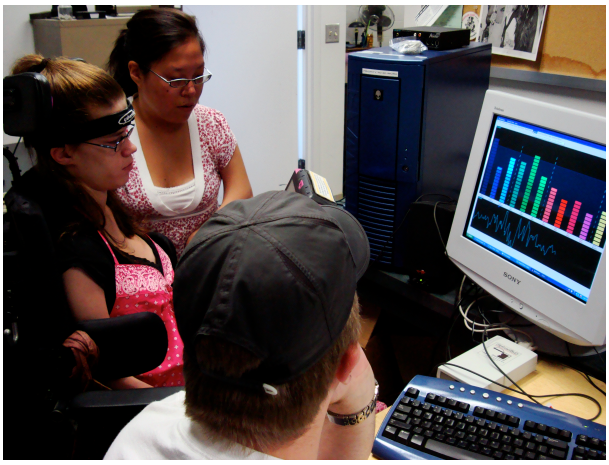
NSF Highlights

Wright State Researchers Explore Ways to Improve Access to Information Technologies



IGERT Fellows Jenny Border and Jim Leonard introduce undergrad Sarah Pyszka to the Brainfingers Accessibility System.

Researchers at Wright State University are seeking ways to improve the accessibility to information technologies for people who are unable to use standard input devices such as the keyboard and the mouse. This work involves collaborations with local partner, Brain Actuated Technologies, Inc. and with Danish researchers at IT Copenhagen. This research is one component of a strategic commitment that Wright State University has made to universal access to education. Leveraging the advantages of a campus designed to accommodate students with mobility impairments, the university has placed specific emphasis on improving the opportunities for students with severe physical disabilities to pursue careers in STEM fields (Science, Technology, Engineering, and Mathematics). The work is supported by two major grants from the National Science Foundation. One of the NSF awards comes from the NSF's IGERT Program (Integrative Graduate Educational and Research Traineeship). This award supports a multidisciplinary graduate research program in Learning with Disability (LwD). The LwD program is a collaboration between the College of Science and Mathematics and the College of Engineering that involves Ph.D. programs in Biomedical Sciences, Computer Science, Engineering, and Human Factors & Industrial/Organizational Psychology. The bulk of the funding for the IGERT program goes to stipends and research support to graduate students whose dissertation research is directed to enhancing learning opportunities for people with disabilities. The second award, from NSF's Research in Disabilities Education (RDE) program supports the Ohio STEM Ability Alliance (OSAA). The OSAA is a collaboration between Wright State, Ohio State, Columbus State, and Sinclair Universities to increase the numbers of students with disabilities who succeed in STEM careers. OSAA is specifically designed to increase the participation and success of students with disabilities in STEM fields of study. The program includes comprehensive advising, learning communities, mentoring, and internship programs. The OSAA program is additionally supported by the State of Ohio in the form of Choose Ohio First Scholarships for Ohio students with disabilities who choose STEM undergraduate majors at OSAA institutions.

The amazement is obvious as attendees at the National Center for Technology Innovation observe IGERT Fellow and OSAA scholar Jenny Border using the Brainfingers Accessibility System. IGERT Fellow Jim Leonard then lets the visitor try it for herself.

The Brainfingers Accessibility System

The Brainfingers Accessibility System is being developed by local entrepreneur Andrew Junker. Research on this system began in collaboration with the Air Force as a potential way to enhance the interface between pilots and their aircraft. More recently it has attracted the interest of computer gamers who are always seeking a competitive edge. The research collaboration between WSU and Brain Actuated Technologies is being supported by a recent grant from the National Center for Technology Innovation (NCTI). WSU graduate students, Jennifer Border, Jeh Cooper, and Jim Leonard recently presented their research at the NCTI National Conference in Washington, D.C., where they were given the “Brightest Idea Award” as one of the most innovative programs currently being supported by NCTI.

The Brainfingers system senses electrical potentials that result from both muscle (e.g., EMG, EOG) and neural (central nervous system) activity. The associated software is able to filter the signals into distinct channels (or brainfingers) associated with the different sources. Activity of the brainfingers can then be mapped to computer commands (e.g., discrete key presses or mouse clicks or proportional cursor movements). The research program at WSU is assessing the viability of this system for improving accessibility to information technology for individuals who are unable to use standard input devices (e.g., keyboard or mouse).

IGERT Fellow and OSAA Scholar, Jennifer Border is a prime example of the potential of the Brainfinger Accessibility system. Due to a congenital disorder, Jennifer has minimal functionality in her arms. As an undergraduate psychology honors student, Jenny typed the papers for her courses and her honors thesis using a stylus held in her mouth. Over the last two years, Jenny has become a skilled user of the Brainfingers System. Jenny beams as she recounts her first experiences playing Mario Brothers using the Brainfingers System. Throughout her youth her only interaction with computer games was as a spectator watching her friends play. She says that with Brainfingers she can finally participate and now appreciates for the first time the joy that her friends were experiencing. Jenny’s graduate research is evaluating human performance using Brainfingers in conjunction with various typing interfaces including the Gaze-Talk system developed at IT Copenhagen and the Dasher system developed at Cambridge University.

They came ...

They saw ...

They conquered ...

WSU Graduate students, Jim Leonard, Jeh Cooper, and Jenny Border receive the Brightest Idea Award at the Annual Conference for the National Center for Technology Innovation in Washington, D.C.

Although there is clear evidence that people can learn to use the Brainfingers associated with muscle sources (EMG - muscle tension; and EOG - eye movements), there is some skepticism about people’s abilities to independently control those Brainfingers associated with central nervous activity (e.g., Alpha and Beta brainwaves). Jeh Cooper’s research is directly assessing this question. Jeh’s research is evaluating people’s ability to learn to use the different Brainfingers independently. Participants in Jeh’s research are given an opportunity to play “Pong” using four different Brainfingers including both muscle and central nervous system sources. Jeh is simultaneously measuring activity from both the muscle and

central nervous system sources. Using cross correlations among the behaviors of the different fingers, he is able to evaluate the degree to which each finger can be controlled independently from the other fingers.

IGERT Fellow, Jim Leonard, is evaluating the potential of the Brainfinger Accessibility system in facilitating communications for people who are 'locked in.' These are people who have degenerative muscle disorders (e.g., ALS or TBI) that severely limit their ability to communicate. In these cases, fully active minds have limited (e.g., eye blinks) or no capability to express their thoughts or feelings due to the lack of control over muscle systems. Jim is working with a local elementary student with a severe degenerative muscle disorder to see whether the Brainfingers system can provide a richer channel for communication.

Eye-Gaze Interaction

Researchers at Wright State have also been collaborating with researchers at IT Copenhagen to develop affordable systems for eye-gaze interactions with computers. These systems are designed to allow people to perform the point and click operations needed to interact with computers (e.g., to surf the web) using their eyes. Again, target populations are those who, due to motor limitations, are unable to use standard devices (e.g., keyboards or mouse). Systems designed at IT Copenhagen use inexpensive, off-the-shelf cameras as the primary source of information for tracking eye-movements. The positive aspect of this is the affordability of these devices, the drawback is the resolution of the eye-tracking. The challenge is to compensate for low camera resolution with clever design of the interactions. The development work at IT Copenhagen is directed by Professor John Paulin Hansen and this work is supported though a European Research Consortium (COGAIN - COmmunication by GAze INteraction).

WSU grad student and IGERT Fellow Julio Mateo has been the primary participant in Dayton. This has involved several trips to Denmark to work with colleagues at IT Copenhagen. Additionally, Dr. Hansen has visited WSU numerous times on research sabbaticals and to attend conferences. His Ph.D. students Javier San Agustin and Henrik Skovsgaard have each made extended visits to WSU in conjunction with their dissertation research.

Javier San Agustin from IT Copenhagen and WSU grad student and IGERT Fellow Julio Mateo work to calibrate an affordable eye-tracking system.

Henrik Skovsgaard from IT Copenhagen demonstrates an eye-tracking system to WSU grad students and IGERT Fellows Allysa George and Stephanie Auld.

Summary

The research described above on hands-free interactions with information technologies is only a small component of a comprehensive program of research and educational opportunities at Wright State University to explore ways to enhance the learning opportunities for diverse populations. Other research

projects include research on computer interfaces and navigation aides for those with visual impairments; interfaces to enhance safety for pilots with hearing impairments; use of virtual reality to facilitate recovery of locomotion for those with leg injuries and artificial limbs. These research programs are supported by faculty involved in Ph.D. programs in the College of Science and Mathematics and the College of Engineering and the work benefits greatly through collaborations with the Office of Disability Services directed by Jeff Vernooy. This work falls within the sphere of The State of Ohio Center of Excellence in Human Centered Innovation at Wright State University.

John Flach, Professor and Chair of Psychology is the Principle Investigator for both programs sponsored by NSF (IGERT:LWD and RDE:OSAA) Clark Shingledecker is the administrative director of the OSAA and IGERT programs. Please contact John Flach (john.flach@wright.edu, Clark Shingledecker (clark.shingledecker@wright.edu), or Jeff Vernooy (jeffrey.vernooy@wright.edu) for additional information or questions related to research and educational opportunities for students with disabilities. Additionally, information can be found through our LWD web page (http://www.wright.edu/lwd/index.html). Note that Choose Ohio First Scholarships are available to Ohio students with disabilities who are interested in pursuing STEM careers.