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A REMOTE ASSISTANCE PLATFORM WITH THE INTEGRATION OF CLOUD COMPUTING AND IOT TO ACHIEVE SST IN HOSPITALITY INDUSTRY

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Abstract

This paper proposed a cloud platform integrating Internet of Things (IoT) to achieve self-service technology (SST) in hospitability industry. In order to achieve the proposed platform, a smart gateway is proposed to integrate underlying IoT devices and sensors. The gateway is developed based on Constrained Application Protocol (CoAP) to seamlessly communicate between IoT layer and cloud computing layer. Based on the proposed architecture, a SST remote assistance and hotel monitoring and control application has been deployed. This application can help hotelier to reduce operation cost and assist customers to use SST and promote customers' satisfaction. In addition, the proposed platform has been practically deployed in the hotel to achieve SST.

Introduction

Front desk is required to provision customers' service such as check-in, check-out and travel inquire in hospitability industry. In the past decade, the front desk has been replaced by self-service technology (SST) such as self-check-in KIOSKs [1]–[8]. SST has been successfully implemented at international and domestic airports, banks and other service around the world. Although self-service kiosks are also currently being introduced in American, European and Asian hotels; however, researches indicate the staff involved and interaction are successful factors to embrace SST [11]–[14].

This paper proposed a platform to provide remote assistance for SST in hospitability industry based on the integration of Internet of Things (IoT) and cloud computing, in which staffs need not to involve on-site but they also can provide assistance service with the cloud platform and remotely control the operation of the KIOSK to help customers to finish check-in or check-out service. The proposed platform can efficient eliminate on-the-spot staffs involved and efficiently allocate human resource to decrease cost. The application of the proposed platform can be a call center of the chain hotels, virtual front desk, and a mobile counter.

The remainder of the paper is organized as follows. In Section 2, we introduce background. The application scenario of the proposed platform integrating IoT is illustrated in Section 3. The integration challenges are described in Section 4. The proposed platform architecture is described in Section 5. Section 6 shows implementation results. Conclusions and future research hints are given in Section 7.

Background

Self-service technology (SST) has been adopted in last decade for hospitality industry [1]–[8]. SST includes check-in, check-out, travel inquire and added-value services. The check-in methods have three (1) Traditional check-in at the front desk, (2) Digital check-in at the KIOSKs, and (3) Mobile check-in with mobile phone. After the check-in process, customers need to acquire the key of the reserved room by traditional check-in method. Digital check-in at the KIOSKs are able to issue a RFID card key to customers. Finally, mobile check-in will send a virtual room key to customers' mobile phone. The key can interact with the lock based on Near Field Communication (NFC). The research results show that two factors cannot be eliminated when these check-methods are performed: (1) the first use of SST also needs stall support, (2) customers like interaction if the front desk is free.

The IoT presents an integrated communication, sensing, and computation technologies that consists of Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones and so on[9]–[11]. IoT devices are able to interact with each other and cooperate with their neighbors to reach common goals using unique addressing schemes. There are several application domains which will be impacted by the emerging Internet of Things. The applications can be classified based on the type of network availability, coverage, scale, heterogeneity, repeatability, user involvement and impact, and categorized into four application domains: (1) Personal and Home; (2) Enterprise; (3) Utilities; and (4) Mobile. The IoT deployment can integrate a lot of appliances and sensors in the hotel. Therefore, the staffs and hotelier can remotely query status and control devices in the IoT.

Cloud computing is a configurable computing resources (e.g., networks, servers, storage, applications, services, and software) model based on on-demand access[11]–[14]. The integration of IoT and Cloud computing is based on Cloud platforms, Cloud infrastructures and IoT middleware. The Cloud platforms are the components responsible for providing the IoT with the necessary and current requirements such

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as real-time processing, scalable storage and global access, as well as expansion towards others opportunities like machine learning. The Cloud infrastructures provides the storage, networking and computing resources required by the IoT and the Cloud platforms. The IoT middleware provides an abstraction layer for the underlying IoT devices, and mechanisms for interacting with Cloud Computing. Therefore, cloud computing provides an interaction interface between hotel staffs and hoteliers and customers.

Therefore, to eliminate the mentioned factors is able to reach the goal of cost reduction for hotels with the efficient human resource allocation. In this paper, the front desk is not required, and staff support and interaction with customers can be remotely satisfied based on the integration of IoT and cloud computing.

Application scenario

There are two operation roles in the application scenario: (1) Hotel staffs and Hotelier, and (2) Customers. As Fig. 1 shown, two blocks is divided from hotel staff and hotelier who operate the platform by mobile APPs or web browser to perform remote assistant for SST and hotel monitoring and control, and customers can use SST and self-check-in in the other block. After finishing self-check-in customers can acquire a RFID room key. If customers cannot finish by themselves, they can make a request for hotel staffs and hotelier with the remote support.

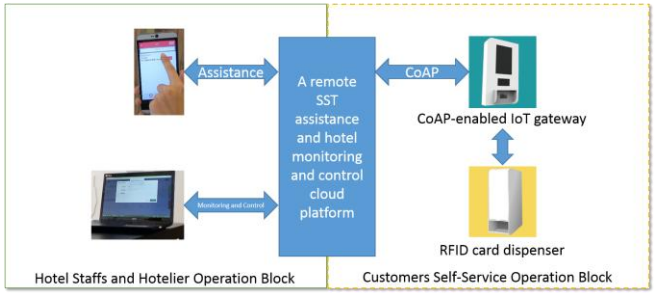

Figure 1. The application scenario of the proposed platform

Integration Challenges

In order to seamlessly integrate IoT into hotel daily operation, and achieve a remote assistant platform to eliminate hotel on-the-spot staffs involved. There are two challenging factors have to be overcome. The factors include (1) Cloud computing and IoT Integration, and (2) Existing heterogeneous sensors and appliances integration. In recently years, front desk staffs dispense RFID room key is a routine and a critical process during customers check-in. Although customers can check-in and open the door of the reserved room by NFC-enabled mobile phone if hotels had deployed mobile APPs of SST. But if the mobile phone or RFID lock cannot support NFC, customers also need to acquire RFID card key or traditional key at the front desk.

Design of the proposed platform

A. Platform architecture

As Fig. 2 shown, this article proposes a remote assistance platform based on the integration IoT and cloud computing to assist customers when they are using SST in the hotel and reduce the usage of on-the-spot staff. The platform consists of three layers: (1)IoT layer, (2) Cloud computing layer, and (3) Service layer. In IoT layer, a smart gateway is proposed based on Constrained Application Protocol (CoAP) [15]. The gateway is an interconnectivity bridge between underlying IoT devices and sensors and CoAP-enabled middleware of the cloud computing layer. The gateway provides various physical communication interfaces to connect underlying IoT appliances. In cloud computing layer, there are three functional components are achieved which are (1) Remote assistance, (2) Remote monitoring, and (3) Remote control. Remote assistance is a module operated by hotel staffs or hoteliers to support customers when they are using SST. Remote monitoring is an automated module to query and collect the status of IoT appliances and sensors. Remote control is operated by hotel staff and hotelier to control underlying IoT devices, e.g. restart, shutdown, and turn on/off digital relays. In addition, an IoT middleware with CoAP is proposed. The middleware is a communication interface between cloud computing and underlying IoT layer. The RESTful API provides programming interfaces between upper layer and cloud computing layer. Service layer is to achieve a SST and hotel monitoring service. A SST assistance and hotel monitoring application is deployed to manage the service.

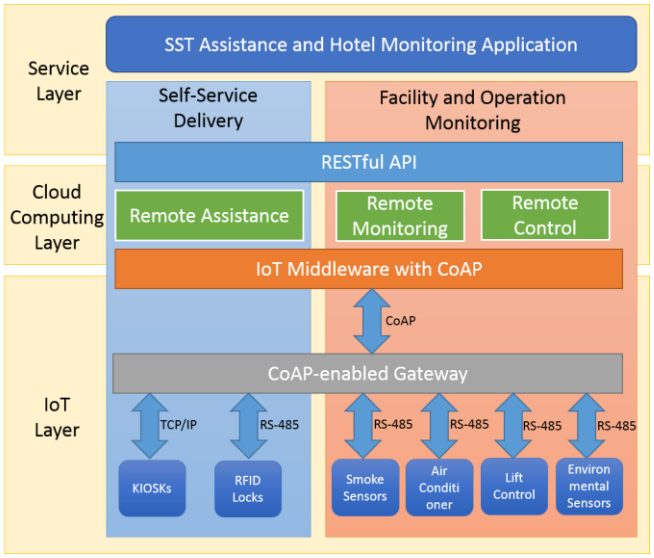

Figure 2. The architecture of the proposed platform

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B. Gateway architecture

Fig. 3 shows the architecture of the proposed gateway. A lightweight IoT middleware is implemented to integrate the existing heterogeneous sensors and appliances. Use of the TCP/IP, RS-485/RS-232 and Digital input/output integrate underlying IoT appliance and sensor. CoAP embedded client is reponsible for communicate with cloud computing layer. SQL Lite is to store the collected data from IoT appliance. Human machine interface (HMI) is to provide a friendly operation interface to customers. The gateway is developed using android operating system.

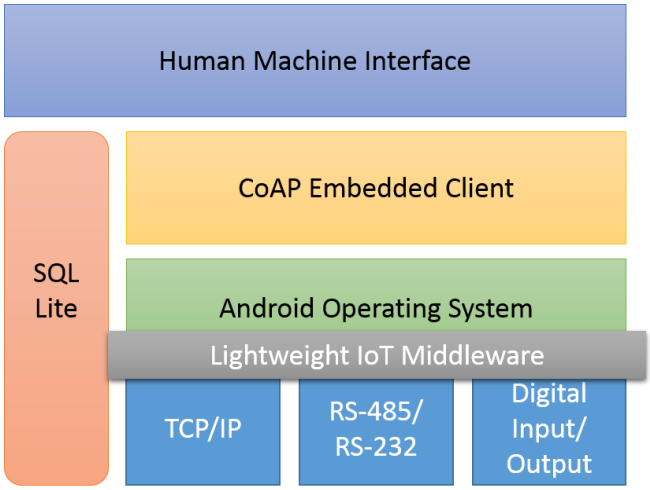

Figure 3. The architecture of CoAP gateway

Implementation Results

A. Results of the proposed platform

The platform is deployed in hicloud that is a cloud as a Service (CaaS) provision by Taiwan telecommunication operator- Hinet (http://hicloud.hinet.net). Figure 4 shows the the web browser interface to provide the status monitoring of IoT devices in the hotel. The hotel staff and hotelier can query and view the status of IoT devices, e.g. lift controller, air conditioning, RFID lock, power saver, and room status and disturb indicators. Figure 5 illustrates an interface for RFID room lock control in the hotel. Hotel staff and hotelier can remotely help customers to turn on or off IoT device if they support remote control. The figure shows to control a RFID lock of the room 201. The control functions include open, close and open once.

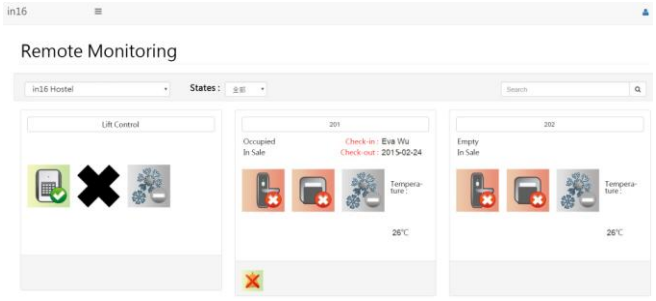

Figure 4. The illustration of the monitoring interface with web browser

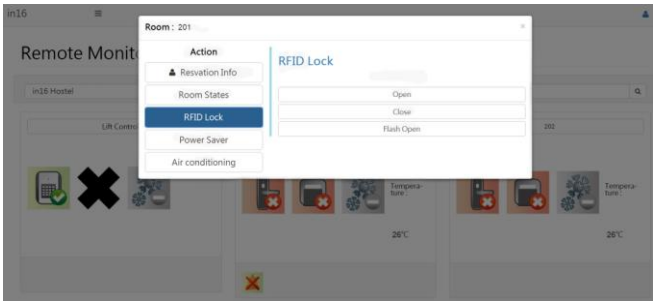

Figure 5. The illustration of the monitoring interface with web browser

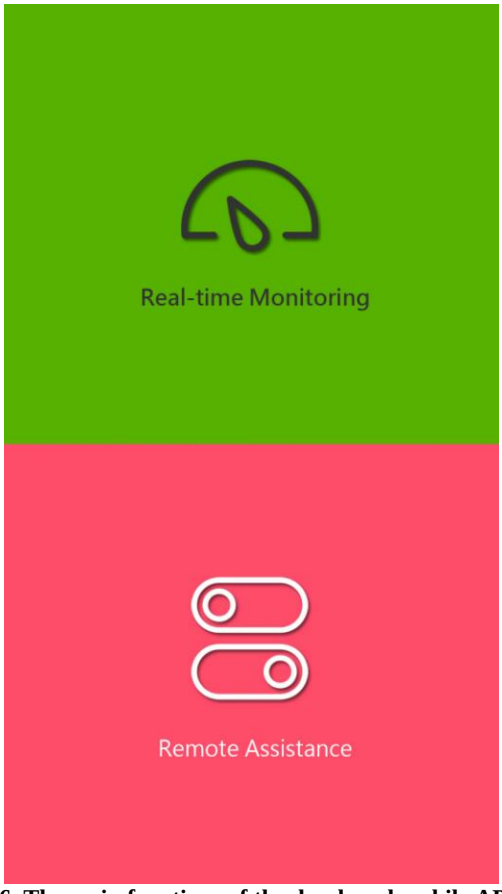

Figure 6. The main functions of the developed mobile APP

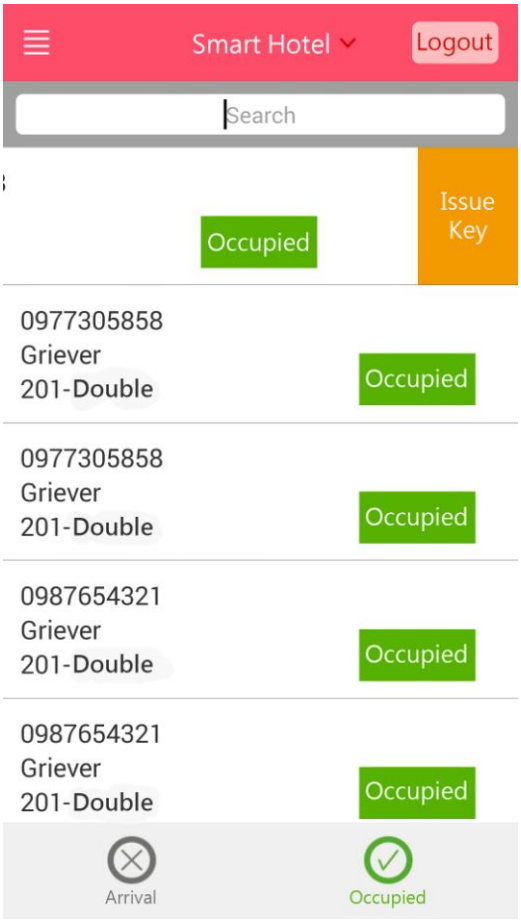

Figure 7. The illustration of RFID card distribution with the mobile APP

In order support hotel staff and hotelier who can remote assist customer and monitor IoT devices in the hotel anytime and anywhere. This paper also develops a mobile APP, as shown in Figure 6. The mobile app support remote assistance and real-time monitoring. If customers make an assistance request for hotel staffs or hotelier they can immediately provide remote assistance service with the mobile APP. As shown in Figure 7, they can help customers to issue a RFID card key remotely.

B. Results of the proposed gateway

Figure 8 shows the hardware block diagram of the proposed gateway. The gateway human machine interface has chosen a 4.3" touch monitor which provide a friendly interaction media to customers to easily finish check-in process by themselves. The back and front side of the gateway is shown in Figure 9 and Figure 10, respectively.

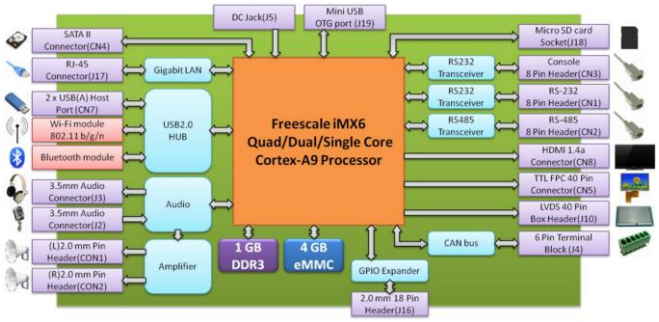

Figure 8. The hardware block diagram of the gateway

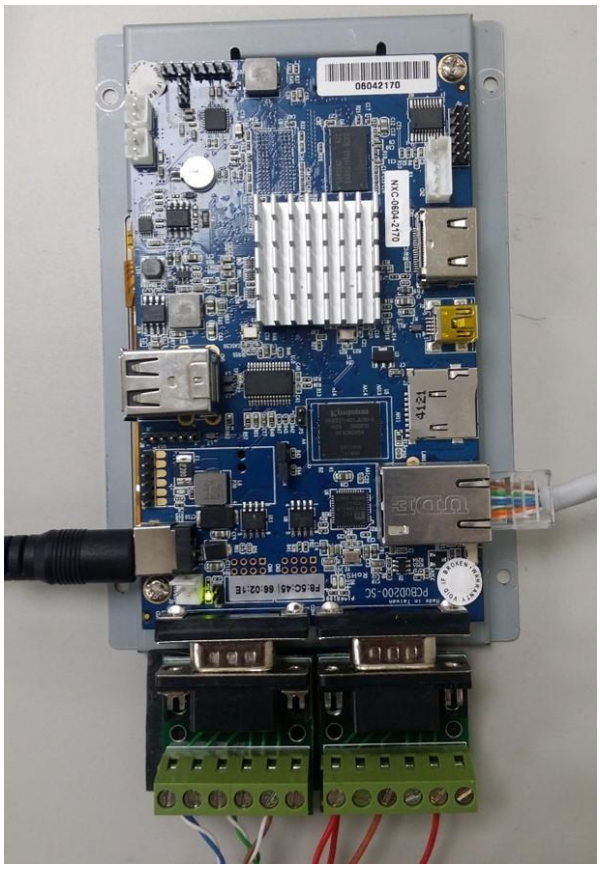

Figure 9. The backside of the gateway

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Figure 10. The front side of the gateway

C. Case Study

The implementation result had been practically deployed in the in16 hotel located in Ilan of Taiwan (http://www.in16.com.tw). The practical installation is shown in Figure 11. The hotel provides SST to the customers, they can book a room based on favorite date. Before approach the reserved date, customers will receive a check-in service notification by email or Short Message Service (SMS). The notification include a QR-Code and a check-in code. When customers arrive in the hotel, they can use QR-Code or the check-in code to finish the check-in process and receive a RFID room key by themselves. If customers cannot finish the process, the staffs or the hotelier of the hotel can remotely assist customers to finish the process and issue a RFID room key to them by web browser or mobile APPs, as shown in Figure 13. An on-site operation video is available on the online video channel (https://goo.gl/LpRxXG).

Figure 11. The illustration of the gateway and card dispenser installation

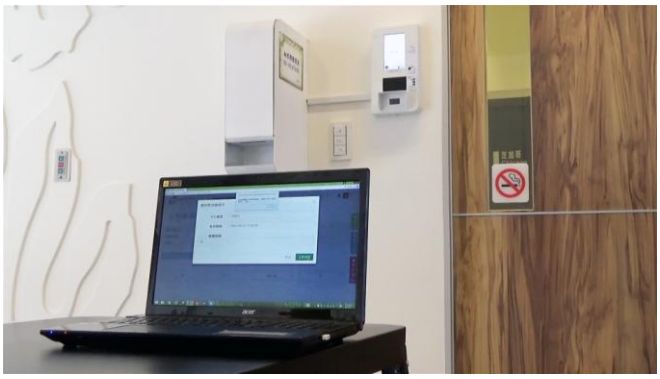

Figure 12. The illustration of the remote assistance using web browser

Conclusions

This paper proposed a platform to provide remote assistance for SST in hospitability industry based on the integration of Internet of Things (IoT) and cloud computing. A smart gateway is proposed to achieve the proposed platform and integrate underlying IoT devices and sensors. The gateway is developed based on Constrained Application Protocol (CoAP) to seamlessly communicate between IoT layer and cloud computing layer. Based on the proposed architecture, a SST remote assistance and hotel monitoring and control application has been deployed, in which hotel staffs need not to involve on-site but they also can provide assistance service with the cloud platform and remotely control the operation of the KIOSK to help customers to finish check-in or check-out service. The proposed platform can efficient eliminate on-the-spot staffs involved and efficiently allocate human resource to decrease cost.

As a result, the proposed platform and applications of this paper can help hotelier and customer reach the goal of the cost reduction and customers' satisfaction, and the proposed platform has been practically deployed in the hotel to

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achieve SST. Evaluation metrics for system, organization, and customer is future research directions.

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