SCIENCE NEWS

Picture This: Camera with No Lens

Engineers develop computerised camera without optics that instead uses an ordinary window as the lens

University of Utah electrical and computer engineers have discovered a way to create an optics-less camera in which a regular pane of glass or any see-through window can become the lens.

Their innovation was detailed in a research paper, "Computational Imaging Enables a 'See-Through' Lensless Camera," published in the newest issue of *Optics Express*. A copy of the paper, which was co-authored by University of Utah electrical and computer engineering graduate Ganghun Kim, is downloaded here.

University of Utah electrical and computer engineering associate professor Rajesh Menon argues that all cameras were developed with the idea that humans look at and decipher the pictures. But what if, he asked, you could develop a camera that can be interpreted by a computer running an algorithm?

"Why don't we think from the ground up to design cameras that are optimized for machines and not humans. That's my philosophical point," he says.

If a normal digital camera sensor such as one for a mobile phone or an SLR camera is pointed at an object without a lens, it results in an image that looks like a pixelated blob. But within that blob is still enough digital information to detect the object if a computer program is properly trained to identify it. You simply create an algorithm to decode the image.

Through a series of experiments, Menon and his team of researchers took a picture of the University of Utah's "U" logo as well as video of an animated stick figure, both displayed on an LED light board. An inexpensive, off-the-shelf camera sensor was connected to the side of a plexiglass window, but pointed into the window while the light board was positioned in front of the pane at a 90-degree angle from the front of the sensor. The resulting image from the camera sensor, with help from a computer processor running

the algorithm, is a low-resolution picture but definitely recognizable. The method also can produce full-motion video as well as color images, Menon says.

The process involves wrapping reflective tape around the edge of the window. Most of the light coming from the object in the picture passes through the glass, but just enough — about 1 percent — scatters through the window and into the camera sensor for the computer algorithm to decode the image.

While the resulting photo is not enough to win a Pulitzer Prize, it would be good enough for applications such as obstacle-avoidance sensors for autonomous cars. But Menon says more powerful camera sensors can produce higher-resolution images.

Applications for a lensless camera can be almost unlimited. Security cameras could be built into a home during construction by using the windows as lenses. It could be used in augmented-reality goggles to reduce their bulk. With current AR glasses, cameras have to be pointed at the user's eyes in order to track their positions, but with this technology they could be positioned on the sides of the lens to reduce size. A car windshield could have multiple cameras along the edges to capture more information. And the technology also could be used in retina or other biometric scanners, which typically have cameras pointed at the eye.

"It's not a one-size-fits-all solution, but it opens up an interesting way to think about imaging systems," Menon says.

From here, Menon and his team will further develop the system, including 3-D images, higher color resolution and photographing objects in regular household light. His current

experiments involved taking pictures of self-illuminated images from the light board.

Longer Hours on Social Media May Increase Teens' Risk of Cyberbullying

Summary: Cyberbullying may be linked to higher use of social network sites by school children aged 14-17 years, rather than to simply having a social network profile, according to a new study that examined data from several European countries.

Researchers at the National and Kapodistrian University of Athens, Greece found that school children in Romania, Germany and Poland were more likely to experience cyberbullying, such as aggressive and threatening messages, social exclusion, spreading rumors and sharing private, inappropriate or humiliating information, if they used social network sites for more than two hours a week day.

Co-author Professor Artemis Tsitsika said: "This is an important finding which challenges past research suggesting that simply having, rather than excessive use of, a social network site profile increases the risk of becoming a victim of cyberbullying."

The researchers found that a relatively high proportion of school children in Romania (37.3%), Greece (26.8%), Germany (24.3%) and Poland (21.5%) have been bullied online whereas a fewer proportion experience cyberbullying in the Netherlands (15.5%), Iceland (13.5%) and Spain (13.3%).

Professor Artemis Tsitsika added: "We found multiple factors, in addition to the time

spent on social media, which may impact cyberbullying frequency and explain the differences between countries. In Greece and Romania higher cyberbullying may be due to a lack of digital literacy and relevant legislation, as well as sudden rise of social media use and a large technological gap between parents and the younger generation. Promotion of internet safety strategies and teaching digital skills in education may contribute to lower rates of cyberbullying in the Netherlands. In all cases higher daily use with no monitoring and digital literacy background may lead to teenagers posting private information and meeting strangers online."

The researchers call for educational settings to integrate ICT education into their curricula, especially in countries where use of the Internet has risen abruptly.

The authors undertook a school-based study across Germany, Greece, Iceland, the Netherlands, Poland, Romania and Spain. Anonymous questionnaires about internet use, social factors and cyberbullying were completed by 12,372 students aged 14 -17 across the seven countries.

They caution that the observational nature of the study limits conclusions about the direct causes of cyberbullying. As five years have passed since the data used in the study was collected, its ability to represent the current picture of cyberbullying may be limited.

Computing Power Used to Track the Spread of Cancer

Summary: Researchers have developed a new computational method that increases the ability to track the spread of cancer cells from one part of the body to another. This

migration of cells can lead to metastatic disease, which causes about 90 percent of cancer deaths from solid tumors — masses of cells that grow in organs such as the breast, prostate or colon. Understanding the drivers of metastasis could lead to new treatments aimed at blocking the process of cancer spreading through the body.

"Are there specific changes, or mutations, within these cells that allow them to migrate?" asked Ben Raphael, a professor of computer science at Princeton and the senior author of the new research. "This has been one of the big mysteries."

In a study published in the May issue of *Nature Genetics*, Raphael and his colleagues presented an algorithm that can track cancer metastasis by integrating DNA sequence data with information on where cells are located in the body. They call it MACHINA, which stands for "metastatic and clonal history integrative analysis."

"Our algorithm enables researchers to infer the past process of metastasis from DNA sequence data obtained at the present time," said Raphael.

The technique yields a clearer picture of cancer migration histories than previous studies that relied on methods based on DNA sequences alone. Some of these studies inferred complex migration patterns that didn't reflect current knowledge of cancer biology.

"The data sets we get these days are very complex, but complex data sets don't always require complex explanations," said Raphael.

By simultaneously tracing cells' mutations and movements, MACHINA found that

metastatic disease in some patients could result from fewer cellular migrations than previously thought. For example, in one breast cancer patient, a previously published analysis proposed that metastatic disease resulted from 14 separate migration events, while MACHINA suggested that a single secondary tumor in the lung seeded the remaining metastases through just five cell migrations. In addition to a breast cancer data set, Raphael and his team applied their algorithm to analyze metastasis patterns from patients with melanoma, ovarian and prostate cancers.

Several additional features helped improve MACHINA's accuracy. The algorithm includes a model for the comigration of genetically different cells, based on experimental evidence that tumor cells can travel in clusters to new sites in the body. It also accounts for the uncertainty in DNA data that comes from sequencing mixtures of genetically distinct tumor cells and healthy cells.

This approach overcomes a number of challenges to draw meaningful conclusions from the "difficult to analyze, noisy" data that result from tumor DNA sequencing, said Andrea Sottoriva, the Chris Rokos Fellow in Evolution and Cancer at the Institute of Cancer Research, London. "I predict this new method will be of widespread use to the genomic community and will shed new light on the most deadly phase of cancer evolution," he said.

MACHINA's development paves the way for a broader examination of metastasis patterns in large cohorts of cancer patients, which could reveal key mutations that cause different types of cancer to spread.

Raphael also plans to make the method more powerful by incorporating data from tumor DNA and tumor cells that circulate in the bloodstream, as well as epigenetic changes — reversible chemical modifications of DNA.

"A better algorithm is like a better microscope," said Raphael. "When you look at nature with a magnifying glass, you may miss important details. If you look with a microscope you can see much more."

Gum Disease May Be a Key Initiator of Rheumatoid Arthritis Related Autoimmunity

Significantly higher prevalence of gum disease found in individuals at risk of rheumatoid arthritis compared to healthy controls

Summary: The results of the study demonstrate increased levels of gum disease, and disease-causing bacteria, in individuals at risk of rheumatoid arthritis (RA).

"It has been shown that RA-associated antibodies, such as anti-citrullinated protein antibodies, are present well before any evidence of joint disease. This suggests they originate from a site outside of the joints," said Dr Kulveer Mankia of Leeds Institute of Rheumatic and Muscoskeletal Medicine and the Leeds Biomedical Research Centre (study author). "Our study is the first to describe clinical periodontal disease and the relative abundance of periodontal bacteria in these at-risk individuals. Our results support the hypothesis that local inflammation at mucosal surfaces, such as the gums in this case, may provide the primary trigger for the systemic autoimmunity seen in RA."

Rheumatoid arthritis is a chronic inflammatory disease that affects a person's joints, causing pain and disability. It can also affect internal organs. Rheumatoid arthritis is more common in older people, but there is also a high prevalence in young adults, adolescents and even children, and it affects women more frequently than men.

The prevalence of gum disease is increased in patients with RA and could be a key initiator of RA-related autoimmunity. This is because autoimmunity in RA is characterised by an antibody response to citrullinated proteins and the oral bacterium Porphyromonas gingivalis (Pg) is the only human pathogen known to express an enzyme that can generate citrullinated proteins.

"We welcome these data in presenting concepts that may enhance clinical understanding of the key initiators of rheumatoid arthritis," said Professor Robert Landewé, Chairperson of the Scientific Programme Committee, EULAR. "This is an essential step towards the ultimate goal of disease prevention."

In results from the study, dentists diagnosed clinical gum disease in significantly more at-risk individuals than in healthy controls (73% vs. 38%, p=0.02). In addition, the percentage of sites with clinical attachment level (CAL), 2mm, pocket depth (PD), 4mm, bleeding on probing (BOP), periodontal disease (PDD), and active periodontal disease (PDD+BOP), were all significantly greater in the at-risk individuals compared to controls (p←0.05). In non-smokers, PDD and active PDD were more prevalent in at-risk individuals compared to controls.

DNA was isolated from the subgingival plaque, next to the gums, of each participant and used to measure the levels of three types of bacteria, Pg, Aggregatibacter actinomycetemcomitans (Aa) and Filifactor Alocis. Results showed that there was increased abundance of both Pg and Aa in at-risk individuals. However, in at-risk individuals, only Pg was significantly increased at healthy dental sites and was associated with the overall extent of gum disease (p←0.001).

The study included 48 at-risk individuals (positive test for anti-citrullinated protein antibodies, musculoskeletal symptoms but no clinical synovitis), 26 patients with RA and 32 healthy controls. The three groups were balanced for age, gender and smoking. At-risk individuals underwent ultrasound assessment to assess for subclinical synovitis; only two (4%) were found to have ultrasound synovitis. Dentists examined six sites per tooth in each participant and a clinical consensus was agreed in each by three dentists.

Study Finds Less Corruption in Countries Where More Women are in Government

Summary: The new research is the most comprehensive study on this topic and looks at the implications of the presence of women in other occupations as including the shares of women in the labor force, clerical positions, and decision making positions such as the CEOs and other managerial positions.

In a cross-country analysis of over 125 countries, this study finds that corruption is lower in countries where a greater share of parliamentarians are women. The study further finds that women's representation in local politics is important too — the likelihood

of having to bribe is lower in regions with a greater representation of women in local-level politics in Europe.

"This research underscores the importance of women empowerment, their presence in leadership roles and their representation in government, said Sarangi, an economics professor and department head at Virginia Tech. "This is especially important in light of the fact that women remain under represented in politics in most countries including the United States."

Less than a quarter of the members of the U.S. Senate are women and only 19 per cent of the women in the U.S. House of Representatives are women. It is also noteworthy that the United Stated never had a women head or president.

The authors speculate that women policymakers are able to have an impact on corruption because they choose different policies from men. An extensive body of prior research shows that women politicians choose policies that are more closely related to the welfare of women, children, and family.

The relationship is robust to the inclusion of a number of other control variables including economic, cultural, and institutional factors. The study also uses a statistical technique, known as the Instrumental Variable analysis, to account for the confounding factors and to establish causality in the relationship. After all it is possible that it is corruption that drives women's participation in politics and not the other way around!

The authors maintain that while the gender-corruption relationship has been studied before, the previous studies suffered from the critique that the relationship between

women's representation in government and corruption was not shown to be causal.

Jha and Sarangi's research is the most comprehensive study on this topic and looks at the implications of the presence of women in other occupations as including the shares of women in the labor force, clerical positions, and decision making positions such as the CEOs and other managerial positions. The study finds that women's presence in these occupations is not significantly associated with corruption, suggesting that it is the policy making role through which women are able to have an impact on corruption.

Sometimes it is believed that the relationship between gender and corruption may disappear as women gain similarity in social status. This is presumably because as the status of women improves, they get access to the networks of corruption and at the same time learn the know-how of engaging in corrupt activities. The results of this study, however, indicate otherwise: the relationship between women's representation in parliament and corruption is stronger for countries where women enjoy a greater equality of status. Once again, this finding further suggests that it's policy making through which women are able to impact corruption.

Jha and Sarangi's study warns that these results do not necessarily mean that women are inherently less corrupt. In fact, their findings suggest otherwise. If women are indeed less corrupt, then there should be a significant negative correlation between all these measures of female participation and corruption.

The policy implications of the study point towards the need for promoting gender

equality in general and promoting the presence of women in politics in particular. Previous research has established that a greater presence of women in government is associated with better education and health outcomes.

Fair Classroom Practices Disarm threat of Evaluation Retaliation

Summary: While tuition inflation presents a challenge for many college-bound students, an area of growing concern for many universities is 'grade inflation' — in part caused when instructors grade more leniently to discourage students from retaliating by giving low teaching evaluations.

Washington State University researchers say instructors can stop worrying about evaluation revenge as long as they use practices in the classroom that students perceive as fair.

"We've long known there's an association between expected students' course grades and how they evaluate teachers. However, our study is the first to show that grades influence evaluations much less, if at all, when students can see what fair processes instructors use to assign grades," said lead author Thomas Tripp, Carson College of Business associate dean, WSU Vancouver.

Tripp conducted this study with former WSU doctoral students, Lixin Jiang, University of Auckland; Kristine Olson, Dixie State University; and Maja Graso, University of Otago.

"Faculty may not feel a need to award artificially high grades if they knew how students' perceptions of justice might influence this relationship," Tripp said.

Fairness is more than grades

The researchers found students' perception of fair classroom processes revolves around four essential teaching practices: (1) following the course rules by using grading rubrics that match stated criteria, and by aligning their course presentation and expectations to the syllabus; (2) obtaining student feedback and incorporating their interests and voice; (3) being aware of bias and grading blindly; and, (4) correcting grades by providing policies for make-up work and absences.

But students' concept of fairness extends beyond just grades, the researchers found.

"We were a bit surprised to learn of other criteria that students defined as 'fair,' including how well the class is run and how much the professor goes out of the way to help students," said Tripp. "We can see how these are important to students, but they don't fit any definition of 'fair' that we know of."

"The most interesting thing we found in our study is that perception of fair process completely eliminated the threat of student retaliation via low teaching evaluations," Tripp said.

Recommendations for instructors

Based on the findings, the researchers recommend instructors follow specific procedures to ensure a fair classroom.

For instance:

Use grading rubrics consistently and share them with students. Course policies, such as late assignment submissions, should be in writing and included in the syllabus. Instructors should include grade-appeal procedures in their course policies, and if possible, have their students submit their

appeals by their student ID numbers rather than by their names. Should a grade appeal move up to a panel, the panel could include students to increase representativeness.

Fair processes worth the effort

"While adding such processes may seem like a lot of work, we believe instituting fair processes is the superior option for several reasons," said Tripp. "Rampant use of grading leniency may contribute to grade inflation, which is advancing each decade and diminishing the power of grades to motivate students to work harder."

Tripp said by ignoring fair classroom processes and by grading leniently, instructors risk creating perceptions of both unfair outcomes and unfair process, a deadly combination that is associated with lower student evaluations of teachers.

Climate Change Accelerating Rise in Sea Levels

Summary: A new study from the University of Waterloo has discovered that rising sea levels could be accelerated by vulnerable ice shelves in the Antarctic.

The study, by an international team of polar scientists led by Canada Research Chair Christine Dow of Waterloo's Faculty of Environment, discovered that the process of warmer ocean water destabilizing ice shelves from below, is also cracking them apart from above, increasing the chance they'll break off.

"We are learning that ice shelves are more vulnerable to rising ocean and air temperatures than we thought," said Dow. "There are dual processes going on here. One that is destabilizing from below, and another

from above. This information could have an impact on our projected timelines for ice shelf collapse and resulting sea level rise due to climate change."

The study, which was conducted over two years, applied methods similar to forensic science on ice shelves which had already calved. Using radar surveys and Landsat imagery, Dow reports direct evidence that a major 2016 calving event at Nansen Ice Shelf in the Ross Sea was the result of fracture driven by channels melted into the bottom of the ice shelf. The surveys also demonstrated that similar basal channel-driven transverse fractures occur elsewhere in Greenland and Antarctica.

As warmer salt water erodes channels into the ice that attaches glaciers to stable land, it also generates massive vertical fractures splitting glaciers from above and below. Surface water melting on top of the ice shelves then pours into these cracks, accelerating the problem further.

"This study is more evidence that the warming effects of climate change are impacting our planet in ways that are often more dangerous than we perhaps had thought," said Dow. "There are many more vulnerable ice shelves in the Antarctic that, if they break up, will accelerate the processes of sea level rise."

Negative vs. Positive Social Media Experiences and Depressive Symptoms

Summary: Negative experiences on social media carry more weight than positive interactions when it comes to the likelihood of young adults reporting depressive symptoms, according to a new analysis. The finding may

be useful for designing interventions and clinical recommendations to reduce the risk of depression.

The finding, reported in the journal *Depression and Anxiety*, may be useful for designing interventions and clinical recommendations to reduce the risk of depression.

"We found that positive experiences on social media were not related or only very slightly linked to lower depressive symptoms. However, negative experiences were strongly and consistently associated with higher depressive symptoms," said lead author Brian Primack, M.D., Ph.D., dean of the Honors College and director of the Center for Research on Media, Technology and Health at Pitt. "Our findings may encourage people to pay closer attention to their online exchanges. Moving forward, these results could assist scientists in developing ways to intervene and counter the negative effects while strengthening the positive ones."

In August 2016, Primack and his team surveyed 1,179 full-time students aged 18 to 30 at the University of West Virginia about their social media use and experiences. The participants also completed a questionnaire to assess their depressive symptoms.

Each 10 per cent increase in positive experiences on social media was associated with a 4 per cent decrease in odds of depressive symptoms, but those results were not statistically significant, meaning that the finding could be due to random chance. However, each 10 per cent increase in negative experiences was associated with a 20 per cent increase in the odds of depressive symptoms, a statistically significant finding.

"It is valuable to know that positive and negative experiences are very differently related to depression," said Primack. "But we don't know from our study whether the negative social media interactions actually caused the depressive symptoms or whether depressed individuals are more likely to seek out negative online interactions. As with many things in social science, the answer is probably some combination of the two, but more research will be needed to disentangle cause and effect."

Other characteristics also were linked to the participants having depressive symptoms. For example, compared with men, women had 50 percent higher odds of having depressive symptoms. Identifying as non-white and having only completed "some college," rather than completing a degree, also were associated with higher odds of depressive symptoms. All of these characteristics have previously been shown to increase a person's likelihood of depression.

While the findings still need to be replicated, Primack said public health practitioners could start using them to educate the public of the risks of negative social media interactions. He also points out that cyberbullying occurs not only among adolescents, but also among adults. Universities, workplaces and community spaces could use the findings to increase awareness around positive and negative social media experiences.

Primack noted that health care professionals working with depressed patients could suggest strategies to improve the quality of online experiences, such as restricting time spent on social media to reduce the number of negative interactions and "unfriending" people or groups that tend to enable negative experiences.

Although the finding was not statistically significant, Primack said that increasing the opportunities for positive experiences on social media is still likely to be worthwhile.

"In other studies, engaging in certain forms of social media use has been shown to enhance communication and social connection," he said. "Certainly, there are many situations in which connecting with others in this way might actually lower depressive symptoms. That just wasn't the primary finding in this particular study."

One in Every Five Deaths in Young Adults is Opioid-related in the United States

Proportion of deaths that are opioid-related has increased by nearly 300 per cent in 15 years

One out of every five deaths among young adults in the United States is related to opioids, suggests a study led by researchers in Canada.

The study, published in *JAMA Network Open* and led by St. Michael's Hospital in Toronto, Ontario, found that the percentage of deaths attributable to opioids in the U.S. increased by 292 per cent from 2001 to 2016, with one in every 65 deaths related to opioid use by 2016. This number varied by age group and sex. Men represented nearly 70 per cent of all opioid deaths by 2016, and the highest burden was among young adults aged 24 to 35 years. This study expands on research in Canadian populations.

"Despite the amount of attention that has been placed on this public health issue, we are increasingly seeing the devastating impact that early loss of life from opioids is having across the United States," said Dr. Tara Gomes, a scientist in the Li Ka Shing Knowledge Institute of St. Michael's. "In the absence of a multidisciplinary approach to this issue that combines access to treatment, harm reduction and education, this crisis will impact the US for generations."

Researchers reviewed all deaths in the US between 2001 and 2016 using the Centers for Disease Control and Prevention (CDC) WONDER Multiple Cause of Death Online Database. This record captures mortality and population estimates across the US by age and sex. The most dramatic increase in illicit and prescribed opioid-related deaths was seen in those aged 24 to 35. By 2016, 20 per cent of all deaths in this age group were related to opioid use — up from only 4 per cent in 2001.

Dr. Gomes, who is also a scientist at the Institute for Clinical Evaluative Sciences in Ontario, and her team found that a total of 1,681,359 years of life were lost prematurely to opioid-related causes in 2016, which exceeds the years of life lost each year from hypertension, HIV/AIDS and pneumonia in the US

"These numbers show us the dramatic impact of opioid-related harms across all demographics in the U.S.," Dr. Gomes said. "We know this is not an isolated public health issue — it is one that spans across North America."

This study was funded by the Canadian Institutes of Health Research and supported by the Institute for Clinical Evaluative Sciences.

An Artificial Nerve System Gives Prosthetic Devices and Robots a Sense of Touch

Summary: Researchers have developed an artificial nervous system that could give prosthetic limbs or robots reflexes and the ability to sense touch.

Stanford and Seoul National University researchers have developed an artificial sensory nerve system that can activate the twitch reflex in a cockroach and identify letters in the Braille alphabet.

The work, reported in *Science*, is a step toward creating artificial skin for prosthetic limbs, to restore sensation to amputees and, perhaps, one day give robots some type of reflex capability.

"We take skin for granted but it's a complex sensing, signaling and decision-making system," said Zhenan Bao, a professor of chemical engineering and one of the senior authors. "This artificial sensory nerve system is a step toward making skin-like sensory neural networks for all sorts of applications."

Building blocks

This milestone is part of Bao's quest to mimic how skin can stretch, repair itself and, most remarkably, act like a smart sensory network that knows not only how to transmit pleasant sensations to the brain, but also when to order the muscles to react reflexively to make prompt decisions.

The new *Science* paper describes how the researchers constructed an artificial sensory nerve circuit that could be embedded in a future skin-like covering for neuro-prosthetic devices and soft robotics. This rudimentary artificial nerve circuit integrates three previously described components.

The first is a touch sensor that can detect even minuscule forces. This sensor sends signals through the second component — a flexible electronic neuron. The touch sensor and electronic neuron are improved versions of inventions previously reported by the Bao lab.

Sensory signals from these components stimulate the third component, an artificial synaptic transistor modeled after human synapses. The synaptic transistor is the brainchild of Tae-Woo Lee of Seoul National University, who spent his sabbatical year in Bao's Stanford lab to initiate the collaborative work.

"Biological synapses can relay signals, and also store information to make simple decisions," said Lee, who was a second senior author on the paper. "The synaptic transistor performs these functions in the artificial nerve circuit."

Lee used a knee reflex as an example of how more-advanced artificial nerve circuits might one day be part of an artificial skin that would give prosthetic devices or robots both senses and reflexes.

In humans, when a sudden tap causes the knee muscles to stretch, certain sensors in those muscles send an impulse through a neuron. The neuron in turn sends a series of signals to the relevant synapses. The synaptic network recognizes the pattern of the sudden stretch and emits two signals simultaneously, one causing the knee muscles to contract reflexively and a second, less urgent signal to register the sensation in the brain.

Making it work

The new work has a long way to go before it reaches that level of complexity. But in the *Science* paper, the group describes how the electronic neuron delivered signals to the synaptic transistor, which was engineered in such a way that it learned to recognize and react to sensory inputs based on the intensity and frequency of low-power signals, just like a biological synapse.

The group members tested the ability of the system to both generate reflexes and sense touch.

In one test they hooked up their artificial nerve to a cockroach leg and applied tiny increments of pressure to their touch sensor. The electronic neuron converted the sensor signal into digital signals and relayed them through the synaptic transistor, causing the leg to twitch more or less vigorously as the pressure on the touch sensor increased or decreased.

They also showed that the artificial nerve could detect various touch sensations. In one experiment the artificial nerve was able to differentiate Braille letters. In another, they rolled a cylinder over the sensor in different directions and accurately detected the direction of the motion.

Bao's graduate students Yeongin Kim and Alex Chortos, plus Wentao Xu, a researcher from Lee's own lab, were also central to integrating the components into the functional artificial sensory nervous system.

The researchers say artificial nerve technology remains in its infancy. For instance, creating artificial skin coverings for prosthetic devices will require new devices to detect heat and other sensations, the ability to embed them into flexible circuits and then a way to interface all of this to the brain.

The group also hopes to create low-power, artificial sensor nets to cover robots, the idea being to make them more agile by providing some of the same feedback that humans derive from their skin.

Photosynthesis Involves a Protein 'Piston'

International research collaboration characterizes a protein complex vital in photosynthesis

Summary: The photo system I (PSI)-ferrodoxin (Fd) complex is important in electron transfer during photosynthesis, through which plants convert sunlight, carbon dioxide, and water into complex chemicals and oxygen. Scientists have recently crystallized the PSI-Fd complex for the first time. They found that the PSI-Fd complex contained Fd with weak and strong binding states and that Fd binding caused the PSI subunits to reorganize into a structure that facilitated rapid electron transfer.

Plants convert water and carbon dioxide into sugars and oxygen by photosynthesis. Photosynthesis is thus integral to life as we know it and has been investigated extensively by researchers around the globe.

However, photosynthesis is a complex microscopic process and some of its aspects are still not well understood. For example, Photosystem I (PSI) is a complicated protein system involved in photosynthesis. PSI reversibly forms complexes with ferredoxin (Fd) that mediate transfer of electrons derived from water. The PSI-Fd complex has not been fully characterized and the atomic-

level interactions between PSI and Fd in the complex remain unclear despite their importance as links in the photosynthetic chain. This is because it is difficult to analyze the weak interactions in such an intricate protein system, which is partly caused by the weak binding interactions in the complex making it challenging to crystallize.

An Osaka University-led international collaboration recently made a breakthrough in knowledge of the PSI-Fd complex by collecting X-ray structural data for this complex isolated from a type of hot spring cyanobacteria. Genji Kurisu and collaborators grew bacteria, purified the PSI-Fd complex, and then grew crystals of the complex. X-ray data for the crystals were subsequently collected and resolved. The X-ray data for the complex provided some interesting information; in particular, that not all PSI-Fd interactions were the same. The results were reported in *Nature Plants*.

"We found that the crystal structure of the PSI-Fd complex contained two PSI trimers and six bound Fds in each crystallographic asymmetric unit," Kurisu says. "The Fds were non-equivalent because they were located at different distances from PSI; that is, Fd had strong and weak binding states in the PSI-Fd complex."

The group's findings were corroborated by the results of further characterization of the PSI-Fd complex by spectroscopic and chromatographic measurements, which also indicated that Fd had two different binding states in the complex. By considering all their experimental findings, the researchers developed a mechanism to explain the formation of two Fd binding states in the PSI-Fd complex.

"We propose that the binding of Fd to PSI lowers the symmetry of the three-dimensional structure of PSI," an associate professor, Hideaki Tanaka, in the team explains. "This induces a piston-like motion of one of the subunits of PSI to provide a complex that displays rapid electron transfer through PSI from the donor (Cyt c6) to the acceptor (Fd)."

The piston-like motion of the PSI subunit is thought to possibly act as a molecular signal across the cell membrane to stimulate rapid electron transfer.

The team's findings may provide clues to allow optimization of artificial photosynthesis to obtain complex chemicals from carbon dioxide, water, and light.

Robot Teaches Itself How to Dress People

Instead of vision, machine relies on force as it pulls a gown onto human arms

Summary: A robot is successfully sliding hospital gowns on people's arms. The machine doesn't use its eyes as it pulls the cloth. Instead, it relies on the forces it feels as it guides the garment onto a person's hand, around the elbow and onto the shoulder.

More than 1 million Americans require daily physical assistance to get dressed because of injury, disease and advanced age. Robots could potentially help, but cloth and the human body are complex.

To help address this need, a robot at the Georgia Institute of Technology is successfully sliding hospital gowns on people's arms. The machine doesn't use its eyes as it pulls the

cloth. Instead, it relies on the forces it feels as it guides the garment onto a person's hand, around the elbow and onto the shoulder.

The machine, a PR2, taught itself in one day, by analyzing nearly 11,000 simulated examples of a robot putting a gown onto a human arm. Some of those attempts were flawless. Others were spectacular failures -- the simulated robot applied dangerous forces to the arm when the cloth would catch on the person's hand or elbow.

From these examples, the PR2's neural network learned to estimate the forces applied to the human. In a sense, the simulations allowed the robot to learn what it feels like to be the human receiving assistance.

"People learn new skills using trial and error. We gave the PR2 the same opportunity," said Zackory Erickson, the lead Georgia Tech Ph.D. student on the research team. "Doing thousands of trials on a human would have been dangerous, let alone impossibly tedious. But in just one day, using simulations, the robot learned what a person may physically feel while getting dressed."

The robot also learned to predict the consequences of moving the gown in different ways. Some motions made the gown taut, pulling hard against the person's body. Other movements slid the gown smoothly along the person's arm. The robot uses these predictions to select motions that comfortably dress the arm.

After success in simulation, the PR2 attempted to dress people. Participants sat in front of the robot and watched as it held a gown and slid it onto their arms. Rather than vision, the robot used its sense of touch to

perform the task based on what it learned about forces during the simulations.

"The key is that the robot is always thinking ahead," said Charlie Kemp, an associate professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University and the lead faculty member. "It asks itself, 'if I pull the gown this way, will it cause more or less force on the person's arm? What would happen if I go that way instead?'"

The researchers varied the robot's timing and allowed it to think as much as a fifth of a second into the future while strategizing about its next move. Less than that caused the robot to fail more often.

"The more robots can understand about us, the more they'll be able to help us," Kemp said. "By predicting the physical implications of their actions, robots can provide assistance that is safer, more comfortable and more effective."

The robot is currently putting the gown on one arm. The entire process takes about 10 seconds. The team says fully dressing a person is something that is many steps away from this work.

Oral Antibiotics May Raise Risk of Kidney Stones

Summary: Pediatric researchers have found that children and adults treated with some oral antibiotics have a significantly higher risk of developing kidney stones. This is the first time that these medicines have been linked to this condition. The strongest risks appeared at younger ages and among patients most recently exposed to antibiotics.

"The overall prevalence of kidney stones has risen by 70 percent over the past 30 years, with particularly sharp increases among adolescents and young women," said study leader Gregory E. Tasian, MD, MSCE, a pediatric urologist at Children's Hospital of Philadelphia (CHOP). Tasian noted that kidney stones were previously rare in children.

Study co-author Michelle Denburg, MD, MSCE, a pediatric nephrologist at CHOP, added, "The reasons for the increase are unknown, but our findings suggest that oral antibiotics play a role, especially given that children are prescribed antibiotics at higher rates than adults."

Tasian, Denburg and colleagues published their study today in the *Journal of the American Society of Nephrology.*

The study team drew on electronic health records from the United Kingdom, covering 13 million adults and children seen by general practitioners in the Health Improvement Network between 1994 and 2015. The team analyzed prior antibiotic exposure for nearly 26,000 patients with kidney stones, compared to nearly 260,000 control subjects.

They found that five classes of oral antibiotics were associated with a diagnosis of kidney stone disease. The five classes were oral sulfas, cephalosporins, fluoroquinolones, nitrofurantoin, and broad-spectrum penicillins. After adjustments for age, sex, race, urinary tract infection, other medications and other medical conditions, patients who received sulfa drugs were more than twice as likely as those not exposed to antibiotics to have kidney stones; for broad-spectrum penicillins, the increased risk was 27 per cent higher.

The strongest risks for kidney stones were in children and adolescents. The risk of kidney stones decreased over time but remained elevated several years after antibiotic use.

Scientists already knew that antibiotics alter the composition of the human microbiome — the community of microorganisms in the body. Disruptions in the intestinal and urinary microbiome have been linked to the occurrence of kidney stones, but no previous studies revealed an association between antibiotic usage and stones.

Tasian pointed out that other researchers have found that roughly 30 pe rcent of antibiotics prescribed in office visits are inappropriate, and children receive more antibiotics than any other age group, so the new findings reinforce the need for clinicians to be careful in prescribing correct antibiotics. He added, "Our findings suggest that antibiotic prescription practices represent a modifiable risk factor — a change in prescribing patterns might decrease the current epidemic of kidney stones in children."

One co-author of the current paper, Jeffrey Gerber, MD, PhD, is an infectious diseases specialist at CHOP who leads programs in antibiotic stewardship — an approach that guides healthcare providers in prescribing the most appropriate antibiotic for each patient's specific infection, with the aims of improving individual outcomes and reducing the overall risk of antibiotic resistance.

Tasian and colleagues are continuing to investigate the microbiomes of children and adolescents with kidney stones in a single-center study at CHOP. Their goal is to expand this research into broader, population-based studies to better understand how variations

in microbiome composition may influence the development of kidney stones.

Stone Age Hepatitis B Virus Decoded

Study recovers oldest viral genomes, and shows the hepatitis B virus has been circulating in Europe for at least 7,000 years

Summary: Scientists have successfully reconstructed genomes from Stone Age and Medieval European strains of the hepatitis B virus. This unprecedented recovery of ancient virus DNA indicates that hepatitis B was circulating in Europe at least 7,000 years ago. An international team of scientists led by researchers at the Max Planck Institute for the Science of Human History and the University of Kiel has successfully reconstructed genomes from Stone Age and Medieval European strains of the hepatitis B virus. While the ancient virus is similar to its modern counterparts, the strains represent a distinct lineage that has likely gone extinct and is most closely related to chimpanzee and gorilla viruses.

The hepatitis B virus (HBV) is one of the most widespread human pathogens known today, affecting over 250 million people worldwide. However, its origin and evolutionary history remain unclear. Studying the evolution and history of the virus has to date been especially difficult, because until now viral DNA had not been successfully recovered from prehistoric samples. In the present study, which has been accepted for publication in the journal *eLife* and is due to be published on May 10, 2018, an international team of researchers led by the Max Planck Institute for the Science of Human History and the Institute of Clinical Molecular Biology at Kiel University, not only recovered ancient viral DNA from skeletons but also reconstructed the genomes of three strains of HBV.

The ancient history of hepatitis B

For this study, the researchers analyzed samples from the teeth of 53 skeletons excavated from Neolithic and medieval sites in Germany. The remains dated from around 5000 BC to 1200 AD. The researchers screened all samples for viral pathogens and detected ancient HBV in three of the individuals. Full HBV genomes were recovered from these samples, two of which were from the Neolithic period, dating to about 7000 and 5000 years ago, and one from the medieval period. The Neolithic genomes represent the by far oldest virus genomes reconstructed to date.

Interestingly, the ancient virus genomes appear to represent distinct lineages that have no close relatives today and possibly went extinct. The two Neolithic genomes, although recovered from individuals that lived 2000 years apart, were relatively similar to each other in comparison with modern strains, and were in fact more closely related to modern strains of HBV found in Chimpanzees and Gorillas. In contrast, the medieval HBV genome is more similar to modern strains, but still represents a separate lineage. This is the case even when it is compared to two previously published HBV genomes recovered from mummies dating to the 16th century. The HBV strains found in these mummies are closely related to modern strains, suggesting a surprising lack of change in the virus over the last 500 years. These findings point to a complicated history for the virus, which may have involved multiple cross-species transmission events.

Long and complicated evolution of one of today's most common viruses

"Taken together, our results demonstrate that HBV already existed in Europeans 7000 years ago and that its genomic structure closely resembled that of modern hepatitis B viruses, despite the differences observed," explains first author Ben Krause-Kyora, of the Max Planck Institute for the Science of Human History and Kiel University. "More ancient precursors, intermediates and modern strains of both human and non-human primate HBV strains need to be sequenced to disentangle the complex evolution of this virus," he adds.

New tool for studying the evolution of blood-borne viruses

Johannes Krause, senior author and director of the Department of Archaeogenetics at the Max Planck Institute for the Science of Human History, emphasizes the most important implication of the study. "Our results reveal the great potential of ancient DNA from human skeletons to allow us to study the evolution of blood-borne viruses. Previously, there was doubt as to whether we would ever be able to study these diseases directly in the past," he explains. "We now have a powerful tool to explore the deep evolutionary history of viral diseases."

Artificial Intelligence Helps Predict Likelihood of Life on Other Worlds

Developments in artificial intelligence may help us to predict the probability of life on other planets, according to new work by a team based at Plymouth University. The study uses artificial neural networks (ANNs) to classify planets into five types, estimating a probability of life in each case, which could be used in future interstellar exploration missions. The work is presented at the European Week of Astronomy and Space Science (EWASS) in Liverpool on 4 April by Mr Christopher Bishop.

Artificial neural networks are systems that attempt to replicate the way the human brain learns. They are one of the main tools used in machine learning, and are particularly good at identifying patterns that are too complex for a biological brain to process.

The team, based at the Centre for Robotics and Neural Systems at Plymouth University, has trained their network to classify planets into five different types, based on whether they are most like the present-day Earth, the early Earth, Mars, Venus or Saturn's moon Titan. All five of these objects are rocky bodies known to have atmospheres, and are among the most potentially habitable objects in our Solar System.

Mr Bishop comments, "We're currently interested in these ANNs for prioritising exploration for a hypothetical, intelligent, interstellar spacecraft scanning an exoplanet system at range."

He adds, "We're also looking at the use of large area, deployable, planar Fresnel antennas to get data back to Earth from an interstellar probe at large distances. This would be needed if the technology is used in robotic spacecraft in the future."

Atmospheric observations — known as spectra — of the five Solar System bodies are presented as inputs to the network, which is then asked to classify them in terms of the planetary type. As life is currently known only

to exist on Earth, the classification uses a 'probability of life' metric which is based on the relatively well-understood atmospheric and orbital properties of the five target types.

Bishop has trained the network with over a hundred different spectral profiles, each with several hundred parameters that contribute to habitability. So far, the network performs well when presented with a test spectral profile that it hasn't seen before.

"Given the results so far, this method may prove to be extremely useful for categorising different types of exoplanets using results from ground-based and near Earth observatories," says Dr Angelo Cangelosi, the supervisor of the project.

The technique may also be ideally suited to selecting targets for future observations, given the increase in spectral detail expected from upcoming space missions such ESA's Ariel Space Mission and NASA's James Webb Space Telescope.

Degrading Plastics Revealed as Source of Greenhouse Gases

Summary: Researchers have found that several greenhouse gases are emitted as common plastics degrade in the environment. Their study reports the unexpected discovery of the universal production of greenhouse gases methane and ethylene by the most common plastics when exposed to sunlight. Researchers from the University of Hawai'i at Minoa School of Ocean and Earth Science and Technology (SOEST) discovered that several greenhouse gases are emitted as common plastics degrade in the environment.

Mass production of plastics started nearly 70 years ago and the production rate is expected

to double over the next two decades. While serving many applications because of their durability, stability and low cost, plastics have deleterious effects on the environment. Plastic is known to release a variety of chemicals during degradation, which has a negative impact on organisms and ecosystems.

The study, published today in *PLOS ONE*, reports the unexpected discovery of the universal production of greenhouse gases methane and ethylene by the most common plastics when exposed to sunlight. The science team tested polycarbonate, acrylic, polypropylene, polyethylene terephthalate, polystyrene, high-density polyethylene and low-density polyethylene (LDPE) — materials used to make food storage, textiles, construction materials, and various plastic goods. Polyethylene, used in shopping bags, is the most produced and discarded synthetic polymer globally and was found to be the most prolific emitter of both gases.

Additionally, the team found that the emission rate of the gases from virgin pellets of LDPE increased during a 212-day experiment and that LDPE debris found in the ocean also emitted greenhouse gases when exposed to sunlight. Once initiated by solar radiation, the emission of these gases continued in the dark.

"We attribute the increased emission of greenhouse gases with time from the virgin pellets to photo-degradation of the plastic, as well as the formation of a surface layer marked with fractures, micro-cracks and pits," said lead author Sarah-Jeanne Royer, a post-doctoral scholar in the Center for Microbial Oceanography: Research and Education (C-MORE) at the time of this

investigation. "With time, these defects increase the surface area available for further photo-chemical degradation and therefore contribute to an acceleration of the rate of gas production."

It is also known that smaller particles, termed 'microplastics,' are eventually produced in the environment and may further accelerate gas production.

"Plastic represents a source of climate-relevant trace gases that is expected to increase as more plastic is produced and accumulated in the environment," said David Karl, senior author on the study and SOEST professor with C-MORE. "This source is not yet budgeted for when assessing global methane and ethylene cycles, and may be significant."

Greenhouse gases directly influence climate change — affecting sea level, global temperatures, ecosystem health on land and in the ocean, and storms, which increase flooding, drought, and erosion.

"Considering the amounts of plastic washing ashore on our coastlines and the amount of plastic exposed to ambient conditions, our finding provides further evidence that we need to stop plastic production at the source, especially single use plastic," said Royer.

Now, Royer is working to develop estimates of the amount of plastic exposed to the environment in oceanic and terrestrial regions, globally, in order to constrain the overall greenhouse gas emissions from plastics.

Source: Science Daily online