

Technology for Human Augmentation

Mike Daily, HRL Laboratories

Antti Oulasvirta, Aalto University

Jun Rekimoto, University of Tokyo

Computing technologies have rapidly transformed our world and, perhaps unsurprisingly, have a profound capacity for transforming us. Given our inherent human vulnerabilities and limitations, these technological advances do more than just pick up the slack. The articles in this special issue exemplify novel ways of augmenting human communications, sensing capacity, neurological fortitude, and more.

Technologies that enhance human productivity and improve or restore capabilities of the human body or mind are an area of computing we refer to as human augmentation. Advances in such technologies are empowering, offering improvements to human health, quality of life, and functional performance. Examples of human-augmentation applications include devices and implants that contribute to advanced sensory capabilities, such as glasses for viewing augmented visual content, next-generation cochlear implants for auditory sensing and processing, limb prostheses or devices that enhance muscle functioning and capabilities with minimal invasiveness, and neurological stimulation techniques to improve learning or cognition.

Other types of human-augmentation technologies work with specific IT resources including the cloud, big data, and mobile computing. These include wearable devices such as watches or bracelets that link the

IN THIS ISSUE

We received numerous high-quality submissions for consideration, and after rigorous assessment by dedicated reviewers, we selected four articles showcasing several important facets of human-augmentation technologies. These include two articles addressing important aspects of visual augmentation for users, one article covering new ideas for human-body-mediated communication, and one article describing new approaches to improving brain function via neurostimulation.

In "Personalizing 3D-Printed Smart Eyeglasses to Augment Daily Life," Florian Wahl, Rui Zhang, Martin Freund, and Oliver Amft describe a digital development process to physically personalize smart eyeglasses for individual wearers. Their model using customization and 3D printing to produce eyeglass frames with embedded sensing technologies yields excellent frame fit and comfort comparable with traditional eyeglasses. The authors also highlight

Mary B. Rosson, John M. Carroll, Kevin M. Irick, and Vijaykrishnan Narayanan discuss an innovative multimodal augmentation system to aid those with visual impairment (more than 285 million people worldwide). Their system design incorporates wearable camera-equipped glasses with direction-indicating vibrating gloves so that visually impaired users can navigate and locate objects in grocery stores, and then grasp them and place them into a shopping cart. Testing for these technologies has been very promising, and there are plans for larger-scale evaluation.

In "Bioacoustics-Based Human-Body-Mediated Communication," Cheng Zhang, Sinan Hersek, Yiming Pu, Danrui Sun, Qiuyue Xue, Thad E. Starner, Gregory D. Abowd, and Omer T. Inan present an acoustic signal-based method using the human body as a communication channel to transmit information across different devices. The authors describe how this capability can be used to transmit text through the human body, communicating between humans as well as with devices outside the body.


In "Does Neurotechnology Produce a Better Brain?," Rajan Bhattacharyya, Brian A. Coffman, Jaehoon Choe, and Matthew E. Phillips describe how complementary neurotechnologies of noninvasive brain recording devices for brain and body signals and noninvasive brain stimulation can be used to augment the human brain. They discuss applications for these technologies in the areas of training, threat detection, and motor skill improvement, as well as the challenges and ethical issues associated with brain monitoring and stimulation in human subjects.

ADVANCES IN HUMAN-AUGMENTATION TECHNOLOGIES OFFER IMPROVEMENTS TO HUMAN HEALTH, QUALITY OF LIFE, AND FUNCTIONAL PERFORMANCE.

human body to external sources of information that are visual, audio, or text based. For this special issue, we focused primarily on approaches utilizing computation-based solutions instead of those that are rooted in purely pharmaceutical, psychological, or physiologic approaches.

several applications of their eyeglasses, including circadian rhythm analysis as well as nutrition monitoring and analysis.

In "Third Eye: A Shopping Assistant for the Visually Impaired," Peter A. Zientara, Sooyeon Lee, Gus H. Smith, Rorry Brenner, Laurent Itti,

We hope you enjoy this special issue. We thank the authors, reviewers, and *Computer's* editor in chief and staff for their hard work and assistance in preparing this special issue. Human-augmentation technologies will continue to be an area of great advancement, with huge potential to benefit individuals and society as a whole. 

myCS

Read your subscriptions
through the myCS
publications portal at

<http://mycs.computer.org>

ABOUT THE AUTHORS

MIKE DAILY is manager of the Systems and Technology Centers at HRL Laboratories. His research interests include augmented and virtual reality, computer vision, autonomous systems and robotics, and machine learning. Daily received an MS in computer science from the University of New Mexico. He is a Senior Member of IEEE and an area editor of *Computer*. Contact him at mjdaily@hrl.com.

ANTTI OULASVIRTA is an associate professor of electrical engineering at Aalto University, where he leads the User Interfaces research group. His research interests include modeling and computational design of human-computer interaction. Oulasvirta received a PhD in cognitive science from the University of Helsinki and is the editor of *Computer's* "Indistinguishable from Magic" column. Contact him at antti.oulasvirta@aalto.fi.

JUN REKIMOTO is a professor in the Interfaculty Initiative in Information Studies at the University of Tokyo and deputy director of Sony Computer Science Laboratories. His research interests include human-computer interaction, computer-augmented environments, and computer-augmented sensing in humans. Rekimoto received a PhD in information science from the Tokyo Institute of Technology. Contact him at rekimoto@acm.org.

Recognizing Excellence in High Performance Computing

Nominations are Solicited for the SEYMOUR CRAY, SIDNEY FERNBACH, & KEN KENNEDY AWARDS

SEYMOUR CRAY COMPUTER ENGINEERING AWARD

Established in late 1997 in memory of Seymour Cray, the Seymour Cray Award is awarded to recognize innovative contributions to high performance computing systems that best exemplify the creative spirit demonstrated by Seymour Cray. The award consists of a crystal memento and honorarium of US\$10,000. This award requires 3 endorsements.



Deadline: 1 July 2017

All nomination details available at
<http://awards.computer.org>



SIDNEY FERNBACH MEMORIAL AWARD

Established in 1992 by the Board of Governors of the IEEE Computer Society. It honors the memory of the late Dr. Sidney Fernbach, one of the pioneers on the development and application of high performance computers for the solution of large computational problems. The award, which consists of a certificate and a US\$2,000 honorarium, is presented annually to an individual for "an outstanding contribution in the application of high performance computers using innovative approaches." This award requires 3 endorsements.

ACM/IEEE-CS KEN KENNEDY AWARD

Established in memory of Ken Kennedy, the founder of Rice University's nationally ranked computer science program and one of the world's foremost experts on high-performance computing. A certificate and US\$5,000 honorarium are awarded jointly by the ACM and the IEEE Computer Society for outstanding contributions to programmability or productivity in high performance computing together with significant community service or mentoring contributions. This award requires 2 endorsements.



IEEE  computer society

