Fuzzy Based Prediction Schema Framework for IoT Based Indoor Environmental Monitoring

Thinagaran Perumal[1], Soumya Kanti Datta[2], T. Ramachandran, Chui Yew Leong, Christian Bonnet[2]
[1]Department of Computer Science, Faculty of Computer Science and Information Technology, Universiti Putra Malaysia, Malaysia, thinagaran@upm.edu.my
[2]EURECOM, France, {dattas, bonnet}@eurecom.fr

***Abstract*-- In recent times, rapid introduction of the Internet of Things (IoT) services in smart environment domain has happened. This has introduced heterogeneous device and data types that lack proper mechanism for joint execution of tasks from an application perspective. In this paper, we propose an integrated indoor environmental monitoring system implemented with a novel IoT framework. It is enabled via fuzzy-based rule schema to resolve the heterogeneity of environmental data in smart home environment. The novel aspect of the framework is that it is developed with a modular repository together with decision-making modules. Our experiments prove this approach to be a viable IoT solution for smart home indoor environment.**

Index Terms — Fuzzy Based Prediction; IoT; Smart Home; Indoor Environmental Monitoring.

I. INTRODUCTION

With the rapid advancements in consumer electronics and networking technologies, a new paradigm on how environmental data is being managed is on the rise. Recently, indoor environmental monitoring has been escalated with the use of computing technologies especially Internet of Things (IoT) has become the core research agenda in the domain of smart environment. A smart home defined as an entity with wide range of heterogeneous services facilitating home users with data acquired from consumer appliances and home dwellers context via a home M2M gateway [1], [6]. Home users often interact with indoor environmental setting like light, temperature, air and normalize them accordingly. Monitoring indoor environment is even more important in smart homes implementing Ambient Assisted Living (AAL) concept [5]. IoT is defined as connecting smart devices like bespoke consumer appliances by enabling seamless connectivity and command exchange [2]. Alternatively, joint execution of command operation is described as the ability of numerous IoT devices to consume data in a unified manner. In the case of indoor environment, IoT management is a major concern for data distribution among heterogeneous IoTs devices as well as to perform joint execution in a federated manner. Figure 1 represents the essentials of IoT objects in indoor environment.

Several related works on indoor environmental monitoring was carried out, such as GatorTech Smart House, CASAS Smart Home and iDorm. These mentioned works are some of the pioneer investigations with bespoke implementation and meant for storing and retrieving data. There is lack of mechanism where data is captured from the environment and processed to obtain information that can assist to make decision accordingly in smart home setting. This includes joint execution of services between heterogeneous IoT devices that could turn up in parallel without home users' involvement. Gradually, consumer electronic devices make the establishment of indoor environment sustainable, however the valid task depends on ensuring the core decision making paradigm among varied IoT devices. Instead, current practice on IoT device integration pretty much focuses on validation that seems difficult due to tight coupling [3]. To be precise, home users in indoor environment prefer the importance of getting collected services of IoT but also capitalize on deciding the contextual requirement, often limited by the explicit situations.

To solve the problem, we present a novel IoT framework that enables indoor environmental monitoring using fuzzy based rules schema. Another novelty is that the framework is that it is developed with a modular repository together with decision making modules. The outline of the paper is depicted as follow. Section 2 presents the system description and Section 3 details the conclusion.

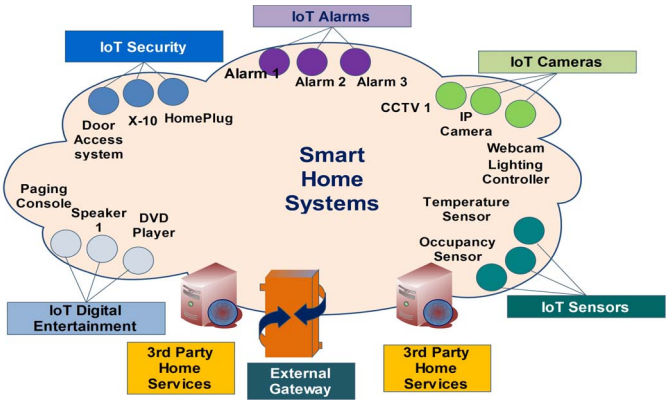


Fig. 1. IoT systems in indoor environment

II. SYSTEM DESCRIPTION

The indoor environmental framework is deployed using three dissimilar IoT subsystems (i.e. temperature, humidity and light sensor) by applying ZigBee communication standards in different zones within a smart home. The data communication of these IoT devices is accomplished by integrating an Internet gateway within the ZigBee network. A custom-built cloud server is installed to host the fuzzy based rule schema that manages the entire indoor environmental framework. The

server gathers the environmental monitoring data sent by the gateway and store in cloud for analytics and displaying them in remote dashboard. Data gathered for the schema framework are registered with timestamps in the remote dashboard. The schema framework applications of the IoT devices are illustrated in Figure 2.

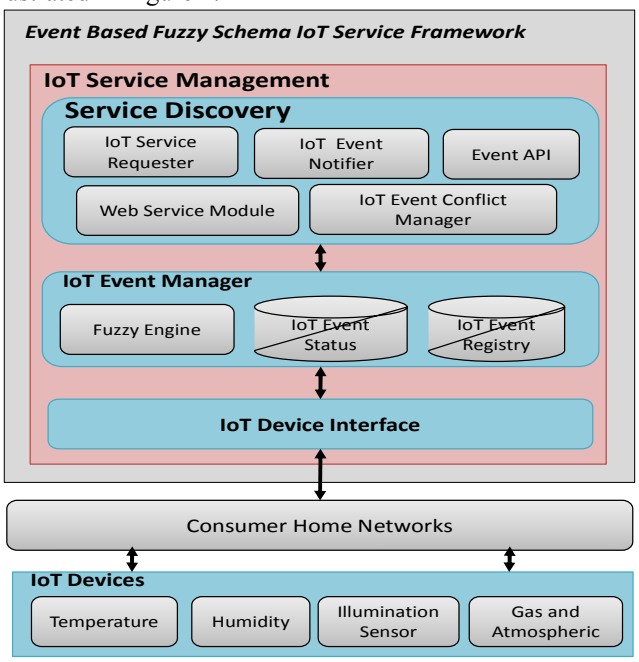
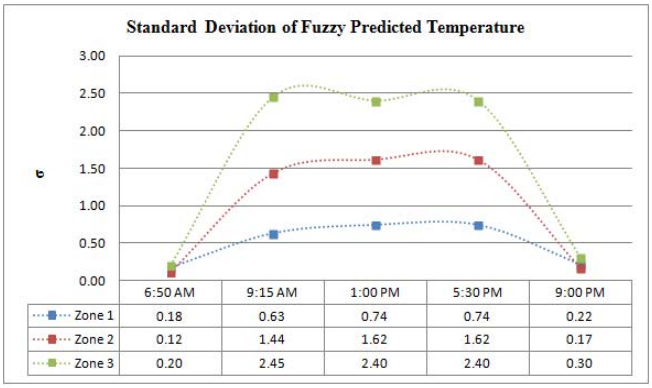


Fig. 2. Schema framework implementation.

The framework would store environmental data, allowing home users to describe configuration, types of IoT devices registered with rule schema matching the services. Using the framework, IoT environmental data are aimed and further included as dependencies into rule layers of IoT Service API, developed as modules integrated within the framework. As different IoT devices consist of different platform settings, the IoT Service API here could ensure easy accumulation of new device dependencies. Once configured, the other module in the framework called IoT Stub will trigger the possible rules based on fuzzy prediction for joint execution to take place. The IoT Stub module will proactively generate specific fuzzy rules to prompt IoT devices based on the system feedback determined by other systems. The rules are routed via Web Services to ensure joint execution among heterogeneous IoT devices or appliances. It is worth to highlight that almost IoT devices can accomplish in diversified conditions using the deployed framework. Figure 3 shows the obtained results.

III. Conclusion

IoT have facilitated heterogeneous computation of environmental monitoring data and integration into bespoke framework easily. The key idea of the proposed framework is to provide a backend based decision making fuzzy prediction for controlling and regulating the indoor environmental data. Our experiments prove that the proposed framework is a viable solution for the described problem.



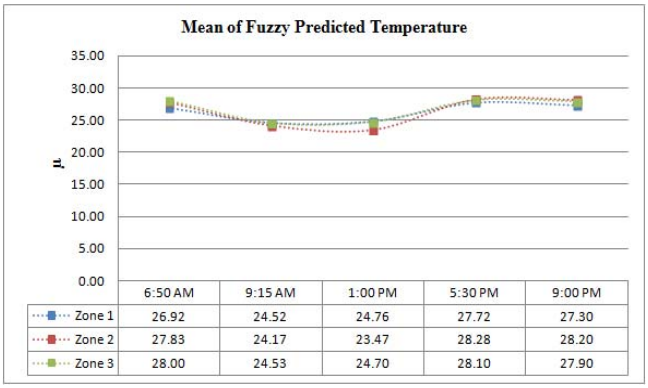


Fig. 3. Performance metric of the fuzzy rules applied over different zones

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