dense tissue, or deep within tissue, because tissue itself also emits some fluorescent light. This light, called autofluorescence, drowns out the signal coming from the sensor.

"All tissues autofluoresce, and this becomes a limiting factor," Koman says. "As the signal from the sensor becomes weaker and weaker, it becomes overtaken by the tissue autofluorescence."

To overcome this limitation, the MIT team came up with a way to modulate the frequency of the fluorescent light emitted by the sensor so that it can be more easily distinguished from the tissue autofluorescence. Their technique, which they call wavelength-induced frequency filtering (WIFF), uses three lasers to create a laser beam with an oscillating wavelength.

When this oscillating beam is shined on the sensor, it causes the fluorescence emitted by the sensor to double its frequency. This allows the fluorescent signal to be easily picked out from the background autofluorescence. Using this system, the researchers were able to enhance the sensors' signal-to-noise ratio more than 50-fold.

One possible application for this kind of sensing is to monitor the effectiveness of chemotherapy drugs. To demonstrate this potential, the researchers focused on glioblastoma, an aggressive type of brain cancer. Patients with this type of cancer usually undergo surgery to remove as much of the tumor as possible, then receive the chemotherapy drug temozolomide (TMZ) to try to eliminate any remaining cancer cells.

This drug can have serious side effects, and it doesn't work for all patients, so it would be helpful to have a way to easily monitor whether it's working or not, Strano says.

When temozolomide enters the body, it gets broken down into smaller compounds, including one known as AIC. The MIT team designed a sensor that could detect AIC and showed that they could implant it as deep as 5.5 centimeters within an animal brain. They were able to read the signal from the sensor even through the animal's skull.

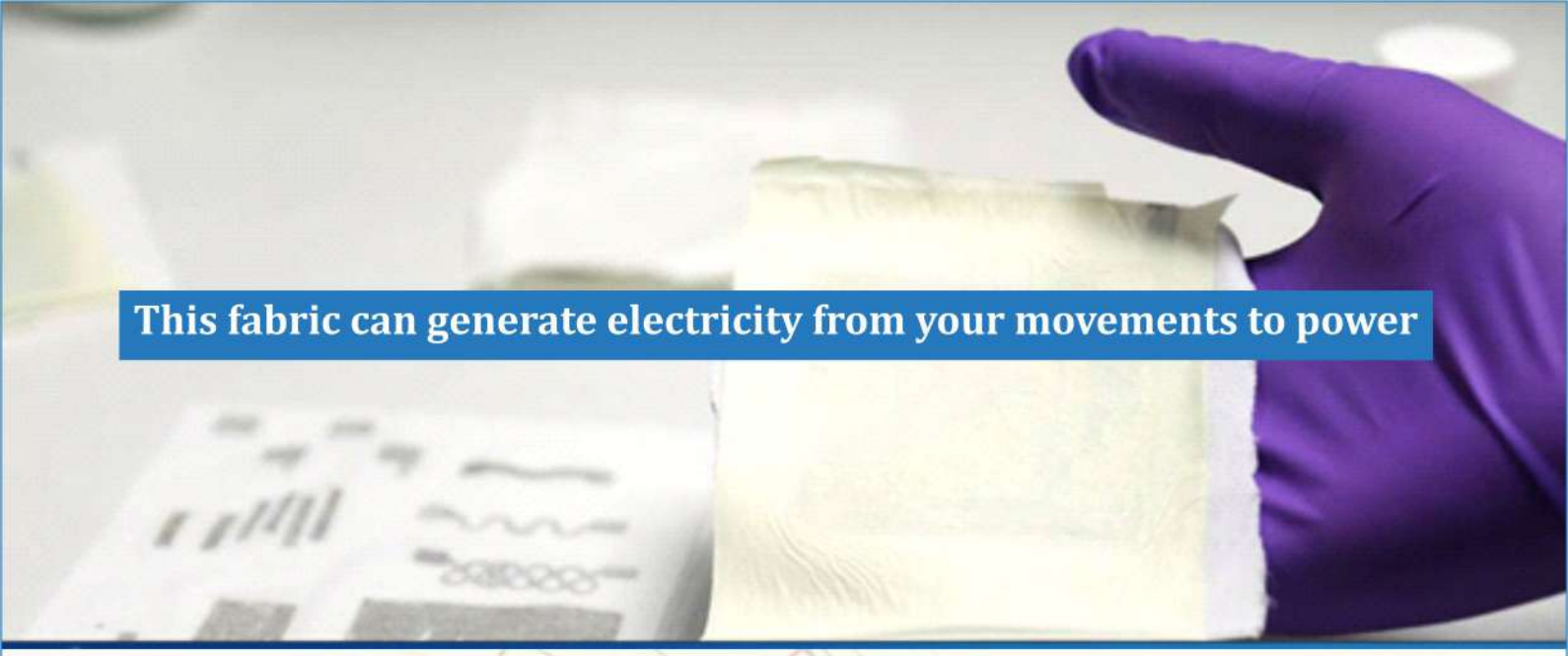
Such sensors could also be designed to detect molecular signatures of tumor cell death, such as reaction oxygen species.

"Any wavelength"

In addition to detecting TMZ activity, the researchers demonstrated that they could use WIFF to enhance the signal from a variety of other sensors, including carbon-nanotube-based sensors that Strano's lab has previously developed to detect hydrogen peroxide, riboflavin, and ascorbic acid.

For this study, the researchers used three lasers together to create the oscillating laser beam, but in future work, they hope to use a tunable laser to create the signal and improve the technique even further. This should become more feasible as the price of tunable lasers decreases and they become faster, the researchers say.

To help make fluorescent sensors easier to use in human patients, the researchers are working on sensors that are biologically resorbable, so they would not need to be surgically removed.

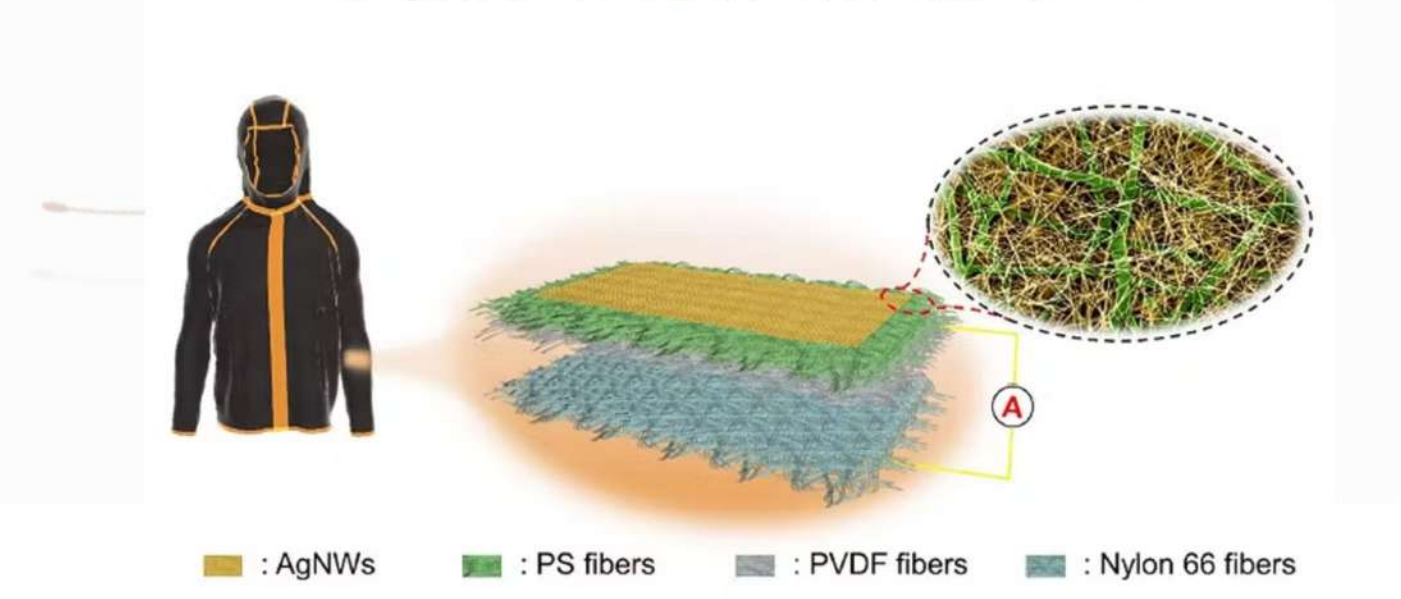


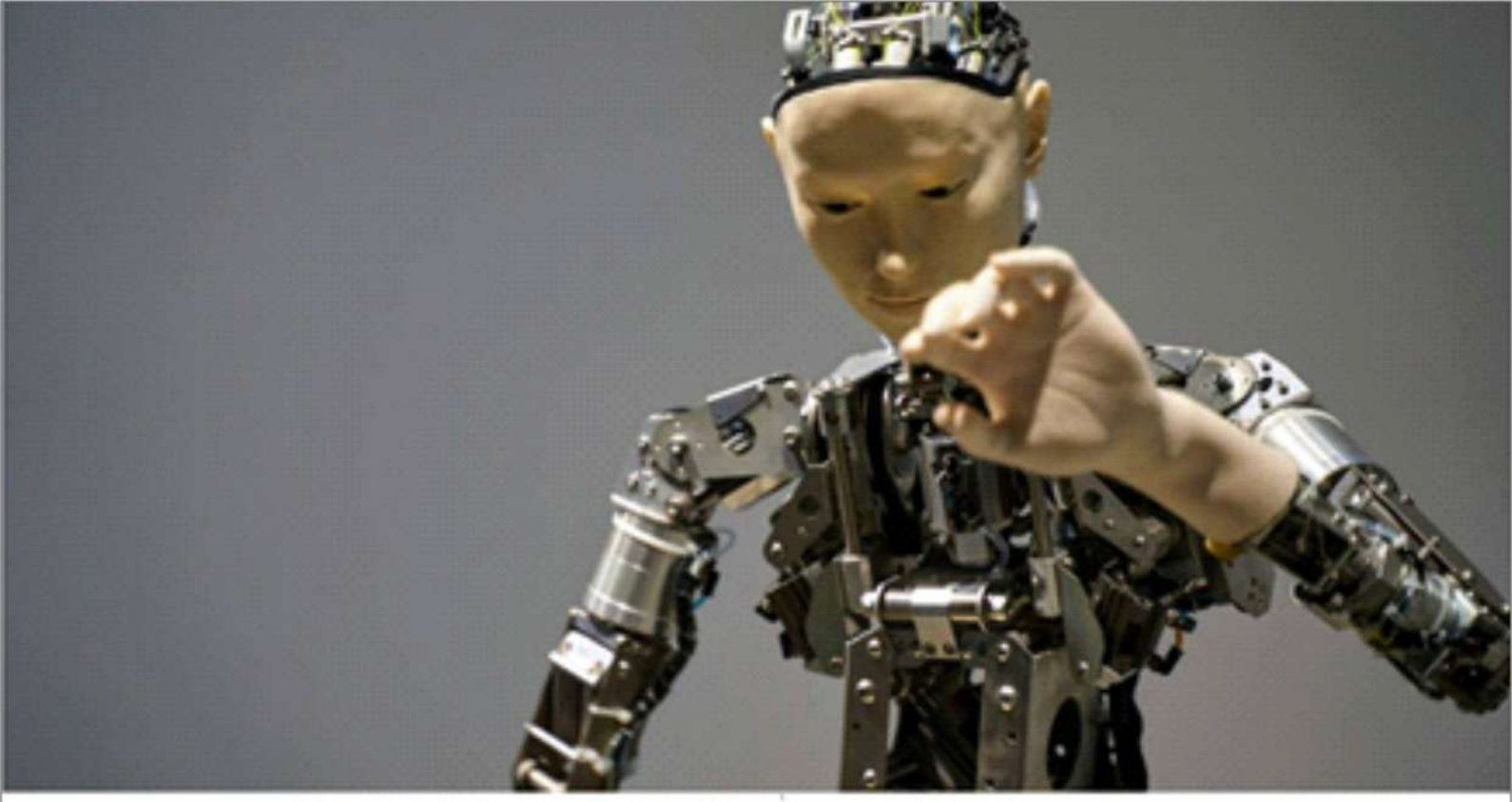
This fabric can generate electricity from your movements to power

This fabric can generate electricity from your movements to power wearables tapping a 3x4 cm piece of stretchable and washable fabric generated enough electricity to light up to 100 LEDs.
Scientists at the Nanyang Technological University, (NTU) Singapore have developed a technology that can create a stretchable and waterproof fabric that can generate energy from your body movements. The researchers envision that this fabric can be used to charge small wearable electronic devices like digital watches and fitness bands.

The researchers created a proof-of-concept, which was documented in a research article published in advanced material. They showed that tapping a 3×4 cm piece of the novel fabric generated enough electricity to light up to 100 LEDs. It produces electricity in two ways: piezoelectricity when it is pressed or squashed, and electricity generated due to the triboelectric effect when it comes in contact with or friction with other materials like skin or other fabrics.

The researchers also found that washing, folding, and crumpling the fabric did not cause any performance degradation. The fabric was also able to maintain stable electrical output for up to five months. According to the researchers, this demonstrates its potential for use as a smart textile and a wearable power source.
For the study, the device's electrical output was only measured for five months but the researchers believed it can still work after that period because output performance was still stable. However, it will be challenging to develop a device with a lifespan that is on part with that expected from the clothes that we wear every day. This is because it is made from a multilayer structure that might become delaminated. This is one of the biggest challenges the technology will have to overcome to become viable for real-world usage.





New research suggests robots could turn racist when built with flawed AI

Experiments showed robots acting out toxic stereotypes with respect to gender, race, and scientifically discredited physiognomy.

A robot that operates using a popular internet-based artificial intelligence system continuously and consistently gravitated to men over women, white people over people of colour, and jumped to conclusions about people's jobs after a glance at their faces. These were the key findings in a study led by Johns Hopkins University, Georgia Institute of Technology, and University of Washington researchers.
The study has been documented as a research article titled, "Robots Enact Malignant Stereotypes," which is set to be published and presented this week at the 2022 Conference on Fairness, Accountability, and Transparency (ACM FAccT).

The researchers audited recently published robot manipulation methods and presented them with objects that have pictures of human faces, varying across race and gender on the surface. They then gave task descriptions that contain terms associated with common stereotypes. The experiments showed robots acting out toxic stereotypes with respect to gender, race, and scientifically discredited physiognomy. Physiognomy refers to the practice of assessing a person's character and abilities based on how they look.
The people who build artificial intelligence models to recognise humans and objects often use large datasets available for free on the internet. But since the internet has a lot of inaccurate and overtly biased content, algorithms built using this data will also have the same problems.

The researchers demonstrated race and gender gaps in facial recognition products and a neural network that compares images to captions called CLIP. Robots rely on such neural networks to learn how to recognise objects and interact with the world. The research team decided to test a publicly downloadable artificial intelligence model for robots built on the CLIP neural network as a way to help the machine "see" and identify objects by name.

Implications
The research team suspects that models with these flaws could be used as foundations for robots being designed for use in homes, as well as in workplaces like warehouses. The team believes that systemic changes to research and business practices are needed to prevent future machines from adopting and reenacting these human stereotypes.

A 3D printed human ear has been successfully transplanted in a world-first

An American biotech company has just announced that they have successfully transplanted a 3D printed human ear into a patient, initially reported by the New York Times. The company, Queens-based 3DBio Therapeutics, printed the ear using the patient's own cells.
The patient in question, a 20-year-old, was born with a congenital disorder that left her with a small and misshapen right ear. According to experts in the field, this is a stunning development and exciting news in the realm of tissue engineering.

The 3-D printed ear was made in a mold that precisely matched the woman's left ear, according to 3DBio Therapeutics. Once completed, the ear was then successfully transplanted on the patient's head in March of this year. The ear will continue to regenerate cartilage tissue over time, giving it the look and feel of a natural ear, the company said.
"It's definitely a big deal," Adam Feinberg told the New York Times in an interview. Dr. Feinberg is a professor of biomedical engineering and materials science and engineering at Carnegie Mellon University and a co-founder of Fluid Form, one of 3DBio's industry competitors. "It shows this technology is not an 'if' anymore, but a 'when,'" he said.

News of the successful operation was made in a press release by 3D Bio on the 2nd of June 2022. Other than that information, little else has been disclosed about the procedure. This is for obvious reasons, as the technology and techniques are something of an industry secret.

Are 3D printed organs safe?

However, the 3DBio said that federal regulators had reviewed the trial design and set strict manufacturing standards and that the data would be published in a medical journal when the study was complete in due course.
The company's larger clinical trial includes around 11 patients and is still ongoing at the time of writing. To this end, it is still very possible that transplants will be rejected by the patients' bodies or lead to other, as yet unforeseen, health complications.

However, since the cells used to make the organs (like the ear question) are from the patients' own bodies, the chances of rejection or complications should be slim. 3DBio was first founded around seven years ago, and the recent successful transplant is but one of several breakthroughs in the field over the last few years. In January, for example, surgeons in Maryland managed to transplant a genetically modified pig's heart into a 57-year-old man with heart disease. This enabled the patient to extend their lives another few vital and priceless months. There are also other developments outside of using animal organs or 3D printed ones that would prove useful. For example, other scientists are developing techniques that could, it is hoped, extend the life of donor organs, so they do not go to waste.This is showing some promising results, with Swiss doctors recently able to transplant a human liver into a patient that had been perfectly preserved for three days. All very exciting, but for the 3D-printed ear recipient, her concerns are much closer to home.

The patient, Alexa, told the New York Times that she was excited about the new ear -- even though it was still covered by a bandage. Children with the same disorder, called microtia often find themselves the subject of teasing from peers, which can lead to anxiety, depression, and hostility. Thankfully, Alexa informed The Times, that her ear never really bothered her until her teens, when she naturally became more self-conscious about her appearance. "You care a little more for your image when you're a teenager," she said. "Some people said things that were not thoughtful, and it started bothering me."

A new 'beam-steering' technology that takes mobile communications beyond 5G is here

Fifth-generation connectivity, or 5G, was highlighted as a significant leap forward in networking protocols.

On the right path towards a fully wireless future, 5G brings incredibly fast data speeds, low latency communications, and higher data caps for mobile devices. The technology offers at least one gigabit per second for connection speeds and millimeter-wave (mmW) bands for supporting applications requiring large capacity.

The promise of a 5G future seemed like it was yesterday. Now, a new beam-steering antenna that increases the efficiency of data transmission for 'beyond 5G' is already here. The technology opens up a vast range of frequencies for mobile communications that are inaccessible to currently used technologies.

Devised by researchers from the University of Birmingham's School of Engineering, the findings revealed that the device can provide continuous 'wide-angle' beam steering - which allows it to track a moving mobile phone user in the same way that a satellite dish turns to track a moving object, but with significantly enhanced speeds.

The experimental results were presented for the first time at the 3rd International Union of Radio Science Atlantic/Asia-Pacific Radio Science Meeting, according to a press release.

Unmatched data transmission efficiency

The beam-steering antenna was developed by Dr. James Churm, Dr. Muhammad Rabbani, and Professor Alexandros Feresidis, Head of the Metamaterials Engineering Laboratory, as a solution for a fixed, base station antenna, for which current technology shows reduced efficiency at higher frequencies. This limits the use of these frequencies for long-distance transmission.

The new technology has shown vast improvements in data transmission efficiency at frequencies ranging across the millimeter wave spectrum, specifically those identified for 5G (mmWave) and 6G, where high efficiency is currently only possible using slow, mechanically steered antenna solutions.

Prototypes of the beam-steering antenna at 26 GHz have shown unmatched data transmission efficiency for 5G mmWave applications. But will the device be compatible with the existing 5G specifications?

Yes. The new technology also doesn't need the 'complex and inefficient feeding networks' required for current antenna systems. Instead, it uses a low complexity system which improves performance and is easy to fabricate.

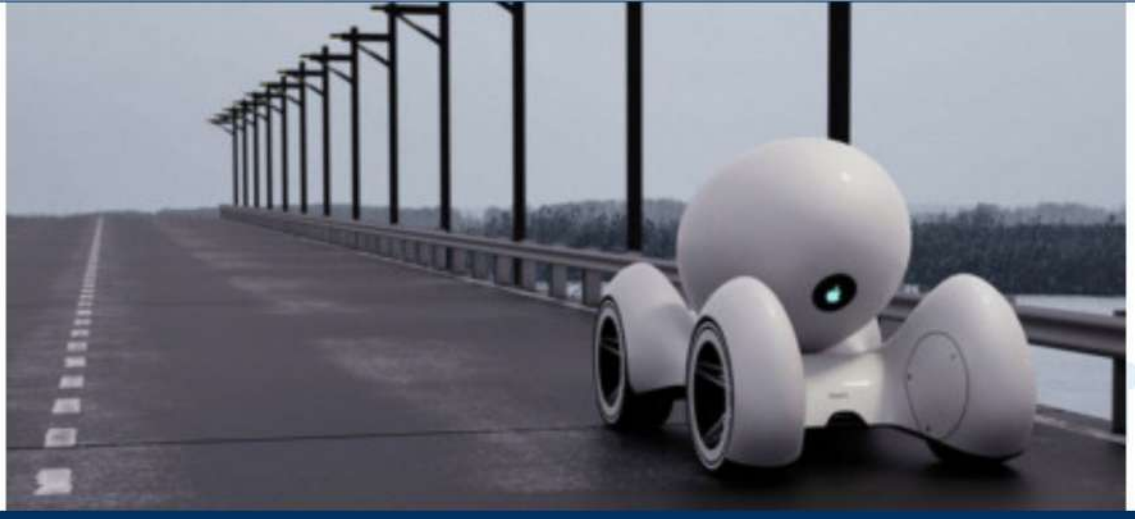
Capable of 94 percent efficiency at 300 GHz

The technology is around the size of an iPhone and uses a metamaterial made from a metal sheet with an array of regularly spaced holes that are micrometers in diameter. A metamaterial is a term used for materials that have been engineered to have special properties that are not found in naturally occurring materials. The special properties include the manipulation of electromagnetic waves by blocking, absorbing, enhancing, or bending waves.

An actuator controls the height of a cavity within the metamaterial, delivery micrometer movements, and, according to its position, the antenna will control the deflection of the team of a radio wave, effectively 'concentrating' the beam into a highly directive signal, and then 'redirecting this energy as desired', whilst also increasing the efficiency of transmission.

The team is currently developing and testing prototypes at higher frequencies and in applications that take it beyond 5G mobile communications.

"Although we developed the technology for use in 5G, our current models show that our beam steering technology may be capable of 94 percent efficiency at 300 GHz. The technology can also be adapted for use in vehicle-to-vehicle, vehicle-to-infrastructure, vehicular radar, and satellite communications, making it good for next-generation use in automotive, radar, space, and defense applications," Churm said.



The Xaver 1000 is a next-gen radar that can actually 'see' through walls

Camero-Tech, a firm based in Israel, has created a next-generation portable, high-performance imaging device that can actually "see" through walls. Called the Xaver 1000, according to a press release from Camero-Tech, the company has now officially added this next-generation of the company's product line.

Camero-Tech is a member of Samy Katsav Group (aka SK Group), and a world leader and pioneer in developing, producing, and marketing pulse-based UWB micro-power radar, like the Xaver 1000.

The company's parent, SK Group, specializes in global frontline defense, law enforcement solutions, marine infrastructure, and property development solutions. They also developed small arms systems, electro-optic and laser solutions, imaging systems, naval solutions, and more. SK Group has a strong track record of technology, experience, and excellence, drawing on Israel's innovation and field-proven solutions.

The new Xaver 1000, according to Camero-Tech, will provide armed forces, law enforcement agencies, intelligence units, and first responders with unmatched operating capabilities.

The latest iteration of their popular Xaver family of products, its predecessors have been deployed by elite customers in the military, law enforcement, intelligence, and search & rescue applications in more than 50 countries worldwide.
"The Xaver family delivers significant capabilities in information gathering, anti-terror activities, hostage rescue, anti-narcotics operations, disaster areas, and many other urban operations and missions," explained Camero-Tech.

The Xaver 1000 will prove to be a powerful tool for various organizations

The Xaver 1000 is equipped with an AI-based live target tracking system as well as its own 3D 'Sense-Through-The-Wall' technology, which allows it to detect and see humans or static objects behind walls and obstructions. High-resolution images of live objects can be seen down to the level of individual body parts too even if targets are sitting, standing, or lying down. It also doesn't matter if they have been stationary for a long time.
Users may also utilize the system to determine the height of objects and if they are adults, children, or animals, giving them an obvious operational edge and the capacity to, as they say, "step into the known".

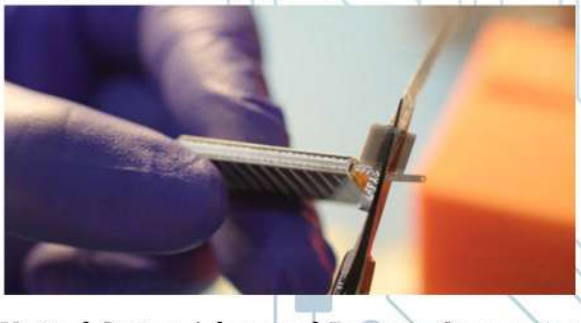
To this end, the Xaver 1000 can be considered an essential system for military, law enforcement, search and rescue teams, and intelligence units operating in a variety of situations, including hostile urban environments and natural disaster sites. It can be operated by a single user and is ready to use at the touch of a button.

“The XaverTM 1000 determines the most suitable approach to ensure successful life-saving missions in a variety of operational scenarios, such as hostage rescue situations,” says Amir Beeri, CEO, and founder of Camero. “A high-resolution 3D view and other powerful tools of the system provide an exceptional level of situational awareness. Being able to achieve a high level of sensitivity, the Xaver™ 1000 is a true game-changer for special forces and law enforcement teams conducting urban and rural operations that require reliable information regarding hidden live objects," he added.

Novel 3D batteries for EVs can be charged more than 98% in under 10 minutes

When it comes to electric vehicles, the main concern is the range anxiety related to mileage per charge and charging time. Now a company from the U.S. seems to have a solution for charging time. 3D Silicon Lithium-ion battery designer and manufacturer Enovix announced that it had demonstrated the ability of its 0.27 Ah Electric Vehicle (EV) test cells to charge from 0-80 percent state-of-charge in just 5.2 minute and achieved a greater than 98 percent charge capacity in under 10 minutes.

Enovix's Co-Founder, CEO, and President, Harrold Rust, pointed out that reaching fast charge times could accelerate mass adoption of EVs and added, "[W]e've been able to demonstrate a level of performance that meets and exceeds many OEM roadmaps. EV manufacturers are in pursuit of batteries that support longer range, while the public and private sectors work to increase EV driver access to fast chargers. We're proud to support these goals to help electrify the automotive industry and demonstrate our batteries are an exciting option to power long-range, fast-charging EVs."



This achievement exceeded the United States Advanced Battery Consortium's (USABC) goal of achieving 80 percent charge in 15 minutes.

"Our unique architecture enables a battery that not only charges in less than 10 minutes but also maintains high cycle life," said Ashok Lahiri, Co-Founder, and CTO of Enovix. "We can improve battery performance today using the same chemistries, but more importantly, we can accelerate the industry's roadmap."

The company's silicon lithium-ion batteries contain a novel 3D architecture and constraint system. The silicon cells have a 100 percent active silicon anode, which can theoretically store more than twice as much lithium as the graphite anode used in nearly all Li-ion batteries.

Enovix's proprietary 3D cell architecture increases energy density and maintains high cycle life. The company's initial goal was to provide designers of category-leading mobile devices with high-energy batteries to create more innovative and effective portable products. Enovix is also developing its 3D cell technology and production process for the electric vehicle and energy storage markets to help enable the widespread utilization of renewable energy.

As part of the company's three-year Department of Energy grant program that pairs a 100 percent active silicon anode with EV-class cathode materials, the company recently announced its cells surpassed 1,000 cycles while retaining 93 percent of their capacity.

Testing also demonstrated that after six months at elevated temperatures, Enovix batteries had a minimal capacity loss. This pairing projects a lifetime of more than 10 years for Enovix batteries.

The competition is fierce

Aiming to decrease the plug-in time for electric vehicles is a shared goal among both research groups and private companies working in the field.

Swiss multinational company ABB claims to have the worlds fastest electric vehical charger, which can power up to four vehicles simultaneously.

The Terra 360 is a modular charger and works with dynamic power distribution. With a design that looks just like a gasoline fueling station and a charging time of just three minutes for a range of 62 miles (100 km).

Also, Penn State engineers have developed lithium iron phosphate batteries, which offer a 250-mile (402 km) range and a charging time of 10 minutes. And they claim that the new battery is more affordable than its competitors.

A research team at the Center for Energy Storage Research of the Korea Institute of Science and Technology (KIST) led by Dr. Hun-Gi Jung had developed a silicon battery that can increase battery capacity four-fold in comparison to graphite anode batteries and also achieve more than 80 percent charge capacity in only five minutes.

Additionally, Japanese tech giant Toshiba's next-generation SCiB rechargeable batteries can be fully charged in just six minutes and offer a range of 200 miles (320 km).

A textile filter paves the way for eco-friendly carbon capture technology

The researchers chose a piece of cotton cloth, known for its versatile properties, and a naturally-occurring enzyme called carbonic anhydrase to create the fabric, whose special property is simply removing carbon dioxide molecules from a gas mixture.

Their findings were published in the journal ACS Sustainable Chemical Engineering earlier this month. It is a known fact that carbon dioxide levels today are some of the highest that has been seen in the past 800,000 years. According to the National Oceanic and Atmospheric Administration, the fossil fuels that people burn for energy are primarily responsible for the current high concentrations of CO2.

"I've been working in this field since 2005. At the time, global CO2 emissions were only 24 billion tonnes per year. Now they are greater than 35 billion tonnes per year. Humans crave energy, and we are throwing away the byproduct of that need for energy — which is carbon dioxide — away in the air and not collecting it. We can't see or smell it. It's very invisible to us, but it's causing a very big problem for our planet, and we need to do something about that," says Salmon. "One thing that we already know about cotton is that it absorbs and transports water and moisture well," she says.

Cotton can also be used to spread the water out into a thin film, creating a very high contact area for the gas. "When carbon dioxide gas molecules have to be removed from gas mixtures, the molecule has to come in contact with something - hence the big surface area," explains Salmon.

Carbon capture within our bodies?

The researchers chose to model their technology on a reaction occurring within our bodies.

Carbonic anhydrase is an enzyme found in abundance in all mammalian tissues, as well as plants, algae, and bacteria. The carbonic anhydrase aids in the conversion of CO_2 and water into bicarbonate (HCO_3^-) and protons (H^+) (and back again). This process is vital for life and central to respiration, digestion, and the regulation of cellular pH levels.

According to the researchers, their "textile filters with enzyme attached work like a mix between an air filter and a water filter that carry out a chemical reaction at the same time."

"There are conventional carbon capture systems working today that are used in the oil and gas industry - to purify methane, natural gas mostly. When natural gas is taken out of the ground, it's often mixed with carbon dioxide. So, the technology for separating carbon dioxide from gases has already existed for decades," explains Salmon.

However, most previous systems released CO2 back into the atmosphere. Whereas the idea behind using these filters is to trap the gas instead, capture it, and it could then be put underground or turned into valuable products.

"Our technology uses textiles and enzymes to capture the CO2 molecules in a very efficient manner," says Salmon.

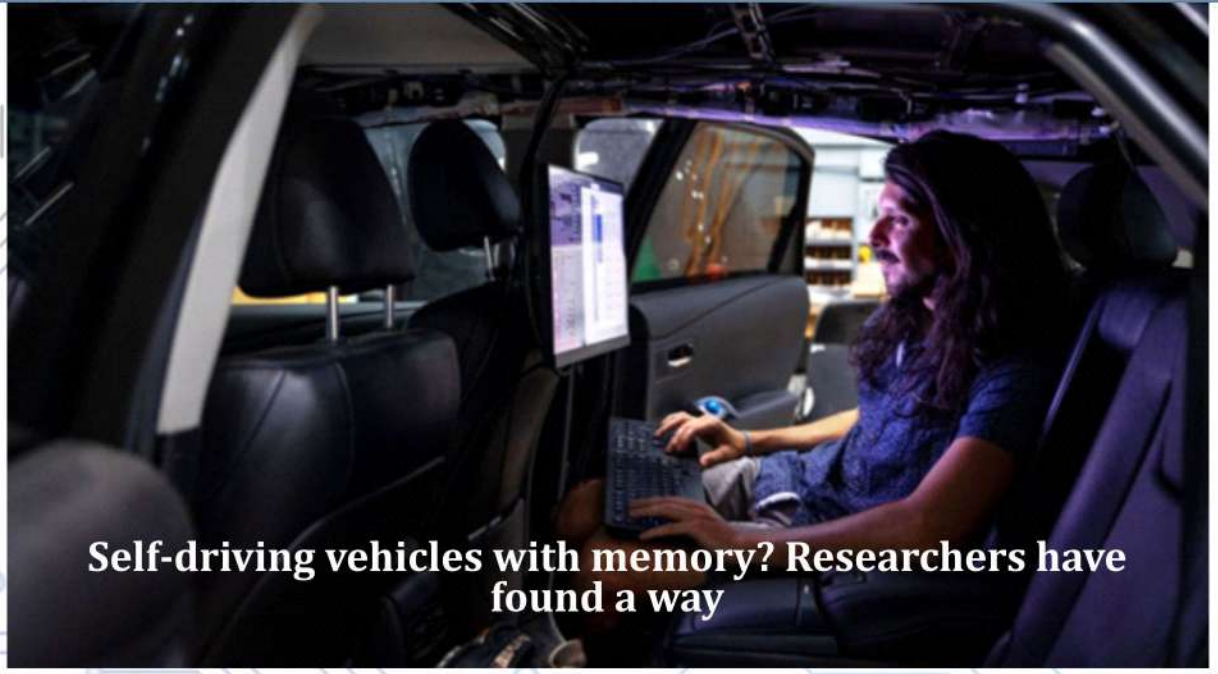
Capturing carbon dioxide for useful purposes

To create the filter, the enzyme was attached to a piece of two-layer cotton fabric by 'dunking' the fabric in a solution containing chitosan, which acts like glue. The material traps the enzyme, which then sticks to the fabric, according to a press release.

A series of experiments were then conducted to see how efficiently the filter would separate carbon dioxide from a mixture of carbon dioxide and nitrogen, simulating levels that equaled those emitted by power plants.

The fabric was rolled into a spiral and shoved into a tube. The researchers pushed the gas through the tube, along with a water-based solution. As the CO2 reacted with the water and the enzyme in the solution, it turned into bicarbonate and dripped down the filter and the tube. Then, they captured the bicarbonate solution and routed it out. It could then be used to create more energy or react with calcium to form limestone.

When the researchers pushed air through the filter at a rate of four liters per minute, they could pull out 52.3 percent of carbon dioxide with a single-stacked filter and 81.7 percent with a double-stacked filter.



Self-driving vehicles with memory? Researchers have found a way

Autonomous vehicles drive themselves on what has been fed into their driving systems, but now this seems to be changing.

Vehicles using artificial neural networks have no memory of the past. They are constantly seeing the world for the first time, no matter how often they've driven down a particular road or in similar weather conditions.

Researchers from Cornell University have developed a way to help autonomous vehicles create "memories" of previous experiences and use them in future navigation, especially during adverse weather conditions when the vehicles cannot safely rely on their sensors.

Led by doctoral student Carlos Diaz-Ruiz, the group compiled a dataset by repeatedly driving a car equipped with LiDAR (Light Detection and Ranging) sensors along a 9.3 mile (15-kilometer) loop in and around Ithaca 40 times over 18 months. The traversals capture varying environments (highway, urban, campus), weather conditions (sunny, rainy, snowy), and times of the day, resulting in a dataset with more than 600,000 scenes.

"It deliberately exposes one of the key challenges in self-driving cars: poor weather conditions," said Diaz-Ruiz. "If the street is covered by snow, humans can rely on memories, but without memories, a neural network is heavily disadvantaged."

The researchers have produced three concurrent papers intending to overcome this limitation. Two of the papers were presented at the Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2022), held June 19-24 in New Orleans.

HINDSIGHT is an approach that uses neural networks to compute descriptors of objects as the car passes them. It then compresses these descriptions, which the group has dubbed SQuaSH (Spatial-Quantized Sparse History) features, and stores them on a virtual map, like a "memory" stored in a human brain.

This means that the next time the self-driving vehicle traverses the same location, it traveled before, it can query the local SQuaSH database of every LiDAR point along the route and "remember" what it had learned last time. The database is continuously updated and shared across vehicles, thus enriching the information available to perform recognition.

Doctoral student Yurong You is the lead author of "HINDSIGHT is 20/20: Leveraging Past Traversals to Aid 3D Perception," which You presented virtually in April at ICLR 2022, the International Conference on Learning Representations. "Learning representations" includes deep learning, a kind of machine learning.

"This information can be added as features to any LiDAR-based 3D object detector," You said. "Both the detector and the SQuaSH representation can be trained jointly without any additional supervision, or human annotation, which is time- and labor-intensive."

While HINDSIGHT still assumes that the artificial neural network is already trained to detect objects and augments it with the capability to create memories, MODEST assumes the artificial neural network in the vehicle has never been exposed to any objects or streets at all. Through multiple traversals of the same route, it can learn what parts of the environment are stationary and which are moving objects. It slowly teaches itself what constitutes other traffic participants and what is safe to ignore.

The researchers hope the approaches could drastically reduce the development cost of autonomous vehicles (which currently still rely heavily on human-annotated data) and make such vehicles more efficient by learning to navigate the locations in which they are used the most.

"In reality, you rarely drive a route for the very first time," said co-author Katie Luo, a doctoral student in the research group. "Either you yourself or someone else has driven it before recently, so it seems only natural to collect that experience and utilize it."

A novel water-based battery is safer than lithium at half the cost

A Boston-area startup called Alsym Energy has introduced a rechargeable battery that could potentially match the performance of lithium-ion batteries at a fraction of the price.

In addition to using inexpensive, easily accessible materials like manganese and metal oxide, the novel battery is based on water, according to an initial report from Fast company.

This means it avoids some of the main drawbacks of current batteries, such as the potential for lithium-ion battery fires and the negative impact of mining on the environment. And thanks to the use of non-toxic materials, the novel battery design is simpler to recycle, which is always a bonus.

Meeting expectations at reduced cost

Electric vehicles are becoming more important as the world's nations step up their efforts to decarbonize the grid. That's because they can aid in decarbonizing both transportation and supply of electricity through reduced tailpipe emissions and offer flexibility. Naturally, many automakers are tapping into the market by producing luxurious EVs; however, the expensive price tag remains to be a problem to this day. The costs are partly due to the lithium-ion batteries that are used in electric vehicles, which are too costly for making EVs that can compete in price tag with cars that run on fossil fuels.

This is where Alsym Energy, which recently emerged from stealth and secured $32 million from investors, comes in. With its first partner being an automaker in India, the startup wants to make it possible for manufacturers to produce cheaper electric vehicles, according to a press release.

“Our motivation was to make it affordable, so that it could be widely deployed as opposed to niche,” Mukesh Chatter, CEO, and co-founder of the startup, told *Fast Company*.

The Alsym Energy's batteries are inexpensive enough that they might be used in developing countries to store off-grid solar power. This is especially crucial for individuals who do not currently have access to energy.

What makes the novel battery so special?

The water-based battery makes use of other affordable, easily accessible components like manganese and metal oxide. Crucially, it does not contain cobalt, an expensive critical component of lithium batteries that also contributes to supply-chain health and environmental issues. It also doesn't use lithium, which present additional mining difficulties. This is incredibly important as lithium has seen a price increase recently and is anticipated to drive up the price of other batteries.

According to the team behind Alsym Energy, the new design has "lithium-like performance". But unlike the latter, Alsym Energy's batteries are not flammable. This saves money as it doesn't require special protection to avoid fires and gives the batteries additional applications, such as use in ships, where the industry is particularly concerned about fire risk.

If all goes to plan, Alsym Energy will start beta testing with its first customers in early 2023, with high-volume production beginning as early as 2025. The novel battery design will surely make waves globally; however, the company's priority is to first make it affordable in low-income regions.