In July 2012, Principal Investigator and CUbiC director, Sethuraman Panchanathan, was awarded a National Science Foundation I-Corps grant for the project, “Haptic Annunciator System for Situational Awareness.” The NSF I-Corps program, or Innovation Corps, trains researchers and engineers to become entrepreneurs in an effort to enrich and broaden the impact of NSF-funded research through customer discovery and commercialization. Each grantee team, composed of a principal investigator, entrepreneurial lead (student) and a business mentor, attends an intensive three-day training workshop. Each day, teams are
required to “get out of the building” to interview would-be customers of their proposed technologies to test and refine customer, product and business hypotheses. Teams are expected to validate and refine their business and products hypotheses to move toward successful commercialization of their innovations.

CUbiC’s NSF I-Corps team was jointly led by P.I. Panchanathan; entrepreneurial lead, Troy McDaniel, a postdoctoral research assistant at CUbiC; and business mentor, Donald J. Becka, a business professional with extensive experience with project and lead team management; negotiating and procuring customers and capital investments; and forming and managing small to large (enterprise-wide) project teams. The funded project, “Haptic Annunciator System for Situational Awareness,” stems from CUbiC’s NSF-funded iLearn project aimed at the development of assistive technology for enhancing the accessibility of education for individuals who are blind or visually impaired. This project evolved into the iCARE project, which encompassed assistive technology development to enhance activities of daily living, including the iCARE Social Interaction Assistant. The Social Interaction Assistant is an assistive technology for individuals with visual impairments for improving access to non-verbal social cues used during social interactions. As part of this project, a haptic belt consisting of an array of vibration motors embedded in a wireless, discreet and waist-worn belt was developed to improve the situational awareness of the wearer by conveying where interaction partners are located via distance and direction cues. The initial marketing focus of the I-Corps team targeted gaming applications given its large market potential, where a haptic belt could be used to improve the situational awareness of gamers, with the intent to later expand and transition to markets within assistive technology, military and remote communication.

The customer discovery exercises were a learning experience for the team, who during the first few days of the workshop (held at the University of Michigan), interviewed gamers, game developers and game sellers to receive real-world feedback regarding the perceived value of their proposed technology for gaming. While some gamers were enthusiastic about the idea, most found the technology cost prohibitive in that they were willing to spend a lot less for a gaming peripheral (an amount well below the cost to build the device). The team quickly pivoted to another commercial opportunity: wearable computers for stroke rehabilitation to support at home use using similar actuator technology found in the haptic belt. Between summer and fall of 2012, the team conducted over 50 interviews with physical therapists, occupational therapists and industry experts to identify the main barriers associated with existing stroke intervention practices. One of these barriers is patients’ non-adherence to therapist-prescribed exercises in the home setting. After validating their hypotheses through customer discovery, the team is currently developing and evaluating a wearable technology to promote stroke exercises at home.

Recently, Panchanathan and McDaniel, together with business mentor and industry expert, Grant Farrell, entered the entrepreneurial program, AZ Furnace, to take patented technology to market through a start-up company. While Panchanathan and McDaniel are still in the early stages of marketing their technology (they recently co-founded their company, RehabDev, LLC), the NSF I-Corps program has instilled fundamental knowledge related to customer discovery and hypothesis testing, enabling them to proceed with confidence rather than guesses and assumptions about market potential. They have also begun to apply these theories and methodologies to other research projects at CUbiC, encouraging researchers to “get out of the lab” to validate the potential use and marketability of technologies.
Many of the applications in machine learning and data mining which deal with physiological and biomedical data require person specific or person adaptive systems. The greatest challenge in developing such systems is the difference in data distributions between the persons or entities, making the task of modeling the data challenging. This research work addressed this problem of distribution differences and developed subject specific predictive and classification models for physiological and biomedical data.

At CUBiC, we have been exploring solutions to overcome the aforementioned challenges associated with traditional motor learning through the use of vibrotactile motor instructions and feedback using wearable computers. We conducted a psychophysical evaluation to find a set of intuitive and distinct vibrotactile instructions to cue fundamental movements of the arm, which allows the approach to be generalized across a variety of applications. The instructions were then augmented with vibratory signals for feedback related to (1) the amount of movement, and (2) the speed of movement. Such an approach could augment traditional motor learning within group settings as well as support remote motor learning in the home environment. We are currently exploring this technology to augment stroke rehabilitation both at the clinic and at home.
Ramin Tadayon is a Ph.D. student at CUbiC Lab. Ramin earned his undergraduate degree in Computer Science and honors degree at ASU, obtaining the Moerl Award as one of the top ten students in his graduating class. He obtained his gaming certificate at ASU’s gaming program, where he began research in serious games and their effects on learning and motivation. He completed his capstone project at CUbiC Lab, developing an Olympic track racing game with accelerometer input and haptic feedback for access by individuals with visual impairments. He has designed multiple games for education, including a platform game to teach elementary mathematics principles. His current research is focused on the design of a framework to motivate players to commit to long-term physical activity through elements of social gaming, for domains such as obesity and stroke rehabilitation. In addition, he is working on the design of a social game to promote community inclusion and a decision tree system to improve the pacemaker assessment process in medical practice. He plans to graduate in Spring of 2016.

Shayok Chakraborty is a Ph.D. student at CUbiC Lab. His research interests are in the fields of machine learning, computer vision and assistive technology. His dissertation work is based on the development of novel and efficient batch mode active learning frameworks, which can automatically identify the salient and representative samples from large amounts of unlabeled data. Shayok has publications in top tier conferences and journals (such as the IEEE CVPR, ICCV, NIPS, ACM Multimedia and the Pattern Recognition journal). His research work was selected for presentation in the Doctoral Symposium of the SDM, ACM Multimedia and AAAI conferences and also at the Multimedia and Vision meeting (organized by IBM Research) and the New York Academy of Sciences. He has a U.S. patent based on his research. He worked as an intern at Microsoft Research, Redmond. At ASU, he has extensively served as a teaching associate in the Computer Science department and has also taught a course on Mathematics. He was featured as an outstanding graduate student by the Graduate College of Arizona State University.

Dr. Vineeth N Balasubramanian completed his Ph.D. in Computer Science at CUbiC under Dr. Panch in Sept. 2010. His dissertation, titled "Conformal Predictions in Multimedia Pattern Recognition" was nominated for the Outstanding Ph.D. Thesis Award in the Department of Computer Science at ASU. He is currently an Assistant Research Professor at CUbiC, as part of the School of Computing, Informatics and Decision Systems Engineering at ASU. He also currently serves as the Associate Director for CUbiC, and as the Research Director for the NSF-funded IGERT program called the Alliance for Person-centered Accessible Technologies (APAcT). He also holds dual master’s degrees in Mathematics and Computer Science from Sri Sathya Sai Institute of Higher Learning, India, and worked at Oracle Corporation for two years before his doctoral studies. Vineeth was awarded the Gold Medals for Academic Excellence in the bachelor’s program in Math in 1999, and for his master’s program in Computer Science in 2003. His research interests include pattern recognition, machine learning, computer vision and multimedia computing for applications in assistive and healthcare technologies. He has published over 40 papers in international peer-reviewed conferences, workshops and journals, holds 2 patents (pending) and is currently co-authoring a monograph based on his dissertation work. He has organized tutorials in leading conferences, such as AAAI and IJCNN, and has also served in the organization of top-tier conferences such as ACM Multimedia. Vineeth remains an active member of the CUbiC family and intends to pursue an academic career that can make a positive impact on the lives of students in the near future.
**Highlights**

**Recent Publications**


5. R. Chattopadhyay, Q. Sun, S. Panchanathan, W. Fan, "Multi-Source Domain Adaptation for Early detection of Fatigue using Surface Electromyogram Signals," ACM Transactions on Knowledge Discovery from Data (TKDD), 2012.


**News**

**VEX Robotics Arizona Volunteer of the Year**

CUBiC Ph.D. student researcher Eric Luster, and this year’s Director of student competitions for the Engineering Open House, received the VEX Robotics volunteer of the year award on Mar. 2.

**Engineering Open House**

The Ira A. Fulton Schools of Engineering hosted an Engineering Open House (EOH). CUBiC held exhibits and demonstrations on a few of their research projects on the Tempe Campus on Mar. 1 and Mar. 2.

**Workshop on Rehabilitation Robotics**

CUBiC attended the Piper Health Solutions Workshop on Rehabilitation Robotics on Feb. 22 and Feb. 23. CUBiC Director Dr. Sethuraman Panchanathan gave a welcome address and Dr. Troy McDaniel gave an invited talk titled, “Vibrotactile motor instructions and feedback to enhance traditional motor learning and rehabilitation intervention.”

**Recent Visitors**

- Dr. Arden L. Bement, Jr., Former Director NSF
- Dr. Jim Levine, Mayo Clinic, Phoenix.
- Robert S. Green, CEO, Arizona Bio Industry (AZBio)
- Josh Friedman, Vice President for Strategic Philanthropy, ASU Foundation
- Alion Science and Technology
- Dr. Andrew Fagg, Associate Professor of Computer Science and Bioengineering, University of Oklahoma
- Walden Grove High School Class (12), Sahuarita, AZ

**Upcoming Events**

**ICME 2013**

The IEEE International Conference on Multimedia and Expo will be held at San Jose between July 15, 2013 and July 19, 2013. CUBiC will have its exhibits and research showcased at the conference. More information can be found at [http://www.icme2013.org/](http://www.icme2013.org/)