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Technical Newsletter

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Alumni Section

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Kubernetes

Awhile ago, we used to follow the monolith architecture to develop an application which leads to slower development speed and if there's an error in any module, it could affect the entire application's availability. When we begin to migrate to a microservice-based architecture the need arises that what should we use to make our service simple to deploy and maintain. Then Docker comes into the frame which is an open platform for running, developing, and shipping applications and makes DevOps easy. It allows you to package and run the application in a container, which is a loosely separated environment. However, where and how should we launch the containers? Well, there are numerous options available for running containers and Kubernetes is one of them.

What is Kubernetes?

The name Kubernetes originates from the Greek word which means pilot. Kubernetes is also known as K8s. Kubernetes is an open-source platform that helps to manage containerized workloads and services, automate and scale deployments, supports stateless, stateful, and data-processing workloads, and can do a lot more. It has a huge, rapidly developing ecosystem. Kubernetes tools, services, and support are available widely. Kubernetes supports several broadly applicable functionality common to PaaS providers, such as deployment, scaling, and load balancing, because it operates at the container level instead of the hardware level. However, Kubernetes is not monolithic. Developers can schedule, deploy, and manage their containerized apps using this fantastic platform.

Why do you need Kubernetes?

Applications can be bundled and run effectively using containers. You must manage the containers that run the applications in a production environment to prevent downtime. For instance, another container needs to start if one goes down. Wouldn't it be simpler if a system handled this behavior? Well in this way, Kubernetes saves the day! It offers deployment patterns, handles application scaling and failover, and does more.

Kubernetes offers you:

Storage orchestration: You can use Kubernetes to automatically mount any storage system you want, including local storage, public cloud services, and more.

Self-healing: Kubernetes replace containers, restarts containers when containers fail, and kill them when they don't respond to a user-defined health check.

Service discovery and load balancing: Kubernetes can expose a container using the DNS name or using their own IP address. In order to ensure a stable deployment, Kubernetes is able to load balance and distribute network traffic.

Secret management: You can manage and store sensitive data like passwords and tokens using Kubernetes.

Components of Kubernetes:

Although the entire system is known as Kubernetes, it is actually made up of numerous individual components that work together to make Kubernetes work. These are the various components of Kubernetes:
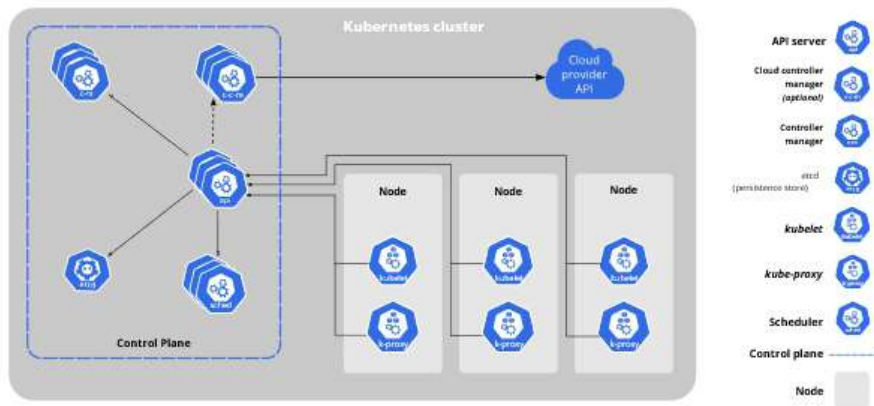
- **API Server:** The Kubernetes API is made available by the API server, which is a part of the Kubernetes control plane. API server scales by deploying more instances. You can run several instances of the Kube API server.
- **Scheduler:** It is also a control plane component that watches for newly created Pods with no assigned node, and selects a node for them to run on.
- **Kube-Controller-manager:** A control plane component that runs every controller which deals with the routine tasks in the cluster.
- **Cloud-controller-manager:** You can connect your cluster to your cloud provider's API using the cloud controller manager.
- **Kubelet:** A node component that runs on each node in the cluster. Also, it interacts with the data store, writing information about newly established services and retrieving information about existing ones.
- **Etcd:** Consistent and highly-available key value store used as Kubernetes' backing store for all cluster data.
- **kube-proxy:** A node component that is a network proxy that runs on each node in your cluster.

__What are nodes and pods?__

Nodes: A Kubernetes cluster consists of a group of worker machines, known as nodes, which run containerized apps. There is at least one worker node in each cluster.

Pods: The smallest Kubernetes cluster unit, a pod is a collection of containers that can share resources and needs to run together.

Kubernetes is amazing! It is expected to continue to be an important area of innovation, with new tools and techniques. Every organization wants to use Kubernetes in their infrastructure today since it has quickly become one of the hottest technologies in the IT industry.
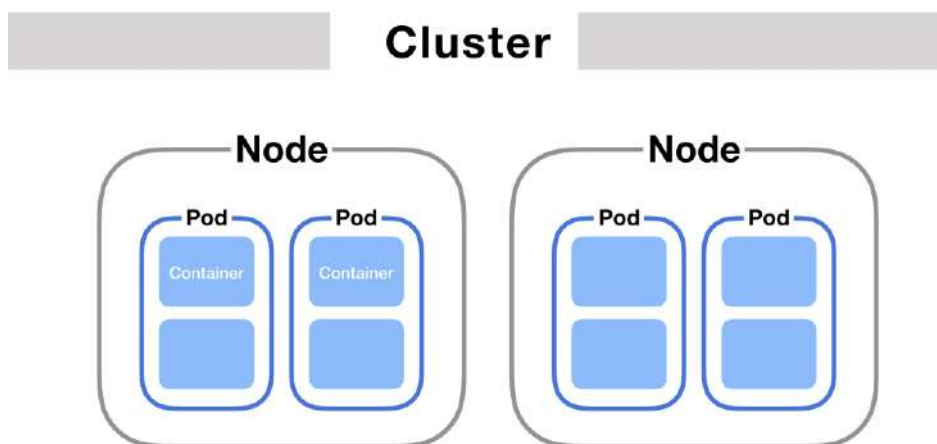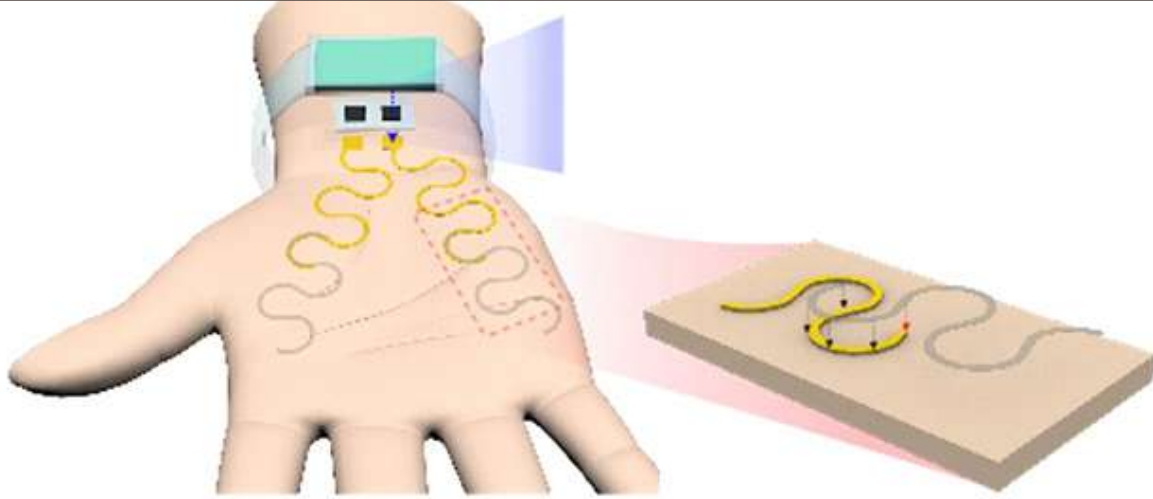
This 'electronic tattoo' can tell when you're stressed out

Researchers at the University of Texas at Austin have developed a temporary "e-tattoo" for the palm that can track excitement and stress using the skin's electrical conductivity. The e-tattoo could be a reliable way for people with conditions such as anxiety or depression to track their emotions.

In a research paper published in the journal *Nature Communications*, the palm tattoo stayed on for 15 hours while subjects did everyday activities such as driving, eating and exercising.

Nanshu Lu, a professor at the University of Texas at Austin's Cockrell School of Engineering, said the e-tattoo could allow patients to track stress levels without wearing a bulky medical device.

"This is such an ultra thin and invisible tattoo," said Lu, an author on the study, "but mechanically, it's resilient enough to survive all kinds of activities."

What is an e-tattoo?

For decades, doctors have placed electrodes on the body to read electrical signals from the brain and heart. Electronic devices that tell us about our health, such as blood pressure monitors, are commonly used at the doctor's office.

Some of the first "electronic tattoos" were made to deliver drugs such as opioids, according to Aaron Franklin, a professor of electrical and computer engineering at Duke University. In the last 5 to 10 years, he said, there's been a push to develop wearable electronic sensors, like Fitbit trackers and smart watches, to monitor health throughout the day instead of only at doctors' appointments.

Lu has studied e-tattoos for over 12 years. She created a stretchable chest tattoo to monitor heart health and was awarded a $1.5 million grant to design an e-tattoo that tracks pneumonia symptoms. She wants to create sensors to collect important medical data that are easy to wear and use.

The goal, she said, is to make electronics, whether they're sensors or processors, "as soft and stretchy as human tissue."

Stress, sweat and sensors

When we experience strong emotions such as excitement and stress, our eccrine sweat glands fill up, making our skin more electrically conductive. Smart watches can contain wrist sensors that measure skin conductivity to track stress levels.

Lu upped the ante, tracking stress in an area of the body that contains the highest concentration of eccrine sweat glands: the palm. An e-tattoo for the palm would give the wearer more accurate stress readings than a smart watch, Lu said, but the tattoo would need to stay on one of the most active parts of the body.

Right now, scientists collect eccrine sweat gland data from the palm by attaching gel electrodes with dangling wires that connect to a wristwatch. Gel electrodes are stiff and bulky and can fall off during everyday activities, Lu said.

Lu's palm e-tattoo goes on just like a temporary tattoo. Her team also created two S-shaped gold ribbons that snake across the palm and connect the palm tattoo to a wristwatch. The wristwatch wirelessly sends the data to a smartphone, where the wearer can read it.

The gold ribbons are extremely thin, just 750 nanometers thick. A sheet of paper, for reference, is about 100,000 nanometers thick.

In the lab, Lu's team first confirmed that the e-tattoo gave similar readings to the gel electrodes. Then they attached two identical watches to the wrists of two people. One watch was connected to gel electrodes on the palm. The other was connected to the ultrathin gold ribbons and the e-tattoo.

They collected data for 15 hours while the people went through everyday motions like studying, eating, exercising and sleeping. The gel electrodes fell off three to five times over the 15 hours. The e-tattoo didn't fall off.

Reliable and Reproducible

Lu's team is not the first to develop an e-tattoo, but it is one of the first to create one for the palm.

For e-tattoos to be used widely in the medical world, they need to conquer two key obstacles, according to Franklin at Duke University. First, their data readings need to be consistently correct. Second, they need to collect reliable data with many different patients those who naturally sweat more or have different skin types, for example.

"Those are the kinds of big problems that await any technology that's going to move past a really nice research paper, which this is," said Franklin, who was not involved with Lu's research.

For Lu's palm e-tattoo to track anxiety and depression, it would need FDA approval. Her plan is to keep fine-tuning the tattoo to provide accurate, continuous information about excitement and stress levels.

Lu sees e-tattoos as a way to "digitize" the human body. She noted a pattern in tech development over the years: Humans are becoming more digital as robots begin to adopt the skills and intelligence of humans. Her goal is to bring humans even closer to bridging that gap.

Researchers develop head-worn device to control mobile manipulators

More than five million people in the United States live with some form of paralysis and may encounter difficulties completing everyday tasks, like grabbing a glass of water or putting on clothes. New research from Carnegie Mellon University's Robotics Institute (RI) aims to increase autonomy for individuals with such motor impairments by introducing a head-worn device that will help them control a mobile manipulator.

Teleoperated mobile manipulators can aid individuals in completing daily activities, but many existing technologies like hand-operated joysticks or web interfaces require a user to have substantial fine motor skills to effectively control them.

Research led by robotics Ph.D. student Akhil Padmanabha offers a new device equipped with a hands-free microphone and head-worn sensor that allows users to control a mobile robot via head motion and speech recognition. Head-Worn Assistive Teleoperation (HAT) requires fewer fine motor skills than other interfaces, offering an alternative for users who face constraints with technology currently on the market.

In addition to Padmanabha, the research team includes Qin Wang, Daphne Han, Jashkumar Diyora, Kriti Kacker, Hamza Khalid, Liang-Jung Chen, Carmel Majidi and Zackory Erickson. In a human study, participants both with and without motor impairments performed multiple household and self-care tasks with low error rates, minimal effort and a high perceived ease of use.

The findings are published on the *arXiv* preprint server.

More information: Akhil Padmanabha et al, HAT: Head-Worn Assistive Teleoperation of Mobile Manipulators, *arXiv* (2022).

OpenAI announces ChatGPT successor GPT-4

OpenAI has released GPT-4 (Generative Pre-trained Transformer 4), the latest version of its hugely popular artificial intelligence chatbot ChatGPT.
The new model can respond to images - providing recipe suggestions from photos of ingredients, for example, as well as writing captions and descriptions. It can also process up to 25,000 words, about eight times as many as ChatGPT. Millions of people have used ChatGPT since it launched in November 2022.

Popular requests for it include writing songs, poems, marketing copy, computer code, and helping with homework - although teachers say students shouldn't use it.
ChatGPT answers questions using natural human-like language, and it can also mimic other writing styles such as songwriters and authors, using the internet as it was in 2021 as its knowledge database.
There are concerns that it could one day take over many jobs currently done by humans.

OpenAI said it had spent six months on safety features for GPT-4, and had trained it on human feedback. However it warned that it may still be prone to sharing disinformation.
GPT-4 will initially be available to ChatGPT Plus subscribers, who pay $20 per month for premium access to the service. It's already powering Microsoft's Bing search engine platform. The tech giant has invested $10b into OpenAI. In a live demo it generated an answer to a complicated tax query, although there was no way to verify its answer. GPT-4, like ChatGPT, is a type of generative artificial intelligence. Generative AI uses algorithms and predictive text to create new content based on prompts.

GPT-4 has "more advanced reasoning skills" than ChatGPT, OpenAI said. The model can, for example, find available meeting times for three schedules.
OpenAI also announced new partnerships with language learning app Duolingo and Be My Eyes, an application for the visually impaired, to create AI Chatbots which can assist their users using natural language.
However, like its predecessors, OpenAI has warned that GPT-4 is still not fully reliable and may "hallucinate" - a phenomenon where AI invents facts or makes reasoning errors.

A new partnership makes special patrol satellites in space a reality

A new Memorandum of Understanding has been signed between Northrop Grumman and IHI to build satellite guardian satellites.

In recent years, the number of satellites orbiting the Earth has been increasing rapidly, with over 8,000 currently in orbit and potentially up to 100,000 in the next ten years, according to the United Nations. This group of satellites is fundamental to modern society. From meteorological satellites to broadcasting and communication satellites, they support many economic and social activities and are a part of the social infrastructure.

So, ensuring these satellites are safe and secure is becoming increasingly important. But some satellites are easy targets, making them vulnerable to malicious attacks. There have also been more cases of strange spacecraft getting close to other satellites, which worries satellite operators. This is why Japan's National Security Strategy and National Defense Strategy call for strengthening "Space Domain Awareness" (SDA), which includes the need for special, maneuverable patrol or police satellites.

"Recently, we have seen a rise in military surveillance efforts from other countries, which is becoming a national security threat," explained Fumiharu Namiki, Vice President of Aero Engine, Space, and Defense Business Area, IHI Corporation.

"We need to characterize suspicious satellites to understand the threat. Northrop Grumman's demonstrated experience in this field and the long-standing cooperation between our companies makes them our best partner to pursue solutions to these problems. We will cooperate together to contribute to the stable use of space," he added.

In response, Northrop Grumman and IHI Corporation (a Tokyo-based company) have agreed to work together to make small, highly maneuverable satellites for SDA missions. These satellites will use satellite buses already made by Northrop Grumman. IHI Corporation has been providing situational awareness data services for a long time.

These services help satellites run safely, and the company has built up a lot of knowledge about how satellites move in geosynchronous earth orbit (GEO). IHI Aerospace, part of the IHI group, has also made propulsion devices for commercial satellites and spacecraft made by Northrop Grumman. The two companies have worked together and trusted each other for a long time.

On the other hand, Northrop Grumman has a long history of making products for the ground and space that help monitor the space environment and find, identify, and describe space objects. The company is a leader in rendezvous and proximity operations in low-Earth-orbit (LEO) and geosynchronous orbit (GEO). It provides customers with critical logistics, servicing, and inspection capabilities across various mission domains.

The goal of the partnership between Northrop Grumman and IHI Corporation is to make space a more important place, especially for activities in GEO and global, national security space that can be done sustainably.

New vocal cords on a chip can let mute people speak

Artificial Technology provides a new paradigm for speech recognition, and is expected to pave the way for applications of mechanical sensors to intelligent home health-monitoring systems.

For those who have lost their voice due to surgery or some other condition, life can prove very difficult. Now, a team of researchers at Beijing's Tsinghua University has engineered a simple device that can give back speech to the voiceless.The new tool is a one-centimeter square that can easily be attached to the throat to transform barely audible sounds and whispers into speech heard at normal audible volumes. The invention is called by the researchers a "graphene-based intelligent, wearable artificial throat" and is powered by a coin-sized battery.

Research team leader Professor Ren Tianling reported that the new innovation has the capacity to detect and translate speech elements such as phonemes, tones, and words at an accuracy rate of 99 percent, according to *TechXplore*. It achieves this by using an artificial intelligence model to interpret captured sounds and bodily vibrations to generate vocalizations.

"Its feasible [voice] fabrication process, stable performance, resistance to noise, and integrated vocalization make the AT a promising tool for next-generation speech recognition and interaction systems," Tianling said. He further explained that the new chip's graphene sensors are ideally suited for the detection of tiny vibrations on skin surfaces. The device, he said, "can sense muscle motions and audio vibrations transmitted to the surface of the skin" and "convert recognizable mechanical information into speech."

Noise interference is not a problem

Better yet, interference from noisy, aggressive environments such as highways, fire disasters, and airplane cockpits do not affect the device. It continues to function at optimum levels regardless of the environment it is in."The speaker's health status, such as neurological diseases, cancer, trauma, and the surrounding environment, noise interference, and transmission medium, often affect the transmission and recognition of sound," Tianling said.

These circumstances do not affect the chip which has the unique quality of being able to function despite any external interference. More studies are required to bring more expressiveness to vocalizations but the researcher believes the device is practical and efficient enough to become commonplace in the future.

"Our intelligent AT provides a new paradigm for speech recognition, and is expected to pave the way for applications of mechanical sensors to intelligent home health-monitoring systems, wearable electronics, and even cryptographic security," he said.

The study was published in **Nature Machine Intelligence** on February 23.

Researchers have recently been pursuing technologies for universal speech recognition and interaction that can work well with subtle sounds or noisy environments. Multichannel acoustic sensors can improve the accuracy of recognition of sound but lead to large devices that cannot be worn. To solve this problem, we propose a graphene-based intelligent, wearable artificial throat (AT) that is sensitive to human speech and vocalization-related motions. Its perception of the mixed modalities of acoustic signals and mechanical motions enables the AT to acquire signals with a low fundamental frequency while remaining noise resistant. The experimental results showed that the mixed-modality AT can detect basic speech elements (phonemes, tones and words) with an average accuracy of 99.05%. We further demonstrated its interactive applications for speech recognition and voice reproduction for the vocally disabled. It was able to recognize everyday words vaguely spoken by a patient with laryngectomy with an accuracy of over 90% through an ensemble AI model. The recognized content was synthesized into speech and played on the AT to rehabilitate the capability of the patient for vocalization.

Novel neutron camera reveals atomic structure of future green technology

According to researchers, the best materials for sustainable energy uses, like turning sunlight or waste heat into electricity, frequently use collective fluctuations of clusters of atoms within a much larger structure.

Called "dynamic disorder," understanding it in materials may help create thermoelectric devices like solid-state refrigerators and heat pumps that are more energy-efficient and improve the direct conversion of waste heat from power plants and automobile exhausts into usable energy. For example, when there wasn't enough sunlight to power the Mars Rover, a thermoelectric device could turn the heat from the radioactive plutonium into electricity.

Materials can act as though they are living and dancing while working inside an operating device; various sections of the material can react and change in unique and unexpected ways.

However, "dynamic disorder" is hard to study because the small, disorganized clusters change over time. Also, researchers aren't interested in "boring" non-changing disorders in materials because they don't improve their qualities.

To help solve this, a new study by researchers from the Université de Bourgogne and Columbia Engineering claims to have created a brand-new type of "camera" that can detect local chaos. Its essential feature is a variable shutter speed: because the disordered atomic clusters are moving, when the team used a slow shutter, the "dynamic disorder" blurred out, but when they used a fast shutter, they could see it.

The new process, called variable shutter atomic pair distribution, or vs PDF, measures atomic positions with a shutter speed of about one picosecond, or a ' million million ' (a trillion) times faster than typical camera shutters.

Professor of materials science, applied physics, and applied mathematics Simon Billinge said, "It gives us a whole new way to untangle the complexities of what is happening in complex materials—hidden effects that can supercharge their properties. With this technique, we can watch a material and see which atoms are dancing and which are sitting it out."

In the future, Billinge is making it easier for scientists to understand and use his method on more dynamically chaotic systems. The technique still needs to be fully automated, but with more work, it should become more common and can be used in many material systems where the movement of atoms is significant. For example, it can be used to watch lithium move in battery electrodes or study the movement of particles when sunlight splits water. You can view the study for yourself in the journal Nature Materials.

"Cubic energy materials such as thermos-electrics or hybrid perovskite materials are often understood to be highly disordered. In GeTe and related IV–VI compounds formed from elements of column IV and VI of the periodic table, this is thought to provide the low thermal conductivities needed for thermoelectric applications. Since conventional crystallography cannot distinguish between static disorder and atomic motions, we develop the energy-resolved variable-shutter pair distribution function technique. This collects structural snapshots with varying exposure times on timescales relevant for atomic motions. In disagreement with previous interpretations, we find the time-averaged structure of GeTe to be crystalline at all temperatures, but with anisotropic anharmonic dynamics at higher temperatures that resemble static disorder at fast shutter speeds, with correlated ferroelectric fluctuations along the <100>c direction. We show that this anisotropy naturally emerges from a Ginzburg–Landau model that couples polarization fluctuations through long-range elastic interactions. By accessing time-dependent atomic correlations in energy materials, we resolve the long-standing disagreement between local and average structure probes and show that spontaneous anisotropy is ubiquitous in cubic IV–VI materials."

Scientists confirm existence of a fifth layer in Earth's core
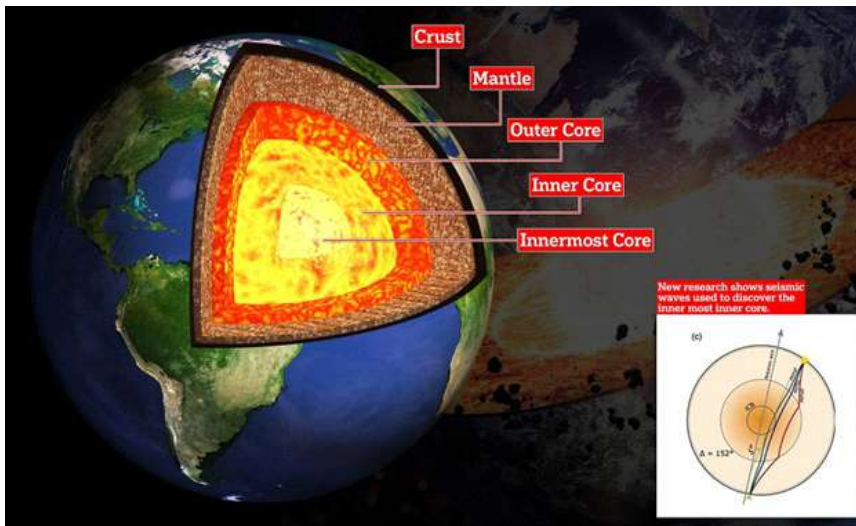
Scientists have excavated a new secret from the Earth's inner world. The researchers, in a new study, have confirmed the existence of a fifth new layer.

Researchers trying to uncover the secrets of Earth's geology have revealed the fifth layer of the planet. Seismic waves generated by earthquakes have revealed new insights about the deepest parts of Earth's inner core. The fifth layer is made of iron and nickel, the same materials that comprise the rest of the inner core.

More about The existence of a fifth layer in Earth's core:

The team of researchers from the Australian National University measured the speeds at which these seismic waves penetrate and pass through the Earth's inner core. The team believes that this has presented evidence of a distinct layer inside Earth known as the innermost inner core.

The existence of an internal metallic ball within the inner core, the innermost inner core, was hypothesised about 20 years ago.

## Key Things to Know About fifth layer in Earth's core:

This layer is a solid 'metallic ball' that sits within the center of the inner core. The findings of the study have been published in the journal Nature Communications, which states that probing the Earth's center is critical for understanding planetary formation and evolution.

So far, four layers of Earth's structure had been identified. This includes – the crust, mantle, outer core, and inner core. The new findings indicate a fifth layer beneath that.

About This Research:

The team assessed the seismic waves that travel directly through the Earth's center and 'spit out' at the opposite side of the globe to where the earthquake was triggered. The waves then travel back to the source of the quake. The team studied the earthquake, which originated in Alaska. The waves bounced off somewhere in the south Atlantic Ocean, before traveling back to Alaska.

The researchers studied the anisotropy of the iron-nickel alloy that comprises the inside of the Earth's inner core. Anisotropy is used to describe how seismic waves speed up or slow down through the material of the Earth's inner core, depending on the direction in which they travel. They found that bouncing seismic waves repeatedly probed spots near the Earth's center from different angles.
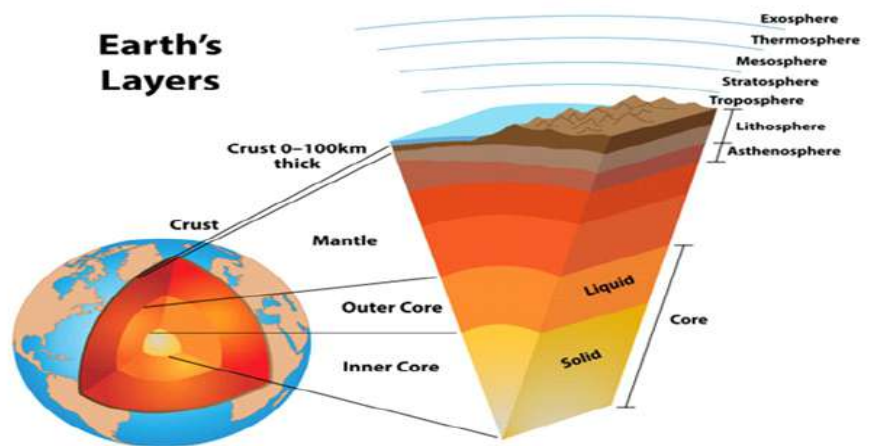
US hands over NISAR satellite to ISRO

NISAR, an Earth-observation satellite, is a joint mission by the National Aeronautics and Space Administration (NASA) and the Indian Space Research Organisation (ISRO).

The Indian Space Research Organisation (ISRO) has received the NASA-ISRO SAR (NISAR) satellite from the U.S. space agency. A US Air Force C-17 aircraft carrying the NASA-ISRO synthetic aperture radar (NISAR) has landed in Bengaluru.

<u>NISAR Satellite- All About</u>

NISAR was envisioned by NASA and ISRO eight years ago in 2014 as a powerful demonstration of the capability of radar as a science tool and help us study Earth's dynamic land and ice surfaces in greater detail than ever before.

NISAR is a Low Earth Orbit observatory jointly developed by NASA and ISRO.

NISAR carries L and S dual-band Synthetic Aperture Radar (SAR), which operates with the Sweep SAR technique to achieve large swaths with high-resolution data. The SAR payloads mounted on Integrated Radar Instrument Structure (IRIS) and the spacecraft bus are together called an observatory.

I.   NISAR will be used by ISRO for a variety of purposes including agricultural mapping, and landslide-prone areas.

II.   NISAR will provide a wealth of data and information about the Earth's surface changes, natural hazards, and ecosystem disturbances, helping to advance our understanding of Earth system processes and climate change.

III.   The mission will provide critical information to help manage natural disasters such as earthquakes, tsunamis, and volcanic eruptions, enabling faster response times and better risk assessments.

The satellite is expected to be launched in 2024 from Satish Dhawan Space Centre in Andhra Pradesh, into a near-polar orbit. The satellite will operate for a minimum of three years. It is a Low Earth Orbit (LEO) observatory.

Meet the world's first artificial energy island

Princess Elisabeth Island, a pioneering electricity grid at sea, connects offshore wind farms to the mainland, and it also creates connections with neighboring countries.

The Princess Elisabeth Zone is a future 3.5 gigawatt (GW) offshore wind farm that will be in the North Sea, almost 45 km (28 miles) off the coast of Belgium. Belgian electricity transmission system operator Elia is developing what will be the world's first offshore artificial energy island.

The island will act as a hub for electricity transmission, receiving power from the Princess Elisabeth Zone, which is the second Belgian offshore wind zone, as well as from interconnectors with other European countries such as the UK and Denmark.

The energy generated by the wind turbines will be transmitted to the island via undersea cables, where it will then be converted to high-voltage electricity and distributed to the Belgian mainland and other European countries.

Elia announced yesterday that Belgian-based offshore construction companies DEME Group and Jan De Nul Group have formed joint venture TM EDISON in order to build Princess Elisabeth Island. Construction will start in early 2024, and completion is planned for mid-2026. It's expected to be fully connected to all wind farms and the mainland by 2030.

The energy island is expected to play a major role in meeting Belgium's renewable energy targets and reducing greenhouse gas emissions. The Belgian government awarded the project with a grant of around €100 million ($106 million).

Scientists invent biomaterial that can heal tissue from the inside out

Scientists at the University of California San Diego have invented a new biomaterial that can be injected intravenously to reduce inflammation in tissue and repair cells, according to a press release by the institution published in late January.

The new material was tested in both rodent and large animal models. It was found to have many case uses in treating tissue damage caused by heart attacks and in aiding patients with traumatic brain injury and pulmonary arterial hypertension.

"This biomaterial allows for treating damaged tissue from the inside out," said Karen Christman, a professor of bioengineering at the University of California San Diego, and the lead researcher on the team that developed the material.

"It's a new approach to regenerative engineering."

Now, the researchers hope to conduct a study on the safety and efficacy of the biomaterial in human subjects within one to two years. Once approved, the material will be put to use, helping those who suffer from heart attacks which have caused them to have scar tissue that diminishes muscle function and can lead to congestive heart failure.

"Coronary artery disease, acute myocardial infarction, and congestive heart failure continue to be the most burdensome public health problems affecting our society today," said Dr. Ryan R. Reeves, a physician in the Division of Cardiovascular Medicine at UC San Diego Health.

"As an interventional cardiologist, who treats patients with coronary artery disease and congestive heart failure on a daily basis, I would love to have another therapy to improve patient outcomes and reduce debilitating symptoms."

Difficult-to-access organs and tissues

Some of the main advantages of the new treatment is that it can be administered immediately after a heart attack and it can get evenly distributed throughout damaged tissue because it's infused or injected intravenously.

"We sought to design a biomaterial therapy that could be delivered to difficult-to-access organs and tissues, and we came up with the method to take advantage of the bloodstream - the vessels that already supply blood to these organs and tissues," said Martin Spang, the paper's first author, who earned his Ph.D. in Christman's group in the Shu Chien-Gene Lay Department of Bioengineering at the UC San Diego Jacobs School of Engineering.

Now, the team is finding new case uses for the biomaterial. "While the majority of work in this study involved the heart, the possibilities of treating other difficult-to-access organs and tissues can open up the field of biomaterials/tissue engineering into treating new diseases," Spang said in the press release.

Researchers use AI to generate images based on people's brain activity

What if an AI could interpret your imagination, turning images in your mind's eye into reality? While that sounds like a detail in a cyberpunk novel, researchers have now accomplished exactly this, according to a recently published paper.

Researchers found that they could reconstruct high-resolution and highly accurate images from brain activity by using the popular Stable Diffusion image generation model, as outlined in a paper published in December. The authors wrote that unlike previous studies, they didn't need to train or fine-tune the AI models to create these images.

The researchers from the Graduate School of Frontier Biosciences at Osaka University said that they first predicted a latent representation, which is a model of the image's data, from functional magnetic resonance imaging (fMRI) signals. Then, the model was processed, and noise was added to it through the diffusion process. Finally, the researchers decoded text representations from fMRI signals within the higher visual cortex and used them as input to produce a final constructed image. The researchers wrote that a few studies have produced high resolution reconstructions of images but it was only after training and fine-tuning generative models. This resulted in limitations because training complex models is challenging and there are not many samples in neuroscience to work with. Prior to this new study, no other researchers had tried using diffusion models for visual reconstruction.

This study was a peek into the internal processes of diffusion models, the researchers concluded, saying that the study was the first to provide a quantitative interpretation of the model from a biological perspective. For example, there is a diagram that the researchers created showing the correlation between stimuli and noise levels in the brain. The higher-level the stimuli, the higher level the noise level would be, and the higher resolution the image would be. In another diagram, the researchers show the engagement of different neural networks in the brain and how it would denoise an image to reconstruct it.

"These results suggest that, at the beginning of the reverse diffusion process, image information is compressed within the bottleneck layer. As denoising progresses, a functional dissociation among U-Net layers emerges within visual cortex: i.e The first layer tends to represent fine-scale details in early visual areas, while the bottleneck layer corresponds to higher-order information in more ventral, semantic areas," the researchers wrote.

In the past, we've seen other examples of how brainwaves and brain functions can create images. In 2014, a Shanghai-based artist Jody Xiong used EEG(electroencephalogram) biosensors to connect sixteen people with disabilities to balloons of paint. The people would then use their thoughts to burst specific balloons and create their own paintings. In another EEG example, artist Lia Chavez created an installation that allowed the electrical impulses in the brain to create sounds and light works. Audiences would wear EEG headsets, which would transfer the signals to an A/V system, where the brainwaves would be reflected through color and sound.

With the advancement of generative AI, more and more researchers have been testing the ways AI models can work with the human brain. In a January 2022 study, researchers at Radboud University in the Netherlands trained a generative AI network, a predecessor of Stable Diffusion, on fMRI data from 1,050 unique faces and converted the brain imaging results into actual images. The study found that the AI was able to perform unparalleled stimulus reconstruction. In the latest study released in December, the researchers revealed that current diffusion models can now achieve high-resolution visual reconstruction.

Scientists find a way to suck up carbon pollution, turn it into baking soda and store it in the oceans

Scientists have set out a way to suck planet-heating carbon pollution from the air, turn it into sodium bicarbonate and store it in oceans, according to a new paper.

The technique could be up to three times more efficient than current carbon capture technology, say the authors of the study, published Wednesday in the journal Science Advances.

Tackling the climate crisis means drastically reducing the burning of fossil fuels, which releases planet-heating pollution. But because humans have already pumped so much of this pollution into the atmosphere and are unlikely to sufficiently reduce emissions in the near term, scientists say we also need to remove it from the air.

Nature does this -- forests and oceans, for example, are valuable carbon sinks but not quickly enough to keep pace with the amounts humans are producing. So we have turned to technology.

One method is to capture carbon pollution directly at the source, for example from steel or cement plants.

But another way, which this study focuses on, is "direct air capture." This involves sucking carbon pollution directly out of the atmosphere and then storing it, often by injecting it into the ground.

The problem with direct air capture is that while carbon dioxide may be a very potent planet-heating gas, its concentrations are very small & it makes up about 0.04% of air. This means removing it directly from the air is challenging and expensive.

It's a "significant hurdle," Arup SenGupta, a professor at Lehigh University and a study author, told CNN.

Even the biggest facilities can only remove relatively small amounts and it costs several hundred dollars to remove each ton of carbon.

Climeworks' direct air removal project in Iceland is the largest facility, according to the company, and can capture up to 4,000 tons of carbon dioxide a year. That's equivalent to the carbon pollution produced by fewer than 800 cars over a year.

The new technique laid out in the study can help tackle those problems, said SenGupta.

The team have used copper to modify the absorbent material used in direct air capture. The result is an absorbent "which can remove CO2 from the atmosphere at ultra-dilute concentration at a capacity which is two to three times greater than existing absorbents," SenGupta said.

This material can be produced easily and cheaply and would help drive down the costs of direct air capture, he added.

Once the carbon dioxide is captured, it can then be turned into sodium bicarbonate, baking soda using seawater and released into the ocean at a small concentration.

The oceans "are infinite sinks," SenGupta said. "If you put all the CO2 from the atmosphere, emitted every day or every year into the ocean, the increase in concentration would be very, very minor," he said.

SenGupta's idea is that direct air capture plants can be located offshore, giving them access to abundant amounts of seawater for the process.

Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh, who was not involved in the study, told CNN that the chemistry was "novel and elegant."

The process is a modification of one we already know, he said, "which is easier to understand, scale-up and develop than something totally new."

But there may be regulatory hurdles to surmount. "Disposing of large tonnages of sodium bicarbonate in the ocean could be legally defined as 'dumping,' which is banned by international treaties," Haszeldine said.

Others remain concerned about negative impacts on the oceans, which are already under pressure from climate change, pollution and other human activity.

Peter Styring, professor of chemical engineering and chemistry at the University of Sheffield, told CNN: "Unless you've got a full eco-toxic study, then you don't know what it's going to do, even at small concentrations."

Direct air capture also remains expensive and inefficient, Styring said. "This is a big scale problem. Why would you capture from the atmosphere when you've got so much coming out of power stations and industrial plants? It just makes sense to go for the high concentrations first," he said.

Some scientists have expressed concerns that a focus on technology to remove carbon pollution could distract from policies to reduce fossil fuel burning, or could give polluters license to carry on polluting.

But given the scale of the climate crisis, there is a big push from governments and international bodies to scale up this technology.

More research will be needed to understand how the method works at scale, Haszeldine said. But it's promising, he added, saying "the world needs lots of this type of discovery."

SenGupta said the technology is ready to be taken out of the lab and trialed. "This is the time to go forward and do something in maybe two or three different places around the world. Let other people get involved, find faults, improve on it, and then proceed accordingly," he said.

It sure seems like Amazon is making a new web browser

Amazon is thinking about releasing a web browser, a boring-sounding project that could have massive implications. The company has sent a survey to users asking detailed questions, including which features would "convince you to download and try" a "new desktop/laptop browser from Amazon."

"We want to understand what our customers value about current web browsers, and what they wish the browsers could do better," Amazon wrote in the survey, first spotted by Nicholas De Leon of Consumer Reports. "By participating in this survey, you will contribute to innovations that improve browsing experiences for millions of people around the world."

The survey asked a variety of questions. Most telling was the last question: "Imagine that there is a new desktop/laptop browser from Amazon available to do. Select which of the following you would most like to know more about." The survey went on to list topics such as privacy, syncing passwords across devices, and shopping features. I'm imagining it right now, Amazon.

You can click through the slideshow above to see more details for yourself. Users were asked to rate the importance of features including text to speech, extensions, the availability to sync data across desktop and mobile devices, and notably blocking third party cookies.

Amazon seems to be seriously considering a web browser of its own, and it comes at a time when it would have an unusual impact on the advertising business. The ad industry is bracing for cataclysmic change as Google moves closer to killing third-party cookies in Chrome, the world's most popular web browser, which would kneecap one of the primary ways businesses track consumers for ads.

Most people don't think of Amazon as an ad company, but it's raking in astonishing marketing revenue. Amazon's ad business made almost $38 billion dollars in 2022, which is more than it made on Prime and all of its other subscription services combined.

Part of what makes Amazon so attractive to marketers is the fact that the company sits on a treasure trove of data about what consumers are buying and what their shopping habits are like. If Amazon could match that information with the data collection that comes from a web browser, it could tip the scales of internet advertising in favor of the retail giant.

Amazon is, at the very least, doing its homework. The survey asked what users use their browsers for, how often they run into frustration with their tabs, and how many hours a day they spend using it.

This isn't Amazon's first dip into the browser waters, though. Amazon did put out a web browser once, which it called Silk. First launched in 2011, Silk was meant for Amazon's own products. The company kept working on it, and Silk last made news when it came to the Echo Show in 2018. The survey suggests, however, that Amazon may release a browser for desktops for the first time.