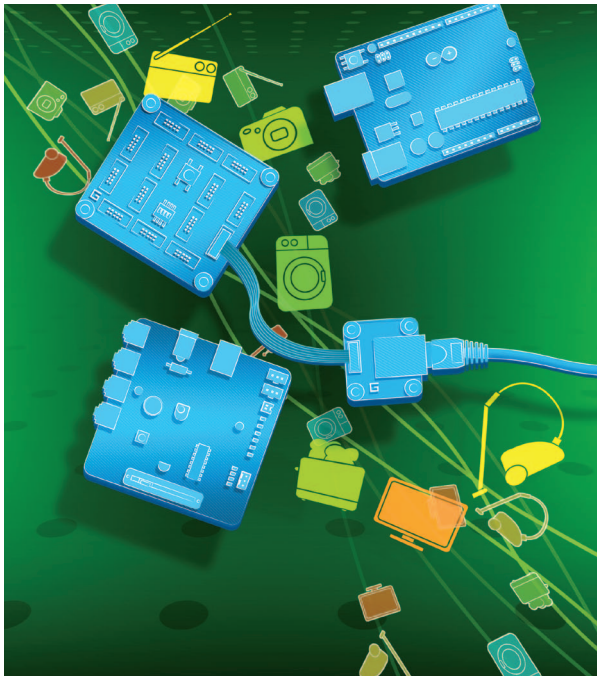

The Internet of Things: The Next Technological Revolution

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A wide range of researchers from academia and industry, as well as businesses, government agencies, and cities, are exploring the technologies comprising the Internet of Things from three main perspectives: scientific theory, engineering design, and the user experience.

The term Internet of Things (IoT) describes several technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. Technologies like RFID, short-range wireless communications, real-time localization, and sensor networks are becoming increasingly pervasive, making the IoT a reality.

In fact, after the World Wide Web and universal mobile accessibility, the IoT represents the most potentially disruptive technological revolution of our lifetime. With 50 to 100 billion things expected to be connected to the Internet by 2020, we are now experiencing a paradigm shift in which everyday objects become interconnected and smart.

However, human understanding and usage of, and interaction and experience with, "smart things" and the systems they form have not developed at the same pace, and this creates challenges with enormous technical, societal, economic, and political consequences. Consequently, a wide range of researchers from academia and industry, as well as businesses, government agencies, and cities, are exploring this exciting technology from three main perspectives: scientific theory, engineering design, and the user experience.

Motivated by this more holistic view, the research community has moved its focus from the system to the end user. This shift aims to empower users by providing them with the knowledge required to understand and control their environment, as well as by offering new accessible and interactive interfaces that go beyond the traditional desktop.

With this in mind, this special issue of *Computer* presents five recent research and deployment case studies. Two of the articles project our readers into futurist scenarios: one imagines nanotechnologies' penetration into embedded computing and electronics, while the other discusses the extent to which neuroscience will drive future IoT development. The remaining three articles offer detailed insight into technological solutions that are unleashing new forms of AI and programming constructs, and discuss their societal impact through end-user empowerment. All of the articles are at the forefront of the user-centered design approach.

IN THIS ISSUE

In "Prototyping Connected Devices for the Internet of Things," an international team of researchers addresses the challenge of providing users with an engaging expe-

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rience in a space with everyday connected objects. The authors focus on Microsoft .Net Gadgeteer, an extensible and reconfigurable hardware platform that opens up unprecedented opportunities for users to imagine new, playful, and personalized forms of interaction and functionalities. The power and simplicity of user-centered programming tools like Gadgeteer are expected to be key facilitators for the wider adoption of IoT-driven do-it-yourself (DIY) development practices.

In "Opportunistic Human Activity and Context Recognition," Daniel Roggen and his coauthors describe a next-generation connected object space. Moving away from a goal-driven and preconfigured system, their approach leverages sensor data and augmented objects available anytime, anywhere in an opportunistic way. The authors take readers through a smart home scenario and describe how their newly developed contextual recognition methods intercept and adapt dynamically to the data made available using their Opportunity framework.

In "Applying Human Learning Principles to User-Centered IoT Systems," Sang Wan Lee and his colleagues describe how they borrowed theories from cognitive psychology to design adaptive IoT systems that radically improve the user interaction experience. The authors showcase the perceptual building blocks that are instrumental for designing user-centered and intelligible IoT systems. In particular, they discuss the FRIEND::Process system, a tool-supported process for organizing human tasks that relies on both top-down and bottom-up organization.

In "Educating the Internet-of-Things Generation," researchers from the Open University describe their successful My Digital Life course, an introductory computer science curriculum centered around and aided by IoT technology. Drawing upon their experience with almost 2,000 students, they highlight the technology's pros and cons for collaborative and collective distance learning, especially for modules with real-world sensing applications.

Finally, in "Realizing the Internet of Nano Things: Challenges, Solutions, and Applications," Sasitharan Balasubramaniam and Jussi Kangasharju offer a compelling vision of nanoscale IoT systems. They discuss research challenges pertaining to data collection at the microscopic level from electromagnetic and molecular nanonetworks, the requirements of corresponding middleware for devices connecting to such networks, and potential IoNT applications.

We optimistically look forward to an IoT-assisted world that is both connected and smarter. The solutions proposed in this issue's cover features address some of the challenges that the IoT poses. Future research will undoubtedly provide solutions for many, if not all, of the unresolved concerns.

We thank all the editors, authors, and reviewers involved for helping to make this special issue a success. We are especially thankful to Ron Vetter, *Computer*'s editor in chief, who approved the special issue and has guided us throughout the process of preparing it for publication.

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