SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

# Weekly Discovery

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4 Nov – 8 Nov 2024

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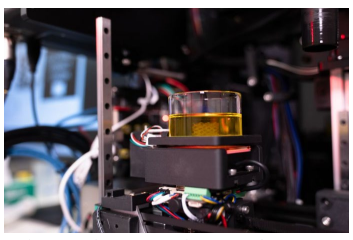
3D PRINTING

### Revolutionary High-Speed 3D Bioprinter Hailed a Gamechanger for Drug Discovery



"Biomedical engineers from the University of Melbourne have invented a 3D printing system, or bioprinter, capable of fabricating structures that closely mimic the diverse tissues in the human body, from soft brain tissue to harder materials like cartilage and bone.

This cutting-edge technology offers cancer researchers an advanced tool for replicating specific organs and tissues, significantly improving the potential to predict and develop new pharmaceutical therapies. This would pave the way for more advanced and ethical drug discovery by reducing the need for animal testing.

Head of the Collins BioMicrosystems Laboratory at the University of Melbourne, Associate Professor David Collins said: "In addition to drastically improving print speed, our approach enables a degree of cell positioning within printed tissues. Incorrect cell positioning is a big reason most 3D bioprinters fail to produce structures that accurately represent human tissue.

"Just as a car requires its mechanical components to be arranged precisely for proper function, so too must the cells in our tissues be organised correctly. Current 3D bioprinters depend on cells aligning naturally without guidance, which presents significant limitations.

"Our system, on the other hand, uses acoustic waves generated by a vibrating bubble to position cells within 3D printed structures. This method provides the necessary head start for cells to develop into the complex tissues found in the human body."

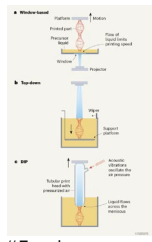
Most commercially available 3D bioprinters rely on a slow, layer-by-layer fabrication approach, which presents several challenges. This method can take hours to finish, jeopardising the viability of living cells during the printing process. Additionally, once printed, the cell structures must be carefully transferred into standard laboratory plates for analysis and imaging—a delicate step that risks compromising the integrity of these fragile structures.

The University of Melbourne research team has flipped the current process on its head by developing a sophisticated optical-based system, replacing the need for a layer-by-layer approach."

Source: unimelb (1 Nov 2024)

3D PRINTING

### Rapid 3D-Printing Method Could Be Used on Space Missions

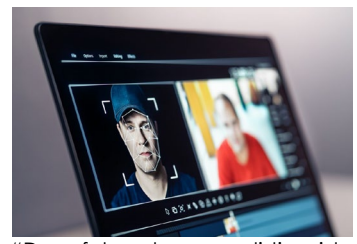


"Fresh approaches to 3D printing promise to transform how, where and by whom objects are produced to serve a broad range of industries, ranging from health care to aerospace. A substantial and expanding category of 3D-printing processes — sometimes called digital light manufacturing — uses patterns of light projected onto a liquid resin to trigger the liquid to solidify at defined positions, thereby forming solid structures in desired shapes. The ultimate goal is to develop these processes to rapidly print features at microscopic scales using a range of materials, with excellent surface finishes and at sizes suitable for industrial applications (potentially up to a scale of many centimetres). However, practical issues limit the speeds of current processes, and the quality of the resulting objects is reduced by the scattering, refraction and absorption of the light patterns in the liquid. Writing in Nature, Vidler and colleagues report a 3D-printing strategy that could solve these problems."

Source: Nature (30 Oct 2024)

AI

### NYU Researchers Develop New Real-Time Deepfake Detection Method



"Deepfakes, hyper-realistic videos and audio created using artificial intelligence, present a growing threat in today's digital world. By manipulating or fabricating content to make it appear authentic, deepfakes can be used to deceive viewers, spread disinformation, and tarnish reputations. Their misuse extends to political propaganda, social manipulation, identity theft, and cybercrime.

As deepfake technology becomes more advanced and widely accessible, the risk of societal harm escalates. Studying deepfakes is crucial to developing detection methods, raising awareness, and establishing legal frameworks to mitigate the damage they can cause in personal, professional, and global spheres. Understanding the risks associated with deepfakes and their potential impact will be necessary for preserving trust in media and digital communication.

That is where Chinmay Hegde, an Associate Professor of Computer Science and Engineering and Electrical and Computer Engineering at NYU Tandon, comes in."

Source: IEEE Spectrum (28 Oct 2024)

AI

### A New Sensor Could Predict Volcanic Eruptions: This Shoebox-Sized Helium Sensor Is Tracking Gas Levels of Italian Volcanoes

"Volcanic eruptions can be fast, deadly, and destructive. That's why every bit of data counts when predicting them.

Sensing company INFICON, based in Bad Ragaz, Switzerland, has developed the first portable helium sensor that can withstand a harsh volcanic environment. They've deployed it to monitor Vulcano and Stromboli, two volcanic islands in Italy. The hope is that such on-site, real-time monitoring could predict eruptions before they become disasters.

When magma is closer to the surface or tectonic plates are moving around, helium levels in the ground increase. Previously, scientists would take gas samples from the volcanoes and send them to a lab for testing, resulting in a measurement every few weeks. But the new sensors are portable and can take measurements every 20 seconds, says Josef Grenz, an engineer at INFICON. If you want fast helium measurements on site, "there is no alternative to our sensors," says Grenz.

Called 'He-Man' sensors, they have two parts: a thin membrane permeable only to helium, and a vacuum chamber that ionizes the helium atoms and takes pressure measurements."

Source: IEEE Spectrum (30 Oct 2024)

AI

### BiomedGPT: AI For Real-Time, Patient-Focused Insight

"Lehigh University collaborates with Massachusetts General Hospital to lead multi-institutional research team in effort to transform medical text and images into faster disease diagnosis, enhanced medical reporting, improved drug discovery, and more.

A picture may be worth a thousand words, but still…they both have a lot of work to do to catch up to BiomedGPT.

Covered recently in the prestigious journal Nature Medicine, BiomedGPT is a new a new type of artificial intelligence (AI) designed to support a wide range of medical and scientific tasks. This new study, conducted in collaboration with multiple institutions, is described in the article as "the first open-source and lightweight vision–language foundation model, designed as a generalist capable of performing various biomedical tasks."

"This work combines two types of AI into a decision support tool for medical providers," explains Lichao Sun, an assistant professor of

ARCHITECTURE

### World Cities Day 2024: Transforming Urban Futures Through Preservation, Innovation, And Resilience

"In honor of World Cities Day, which concludes Urban October, this year's theme, "Youth Leading Climate and Local Action for Cities," reflects a growing momentum for sustainable urban solutions championed by local communities and progressive policies. Around the world, cities face intensified demands for resilience, preservation, and innovation as they address challenges from the climate crisis to cultural heritage conservation. These initiatives illustrate a global trend in urban planning, where sustainability, adaptability, and inclusive community priorities take center stage.

In this roundup, ArchDaily consolidates this year's transformative updates in cities worldwide, organized into thematic clusters that capture the evolving nature of urban design and policy in 2024. Projects like the extensive renovations of Barcelona's La Rambla and the preservation efforts around Chicago's historic skyscrapers highlight preservation of urban heritage, while initiatives in Venice and Los Angeles respond to overtourism and housing pressures, balancing livability with growth.

DESIGN

### Dezeen's Guide to Mid-Century Modern Design from A To Z

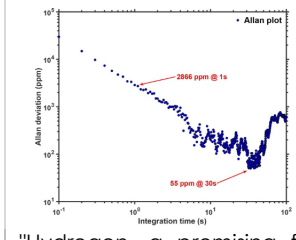

"To conclude our mid-century modern series, we've rounded up everything you need to know about the design and architecture movement from A to Z.

For the last article in our series exploring mid-century modern design and architecture, we've collated 28 of its most influential proponents, furniture designs, places, materials and companies.

Read on to discover who makes up the mid-century modern A to Z…"

ENERGY

### Towards A Hydrogen-Powered Future: Highly Sensitive Hydrogen Detection System




"Hydrogen, a promising fuel, has extensive applications in many sectors. However, its safe and widespread use necessitates reliable sensing methods. While tunable diode laser absorption spectroscopy (TDLAS) has proved to be an effective gas sensing method, detecting hydrogen using TDLAS is difficult due to its weak light absorption property in the infrared region. Addressing this issue, researchers developed an innovative calibration-free technique that significantly enhances the accuracy and detection limits for sensing hydrogen using TDLAS."

computer science and engineering at Lehigh University and a lead author of the study. "One side of the system is trained to understand biomedical images, and one is trained to understand and assess biomedical text. The combination of these allows the model to tackle a wide range of biomedical challenges, using insight gleaned from databases of biomedical imagery and from the analysis and synthesis of scientific and medical research reports."

BiomedGPT is led by a core Lehigh faculty team in computer science and engineering, with contributions from Sun and colleagues Lifang He, an assistant professor, and Brian D. Davison, professor and chair. Sun reports that the team's success is bolstered by the outstanding work of an active group of CSE doctoral students including Kai Zhang, Rong Zhou, Eashan Adhikarla, Zhiling Yan, Yixin Liu, and Jun Yu.

'16 state-of-the-art results' for medical practitioners and patients

The key innovation described in the August 7 Nature Medicine article, "A generalist vision–language foundation model for diverse biomedical tasks," is that this AI model doesn't need to be specialized for each task. Typically, AI systems are trained for specific jobs, like recognizing tumors in X-rays or summarizing medical papers. However, this new model can handle many different tasks using the same underlying technology. This versatility makes it a "generalist" model—and a powerful new tool in the hands of medical providers."

Source: lehigh (4 Nov 2024)

Meanwhile, ambitious master plans have been announced, including the revitalization of industrial sites in Tallinn and Connecticut, reflect how cities are reimagining their urban fabric. Finally, post-disaster rebuilding in Kharkiv and Türkiye underscores the urgency of resilience-driven design, ensuring that cities can endure and evolve even in challenging times. Together, these updates offer a glimpse into the global forces reshaping urban landscapes

Read on to discover a selection of pivotal updates from cities worldwide, showcasing the effort to create more sustainable and resilient cities."

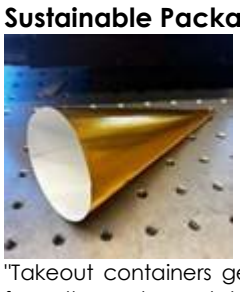
Source: Archdaily (31 Oct 2024)

Source: Dezeen (1 Nov 2024)

Source: CN (5 Nov 2024)

MATERIALS

## A Paper-Aluminum Combo for Strong, Sustainable Packaging



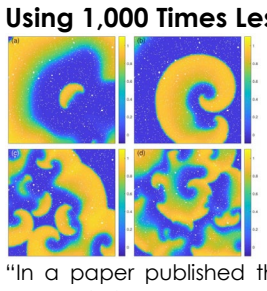
"Takeout containers get your favorite noodles from the restaurant to your dining table (or couch) without incident, but they are nearly impossible to recycle if they are made from foil-lined plastics. Research published in ACS Omega suggests that replacing the plastic layer with paper could create a more sustainable packaging material. The researchers used mechanical demonstrations and computer simulations to identify paper-aluminum laminate designs that won't compromise on performance.

Protective packaging, like containers made from polyethylene and aluminum laminates, combines the strength and durability of plastic with the moisture- and light-blocking properties of aluminum foil. While these materials are effective, there's been a shift toward consumers desiring less plastic and more environmentally friendly materials in the packaging that comes into their homes. To create such an option for protective packaging without sacrificing functionality, Hamed Zarei and colleagues designed a variety of paper-aluminum laminates and compared their strength and durability to common polyethylene-aluminum packaging."

Source: Eurekalert! (31 Oct 2024)

OPTIMIZATION

## Defibrillation Devices Can Save Lives Using 1,000 Times Less Electricity



"In a paper published this week in Chaos, by AIP Publishing, researchers from Sergio Arboleda University in Bogotá, Colombia, and the Georgia Institute of Technology in Atlanta used an electrophysiological computer model of the heart's electrical circuits to examine the effect of the applied voltage field in multiple fibrillation-defibrillation scenarios. They discovered far less energy is needed than is currently used in state-of-the-art defibrillation techniques.

"The results were not at all what we expected. We learned the mechanism for ultra-low-energy defibrillation is not related to synchronization of the excitation waves like we thought, but is instead related to whether the waves manage to propagate across regions of the tissue which have not had the time to fully recover from a previous excitation," author Roman Grigoriev said. "Our focus was on finding the optimal variation in time of the applied electric field over an extended time interval. Since the length of the time interval is not known a priori, it was incremented until a defibrillating protocol was found."

The authors applied an adjoint optimization method, which aims to achieve a desired result, defibrillation in this case, by solving the electrophysiologic model for a given voltage input and looping backward through time to determine the correction to the voltage profile that will successfully defibrillate irregular heart activity while reducing the energy the most.

Energy reduction in defibrillation devices is an active area of research. While defibrillators are often successful at ending dangerous arrhythmias in patients, they are painful and cause damage to the cardiac tissue.

"Existing low-energy defibrillation protocols yield only a moderate reduction in tissue damage and pain," Grigoriev said. "Our study shows these can be completely eliminated. Conventional protocols require substantial power for implantable defibrillators-cardioverters (ICDs), and replacement surgeries carry substantial health risks."

Source: AIP (5 Nov 2024)

QUANTUM NETWORK

## A Rudimentary Quantum Network Link Between Dutch Cities

"An international research team led by QuTech has demonstrated a network connection between quantum processors over metropolitan distances. Their result marks a key advance from early research networks in the lab towards a future quantum internet. The team developed fully independently operating nodes and integrated these with deployed optical internet fibre, enabling a 25 km quantum link. The researchers published their findings in Science Advances.

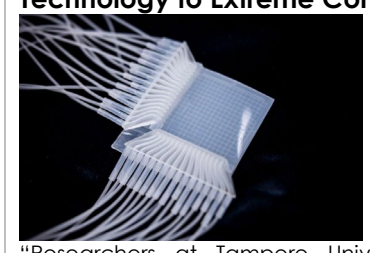
The internet allows people to share information (bits) globally. A future quantum internet will enable sharing quantum information (qubits) over a new type of network. Such qubits can not only take the values 0 or 1, but also superpositions of those (0 and 1 at the same time). In addition, qubits can be entangled, which means they share a quantum connection enabling instant correlations, no matter the distance.

Researchers around the globe are working to build quantum networks that make use of these features to offer fundamentally new communication and computing capabilities, in coexistence with the current internet. For example, qubits can generate secure encryption keys for safely sharing financial or medical data. Quantum links can also connect distant quantum computers, enhancing their power and allowing access with full privacy for users."

Source: tudelft (31 Oct 2024)

SENSORS

## Non-Electric Touchpad Takes Sensor Technology to Extreme Conditions



"Researchers at Tampere University have developed the world's first soft touchpad that is able to sense the force, area and location of contact without electricity. That has traditionally required electronic sensors, but the newly developed touchpad does not need electricity as it uses pneumatic channels embedded in the device for detection.

Made entirely of soft silicone, the device contains 32 channels that adapt to touch, each only a few hundred micrometres wide. In addition to detecting the force, area, and location of touch, the device is precise enough to recognise handwritten letters on its surface and it can even distinguish multiple simultaneous touches.

"Electronic sensors may stop functioning in extreme conditions, such as in a strong magnetic field. Since the touchpad is not electric, a strong magnetic field does not affect it, which makes it ideal for use in devices such as MRI machines," says Doctoral Researcher Vilma Lampinen.

The sensor technology used in the touchpad enables, for example, that if cancer tumours are found during an MRI scan, a pneumatic robot can take a biopsy while the patient is being scanned. The sensor technology guides this robot together with the data produced by the MRI images.

The pneumatic device can also be used in strong radiation or conditions where even a small spark of electricity would cause a serious hazard."

Source: TUNI (24 Oct 2024)