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Daniel Burrus'

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# TECHNOTRENDS® NEWSLETTER

*The biggest ideas that are changing everything*

## IN THIS ISSUE



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# The Advantage of Edge Computing

*By Daniel Burrus, CEO of Burrus Research*

One of the strategic topics being discussed in business circles today is how to harness the true potential that resides in all the data we have and are generating. This huge amount of data is often referred to as big data. However, when you look ahead at the hard trends that are shaping the future including the rapid growth of the Internet of Things (IoT), the accelerating use of artificial intelligence and the digitization of just about everything, you can clearly see that today's big data is quite small in comparison. The amount of data we will be generating in just the next few years, not to mention by 2025 and beyond, creates both enormous challenges as well as opportunities for every organization. Reacting faster will help a little, but by becoming anticipatory, we can turn a rapidly growing problem into an opportunity now.

With wide-scale use of the cloud now becoming the norm rather than the exception, many pundits and industry observers agreed – we had arrived at an optimal computing function and storage destination that would likely last for many years.

> *Technology driven innovations are advancing at an exponential rate*

But, as rock icon Neil Young said in one of his albums, rust never sleeps. In this case, technology-driven innovations are advancing at an exponential rate, rendering many current strategies and technologies either ineffective or obsolete.

The straw that will break the camel's back will be the exponential impact of the IoT, the enormous and rapidly growing network of connected sensors, machines and devices, all creating billions of terabytes of data at an accelerating rate.

Given the massive and increasing amount of data that will be created on a daily basis, accessing, interpreting and acting on all that data quickly and efficiently isn't a cloud-friendly function. Without a new solution in place, it can lead to squandered opportunity, as valuable time-sensitive data withers while it waits for analysis and subsequent action.

Edge computing can help clear up that backlog in any number of settings and applications by effectively putting processing power a good deal closer to where the action is happening. And, in so doing, it can offer game-changing opportunities for all sorts of organizations looking to leverage the advantages of IoT without many of the more problematic and predictable drawbacks.

**What Is Edge Computing?**

Edge computing is a type of information technology architecture in which data is processed as close to the original source as possible. It incorporates a horizontal network that distributes the resources and services of computing and control, storage, networking and communications closer to the data sources. In effect, rather than merely sending data elsewhere, any device with computing, storage and network connectivity can be connected to programmable automation controllers that handle

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TECHNOLOGY NEWS HIGHLIGHTS

# Graphene From Cooking Oil

It's no secret that graphene is a wonder material with incredible properties in terms of strength, hardness, flexibility and conductivity. But applications for the much-touted nanomaterial have been limited due to the high cost of producing it in large quantities.

Normally, graphene is fabricated in a vacuum at extremely high temperatures using purified components in a process that takes several hours.

Now scientists have found a way to create it from inexpensive soybean cooking oil at normal atmospheric conditions using a new technique dubbed "GraphAir."

The oil is heated in a tube furnace for approximately 30 minutes to break the compounds into their carbon building blocks.

The carbon is then placed on a nickel foil surface where it diffuses and cools into a rectangle just one nanometer thick.

The method is not only cheaper (reducing the cost of production tenfold), but also faster than vacuum techniques. The process even works with waste oils, offering a sustainable option for recycling something that would otherwise be discarded.

Although the largest film that can be made currently is about the size of a credit card, time will tell whether the technique can be scaled up – a step that will be crucial to moving graphene out of the laboratory and into everyday devices.

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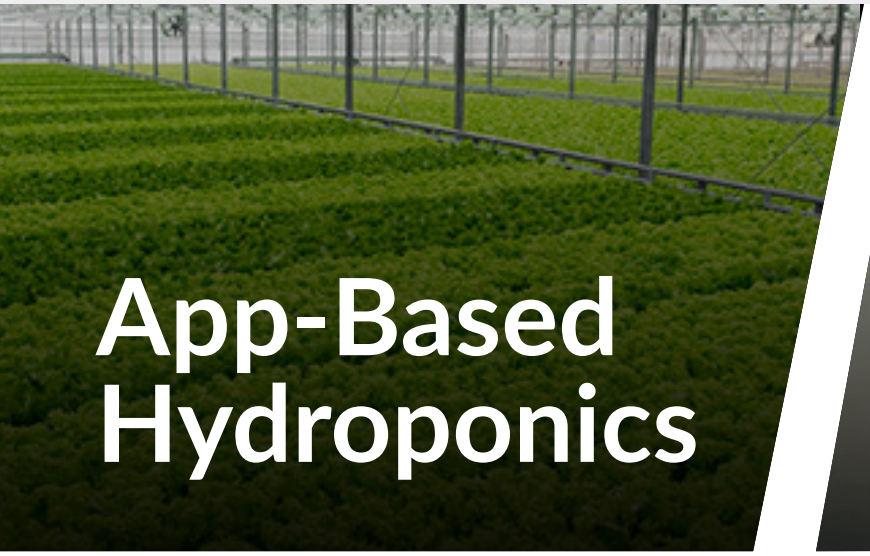


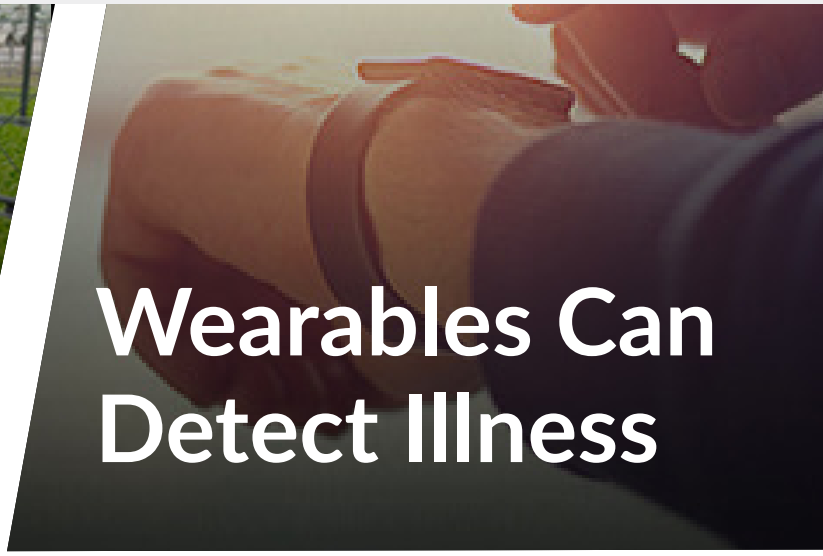
# App-Based Hydroponics

A group of Vietnamese researchers has developed an Internet of Things (IoT) system for hydroponic agriculture that can increase yields by up to 50 percent while reducing time-to-harvest to 30 percent of what is normally required.

The comprehensive system was developed in a cooperative effort between information technology and agriculture experts with a goal of improving food quality and cleanliness. It consists of three main parts: the hydroponic components (which are similar to any other hydroponic system, i.e., tanks, tubes, pumps and lights), a network of IoT sensors and hardware that monitor and control environmental conditions, and a smartphone app that's compatible with Android and iOS platforms. The system enables users to monitor and adjust humidity, temperature and light levels remotely for optimal growing conditions.

The app is priced at $220 to $440 for the farming version and $90 to $130 for the home version. Within a month of commercialization, it received two prestigious awards for "Best Agricultural Project" and "Most Potential Startup Project." It is currently in use at about 50 locations around Vietnam.

*For information: Dan Xuan Truong, Hachi Group; Web site: http://vneconomictimes.com/article/op-eds/hydroponic-system-app-to-boost-harvests*



# Wearables Can Detect Illness

Researchers recently presented the results of a two-year study in which they collected wearable device data from 60 people and correlated it with other health information to determine whether personal self-monitoring could be used to flag the onset of disease. It was concluded that by continuously following various physiological parameters and comparing them to a person's normal baseline measurements, these devices could potentially provide early detection of not only things like the common cold, but also more complex conditions such as Lyme disease and diabetes.

Wearing between one and seven commercially available monitors, participants gathered up to 250,000 measurements per day, including data on weight, heart rate, oxygen level, skin temperature, type of activity, calories expended and exposure to gamma rays and/or x-rays. Over the course of the study, approximately two billion data points were collected. Deviation patterns associated with environmental conditions, illness or other health factors were then analyzed to develop algorithms, which could be used to sense when a person is becoming sick.

In an isolated example, when one of the researchers contracted Lyme disease while on vacation, an elevated heart rate, decreased oxygen and low-grade fever prompted him

to seek medical attention. The diagnosis was confirmed early and antibiotics reversed the symptoms.

In other volunteers, variations in daytime and nighttime heart rate patterns helped successfully distinguish participants with insulin resistance – a precursor to Type 2 diabetes. And in several cases, reduced oxygenation during airplane flights was strongly associated with fatigue that is often attributed to "jet lag." Although it will take some time to determine just how this information can be integrated into clinical practice, wearable biosensors could someday help us to maintain much healthier lifestyles by providing personal, actionable feedback.

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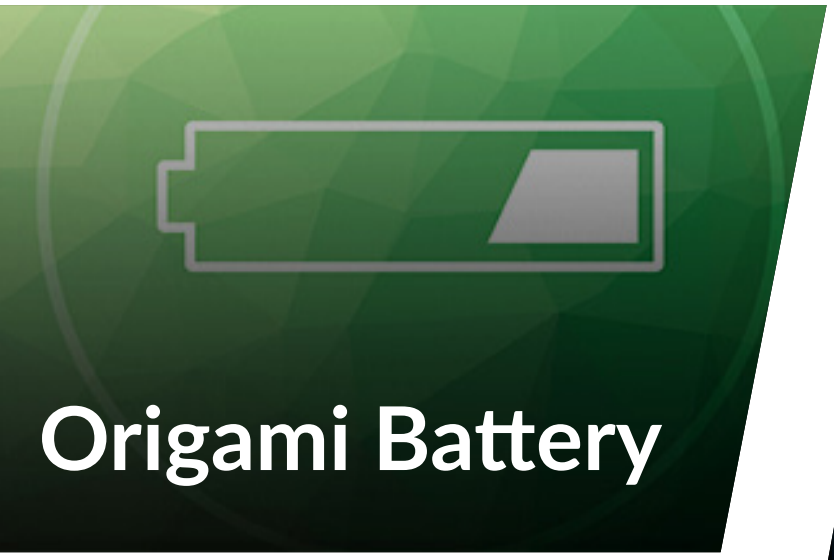

# Origami Battery

Disposable, paper-based electronics – also known as "papertronics" – is fast-emerging in the diagnostic sensor arena. Because paper is low-cost, readily available, highly portable and biodegradable, it's the ideal substrate for use in remote areas where resources are limited. Now engineers have developed a paper-based battery, using bacteria, which could provide the necessary power source for a variety of papertronics devices.

The new battery is constructed in layers – including an anode, cathode and proton exchange membrane (PEM) – on a piece of chromatography paper. Cellular respiration within a few drops of bacteria-filled liquid generates the power. By folding and stacking layers in different ways, the power and current outputs can be improved significantly. Using six batteries in three parallel series, the researchers were able to generate over 21 microwatts at 125 microamps. In a six-by-six configuration, the observed output was nearly 45 microwatts at 105 microamps. Either way, the system generates adequate power to run biosensors for monitoring glucose levels or detecting pathogens. And because the microorganisms can harvest electricity from any biodegradable material, the battery could be run on dirty wastewater, which is readily available even in underdeveloped areas.

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# Atomic Radio

Engineers have built the world's smallest radio with building blocks the size of two atoms. It utilizes atomic-scale imperfections in pink diamonds known as nitrogen-vacancy (NV) centers, which can be created by replacing one carbon atom with a single nitrogen atom and then removing an atom next to it. The resulting

"holes" possess several useful properties, including sensitivity to electromagnetic fields such as those used in FM radio.

When radio waves enter an NV center, they are converted to red light. A photodiode is used to convert the light into current, and the current is then fed into a simple speaker or headphone to generate sound. The receiving frequency of the NV centers can be tuned by creating a strong magnetic field around the diamond using an electromagnet.

Although billions of NV centers were used to boost the signal strength, the radio will also work with a single NV center. It can operate in extreme environments like those encountered in space; the researchers were able to play music at 350 degrees Celsius (about 660 degrees Fahrenheit). Since diamonds are biocompatible, they could be used inside the human body, and their ability to convert information into light makes the tiny radios excellent candidates for quantum computing, photonics and sensing.

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# Solar Roads

One drawback of solar farms is that they occupy lots of land which could otherwise be used for agriculture. So engineers have been designing ways to incorporate solar panels into other surfaces, including floor tiles, roof shingles and even a bicycle path. Now, a French engineering firm has developed panels that will withstand the weight of just about any type of traffic, bringing the promise of solar roads closer to reality than ever.

Layers of plastic are used to create a durable casing that protects the electrical components, and crushed glass is added to the top layer to produce an anti-slip surface. The product, known as Wattway, is strong enough to hold up to an 18-wheeler.

The first test site, a 2,800-square-meter section of roadway in the village of Tourouvre, France, is expected to generate 280 kilowatts at peak capacity and will be linked to the public lighting system.

Other test sites throughout the EU, Africa, Asia and North America will test for different types of traffic and climate conditions. Each will also experiment with different forms of power generation – feeding into the grid, charging electric vehicles, or powering a hydrogen power plant or street lighting.

At a cost of €2,000 (about US$2,100) per square meter, applications for the technology are currently limited to proof-of-concept demonstrations. However, the developers believe that pricing for the new solar roadways will be competitive with traditional solar farms by 2020.

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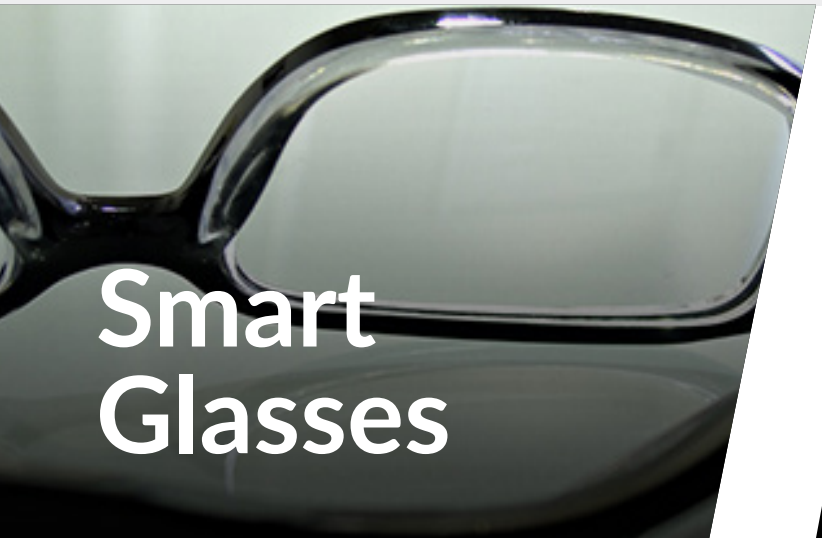

# Smart Glasses

A new technology could revolutionize the way eyeglass-wearers view the world – adaptive lenses that automatically focus on whatever the user is looking at. The device would eliminate the need to swap between different pairs of glasses and allow prescription changes to be made quickly and easily.

The lenses consist of a flexible membrane filled with glycerin and connected to a series of mechanical actuators. As the membrane is pushed back and forth, it alters the curvature of the lens and liquid, varying the focal length between the lens and the eye. Infrared sensors in the frame are used to determine the distance between the wearer's eye and the object on which they are focused, and to instruct the actuators accordingly. The system is calibrated via a smartphone app, which can also be used to update future prescriptions.

Although the prototype device presented at this year's Consumer Electronics Show is somewhat bulky, the developers plan to focus on refining the product to be market-ready in about three years.

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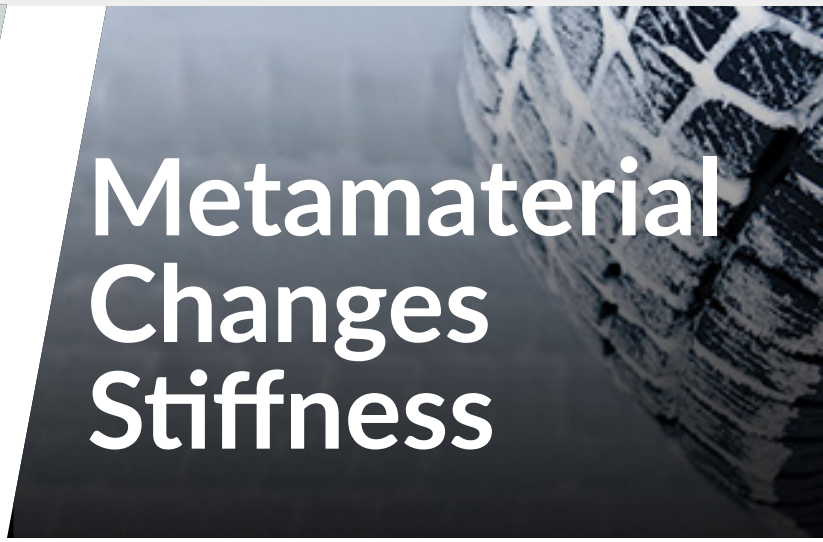

# Metamaterial Changes Stiffness

Metamaterials are manmade substances that derive their properties from their structure rather than their base materials, and typically exhibit novel characteristics that do not occur in nature. Such is the case with a new material that can increase its surface stiffness by several orders of magnitude – from that of rubber to that of steel... and back again.

Researchers have demonstrated that the rigidity of the new material changes depending on the manner in which outside forces come into contact with it. When an object hits the edge, the geometry of the metamaterial, and therefore the way it responds to stress, are altered.

The applications for the new material are vast. For example, tires could be made to automatically adjust to road conditions; vehicles could be made safer and more impact- resistant by adjusting to absorb energy during a collision; someday it could even be used to construct reusable rocket systems.

*For information: Xiaoming Mao, University of Michigan, Department of Physics, 450 Church Street, Ann Arbor, MI 48109; phone: 734-763-5349; email: maox@umich.edu; Web site: http://umich.edu/ or http://ns.umich.edu/new/releases/24476-new-metamaterial-can-switch-from-hard-to-soft-and-back-again*

# The Advantage of Edge Computing

*continued from page 1*

processing, communication and more. Thanks to advances in dematerialization and miniaturization, this can be accomplished in powerful new ways.

Edge computing is inherently flexible from a physical standpoint. Any device with computing, storage and network connectivity can be connected to programmable automation controllers that handle processing, communication and other tasks. These can be located on a factory production floor, in a car, along a train or subway track, on an oil rig and in countless other settings.

**The Difference Between "Fog" and "Edge" Computing**

In examining this overall topic, you may come across the term "fog" computing, which, as it happens, is often used interchangeably with edge computing. But there are some significant distinctions.

In a sense, fog computing is more centralized. This system focuses processing efforts at the local area network end of the overall chain. Data from various points in the network is processed and stored within the network via an IoT gateway. The processed data, along with any additional directions, are then sent back out to the necessary devices.

By contrast, edge computing essentially moves actual processing closer to the data sources. Instead of doing most of the processing at a centralized location, each device within the network carries some of the information-processing load.

In one respect, by distributing more processing responsibility along a greater part of the overall network than does fog computing, edge computing provides a buffer against widespread system failures. And, as I'll discuss later, edge computing is particularly useful in combatting cybercrime and other sorts of security breaches.

This article offers a comprehensive discussion of the differences between as well as the varied advantages and drawbacks of both edge and fog computing.

**The Advantages and Applications of Edge Computing**

The potential of edge computing is both powerful and broad across any number of possible applications:

- In industrial and manufacturing settings, edge devices including machines and sensors can capture streaming data that can be used to predict and prevent a part from failing. If a problem or slowdown occurs, edge computing can reroute traffic or modify production for maximum productivity and head off product defects quickly and efficiently. As a result, you can increase speed and reduce costs while boosting revenue at a new and amazing rate.
- Drones and computer-controlled drones are used increasingly in any number of commercial and public safety applications. One major problem is that drones traditionally need to, in effect, "phone home" to take any action on data that's collected. Edge computing allows drones to analyze information and, from there, take appropriate steps. For instance, drones examining a remote forest fire, a collapsed building or a major traffic accident can pinpoint a problem and act instantly as well as identify nearby emergency personnel. By providing those people with valuable information and other analysis, response time can become that much faster and more effective.
- Edge computing can also be effectively applied in non-emergency applications. As this article discusses, cities such as Mesa, Az. and Palo Alto, Ca. are employing edge computing to monitor civic management issues such as traffic patterns and flow as well as home energy consumption.
- Edge computing can also benefit organizations that use a network of widely located

branch or network offices. By installing intermediary micro data centers or high-performance servers at such remote locations – effectively replicating cloud services on a local level – employees and others working away from a centralized location or headquarters can have the ability to act on valuable information in a fraction of the time needed to first send the data to cloud storage.

- Edge computing also complements new products and services in ways that other forms of technology are lacking. For instance, self-driving cars produce enormous amounts of data. Directing that information elsewhere would prove too slow in situations that mandate fast response, such as whether to increase speed or slow down. Automakers such as Tesla use advanced edge computing technology to provide instant analysis and direction.
- Edge computing can also prove a boon to cybersecurity. Since computing and control occur near the original source of the data – rather than in massive storage systems – unusual or suspicious activity can be faster and easier to spot. Additionally, since edge computing allows for communication, networking and other tasks without extensive routing, a higher level of containment is possible, providing less opportunity for cyberattacks.
- Edge computing also boosts the opportunity for collaboration, one of the central elements of my Anticipatory Organization™ Learning System. Currently, the sensors and connected machines are far from the various teams and groups within a large organization. Edge computing allows for instant response as well as closer and greater contact with teams and groups, promoting faster response and greater accessibility to information afforded by IoT.

**Both/And, not Either/Or**

Given the enormous game-changing potential of edge computing, it can be tempting to say that today's more established technology systems will likely fade into obscurity. That would be an error.

Edge computing is not unduly limiting. In fact, it's an ideal example of my "Both/And" principle. While edge computing offers remarkable opportunities, we're certainly not going to stop using the cloud and related technologies. Rather, it's a complementary relationship in which both boost the other's value.

That makes edge computing a component that adds overall flexibility to any intelligent network. Although one of edge computing's advantages is the capacity to analyze and act upon data that requires a quick response, information that is less pressing in nature can always be moved to an intermediary. Particularly large or less time-sensitive data and information can also be transferred to the cloud for analysis, comprehensive analytics or simply long-term storage. Nor are advantages limited to a more effective system that appropriately prioritizes and analyzes certain data while filing away less time-sensitive information for subsequent use. Edge computing can also address bandwidth capacity and other communications challenges, particularly with the increased demands of artificial intelligence and other uses. That, in turn, can make the production of revenue-generating products and services more efficient and therefore more cost-effective.

Ultimately, edge computing also affords the opportunity to make the most of your overall investment in your technology. Looked at one way, edge computing efficiently distributes the allocation of function as opposed to resources. That not only makes configuration and management less of a chore, it also boosts overall efficiency and response time and allows you to make the most of the enormous resources and data afforded by IoT.

That can afford game-changing opportunities of all sorts for a broad array of organizations.

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