Platform Design for Social Internet of Things

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***Abstract*-- Due to the advance of Internet of Things (IoT) and the support of cloud computing and big data technologies, people start enjoying smart services. These services extend from smart homes, smart factories, to smart grids, etc. Taking the smart home as an example, there are some commercial products with integrated hardware and software to make living space more automated and smart. However, these products are diverse and hard to be integrated together. In this paper, we show a platform design that can manage various IoT devices (sensors and actuators) operating with different protocols such as MQTT, CoAP, and HTTP. Moreover, this platform provides data visualization and analysis of sensed data. The social network is also connected to the platform such that users can be informed with any data anomalies from sensed environments.**

I. INTRODUCTION

The basic idea of Internet of Things (IoT) is to collect and exchange data through interchange networks among physical entities, which can be small objects such as electric sockets and mobile phones or large objects such as cars and buildings. The data mentioned above are sensed data from sensors mounted to these physical entities to reflect their current states such as velocity, temperature, and humidity. Moreover, these physical entities can interact with each other by triggering those actuators equipped with them. With the IoT technology, many smart applications can be applied to homes, cities, offices, factories, etc.

In the example of smart home, simply collecting environmental data via sensors is not enough for users. We need to not only collect these data but also analyze these data to understand or predict any surrounding changes. Suitable reactions to these changes are then triggered. Sensed data have the same characteristics as big data in volume, variety, and velocity. Distributed and parallel computing techniques should be involved in data storage and process.

For the purpose of data collection and data analysis in any smart spaces, we need to develop an IoT platform that integrates related hardware and software. Users can monitor sensors and control actuators on this platform. By importing software modules into this platform, more value-added services such as data visualization and social data sharing can be provided.

II. MOTIVATION

An integrated device management platform is important to the success of IoT. This platform should support diverse IoT devices and can talk with them in their own communication protocols. Moreover, this platform should provide customized interfaces to manage and control these devices.

There are several communication protocols for IoT such as MQTT and CoAP [1]. MQTT (Message Queuing Telemetry Transport) provides publish/subscribe communication model based on the TCP. CoAP (Constrained Application Protocol) provides request/response communication model based on the UDP. Several research papers present the work on protocol integration [2][3]. There are some commercial products, such as Intel IoT Gateway, SparkGate-7 Open IoT Gateway, and AllJoyn Gateway Agent, that provide the IoT gateway function to bridge different protocols,

The online IoT platform, namely ThingSpeak, supports for the collection of sensed data into a cloud-based server where MATLAB macro functions are used to analyze these data [4]. When sensed data values exceed pre-defined thresholds, ThingSpeak will post messages through Twitter to inform corresponding users. Using social network media is a good way to disseminate messages to users carrying with different kinds of information browsing devices [5].

In this paper, we show the work to design an IoT platform like ThingSpeak, but we provide more features that are powerful as follows. Multiple IoT protocols are integrated together; a cloud-based service mode (i.e., Software as a Service, SaaS) is used for the reason of system scalability and computing power; users can easily configure the interaction between sensors and actuators.

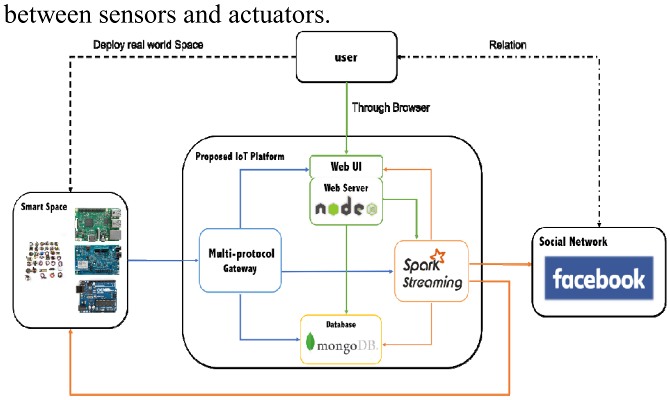

Fig. 1. System architecture and data flow.

III. SYSTEM ARCHITECTURE

The system architecture of our proposed platform is shown in Fig. 1. The left part of the figure is any smart space created by users. This smart space includes one or more sensor gateway designed with control boards such as Raspberry Pi, Arduino, and Intel Edison. This sensor gateway connects to

This research was partially supported by Ministry of Science and Technology of the Republic of China under Contract No. MOST 105-2221-E-259-019.

other sensors, such as temperature sensors and carbon monoxide sensors, and other actuators, such as LED lights and buzzers.

The middle part is the core of our platform, which contains several components. The web server provides a web-based user interface to support system functions such as user/device registration and configuration, data visualization, and anomaly detection. The multi-protocol gateway developed by the open source library Eclipse Ponte can convert any data streams in MQTT, CoAP, or HTTP formats into the same format of MQTT. This gateway will push the incoming data stream into both a database for storage and a Spark server for analysis. When the Spark server detects any data anomalies based on threshold or three-sigma rules, a message post to the Facebook is triggered at the right part of the figure.

To confirm system security, each device in the platform should be registered with an access token as an authentication proof to the platform. The data issued from the device should contain the correct access token. Otherwise, the platform will reject any illegal data.

IV. DEMONSTRATION

A user can create its own smart space by registering sensors first with specified names and sensing intervals (see Fig. 2). Our platform will feedback with access tokens. The sensed data stream will be drawn in a line curve continually. In addition, the user can register any actuators by specifying names, protocols, and action URLs (see Fig. 3). The test button on the interface can trigger the corresponding action to the actuator as the example of opening an LED light (see Fig. 4).

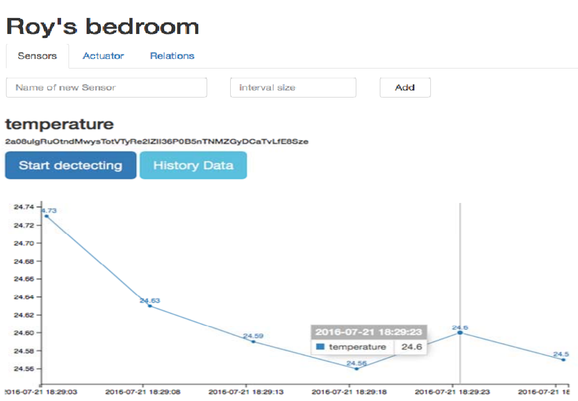

Fig. 2. The registration of a temperature sensor.

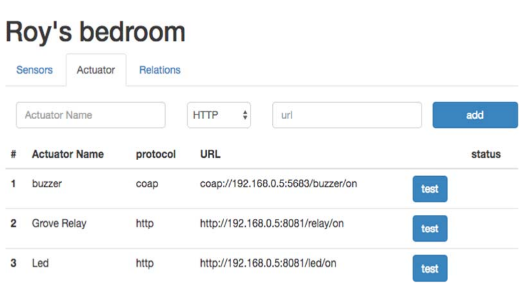

Fig. 3. The registration of some actuators.

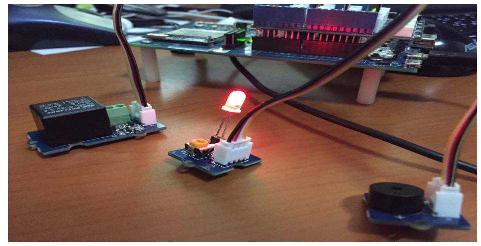

Fig. 4. The remote test of an LED light.

When the user selects to start anomaly detection, a setting interface is open (see Fig. 5). We provide three detection methods: user-defined threshold, standard reference threshold, and three-sigma rule. The user can further indicate which actuators will be triggered and what message content will be posted to which user groups or which friends.

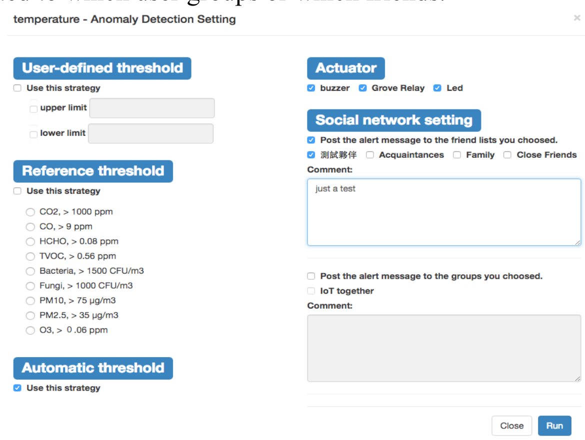

Fig. 5. The setting interface about anomaly detection.

V. CONCLUSION

We develop a device management platform for IoT such that users can conveniently monitor sensing data and control actuators remotely. This platform is established on a cloud server operating with Hadoop and Spark. Because a social network is connected, this platform can automatically post notification messages to users when data anomaly happens. The whole design is practical and flexible for further function extension.

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