RECENT years have seen an explosion of deeply embedded, smart, and highly connected computing devices in diverse form factors. In particular, wearable and implant technologies, and Internet of Things (IoT) have made significant forays into nearly all aspects of our life, including health, entertainment, fashion, and social behavior. With advances in technology and process miniaturization, design of new and advanced sensors, pervasive connectivity, and the trend in business towards cloud-driven data-centric solutions, the future is projected to see an even higher proliferation of systems comprising of such devices that coordinate through cloud to solve complex, distributed tasks. Commensurate with computing capability, the applications have also scaled in complexity by several factors, e.g., from smart phones to smart cities. On the other hand, the device explosion and high connectivity have induced new research challenges affecting a wide diversity of areas, including health care, retail, computer security, data analytics, computer architecture, physical design, and more. Furthermore, a comprehensive solution to the research challenges requires a close collaboration between these different areas to ensure usability and interoperability of solutions.

This special issue documents some recent progress in this challenging research area. Note that the area is vast, touching almost every subject in computing and electrical engineering with a large variety of tools, techniques, and applications. Covering the entire research spectrum is far beyond the scope of a single special issue. Instead, our goal has been to try to provide a sampling of different topics in this exciting domain, highlight the diversity of research involved, and capture some emerging trends. With that goal in mind, this issue provides five representative articles covering a wide range of topics encompassing new applications, challenges and approaches towards designing IoT systems.

The first three articles provide a glimpse of the new technology in healthcare and biomedical applications. “Adaptive and Personalized Gesture Recognition using Textile Capacitive Sensor Arrays” by Alexander Nelson, Gurashish Singh, Ryan Robucci, Chintan Patel, and Nilanjan Banerjee, presents a non-contact proximity gesture recognition system. The approach permits gesture recognition of patients with upper extremity mobility impairment through fabric capacitive sensor arrays, avoiding the physical contact and intrusiveness of current assistive technology solutions. In the next article titled “Asthma Pattern Identification via Continuous Diaphragm Motion Monitoring”, Menghan Liu and Ming-Chun Huang propose an ultrasound system for monitoring respiratory status of asthma through diaphragm movement detection. Finally, in “Energy-Efficient Long-term Continuous Personal Health Monitoring”, Arsalan Mohsen Nia, Mehran Mozaffari-Kermani, Susmita Sur-Kolay, Anand Raghunathan, and Niraj K. Jha discuss continuous health monitoring (CHM), which is another critical topic in biomedical applications. They present ways for energy-efficient long-term CHM through novel, low-energy schemes for sample aggregation, anomaly-driven transmission, and compressive sensing.

The final two papers deal with another critical aspect of the emergent applications, security. The paper “Privacy and Security in Internet of Things and Wearable Devices” by Orlando Arias, Jacob Wurm, Khoa Hoang, and Yier Jin, considers privacy concerns in the environment in which embedded systems with sensors attached are continually collecting data; it proposes design flow enhancements and security enhancements to address such concerns. Finally, the article “A PUF-Enabled Secure Architecture for FPGA-based IoT Applications” by Anju P. Johnson, Rajat Subhra Chakraborty, and Debdeep Mukhopadhyay proposes a secure architecture for IoT applications based on the Dynamic Partial Reconfiguration (DPR) capabilities of FPGAs. They present a modified DPR methodology to implement a light-weight cryptographic security protocol, identify threats from availability of DPR at IoT nodes, and implements a solution based on Physically Unclonable Function (PUF).

The emerging world of wearables, implants, and IoTs will encompass a large diversity of applications, with unique challenges in design, validation, security, and energy requirements. Addressing all the technology challenges for these applications will likely remain an elusive goal in the foreseeable future. However, the area is vast, the challenges are real, and there is an encouraging trend of different areas coming together in close collaboration to address them. We hope these five articles provide a glimpse to the various applications and technology challenges in the broad and rapidly evolving field of internet-of-things. We hope that they introduce new concepts, tickle your intellect, and spur innovation in this field of growing importance.
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