SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Weekly Discovery

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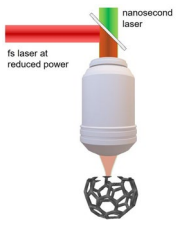
1 Jul – 5 Jul 2024

3D PRINTING

Precise And Less Expensive 3D Printing of Complex, High-Resolution Structures



"WASHINGTON — Researchers have developed a new two-photon polymerization technique that uses two lasers to 3D print complex high-resolution structures. The advance could make this 3D printing process less expensive, helping it find wider use in a variety of applications.

Two-photon polymerization is an advanced additive manufacturing technique that traditionally uses femtosecond lasers to polymerize materials in a precise, 3D manner. Although this process works well for making high-resolution microstructures, it isn't widely used in manufacturing because femtosecond lasers are expensive and increase the cost of printing parts.

"We combined a relatively low-cost laser emitting visible light with a femtosecond laser emitting infrared pulses to reduce the power requirement of the femtosecond laser," said research team leader Xianfan Xu from Purdue University. "In this way, with a given femtosecond laser power, the printing throughput can be increased, leading to a lower cost for printing individual parts."

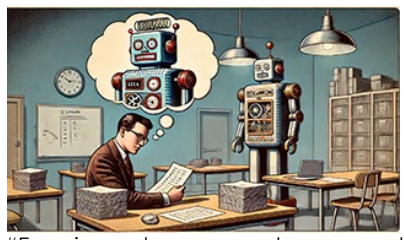
In the Optica Publishing Group Journal Optics Express, the researchers show that the two-laser approach reduces the femtosecond laser 3D printing power needed by as much as 50% compared to using a femtosecond laser alone.

"3D printing with high resolution has many applications, including 3D electronics devices, micro-robots for the biomedical field and 3D structures or scaffolds for tissue engineering," said Xu. "Our novel, 3D printing approach can be readily implemented in many existing femtosecond laser 3D printing systems."

Source: Eurekalert! (2 Jul 2024)

AI

AI Generated Exam Answers Undetected in Real World Test



"Experienced exam markers may struggle to spot answers generated by Artificial Intelligence (AI), researchers have found.

The study was conducted at the University of Reading, UK, where university leaders are working to identify potential risks and opportunities of AI for research, teaching, learning, and assessment, with updated advice already issued to staff and students as a result of their findings.

The researchers are calling for the global education sector to follow the example of Reading, and others who are also forming new policies and guidance and do more to address this emerging issue.

In a rigorous blind test of a real-life university examinations system, published today (26 June) in PLOS ONE, ChatGPT generated exam answers, submitted for several undergraduate psychology modules, went undetected in 94% of cases and, on average, attained higher grades than real student submissions.

This was the largest and most robust blind study of its kind, to date, to challenge human educators to detect AI-generated content.

Associate Professor Peter Scarfe and Professor Etienne Roesch, who led the study at Reading's School of Psychology and Clinical Language Sciences, said their findings should provide a "wakeup call" for educators across the world. A recent UNESCO survey of 450 schools and universities found that less than 10% had policies or guidance on the use of generative AI.

Dr Scarfe said: "Many institutions have moved away from traditional exams to make assessment more inclusive. Our research shows it is of international importance to understand how AI will affect the integrity of educational assessments.

"We won't necessarily go back fully to hand-written exams, but global education sector will need to evolve in the face of AI.

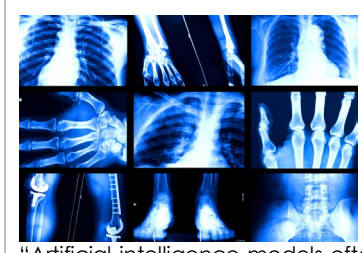
"It is testament to the candid academic rigour and commitment to research integrity at Reading that we have turned the microscope on ourselves to lead in this."

Professor Roesch said: "As a sector, we need to agree how we expect students to use and acknowledge the role of AI in their work. The same is true of the wider use of AI in other areas of life to prevent a crisis of trust across society.

Source: READING (28 Jun 2024)

AI

Study Reveals Why AI Models That Analyze Medical Images Can Be Biased



"Artificial intelligence models often play a role in medical diagnoses, especially when it comes to analyzing images such as X-rays. However, studies have found that these models don't always perform well across all demographic groups, usually faring worse on women and people of color.

These models have also been shown to develop some surprising abilities. In 2022, MIT researchers reported that AI models can make accurate predictions about a patient's race from their chest X-rays — something that the most skilled radiologists can't do.

That research team has now found that the models that are most accurate at making demographic predictions also show the biggest "fairness gaps" — that is, discrepancies in their ability to accurately diagnose images of people of different races or genders. The findings suggest that these models may be using "demographic shortcuts" when making their diagnostic evaluations, which lead to incorrect results for women, Black people, and other groups, the researchers say.

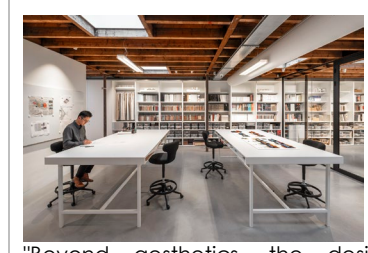
"It's well-established that high-capacity machine-learning models are good predictors of human demographics such as self-reported race or sex or age. This paper re-demonstrates that capacity, and then links that capacity to the lack of performance across different groups, which has never been done," says Marzyeh Ghassemi, an MIT associate professor of electrical engineering and computer science, a member of MIT's Institute for Medical Engineering and Science, and the senior author of the study.

The researchers also found that they could retrain the models in a way that improves their fairness. However, their approached to "debiasing" worked best when the models were tested on the same types of patients they were trained on, such as patients from the same hospital. When these models were applied to patients from different hospitals, the fairness gaps reappeared."

Source: MIT (28 Jun 2024)

ARCHITECTURE

Investing In Wellbeing: How Healthy Workspaces Drive Productivity and Profit



"Beyond aesthetics, the design of our workplaces directly impacts our health. Studies reveal a clear link between poor light quality and limited access to natural views with increased sick leave. Smoke-free policies have been demonstrably effective, reducing smoking prevalence by 3.8% and lowering tobacco consumption by a significant 3.1 cigarettes per day for continuing smokers. Workplaces can either support wellbeing or be a detriment to it. Conscious office design can blend aspects of health in spaces to cultivate physical, mental, and social well-being.

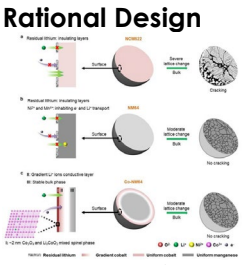
With an increased recognition of the synergy between workplace design and employee well-being, organizations are incorporating health-centric design practices to promote an engaged and productive workforce. Workplace strategy geared toward occupant well-being benefits individual workers while contributing to the overall success of the organization.

The growing body of research on the impact of physical environments on well-being highlights the importance of design in encouraging healthy workspaces. Several key strategies are emerging to combat indoor environmental challenges and promote employee well-being. Air quality management has become a critical focus, with studies showing indoor pollutants in offices can be up to 100 times higher than outdoor levels. To address this, advanced ventilation systems and low-emission materials are being implemented, alongside smoke-free policies that have demonstrated success in reducing smoking prevalence."

Source: Archdaily (1 Jul 2024)

BATTERIES

Low-Cobalt, High-Performance Lithium-Ion Batteries Achieved by Rational Design



"Researchers from Hunan University have designed a layered oxide cathode for rechargeable lithium-ion batteries that achieves fast-charging performance, long life, and high safety using only an ultra-low amount of cobalt. The study was published in the journal National Science Open.

In recent years, lithium-ion secondary batteries have played a crucial role in the rapid increase of electric vehicles worldwide. Typically, lithium-ion battery cathodes contain cobalt to ensure fast-charging capabilities. However, the surging demand for cobalt and its limited supply have significantly increased the cost of lithium-ion battery materials. The primary challenge has been to reduce cobalt usage while maintaining fast-charging performance.

DESIGN

UK Design Education Has "Fundamental Problem" says Jo Johnson

"British politician Jo Johnson, brother to the former prime minister Boris Johnson, has criticised the current state of Britain's design and technology education.

Speaking at the launch of the Design Council's report A Blueprint for Renewal: Design and Technology Education, Johnson outlined his frustrations and called for changes to the country's education system.

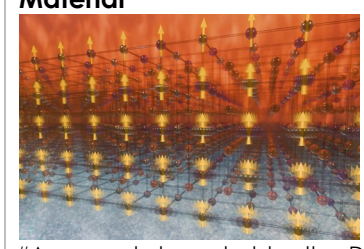
Secondary school system is "totally constipated"

"We have a big problem," Johnson said. "And that problem is a totally constipated secondary school system at the moment, which has been bunged up by reforms that tried to take our curriculum back to the 1950s."

"This government has unfortunately stuck our secondary education system in a mindset that thinks the way we did things in the 1950s is the way we need to do things in [...] the 21st century.

MATERIALS

Scientists Probe Chilling Behavior of Promising Solid-State Cooling Material



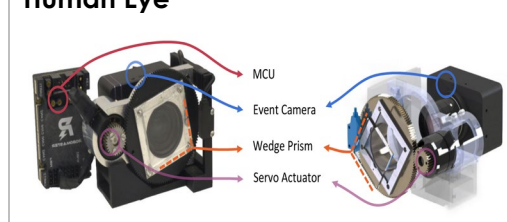
"A research team led by the Department of Energy's Oak Ridge National Laboratory has bridged a knowledge gap in atomic-scale heat motion. This new understanding holds promise for enhancing materials to advance an emerging technology called solid-state cooling.

An environmentally friendly innovation, solid-state cooling could efficiently chill many things in daily life from food to vehicles to electronics — without traditional refrigerant liquids and gases or moving parts. The system would operate via a quiet, compact and lightweight system that allows precise temperature control.

Although the discovery of improved materials and the invention of higher-quality devices are already helping to promote the growth of the new cooling method, a deeper understanding of material enhancements is essential. The research team used a suite of neutron-scattering instruments to examine at the atomic scale a material that scientists consider to be an optimal candidate for use in solid-state cooling.

OPTICS

UMD Researchers Develop New and Improved Camera Inspired by The Human Eye



"A team led by University of Maryland computer scientists invented a camera mechanism that improves how robots see and react to the world around them. Inspired by how the human eye works, their innovative camera system mimics the tiny involuntary movements used by the eye to maintain clear and stable vision over time. The team's prototyping and testing of the camera—called the Artificial Microsaccade-Enhanced Event Camera (AMI-EV)—was detailed in a paper published in the journal Science Robotics in May 2024.

"Event cameras are a relatively new technology better at tracking moving objects than traditional cameras, but today's event cameras struggle to capture sharp, blur-free images when there's a lot of motion involved," said the paper's lead author Botao He, a computer science Ph.D. student at UMD. "It's a big problem because robots and many other technologies—such as self-driving cars—rely on accurate and timely images to react correctly to a changing environment. So, we asked ourselves: How do humans and animals make sure their vision stays focused on a moving object?"

To address this issue, the researchers synthesized a rational structure composed of a robust conductive protective layer, gradient Li+ ions conductive layer and stable bulk phase by optimizing the distribution of cobalt in high-nickel layered oxide cathode particles. Analysis showed that the robust conductive protective layer, gradient Li+ ions conductive layer significantly enhanced the ionic and electronic conductivity of the material. Consequently, this structure exhibited excellent rate performance (fast-charging) even with an ultra-low amount of cobalt. Additionally, the bulk phase with moderate cation mixing and the surface conductive protective layer effectively ensured material stability, achieving outstanding cycling stability and safety. In terms of battery performance, the designed cathode has doubled in rate performance (5 C) and retained 90.4% capacity after 300 cycles at high voltage in the full cell. These advantages suggest that the designed cathode has great potential for practical applications."

Source: Eurekalert! (2 Jul 2024)

"What is really frustrating me at the moment is that, although design is one of Britain's great strengths [...], I do feel that we're fundamentally shortchanging ourselves as a country in terms of exploiting the huge potential we have to do even better than we do already."

Citing reforms that were introduced in 2010 and further developed in 2017, Johnson continued, "we have a curriculum at the moment [...] that is completely outdated in terms of its excessive emphasis on a very narrow range of academic subjects."

He was referring to the English Baccalaureate (EBacc) subjects that GCSE students must take, which include English language and literature, mathematics, the sciences, geography or history, and a language."

Source: Dezeen (3 July 2024)

The material, a nickel-cobalt-manganese-indium magnetic shape-memory alloy, can be deformed and then returned to its original shape by driving it through a phase transition either by increasing temperature or by applying a magnetic field. When subjected to a magnetic field, the material undergoes a magnetic and structural phase transition, during which it absorbs and releases heat, a behavior known as the magnetocaloric effect. In solid-state cooling applications, the effect is harnessed to provide refrigeration. A key characteristic of the material is its nearness to disordered conditions known as ferroic glassy states, because they present a way to enhance the material's ability to store and release heat.

Magnons, also known as spin waves, and phonons, or vibrations, couple in a synchronized dance in small regions distributed across the disordered arrangement of atoms that comprise the material. The researchers found that patterns of behavior in these small regions, referred to as localized hybrid magnon-phonon modes in the team's paper detailing the research, have important implications for the thermal properties of the material."

Source: ORNL (1 Jul 2024)

For He's team, the answer was microsaccades, small and quick eye movements that involuntarily occur when a person tries to focus their view. Through these minute yet continuous movements, the human eye can keep focus on an object and its visual textures—such as color, depth and shadowing—accurately over time.

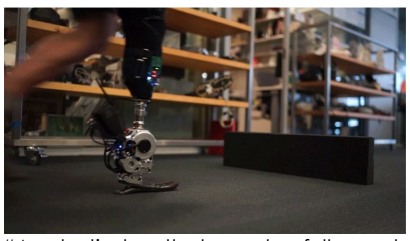
"We figured that just like how our eyes need those tiny movements to stay focused, a camera could use a similar principle to capture clear and accurate images without motion-caused blurring," he said.

The team successfully replicated microsaccades by inserting a rotating prism inside the AMI-EV to redirect light beams captured by the lens. The continuous rotational movement of the prism simulated the movements naturally occurring within a human eye, allowing the camera to stabilize the textures of a recorded object just as a human would. The team then developed software to compensate for the prism's movement within the AMI-EV to consolidate stable images from the shifting lights."

Source: CMNS (2 Jul 2024)

ROBOTIC

Bionic Leg Moves Like a Natural Limb — Without Conscious Thought



"A robotic leg that can be fully controlled by the brain and spinal cord has enabled seven people who had lost a lower leg to walk roughly as fast as people without amputations.

The bionic limb uses a computer interface that amplifies nerve signals from muscles in the remaining part of the leg and allows the wearer to move the prosthesis with their own thoughts and natural reflexes.

In a clinical trial involving 14 people, participants with this interface were able to walk 41% faster than were those with standard robotic legs. They also had better balance and ability to change their speed, climb stairs and step over obstacles. The results were published today in Nature Medicine1.

"This is the first study that demonstrates natural gait patterns with a full neural modulation where the person's brain is 100% in command of the bionic prosthesis, not a robotic algorithm," said study co-author Hugh Herr, a biophysicist at the Massachusetts Institute of Technology in Cambridge, at a press conference announcing the findings.

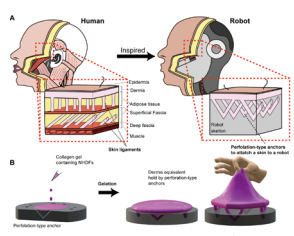
"Even though the limb is made of titanium and silicone and all these various electromechanical components, the limb feels natural, and it moves naturally without even conscious thought," he added.

Herr had both of his legs amputated after being caught in a blizzard while ice climbing on New Hampshire's Mount Washington in 1982. He says he would consider using the interface devices for his limbs in future."

Source: Nature (1 July 2024)

ROBOTS

Robots Face the Future



"Researchers have found a way to bind engineered skin tissue to the complex forms of humanoid robots. This brings with it potential benefits to robotic platforms such as increased mobility, self-healing abilities, embedded sensing capabilities and an increasingly lifelike appearance. Taking inspiration from human skin ligaments, the team, led by Professor Shoji Takeuchi of the University of Tokyo, included special perforations in a robot face, which helped a layer of skin take hold. Their research could be useful in the cosmetics industry and to help train plastic surgeons.

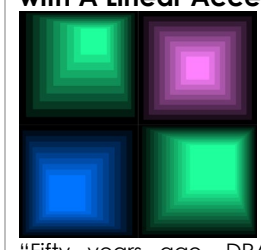
Takeuchi is a pioneer in the field of biohybrid robotics, where biology and mechanical engineering meet. So far, his lab, the Biohybrid Systems Laboratory, has created mini robots that walk using biological muscle tissue, 3D printed lab-grown meat, engineered skin that can heal, and more. It was during research on the last of these items that Takeuchi felt the need to take the idea of robotic skin further to improve its properties and capabilities."

"During previous research on a finger-shaped robot covered in engineered skin tissue we grew in our lab, I felt the need for better adhesion between the robotic features and the subcutaneous structure of the skin," said Takeuchi. "By mimicking human skin-ligament structures and by using specially made V-shaped perforations in solid materials, we found a way to bind skin to complex structures. The natural flexibility of the skin and the strong method of adhesion mean the skin can move with the mechanical components of the robot without tearing or peeling away."

Source: UTokyo (26 Jun 2024)

SEMICONDUCTORS

Scaling Compute to Satiate AI TSMC Bets on Stacking GPUs While Japanese Researchers Shrink Devices with A Linear Accelerator



"Fifty years ago, DRAM inventor and IEEE Medal of Honor recipient Robert Dennard created what essentially became the semiconductor industry's path to perpetually increasing transistor density and chip performance. That path became known as Dennard scaling, and it helped codify Gordon Moore's postulate about device dimensions shrinking by half every 18 to 24 months. For decades it compelled engineers to push the physical limits of semiconductor devices.

But in the mid-2000s, when Dennard scaling began running out of juice, chipmakers had to turn to exotic solutions like extreme ultraviolet (EUV) lithography systems to try to keep Moore's Law on pace. On a visit to GlobalFoundries in Malta, N.Y., in 2017 to see the company install its first EUV system, senior editor Samuel K. Moore asked one expert what the fab would need to achieve even smaller device dimensions. "We'd probably have to build a particle accelerator under the parking lot," the man joked. The idea seemed so fantastic that it stuck with Moore.

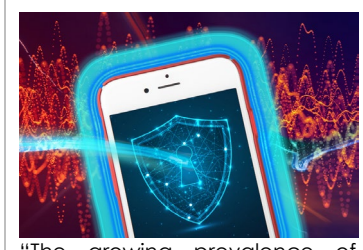
So when Tokyo-based tech journalist John Boyd recently pitched a story about an effort to harness a linear accelerator as an EUV light source, Moore was excited. Boyd's visit to the High Energy Accelerator Research Organization, known as KEK, in Tsukuba, Japan, became the basis for "Is the Future of Moore's Law in a Particle Accelerator?" As he reports, KEK's system generates light by "boosting electrons to relativistic speeds and then deviating their motion in a particular way.

So far, KEK researchers have managed to blast a 17-megaelectron-volt electron beam in bursts of 20-micrometer infrared light, a ways away from the current industry standard of 13.5 nanometers. But the KEK team is optimistic about their technology's prospects."

Source: IEEE Spectrum (28 Jun 2024)

TELECOMMUNICATION

Wireless Receiver Blocks Interference for Better Mobile Device Performance



"The growing prevalence of high-speed wireless communication devices, from 5G mobile phones to sensors for autonomous vehicles, is leading to increasingly crowded airwaves. This makes the ability to block interfering signals that can hamper device performance an even more important — and more challenging — problem.

With these and other emerging applications in mind, MIT researchers demonstrated a new millimeter-wave multiple-input-multiple-output (MIMO) wireless receiver architecture that can handle stronger spatial interference than previous designs. MIMO systems have multiple antennas, enabling them to transmit and receive signals from different directions. Their wireless receiver senses and blocks spatial interference at the earliest opportunity, before unwanted signals have been amplified, which improves performance.

Key to this MIMO receiver architecture is a special circuit that can target and cancel out unwanted signals, known as a nonreciprocal phase shifter. By making a novel phase shifter structure that is reconfigurable, low-power, and compact, the researchers show how it can be used to cancel out interference earlier in the receiver chain.

Their receiver can block up to four times more interference than some similar devices. In addition, the interference-blocking components can be switched on and off as needed to conserve energy.

In a mobile phone, such a receiver could help mitigate signal quality issues that can lead to slow and choppy Zoom calling or video streaming."

Source: MIT (27 Jun 2024)