INCUBATOR

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INC Co-director, Gert Cauwenberghs , part of the team

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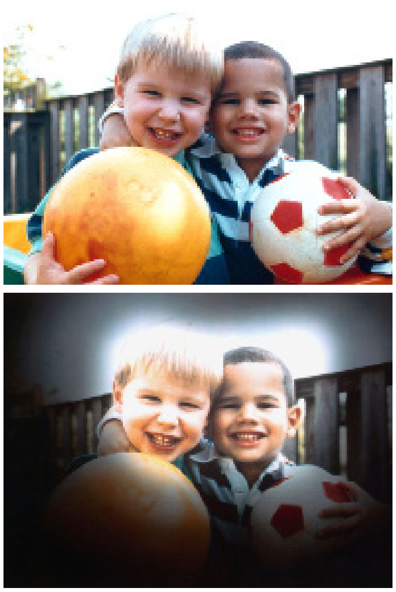
CAN A PAIR OF GOGGLES HELP CATCH THE "SNEAK THIEF OF SIGHT" ?

Glaucoma is a preventable disease, yet many patients go blind as a result. The problem? Late detection and lack of frequent monitoring after initial detection. Some call Glaucoma the "Sneak Thief of Sight" because it can progress slowly, without notice, until vision is lost. As eyesight diminishes, the brain fills in the gaps. By the time the disease is noticed, more than forty percent of vision can be irrecoverably lost. Doctors, scientists, and engineers are searching for better ways to monitor the disease.

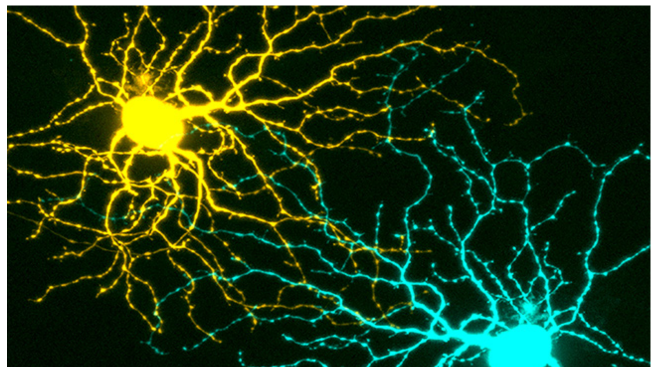
The loss of vision from glaucoma is directly related to the progressive degeneration of retinal ganglion cells - the eye's messengers to the brain. The most common cause of glaucoma is an increase of ocular pressure and thus, doctors have devised multiple methods for measuring this pressure as a diagnostic tool. However, people with high ocular pressure do not always have glaucoma, and vice versa - some types of glaucoma are not caused by excessive ocular pressure. That is why a more direct measure of glaucoma is its outcome - visual field loss.

The brain is a master magician, or more aptly, illusionist. It can fill in gaps in our eyesight. That is why we cannot notice a blind spot that we all have - a part of the eye without photoreceptors where the optic nerve exits the eye. However, if something appears in that area, we cannot perceive it. Glaucoma can produce many blind spots without notice, so one must test these with a visual field test for which a patient must fix their gaze while flashes of light dance around their periphery. Flashes that cannot be detected signify a blind spot.



The same photo as it might be viewed by a patient with late stage glaucoma (www.nei.nih.gov)

The most widely used method to evaluate the field of vision, standard automated perimetry (SAP), requires a skilled technician, a room with stable ambient light, and an attentive patient. Sitting at the machine with the chin propped up on a ledge, a patient must fix their eye at a target and then simultaneously press a button when stimulated with light. The test takes about fifteen minutes and suffers from test-retest variability perhaps due to human error on the part of the patient. So, why not measure a more direct readout of visual stimulation: brain signals? Visual signals from the retina are quickly sent to the surface of the back of the head known as the primary visual cortex. And signals found here are arranged in a spatial map corresponding to a map of the retina. This means



Healthy retinal ganglion cells filled with fluorescent dye. These cells are destroyed in patients with glaucoma leading to progressive vision loss. image from El-Danaf et al. (2015) Journal of Neuroscience.

if a visual stimulus doesn't make its way to the primary visual cortex, the spot on the retina where the stimulus appeared is likely dysfunctional. Early attempts at this approach measured visually-evoked potentials and have produced promising results, but haven't eliminated a big drawback to current glaucoma testing: the need for a cumbersome procedure driven by a skilled professional. In this case, someone needs to carefully prepare the skin of the patient with conductive gel to place electrodes.

Enter nGoggle, a San Diego startup cofounded by the INC's Tzyy-Ping Jung and ophthalmologist Dr. Felipe Medeiros to harness the power of virtual reality and brain computer interface technologies to assess visual function. The nGoggle prototype has been developed by adding sensors, actuators and processors to a Samsung Gear VR Goggle. Essentially, a patient can put on the nGoggle without assistance and dry EEG sensors will slide into place. As flickering patterns appear, the EEG sensors pick up neural signatures of the visual stimuli. In addition, electrooculogram sensors can detect trials during which a patient has moved their eyes or has broken fixation. These trials are automatically discarded. Without the need for patient feedback, many stimuli can be displayed simultaneously. All in all, the nGoggle paradigm for assessing visual function takes just three minutes, one-fifth of the current method, SAP. As

CAN A PAIR OF GOGGLES HELP CATCH THE "SNEAK THIEF OF SIGHT" ? CTND

Top: Humphrey Visual Field Analyzer - a standard automated perimetry device (www.zeiss.com)
Bottom: nGoggle prototype, a portable brain-computer interface for assessment of visual function.

with any new diagnostic tool, it needs to be rigorously tested to see if it holds up in a clinical setting and to assess if it is of equal or greater reliability than current tools. As CEO Stanley Kim asserts, "We are still validating the technology to ensure adoption by the medical community - not just another digital health company with another "better" technology. We want to create a standard in the industry."

Preliminary results for the nGoggle have been very promising. In a recent study, published in JAMA Ophthalmology, the nGoggle system was able to distinguish between subjects with and without glaucomatous eyes with equal specificity as SAP. It even appeared to be slightly more sensitive than SAP which suggests it may be able to detect losses in visual field at earlier stages of glaucoma. Equally promising was the low test-retest variability reported for nGoggle in contrast with high variability that plagues tests that require patients' subjective responses. While the results are exciting, more research will need to be conducted to determine how well nGoggle can track the progression of glaucoma and to determine if the wearable headset can be operated successfully without any expert supervision, like in the home. Seed funding from the The National Eye Institute, awarded this past April as part of the Small Business Innovation Research program, will help to fund future studies.

For a disease that affects 60 million worldwide and costs the US government 1.5 billion annually, a change to the current paradigm of visual field testing can have a huge impact. nGoggle may be the cheap, easy to use, precise tool that practitioners and patients have been seeking in the fight to catch and track glaucoma. But first they will have to prove to the medical community that they are worthy of an institutional overhaul. In the meantime, keep your eyes open. It seems that better methods of detection may be in sight.

Tzyy-Ping Jung, co-founder and chief scientific advisor of nGoggle

DR. JOHN IVERSEN INVOLVED IN NIH/KENNEDY CENTER MUSIC AND HEALTH INITIATIVE WORKSHOP

Dr. Iversen was one of three speakers at a National Institutes of Health (NIH) workshop held on January 26-27, 2017. He spoke about music and child development. The purpose of the workshop was to help guide the direction of a new partnership between the NIH and the John F. Kennedy Center for the Performing Arts to expand on an initiative that NIH has had with the National Symphony Orchestra (NSO) called Sound Health. The goal of the initiative is "to increase our understanding of how music affects health, with an emphasis on the basic neuroscience of music and potential clinical applications.
(From tdlc.ucsd.edu)

THE BRAIN IN MOTION: HOW VIRTUAL REALITY MAY INSTRUCT REALITY

Cooperation; It's what allows us to work together to create skyscrapers and perform symphonic masterpieces. And it may save your life in the battlefield. How can we predict one's ability to cooperate in a battle-like situation? That is the question behind Dr. Joe Snider's latest experimental endeavor, a collaboration with SPAWAR (Space and Naval Warfare Systems Command), a research arm of the Navy. To study cooperation, Snider has devised a "cover and clear" task where two participants must work together to keep each other safe.

Participants of Snider's study will not be protecting each other by fending off real threats. Instead, they will be navigating a virtual battle environment designed by Snider. I test out his task in the basement of the Supercomputer Center. To enter Snider's fictitious world, I don a VR headset and wield a remote control that acts as my weapon. As the task begins, I see that I am surrounded by four large shipping containers that block my view. I have a partner who I know is just Snider, but who appears in my virtual world as a floating white sphere with eyes carrying a gun that shoots white balls. Our task is to cover each other and shoot the bad guys who appear between the

A subject interacting with a virtual reality environment while wearing EEG sensors in the MoBi lab (mobile brain and body imaging)

containers without notice. Snider, as a joke, decides to shoot me instead on our trial run. He says, "It's more fun that way". I guess it's a good thing he won't be a subject for his own study.

In Snider's study, the performance of a subject in the virtual shooting match is just one outcome of the experiment. For one, virtual reality allows Snider to know exactly what each participant is seeing and he can use that information for his analyses. Also, Snider will be recording movement and collecting EEG (electroencephalogram) signals. All of these measurements are combined to look for correlations between brain activity, movement, and task performance. Snider is optimistic about the kinds of signals he will find. For instance, in a previous study using virtual space, he found signals around the parietal cortex that encoded the subjects' position, analogous to signals found in the hippocampus known as "place fields". And in a pilot study similar to this one, where two subjects played the game in an fMRI machine, he found that two subjects who cooperated had similar patterns of brain activity.

Joe Snider, VR guru

The really novel part of Snider's research is that EEG signals are captured while subjects are actually moving, engaging their body and their mind. He says that at first, researchers were skeptical that he could get reliable brain recordings with so much movement as most studies are performed on motionless people who are asked to keep their eyes fixed on a dot at the center of a computer screen.

But, if scientists really want to understand and predict behavior or get a glimpse of what the brain might be doing in the real world, moving through virtual space might get them that much closer. In Snider's case, he hopes his study will yield a brain signature that predicts cooperation and some clues about how to build better partnerships in the battlefield and in civilian life.

VR controller like the ones used in Snider's study to aim virtual weapons.

SCIENTIST SPOTLIGHT : YING WU

Ying Wu's journey to science started with a love for literature and poetry. Now, as a scientist at the INC, she studies the cognitive science underlying creativity and insight. Read through to the end to find out what's fishy about Ying's mornings and evenings.

Ying Wu reads poetry at the Escondido Municipal Art Gallery as part of a Poet's Inland North Country event hosted by Rocert O'Sullivan Schleith.

How did you become interested in cognitive science?

YING: It was a progression, I guess, from being really interested in literature, to being more interested in language and linguistics. Language is such a fascinating phenomenon and I was interested more in the psychological and the neurobiological aspects of it. How is it that we're able to learn language? Especially children with fairly minimal instruction? What are good ways to teach a second language? Why are there certain commonalities across languages of the world?

You earned your masters in applied linguistics from UCLA and then attended UCSD for graduate school in cognitive science. What did you study?

YING: I studied the integration of gesture in speech. A lot of times when we gesture, we don't just gesture in isolation from speech. It's usually connected. The kind of gestures I was focusing on were things like if someone says, "Get the bowl off the table," and uses a gesture like making a bowl shape with their hands, you can use that information to draw more inferences about what the person means. Gestures are very fleeting and they don't have the same instantiation in our minds as language, so how do we interpret them? Do we use that information when we're listening to language or comprehending? Those were the kind of questions I was asking.

Are you still asking the same questions at the INC?

YING: No. Since I've been here, my work is focused a lot more on problem solving, insight and creativity. Also, I work with students tackling bioengineering and neuroscience challenges. It might sound kind of weird, but there's been so many new technologies in just the past few years for collecting EEG and eye movement data, as well as body movement. Things have become a lot less expensive and more portable and wearable than ever before, so suddenly there's all these new possibilities that weren't around even when I was in graduate school.

You are working on many projects at the INC. Are there any that excite you the most?

YING: I see them as all being interconnected. The thing that's most exciting is just the promise of really transforming how we do cognitive neuroscience. It's not one specific project, but the overall possibilities. What really excites me is the possibility of generalizing our work in the lab out into the real world. I think that we can get a lot more information about people's brain dynamics in real world tasks. You don't always know, if you study something like a laboratory based paradigm, how well your conclusions generalize to what happens when people are actually doing things. And we can study things that have never been studied before.

My pet example is to look at the eight hour work schedule. In reality, that doesn't always fit people's bio-rhythms. You may have noticed yourself, there's an afternoon slump a lot of times. I feel like if you could use some of these portable systems to capture EEG signals and eye tracking and other physiological measures, you might be able to tell people when is a good time to work and when they should take a break. That prediction and subsequent action might be much more efficient than just expecting people to be there from 9:00 to 5:00.

What do you like to do outside of the lab?

YING: I recently started hosting a poetry reading series at Gelato Vero Caffe every second Friday of the month. Weirdly enough, I hosted the first event a few weeks ago, and one of the women there was talking to me who I'd seen at a different poetry event. She asked, "Oh, do you work at Southwestern College?"
I said, "No, I work at UCSD."
She said, "Oh, really? So do I."
I asked where, and she said, "Oh, I work at the Supercomputer Center."
Isn't that amazing?

SCIENTIST SPOTLIGHT : YING WU CNTD

Do poetry and science ever collide in your life?

YING: I did a community art project called Concept Fusion where I went to a middle school and presented metaphor theory and had the kids come up with metaphors for abstract concepts. It was through this program called Smart Fridays and the idea is to have local artists volunteer at a school. I did a mini lecture where I tried to explain what metaphor is and some basics of conceptual metaphor theory. Then we read a short poem by Langston Hughes. We talked about the metaphors and I had the students generate their own metaphors by starting with an abstract concept and asking them to map it to something concrete. The results were quite poetic.

One girl said, "Friends are tape when I am torn." One person said something like, "Kindness is sugar of the soul" and "Excitement tingles like Pop Rocks." One of my favorites was, "Loneliness is a single letter on a blank page."

Anyhow, that's one of the really interesting ways that cognitive science and science in general can be used in the arts community.

> I am really very interested in drawing connections between science and art. And I think my research bridges that gap because I study creativity and insight.

Studying insight and creativity sounds difficult. How do you study such behaviors?

YING: Creativity is fundamentally difficult to study because it is hard to operationalize. There are a few tasks that are used over and over and over again in the field to measure whether somebody's in a more or less creative state. One is called the alternative uses task. You say, "Okay, you have three minutes. Name as many different uses for a brick that you can think of." Somebody might say something common like a paper weight. Or they might say something really new, like you could break it and write on a sidewalk with it. Apparently there are actually norms. To score you just say, "If this is something that nobody says, then it gets a high score." If it's something that everybody says, I think it gets either no score or a low score. That's how you measure who has more creative versus less creative ideas. You could also just look at the number of ideas generated too.

Ying at the helm - captain of her own ship!

I heard that you live on a boat in Point Loma. What is that like?

YING: You feel the wind and you can hear the sea birds. Whenever we wash the dishes, the water drips down, and the fish come up to eat whatever it is. I like that a lot. In the summer and the early fall, there are all these fish that are young. They're small, but you can see them flashing silver under the water. Whole big swarms of them. Sometimes jellyfish come through or there are crabs on the dock. Sometimes we anchor out in La Playa or something and just relax. Or sometimes we'll spend the night. We anchor near the Zuniga jetty.

What's the name of your boat?

YING: It's called Surf Cat.

Ying and her daughter, Samara, aboard the Surf Cat

SENSOR-EQUIPPED GLOVE COULD HELP DOCTORS TAKE GUESSWORK OUT OF MEASURING SPASTICITY

Leanne Chukoskie Is Part of an Interdisciplinary Team Working On a Glove Sensor

Everyone experiences stiff muscles from time to time, whether after a rigorous workout, in cold weather, or after falling asleep in an unusual position. People with cerebral palsy, stroke and multiple sclerosis, however, live with stiff muscles every single day, making routine actions such as extending an arm extremely difficult and painful for them. And since there isn't a foolproof way to objectively rate muscle stiffness, these patients often receive doses of medication that are either too low or too high.

Now, an interdisciplinary team of researchers at UC San Diego and Rady Children's Hospital has developed new wearable sensors and robotics technology that could be used to accurately measure muscle stiffness during physical exams. "Our goal is to create a system that could augment existing medical procedures by providing a consistent, objective rating," said Harinath Garudadri, a research scientist at the university's Qualcomm Institute and the project's lead investigator.

"Many clinical exams and procedures are very subjective and rely on measurements that are done with a physician's hands," said Andrew Skalsky, director of the division of Rehabilitation Medicine at Rady Children's Hospital. "We often make major medical decisions and diagnoses based on touch and feel. With this technology, we can start to develop objective measurements for subjective processes."

The level of muscle stiffness, known as spasticity, is typically evaluated using a six-point rating scale called the Modified Ashworth Scale. This scale is the current hospital standard, but it is subjective and often yields ratings that vary from one doctor to another. These ratings help dictate the dose of medication patients are prescribed to manage their spasticity. Inconsistent and inaccurate ratings can either lead to dangerous overdose or ineffective treatment as a result of doses that are too low.

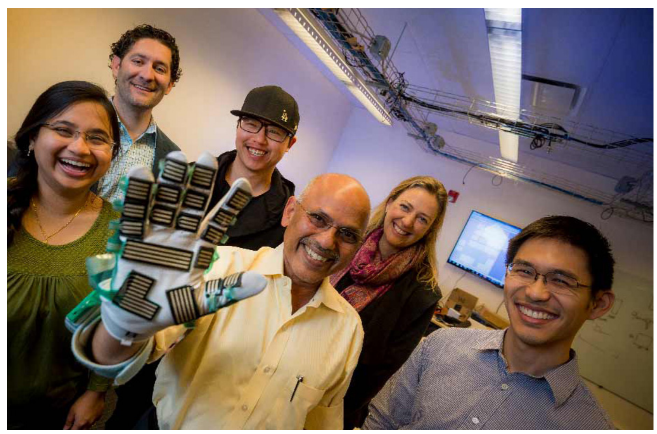
Patient feedback can also skew these ratings, Skalsky said. "Sometimes, patients think that they aren't getting enough medicine and end up being put on a higher dose than they should actually be on. That's thousands of dollars' worth of medicine that could potentially be saved."

'SENSORED' GLOVE

Garudadri and Skalsky teamed up with electrical engineers and neuroscientists at UC San Diego to develop a glove equipped with sensors that is a more reliable tool and will enable doctors to come up with objective, accurate and consistent number ratings when evaluating spasticity in patients ongoing treatment.

The device is built on a regular sports glove that a doctor can wear while holding and moving a patient's limb back and forth. Taped onto the palm are more than 300 pressure sensors that measure the amount of force required to move a patient's limb.

A motion sensor taped on the back measures how fast the limb is being moved. The glove is connected to a computer via USB. Data from all the sensors are transmitted to the computer, where they are integrated, processed and mapped in real time using advanced signal processing algorithms developed by Garudadri's research group. The computer provides a numerical



The team gathers around the glove, worn by Harinath Garudadri

reading that calculates the actual power required to move a patient's limb—the more power needed, the more severe the patient's spasticity.

"We're instrumenting the doctor instead of the patients," said Padmaja Jonnalagedda, an electrical engineering graduate student who worked on refining the algorithms. "It's more convenient for patients to not have to wear all these sensors all over their bodies. It's also more practical to equip just the doctor when you think about the large patient to doctor ratio, especially in developing nations or rural areas around the world," she said.

Researchers built another robotic device that they call the "mock patient" to serve as a control to validate their results. The mock patient consists of an artificial arm that can be moved up and down, simulating the flexing motion of an actual patient's arm. The artificial arm is connected to a rotating disc that can be manually adjusted to different resistance levels, like bike gears. The arm is embedded with its own set of sensors that measure

SENSOR-EQUIPPED GLOVE COULD HELP DOCTORS TAKE GUESSWORK OUT OF MEASURING SPASTICITY CNTD

the power needed to overcome the resistance and get it moving. Researchers can set the resistance, know the amount of power required to move the arm and then test whether the glove produces a matching result.

"The mock patient provides a ground truth to verify that what the glove is measuring is indeed a real number," said Fei Deng, an electrical engineering graduate student who was in charge of building the mock patient.

OBJECTIVE TOUCH

In an initial study, two physicians trained in spasticity assessment were instructed to test the glove on five different patients with cerebral palsy. Each physician wore the glove while performing various movement tasks, including flexing and extending the patients' arms and legs. The physicians were asked to provide their own spasticity ratings according to the Modified Ashworth Scale, without knowing the readings from the glove. They also did not know what spasticity ratings the other was giving.

Left to Right: Dr. Andrew Skalsky and Leanne Chukoskie

The research team compared the results. They found that only 27 percent of the physicians' spasticity ratings agreed with each other. By comparison, 64 percent of the measurements made by the glove agreed with the numbers generated by the mock patient. "This number needs to be higher if we want to deploy our system for use in the hospital, but it shows better consistency than existing spasticity assessments," Garudadri said.

"The multidisciplinary nature of our team is what makes this project so exciting and successful. Experts in signal processing, robotics, printable electronics, neurosciences and medicine came together to transform a subjective process into something that's objective and could improve patient care and outcomes," said Leanne Chukoskie, research scientist at the Institute for Neural Computation at UC San Diego.

Researchers say the technology could potentially be applied in other procedures where doctors have to rely on touch and feel to evaluate a patient's condition: monitoring spine health, assessing the severity of hip dislocation in infants, rehabilitation therapy, physical therapy, and more.

NEXT STEPS

The team is seeking medical experts trained in spasticity assessment to test their system and provide feedback. Researchers are also continuing to improve the system. Tina Ng, one of the electrical engineering professors on the project, is developing sensors that are more robust and can be directly printed onto the glove, rather than taped onto the surface like they are now. "This will make it easier to create different sizes of gloves," Ng said.

Michael Yip, an electrical engineering professor and a core member of the Contextual Robotics Institute at UC San Diego, is integrating haptics, or force feedback, into the new mock patient. "Now, being able to actively push back on the doctor's arms and replaying real profiles of patients' spasticity on the simulator will allow doctors to improve their ability to assess and treat patients, and provide data to improve objective metrics from the glove," Yip said.

Other members of the team are electrical engineering professor Truong Nguyen at UC San Diego and Kyle Douglas, an electrical engineering undergraduate student at UC Santa Barbara.

Engineering graduate student Padmaja Jonnalagedda wearing the glove

Written by Liezel Labios

Originally appeared in UCSD News in April of 2017

Photos by Erik Jepsen

INSIDE A BRAIN HACKATHON

INC MEMBERS COMPETE FOR A CASH PRIZE

Imagine a world in which you can play a video game without a controller or a world in which your phone can send you reminders to calm down when you are feeling out of whack. Well, you don't really have to imagine, because technologies like this already exist, albeit in early stages, that allow signals from your brain to communicate directly with computers to do something useful for you. These technologies are called Brain Machine Interfaces or Brain Computer Interfaces, BMI or BCI for short.

Up until recently, most BCIs used signals from the brain that were captured using invasive electrodes meaning that the skull was opened and electrodes were placed either inside the brain or inside the scalp. This allowed access to clear signals from the brain that could be localized to specific areas. But if this technology is to be ubiquitous, we will have to use brain signals that can be recorded non-invasively, with measurements that we call EEGs, or electroencephalograms. A collective firing of many neurons in your cortex, or the outer layer of your brain, can generate signals that can be captured by electrodes placed on your head. With better and cheaper sensors on the rise and more computing power, the use of EEG as a signal for BCIs for the average consumer becomes more of a possibility.

And the possibilities of these interfaces are just being explored right now. Recently, there has been a push towards translational applications of BCIs and the hope is that the technology will one day become ubiquitous like the smart phones we keep by us at all times. That is the main purpose of a brain hackathon, an event where developers, neuroscientists, computer scientists, and any other interested parties get together in small teams to brainstorm and demonstrate new functionalities for BCIs. Former INC member and founder of Qusp, Tim Mullen, partnered with CWLab International and IEEE to host a hackathon in downtown San Diego last September. The hackathon was held at the office of the startup incubator, EvoNexus, adorned with whiteboards covered in scribbles, oddly shaped couches, and the requisite ping pong table. Let's take a look inside this brain hackathon to see how it operates and what possibilities it unearths.

Top: Some of the EEG sensors available to hackathon participants
Bottom: John Iversen and Joseph Heng developing their project

As Narisa Chu, CWLab co-founder, welcomes the participants from around the US, a team arrives that traveled 6,000 miles from Taiwan. She hurries them in to join the other teams from Florida, Chicago, and of course, San Diego. Team SPAWAR (Space and Naval Warfare) is comprised of Navy researchers from Point Loma, and team GOBLIN (Group Brain Dynamics in Learning Network) includes INC researchers John Iversen, Alex Khalil, and a visiting Masters student from Switzerland, Joseph Heng. Participants are asked to put aside their weekend, and work for two days straight on a way to apply BCIs to everyday problems, to translate the recent advances in sensors and computing to bring BCIs to the real world. Prizes range from $300 for third prize to $1000 for first place, but most participants are driven by the challenge of using the EEG equipment, by their love of playing with data, and the curiosity of seeing what they can create within the constraints of the contest.

Tim Mullen shows off a table full of EEG sensors that are available for the teams to use for their projects- from bulky sensors that look like a bike helmet, to small sensors that look like a headset a McDonald's employee might wear. One of the main challenges of this hackathon is choosing the right EEG sensor model and placing the EEG electrodes well. As Tim explains,

INSIDE A BRAIN HACKATHON CNTD

Top: John Iversen shares Goblin's proposal. Bottom: Joseph Heng and Alex Khalil demonstrate their tug of war game with cognionics headsets

electrical activity in the brain gets filtered through the skull so that only low frequency signals pass through and are detected by the EEG sensors. The signals that one can detect are usually slow oscillations, or waves, of neural activity. You may have heard of some of these when referring to sleep- delta, theta, alpha, beta, gamma waves. With these sensors and the signals they capture, teams must come up with an innovative application. If this all sounds easy to you, it's not and the brain hackathoners are well aware of this and spend the next day and a half pooling collective wisdom, creativity, and grit to put together a presentation for the judges.

After a triumphant call to action from Tim,

" Go forth and Hack! "

people shuffle back to their meeting rooms to start their projects and for the rest of the weekend, EvoNexus is buzzing with activity which all comes to an end when the teams are asked to present their final projects. Each team is given five minutes to pitch their BCI applications and I shadow the judges to hear about the ideas dreamed up at EvoNexus. One team builds an app to find love by connecting two potential mates that share similar brain responses to a series of random photos. Another tracks one's focus and plays a tone each time focus wanders. Examples of other ideas include a sonic game where doors to new soundscapes are opened using the mind, an app that uses responses to pictures of food to narrow down yelp restaurant choices, and an alert system for when someone has an epileptic seizure. With 16 pitches in all, the judges have a lot to discuss and they deliberate in a conference room. Finally, the first prize is announced with everyone waiting in anticipation.

Goblin of UCSD takes first prize, by impressing the judges with a two player tug of war game using players' mastery of their brain waves. But for Team Goblin this is just the start. They want to use BCI games to help them study how kids process language. Khalil interjects, "But you know that is the sci fi end of things, for now this is more practical."

After the award ceremony and some words of encouragement from Mullen, the hackers disperse into a world that lags behind the future they envisioned here for three days in downtown San Diego. I'm not sure how long it will be before everyone wears EEG sensors like they wear fitbits, with notifications telling you how focused you were during work, with computers predicting love interests so that you don't have to bother with swiping right. But what I do know is that every day and every brain hackathon brings us closer to our

Left to right: Narisa Chu (IEEE Hackathon co-organizer), Team Goblin (John Iversen, Joseph Heng, Alex Khalil), Tim Mullen (IEEE Hackathon co-organizer)

Originally appeared as a podcast for NeuWrite

You can listen to it at https://neuwritesd.org/2017/01/05/brain-hackathon-towards-becoming-the-cyborg-you-always-wanted-to-be/

Photos Provided by Hackathon Team

A VISION FOR AUTISM

Leanne Chukoskie didn't always intend to study autism. When her nephew was diagnosed with the disorder, she diverted her research trajectory to study a developmental disorder that affects one in every 68 children in the US.

As many scientific researchers can attest, specialization is tantamount to breadth of knowledge within a given field. Chukoskie is a neuroscientist, but her early research focus was in visual neurophysiology. Thus, when her family turned to her in the wake of her nephew's diagnosis, she didn't have many answers. So, she did what any good scientist would do and devoured the available primary literature. During this literature binge, it dawned on Chukoskie that she could apply her skills as a visual neuroscientist to the autism field.

As both a graduate student at NYU and a postdoctoral fellow at the Salk Institute for Biological Studies, Chukoskie studied how the brain interprets eye movements to allow for motion perception. She thought a lot about the intersection of movement, eye gaze, attention, and cognition. Excited by the prospect of studying autism, she applied to the Cold Spring Harbor "Workshop on Autism Spectrum Disorders", seeking out the organizer to explain her interest and somewhat atypical background. She was accepted, and so began her new scientific path. Six months after that meeting, she was offered a job to lead a high risk, high impact research initiative devised by Cure Autism Now and Autism Speaks.

Top: Leanne wearing the eye gaze tracking headset
Bottom: Fungi explode in the video game Shroom Digger

During her time leading the initiative, Chukoskie noticed that there was something lacking in the autism field - quantifiability. Many of the measurements used were subjective and based on questionnaires or clinical judgment. How, asked Chukoskie, can you assess the efficacy of an intervention without an objective and quantitative measure? Here is where Chukoskie realized the potential to use movement as a metric for understanding autism and other developmental disorders.

While many think of autism as a disorder of social interaction, there are other symptoms typical of many autistic individuals such as sensory hypersensitivity, and motor impairments. Subtle motor impairments can be observed by measuring the movement of the eyes- how they shift from place to place, how well they move to find a target, and how well they stay in place when instructed. Chukoskie likely wouldn't have thought to use the eyes as a proxy for movement abilities if she hadn't spent years tracking the eyes of monkeys in her earlier work studying the visual system. This unique approach for studying autism impressed the director of the Research on Autism and Development Lab at UCSD, Dr. Jeanne Townsend.

Chukoskie found a kindred spirit in Dr. Townsend. As Chukoskie recalls, Townsend told her "Before I retire, I want to not only measure, but to intervene." Together, they devise experiments to improve the motor planning and execution capabilities of children with autism. They've had to be creative in this process to find tasks that are both engaging and accessible. What better way to capture a child's attention than a video game? Using eye tracking technology, they collaborated with a developer to create a set of video games which use eye gaze as the controller to steer spaceships, blow up mushrooms and play whack-a-mole.

So far, preliminary results have been promising. Subjects have shown improvements in other fixation and spatial attention tasks after daily videogame training. The ultimate question is whether these improvements can translate into meaningful behavioral changes for those on the autism spectrum like an increase in social engagement. Once again, Chukoskie is looking to eye gaze to give her quantifiable information about social engagement. In collaboration with Townsend and, Professor Pamela Cosman, an electrical engineer, she is developing a system for clinical use that can quantify a patient's real-world gaze behavior. How often might an individual with autism make eye contact with a nearby individual versus focus on the lamp in the corner of the room? By quantifying social and motor impairments and working to improve these metrics, Chukoskie is sure to make a big splash in the Autism field.

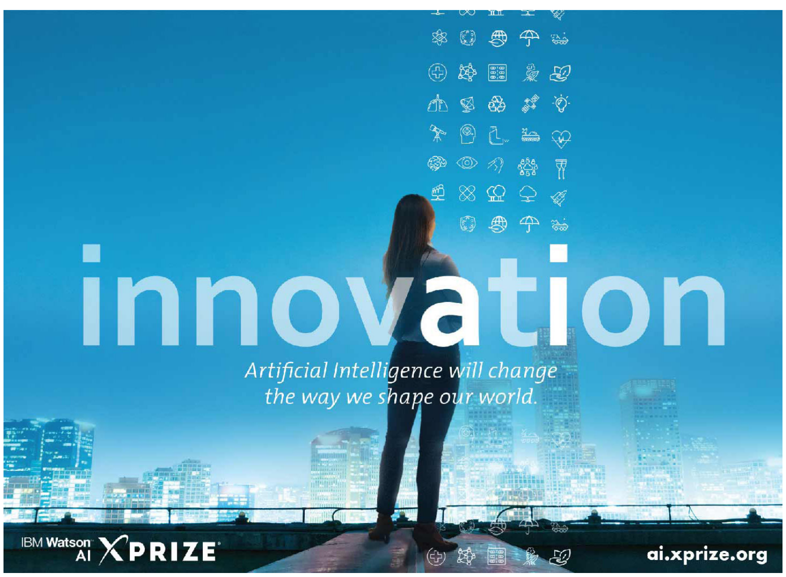
UC SAN DIEGO RESEARCHERS SELECTED FOR IBM WATSON AI XPRIZE® COMPETITION

TEAM AIMS TO GIVE "CREATIVE MACHINE THINKING" ABILITIES TO LEADING COGNITIVE COMPUTING SYSTEMS

A team of researchers at UC San Diego has been selected to take part in the IBM Watson AI XPRIZE ®. The competition aims to accelerate the development and adoption of artificial intelligence (AI) technologies that are truly scalable and have the capacity to solve grand challenges facing society.

The UC San Diego scientists plan to give some of the world's most sophisticated computing systems the ability to come up with new ideas and perform "creative machine thinking." This work has applications for a wide range of areas, including contextual data analytics, transportation systems, communications networks, studying the spread of infectious diseases as well as malware, cybersecurity, genomic medicine, autonomous vehicles, and the study of the biological brain and neurological disorders.

The UC San Diego team – called the UC San Diego Center for Engineered Natural Intelligence Team is one of only eight university-led teams in the competition, which includes $5 million in prizes. One hundred forty seven teams will take part in the first round of the competition.



The driving force behind the UC San Diego team is the leadership of the UC San Diego Center for Engineered Natural Intelligence (CENI), which is a new interdisciplinary research center at the Jacobs School of Engineering. The team is leveraging its unique expertise in theoretical and computational neuroscience, experimental neurobiology, neural engineering, mathematics, and algorithms to develop natural intelligence for machines. The goal is to give cognitive computing systems the ability to think creatively on their own and to arrive at original ideas and thoughts about specific problems or specific classes of problems. Getting there will require the researchers to leverage their work on a new class of dynamic artificial neural networks that go beyond traditional machine learning methods.

For the XPRIZE competition, the UC San Diego team is working on proof-of-concept demos that will help the general public experience what is possible when they apply the work of the Center for Engineered Natural Intelligence to some of the world's most advanced cognitive computing systems.

"We are working towards enabling cognitive computing systems to achieve creative machine thinking through the generation of internal representations that go beyond patterns in data ingested by these systems. We are also working to enable these systems to express those thoughts to humans in real time using natural language," said Gabriel A. Silva, a professor of bioengineering and neurosciences at UC San Diego, who leads the Center for Engineered Natural Intelligence. "The algorithms we are developing and the engineering we are doing to push the limits of artificial intelligence are also allowing us to approach the study of the biological brain as a system from new perspectives. This is extremely rewarding because it offers new opportunities to understand how the biological brain functions."

ENHANCED COGNITIVE COMPUTING SYSTEMS

The UC San Diego Center for Engineered Natural Intelligence is already developing artificial intelligence systems based on unique neuroscience and mathematics-based theoretical frameworks. These frameworks have allowed the team to abstract algorithms from the biological brain that capture insights on how the brain manipulates data and learns, and how natural language is generated by the brain. The UC San Diego team plans to use these algorithms and software systems to leverage existing core natural language processing and deep learning capabilities of today's cutting edge cognitive computing systems to build a higher level of cognitive processes. This will be critical for realizing the full potential of machine learning and artificial intelligence.

The researchers envision that their approach will

UC SAN DIEGO RESEARCHERS SELECTED FOR IBM WATSON AI XPRIZE® COMPETITION CTND

lead to a new generation of systems that do not suffer from the constraints of today's machine learning technologies, including the need for extremely large training sets and huge computational and energy resources. The team also aims to create systems that avoid another important bottleneck: an almost complete inability to adapt or abstract beyond training sets. The biological brain's ability to learn by analogy and extrapolate beyond a very small, limited training set, is the basis for creativity and original thoughts.

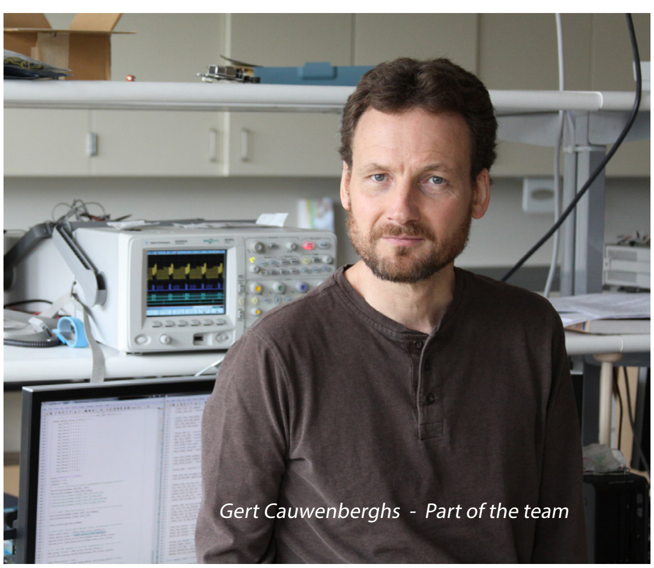
"For engineers, building creative capabilities into cognitive computing systems is one of the grand challenges for the future. But nature has already solved this problem many times," said Timothy Gentner, a professor of psychology and neurobiology at UC San Diego. "By leveraging neurocomputational strategies and neurophysiological insights gleaned from empirical studies of how real brains learn and manipulate information during cognitive behaviors, our team aims to build more efficient, robust, smarter and more creative machines."

In short, the UC San Diego Center for Engineered Natural Intelligence Team aims to build out the capabilities of cognitive computing systems so that these platforms function more like a biological brain.

This approach will produce – in the "brains" of machines – ideas not present in existing associations or data patterns.

UC SAN DIEGO TEAM

The UC San Diego Center for Engineered Natural Intelligence Team for the IBM Watson AI XPRIZE includes:



Gert Cauwenberghs - Part of the team

GERT CAUWENBERGHS, professor of bioengineering and neurobiology. Cauwenberghs leads the Integrated Systems Neuroengineering lab at UC San Diego and he Co-directs the INC.

HENRY ABARBANEL, professor of physics at UC San Diego and also research physicist at the university's Scripps Institution of Oceanography

FAN CHUNG GRAHAM, professor of mathematics and computer science and engineering

JEFFREY L. ELMAN, distinguished professor of cognitive science, Chancellor's Associates Endowed Chair

TIMOTHY GENTNER, professor of psychology and neurobiology Gentner lab at UC San Diego

GABRIEL A. SILVA, professor of bioengineering and neurosciences Silva leads Mathematical Neuroscience @ UCSD and directs the Center for Engineered Natural Intelligence at the UC San Diego Jacobs School of Engineering.

The team also includes a number of graduate students, postdoctoral researchers, research scientists and programmers.

IBM WATSON AI XPRIZE®

Driven by the desire to accelerate human and AI collaboration for the greater good, the IBM Watson AI XPRIZE provides an interdisciplinary platform for domain experts, developers and innovators, through collaboration, to push the boundaries of AI to new heights. One of the goals of the competition is to promote wider collaboration and support from the AI community to help all innovators create scalable solutions and audacious breakthroughs to address humanity's grandest challenges.

The IBM Watson AI XPRIZE includes four rounds. Each year, the teams will be evaluated for the opportunity to advance to the next round of the competition. The three finalist teams will take the stage at the TED 2020 conference in April 2020 to deliver talks demonstrating what they have achieved. The teams will also have an option to compete for two milestone prizes along the way. For more information, visit http://ai.xprize.org/

Written by Daniel Kane

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