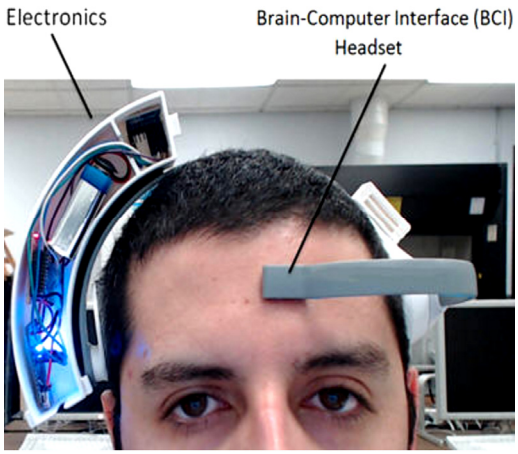
## *Facial Expression and Head Movement based Communication Device*




- **Utilizes blinks (EMG signals) and head movements**
- **Allows user to operate a computer and engage in electronic communications such as email, text, etc.**
- **Cost per device: less than $150**
- **Project funded by Disability Communication Fund and NSF**
- **As part of the project activity, 25 PALS (persons with ALS) were provided with the device at no cost to them.**

See below photos and comments from PALS from prototype trial sessions of the *Facial Expression and Head Movement based Communication Device* as part of a sponsored project.

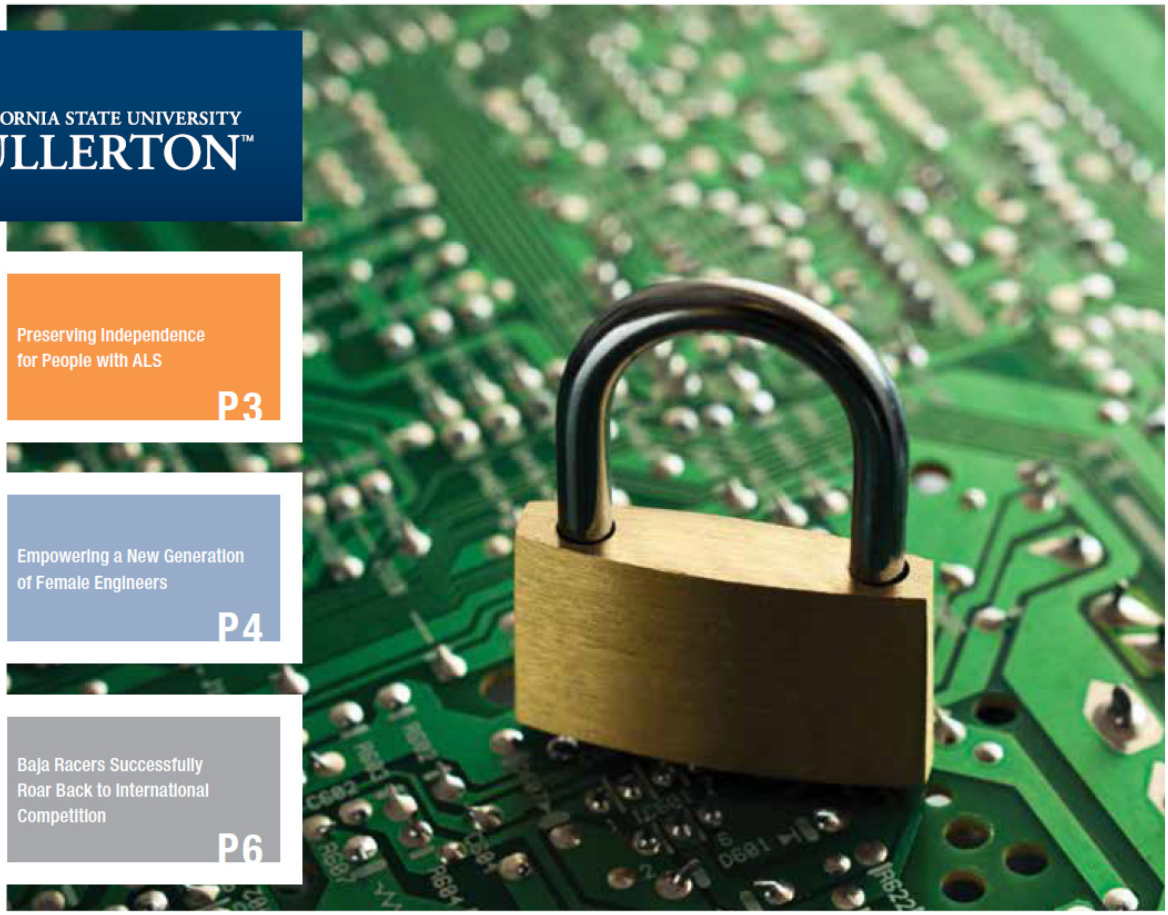
**KTLA News channel Interview - Facial Expression & Head Movement based Communication Device**


CALIFORNIA STATE UNIVERSITY FULLERTON™

Preserving Independence for People with ALS P3

Empowering a New Generation of Female Engineers P4

Baja Racers Successfully Roar Back to International Competition P6



CONNECTION

NEWS FROM THE COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

Issue Nine // Fall/Winter 2015

# New Cyber Security Center Opens to Educate and Protect

CSUF's newly established Center for Cyber Security in the College of Engineering & Computer Science (ECS) serves as a hub for security-related activities with a goal of establishing ECS as a leader in security education, research, and outreach.

Funded in part by Raytheon, the center will increase awareness of cyber and computer security.

"From job training to education, research, and outreach, the Center for Cyber Security provides expertise about cyber security issues," says ECS Dean Raman Unnikrishnan.

## Creating a Talent Pipeline

"Instead of teaching security as an afterthought or as an elective, we will incorporate the topic into mainstream curriculum," Unnikrishnan says. "We will integrate security into the thought and design processes of engineers and computer scientists."

Already, students can take "Introduction to Computer Security," "Cryptography," "Network Security Fundamentals," and "Cloud Computing and Security" courses. Faculty are developing additional courses, including malware analysis, and are working toward establishing an advising track in cybersecurity.

The center will provide outreach to organizations about security issues, as well as technical assistance and security analysis for community and industry organizations. ECS holds an annual Cyber Security Day to further communicate the importance of cyber security. This year's Nov. 13 event featured industry experts and student research presentations.

CONTINUED ON PAGE 2 ›

# Preserving Independence for People with ALS

George's students Aaron Castillo (right) and David Diaz (left) test the headset prototype on alumnus Dean Zarkos (far left).

**Kiran George, associate professor of computer engineering,** and his students are developing a device that will change the lives of patients dealing with degenerative illnesses such as amyotrophic lateral sclerosis (ALS).

"Fifty million Americans are affected each year with neurodegenerative disorders such as ALS, primary lateral sclerosis, and progressive bulbar palsy," says George. "Most of these patients lose their ability to speak and use their hands – especially in the final stages of the disease. They face tremendous barriers that make electronic communication a challenge, and this inability to communicate is equally frustrating and emotionally devastating."

George's proposed low-cost, brain-computer interface (BCI) electronic communication system would translate users' brain activities into computer commands. Last spring, Cal State Fullerton received a $100,000 grant from the Disability Communications Fund to design and pilot the project.

"Brain-computer-interface (BCI) creates a direct pathway between the brain and an external device," explains George. "Our goal is to enable people with ALS (PALS) to effortlessly access the Internet and engage in electronic communications."

The system's sensors will track thoughts, facial expressions, eye movements, and head movements and allow the user to email, text, chat, and Skype by voluntarily manipulating these bio-signals.

The most challenging aspect of the project is keeping the cost low (less than $200).

"Current systems cost thousands of dollars, so we're exploring alternative designs to find the optimum balance between cost and effectiveness," says George.

The team completed its preliminary prototype design last summer and ran trials with the ALS Association's Orange County chapter – receiving feedback from more than 15 PALS and 20 healthy subjects. In January, they'll train 20 PALS to use the devices in their homes.

50 million
AMERICANS ARE AFFECTED **EACH YEAR** WITH NEURO-DEGENERATIVE DISORDERS

George's brain-computer interface (BCI) electronic communication system needs to cost **less than**
$200
TO BE MARKET-READY

THE SYSTEM'S SENSORS WILL TRACK:

- THOUGHTS
- FACIAL EXPRESSIONS
- EYE MOVEMENTS
- HEAD MOVEMENTS

TO ALLOW THE USER TO EMAIL, TEXT, CHAT, AND SKYPE

http://www.fullerton.edu/ecs/_resources/pdf/ECS_Newsletter_Fall_2015_eVersion.pdf

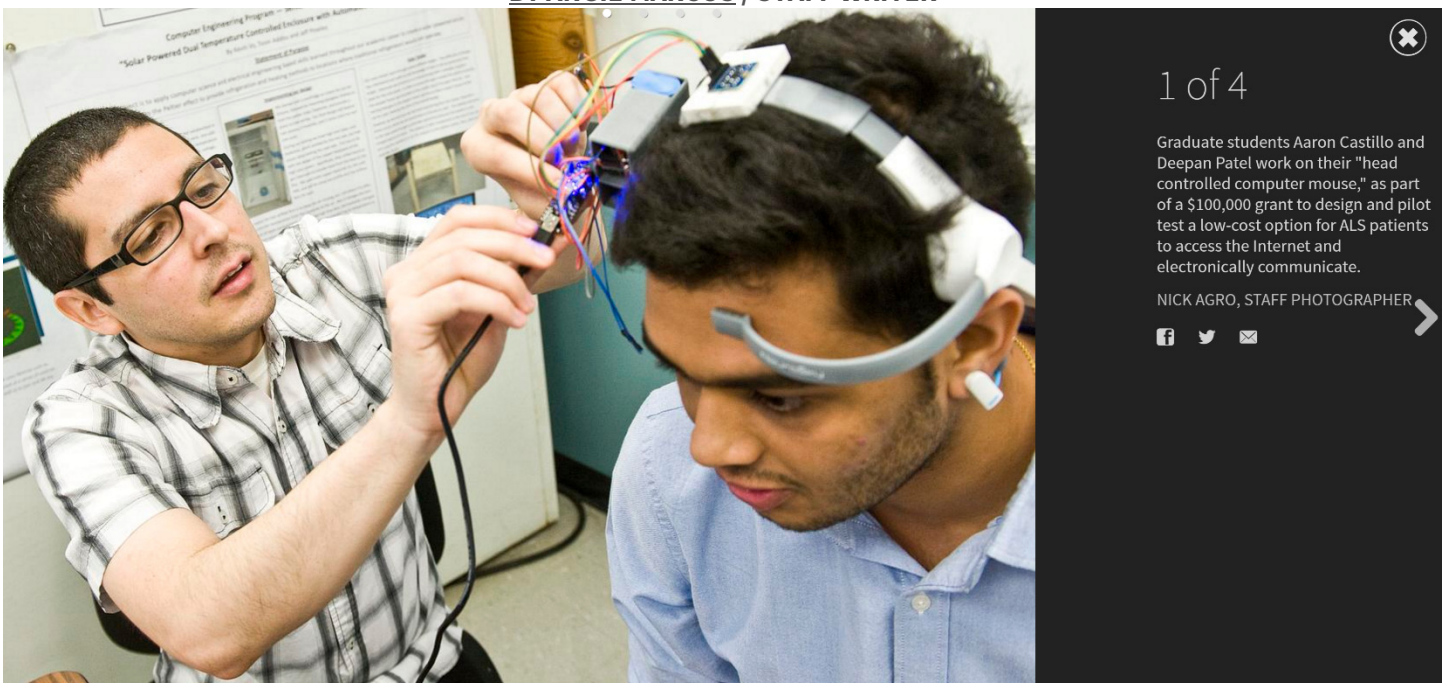
LIFE

# CSUF students work on a low-cost device to help people with ALS communicate online

April 21, 2015

Updated 8:11 p.m.

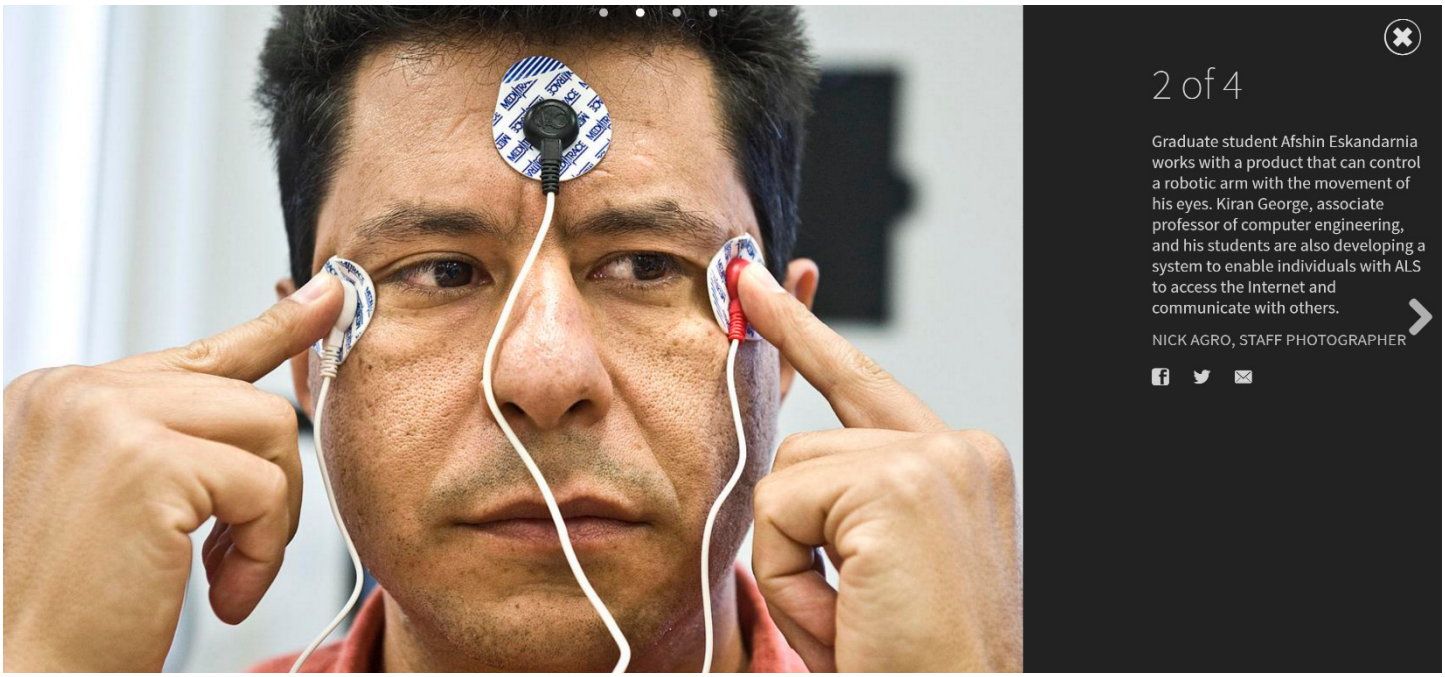
BY ANGIE MARCOS / STAFF WRITER




Tilt your head to the left and the cursor on your computer moves in that direction. Tilt your head to the right and the cursor immediately flashes across your screen to the right.

Raising your eyebrows enables a left click, while hard blinking your eyes enables a right click.

This is happening with a low-cost device seven Cal State Fullerton engineering students are working on. They hope it will allow those with amyotrophic lateral sclerosis, or ALS, to access the Internet and communicate with people electronically.




ALS, also referred to as Lou Gehrig's Disease, is a progressive neurodegenerative disease that affects nerve cells in the brain and spinal cord. The disease can cause muscle weakness in hands, arms and legs and can affect speech, swallowing and breathing.

About 75 percent of people with ALS – or PALS – require some form of communication assistance.

The CSUF project, titled "Low-cost brain-computer interface based wireless electronic communication system for ALS patients," is being led by Cal State Fullerton associate professor of computer engineering Kiran George.

George invited a select number of students from his classes to participate in the project.

The team is working to make the device as impactful, user-friendly and low-cost as possible, George said.

With the aid of the device, PALS will be able to communicate via email, text and chat messaging, social media and Skype, among an array of other options.

"Due to the aggressive and progressive nature of the disease, PALS are unable to leave the house," George said. "Simple tasks such as Internet browsing and electronic communications via social and media outlets allow them to stay connected to friends and family, and help them interact with fellow PALS."

**How it works**

Seven computer engineering and electrical engineering graduate and undergraduate students are working to create two types of headsets for the system.

"Dr. George offered me the opportunity to do some real life research and I jumped at it," said Aaron Castillo, a 31-year-old graduate computer engineering student.

"We just want to improve their quality of life as much as we can," he said.


The electronic communication device is made up of four main parts: a gyroscope, which measures orientation; a transceiver chip, which is a module that is used to communicate wirelessly; a microcontroller; and a brain-computer interface headset.

The headset has an arm that extends over the individual's forehead. The arm recognizes the user's facial expressions and movements when they raise their eyebrows – left click – or hard blink – right click.

The gyroscope recognizes when the individual tilts his or her head left or right, allowing the mouse cursor to mimic the movement.

If an individual's ALS is so severe it has inhibited their ability to hold their head upright, the headset can be re-configured to recognize the head tilt as the neutral point.

The most challenging part of the project has been keeping the cost of the device reasonably low, George said.

Ideally, the group would like the system to cost less than $200; similar systems can cost thousands of dollars.

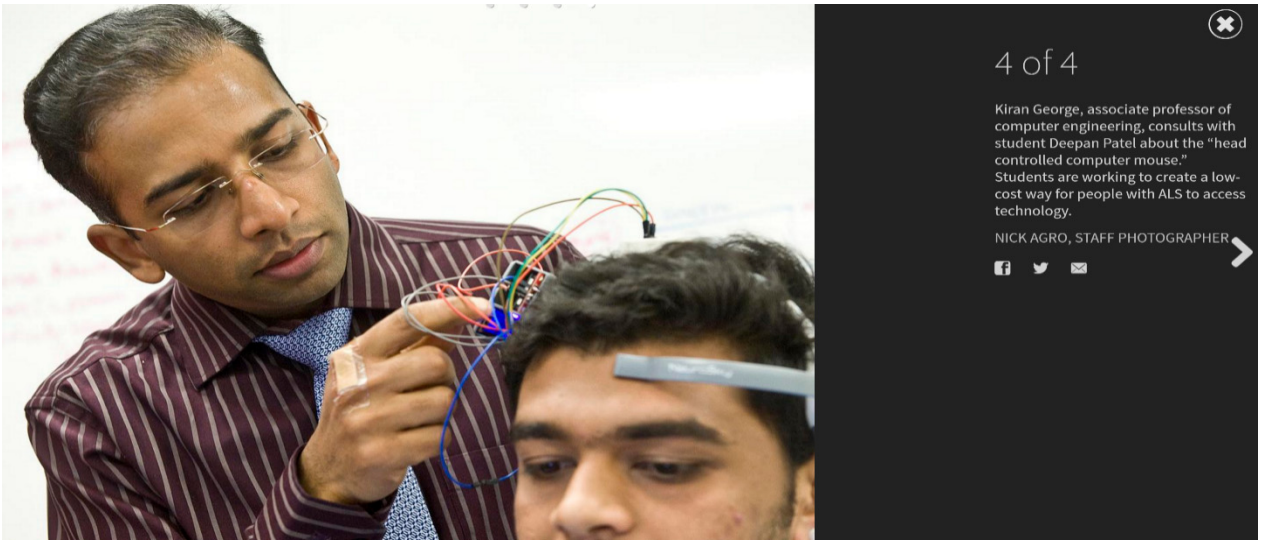
"We're trying to find as many cheap parts as we can and stretch them to their limits," Castillo said. "The most expensive part is the headset."

A second project the students are working on is an extension of the electronic communication project: An "electrooculography" system for a robotic arm.

The EOG system will allow the arm to be controlled by a person's eye movement. If the individual looks left, the arm will move left; look right and the arm follows suit.

Next on the agenda is allowing the arm to grasp objects and bring them to the individual based on eye movement and facial movement.

Students have worked on the software, manufacturing and configuring of many of the projects' details. Other items, like the robotic arm itself, were purchased from outside vendors.




Prototypes for both projects are still under evaluation.

**A user-friendly device for individuals with ALS**

David Diaz, a 25-year-old computer engineering graduate student, is working on a virtual keyboard for the electronic communication project.

With a readily available virtual keyboard, not much clicking is needed. Instead, the individual can lead the cursor with a tilt of the head to the first few letters of a word and the software will offer word suggestions, Diaz said.

This adds to the project's main goal of helping PALS communicate in a world that relies so heavily on technology, he said.

ALS is a variable disease, meaning it effects each person in a different way and at a different rate.

This is what has made the project most challenging for Diaz.

"I can test this as much as I want on myself, but you may have a different hard blink or eyebrow raise than me," Diaz said.

Because of this, each headset can be customized to reflect each individual's current needs, he said.

"We want to be able to use daily technology to our advantage," Diaz said. "Having this gives (PALS) the chance to communicate with people all over the world."

George became interested in the electronic communications project when he was a part of a mind-controlled robotic arm project last year headed by the ALS Association's Orange County chapter. In the next couple of months, the group will test its prototypes on PALS through a partnership they have formed with the Orange County chapter.

George recently received a $100,000 grant from the Disability Communications Fund for the development of the project.

http://www.ocregister.com/articles/project-658920-arm-george.html

# Grant will fund project to create communication device for ALS patients

BY
ANDREW CAMPA

– POSTED ON MARCH 17, 2015**POSTED IN:** NEWS

The group of students, led by Associate Computer Engineering Professor Kiran George, are working to creat an affordable communication device for patients diagnosed with ALS. (Courtesy of Kiran George)

A group of students, led by a Cal State Fullerton computer engineering professor, is working to make communication easier for patients diagnosed with amyotrophic lateral sclerosis, also known as Lou Gehrig's disease or ALS.

Kiran George, Ph.D., associate professor of computer engineering, hopes to create an affordable wireless prototype that will allow people with ALS to communicate and even use social media through thoughts and body signals, he said. The project is funded by a $100,000 grant from teh Disability Communications fund based in Oakland, California.

The device George and his team are developing would cost a fraction of what current communication systems do—just $200.

The device would take steps toward limiting the cost of living with ALS, which can reach into the six figures over a lifetime.

Costs associated with ALS care have been estimated at $63,692 per year, according to a 2013 study by the Muscular Dystrophy Association.

"The overarching goal of this project is to design and pilot test a low-cost electronic communication system that would allow persons with ALS to effortlessly access the internet and engage in electronic communications," George said in an e-mail.

Current communications systems are pricey and don't adapt well to patients' changing conditions, George said.

“Currently available systems, similar to the one being developed at CSUF, cost thousands of dollars,” George said.

“Moreover, these systems cannot be customized to the needs of patients as their symptoms worsen—as the disease progresses patients are unable to use the previously used input.”

The system George and his team are working on would improve on some of those deficiencies.

“The communication system I envision is a wireless headset with four to five sensors that the patients would wear to operate a laptop or tablet that will have a shelf-life of three to four years,” George said.

The system would track biosignals, including thoughts, through EEG signals and facial expressions using EMG signals. It would also track movement of the patient’s head using a gyroscope, George said.

The system will let patients control electronic devices such as laptops and tablets for communications such as email, text, chat and Skype by voluntarily manipulating these biosignals, he said.

In accepting the grant, George and his students have one year to develop the system, and will file two progress reports with the Disability Communications Fund, the first of which will be due in June.

Before then, George plans to test a prototype with patients in May.

The thought of learning valuable experience was one that 25-year-old Fullerton master’s student, David Diaz, said he couldn’t pass up.

“(George has) given us an objective toward making it easy for ALS patients to work toward having the ability and convenience to work on the computer with limited movement,” Diaz said. “He provides us adequate tools, software, equipment to help us work toward that experience.

For now, George has five CSUF students performing a variety of tasks, but that number could increase soon.

“Currently all students working on the project are students from my classes,” George said. “In summer, several students from the community colleges will also have the opportunity to be involved in the project.”

Yeu Cheng, a second-year computer engineering master’s student, contributes to the technical aspects of the project.

The experience goes beyond working with the latest tools and gives the group a chance to impact others’ lives, he said.

“We’re really working with very cutting-edge technology and it’s kind of like a field that’s still very new,” Cheng said. “You know, the emergence of robotics mixed with interfacing with the brain and all that, so it’s really exciting to work in the field and to know that what we do can potentially have a positive impact on the people with ALS.”

https://dailytitan.com/news/grant-will-fund-project-to-create-communication-device-for-als-patients/article_42715ee9-b08a-5545-800d-f861243a97f7.html

CSUF NEWS SERVICE

# Student Research for ALS Patients

*User-Friendly Prototype Helps People Communicate Online*

Aug. 25, 2015

*Student Aaron Castillo tests a high-tech communication device that he and fellow classmates are developing with computer engineering faculty mentor Kiran George to help those with ALS.*

Computer engineering major Krystle Ilisastigui hopes her efforts to help develop a high-tech communication device will improve the quality of life for those with amyotrophic lateral sclerosis, or ALS.

Ilisastigui and several of her classmates are developing an electronic communication system to enable ALS patients to access the Internet and communicate via email, text document, chat or Skype using thoughts, facial expressions and head movements, said Kiran George, associate professor of computer engineering.

George and his students have worked on the prototype since February — supported by a $100,000 grant from the Oakland-based Disability Communications Fund — and partnered with the ALS Association Orange County Chapter to fine-tune the technology and design.
This summer, the communication device was tested with the help of patients at the chapter's Tustin office.

*Student David Diaz tests an electronic communication system with the help of alumnus Dean Zarkos, which would allow him and other ALS patients to use a computer using thoughts, facial expressions and head movements.*

I have 100 percent faith in you," said Cal State Fullerton alumnus Dean Zarkos, diagnosed with ALS in 2011, as students placed a wireless headset on him.

With the device, patients like Zarkos — who uses a motorized wheelchair and is unable to move his hands, arms or legs — can communicate online with head tilts and facial expressions.

"What they are doing is phenomenal: it's cutting-edge technology. Anything that can help patients like myself is a tremendous asset for us," said Zarkos '78 (B.A. political science) of Seal Beach, who holds an MBA and law degree and owns a property management business.

"I can see it opening up the world for people like me. You can do email — communicate with anybody. These students make me proud to be a Titan."

ALS, commonly known as Lou Gehrig's disease, is a progressive neurodegenerative disease. An estimated 75 percent of ALS patients lose their ability to speak, along with use of their hands, said George. Speech problems are progressive, and most will experience a severe breakdown in their ability to communicate with others, he added.

"Patients face tremendous barriers that make electronic communication a challenge. This inability to communicate is equally frustrating and emotionally devastating," George added. "But this device will help them to engage in electronic communication and allow them to stay connected to friends and family."

What is most appealing about the technology is that the device is user-friendly, requires minimal training and is low cost, observed Jared Mullins '04 (B.A. political science), executive director of the ALS Orange County Chapter.

The wireless communication system utilizes commercially off-the-shelf components to minimize design time and cost, George explained. The goal is to keep the device's cost under $150.

While the project allows students to apply what they learn in class and put it to practical use, it also is an eye-opening experience in seeing how their work could help ALS patients regain control of simple tasks.

"It's been challenging and a great learning experience for us to work directly with the patients," said graduate student David Diaz. "It's real hands-on — something you are not going to get in the classroom."

Fellow graduate student Aaron Castillo added that one of the biggest challenges has been to personalize the device to meet patients' needs as the disease progresses.

"We're going to give this project everything we have; we just want to help," Castillo said.

George and his students also are working on other brain-controlled systems for ALS patients, in which thoughts and expressions can be used to control a robotic arm and electric wheelchair.
http://news.fullerton.edu/2015su/ALS-research.aspx
http://news.fullerton.edu/publications/titan-report/Titan-Report-Oct-2015.pdf

TITAN REPORT

CALIFORNIA STATE UNIVERSITY FULLERTON

OCTOBER 2015 | news.fullerton.edu

## STUDENT RESEARCH FOR ALS PATIENTS HELPS PEOPLE COMMUNICATE ONLINE

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If you are interested in supporting this project, contact Hart Roussel, director of development for the College of Engineering and Computer Science, at hroussel@fullerton.edu.