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Technology for Human Augmentation

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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 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.

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

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 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, 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.

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.

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