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A University of Texas at Arlington College of Engineering team has received two National Science Foundation grants worth a combined $802,000 to develop an adaptive, game-driven system to improve physical and mental assessments of children with cerebral palsy. The disorder affects movement, muscle tone or posture and is caused by injury or abnormal development in the immature brain, most often before birth, according to the National Institutes of Health. Some 800,000 children and adults in the United States are living with one or more of the symptoms of cerebral palsy, the United Cerebral Palsy Foundation estimates. The Centers for Disease Control and Prevention estimates that 10,000 babies are born in the U.S. each year will develop cerebral palsy.

Fillia Makedon, chair of UT Arlington’s Department of Computer Science and Engineering, is principal investigator for the project, which will focus on children ages 5 to 8 years old. She credited Georgios Alexandrakis, a UT Arlington assistant professor of bioengineering, with proposing the collaborative research project.

“We talk to a lot of doctors and they thought teaming up to build this system would be a great idea that could benefit a lot of children,” Alexandrakis said.

Makedon’s team is developing a cyber-physical system called CPLAY. Families of affected children would be able to download different types of game therapy from the Internet.

“A back-end system would allow the clinician to see a history of how the child performed at different times of day, before or after a medication, and prescribe changes to the game activity remotely,” Makedon said. One idea the team has discussed is using a “data glove” that would allow a clinician to precisely determine the movement of the hand and each finger as the child plays. The game collects and analyzes different game performance parameters, such as how fast the child responds to the game, how long he plays and what type of score he gets in the game. Such data could help therapists relate to the patient’s daily life routine and occupational therapy treatment, Makedon said.

The team would develop simple games that could be programmed to the individual. Games could be changed for speed, complexity, color and other features to adapt to a child’s capabilities or preferences, Makedon added.

“These changes are important for diagnosis,” Makedon said. “The games can be played with any touch screen computer or mobile device.”

The games could be programmed to increase in complexity as the patient becomes better at the game, Makedon said. Occupational therapists would use these games to check the impact of their treatment.

“The feedback we receive from those children playing these games would better enable caregivers to use the correct rehabilitation regimen,” Makedon said.

Other physiological and clinical measures about the child also can be collected, such as facial expressions, the level of concentration through eye tracking, how the brain responds with a non-invasive brain-imaging headband, and verbal or sound expressions the child makes.
In addition, a video camera could capture and analyze facial expressions that could tell caregivers what kind of difficulty that patient might be having with those games, said Vassilis Athitsos, a UT Arlington assistant professor of computer science and engineering who is also working on the cerebral palsy project. Heng Huang, also a UT Arlington computer science and engineering assistant professor, said a camera could be mounted to measure emotion and facial change.

“Those expressions give caregivers a lot of feedback,” he said.

Alexandrakis will perform imaging of the activation patterns in the children using functional near-infrared spectroscopy, or fNIRS. The process involves a fiber optic device that is placed on the scalp while the child is playing the game. Near-infrared light scans the surface of the brain to localize areas activated during play. The measurements will provide caregivers a baseline of brain activity for each child, which is expected to differ with impairment level. The fNIRS measurements will be performed with a headband device consisting of “brush optodes,” which consist of fiber optic bundles that look like brushes so that they can thread through hair to perform imaging of brain activation patterns with increased sensitivity, Athitsos said.

The technology was recently developed through collaboration between Alexandrakis, Duncan MacFarlane of UT Dallas and Chester Wildey of MRRRA Inc. and funded through a TxMed consortium seed grant financed by UT Arlington, UT Dallas, Texas Instruments and Texas Health Resources.

The team has been working with rehabilitation and physical and occupational therapy experts and consultants from various institutions. Olga Dreeben, associate professor at UNT Health Science Center, provides evaluation and subjects. Angie Boisselle is an occupational therapy consultant at Cook Children Hospital. Maura Iversen, professor and chair of Physical Therapy at Northeastern University, believes that computer-based diagnostic technologies also could be used to assess many other debilitating conditions.

Makedon said she hopes the research results would lead toward transforming the way rehabilitation is done in the 21st century, especially for chronic diseases, by allowing the collection of valuable data from child activities at home, prior to visits with the therapist in the clinic.

This type of system that is being developed also introduces new ways of educating the physical and occupational therapist, Makedon said. It allows the therapist to compare histories of other children, and get a better understanding of how the child performs throughout the week. It also engages the parents and siblings in fun activities with the child, said Monica Basco, a UT Arlington assistant professor in psychology. “What we want to do with this system is not only measure the physical, but the mental state of the child as well,” Makedon said. “We think that would lead to a better life for these children.”

We are also hoping to apply the findings to other systems we are currently designing for stroke patients. Other members of the research team include Zhengyi Le of UT Arlington’s computer science and engineering department and Dan Popa of the electrical engineering department.

Provided by University of Texas at Arlington

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