CAUSE NO. 08-08056

MARCELA AND JOSE BUSTAMANTE, AS NEXT FRIENDS OF DANIELLA BUSTAMANTE,	§	IN THE DISTRICT COURT
Plaintiffs,	§	
vs.	§	
	§	OF DALLAS COUNTY, TEXAS
JORGE FABIO LLAMAS-SOFORO, M.D.; JORGE FABIO LLAMAS-SOFORO, M.D., P.A., D/B/A EL PASO EYE CARE CENTER, ENRIQUE N. PONTE, JR., M.D., PEDIATRIX MEDICAL SERVICES, INC., AND PEDIATRIX MEDICAL GROUP, INC.,	§	
Defendants.	§	101st JUDICIAL DISTRICT

PLAINTIFFS' BRIEF REGARDING FUTURE MEDICAL EXPENSES

COME NOW PLAINTIFFS, who file this brief regarding Recovery of Future Medical Expenses for Daniella Bustamante. In support thereof, Plaintiffs respectfully show the Court:

I.

BACKGROUND

Plaintiff put on proof at trial through ophthalmologist William Good, MD and Life Care Planner Helen Woodard that Daniella Bustamante in reasonable probability requires future medical care including life care expenses as well as the associated costs in an amount approximating $150,000. In addition, Plaintiff put on proof at trial that there are existing medical advances that are not commercially available for humans yet but will be available to Daniella in her lifetime for electronic retinal implants that would benefit her vision. As of this

writing, undersigned counsel has learned that such devices are now available for commercial use on human beings – the first such implantation was accomplished in Italy on October 9, 2011. The US Patent Office issued a patent for this technology in the United States on September 8, 2011. [See attached].

The testimony of these medical advances was admitted without objection and was also argued to the jury without objection. In closing, Plaintiff requested an amount of approximately $1,000,000 to cover future medical care as well as to cover medical advances such as retinal implants. The jury awarded $962,000 to cover such medical needs over this child's 80-some-odd year life expectancy. That is only $15,516 per year over her adult life.

The Court and parties should note that this was not an out-of-control jury, as indicated by their award of only $18,000 for past damages, $0.00 for future physical impairment, and $152,000 for future disfigurement, physical pain, and mental anguish. Rather, this jury appeared to carefully consider all evidence and render a thoughtful verdict.

The purpose of this brief is to address the Court's concern whether the award of $962,000 for future medical care is proper. As explained below, it is proper under existing law.

II.

IS PLAINTIFF REQUIRED TO PROVE FUTURE MEDICAL EXPENSES TO A REASONABLE MEDICAL PROBABILITY

The threshold inquiry is the burden of proof for the amount awarded for future medical expenses. Must the Plaintiff prove the amount awarded by a reasonable medical probability? This question has been addressed by the Courts of Appeals and the answer is "no." Plaintiffs need not prove future medical expenses to a reasonable medical probability. [Columbia Medical

Center v. Bush, 122 S.W.3d 835, 863 (Tex.App.—Fort Worth 2003, pet. denied); Furr's Inc. v. Logan, 893 S.W.2d 187, 194 (Tex.App.—El Paso 1995, no writ)].

III.

RECOVERY OF FUTURE MEDICAL CARE AND MEDICAL ADVANCES

The Dallas Court of Appeals has written on recovery for future medical expenses on at least three occasions.

In Thate v.Texas & Pacific Ry. Co., 595 S.W.2d 591, 601 (Tex.App.— Dallas 1980, writ dism'd) the Court stated "[t]he only requirement to support a verdict on this issue is that there be evidence in the record of the reasonable value of past medical treatment and to establish the probable necessity of future medical treatment. Determination of the expense of future treatment is a matter for the jury to determine in the exercise of their sound discretion under proper instructions from the court." [See also, City of Houston v. Moore, 389 S.W.2d 545, 550 (Tex.Civ.App. Houston 1965, writ ref'd n. r. e.); Edens-Birch Lumber Co. v. Wood, 139 S.W.2d 881, 886-89 (Tex.Civ.App. Beaumont 1940, writ dism'd judgmt. cor.)].

On each occasion the Dallas Court of Appeals has addressed future medical expenses it stated that the amount for future medical expenses includes future medical advances and is "always speculative" and "uncertain" but such awards are to be left to the "sound discretion" of the jury; the courts should be "particularly reluctant" to disturb such awards. [See Thate v.Texas & Pacific Ry. Co., 595 S.W.2d at 601; Wal-Mart Stores v. Crosby, 295 S.W.3d 346, 354 (Tex.App.—Dallas 2009, writ denied); Sanmina-SCI Corp. v. Ogburn, 153 S.W.3d 639, 642 (Tex.App.—Dallas 2004, pet. denied)].

In Wal-Mart Stores v. Crosby, the Court stated that an award for future medical expenses is always speculative due in part to future medical advances and uncertainty about the future

costs of goods and services. [Id. at page 354]. Nevertheless, the Court held such awards proper and stated that the appellate courts are "particularly reluctant" to disturb an award of future medical expenses. [Id.]

In Sanmina-SCI Corp. v. Ogburn, the Court repeated the same principles in reviewing awards of future medical expenses; to wit, that 1) such awards may include amounts for medical advances that are by their very nature uncertain or speculative and 2) courts should be particularly reluctant to disturb such awards. [Id. at page 643].

In fact, over and over again, the Courts of Appeals state they should be "particularly reluctant" to disturb awards for future medical expenses and leave such matters to the "sound discretion" of the juries. For example, in Pipgras v. Hart , 832 S.W.2d 360, 365 (Tex.App.—Fort Worth 1992, writ denied)] the Court stated "[a]n award of future damages in a personal injury case is always speculative. Life expectancy, medical advances, and the future cost of products, services and money are not matters of certainty, thus appellate courts are particularly reluctant to disturb a jury's award of these damages. Often, a jury must extrapolate an award of future damages from proof of other matters, for example, an award of future medical damages based upon a finding of past medical treatment." [See also Simmons v. Bisland, 03-08-00141-CV at page 6 (Tex.App.—Austin April 4, 2009, pet. denied); Antonov v. Walters, 168 S.W.3d 901, 908 (Tex.App—Fort Worth 2005, pet.denied); Spohn v. De La Fuente, 13-04-00485-CV at page 8 ("no precise evidence is required to support an award for future medical costs * * * there is no requirement that the plaintiff establish such costs through expert testimony.")].

The jury is allowed to make its decision regarding the amount of future medical expenses based on the nature of the injury, the medical care rendered before trial, the progress made toward recovery, and the plaintiff's condition at the time of trial. [Spohn, at page 8; Antonov,

168 S.W.3d at 908; Tagle v. Galvan, 155 S.W.3d 510, 519 (Tex.App.—San Antonio 2004, no pet.); Rosenboom Mach. & Tool v. Machala, 995 S.W. 2d 817, 828 (Tex.App.—Houston [1st Dist.] 1999, pet.denied); City of San Antonio v. Vela, 762 S.W.2d 314, 321 (Tex.App.—San Antonio 1988, writ denied)].

In Texas, juries are specifically allowed to award damages for future medical advances. In this case, we are talking about medical advances up to 80-years into the future. If the juries are limited to only the medical technology that exists at the time of trial and the specific costs associated with such then it makes a mockery of the law allowing awards for future medical advances in a case in which life expectancy is up to 80-years in the future. Under the law, the costs awarded for future medical care is proper in this case based on the expert testimony at trial, the nature of the injury, the medical care rendered before trial, the progress made toward recovery, and the plaintiff's condition at the time of trial.

FOR THESE REASONS, Plaintiff respectfully requests the Court enter judgment on the jury verdict and not disturb the damages awarded for future medical expenses; and for such other relief to which Plaintiffs are justly entitled.

Respectfully Submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the above and foregoing has been served upon all counsel of record on December 2, 2011, as follows:

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August 16, 2011

Press Release, 11-47

United States Patent and Trademark Office Issues Patent Number 8,000,000

Patent Awarded to Second Sight Medical Products for a "Visual Prosthesis Apparatus" that Enhances Visual Perception for the Sight Impaired

WASHINGTON – The Department of Commerce's United States Patent and Trademark Office (USPTO) today issued patent number 8,000,000 to Second Sight Medical Products, Inc., for a visual prosthesis apparatus that enhances visual perception for people who have gone blind due to outer retinal degeneration. The invention uses electrical stimulation of the retina to produce the visual perception of patterns of light. The product, the Argus® II, is currently in U.S. clinical trials and has received marketing approval in Europe.

"This kind of innovation is a driver of our nation's economic growth and job creation," said Under Secretary of Commerce for Intellectual Property and Director of the USPTO David Kappos. "The USPTO plays a major role in serving America's innovators by granting the intellectual property rights they need to secure investment capital, build companies and bring their products and services to the global marketplace."

"Second Sight has 90 issued U.S. patents surrounding technology associated with sight restoration for the blind and treatment of a variety of other medical conditions," said Robert Greenberg, president and CEO of Second Sight. "This patent protection and significant federal support for innovation have already played key roles in creating nearly 100 U.S. jobs at our company. Once the Argus II has FDA approval in the United States, we expect to create hundreds of more jobs over the next several years, while delivering a breakthrough treatment for a previously untreatable medical condition."

It took 75 years to get to patent 1 million in August 1911, yet just under six years to get from patent number 7,000,000 to today's patent number 8,000,000. More information on these milestones is available online.

About Patent Number 8,000,000

In a healthy eye, the photoreceptors (rods and cones) on the retina convert light into tiny electrochemical impulses that are sent through the optic nerve and into the brain, where they are decoded into images. If the photoreceptors no longer function correctly, the first step in this process is disrupted and the visual system cannot transform light into images, causing blindness.

The system awarded patent number 8,000,000 is designed to bypass the damaged photoreceptors altogether. A miniature video camera housed in the patient's glasses sends information to a small computer worn by the patient where it is processed and transformed into instructions transmitted wirelessly to a receiver in an implanted stimulator. The signals are then sent to an electrode array, attached to the retina, which emits small pulses of electricity. These electrical pulses are intended to bypass the damaged photoreceptors and stimulate the retina's remaining cells to transmit the visual information along the optic nerve to the brain.

The signing and presentation of the 8 millionth patent by Director Kappos will take place at the Smithsonian American Art Museum on Sept. 8, 2011.

About Second Sight Medical Products

Second Sight Medical Products, Inc., located in Sylmar, Calif., is a privately held company founded in 1998 by Alfred Mann, Dr. Sam Williams and Gunnar Bjorg with the goal of creating a retinal prosthesis to provide sight to subjects blinded from outer retinal degenerations, such as retinitis pigmentosa.

For more information about Second Sight Medical Products, please visit www.2-sight.com or call 818-833-5026. Second Sight and Argus are registered trademarks of Second Sight Medical Products, Inc.

To stay current with the USPTO, subscribe to regular email updates at www.uspto.gov/subscribe.

###

Second Sight announces First Commercial Implant of Retinal Prosthesis

Argus® II becomes the first ever commercial artificial retina.

Lausanne, November 2nd – Second Sight Medical Products, Inc., the world's leading developer of retinal prostheses for the blind, announced that the first ever commercial implantation of such a prosthesis was successfully completed on Saturday, October 29th in Pisa, Italy. The company's **Argus® II Retinal Prosthesis System** **('Argus II')** was surgically implanted by Dr. Stanislao Rizzo, Director of the University Hospital Ophthalmic Department of Pisa, in a patient suffering from advanced Retinitis Pigmentosa (RP). Argus II, which received marketing clearance in Europe earlier this year, becomes the world's first ever commercial implant intended to restore some vision to a previously blind patient.

"I am very pleased to offer in Italy for the first time ever this approved treatment for blindness due to RP. I hope that it will encourage patients suffering from this impactful condition to seek medical advice in centers of excellence around Europe, like the one we have here in Pisa," said Dr. Rizzo. "It is wonderful that medicine can now do something for the blind."

Argus II is Second Sight's less invasive second generation implantable device intended to treat blind people suffering from degenerative diseases of the outer retina such as RP. The system works by converting video images captured by a miniature camera, housed in the patient's glasses, into a series of small electrical pulses that are transmitted wirelessly to an array of electrodes on the surface of the retina (epi-retinal). These pulses are intended to stimulate the retina's remaining cells resulting in the corresponding perception of patterns of light in the brain. Patients can learn to interpret these visual patterns thereby gaining some functional vision. The system was tested in a multi-center international clinical trial that began in 2007.

Dr. Rizzo indicated that the surgery proceeded without incident, and that the patient is recovering very well. Within a week of surgery, testing of the implanted device will begin and the **Argus II** will be electronically customized for the patient, who could be using the system at home before the end of the month. Typically, patients require a short period of training and low vision rehabilitation to obtain the best results.

Gregoire Cosendai, PhD, head of Second Sight's European subsidiary added, "This is truly a historic event that has been decades in the making. This milestone is significant for the company and the field of vision restoration, but most importantly, for these patients who now have a treatment option." Cosendai further indicated that the **Argus II** system is currently available in Germany, France, the UK, and Switzerland, and that Second Sight is actively adding more centers throughout the EEA.

For more information please contact

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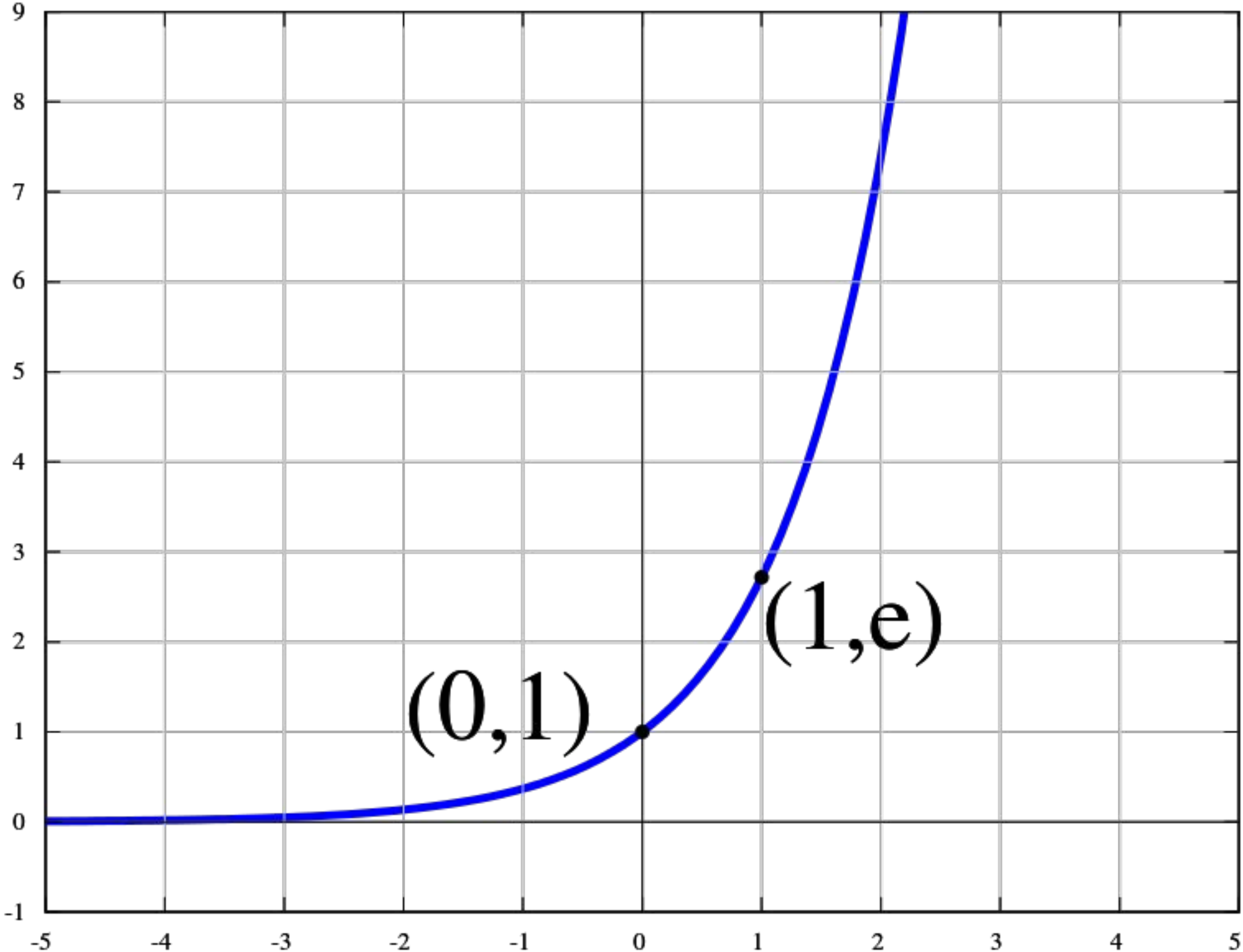
Second Sight Medical Products, Inc., located in Los Angeles, California, was founded in 1998 to create a retinal prosthesis to provide sight to patients blinded from outer retinal degenerations, such as Retinitis Pigmentosa. Through dedication and innovation, Second Sight's mission is to develop, manufacture and market implantable visual prosthetics to enable blind individuals to achieve greater independence. European Headquarters are in Lausanne, Switzerland. Second Sight and Argus are registered trademarks and the Second Sight logo is a trademark of Second Sight Medical Products, Inc. Argus II is not approved for commercial use in the United States; it is being used in clinical trials under an FDA-approved Investigational Device Exemption (IDE).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5 Robot Butlers To Manage Your Smart Home

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9 months ago

The Jetsons did not lie to you: in the future, we will all have robot butlers. At least that's what Asus would have you believe. At the Computex trade show in Taipei this week, the tech giant revealed its latest product is not a phone or laptop, but a personal robot called **Zenbo (http://zenbo.asus.com/)**.

Jonney Shih, the Asus chairman, said: "For decades, humans have dreamed of owning such a companion: one that is smart, dear to our hearts, and always at our disposal. Our ambition is to enable robotic computing for every household."

However, while this is a radical departure for Asus, Zenbo is part of a wider trend of real-life droids launching this year with Segway announcing its **hoverboard bot (http://robot.segway.com/)** in January and **Buddy the family companion (http://www.bluefrogrobotics.com /en/home/)** being sent out to Kickstarter backers in July.

The main purpose of all these androids seems to be to provide a more human-like interface for controlling your disparate smart home devices and searching the internet without having to fiddle around with apps.

Zenbo will cost $599 (around £410), which is little more than a high-end smartphone, but still about $400 more than an Amazon

Echo, so it remains to be seen if added mobility and a cute pout is enough to justify the extra cost.

But if you'd rather tell your friends that you have your very own C3PO at home rather than **a lamp shade containing a Google genie (https://www.gadgetdaily.xyz/5-biggest-tech-announcements-at-google-io-2016/)**, here's a round-up of the five personal robots that want to come home with you and obey your every command.

1. Zenbo

Though it looks like a 2002 Apple iMac, Zenbo can read you recipes while you cook, play with your children and remind grandpa to take his medicine.

Its touchscreen head displays a face with emotions, it can respond to voice commands and move around independently on two wheels. Connected to wi-fi, it can control everything from compatible lights and TVs to allowing you to view visitors at the door on its screen and then unlock it with your voice.

Zenbo also has a built-in camera to take pictures and can entertain children with educational games and interactive stories. As well as reminding older users to take their medicine, it can monitor the home for emergency situations such as falls. If Zenbo detects a problem, the domestic drone will notify carers and allow them to pilot the robot remotely, using the camera to

inspect the area.

Unfortunately, there is no word on when the Zenbo will go actually on sale, but developers can register their interest now.

The Zenbo costs $599 (around £410). For more information, visit **zenbo.asus.com (http://zenbo.asus.com/)**.

2. Buddy

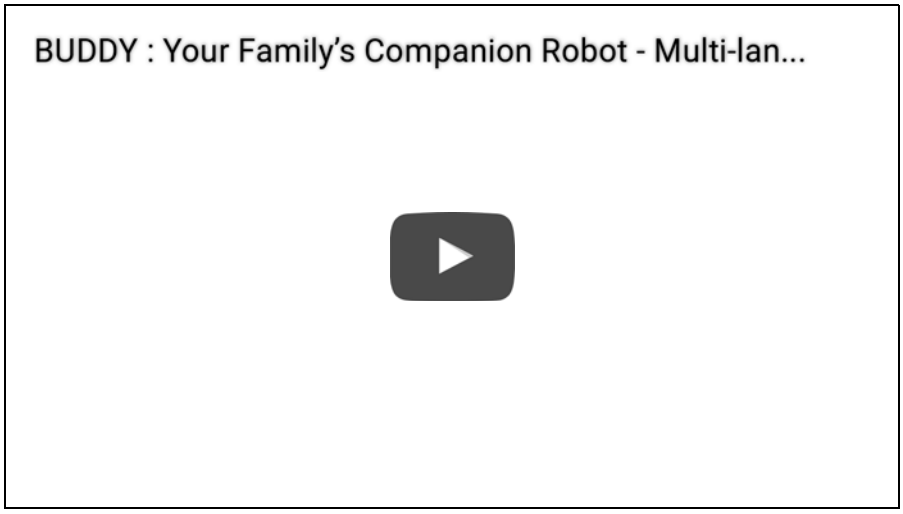
Before Zenbo came along, Buddy was arguably the cutest robot butler on the block. But once you've looked past his amicable exterior, he's actually one of the most sophisticated robots out there, which you can buy for little more than a new games console. For kids, Buddy is the ultimate imaginary friend: he can read then stories, play hide-and-seek, teach them to spell, count

and even introduce them to programming.

But the French-made Buddy is isn't just a toy. For adults, Buddy can act as your own personal assistant, reminding you of your appointments and giving you travel updates before you leave the house. More advanced features include patrolling the house as a robotic security guard while you are out, sending alerts if senses unusual movement or the temperature rises suddenly, suggesting a fire. Buddy can also connect over Bluetooth and Wi-Fi with all of the gadgets in your smart home, acting as a hub that responds to your voice commands.

Additional accessories add to Buddy's arsenal of features, including a an attachable pico projector for family movie night and customisable arm, which allows Buddy to appear more animated and interact with the world.

Buddy is available to preorder now and should arrive this December.



Buddy costs €646 (around £500/$720). For more information, visit **bluefrogrobotics.com (http://www.bluefrogrobotics.com/en/home/)**.

3. Alpha 2

Costing almost a £1,000, Alpha 2 is perhaps the most expensive personal robot you can buy right now, but it also has the most features, not to mention actual legs. As well as reminding you about appointments and controlling the tech around your house, Alpha 2 can tutor you in French, sing songs, and recognise up to 50 faces so that it can personally engage with each member of your family.

Its humanoid build is supported by 20 servos making it surprisingly spry. In fact, in addition to being able to guide you through your morning yoga positions, Alpha 2 can perform each one as well. While its walking isn't perfect, its movements are quite fluid and it can also dance, wave its hands and nod.

Alpha 2's Indiegogo also promises the robot will respond to cutting-edge inputs, including ultrasonic, pressure and touch sensors. The first Alpha 2 bots should ship to backers later this month.

Alpha 2 costs £920/$1,300. For more information, visit **ubtrobot.com (http://www.ubtrobot.com/en/)**.

4. Ulo

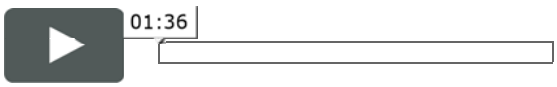
Ulo is little more than a glorified surveillance system, but look at that face! This wifi-connected owlet's beak is actually a two-way mirror containing a camera and motion sensor that watches and records what's going on. Appropriately for an owl-shaped security guard, it also has night vision to work in the dark. In alert mode, if Ulo senses movement, it'll send you a GIF of its CCTV footage.

Ulo also communicates through its big beaming eyes, which are actually two 1.22-inch LCD screens, similar to those that appear in many popular smartwatches. If Ulo is low on battery his eyes will look heavy and tired and if you're watching its live video feed it will squint.

Using IFTTT, Ulo's functions can trigger or be triggered by other connected devices or internet services. For example, if Ulo senses movement at night, your Philip Hue lights will switch on. If weather forecasts say its going to rain, Ulo will look grumpy.

Kickstarter backers are expected to receive their Ulo robots this November, while the rest of us will have to wait until early 2017, though you can preorder your owl today.

Ulo
from **Vivien Muller**



Ulo costs €199 (around £153/$223). For more information, visit

mu-design.lu (http://mu-design.lu/#ulo).

5. Segway Robot

While hoverboards were the must-have toy leading up to Christmas last year, there was something of a backlash **after cheaper models started exploding (http://www.cnet.com/uk/news/why-are-hoverboards-exploding-and-catching-fire/)**, and the two-wheeled rides were pulled from stores. But Segway is confident it can bring the hoverboard back by turning it into a robot.

Like the other robo-butlers here, the Segway Robot can take photos and videos and can communicate with your smart home. Running on Android, the idea is that developers will create apps for the robot and, like Buddy, you can also buy customisable attachments, including a pair of arms that look like they were taken from an oversized Lego mini figure.

Unfortunately, you can't ride your robot and talk to it at the same time as its head has to fold away in order for you to stand on it. But you can use the robot outside, commanding it to follow you and it'll use its Intel RealSense 3D-mapping cameras to map it surroundings, avoid objects and track you.

The Segway Robot Developer Edition launches this autumn. For more information, visit **robot.segway.com (http://robot.segway.com/)**.

This article contains extracts from the feature 'Hi, Robot' that appeared in **Gadget issue 8 (https://www.imagineshop.co.uk/magazines/gadget/gadget008.html)**. **Buy the latest issue of Gadget now (https://www.imagineshop.co.uk/magazines/gadget.html)** or **download the digital edition (https://www.imagineshop.co.uk/magazines/gadget.html)**.

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Brain to robot: 'Move, please'

Date: September 21, 2016

Source: ETH Zurich

Summary: Using the power of thought to control a robot that helps to move a paralysed hand: new research could fundamentally change the therapy and daily lives of stroke patients.

FULL STORY

Using the power of thought to control a robot that helps to move a paralysed hand: a project from the ETH Rehabilitation Engineering Laboratory could fundamentally change the therapy and daily lives of stroke patients.

One in six people will suffer a stroke in their lifetime. In Switzerland alone, stroke affects 16,000 people every year. Two thirds of those affected suffer from paralysis of the arm. Intensive training can -- depending on the extent of damage to the brain -- help patients regain a certain degree of control over their arms and hands. This may take the form of classic physio- and occupational therapy, or it may also involve robots.

Roger Gassert, Professor of Rehabilitation Engineering at ETH Zurich, has developed a number of robotic devices that train hand functions and sees this as a good way to support patient therapy. However, both physio- and robot-assisted therapy are usually limited to one or two training sessions a day; and for patients, travelling to and from therapy can also be time consuming.

Exoskeletons as exercise robots

"My vision is that instead of performing exercises in an abstract situation at the clinic, patients will be able to integrate them into their daily life at home, supported -- depending on the severity of their impairments -- by a robot," Gassert says, presenting an exoskeleton for the hand. He developed the idea for this robotic device together with Professor Jumpei Arata from Kyushu University (Japan) while the latter was working in Gassert's laboratory during a sabbatical in 2010.

"Existing exoskeletons are heavy, and this is a problem for our patients because it renders them unable to lift their hands," Gassert says, explaining the concept. The patients also have difficulty feeling objects and exerting the right amount of force. "That's why we wanted to develop a model that leaves the palm of the hand more or less free, allowing patients to perform daily activities that support not only motor functions but somatosensory functions as well," he says. Arata developed a mechanism for the finger featuring three overlapping leaf springs. A motor moves the middle spring, which transmits the force to the different segments of the finger through the other two springs. The fingers thus automatically adapt to the shape of the object the patient wants to grasp.

However, the integrated motors brought the weight of the exoskeleton to 250 grams, which in clinical tests proved too heavy for patients. The solution was to remove the motors from the hand and fix them to the patient's back. The force is transmitted to the exoskeleton using a bicycle brake cable. The hand module now weighs slightly less than 120 grams and is strong enough to lift a litre bottle of mineral water.

Researching brain processes

Gassert is currently driven by the question of what happens in the brain and how commands pass from the brain to reach the extremities after a stroke. "Especially with seriously affected patients, the connection between the brain and the hand is often severely or completely disrupted," Gassert explains, "so we are looking for a solution that will help patients pass on commands to the robotic device intuitively." The idea is to detect in the brain a patient's intention to move his or her hand and directly pass this information on to the exoskeleton. This may also produce a therapeutic benefit. According to Gassert, a number of studies show that it is possible to strengthen existing neural connections between the brain and the hand with regular exercise. An important component for this is that the brain receives somatosensory feedback from the hand when it produces a command to move.

In order to understand what goes on in the brain, Gassert is carrying out fundamental research with clinicians, neuroscientists and therapists. For their research, the scientists can draw on a number of imaging techniques, such as functional magnetic resonance imaging (fMRI), which allows them to map the activities of the whole brain. While this technology allows them to gain fundamental new insights, fMRI is both very expensive and highly complex and consequently not suitable for therapy. "And of course, it's not portable," Gassert adds with a mind to his project. He therefore focuses on simpler techniques such as electroencephalography (EEG) -- and in particular functional near-infrared spectroscopy (fNIRS), the least expensive of these technologies. Gassert is currently engaged in the challenging task of figuring out whether and how fNIRS can be robustly employed. He is working on this together with a group from the University Hospital, who are contributing their experience in clinical application of the technology.

Fundamental insights

Another question that is still not fully understood is how the brain controls limbs that interact with the environment. "Here, robotics is making a valuable contribution to basic research because it is ideally suited for capturing a movement, perturbing it and measuring the reaction," Gassert explains. For example, the robotics experts have developed an exoskeleton that makes it possible to block the knee for 200 milliseconds while walking and extend it by 5 degrees. With the help of sensors, the scientists measure the forces that are involved and use this data to infer how the brain modulates the stiffness of the knee. These findings then flow into applications such as the control of new, active prostheses.

If the researchers succeed in establishing an interaction between the brain and the exoskeleton, the result will be a device that is ideally suited for therapy. If, on the other hand, the deficits are permanent, a robotic device could offer long-term support -- as an alternative to invasive methods, which are also being researched. These for instance envisage implanting electrodes in the brain and triggering stimulators in the muscles. However, as long as stroke patients can expect to experience a reasonable degree of recovery, the robot-assisted therapy will be the obvious choice.

Story Source:

Materials provided by **ETH Zurich**. Original written by Roland Baumann. *Note: Content may be edited for style and length.*

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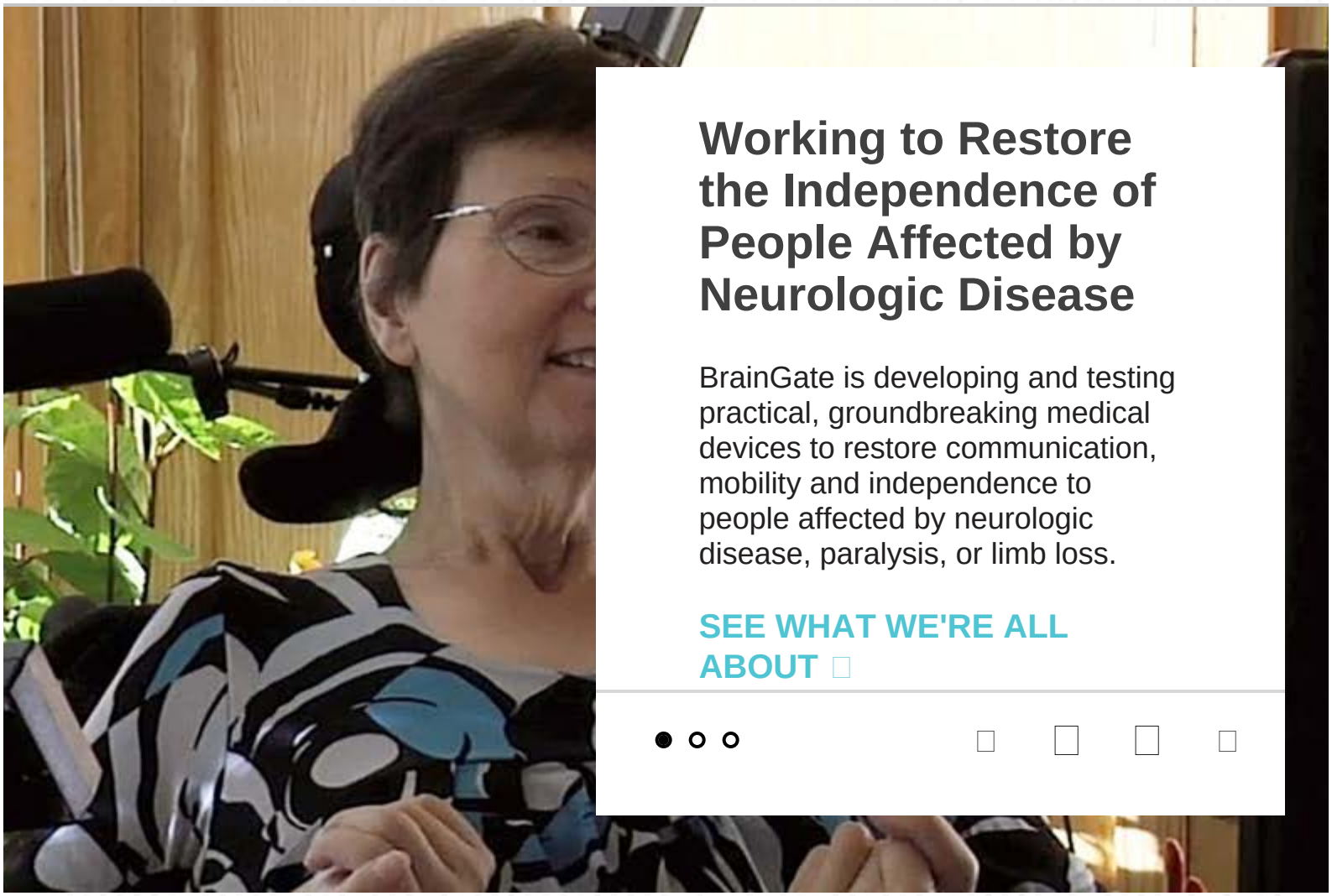

Working to Restore the Independence of People Affected by Neurologic Disease

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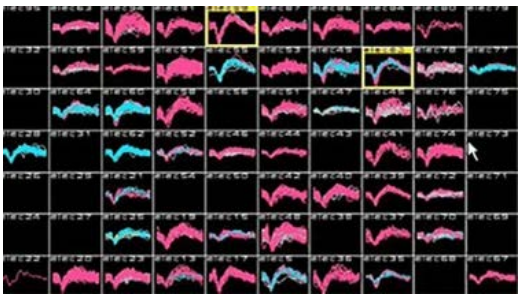

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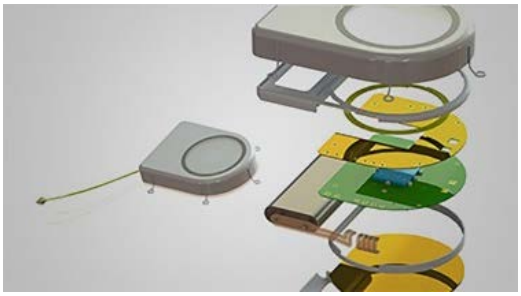
Together with our incredible research participants, harnessing the rare opportunity provided by chronic intracortical recordings to better understand how the human brain works.



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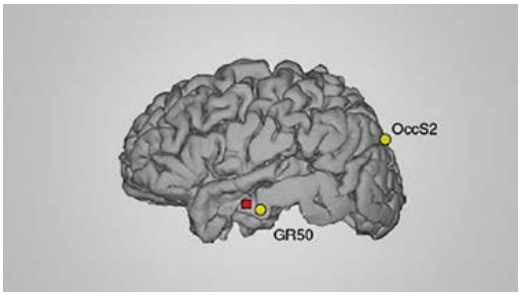

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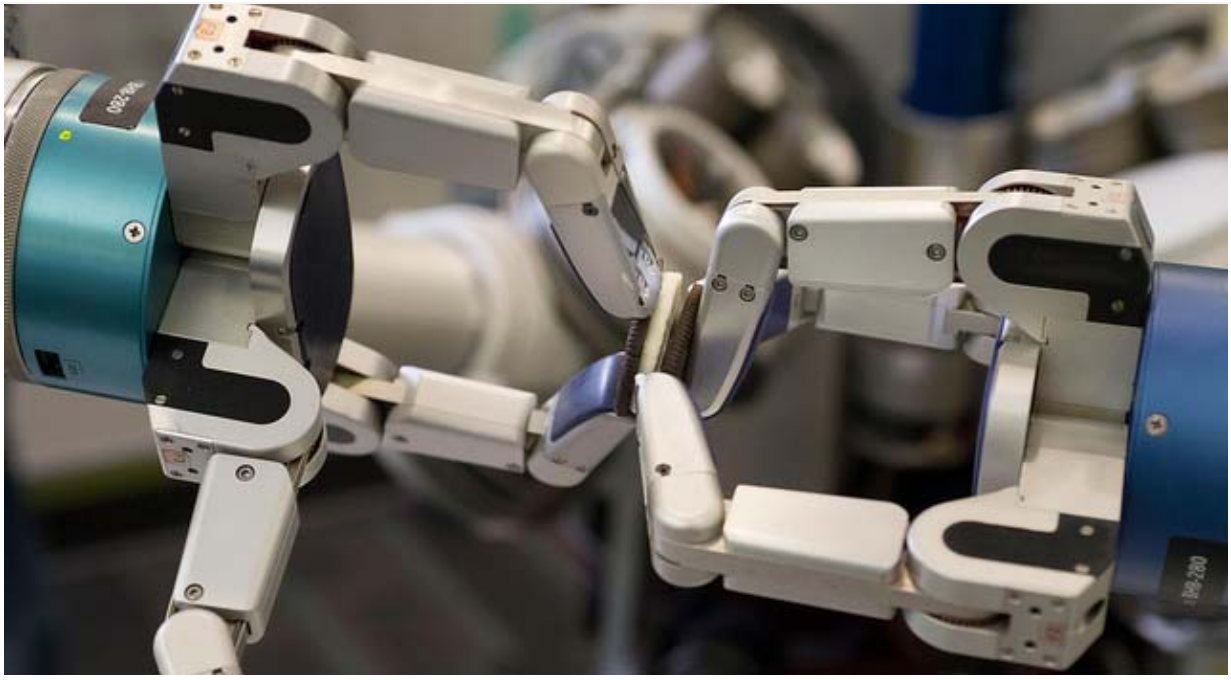


Robots are extremely effective in environments like factory floors that are structured for them, and currently ineffective in environments like our homes that are structured for humans. The Personal Robotics Lab of the Robotics Institute at Carnegie Mellon University is developing the fundamental building blocks of perception, navigation, manipulation, and interaction that will enable robots to perform useful tasks in environments structured for humans

The lab was founded by Professor Siddhartha Srinivasa (http://www.cs.cmu.edu/~siddh/) in 2006 with funding from Intel Pittsburgh (http://www.cmu.edu/corporate/partnerships/intel.shtml) and the Quality of Life Technologies NSF ERC (http://www.qolt.org).

OUR RESEARCH

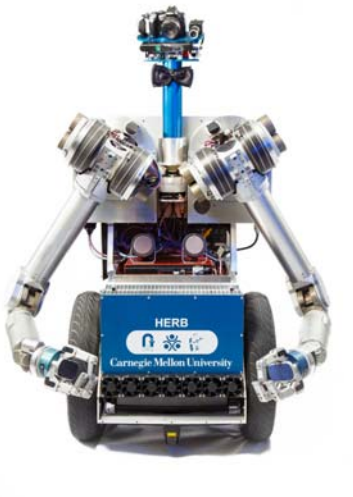
Our current research focus is on two main topics, Physics-based Manipulation (/projects/#manipulation), and the Mathematics of Human-Robot Interaction (/projects/#interaction). They are heavily intertwined, both born out of the goal of robots performing complex manipulation tasks with and around people.

We are also working on Manipulation Planning (/projects/#planning) and Perception for

(http://www.cmu.edu) Manipulation (/projects/#perception), and have a growing interest in expressive and legible (/projects/#interaction) motion.

We are also in the process of publicly publishing several libraries we use internally for planning, perception, and control, and much of our work is open source and available on GitHub (https://github.com/personalrobotics).

HERB



HERB, the Home Exploring Robot Butler, serves as the realistic testbed for all of our algorithms and as a focal point of our industry and academic collaborations. He is a bimanual mobile manipulator comprised of two Barret WAM arms on a Segway base equipped with a suite of image and range senors.

Lately, Herb's taken on quite the life of his own. You can keep up with his exploits on his homepage (http://www.cmu.edu/herb-robot)

CONTACT US

Press

We love to talk about our work, however we receive more requests of this nature than we can handle. Please contact Byron Spice (http://www.cs.cmu.edu/directory/byron-spice) about your request and we'll do our best.

Undergraduates

We're always looking for capable, hardworking undergraduates to join the lab. See the undergrads (/undergrads/) page for information on funding and projects we'd like help with.

F&P Personal Robotics

Personal Service Robotics

P-Rob is designed to serve humans. Its sensitive soft cover not only protects but also increases the positive relation between humans and robots. The ability to cope with different situations and to learn enable the flexible and convenient performance use of the P-Rob in human environments.

Applications



Products

F&P Robotics AG offers complete robotic solutions, combining robot arm, effector technologies and software.

Servant

The characteris[illegible]the P-Rob make him [illegible]al servant of humans. personal appearan[illegible] interactive functio[illegible] immediately brea[illegible]e in catering, health c[illegible] restaurant setting[illegible]b does not make c[illegible] compromises o[illegible] guaranteeing harm free interactions with young, mature and vulnerable people.

Attendant

P-Rob is able to [illegible]b guidance, suppo[illegible] other help in all [illegible] situations. At ev[illegible]ly places, on mobil[illegible] or what ever cor[illegible] The important a[illegible] personal commu[illegible]ed and situatednes[illegible] functions take a[illegible] of sensorics, visi[illegible] context awareness of the robot.

P-Rob

Versatile and safe Robot Arm working alongside humans

The P-Rob is a collaborative robot arm manipulator with 4 to 6 degree of freedom. The soft cover of the robot not only increases safety, but also increases the acceptance among its users.

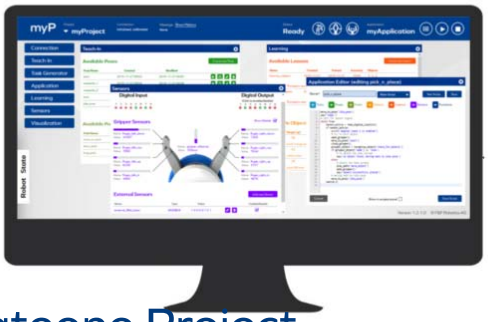
MORE

P-Grip

Gripper for sensitive and safe grasping

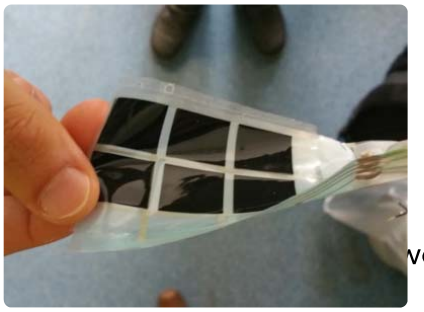
P-Grip is a family of grippers suited to P-Rob. The versatile robotic gripper system for sensitive and safe grasping offers solutions for all kind of manipulations. opening, item lifting and good transportations.

MORE



News

Gateone Project



Together with the research organization CSEM, F&P implemented a gateone-project integrating flexible pressure sensors into the skin of P-Rob.

P-Solution

CONTINUE READING

To generate as much benefit for our clients as possible, F&P and its partners offer a range of services including design, implementation, training and support

Prior to a project we conduct feasibility studies. Existing clients profit from our personal support and tailored trainings.

Posted on Wednesday February 1st, 2017 by Lea Stettler
Posted in Industrial Automation, Media, Service Robotics, Technology

Man's World 2017

From February 2 to February 5 Man's World took place in Zurich Oerlikon. F&P attended the event with P-Rob and a demo corresponding to the topic of the exhibition.

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Posted on Monday January 30th, 2017 by Lea Stettler
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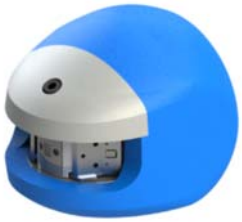
Technical Updates



- French language in panel interface is now available
    - The description of the project specific user dialog is now available in French.

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Posted on Wednesday January 25th, 2017 by Lea Stettler
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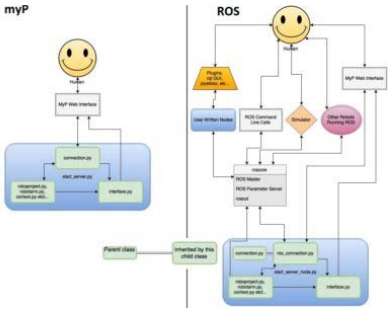
ROS-Package for P-Rob



The ROS Package for P-Rob offers amazing possibilities.

CONTINUE READING

Posted on Wednesday December 7th, 2016 by Lea Stettler
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TO THE NEWSLETTER

Posted on Wednesday December 7th, 2016 by Lea Stettler
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Mind-Controlled Prosthetic Arm Moves Individual ‘Fingers’

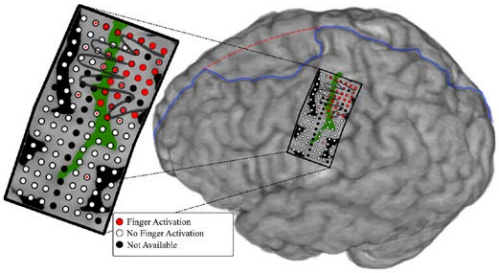
Release Date: February 15, 2016

SHARE FAST FACTS

Mind-controlled “arm” can move individual digits. - Click to Tweet

Mind-controlled prostheses slightly closer to enabling piano playing. - Click to Tweet

Physicians and biomedical engineers from Johns Hopkins report what they believe is the first successful effort to wiggle fingers individually and independently of each other using a mind-controlled artificial “arm” to control the movement.



An illustration showing the electrode array on the subject’s brain, including a representation of what part of the brain controls each finger.

Credit: Guy Hotson

The proof-of-concept feat, described online this week in the *Journal*

FOR THE MEDIA

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of Neural Engineering, represents a potential advance in technologies to restore refined hand function to those who have lost arms to injury or disease, the researchers say. The young man on whom the experiment was performed was not missing an arm or hand, but he was outfitted with a device that essentially took advantage of a brain-mapping procedure to bypass control of his own arm and hand.

“We believe this is the first time a person using a mind-controlled prosthesis has immediately performed individual digit movements without extensive training,” says senior author Nathan Crone, M.D., professor of neurology at the Johns Hopkins University School of Medicine. “This technology goes beyond available prostheses, in which the artificial digits, or fingers, moved as a single unit to make a grabbing motion, like one used to grip a tennis ball.

For the experiment, the research team recruited a young man with epilepsy already scheduled to undergo brain mapping at The Johns Hopkins Hospital’s Epilepsy Monitoring Unit to pinpoint the origin of his seizures.

While brain recordings were made using electrodes surgically implanted for clinical reasons, the signals also control a modular prosthetic limb developed by the Johns Hopkins University Applied Physics Laboratory.

Prior to connecting the prosthesis, the researchers mapped and tracked the specific parts of the subject’s brain responsible for moving each finger, then programmed the prosthesis to move the corresponding finger.

First, the patient’s neurosurgeon placed an array of 128 electrode sensors — all on a single rectangular sheet of film the size of a credit card — on the part of the man’s brain that normally controls hand and arm movements. Each sensor measured a circle of brain

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tissue 1 millimeter in diameter.

The computer program the Johns Hopkins team developed had the man move individual fingers on command and recorded which parts of the brain the “lit up” when each sensor detected an electric signal.

In addition to collecting data on the parts of brain involved in motor movement, the researchers measured electrical brain activity involved in tactile sensation. To do this, the subject was outfitted with a glove with small, vibrating buzzers in the fingertips, which went off individually in each finger. The researchers measured the resulting electrical activity in the brain for each finger connection.

After the motor and sensory data were collected, the researchers programmed the prosthetic arm to move corresponding fingers based on which part of the brain was active. The researchers turned on the prosthetic arm, which was wired to the patient through the brain electrodes, and asked the subject to “think” about individually moving thumb, index, middle, ring and pinkie fingers. The electrical activity generated in the brain moved the fingers.

“The electrodes used to measure brain activity in this study gave us better resolution of a large region of cortex than anything we’ve used before and allowed for more precise spatial mapping in the brain,” says Guy Hotson, graduate student and lead author of the study. “This precision is what allowed us to separate the control of individual fingers.”

Initially, the mind-controlled limb had an accuracy of 76 percent. Once the researchers coupled the ring and pinkie fingers together, the accuracy increased to 88 percent.

“The part of the brain that controls the pinkie and ring fingers overlaps, and most people move the two fingers together,” says Crone. “It makes sense that coupling these two fingers improved the accuracy.”

The researchers note there was no pre-training required for the subject to gain this level of control, and the entire experiment took less than two hours.

Crone cautions that application of this technology to those actually missing limbs is still some years off and will be costly, requiring extensive mapping and computer programming. According to the Amputee Coalition, over 100,000 people living in the U.S. have amputated hands or arms, and most could potentially benefit from such technology.

Additional authors on the study include David McMullen, Matthew Fifer, William Anderson and Nitish Thakor of Johns Hopkins Medicine and Matthew Johannes, Kapil Katyal, Matthew Para, Robert Armiger and Brock Wester of the Johns Hopkins Applied Physics Laboratory.

This study was funded by the National Institute of Neurological Disorders and Stroke (grant number 1R01NS088606-01).

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OUSSAMA KHATIB

PROFESSOR, DEPARTMENT OF COMPUTER SCIENCE
DIRECTOR OF STANFORD ROBOTICS LAB

Research Interests

Methodologies and technologies of autonomous robots, cooperative robots, human-centered robotics, haptic interaction, dynamic simulation, virtual environments, augmented teleoperation, and human-friendly robot design.

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We are excited to announce the launch of the first underwater robot capable of bimanual dextrous manipulation.

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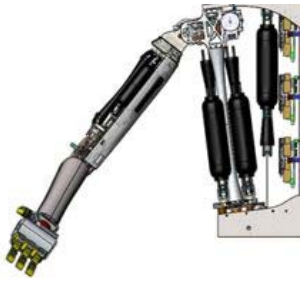

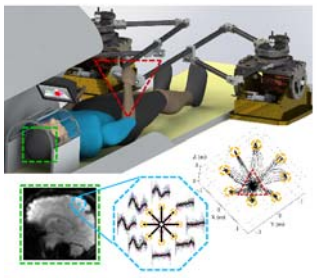

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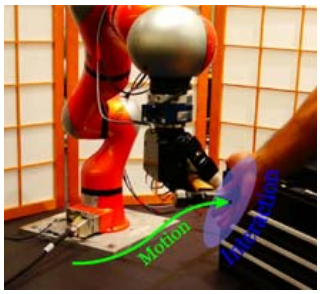

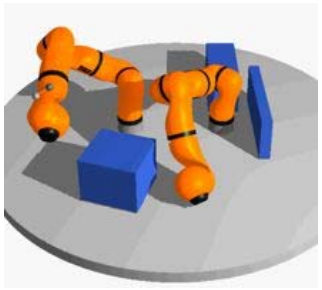

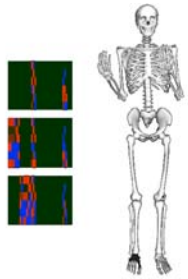

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Össur Introduces First Mind-Controlled Bionic Prosthetic Lower Limbs for Amputees (/corporate/about-ossur/ossur-news/1246-ossur-introduces-first-mind-controlled-bionic-prosthetic-lower-limbs-for-amputees)

Össur Technology Adapts To User's Subconscious, Intuitive Actions

Two amputees are the first people in the world able to control their Bionic prosthetic legs with their thoughts, thanks to tiny implanted myoelectric sensors (IMES) that have been surgically placed in their residual muscle tissue. The IMES, which was provided by the Alfred Mann Foundation, instantaneously triggers the desired movement, via a receiver located inside the prosthesis. This process occurs subconsciously, continuously and in real-time.

The announcement was made today by Jon Sigurdsson, President & CEO of Össur, the global innovator credited with creating the world's first Bionic prostheses for amputees.

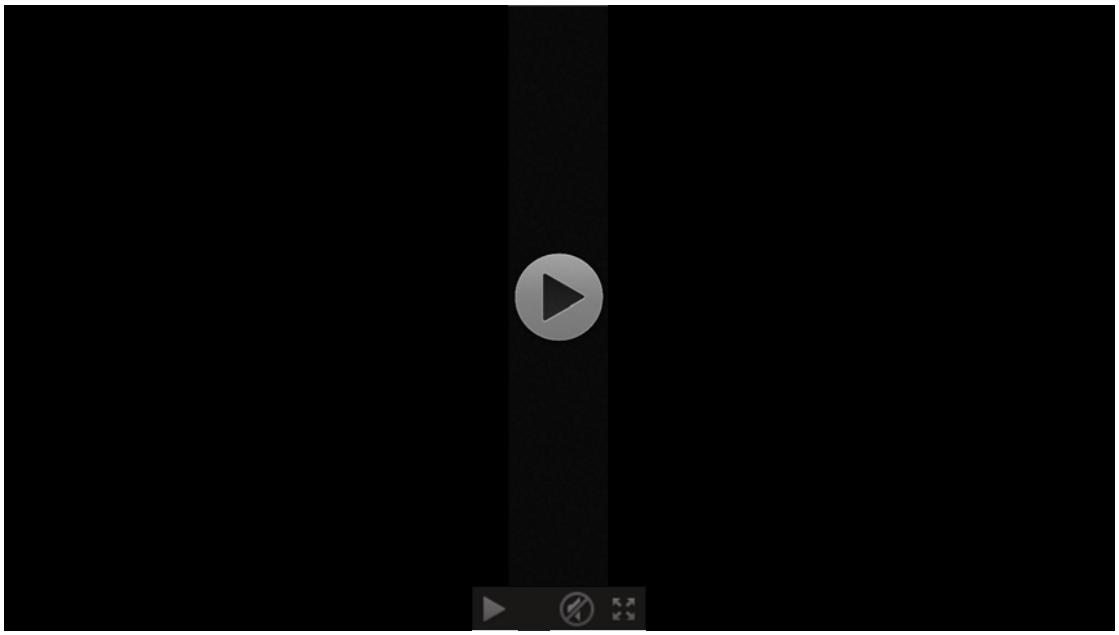
"Mind-controlled Bionic prosthetic legs are a remarkable clinical breakthrough in next-generation Bionic technology," Sigurdsson said, speaking at the company's Capital Markets Day in Copenhagen. "By adapting not only to the individual's intentional movements but to intuitive actions, we are closer than ever to creating prosthetics that are truly integrated with their user."

How Mind-Controlled Bionic Prosthetics Work

Össur's commercially available Bionic prostheses are smart limbs capable of real-time learning and automatically adjusting to their user's walking style (gait), speed and terrain. Walking with a Bionic prosthesis, however, still typically requires some conscious, intentional thought from the user.

According to Dr. Thorvaldur Ingvarsson, M.D., Ph.D, the orthopaedic surgeon who leads Össur's research and development efforts and spearheaded the mind-controlled prosthetics project, movement in able-bodied individuals generally begins subconsciously, which triggers electrical impulses inside the body that catalyze the appropriate muscles into action. Össur's new technology replicates that process in an amputee: that electronic impulse from the brain is received by an IMES that was surgically placed by Dr. Ingvarsson into muscles in the amputee's residual limb.

"The technology allows the user's experience with their prosthesis to become more intuitive and integrative," Dr. Ingvarsson said. "The result is the instantaneous physical movement of the prosthesis however the amputee intended. They no longer need to think about their movements because their unconscious reflexes are automatically converted into myoelectric impulses that control their Bionic prosthesis."



Promising First-In-Man Results

According to Dr. Ingvarsson, the mind-controlled technology works with all current commercially available Össur Bionic prostheses, including the company's POWER KNEE (/power-knee), RHEO KNEE (/rheoknee), PROPRIO FOOT (/proprio-foot) and SYMBIONIC LEG (/symbionicleg).

Two amputees have participated in the company's initial First-in-Man research. Both were implanted with the IMES and have been living with Össur's mind-controlled Bionic prostheses for more than one year. Dr. Ingvarsson notes that feedback from both users has been very positive, and that clinical trials to further assess the technology will continue.

"As a global leader in prosthetics and orthopaedics, we at Össur never stop innovating. We are resolute in our commitment to expand the boundaries of possibility, so that we may help even more people enjoy a life without limitations," Sigurdsson concluded.

About Össur

Össur (NASDAQ: OSSR) is a global leader in non-invasive orthopaedics that help people live a life without limitations. Its business is focused on improving people's mobility through the delivery of innovative technologies within the fields of Prosthetic, Osteoarthritis and Injury Solutions.

A recognized "Technology Pioneer," Össur invests significantly in research and product development—its award-winning designs ensuring a consistently strong position in the market. Successful patient and clinical outcomes are further empowered via Össur's educational programs and business solutions. Headquartered in Iceland, Össur has major operations in the Americas, Europe and Asia, with additional distributors worldwide. www.ossur.com

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03/02/2017 - **CROSSING OF LAKE BAÏKAL : A REMARKABLE ADVENTURE OF BLIND PEOPLE**

With the objective to raise awareness about blind people and their abilities, a guided adventure, with the aim to cross the Siberian Lake Baïkal in winter, will be followed by RFI and scientific researchers from February 24th to March 2nd, 2017.

03/02/2017 - **CAPITAL: THESE 21 INNOVATIONS WHICH WILL PUSH THE FUTURE OF MEDICINE**

Surgery revolution, nano-robotic growth, new bio-therapies, visual prosthesis... There have never been so many promises for improved treatments.

24/11/2016 - **TV SUD NÎMES : FIRST IMPLANT OF A NEW GENERATION RETINAL PROSTHESIS**

A new generation of retinal prosthesis was implanted for the first time at the University Hospital of Nimes. The principle of this implant is simple: a camera, integrated in glasses, will transform the image into electrical stimulation.

08/11/2016 - **EVENING STANDARD LONDON : BLIND MAN RECOVERS SOME SIGHT AFTER GETTING 'BIONIC EYE' FROM MOORFIELDS LONDON SURGEONS**

He is the first in the UK to benefit from a trial of a pioneering system at Moorfields Eye Hospital.
The patient, 73, has retinitis pigmentosa, the most common cause of inherited blindness ? affecting 1.5 million people worldwide. He has been blind for more than 20 years....

05/10/2016 - **RETINA TODAY : RESTORING VISUAL FUNCTION WITH A BIONIC RETINAL IMPLANT: MISSION IM?POSSIBLE?**

"Artificial bionic vision technology offers promising results, but postimplantation re-education and training are needed to provide more meaningful visual perception. Hope

and expectations remain high on the frontier of neuroscience and neuroophthalmology, interfacing the worlds of the eye and the brain."

18/09/2016 - **RACONTEUR - DEVELOPMENTS IN RETINAL IMPLANTS GIVE HOPE TO THOSE WITH SIGHT LOSS**

Clinical trials are underway in the UK for a new ?bionic? vision system with the potential to restore vision in patients with sight loss. Following approval from the Medicines and Healthcare products Regulatory Agency, clinical trials of the Iris II have now begun at Moorfields Eye Hospital NHS Trust in London as part of a multi-centric European study to assess its safety and performance.

18/09/2016 - **BIONIC VISION WILL CHANGE CONCEPTS OF SIGHT**

Technological innovations are revolutionising eyecare and giving hope to millions with lost or impaired sight.
The second Moorfields project is part of a European multi-centre trial with the IRIS Bionic Vision System that uses a special camera, processor pack and a retinal implant to bypass the photo processors that atrophy in a range of conditions.

16/09/2016 - **CHALLENGES - EXOSKELETON, ARTIFICIAL RETINA, BIOACTIVE GLASS: FRENCH TEN TECHNOLOGIES THAT HAVE THE AMBITION TO CHANGE THE LIVES OF PATIENTS**

Last week, the meetings on Medical Progress organized by Snitem had the opportunity to provide an overview of the "medical device" companies. In this very diverse industry, ranging from bandage to resuscitation equipment through to prosthesis, Challenges selected 10 disruptive technologies, already marketed or about to be. ... All these projects demonstrate a creativity and remarkable scientific excellence.

02/08/2016 - **FOUNDATION FIGHTING BLINDNESS EYE ON THE CURE : PIXIUM VISION REPORTS PROGRESS IN DEVELOPMENT OF TWO BIONIC RETINA SYSTEMS**

While several companies and laboratories around the world are at various stages of bionic-retina development, Pixium Vision located in France, is progressing impressively down two paths ...

28/07/2016 - **TV FINANCE : PIXIUM VISION - IRIS II IS NOW APPROVED FOR RETINITIS PIGMENTOSA AND TOMORROW, PRIMA FOR AMD**

Pierre Kemula CFO of Pixium Vision, commented on market approval of the product IRIS II in the European Union to patients with retinitis pigmentosa and upcoming projects especially concerning future product of Pixium, PRIMA, for macular degeneration. Pierre Kemula CFO Pixium Vision, was the guest of Lucie Morlot on Direct Markets.

26/07/2016 - **BIONIC EYE FROM PIXIUM VISION TO BE COMMERCIALIZED SHORTLY IN EUROPE**

Designed by the French company Pixium Vision, the bionic eye IRIS II allows blind patients with retinal degeneration, to regain form of vision. The company had succeeded with its first implant in a 58 yrs old patient. Following the progress, Pixium vision has received CE Mark to market its bionic eye in Europe. - With Bernard Gilly, President Pixium Vision. - Good Morning Business Tuesday, July 26, 2016, presented by Stéphane Soumier on BFM Business

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25/07/2016 - **PIXIUM VISION ANNOUNCES CE MARKET APPROVAL OF IRIS®II**

Good news for Pixium Vision, a company developing innovative bionic vision systems to enable patients with vision loss to live more independently. It has obtained the CE mark for its bionic vision system IRIS®II, for blind people suffering from retinal degeneration. This approval is an important step allowing Pixium Vision to start commercialising the bionic vision system Iris II in Europe. - With: Pierre Kemula CFO Pixium Vision. Bourse Integrale, Monday, July 25, 2016, presented by Gregory Favet on BFM Business.

07/07/2016 - **EE TIMES EUROPE : FROM IMPLANTABLE RETINAL PIXELS TO VISUAL CORTEX STIMULATION**

French Startup Pixium Vision is moving fast in the field of vision restauration. The company is not only developing two distinct retinal-implant technologies to circumvent retinal degenerative diseases, it also hopes to be able one day to feed visual stimulation (from its proprietary bioinspired neuromorphic imaging sensor) directly to the visual cortex.

09/06/2016 - **OPTOMETRY TODAY : MOORFIELDS EYE HOSPITAL LONDON IS PART OF AN INTERNATIONAL TRIAL FOR AN ADAPTABLE BIONIC RETINAL IMPLANT SYSTEM**

A Moorfields Eye Hospital surgeon believes that we now have the technology to replace the eye's degenerated photoreceptors with a new, modifiable bionic eye..... he described the IRIS II - which comprises an epi-retinal 150 electrodes implant and a "bio-inspired" camera - as a "second generation" system

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08/06/2016 - **MEDGADGET : UK REGULATORY AUTHORITY GRANTS CLINICAL TRIAL APPROVAL FOR PIXIUM VISION'S BIONIC VISION SYSTEM**

The UK regulatory authority, Medicines & Healthcare products Regulatory Agency (MHRA), has granted clinical trial approval for Pixium Vision?s 150 Electrode IRIS II bionic vision system.

27/05/2016 - **FRANCE 24 TECH 24 : TREATING BLINDNESS WITH BIONIC EYES**

Getting over your greatest fears with virtual reality, using a connected glove to translate sign language and treating blindness with bionic eyes... In this show, we explore the different ways in which technology is helping us heal our senses.

04/05/2016 - **BIONIC VISION OF THIS MEDTECH TO TACKLE AMD**

New evidence of the effectiveness of the technology being developed by the French medtech to offset the loss of central vision caused by AMD were presented at a major conference ARVO 2016 in the United States.

31/03/2016 - **"BLINDNESS IS NO LONGER INEVITABLE"**

INTERVIEW - Professor José-Alain Sahel, Director of the Vision Institute, a pioneer in the field of retinal implants, returns to the spectacular advances that now allow to save or

provide form of visual perception to millions of people.

29/03/2016 - **FRANCE CULTURE WITH RENÉ FRYDMAN : SEE WITH YOUR EYES CLOSED - ADVANCES IN ARTIFICIAL RETINA**

Professor José Sahel, specialist in regenerative therapies for the eye, Director of the Vision Institute, will discuss in the program, what can be expected from the "bionic eye" or "artificial retina". Since many years the research teams have been trying to limit the loss of photo receptors from diseases such as retinitis pigmentosa or macular degeneration. Importantly, the implants are improving, they are placed on or below the surface of the retina, with increasing number of electrodes : is the exit from the tunnel near?

25/02/2016 - **PIXIUM VISION DEVELOPPING IRIS®II BIONIC VISION SYSTEM - 25/02**

Pixium Vision develops innovative bionic vision systems to artificially stimulate the degenerated retina inducing a form of vision. With 150 electrodes, this retinal implant is intended for patients who have become blind due to degenerative disorders of the eye, such as retinitis pigmentosa.

25/02/2016 - **AN IMPLANT IRIS®II ALLOWS THE BLIND TO PERCEIVE LIGHT SIGNALS AGAIN : BFM BUSINESS**

It is an outstanding technological and medical achievement. A French company, Pixium Vision, specialized in bionic vision systems, has developed a bionic eye that can restore partially sight to some people who have lost their sight.

18/01/2016 - **EDISON RESEARCH : PIXIUM VISION FILES FOR CE MARK FOR IRIS®II AND ANNOUNCES SAFETY DATA FOR PRIMA**

Introducing the second-generation implant

01/01/2016 - **PIXIUM WILL DELIVER VISION EN 2016**

The French company specialized in vision restoration could market its system for the blind in the second half of 2016.

10/12/2015 - **THE BIONIC EYE, A HOPE FOR MILLIONS OF BLIND AND VISUALLY IMPAIRED -**

WE DEMAIN

Blindness is not without treatment! With the development of bionic eyes that have already allowed patients to partially recover form of sight.

26/11/2015 - **HOW NEUROMORPHIC IMAGE SENSORS STEAL TRICKS FROM THE HUMAN EYE**

By prioritizing the dynamic parts of a scene, machines can capture images more efficiently. Inspired by the biology of the eye and brain, we began developing imagers containing arrays of independently operating pixel sensors ... natural application of neuromorphic vision sensors is in electronic retinal implants for restoring sight to those whose vision has been lost to disease.

25/10/2015 - **THE BIONIC EYE THAT GIVES FORM OF SIGHT TO THE BLIND - LE JOURNAL DU DIMANCHE**

A French company is developing since 2011, a technology for visual restoration for certain serious ophthalmic pathologies. The first generation of Pixium implants should be marketed next year.

17/10/2015 - **PIXIUM VISION IS DEVELOPING VISION RESTORATION SYSTEM - YOUR HEALTH, PRESENTED BY ALAIN DUCARDONNET**

Pixium Vision was the guest of *"Your health interests me"* on Saturday, October 17, 2015, presented by Alain Ducardonnet on BFM Business.

08/10/2015 - **THE ANTHONY MOREL CHRONICLE: TECHNOLOGY FOR THE BLIND - BFM TV RMC**

Anthony Morel presented several technical innovations improving the lives of blind people. Those who suffer from macular degeneration can partially recover some sight with electronic goggles connected with retinal implants.

06/10/2015 - **DISCOVER THE WINNERS OF THE 2015 EDITION OF THE INNOVATION PRIZE BY UNIVERSAL BIOTECH**

Winners announced from 6 finalists shortlisted from 136 eligible projects issued from the 289 applications representing 34 countries. Selection criteria were based on the scientific quality of the innovation, IP, industrial feasibility and HR quality.

24/09/2015 - **RETINAL IMPLANTS: PAINTING THE FUTURE**

For the 15 M Americans who have been diagnosed with macular degeneration, vision deteriorates slowly from the

center of the eye, out. It?s the leading cause of blindness and there is no cure. Now, a new implant could keep these patients from completely losing their sight. Stanford University's Daniel Palanker, PhD, is developing the first-of-its-kind, minimally invasive, retinal implant that could give sight to people.

25/07/2015 - **WIRELESS SUBRETINAL IMPLANT HOLDS PROMISE FOR THE VISUALLY IMPAIRED : EDN NETWORK TECH EDGE**

The French company's PRIMA subretinal system is based on a tiny silicon implant containing several thousand electrodes that is placed just behind the retina?"the part of the eye containing photoreceptor cells. The honeycomb-shaped wireless device converts light transmitted from special glasses worn by the recipient into electrical current, which stimulates the retina's bipolar cells. According to Pixium, this approach enables a more physiological processing of the visual signal.

17/06/2015 - **FRANCE BIOTECH ANNOUNCES THE SECOND EDITION OF FRENCH BIOTECH DAYS NEW YORK**

10/06/2015 - **THE SHARPER IMAGE : THE OPHTHALMOLOGIST**

Photovoltaic pixels could help create a wireless retinal prosthesis with a much better spatial resolution than current offerings : The Ophthalmologist

28/04/2015 - **TINY IMPLANTABLE SOLAR PANELS COULD HELP THE BLIND SEE ONE DAY : FUSION NET**

Inside your eye are tiny retinal cells whose job is to translate the visual signals you encounter every day - colors and edges - into signals your brain can understand. Without these photoreceptors, you can't see. And retinal degeneration, in which these receptors start to die off, is one of the leading causes of blindness. But one group of scientists may be nearing a solution. In a paper published in the journal Nature Medicine this week, researchers describe a tiny, honeycomb-shaped wireless implant that helps restore vision in rats with retinal degeneration.

28/04/2015 - **A NEW BIONIC EYE: INFRARED**

LIGHT-POWERED RETINA IMPLANT COMING

At the IEEE Neural Engineering meeting in Montpellier, France last week, researchers described their progress toward this goal. In one talk, a Stanford scientist described a clever visual prosthetic that?s photovoltaic.... to be commercialized by the French company Pixium Vision, with clinical trials scheduled for 2016.

23/04/2015 - **BIONIC RETINA, HOW TO GIVE HOPE TO THE BLIND**

HIGH-TECH

New implant system allows some blind to distinguish light again. Some patients have benefited from these artificial bionic retinas. Meeting with one of these people who are in clinical testing at the Vision Institute in Paris.

07/04/2015 - **THE ERA OF IMPROVED HUMAN BODY HAS BEGUN**

The technology allows to overcome the shortcomings of the body. The transhumanists dream has never been so real. Ophthalmology is also undergoing a profound revolution.

04/03/2015 - **THE ARTIFICIAL RETINA ON THE VERGE OF BECOMING REAL**

Blindness caused by retinitis pigmentosa and AMD will soon not be inevitable. Thanks to the IRIS system developed by Pixium Vision, patients could benefit from partial restoration of vision. Presented at the 1st Vision Innovation conference, the technology should be released by the end of 2015?..

21/02/2015 - **THE ECONOMIST: TREATING BLINDNESS - BIONIC EYES**

The Economist : Treating Blindness - Bionic Eyes A new device may restore vision to those whose sight is dwindling

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13/02/2015 - **SAN JOSE MERCURY NEWS: BIONIC EYES OFFERING BETTER SIGHT TO BLIND**

San Jose Mercury News: American Association for the Advancement of Science AAAS 2015 conference in San Jose - **Bionic eyes offering better sight to blind**

07/12/2014 - **BLOOMBERG TV - BIONIC EYES: A LOOK INTO THE FUTURE**

What if the blind could see again - A look at Pixium Vision's vision restoration system.

Bloomberg

02/11/2014 - **THIS WEEK'S TALENT PIXIUM VISION - EUROPE1**

The show presents Pixium Vision, private company composed of researchers and entrepreneurs, developing systems aimed at regaining vision for people who lost it.

30/10/2014 - **« BIONIC EYE PRESENTED IN MARSEILLE » - LA PROVENCE.COM**

The visual restoration system developed by Pixium Vision has been presented at the 4th Eurobiomed-Ophtabiotech convention in Marseille.

29/10/2014 - **MY DREAM, SEE MY GRANDCHILDREN - LE PARISIEN**

Article and video presenting Jean who has been using Pixium Vision's visual restoration system. He explains what he can see and how he reeducate his vision.

03/10/2014 - **WHAT IF THE BLIND COULD SEE AGAIN - OUEST FRANCE**

The system developed by PIxium Vision allows people who lost sight to regain a visual perception of their environment: patients testify.

31/08/2014 - **IMPLANTS IN SIGHT - LIBÉRATION**

Article on technologies developed around neuro-implants, notably the IRIS and PRIMA systems developed by Pixium Vision among the most recent in the area.

11/08/2014 - **TOWARD GRAPHENE BASED BIONIC VISION - THE TECHNOLOGIST**

European physicists team up with a leading company to develop an artificial retina based on the remarkable properties of graphene. Retina implants could help restore vision in people suffering degenerative eye disease

09/07/2014 - **INNOVATION : A FRENCH ASSET FOR**

OUR HEALTH ~ MARISOL TOURAINE

France is at the forefront in the field of innovation for healthcare. An opportunity to seize : in addition to the therapeutic gain for patients, it also strengthens the competitiveness in our country and stimulates economic growth.
- Marisol Touraine is the minister of social affaires, health and women's rights

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24/06/2014 - RETINAL IMPLANT COULD RESTORE FUNCTIONAL SIGHT : MEDICAL DESIGN TECHNOLOGY

A team led by Stanford University researchers has developed a tiny wireless retinal implant. A paper describing the implant was published online April 27 in Nature Medicine.
Results in rat studies suggest it could provide functional vision to patients with retinal degenerative diseases, such as retinitis pigmentosa or macular degeneration.

24/06/2014 - THE RETINAL IMPLANT REVOLUTION IN VISION- LES ECHOS

Just as the French company Pixium Vision, publicly traded for one week, several start-ups rely on electronic implants to restore sight to the visually impaired.

22/06/2014 - BERNARD GILLY, PRESIDENT OF PIXIUM VISION : THE TECHNOLOGY HAS EVOLVED ENOUGH - LA BOURSE ET LA VIE

Bernard Gilly, President of Pixium Vision is invited to La Bourse et la Vie to talk about business strategy and perspectives, following the success of the IPO.

19/06/2014 - PIXIUM: SUCCESSFUL IPO - LE REVENU

19/06/2014 - The price of the IPO was set at the lower end of the bracket. However, demand has been strong and opens the possibility for society to exercise its over-allotment option.

18/06/2014 - INTÉGRALE BOURSE : TODAY'S COMPANY PROFILE » - BFM BUSINESS

18/06/2014 - Invited on BFM Business on the day Pixium Vision is listed on Euronext, Bernard Gilly, Pixium Vision's CEO, presented the technology behind the firm's visual restoration systems.

13/06/2014 - « AN EYE IMPLANT TO REGAIN SIGHT » - LA TRIBUNE

13/06/2014 - More details on Pixium Vision's strategy and

IRIS' functioning (article in French)

13/06/2014 - **« INTERVIEW WITH BERNARD GILLY, CEO OF PIXIUM VISION » - BOURSIER.COM**

13/06/2014 - Bernard Gilly comments on the Pixium Vision?s products and tells more on the on-going IPO (article in French)

07/06/2014 - **GIVE VISION BACK TO BLIND PEOPLE - INVESTIR**

07/06/2014 - The article describes the system developed by Pixium Vision meant to answer blind patients who lost sight and for whom no treatment exist. The journalist makes a buy recommendation.

06/06/2014 - **FRANCE INFO - IPO PIXIUM VISION**

06/06/2014 - Radio interview with Bernard Gilly presenting Pixium Vision's public offering on Euronext Paris.

03/06/2014 - **LE REVENU TV - «PIXIUM, A PIONEER IN VISUAL RESTORATION, GOES PUBLIC»**

03/06/2014 - Bernard Gilly is interviewed to present Pixium Vision's visual restauration systems - technology and details the company's ambition through its public listing.

19/05/2014 - **BFM BUSINESS - GOOD MORNING BUSINESS**

19/05/2014 - StÃ©phane Soumier speaks to Pixium Vision's Executive Chairman Bernard Gilly about the technology developed by Pixium Vision to enable patients who have lost their sight to regain vision and lead more independent lives. This has been made possible thanks to advances in neuromodulation technologies.

09/05/2014 - **FRANCE INFO - AN IMPLANT GIVES SIGHT BACK TO SOME BLIND PEOPLE, A 'MIRACLE'**

09/05/2014 - The implant developed by Pixium Vision has been presented in the show le Plus France Info presented by Bruno Rougier. It includes the testimony of Barbara, a patient participating in clinical trials, who describes this innovation as

miraculous.

03/05/2014 - **LE MONDE - PIXIUM GIVES VISION BACK TO BLIND PEOPLE**

03/05/2014 - The article paints a portrait of Pixium Vision and describes its IRIS technology as well as its intentions to continue its innovation in the retinal implant space. The article also highlights the global need for new technology solutions for restoring sight and follows the progress of a blind patient undergoing rehabilitation following surgery to receive the IRIS implant.

16/04/2014 - **TFI NEWS: PROGRESS IN THE FIGHT AGAINST BLINDNESS**

A team of French doctors successfully implanted retinal implant systems, a significant advance towards vision restoration. The feature story reports the testimony of a patient, implanted 6 months ago and having lost sight 20 years ago, demonstrates her ability to seize objects. Bernard Gilly (Executive Chairman of Pixium Vison), Dr. Yannick Le Mer (eye surgeon) and Prof. José-Alain Sahel (Director of the Institut de la Vision) detail how such progress has been made possible.

15/04/2014 - **FUTUREMAG: AN ARTIFICIAL RETINA FOR BLIND PEOPLE**

The Institut de la Vision in Paris has achieved a major technological breakthrough in the treatment of blindness with the ?artificial retina?, an implant that enables the partial restoration of lost vision. Following a surgical operation and 18 months of rehabilitation, the patient will at last be able to see the light again.

14/04/2014 - **LE QUOTIDIEN DU MÉDECIN - THE HOPE OF ELECTRONIC RETINAL IMPLANTS**

17/04/2014 - Pixium Vision develops visual restoration systems comprising retinal implants, allowing for the stimulation of neuronal cells, for people with defective photoreceptors. Within l'Institut de la Vision, the company has created two systems allowing the brain to interpret the signals received from the implant. Clinical trials are currently taking place for the first system (IRIS) and will begin in 2015 for the second system (PRIMA).

13/04/2014 - **VIDEO : GIVING SIGHT BACK TO THE BLIND, BERNARD GILLY IN GOOD MORNING BUSINESS - 26/11**

On November 26th, macular degeneration care was the topic discussed with Bernard Gilly, President of Pixium Vision, in Good Morning Business with Stéphane Soumier, of BFM Business.

Twitter @PixiumVision

Loading...

CURRENT PRICE	6.49€
OPENING PRICE	6.30€
PREVIOUS CLOSE	6.23€

Price	Change	%	High	Low
6.49€	0.26€	+4.17%	6.75€	6.30€

15-02-2017 17:35 CET

Pixium Vision shares are eligible for the French tax incentivized PEA-PME and FCPI investment vehicles. Pixium Vision shares are eligible for the French tax incentivized PEA-PME and FCPI investment vehicles.

COMPANY

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TECHNOLOGY

Technology
Bionic VRS Technology
Smart Bioinspired Neuromorphic (Event-Based) Camera
IRIS® Bionic Vision Restoration System
PRIMA Bionic Vision Restoration System

PATIENTS

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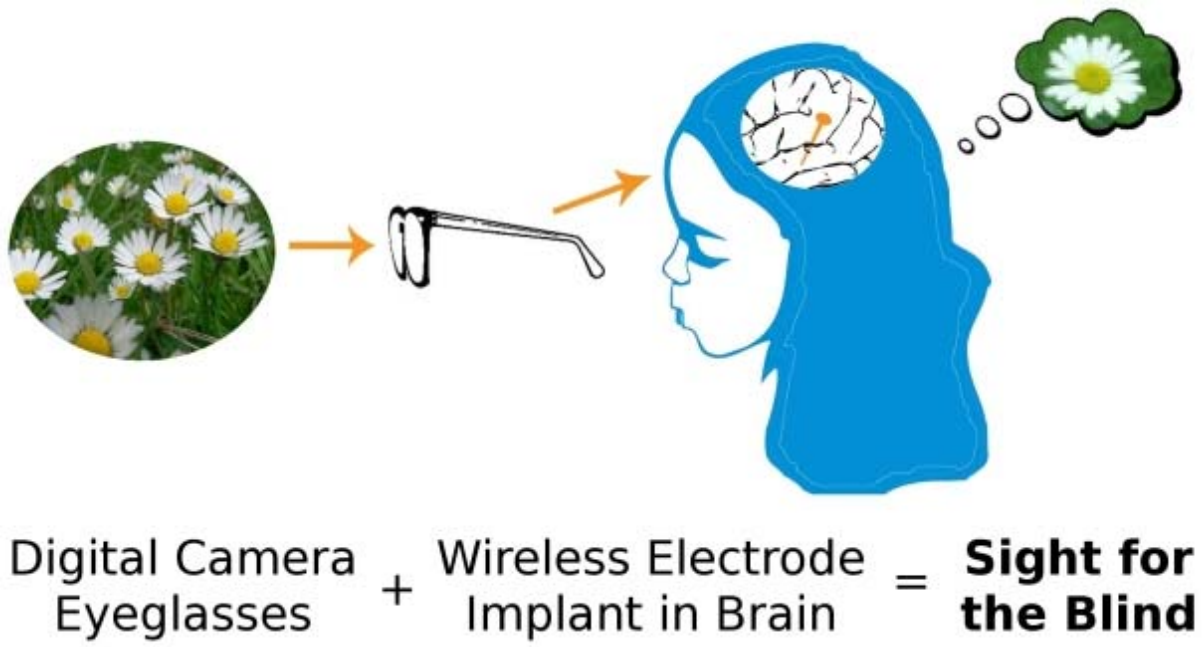


Restoring Sight to the Blind

info@sight2blind.org

Welcome to the home page of the Thalamic Visual Prosthesis Project.

¤ **Support our work.** We rely on donations from individuals and foundations to support our important research to restore sight to the blind. If you are interested in making a tax-deductible gift, visit https://giving.massgeneral.org/donate/pezaris-lab. *Any amount helps*. Please inquire with your employer's HR department if they match charitable donations. And thank you.

¤ The fundamental idea we are pursuing is to provide restoration of sight to the blind. We hope to accomplish this by implanting multi-wire electrodes in the lateral geniculate nucleus (LGN), the part of the thalamus that relays signals from the retina in the eye to the primary visual cortex at the rear of the head. In leading causes of blindness, the eye ceases working as a light-sensitive organ, but the remainder of the visual system is largely intact. By sending signals from an external man-made sensor such as a digital camera into the brain through carefully implanted electrodes in the LGN, we hope to provide a crude approximation to normal vision and restoration of sight to the blind.

It is important to understand that we do not anticipate restoring vision that is in any way

close to normal. Our best guess is that a visual prosthesis will provide the patient with an improvement in their quality of life, being able to navigate more easily through familiar and perhaps unfamiliar surroundings. We hope that it will allow the patient to distinguish and identify simple objects, perhaps even help recognize people. But, it is important to understand that these hopes are some time to come. There is a tremendous amount of work to be done before we have even the crudest initial experimental device temporarily implanted in a human.

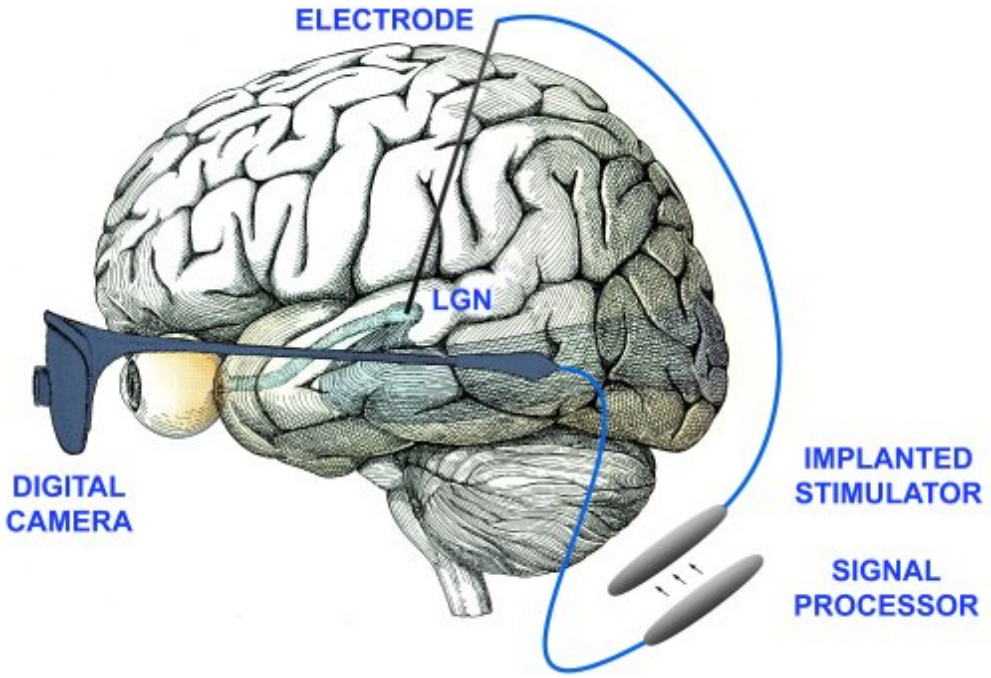
¤ We have published a scientific paper describing our first high-profile results:

J. S. Pezaris and R. C. Reid, "Demonstration of artificial visual percepts generated through thalamic microstimulation," *Proceedings of the National Academy of Science*, 104(18):7670-7675, May 1, 2007 [PDF]

¤ Here are a few selected examples of the press coverage on the paper:

The Economist
BBC
Neurophilosophy
The New Scientist
Associated Press (NYT)
Technoglogy Review

¤ The following illustration depicts a schematized version of an initial device and shows the basic elements of the design.



This cartoon diagram shows how a visual prosthesis might work someday. The

patient would wear a special set of glasses with a small digital camera mounted in the lens. The camera would have a wire that communicates to an external signal processor, worn in a pocket or on a belt. The signal processor would translate the image from the camera into the neural impulses and transmit them wirelessly to an implanted stimulator. The stimulator would drive the electrode, surgically placed in the brain, delivering images to the visual system. We expect the actual surgery to be comparatively minor, as it is based on the well-developed methods of Deep Brain Stimulation already used extensively to treat Parkinson's tremor.

Credit: J. S. Pezaris, adapted with permission from D. H. Hubel.

¤ The first of two small movies accompanying the article and press coverage helps understand what the animals are doing in this experiment.

This animation combines the animal's eye position, what it sees on the screen normally, and a simulation of the artificial percept. As part of the experiment, the animal's eye position is measured, and we show where it was looking on the computer screen by a blue dot. Targets that appear on the screen are white dots, and the animal has been trained to look at them, from a first one that appears in the center, to a normal second one that appears further away. In some instances the second point is not on the screen, but is created artificially through electrical stimulation. Although there is a yellow star depicting the electrical stimulation in this movie, in the experiment, nothing appeared on the screen in front of the animal. When the second point is artificial, the animal looks down and to the right, just as if it saw one of the normal points. By changing the placement of the electrode, we can change where the percept appears.

Credit: J. S. Pezaris.

¤ The second of the two movies helps us understand what prosthetic vision might appear like to the patient. This could be called an artist's rendition of the experience. There are numerous assumptions that underlay the simulation, many of which are likely incorrect; this movie should serve only as a guide.

On the left is a movie made with a small digital camera. On the right is the same movie, as it would appear to a patient with bilateral implants having 350 pixels per hemisphere. As the simulated patient moves their gaze around, as indicated by the red point, you see the pattern of pixels shifting across the image.

There are two things to notice in this movie. The first is that before the movie begins, the image on the right is not identifiable, but as soon as the animation starts to run, the brain does a marvelous job of integrating different facets of the image and the woman's face becomes clear. The second is that the right image contains about 700 pixels, while the left image contains 70,000; while not all of the fine details are resolvable, a remarkable amount of information can be conveyed in a relatively small number of pixels.

Credit: J. S. Pezaris.

¤ We have published a second scientific paper showing progress on the design parameters of a device:

J. S. Pezaris and R. C. Reid, "Simulations of electrode placement for a thalamic visual prosthesis," *IEEE Transactions on Biomedical Engineering*, 56(1):172-178, 2009 [PDF]

¤ We have published a scientific paper discussing possible modes of bringing signals into the brain, specifically using a thalamic visual prosthesis as an example of the larger field of computer-to-brain interfaces:

J. S. Pezaris and E. E. Eskandar, "Getting signals into the brain: Visual prosthetics through thalamic microstimulation," *Neurosurgical Focus*, 27(1):E6 2009 [PDF]

¤ Recently, there has been an effort to simulate how prosthetic vision will appear to the eventual recipient of an implant by using virtual reality technologies. We developed a simulation and used it to assess the visual acuity that would be available using a suite of different designs:

> B. Bourkiza, M. Vurro, A. Jeffries, and J. S. Pezaris, "Visual Acuity of Simulated Thalamic Visual Prostheses in Normally Sighted Humans," *PLOS ONE*, 10.1371/journal.pone.0073592

¤ Continuing in that line of research, we adapted the simulation so that it could be used to test reading ability. Reading is one of the standard activities of daily living, and lends itself to easy measurement and analysis, as is detailed in our most recent publication:

> M. Vurro, A. M. Crowell, and J. S. Pezaris, "Simulation of thalamic prosthetic vision: reading accuracy, speed, and acuity in sighted humans," *Frontiers in Human Neuroscience*, 10.3389/fnhum.2014.00816

Here is a movie from that study that shows one of our subjects reading the sentence "Ten different kinds / of flowers grow by / the side of the road" out loud using a simulated prosthesis. The subject's eye position is shown by the red circle, but was not visible to them during the experiment. The pattern darts about the screen as the subject looks from word to word. It might seem amazing that they were able to read at all; we have found a large gap between what someone **watching** one of these experiments understands and what the subject **performing** the experiment experiences. The simulated phosphene vision here has many more phosphenes (four thousand) than would be available from the proposed device, but we also tested lower resolution versions. Watch it a few times, and you'll start to see the words better, but keep in mind the person in this example had never used the simulation before.

Credit: J. S. Pezaris.

¤ In preparation for implanting a first-generation prototype in an animal model, we have

been training monkeys to perform the same letter recognition task that we did with humans in the Bourkiza, et al. work above. While monkeys don't understand images of letters the way that humans do, they are very capable of distinguishing arbitrary visual shapes. We use letters as a convenient set of arbitrary shapes because they allow us to directly compare animal results with human results. During the training, we had the animals perform exactly the same task as before, in a simulation of artificial vision. Because monkeys learn this task much more slowly than humans, the training gave us an opportunity to study the learning of the task in very fine detail.

Killian NJ, Vurro M, Keith SB, Kyada M, Pezaris JS, "Perceptual learning in a non-human primate model of artificial vision," *Scientific Reports*, 10.1038/srep36329

¤ Finally, there is a longer video that describes the research, although it is somewhat dated at this point. If the movie does not play, it can be downloaded as a WMV file by clicking here.

Credit: J. S. Pezaris.

The retinal implant provides stimulation to induce visual perception in blind individuals.

Argus® II Retinal Prosthesis System

The Argus® II Retinal Prosthesis System ("Argus II") is also known as the bionic eye or the retinal implant. It is intended to provide electrical stimulation of the retina to induce visual perception in blind individuals. It is indicated for use in patients with severe to profound retinitis pigmentosa. A miniature video camera housed in the patient's glasses captures a scene. The video is sent to a small patient-worn computer (i.e., the video processing unit – VPU) where it is processed and transformed into instructions that are sent back to the glasses via a cable. These instructions are transmitted wirelessly to an antenna in the retinal implant. The signals are then sent to the electrode array, which emits small pulses of electricity. These pulses bypass the damaged photoreceptors and stimulate

the retina's remaining cells, which transmit the visual information along the optic nerve to the brain, creating the perception of patterns of light. Patients learn to interpret these visual patterns with their retinal implant.

The Argus® II Retinal Prosthesis System ("Argus II") is intended to provide electrical stimulation of the retina to induce visual perception in blind individuals.

HUMANITARIAN DEVICE: Authorized by Federal (U.S.) law to provide electrical stimulation of the retina to induce visual perception in blind patients with severe to profound retinitis pigmentosa and bare light or no light perception in both eyes. The effectiveness of this device for this use has not been demonstrated.

Human Limb Regeneration

Making Limb Regeneration For Humans Possible

Scientists Plan Regeneration Of Lost Limbs For Humans

September 14, 2015 By Alexander — 17 Comments

In pioneering new research, the holy grail in regeneration of lost limbs for amputees is coming to fruition. Scientists have now succeed in growing a new rat limb in the laboratory.

They want to refine the technology and attempt to regrow a new arm for a monkey. The goal to eventually use human stem cells to grow new limbs that would be transplanted in humans.

In June 2015, I was reading about a report in the media that regenerative scientists at the Massachusetts General Hospital (MGH) and with Harvard Medical School, had regenerated a rat bio-limb with functional vascular and muscle tissue. Thus researchers adapted an experimental procedure used to develop bio-artificial organs.

It is hoped that eventually the developing technology can regenerate human limbs suitable for transplantation on demand.

Professor Harald Ott is leading this research project and is the director of organ repair and regeneration lab at MGH in Boston. He points out that there is no real good options for replacing lost limbs at the moment.

In America alone, around 185,000 amputations happen each year and over 2 million Americans are living with limb loss.

Prosthetic limb technologies have certainly improved over the decades and especially in the past 10 years but nothing can be a substitute for the real natural limb.

It be great to put things back the way they were before the patient's injuries. Making them whole and complete again. Well now with the advancements of science we can, as we start entering compelling and unknown territory.

Regenerative medicine is very much in its infancy but what is being revealed right now and being developed is highly significant.

No one really knows how regenerative medicine will take

off over the next decade but one thing is for sure that it will be really big and is going to completely change our lives and how we live.

Not least in upgrading and improving the human experience and the quality of our lives, expanding our longevity.

Limb Transplants

In the past 20 years there have been a number of hand transplants from donors.

Also in a recent research project with the US Military, a marine who lost both his arms below the elbow, successfully had a double arm and hand transplant. I am aware that the outcome of this procedure is still a great success with the patient.

These kind of procedures are great achievements in improving the quality of the patient's life.

However, they can expose the patient to a life long treatment with immune-suppressant drug treatments to combat any rejection from the body of the new body part. These treatments can have a damaging effect on the patient's immune system making them vulnerable to viruses and diseases.

Regrowing New Limbs

The research being carried out is an ambitious project involving regeneration of limbs made up of cells from the recipient's own body to grow an arm or leg. This means that it will unlikely be rejected by the patient's immune system.

So far the research has been successful to regrow a rat's arm and now they want to do the same with a monkey's arm. Thus upgrading and attempting the process from the rodent to a

primate.

In fact the scientists have successfully decellularized baboon forearms to clarify the feasibility of the study, therefore taking it to a level that would be required for human patients.

The Procedure

What is know as Progenitor cells are required to regenerate all of the tissues that make up the limb. These can be provided by the patient, however, what has been lacking was a scaffold on which the cells develop into the correct tissues.

The process involves stripping living cells from a donor using a detergent solution. The remaining matrix is then repopulated with the progenitor cells that is appropriate for the specific organ to grow. The same idea is used for growing a limb but is more complex as the primary vasculature and nerve matrix must be preserved.

Once all the cellular materials are removed which takes about a week, what you have left is the cell free matrix that provides the appropriate structure of all the limb's composite tissues.

In other words, the frame work structure that is left, is similar to the shape of a car, but you have blasted everything away except the metal frame.

While a donor limb was used in this process mentioned above, in the future the cells will be taken from the recipient. Therefore, the outcome will be genetically compatible with the patient's body.

So that suitable regeneration could take place, the limb was placed inside a bio-reactor that supplies oxygen, nutrients, along with electrical stimulation. This process took a few weeks for the limb to finish growing.

On testing, scientists stimulated the new grown limb with electricity and observed that the paw would close and open, meaning that the muscles were functional. Researchers then proceeded to attach the limb to the rat under sedation and found that blood circulation developed.

In addition, they tested electrical stimulation after the limb was attach and saw movement of the animals paws.

Nerve Cell Regeneration

Along with the plan to regrow an arm in a monkey, the next step is to ensure that the nerves develop within the new grown limb. Nerve signaling reintegration does occur with hand transplants but with a new bio “artificial” limb it may be more complex.

While scientists are now starting to set their sights on how they could apply this technology to humans one day, there is still many challenges ahead to overcome. They feel it could be 10 years before possible medical trials may occur, however, this is not that far away, and the 2020s should be very interesting in what is possible in medical science.

Ott feels that he will be working in science long enough to see this research come to manifestation. As he says: “I will live to the clinical application of this.”

A Moment Of Reflection

It is perhaps worth pondering on the implications of not just the above and how these technologies will eventually change society, but also regenerative medicine in general.

Today parents and rightly so, will tell their children how important looking after your second set of teeth, since it is the only ones you have. As when they are lost then they are gone for good.

However, that is not really true anymore, since the new kind of era we are entering now means we can just grow them back! In fact new experimental procedures are coming on the stage now in dentistry where they are starting to do this a little. With new methods in treatments for fillings instead of drilling the teeth.

While this website is focusing on limb regeneration, I have been researching in other specific areas of regeneration including organ and breast regeneration. Regrowing breasts for women whom have had a single or double mastectomy, is also been done in clinical trials.

As far back as 2009 a project in Australia where a clinical trial was taking place, using the patient's own stem cells to regenerate the lost breast using a scaffold matrix. As a new treatment instead of using silicon implants with have their own problems.

Again we can now make a lady whole and complete again. However, this procedure was a trial and I believe some women were a success but there were problems with others. So the trials were stopped until further advancements and understanding of the technologies in regenerating a women's breast.

I am not familiar with the latest developments in stem cell reconstruction breast surgery for mastectomy patients. Apart from in 2014 a New Zealand women in her 60s, has had a new procedure to regenerate her left breast that was removed due to cancer.

In the media back in 2012 the celebrity Suzanne Somers whom lost a breast due to cancer, was the first woman in America to have the treatment with great success. She mentioned that she wanted to wait until the stem cell technology became available and not have the current silicon implants.

Filed Under: Limb Regeneration, Recent Articles

Comments

Ira says
September 17, 2015 at 4:09 pm

It will be interesting to see how the regeneration turns out. If a limb lost could regrow and be successful, it would be wonderful.

Reply

Alexander says
September 17, 2015 at 7:17 pm

Thank you Ira. Yes indeed it would be fantastic. At this point its too early to say when but the next 10 years will be interesting to see how this plays out. I reckon stem cell technologies will start to explode.

On another website from a research institute in California that specializes in limb regeneration and has its funding from the DoD. A lead scientist responding to a comment from someone (an Olympic skier) who lost their foot due to a rare disease. The scientist pointed out that he would not be working as hard as he could to see it happen, if he didn't think it would be possible someday.

Alex.

Reply

Barry says
September 23, 2015 at 10:06 pm

Hi Alexander,the things that can be done today is amazing.It is almost scary. Growing a limb on a human is great news but as usual where else will this technology start being used for bad instead of good? Growing who knows what to change identities? Gotta make you wonder. Great info though.you made me think.
Cheers,
Barry

Reply

Alexander says
September 24, 2015 at 7:21 am

Hi Barry, Thank you for your insightful thoughts. It is indeed fantastic but you are right we have to be careful and look at the ethical challenges ahead. Knowledge is neither good or bad but the intent behind it. And in the wrong hands it can be devastating. I guess one thing comes to mind is super soldiers or those with super human abilities – if that's possible. So in the military is one area where it can be used as a deadly weapon and abused. But I am confident we will get through those issues and use science and knowledge for the greater good of humanity. Just focusing on healing and regeneration.

Reply

Rawl says
September 24, 2015 at 12:29 am

Wow! I wish I had the words to express how amazing this is! I didn't know that a breast was regrown. I knew science had been working on regrowing limbs but didn't know they were so close. Are there any plans for cost and if expensive would there be scholarships or funds for those less fortunate?

Rawl

Reply

Alexander says
September 24, 2015 at 7:59 am

Thank you so much for your comments! I am thrilled of your enthusiasm with limb regeneration and regenerative medicine in general.

I did some research a few years back and they had some success with breast tissue regeneration in Australia but then they stopped I believe due to complications. But recently what is called 'breast stem cell reconstruction surgery' is showing up in the media from time to time. I think not many women know this is available and if she is willing to get a second opinion, then there is the cost and if the doctor feels if such treatment would be successful.

To answer your last question would require me to write another article about challenges of costs and the technology being available to those with the financial resources. Scholarships is something I can look into and incorporate it into my article on this.

Reply

Gin says

September 24, 2015 at 6:57 am

Woww. I am always fascinated by science and how it can enable seemingly impossible things to happen. I'm just wondering, will the cells in the regenerated limb be from stem cells? I have heard that those can be used to regenerate organs, or maybe it is still a work in progress. And why did you say that regenerating nerve cells for a a lost limb may be more difficult than a hand?

Thank you and keep writing these awesome posts!

Reply

Alexander says
September 24, 2015 at 8:23 am

Hi Gin and thank you for your great comment. Indeed I will keep writing my posts, thanks again for the compliments. I think yes it would be from stem cells but the method they are working on in that area of research is growing the limb in the lab similar to what they are going with organs. That's assuming it would work and be practical and safe for the patient.

The other method and most of the research on this website looks at, is stimulating the body to grow back the limb, similar to what the salamander does. This would be the ultimate holy grail as it should in theory know what is needed to be regenerated since the building instructions are already in the DNA.

In the above article they are looking at growing the new limb in the lab based on the stem cell donor and once grown, then surgically attach it to the body.

For organs, I understand they have had some success with bladders as they are not as complex but more difficult organs such as kidneys are not yet possible.

They have been using 3D printing of organs with human cells and animals parts

in the lab so they are getting there. 3D printing with stem cell technologies is something I will be writing about as this is another area of regenerative medicine. Scientists are working on bio-printing new body parts.

For nerve cells, with a limb transplant, the nerves are already there so if the procedure goes well and the body excepts the transplant the existing nerves will operate. With a new limb that is grown, the nerves would have to be grown as well for the bio-limb and that part is more complex as they would have to produce the right matrix for the nerves to generate. Its a highly complex process. I could review this and update my post with more information.

Reply

Ughur says
May 18, 2016 at 11:56 am

Hi.5 month ago I lost my fingers and some part of my hand .it is interesting to me, this moment this printer can print a hand?

Reply

Alexander says
May 29, 2016 at 8:06 pm

Hi Ughur,

Thank you for your comment and sorry about your injuries. There are now new emerging technologies with 3D Printing that can print human tissues and I do know a company in California whom does 3D printing of prosthetic limbs with the aim of making them more stylish and less noticeable (ie. it could look like a

colorful tattoo).

The company mentioned that they intend to progress eventually into 3D Printing of human stem cells meaning that they will print the persons limb and then it would be surgically reattached. They don't know when this would occur but they feel this is how it will progress.

Scientists are now working hard on 3D Printing of fingers, hands and organs but they are not advanced yet on making them alive and attaching them to the patient. This will happen as can be seen with the above research its certainly going to happen as things get more advanced.

I think a recent area of very compelling research is a new kind of stem cell technology that promotes the equivalent of salamander-like and newt-like flare regeneration characteristics. Many interesting discoveries and advancements are now coming out of Australia. This new breakthrough in regeneration allows bone and tissue regeneration and trials are being planned for 2017. The trials are not going to regrow lost limbs – at least not yet – but you can be sure that is where it will be heading as we travel into the next decade.

I am writing up about this new breakthrough game changer research and it will speed up the progress in eventual regeneration of limbs and organs.

Thanks,
Alexander.

Reply

Ughur says
June 5, 2016 at 9:11 am

I have written to Australia. but they have answered me that it isn't there. maybe I haven't correctly explained.do you have concrete information about this .thanks

Reply

Alexander says
June 5, 2016 at 2:43 pm

Hi Ughur,

Thanks for your comment and questions. Are you referring to this research on bio-limb rat? As this was done in the USA in Boston, here is a link to their official research paper on bioartificial limb graft.

If you are referring to the Breast Regeneration I mentioned above in Australia, then here are some articles based on this.

The UK Guardian on 'Breast regrowth procedure trialled for mastectomy patients' in 2009.

Australian Melbourne Surgeons – 'Doctors can regrow breast tissue after surgery' in 2012.

Article on 'Regenerative Medicine Grows A New Breast For Suzanne Somers' – published in 2012.

Let me know if you have any other questions.

Thanks,
Alexander.

Reply

Ughur says
June 6, 2016 at 11:41 pm

Hi Alexander,
Really I am very intrested in this regeneration.And nearly 1 or 2 months I reserch a lot of information and really get much more information about this every day and I found you site by this way.Now I have a lot of fiels and I want to share my information with you.of course if you also want.every day I find new things and when I read them,I think that it is possible and I can reach my goal but when I contact with them, they answer completely different with what I read.maybe I cant explain rite???I need your help and advice to understand them.why their articles and answers are different…
Thanks.

Reply

Ughur says
June 6, 2016 at 6:30 pm

HI Alexandr,

Really I am very intrested in this regeneration.And nearly 1 or 2 months I reserch a lot of information and really get much more information about this every day and I found you site by this way.Now I have a lot of fiels (links/sites) and I want to share my information with you.of course if you also want.every day I find new things and when I read them,I think that it is possible and I can reach my goal but when I contact with them, they answer completely different with what I read.maybe I cant explain rite???I need your help and advice to understand them.why their articles and answers are different…

thanks.

Reply

Ughur says
June 7, 2016 at 5:44 pm

Hi Alexander,
Really I am very intrested in this regeneration.And nearly 1 or 2 months I reserch a lot of information and really get much more information about this every day and I found you site by this way.Now I have a lot of fiels and I want to share my information with you.of course if you also want.every day I find new things and when I read them,I think that it is possible and I can reach my goal but when I contact with them, they answer completely different with what I read.maybe I cant explain rite???I need your help and advice to understand them.why their articles and answers are different…
Thanks.

Reply

Alex says
November 16, 2016 at 4:24 pm

I too am about to lose one of my legs just below my knee due to a bone deformity that messed up my foot and made it nearly unusable. Ive been waiting my whole life for something like this and im only 25 the one thing that would give me that push to finally end this pain and get an amputation is knowing that i could have the limb back in normal form. Im so excited for something like this i pray every night that it happens in the next ten years so i could finally live a normal active life while im still young. Would anybody have any idea of the cost of getting a new limb tho???

Reply

Pinky says
January 30, 2017 at 6:10 am

Hi. My friend had lost 3 toe fongers and his ring finger. Can that be regrown in todays date? If so where to contact and how much time can it take. Please guide. It would be of great help.

Reply

Leave a Reply

Your email address will not be published. Required fields are marked *

Comment

Name *

Email *

Website

Post Comment

ABOUT ALEXANDER

I have a passion for Regenerative Medicine and in particular Limb Regeneration that will transform the lives of those whom have suffered from such life changing injuries. I created this website to bring knowledge and education to the surface that will transform people's lives for the better. Read More…

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SCIENCE

New Prospects for Growing Human Replacement Organs in Animals

By NICHOLAS WADE JAN. 26, 2017

For the first time, biologists have succeeded in growing human stem cells in pig embryos, shifting from science fiction to the realm of the possible the idea of developing human organs in animals for later transplant.

The approach involves generating stem cells from a patient's skin, growing the desired new organ in a large animal like a pig, and then harvesting it for transplant into the patient's body. Since the organ would be made of a patient's own cells, there would be little risk of immune rejection.

The human-organ-growing pigs would be examples of chimeras, animals composed of two different genomes. They would be generated by implanting human stem cells into an early pig embryo, resulting in an animal composed of mixed pig and human cells.

One team of biologists, led by Jun Wu and Juan Carlos Izpisua Belmonte at the Salk Institute, has shown for the first time that human stem cells can contribute to forming the tissues of a pig, despite the 90 million years of evolution between the two species.

Another group, headed by Tomoyuki Yamaguchi and Hideyuki Sato of the University of Tokyo, and Hiromitsu Nakauchi of Stanford, has reversed diabetes in mice by inserting pancreas glands composed of mouse cells that were grown in a rat. The Salk team's report is published in Thursday's issue of Cell and the Stanford-Tokyo team's

in Wednesday's issue of Nature.

The two reports together establish the feasibility of trying to grow replacement human organs in animals, though such a goal is still far off.

"I think this is very promising work in principle," said Rudolf Jaenisch, a stem cell expert at the Whitehead Institute in Cambridge, Mass.

Many technical and ethical barriers have yet to be overcome, but the research is advancing alongside the acute need for organs; some 76,000 people in the United States alone are awaiting transplants. Creating chimeras, especially those with human cells, may prove controversial, given the possibility that test animals could be humanized in undesirable ways. One would be if human cells should be incorporated into a pig's brain, endowing it with human qualities. Almost no one wants a talking pig.

Another untoward outcome would be if human cells should come to compose the pig's reproductive tissues. Few people want to see what might result from the union between a pig with human sperm and a sow with human eggs.

In 2005, Senator Sam Brownback of Kansas introduced a bill imposing a $1 million fine on anyone creating and profiting from a chimera with human cells in its brain or reproductive tissues. That bill went nowhere, but in deference to public concerns the National Institutes of Health in 2015 instituted a moratorium on using public funds to insert human cells into animal embryos.

The N.I.H. proposed last August to lift the ban, but to require grant proposals involving the insertion of human stem cells into early animal embryos to be examined by an expert committee. The public comment period on the proposal drew 22,000 responses that it reviewed. .

The ban is still in place, and it's unclear whether the Trump administration would continue to consider lifting the moratorium or whether new objections would be raised to using public funds for this line of research.

"We have no indication one way or another that they have any opinions on this," said Carrie D. Wolinetz, the associate director for science policy at the N.I.H.

Insertion of human stem cells into the early embryos of monkeys was prohibited in 2009, and remains so because monkeys, given their evolutionary closeness to humans, might easily have their brains altered by human cells.

Biologists' interest in chimeras has been prompted by the limited success in coaxing medically useful tissues from stem cells grown in glassware. All-purpose human stem cells were first derived from human embryos in 1998 and from ordinary adult tissue cells in 2007. After each discovery there were hopes of converting the cells into therapeutic tissues by exposing them in glassware to the sequence of natural chemicals that in the living embryo directs them into constructing the heart, brain, lungs and other organs.

But no one knows exactly what sequence of chemicals is required for the generation of each different tissue or organ. This may be why glassware experiments with stem cells have not yet lived up to their full promise. Some biologists believe a better approach may be to grow stem cells not in glassware but in a developing embryo, where they will be exposed to the natural sequence of chemicals required to induce each type of organ.

"In the last 18 years, hundreds of labs, including ours, have tried to generate different cell types from human pluripotent stem cells in the culture dish with a cocktail of factors," Dr. Izpisua Belmonte said. "But the cocktails are not identical to what the cells experience in the embryo. So I thought, 'Why not let nature do the job?'"

Dr. Izpisua Belmonte's and Dr. Nakauchi's teams have both pursued a strategy of directing the human donor cells to generate specific organs in the recipient species. This is desirable for both technical and ethical reasons. Dr. Nakauchi has disabled the master gene in rats for making a pancreas so that when mouse stem cells are injected into the early embryo of such a rat, the growing embryo has no choice but to construct its pancreas of pure mouse cells, instead of the usual mixture of rat and mouse cells.

Generating inviting homes for the donor cells may reduce the risk that they will be incorporated in nontarget tissues like the brain or reproductive tissues. Also, an organ made purely of donor cells can be transplanted into the donor animal with

minimal fear of rejection.

In practice, about 10 percent of the mouse pancreases generated in rats was composed of rat cells, because the rat supplies the blood vessels for the organ. But the rat blood vessels seem to be quickly replaced when the organs are transferred to mice.

The mice with their new pancreases lived in good health for a year after the transplant. They came from the same inbred strain as the donor mice, so they did not reject their new organs.

The result provides proof of principle that Type 1 diabetes can be treated by growing a pancreas from an individual's cells in another animal, Dr. Nakauchi and colleagues conclude.

The next step is to repeat the experiment in pigs, which produce organs of a more suitable size for use in humans. Dr. Izpisua Belmonte's team has now shown that human stem cells do survive in pig embryos and help form their organs, although not very efficiently. "The human cell doesn't contribute much. To the brain we observed little or no contribution at all," said his colleague Dr. Wu. "This is good news because we can guide the human cells to the organ we want."

Both Dr. Izpisua Belmonte and Dr. Nakauchi said there was a long way to go before human organs could successfully be grown in animals like pigs. Chimeras will be more immediately useful in studying human embryogenesis, testing drugs and following the progress of disease.

To achieve the goal of growing human organs for transplant, researchers must first engineer pigs that cannot make the organ of interest. In mice, this has already been done for the pancreas, heart and eye. They must then show that human stem cells can construct such an organ in a pig. Since the pig will supply the blood vessels and nerves, these will need to be replaced by the recipient's cells after transplant without triggering immune rejection.

If rejection does occur, the researchers will have to knock out the pig's vasculature genes and arrange for these too to be humanized. Complex organs, like the heart, will be harder to grow than those like the pancreas which has a single kind

of progenitor cell. All these steps, though they seem feasible, will require several years to develop and test.

Both scientists expressed confidence that ethical concerns about chimera research could be addressed. Chimeras are typically mosaics in which each organ is a mixture of the host and donor cells. But new techniques like the Crispr-Cas gene editing system should allow the human cells in a pig embryo both to be channeled into organs of interest and to be excluded from tissues of concern like the brain and reproductive tissues.

"This isn't dangerous research. We're not creating monsters," Dr. Nakauchi said.

"There isn't a need to get into a debate about moral humanization if scientists target the organs where the human cells will go," said Insoo Hyun, a medical ethicist at Case Western Reserve University. "Scientists are not making chimeras just for fun — it's to relieve the dire shortage of transplantable organs."

Concern about human cells' incorporation into a lower animal's brain is not without basis. Dr. Steven Goldman of the University of Rochester Medical Center found in 2013 that mice injected with a special type of human brain cell had enhanced learning abilities. But other forms of humanized mice, such as mice engineered to have a human immune system, are routine laboratory animals that seem to occasion little angst.

Dr. Izpisua Belmonte's insertion of human stem cells into pig embryos was not affected by the N.I.H. moratorium on such chimeras because he used private funds. His experiment was approved by the authorities in Spain and in California, and following their advice, the development of the pig chimeras was stopped after four weeks in the womb.

Dr. Nakauchi moved his lab to Stanford from Tokyo in 2014 because Japanese regulations do not allow chimera research, only to be hit with the N.I.H. moratorium a year later, which prevented him from making chimeras with human cells. His mouse pancreas experiment has taken eight or nine years to complete. "I have been in a very frustrating situation," he said.

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11 Body Parts Grown in the Lab

By Mindy Weisberger, Senior Writer | January 26, 2016 09:28am ET

A lab-grown urethra, the duct that conducts urine away from the bladder, and carries semen in male placental mammals.

Credit: Wake Forest School of Medicine

Regrowing a missing limb is no big deal — to a starfish or salamander, creatures that are well-known for using regenerative "superpowers" to

For humans, though, what's lost is lost — or is it?

Individual cells in your body are constantly being replaced as they wear out, a process that slows with aging but continues throughout the human lifetime. You can even observe this frequent and visible regeneration in one of your organs: your skin. In fact, humans shed their entire outer layer of skin every two to four weeks, losing about 18 ounces (510 grams) of skin cells per year, according to the American Chemical Society.

However, regenerating complete organs and body parts, a common practice among "Doctor Who's" Time Lords, is beyond the scope of human biology. But in recent years, scientists have successfully cultivated a range of human body structures, similar structures that have been successfully tested in animals, and small-scale human organs known as "organoids," which are used to study human organ function and structure at a level of detail that was previously impossible. Here are some recent examples:

Fallopian tubes

Using stem cells, scientists from the Max Planck Institute for Infection Biology in Berlin grew the innermost cellular layer of human fallopian tubes, the structures that connect the ovaries and uterus. In a statement released on Jan. 11, the researchers describe the resulting organoids as sharing the features and shapes that are particular to full-size fallopian tubes. (Image credit: MPI f. Infection Biology)

Minibrain

A lab-grown brain the size of a pencil eraser was cultivated from skin cells by The Ohio State University (OSU) scientists, and is structurally and genetically similar to the brain of a 5-week-old human fetus. Described as "a brain changer" by OSU representatives in an Aug. 18 statement, the organoid has functioning neurons with signal-carrying extensions like axons and dendrites. In the photo of the minibrain, labels identify structures that are typically found in a fetal brain. (Image credit: The Ohio State University)

Miniheart

Researchers prompted stem cells to develop into heart muscle and connective tissue, and then organize into tiny chambers and "beat." In a video of the achievement, the heart muscle cells (indicated by red at the center) are beating while connective tissue (green ring) secures the miniheart to the dish where it grew. Kevin Healy, a University of California, Berkeley, professor of bioengineering and co-senior author of the study, said in a statement. "This technology could help us quickly screen for drugs likely to generate cardiac birth defects, and guide decisions about which drugs are dangerous during pregnancy." The research was published March 2015 in the journal Nature Communications (Video credit: Zhen Ma, UC Berkeley)

Minikidney

A team of Australian scientists grew a minikidney, differentiating stem cells to form an organ with the three distinct types of kidney cells for the first time.

The researchers grew the organoid in a process that followed normal kidney development. In the image, the three colors represent the types of kidney cells that form "nephrons," the different structures within the kidney. (Image credit: Minoru Takasato)

Minilung

Researchers from several institutions collaborated to grow 3D lung organoids that developed bronchi, or airway structures, and lung sacs. "These minilungs can mimic the responses of real tissues and will be a good model to study how organs form [and] change with disease, and how they might respond to new drugs," Jason R. Spence, senior study author and an assistant professor of internal medicine and cell and developmental biology at the University of Michigan Medical School, said in a statement. The minilungs survived in the lab for more than 100 days. (Image credit: University of Michigan Health System)

Ministomach

Ministomachs that took about one month to cultivate in a petri dish formed "oval-shaped, hollow structures" resembling one of the stomach's two sections, said Jim Wells, study co-author and a professor of developmental biology at Cincinnati Children's Hospital Medical Center. Wells told Live Science that the tiny stomachs, which measured about 0.1 inches (3 millimeters) in diameter, would be especially helpful to scientists studying the effects of a certain bacterium that causes gastric disease. This is because the bacteria behave differently in animal subjects, he said. (Image credit: Kyle McCracken)

Vagina

In April 2014, a study published in the journal The Lancet described the successful transplants of lab-grown vaginas, created by nurturing the patients' cells on a vagina-shaped scaffold. The transplants, conducted several years earlier in four girls and young women between the ages of 13 and 18, corrected a congenital defect in which the vagina and uterus are missing or underdeveloped. The teenagers were examined annually for eight years after the transplants, during which time the organs functioned normally, allowing pain-free intercourse. (Image credit: Dr. Yuanyuan Zhang, Wake Forest Institute for Regenerative Medicine)

Penis

Scientists at the Wake Forest Institute for Regenerative Medicine used rabbit cells to grow penile erectile tissue, transplanting the lab-grown penises onto male rabbits, which then mated successfully. But the process is still in the experimental stages, and approval from the US Food and Drug Administration is required for the team to extend its work and incorporate human tissue and subjects. The U.S. Armed Forces Institute of

Regenerative Medicine is providing money for the study, as the research could benefit soldiers who suffered groin injuries in combat. (Image credit: Wake Forest Institute for Regenerative Medicine)

Esophagus

At Kuban State Medical University in Krasnodar, Russia, an international team of scientists constructed a working esophagus by growing stem cells on a scaffold for three weeks; they then successfully implanted the organ in rats. The scientists tested the new esophagus for durability by inflating and deflating it 10,000 times, implanting the artificial structures in 10 rats and replacing up to 20 percent of the animals' original organs. (Image credit: Macchiarini et al.)

Ear

Now hear this: Scientists have 3D printed human ears, cultivating them by coating molded ear-forms with living cells that grew around the frame. The researchers created the ear-shaped mold by modeling a child's ear using 3D software and then sending the model to a 3D printer. Once the scientists had the mold in hand, they injected it with a cocktail of living ear cells and collagen from cows, and "out popped an ear," Live Science reported. The fabricated ears were then implanted on rats for one to three months while scientists evaluated changes in size and shape as the organs grew. (Image credit: Lindsay France/Cornell University Photography)

Liver cells

The liver, the largest organ inside the human body, is capable of great feats of repair and regeneration while in its proper place. Outside the body, the organ has provided a challenge; it has proven exceedingly difficult for scientists to grow liver cells, called hepatocytes, and keep them alive. For the first time, scientists from Germany and Israel successfully cultivated hepatocytes in the laboratory, publishing their research Oct. 26, 2015, in the journal Nature Biotechnology. Though not a full-fledged organ (or even an organoid), this development holds promising implications for clinical study, with Yaakov Nahmias, director of the Alexander Grass Center for Bioengineering at the Hebrew University of Jerusalem and the study's lead author, describing it in a statement as "the holy grail of liver research." (Image credit: Yaakov Nahmias)

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Mindy Weisberger is a senior writer for Live Science covering general science topics, especially those relating to brains, bodies, and behaviors in humans and other animals — living and extinct. Mindy studied filmmaking at Columbia University; her videos about dinosaurs, biodiversity, human origins, evolution, and astrophysics appear in the American Museum of Natural History, on YouTube, and in museums and science centers worldwide. Follow Mindy on Twitter.

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