論文の内容の要旨

論文題目　　A Programming Framework for Automatic Management of IoT-enabled Smart Buildings（IoT-enabled スマートビルの自動管理のためのプログラミングフレームワーク）

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In recent times, with the development of advanced technologies, the connectivity of devices has significantly improved in smart buildings. Remote data access and device control are enabled through open RESTful interfaces and the application paradigm has changed as a result of interface unification. Further, the smart building has become a programmable architecture that can now be regarded as a distributed-hardware computer. Consequently, residents can now be regarded as users who will become a constant part of the smart environment in the near future.

Meanwhile, improving energy efficiency is a major issue in building automation. Energy efficiency involves several sub-factors, such as energy consumption, human comfort, and productivity. The factor(s) that needs to be addressed first depends on the specific real-time context. Building automation applications usually have to make compromises among these factors. Therefore, it is important to design a programming environment for such a "computer" to perform personalized, precise, and collaborative control as we did in classic computers for smart buildings. However, these users are usually ordinary people who are not good at programming or may not be familiar with the target building. Describing available services and providing an easier programming environment for these users is a significant challenge.

State-of-the-art protocol suites such as 6LoWPAN and CoAP connect constrained devices to the Internet. With RESTful open APIs, the heterogeneous networks in smart buildings have become homogeneous, resulting in such a building becoming a programmable architecture. Further, devices from different subsystems now cooperate very easily. However, a unified lightweight distributed programming framework for personalized, precise, flexible, and collaborative control of smart buildings is needed. Consequently, we propose a programming framework for automatic management of smart buildings that addresses these issues. This framework abstracts and hides lower-layer building structure and service details and provides descriptive automatic management languages for smart building users such as building administrators, IT managers, facility managers, and developers. A building resource description schema is also provided to enable these users to refer to services when writing management policies using proposed descriptive languages.

We evaluated the proposed framework via field experiments in the Daiwa Ubiquitous Computing Research Buildings (DUCRB). Several energy management policies were written using the proposed framework. Prototypes of supporting tools were also implemented to provide an efficient programming environment for smart buildings. The results demonstrate that the proposed framework enables the users to develop efficient automatic management applications in IoT-enabled smart buildings. The main contributions of this research include two descriptive languages for automatic management of IoT-enabled smart buildings, a smart building resource representation schema for describing the available resources in a building, and tools such as compiler, interpreter, and programming language editor to simplify the programming process for smart building users.