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In This Issue.....

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Self Sovereign Identity and why we need it: A story

I was in Shoppers Stop a few weeks ago when I came to know about one super initiative. SS don't print invoices anymore and they are saving paper, energy, time and also making this contactless. I am supporting the initiative whole heartedly.
Here is the problem- As per Govt norms, one can't sell anything without invoice.

Here is the answer-

1. Give your mobile number to them and they will send you an invoice link to *download*.
2. Give them your email id and they will share a pdf on email too.

I left the billing counter without making this purchase because I refused to share my mobile number or email id.

Here is my arguments for it-

1. I have handed over my mobile number/email and I have no control where SS hand over it further. I can't make SS delete my number ever.
2. I have no control if SS starts sending me 3-4 promotions every week.
3. I have no control if they decide to call me during office meetings.

Life will be tough for me and that all started because I have purchased a few T-shirts.

I had other options and I bought T-Shirts from someone else. But something is gravely wrong in this process and I, too, can't back my decision for long.
There will be more and more companies going contactless and will stop printing bills and Govt norms demand invoice.
"Aaj bass kahani hi sunaunga", let me move forward with another incident-

I was out for a client meeting and the hotel was asking for Vaccination proof. We were 7 people in total from 3 organisations and just wanted to book a meeting room for us where food can be served.
The demand from the hotel is very genuine.

They want Aadhaar card and vaccination proof, both documents from each individual. We all were sitting in the reception area and I was feeling uneasy asking my guests to submit their id and vaccination certificates.

Feeling uneasy can be understood as a personal problem and you can call me a person with a lack of professional skills.

But here is the challenge-

1. People, whom I was meeting were big people and exposing their identity just for a hotel checkin is a security risk. Hotel staff are least trained to handle sensitive information. And, overall we are living in a world where banks can also be hacked. This is just a poor hotel.
2. Handing over data is another problem. Staff is asking for a print copy or I can send all the docs to his personal WhatsApp number. *Am I a fool to share my guests' documents to a random WhatsApp number?*
3. **No, I am not.** Fortunately we got another restaurant with a decent meeting area and we quickly settled there. I just shared my identity on behalf of a complete group and cut the problem short to 1/7.

Still, I am not happy. I can keep telling you such stories and that can turn into a book. Then you will say, **"Chetan bhai, aap complain bahut karte ho. Poori kitab likh daale."**

Why am I telling this and what is the context?
I am a software professional, too, like you all.

Don't you think that such exposure of data should be on a transactional basis only, so:

1. If I want to get an invoice so my mobile number shouldn't be used post invoice sending activity. And it should be guaranteed by technology.
2. If I want to get admission rights and need to show my vaccination certificate, shouldn't it be done without revealing my address, age, UHID, and other sensitive information?
3. Why do Amazon, Flipkart, Zomato, Swiggy people making entry in society register everyday and on every visit? And that register is just useless, no verification, no tracking, no information sharing, and no information security.

This is where Self Sovereign Identity comes into the picture. Sovereignty is about governance and authentication mechanisms.
SSI is one decentralized identity.

Think of it as a cryptographic key pair. You are having a public key and you are transacting with that public key only. This public key can be used as Mobile, Email, Employee ID, UHID, UIDAI or what not.

That public key has an entry in Blockchain based decentralized public ledger and also has an entry for all the functions that can be run on that public key. Things don't end here. Everytime someone wants to authenticate you, a notification will come to your mobile app and you / only you can provide the consent for that specific transaction.
Let's move from the technicality of SSI for now, I shall take it up in another article or in some other forum.

Let's solve the challenges with SSI workflow and you may visualize the solution with me.

I have a SSI based mobile app and I have generated one Public Key and paired Private Key. PPK is a standard cryptography concept and I am not going into details. App hides all the complexity and it's just like clicking create an account.
Then I call UIDAI APIs and get my details verified from UIDAI and now it is recorded by the digital signatures of UIDAI. Verifiable without sending data to UIDAI. Digital Signature is the proof in itself.
Similarly I fetched my vaccination certificates to my SSI ID and again Digital Signatures from MoH, Government of India are there.
I have added all my email id, mobile numbers, driving license or whatever. Everything will stay just on my mobile.

*Shoppers Stop will scan a QR code on my mobile app (that QR code was generated just with my email id field and SS can't decode that. SS will scan that QR with an SSI based backend system that is not in the control of SS. This backend system itself will call one function send_email(email_id, content, attachment, **). It ends here and my email can't be used beyond sending this invoice. I will be a happy person forever then.*

I am again having a meeting with the same 6 people and in the same hotel. Now, all seven people have our respective SSI based mobile apps.
All 7 people have verified Vaccination certs on mobile. They are just sharing the proof to me under a single request (it is like scanning QR code on mobile from the SSI app, and done) and I am creating one collective presentation proof for hotel staff. All in a QR code or (read it string). Hotel Staff just scan QR Code with SSI enabled backend. The person got the proof of vaccination verified cryptographically.
It is done seamlessly because each individual of us, 7 people, have registered a public key on a ledger and this SSI backend is verifying our certificates cryptographically (read it mathematically).
I am not feeling ashamed anymore. I am not feeling guilty anymore because I am exposing my people to the threat of data abuse.

I am a happy soul now.
Let's discuss it more and build the tech for a more secure (sovereign) World.

Astronomers find two new galaxies 'Hiding' behind curtain of dust

The mysteries trapped in the corners of the universe are far more exciting than anyone could ever imagine. With each passing day and month, astronomers find new riddles and solve them in what is as puzzling as they are delightful. Sometimes astronomers find things in a place they least expect them to be. And that's exactly what has happened with a group of astronomers looking for a simple sample of distant galaxies. Using radio waves, they discovered two “invisible” galaxies hiding behind a curtain of dust near the dawn of the universe. This curtain of dust was hitherto obscuring the galaxies from their view. The galaxies have been named REBELS-12-2 and REBELS-29-2 and they are among the most distant known galaxies.

Although the light from them has travelled 13 billion years to reach Earth, the galaxies are actually much farther away than that now — a staggering 29 billion light-years away. This is because the universe continuously expands. The astronomers used the Atacama Large Millimetre Array (ALMA), which captures radio waves.

The researchers have detailed their discovery in a paper published in the Natural journal. The study suggests that there were far more galaxies in the early universe than previously thought and raises new questions about our understanding of the universe. The astronomers have calculated that 10–20 percent of galaxies from the early universe may be hiding behind dust clouds, waiting to be discovered someday.

Astronomers usually use the Hubble Space Telescope to study cosmic mysteries. Though it has the most unobstructed view of the universe, Hubble can't see everything as it watches the skies mostly in ultraviolet and visible wavelengths of light. So, this group of astronomers used the ALMA telescope, which operates at wavelengths of 0.32mm to 3.6mm.

Pascal Oesch, an author of the study, said they were looking at a group of very distant galaxies with ALMA and then they noticed that two of them had a neighbour that wasn't expected "to be there at all.” Both these neighbouring galaxies were surrounded with dust which blocked some of their light and Hubble couldn't see them.

"We are trying to put the big puzzle about the universe's formation together and answer the most basic question: 'Where does it all come from?'" Oesch said.

The astronomers are now waiting for more powerful instruments to be put in space so that their work can move forward. One of these power tools is the James Webb Space Telescope, which will specialise in infrared imaging of the cosmos. It is set to launch towards the end of this year, likely on December 22.

Are phones designed to slow down over time? let's review the evidence

It's usually around this time of year you hear people complain about their phones slowing down. Apple and Google release new versions of their operating systems (OS) and suddenly there's a slew of people clamining their old device to lag– conveniently just before Christmas.

But do manufacturers really slow down our phones on purpose to nudge us towards shiny new ones, as has been claimed?

The answer to this, as usual, is complicated. Let's take a look at the evidence.

The ol' operating system shuffle

Every year, usually around May and June, tech companies announce their new OS updates. The main news surrounding the releases is often new system features such as facetime enhancements, improvements to voice assistance or a fancier system design But did you know these features are optimized for the new hardware traditionally released during the summer, and the chips that come with it?

As such, system updates have to be programmed to work towards two goals. The first is to support the new hardware and chip, which deliver the newest features.

The second is to continue to work with existing hardware that won't support the new features. And this means coding the OS so it's not *reliant* on the new features having to work.

This challenge exists for desktop OSs as well, as evidenced by the recent removal of old systems from the window 11 compatibility software Microsoft decided coding around new features was an insurmountable challenge in some instances.

Hardships with hardware

So your old smartphone won't support new features – fair enough. But why does it feel like the new OS update is making existing features slower? To understand this, you need to first understand some of the mechanics of chip design.

Apple used to use other manufacturers' chips for its devices, but for the past few years has made its own custom silicon. This is referred to as a “system on chip(SOC), as the entire system exists on a single chip designed and manufactured by Apple.

But even if manufacturers design their own chips, it can be hard to predict what consumers will want in the future, and thus which upgrades will come with future iterations of a device.

Manufacturers have to write OS updates to suit the latest hardware, so consumers who purchase it can take advantage of the latest features. In doing so, they must work around the fact that older hardware doesn't have the same capacity.

These workarounds mean older devices will run more slowly with the new OS installed, even for tasks the system had done for years. The latest OS is not written to make your old device slower, but because it's written for the latest device, it can't help but run more slowly on old hardware.

Examples of this abound in the industry, with many articles written about a newly released OS version running slow on older devices until the manufacturer optimises it (if they ever do).

You might be wondering: if a new OS will slow down old phones, why install the update at all?

Well, it's because people don't like being told to stick with old features. Apple recently allowed users of its latest devices to keep the old system, but this is unusual. There is usually a push for user to install new software version.

It's all business

The truth is device manufacturers are in the business to make money. And this means being able to sell new devices.

While there is often an implied expectation from consumers that manufacturers will commit to maintaining old products, at the same time they need to write updates that will work for their latest hardware.

Meanwhile, tech companies aren't doing enough to educate users on how to adjust their settings to get the best out of their phones, or how to manage software bluest which might contribute to a phone slowing down.

Compounding this are other factors such as network connection issues, like when the 3G mobile network was stopped.

Burden of proof

There's something else to consider, too. If an OS update *was* designed to intentionally slow down a phone over time, this would be very difficult to prove.

The system codes are “closed source”, so experts can't look into them. The best we can do is run timers on different processes and see if they are slowing down over time.

But even if they are, is it because of a system update that can't be supported by old hardware, or is it malicious conduct from the manufacturer? Could the code be written to force the device to sleep for half a second, every ten seconds, with a sleep command?

It's hard to say for sure, although our personal opinion is this is highly unlikely.

Choose not to play

Ultimately, the issue comes down to how device manufacturers sell their products.

The best option for their bottom line is to deliver OS updates and features that work with the latest hardware, even if this leaves old devices behind. The evidence suggests manufacturers are not intentionally slowing phones down, but are prioritizing the latest release so you'll buy it.

In the meantime, if your slow device is getting you down, the best option is to resist the urge to upgrade. You might get prompts directing you to install the latest OS version (and the frequency of these will depend on the company) but you can ignore them.

There may be auto-updates which you can't avoid, but in most cases, these are for security purposes and don't include major changes or new features. It's only once these security updates stop coming that you should upgrade.

Until then, a phone running on its original OS should, in theory, run well for a long time.

'Deepfaking the mind' could improve brain-computer interfaces for people with disabilities

Researchers at the USC Viterbi School of Engineering are using generative adversarial networks (GANs) -- technology best known for creating deepfake videos and photorealistic human faces -- to improve brain-computer interfaces for people with disabilities.

In a paper published in *Nature Biomedical Engineering*, the team successfully taught an AI to generate synthetic brain activity data. The data, specifically neural signals called spike trains, can be fed into machine-learning algorithms to improve the usability of brain-computer interfaces (BCI).

BCI systems work by analysing a person's brain signals and translating that neural activity into commands, allowing the user to control digital devices like computer cursors using only their thoughts. These devices can improve quality of life for people with motor dysfunction or paralysis, even those struggling with locked-in syndrome -- when a person is fully conscious but unable to move or communicate.

Various forms of BCI are already available, from caps that measure brain signals to devices implanted in brain tissues. New use cases are being identified all the time, from neurorehabilitation to treating depression. But despite all of this promise, it has proved challenging to make these systems fast and robust enough for the real world.

Specifically, to make sense of their inputs, BCIs need huge amounts of neural data and long periods of training, calibration and learning.

"Getting enough data for the algorithms that power BCIs can be difficult, expensive, or even impossible if paralyzed individuals are not able to produce sufficiently robust brain signals," said Laurent Itti, a computer science professor and study co-author.

Another obstacle: the technology is user-specific and has to be trained from scratch for each person.

Generating synthetic neurological data

What if, instead, you could create synthetic neurological data -- artificially computer-generated data -- that could "stand in" for data obtained from the real world?

Enter generative adversarial networks. Known for creating "deep fakes," GANs can create a virtually unlimited number of new, similar images by running through a trial-and-error process.

Lead author Shixian Wen, a Ph.D. student advised by Itti, wondered if GANs could also create training data for BCIs by generating synthetic neurological data indistinguishable from the real thing.

In an experiment described in the paper, the researchers trained a deep-learning spike synthesizer with one session of data recorded from a monkey reaching for an object. Then, they used the synthesizer to generate large amounts of similar -- albeit fake -- neural data.

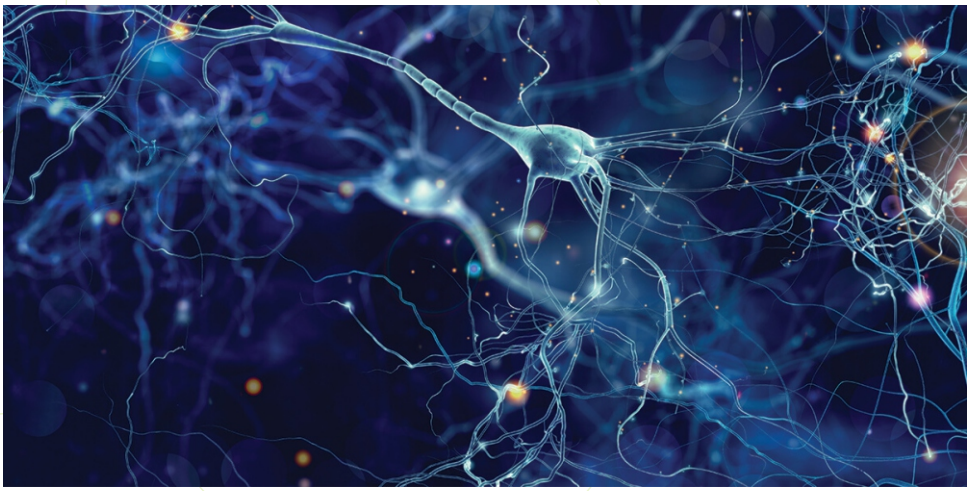
The team then combined the synthesized data with small amounts of new real data -- either from the same monkey on a different day, or from a different monkey -- to train a BCI. This approach got the system up and running much faster than current standard methods. In fact, the researchers found that GAN-synthesized neural data improved a BCI's overall training speed by up to 20 times.

"Less than a minute's worth of real data combined with the synthetic data works as well as 20 minutes of real data," said Wen.

"It is the first time we've seen AI generate the recipe for thought or movement via the creation of synthetic spike trains. This research is a critical step towards making BCIs more suitable for real-world use."

Additionally, after training on one experimental session, the system rapidly adapted to new sessions, or subjects, using limited additional neural data.

"That's the big innovation here -- creating fake spike trains that look just like they come from this person as they imagine doing different motions, then also using this data to assist with learning on the next person," said Itti.
Beyond BCIs, GAN-generated synthetic data could lead to breakthroughs in other data-hungry areas of artificial intelligence by speeding up training and improving performance.
"When a company is ready to start commercializing a robotic skeleton, robotic arm or speech synthesis system, they should look at this method, because it might help them with accelerating the training and retraining," said Itti. "As for using GAN to improve brain-computer interfaces, I think this is only the beginning."
The paper was co-authored by Tommaso Furlanello, a USC Ph.D. graduate; Allen Yin of Facebook; M.G. Perich of the University of Geneva and L.E. Miller of Northwestern University.



New holographic camera sees the unseen with high precision

Northwestern University researchers have invented a new high-resolution camera that can see the unseen -- including around corners and through scattering media, such as skin, fog or potentially even the human skull.

Called synthetic wavelength holography, the new method works by indirectly scattering coherent light onto hidden objects, which then scatters again and travels back to a camera. From there, an algorithm reconstructs the scattered light signal to reveal the hidden objects. Due to its high temporal resolution, the method also has potential to image fast-moving objects, such as the beating heart through the chest or speeding cars around a street corner.

The relatively new research field of imaging objects behind occlusions or scattering media is called non-line-of-sight (NLoS) imaging. Compared to related NLoS imaging technologies, the Northwestern method can rapidly capture full-field images of large areas with submillimeter precision. With this level of resolution, the computational camera could potentially image through the skin to see even the tiniest capillaries at work.

While the method has obvious potential for noninvasive medical imaging, early-warning navigation systems for automobiles and industrial inspection in tightly confined spaces, the researchers believe potential applications are endless.

"Our technology will usher in a new wave of imaging capabilities," said Northwestern's Florian Willomitzer, first author of the study. "Our current sensor prototypes use visible or infrared light, but the principle is universal and could be extended to other wavelengths. For example, the same method could be applied to radio waves for space exploration or underwater acoustic imaging. It can be applied to many areas, and we have only scratched the surface."

Willomitzer is a research assistant professor of electrical and computer engineering at Northwestern's McCormick School of Engineering. Northwestern co-authors include Oliver Cossairt, associate professor of computer science and electrical and computer engineering, and former Ph.D. student Fengqiang Li. The Northwestern researchers collaborated closely with Prasanna Rangarajan, Muralidhar Balaji and Marc Christensen, all researchers at Southern Methodist University.

Intercepting scattered light

Seeing around a corner versus imaging an organ inside the human body might seem like very different challenges, but Willomitzer said they are actually closely related. Both deal with scattering media, in which light hits an object and scatters in a manner that a direct image of the object can no longer be seen.

"If you have ever tried to shine a flashlight through your hand, then you have experienced this phenomenon," Willomitzer said. "You see a bright spot on the other side of your hand, but, theoretically, there should be a shadow cast by your bones, revealing the bones' structure. Instead, the light that passes the bones gets scattered within the tissue in all directions, completely blurring out the shadow image."

The goal, then, is to intercept the scattered light in order to reconstruct the inherent information about its time of travel to reveal the hidden object. But that presents its own challenge.

"Nothing is faster than the speed of light, so if you want to measure light's time of travel with high precision, then you need extremely fast detectors," Willomitzer said. "Such detectors can be terribly expensive."

Tailored waves

To eliminate the need for fast detectors, Willomitzer and his colleagues merged light waves from two lasers in order to generate a synthetic light wave that can be specifically tailored to holographic imaging in different scattering scenarios.

"That's the big innovation here -- creating fake spike trains that look just like they come from this person as they imagine doing different motions, then also using this data to assist with learning on the next person," said Itti.

Beyond BCIs, GAN-generated synthetic data could lead to breakthroughs in other data-hungry areas of artificial intelligence by speeding up training and improving performance.

"When a company is ready to start commercializing a robotic skeleton, robotic arm or speech synthesis system, they should look at this method, because it might help them with accelerating the training and retraining," said Itti. "As for using GAN to improve brain-computer interfaces, I think this is only the beginning."

The paper was co-authored by Tommaso Furlanello, a USC Ph.D. graduate; Allen Yin of Facebook; M.G. Perich of the University of Geneva and L.E. Miller of Northw"If you can capture the entire light field of an object in a hologram, then you can reconstruct the object's three-dimensional shape in its entirety," Willomitzer explained. "We do this holographic imaging around a corner or through scatterers -- with synthetic waves instead of normal light waves."

Over the years, there have been many NLoS imaging attempts to recover images of hidden objects. But these methods typically have one or more problems. They either have low resolution, an extremely small angular field of regard, require a time-consuming raster scan or need large probing areas to measure the scattered light signal.

The new technology, however, overcomes these issues and is the first method for imaging around corners and through scattering media that combines high spatial resolution, high temporal resolution, a small probing area and a large angular field of view. This means that the camera can image tiny features in tightly confined spaces as well as hidden objects in large areas with high resolution -- even when the objects are moving.

Turning 'walls into mirrors'

Because light only travels on straight paths, an opaque barrier (such as a wall, shrub or automobile) must be present in order for the new device to see around corners. The light is emitted from the sensor unit (which could be mounted on top of a car), bounces off the barrier, then hits the object around the corner. The light then bounces back to the barrier and ultimately back into the detector of the sensor unit.

"It's like we can plant a virtual computational camera on every remote surface to see the world from the surface's perspective," Willomitzer said.

For people driving roads curving through a mountain pass or snaking through a rural forest, this method could prevent accidents by revealing other cars or deer just out of sight around the bend. "This technique turns walls into mirrors," Willomitzer said. "It gets better as the technique also can work at night and in foggy weather conditions."

In this manner, the high-resolution technology also could replace (or supplement) endoscopes for medical and industrial imaging. Instead of needing a flexible camera, capable of turning corners and twisting through tight spaces -- for a colonoscopy, for example -- synthetic wavelength holography could use light to see around the many folds inside the intestines.

Similarly, synthetic wavelength holography could image inside industrial equipment while it is still running -- a feat that is impossible for current endoscopes.

"If you have a running turbine and want to inspect defects inside, you would typically use an endoscope," Willomitzer said. "But some defects only show up when the device is in motion. You cannot use an endoscope and look inside the turbine from the front while it is running. Our sensor can look inside a running turbine to detect structures that are smaller than one millimeter."

Although the technology is currently a prototype, Willomitzer believes it will eventually be used to help drivers avoid accidents. "It's still a long way to go before we see these kinds of imagers built in cars or approved for medical applications," he said. "Maybe 10 years or even more, but it will come."estern University.

IIT Kanpur develops self-sustained mechanism to monitor Ganga river

The project has been implemented by a team of earth scientists, mechanical, electrical, and aerospace engineers from the institute, led by Prof Bishakh Bhattacharya as the principal investigator.

Indian Institute of Technology Kanpur has developed a self-sustained Aquatic Autonomous Observatory named 'Niracara Svayamsasita VedhShala (NSVS)', for in situ monitoring, real time data transmission and web-based visualization of the river Ganga.

AR Harish, Dean of Research and Development, IIT Kanpur, inaugurated the system at Laxman Ghat, Bithoor.

In its current capacity, the system can sense three important parameters -- pH, conductivity and dissolved oxygen capacity of water.

This can be further utilized to estimate Total Dissolved Solid (TDS), specific gravity and presence of metallic ions in water, IIT Kanpur said.

"The system autonomously collects the data in every fifteen minutes and report it through wireless network to the Institute. For self-sustenance, the platform is equipped with energy harvesting systems consisting of solar cells and a unique Vortex Induced Vibration (VIV) system which can extract energy from the flow of river," it added.

The project has been implemented by a team of earth scientists, mechanical, electrical, and aerospace engineers from the institute, led by Prof Bishakh Bhattacharya as the principal investigator.

IIT Kanpur said NSVS system has been developed as a "low-cost, multi-parameter, water quality monitoring platform that would consist of array of sensors and auto sampler placed on a stationary platform which is semi-submersible, all-weather, robust, and perfectly stable."

Prof Abhay Karandikar, Director, IIT Kanpur said, "The Ganga is not just a river but a cultural heritage for us, and therefore it is our responsibility to safeguard it from any harm. IIT Kanpur has been doing rigorous research and developing various mechanisms to study the ecosystem of the Ganga and the impact of climate change on it. I congratulate the team led by Prof Bishakh Bhattacharya on the inauguration of the NSVS system, which will ensure real-time, in-situ monitoring of the river Ganga for ensuring its good health."

IIT Kanpur has also recently launched a 'Ganga Atlas' and a workflow that allows users to process and analyse declassified imagery of riverine environments at minimal cost, using an open-source software.

IIT Kanpur said it had earlier conducted a research on the high resilience of dissolved heavy metals in the Ganga river, impact of immersion of dead bodies in the river and held a roundtable discussion on the rejuvenation of rivulets in the Ganga river basin, among other initiatives.

Peeking into a chrysalis, incredible videos capture butterfly wings forming during metamorphosis

The findings could inform the design of new materials such as iridescent windows or waterproof textiles.

If you brush against the wings of a butterfly, you will likely come away with a fine sprinkling of powder. This lepidopteran dust is made up of tiny microscopic scales, hundreds of thousands of which paper a butterfly's wings like shingles on a wafer-thin roof. The structure and arrangement of these scales give a butterfly its color and shimmer, and help shield the insect from the elements.

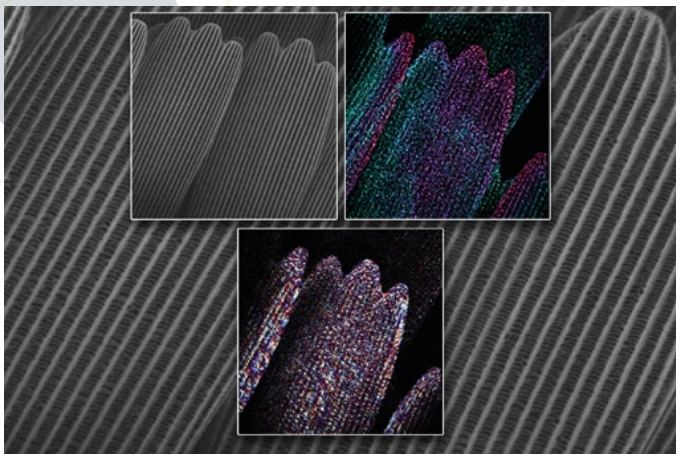
In November 2021, MIT engineers have captured the intricate choreography of butterfly scales forming during metamorphosis. The team has for the first time continuously observed the wing scales growing and assembling as a developing butterfly transforms inside its chrysalis.

With some minor surgery and a clever imaging approach, the researchers were able to watch wing scales form in specimens of *Vanessa cardui,* commonly known as the Painted Lady butterfly. They observed that, as a wing forms, cells on its surface line up in orderly rows as they grow. These cells quickly differentiate into alternating “cover” and “ground” scales, producing an overlapping shingle-like pattern. As they reach their full size, the scales sprout thin ridges along their length — tiny corrugated features that control the insect's color and help it to shed rain and moisture.

The team's study, published on November 22, 2021in the *Proceedings of the National Academy of Sciences*, offers the most detailed look yet at the budding architecture of butterfly scales. The new visualizations also could serve as a blueprint for designing new functional materials, such as iridescent windows and waterproof textiles.

“Butterfly wings control many of their attributes by precisely forming the structural architecture of their wing scales,” says lead author Anthony McDougal, a research assistant in MIT's Department of Mechanical Engineering. “This strategy might be used, for example, to give both color and self-cleaning properties to automobiles and buildings. Now we can learn from butterflies' structural control of these complex, micro-nanostructured materials.”

McDougal's co-authors at MIT include postdoc Sungsam Kang, research scientist Zahid Yaqoob, professor of mechanical engineering and biological engineering Peter So, and associate professor of mechanical engineering Mathias Kolle.



Healable carbon fiber composite offers path to long-lasting, sustainable materials

Because of their high strength and light weight, carbon-fiber-based composite materials are gradually replacing metals for advancing all kinds of products and applications, from airplanes to wind turbines to golf clubs. But there's a trade-off. Once damaged or compromised, the most commonly-used carbon fiber materials are nearly impossible to repair or recycle.

In a paper posted on first week of november in the journal Carbon, a research team that includes UW mechanical engineering Assistant Professor Aniruddh Vashisth describes a new type of carbon fiber reinforced material that is as strong and light as traditionally used ones but can be repeatedly healed with heat, reversing any fatigue damage and providing a way to break it down and recycle it when it reaches the end of its life.

“Developing fatigue-resistant composites is a major need in the manufacturing community,” says Vashisth. “In this paper, we demonstrate a material where either traditional heat sources or radio frequency heating can be used to reverse and postpone its aging process indefinitely.”

The material is part of a recently developed group known as carbon fiber reinforced vitrimers (vCFRP). The materials typically used today, whether in sporting goods or aerospace, are carbon fiber reinforced polymers (CFRP).

Traditional CFRPs typically fall into two categories: thermoset or thermoplastic. The “set” variety contains an epoxy, a glue-like material where the chemical links holding it together harden permanently. The “plastic” version contains a softer type of glue so it can be melted back down and reworked, but this becomes a drawback for high strength and stiffness. Vitrimers on the other hand, can link, unlink and re-link, providing a middle ground between the two.

“Imagine each of these materials is a room full of people,” says Vashisth. “In the thermoset room all of the people are holding hands and won't let go. In the thermoplastic room people are shaking hands and moving all around. In the vitrimer room people shake hands with their neighbor but they have the capacity to exchange handshakes and make new neighbors so that the total number of interconnections remains the same. That re-connection is how the material gets repaired and this paper was the first to use atomic-scale simulations to understand the underlying mechanisms for those chemical handshakes.”

The research team believes vitrimers could be a viable alternative for many products currently manufactured from thermosets, something badly needed as thermoset composites have begun piling up in landfills. The team says that healable vCFRPs would be a major shift toward a dynamic material with a different set of considerations in terms of life-cycle cost, reliability, safety and maintenance.

“These materials can translate the linear life cycle of plastics to a circular one, which would be a great step towards sustainability” says Nikhil Koratkar, the John A. Clark and Edward T. Crossan Professor of Mechanical, Aerospace and Nuclear Engineering at Rensselaer Polytechnic Institute (RPI) and one of Vashisth's co-authors on the new paper.

In addition to Koratkar and Vashisth, the research team also included Mithil Kamble and Professor Catalin Picu of RPI, and Hongkun Yang and Professor Dong Wang of the Beijing University of Chemical Technology.

Breakthrough "Smoking Gun" discovery in power consumption in electronic devices

In a new FLEET theoretical study published recently in *Physical Review Letters*, the so called 'smoking gun' in the search for the topological magnetic monopole — also known as the Berry curvature — has been found.

The discovery is a breakthrough in the search for topological effects in non-equilibrium systems.

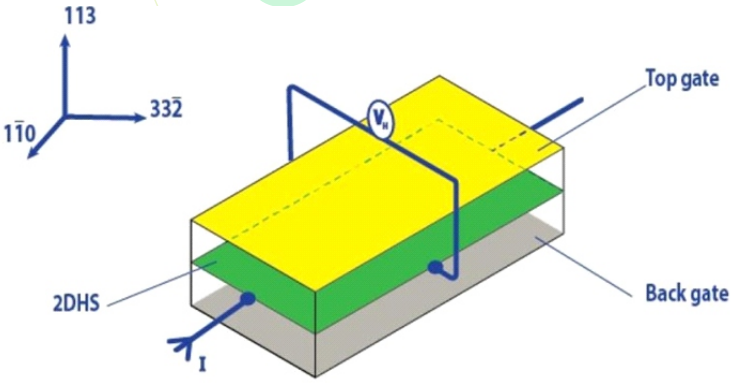
The group, led by UNSW physicist and Associate Professor, Dimi Culcer, identified an unconventional Hall effect, driven by an in-plane magnetic field in semiconductor hole systems that can be traced exclusively to the Berry curvature.

Enhanced topological effects will permit low-energy topological electronics to be viable for large-scale, room-temperature operation, and therefore support the IEEE roadmap towards future electronics sustainability.

Isolating response a breakthrough moment

"Isolating topological responses in 'regular conductors' has been a historically difficult task," says research team leader A/Prof Dimi Culcer (UNSW). "Even though these topological responses are believed to be ubiquitous in solids."

Quantized responses, such as the quantum Hall and quantum spin-Hall effects provide a clear fingerprint of topology, yet these have only been observed in one-dimensional (1D) In `regular' conductors, meaning 2D and 3D systems, plenty of theoretical literature exists predicting topological contributions to e.g. the anomalous Hall effect, but these have never been observed unambiguously in a transport measurement.



There are two main reasons for this:

(i) spin-up and spin-down electrons usually make opposite contributions, and these nearly cancel out;

(ii) (ii) whatever is left is overwhelmed by disorder.

The new FLEET paper remedies this long-standing shortcoming by identifying a two-dimensional system in which the Berry curvature, and only the Berry curvature, is responsible for the Hall signal linear in the applied in-plane magnetic field.

"Remarkably, all disorder contributions vanish: we are not aware of any other multi-dimensional system in which this is true," says lead author, UNSW PhD student James Cullen. "Its experimental measurement is accessible to any state-of-the-art laboratory worldwide, hence we expect strong interest from experimentalists."systems and are intimately connected with the existence of edge states.

New machine-learning system gives robots social skills

A new machine-learning system helps robots understand and perform certain social interactions.

Robots can deliver food on a college campus and hit a hole-in-one on the golf course, but even the most sophisticated robot can't perform basic social interactions that are critical to everyday human life.

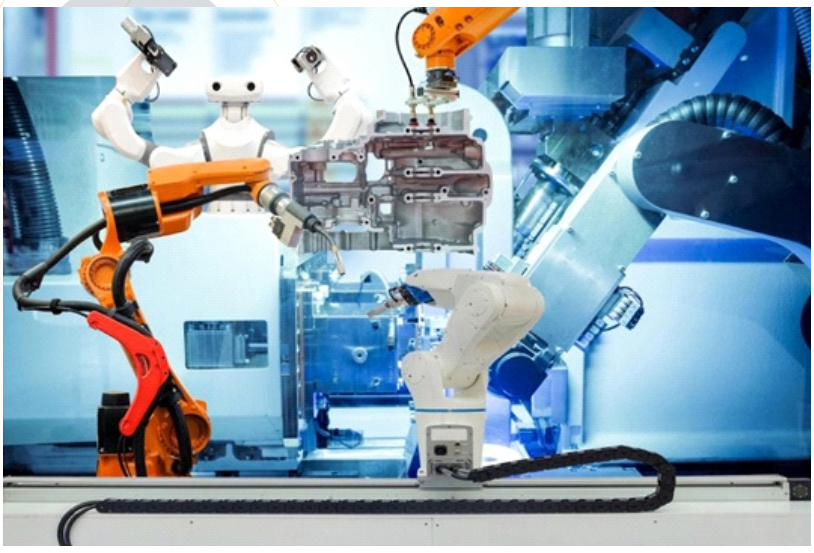
MIT researchers have now incorporated certain social interactions into a framework for robotics, enabling machines to understand what it means to help or hinder one another, and to learn to perform these social behaviors on their own. In a simulated environment, a robot watches its companion, guesses what task it wants to accomplish, and then helps or hinders this other robot based on its own goals.

The researchers also showed that their model creates realistic and predictable social interactions. When they showed videos of these simulated robots interacting with one another to humans, the human viewers mostly agreed with the model about what type of social behavior was occurring.

Enabling robots to exhibit social skills could lead to smoother and more positive human-robot interactions. For instance, a robot in an assisted living facility could use these capabilities to help create a more caring environment for elderly individuals. The new model may also enable scientists to measure social interactions quantitatively, which could help psychologists study autism or analyze the effects of antidepressants.

“Robots will live in our world soon enough, and they really need to learn how to communicate with us on human terms. They need to understand when it is time for them to help and when it is time for them to see what they can do to prevent something from happening. This is very early work and we are barely scratching the surface, but I feel like this is the first very serious attempt for understanding what it means for humans and machines to interact socially,” says Boris Katz, principal research scientist and head of the InfoLab Group in MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and a member of the Center for Brains, Minds, and Machines (CBMM).

Joining Katz on the paper are co-lead author Ravi Tejwani, a research assistant at CSAIL; co-lead author Yen-Ling Kuo, a CSAIL PhD student; Tianmin Shu, a postdoc in the Department of Brain and Cognitive Sciences; and senior author Andrei Barbu, a research scientist at CSAIL and CBMM. The research will be presented at the Conference on Robot Learning in November.



Good news! Drinking coffee may lower your risk of Alzheimer disease

Good news for those of us who can't face the day without their morning flat white: a long-term study has revealed drinking higher amounts of coffee may make you less likely to develop Alzheimer's disease.

As part of the Australian Imaging, Biomarkers and Lifestyle Study of aging, researchers from Edith Cowan University (ECU) investigated whether coffee intake affected the rate of cognitive decline of more than 200 Australians over a decade.

Lead investigator Dr. Samantha Gardener said results showed an association between coffee and several important markers related to Alzheimer's disease.

"We found participants with no memory impairments and with higher coffee consumption at the start of the study had lower risk of transitioning to mild cognitive impairment — which often precedes Alzheimer's disease — or developing Alzheimer's disease over the course of the study," she said.

Drinking more coffee gave positive results in relation to certain domains of cognitive function, specifically executive function which includes planning, self-control, and attention.

Higher coffee intake also seemed to be linked to slowing the accumulation of the amyloid protein in the brain, a key factor in the development of Alzheimer's disease.

Dr. Gardener said although further research was needed, the study was encouraging as it indicated drinking coffee could be an easy way to help delay the onset of Alzheimer's disease.

"It's a simple thing that people can change," she said.

"It could be particularly useful for people who are at risk of cognitive decline but haven't developed any symptoms.

"We might be able to develop some clear guidelines people can follow in middle age and hopefully it could then have a lasting effect."

Make it a double

If you only allow yourself one cup of coffee a day, the study indicates you might be better off treating yourself to an extra cup, although a maximum number of cups per day that provided a beneficial effect was not able to be established from the current study.

"If the average cup of coffee made at home is 240g, increasing to two cups a day could potentially lower cognitive decline by eight percent after 18 months," Dr. Gardener said.

"It could also see a five percent decrease in amyloid accumulation in the brain over the same time period."

In Alzheimer's disease, the amyloid clumps together forming plaques which are toxic to the brain.

The study was unable to differentiate between caffeinated and de-caffeinated coffee, nor the benefits or consequences of how it was prepared (brewing method, the presence of milk and/or sugar, etc).

Dr. Gardener said the relationship between coffee and brain function was worth pursuing.

"We need to evaluate whether coffee intake could one day be recommended as a lifestyle factor aimed at delaying the onset of Alzheimer's disease," she said.

More than just caffeine

Researchers are yet to determine precisely which constituents of coffee are behind its seemingly positive effects on brain health.

Though caffeine has been linked to the results, preliminary research shows it may not be the sole contributor to potentially delaying Alzheimer's disease.

"Crude caffeine" is the by-product of de-caffeinating coffee and has been shown to be as effective in partially preventing memory impairment in mice, while other coffee components such as cafestol, kahweol, and Eicosanoyl-5-hydroxytryptamide have also been seen to affect cognitive impairment in animals in various studies.