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Innovations of NASA in Biomedical Engineering

When we talk about **NASA**, it's not always the nation's civilian space program for aeronautics and aerospace research. The recent launch of NASA's Curiosity Mars Rover has been phenomenal. People often argue on what NASA has actually done for us. Sending robots to other planets and controlling from Earth doesn't make any sense to the common man. Is that what you think NASA is all about? (May be not). So, I came across some answers to this question and found details about the technologies and innovations that have emerged out of research and development at NASA. Here are the contributions in the healthcare field:

1. *Adam Kissiah's Cochlear Implant*

After having a profound hearing loss, he developed the cochlear implant, a device that has restored hearing for thousands, and allowed people who were born deaf, to hear for the first time. It has brought a smile on the faces of many people. Kissiah had no medical training, but used the knowledge he gained as an electronics instrumentation engineer at NASA's Kennedy Space

EDITORIAL

SADANAND B KULKARNI

Welcome to March-April issue of ENGMEDNEWS. It gives me distinct pleasure to enlighten all of you about the research work done on two articles that is published in this newsletter.

The first article mainly focuses on innovation of NASA in biomedical engineering.

The second article is about an ongoing research on a technology that tries to shed light on how to control computers using brain signals directly.

I believe that these research works have uplifted the technology of medical world by making it cost effective and efficient.

I hope you all find this newsletter informative and useful.

Centre.

2. Detection of Cataracts

NASA researcher Dr. Rafat Ansari was working on experiments involving small particles suspended in liquids, when he realized that his work could possibly help detect cataracts, the degenerative eye condition afflicting his father. Now the instrument is being adopted to identify other eye diseases, diabetes and possibly even Alzheimer's. As a child in Pakistan, he decided to become a scientist because he saw people walking on the moon.

3. Lifeshears – Rescue tool and a Heart Pump

This is a rescue tool which quickly cuts debris to free and rescue accident victims, using the same power source used to separate Solid Rocket Boosters from the Shuttle. It also acts as a lifesaving heart pump, used to keep patients alive while they're waiting for a transplant.

4. Attention Getter

Techniques used to measure brain activity in NASA pilots are being used to improve attention spans for children with Attention Deficit Hyperactivity Disorder (ADHD)

Scientists Discover How Bacteria Changes Ions Into Gold

Bacteria with the ability to change ions into solid gold? This scenario may sound like a biochemist's version of a fairy tale, but it's real and scientists at McMaster University have just described how the process works in a recent article in a journal.

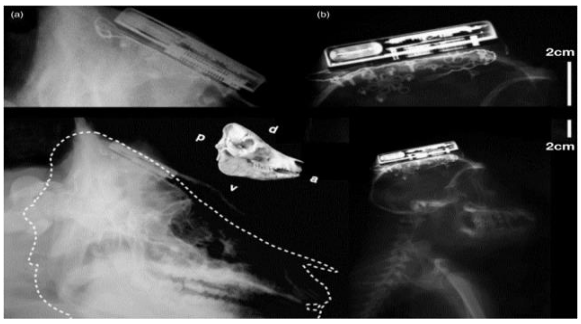
The bacterium is called Delftia acidovorans, and it turns out that its King Midas-like conversion is part of a self-defense mechanism. Gold ions dissolved in water are toxic. The bacteria sense them and release a protein called Delftibactin A. This protein acts as a shield for the bacteria and changes the poisonous ions into harmless particles that accumulate outside the cells.

Although the amount of gold that Delftia acidovorans release is tiny (the particles are 25-50 nanometers across) it is possible that the bacteria or the protein could someday be used to dissolve gold from water or to help people identify streams and rivers carrying the mineral.

Monkeys and Pigs control Computers wirelessly using Brain Signals

It would really be great if we could control our PC with our brain. Well, this sort of thing may be closer than you think. Brain-computer interfaces that can translate thoughts into actions will change how stroke patients, paraplegics and other people with limited mobility interact with their surroundings. Till date these devices have involved bulky corded equipment inside

research labs, requiring patients to be tethered to a computer. Lately, researchers at Brown University have built the first wireless version. Like a cell phone embedded in the brain, their new implantable brain sensor can relay broadband signals in real time from up to 100 neurons. It can also be used to control wheelchairs, robotic arms, or computer interfaces like cursors and keyboards. Brown and a commercial spin-off called Brain Gate have been testing a wired version of the system for years. But being tethered to a computer limits a patient's



X-rays of brain-computer-interface implants in Yorkshire pigs and rhesus macaque monkeys several months after surgery.

range of motion — and it leaves an incision in your head that's susceptible to infection, says Juan Aceros, a researcher on the project who is now an engineering professor at North Florida University.

So far, the wireless version has only been tested in two Yorkshire pigs and four rhesus macaque monkeys, but Aceros says they plan to test the system on human subjects. The approval from the FDA is required, which may take a couple years. The good news is the devices have been implanted in the animal subjects for over a year without significant complications.

Implantable Brain Interface Engineers Arto Nurmikko and Ming Yin examine their prototype wireless, broadband neural sensing device. If you're an able-bodied person, don't expect your doctor to implant this device in your head anytime soon. For now, the team's primary goal is to help disabled humans, as was detailed in a paper published last May on Brain Gate's efforts to help stroke patients control a robotic arm. One patient was able to use the arm to serve herself coffee — the most complex action that had been achieved through neuro prosthetics at the time — simply by imagining herself using her own arm to maneuver the cup.

The wireless implant is contained in a 56 by 42 by 9 mm hermetically sealed titanium case. A bulk of the device sits on top of the skull under the skin. Only a tiny sensor is inserted about one millimeter into either the motor cortex or primary somatosensory cortex region of the cerebral cortex of the subject's brain. Depending on what sort of neural signals researchers want to pick-up, they may need to implant deeper into another part of the brain.

The team at Brown implanted the device into the motor cortex because they're interested in the motor activity. "We're targeting the cortex because it lets us work with neuroprosthetics," Aceros says Just like many cell phones and other electronic devices, the implant can be inductively recharged — i.e., recharged wirelessly. It consumes only about 100mW of power and can last for upto seven hours. "Just a few years ago, this device would have been impossible to manufacture," says Aceros. "We worked with companies to push the state of the art in this design."

The transmitter's range is between 2m-3m, says Aceros. They have already developed a more advanced system that uses less power, has more range, and can actually receive input. The current version can only record neural activity, but the next version's

stimulation function would enable patients to feel the weight of something lifted with a robotic arm, says Aceros. “Being able to feel weight gives people more control,” he says But it wouldn’t be possible to check your facebook updates through the implant, so don’t think these devices are replacing your laptops or smart phones.

This raises the question of what happens when a patient wants to upgrade to a newer model. Aceros says that they have successfully tested replacing implants in animal subjects. “It is brain surgery,” he says. “However, it’s not something where you have to kill the subject, you can just come and take it out.”One of the few problems the team has run into was the heating of the device, which required them to spray cold water on the heads of test animals to keep them comfortable. But they were able to solve this problem and can now charge wirelessly without the device getting too hot. The team has planned for every contingency they could think of, which is part of why the process has been so smooth. But there are potential problems looming on the horizon given that researchers have demonstrated the ability to remotely hack certain types of insulin pumps and defibrillators, it seems like it’s only a matter of time before someone figures out how to exploit brain implants. But we’re still a long way from that.

“At the current state of neuro-scientific research, simply interpreting the data we collect is an enormous challenge and is being tackled by neuroscientists around the world,” says Dave Borton, one of the primary authors of the paper. “However, one day our understanding of the brain will be much greater, and privacy will play an increasingly large role in technological development.”

“Without a doubt, at that time security and privacy measures will need to be implemented, just like we do now with personal data,” he says. “For now, we focus our thoughts on solving the fundamental challenges in extracting the information out of the brain for use in basic neuroscience studies, and potential therapies for neuromotor disease.”

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