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Design and Implementation of a Smart Signage System based on the Internet of Things(IoT) for Elevators

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Abstract

The existing digital signage systems inside the elevators are a lack of tailored contents appropriate to the space and environment inside or outside the elevators. Also, they almost impossible to flexibly respond to various contents disclosure according to the demand of the consumers or the elevator markets.

Therefore we design and implement an IoT(Internet of Things)-based smart digital signage system for the safety of elevator passengers.. In order to provide IoT-based information to the smart digital signage within the elevator, we propose an IoT system as a set-top box with gyroscope sensor, acceleration sensor, RFID(Radio-Frequency Identification), fine dust sensor, etc., which processes various data collected by the sensors and provides the elevator passengers with various tailored contents such as elevator driving information, environmental information inside and outside the elevator, and disaster information in addition to simple advertisement information. The proposed IoT system is a set-top box that operates the smart digital signage and has an independent information control processor based on the IoT sensors that do not depend on the elevator control system. For the proposed smart digital signage, it supports an operating system that is independent of the elevator driving service as well as the media service. So the smart signage system has a characteristic that it does not depend on the elevator control system since it is a stand-along IoT-based information control system. With the proposed system providing intuitive content for the surge, steep descent, and radical movements of an elevator due to an emergency situation, the elevator passengers should be able to recognize the situation quickly and respond accordingly.

In the near future, the proposed system will expand the market of digital signage applied in conjunction with the development of contents in the disaster, safety and environment fields, and expect expected to revitalize related industries associated with signage.

Key words: *Smart Signage, Internet of Things, Elevator, Safety, Disaster*

1. INTRODUCTION

Conventional digital signage system inside the elevators is a medium for simply replaying contents such as

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advertisements that can be obtained in broadcasting rather than producing content suitable for an elevator environment[1-3]. That is, there is a lack of tailored contents appropriate to the space and environment in the elevator. In addition, the existing elevator signage system is a standardized single platform environment, and it is almost impossible to flexibly respond to various contents disclosure according to the demand of the consumer or the market[4].

So there is a need for a digital signage platform for elevators that can flexibly cope with changes in contents according to the needs of consumers and the market. For example, by providing intuitive content for the surge, steep descent, and radical movements of an elevator due to an emergency situation such as an earthquake or fire, the elevator passengers should be able to recognize the situation quickly and respond accordingly[3,4].

Therefore we design and implement an smart digital signage system based on the IoT(Internet of Things) for the safety of elevator passengers. In order to provide IoT-based information to the digital signage system inside the elevator, we propose an IoT system with gyroscope sensor, acceleration sensor, RFID(Radio-Frequency Identification), fine dust sensor, etc., which processes various data collected by the sensors and provides the elevator users with various tailored contents such as elevator driving information, environmental information inside and outside the elevator, and disaster information in addition to simple advertisement information[5]. The proposed IoT system is a set-top box that operates the smart digital signage and has an independent information control processor based on the IoT sensors that do not depend on the elevator control system. For the proposed smart digital signage, it supports an operating system that is independent of the elevator driving service as well as the media service. Therefore the smart signage has a characteristic that it does not depend on the elevator control system because it is a stand-along IoT-based information control system.

In the near future, the proposed system will expand the market of digital signage applied in conjunction with the development of contents in the disaster, safety and environment fields, and expect expected to revitalize related industries associated with signage.

The paper begins with a review of related works, then goes on to describe an architecture of the proposed platform, before providing implementation from an early user study, followed by a discussion and conclusion.

2. Related Works

During the past decade, the IoT has gained significant attention in academia as well as industry[5-7]. According to ABI Research, more than 30 billion devices will be wirelessly connected to the IoT(or IoE, Internet of Everything) by 2020[5]. In a recent survey and study carried out by the Pew Research Internet Project, a large majority(83%) of the technology experts and engaged Internet users who responded agreed with the notion that the Internet/Cloud of Things, including embedded and wearable computing(and the corresponding dynamic systems[6]), will have widespread and beneficial effects by 2025[7]. Since ThyssenKrupp claim to bring the elevator into the IoT, ThyssenKrupp are taking the data from the elevator controller and storing it on the cloud, analyzing and interpreting it, and applying machine-learning techniques to it[3].

Although content services related to the operation of elevators are essential, security makes it difficult for operational information collection solutions to produce content behind the manufacturer's closed doors to the elevator operating protocol[4,10,11]. Thus, in most elevator manufacturers' protocol-closed situations, effective information gathering technology for operational information content services is needed and a platform is needed to flexibly cope with changes in content resulting from consumer or market needs. In addition, a platform is needed to enable the prompt status recognition and response of elevator passengers by providing intuitive content for the surge, steep descent, and radical movements of elevators due to earthquake or emergency situations[4,10].

Therefore, we develop an elevator-only smart signage that provides intuitive content by linking disaster with safety and environmental information.

3. AN ARCHITECTURE OF AN IOT-BASED SMART SIGNAGE SYSTEM

In this chapter, we design of an IoT-based elevator-only smart signage that provides disaster information, safety, and environmental information. The proposed signage computes various data collected from gyroscope sensors, RFIDs and fine dust sensors to provide elevator users with a variety of customized content, such as operation information, environmental information and disaster information, in addition to simple advertisement information.

3.1 Design of the signage system

The IoT-based smart signage system consists of sensor components of the IoT, a set-top box and a display module as shown in Figure 1.

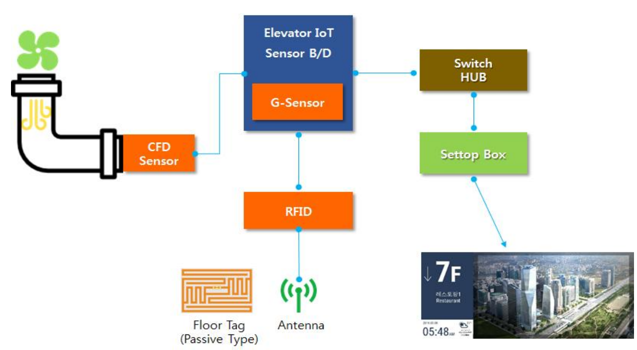

Figure. 1. An overall block diagram of the IoT-based smart signage system

Among the sensor components, RFID (Radio Frequency Identification) as USN (Ubiquitous Sensor Network) technology recognizes information on the current floor of the elevator independently of the elevator manufacturer's protocol opening, and recognizes the direction of operation of the elevator using G-sensor. It provides environmental information to passengers and elevator manufacturers by measuring fine dust in elevators. CFD sensor performs a role of measuring fine dust in elevators. The information collected is then passed to the set-top box and processed to provide information to the occupants and elevator manufacturers.

Figure 1 shows a block diagram of the system for sensors installed in the elevator. The CFD sensor attached to the ventilation shaft of the elevator accurately predicts the distribution of fine dust in the elevator and provides users with information on the environment of fine dust. It also uses an RFID antenna to detect the floor tag and recognize the current floor of the elevator. The collected information is passed to the set-top box to be presented to the smart signage.

(1) A PCB configuration for the IoT module

The IoT module is a block diagram of the IoT module to control the sensors for the proposed elevator-only smart signage. This is primarily aimed at transmitting information collected from sensors to the set-top box and digital signage server.

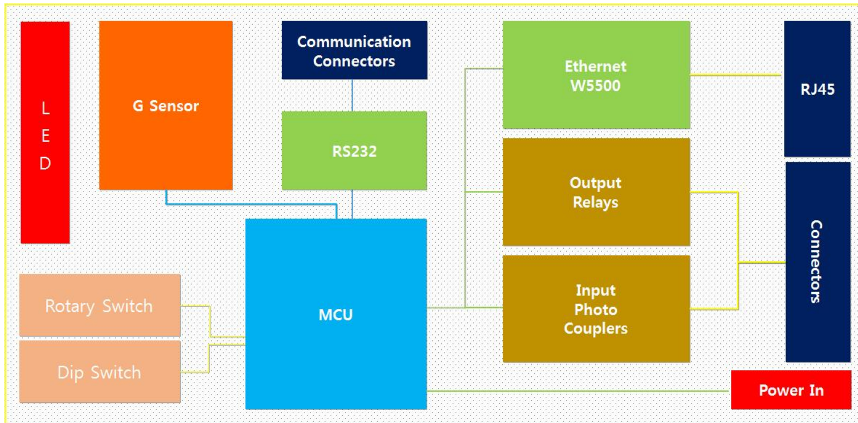

Figure 2. A block diagram of the IoT module

Figure 2 shows the PCB configuration diagram of the IoT module for collecting information on elevators, and transfers the data collected from the connected sensors to the set-top box and digital signage server.

(2) A set-top box configuration diagram

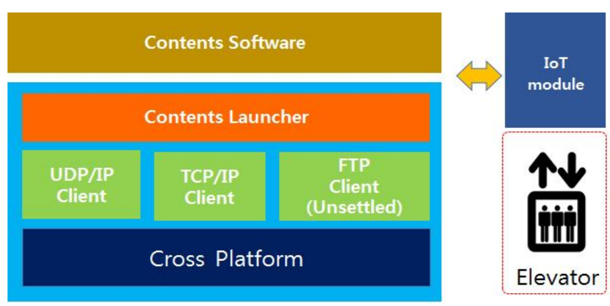

Figure 3. A block diagram of the set-top box

Figure 3 shows the configuration diagram of a set-top box for transferring data to an elevator-only smart signage presented in this paper. The proposed set-top box develops a cross-platform digital signage exclusively for elevators, which has the effect of cost savings in line with the changing digital signage platform.

3.2 The configuration of the signage management server

The signage management server receives various measured information collected from the IoT modules. Figure 4 shows the server configuration. Its main purpose is to collect additional acceleration data and fine dust measurement data from the IoT-based elevator operation information collection modules, and it will also play the role of existing digital signage servers. Data collected from the sensors is compressed and stored in the databases, and the information is digitally transmitted to the concerned parties and contractors.

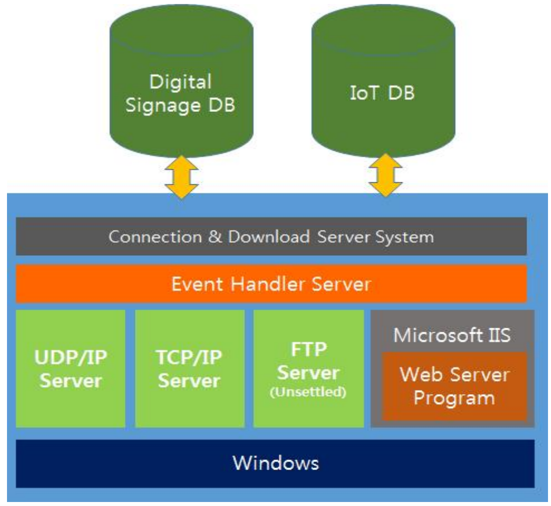

Figure 4. The signage management server configuration

4. IMPLEMENTATION

4.1 A floor recognition mechanism by RFID

The IoT-based elevator-only smart signage system proposed in this paper placed a floor sensor and a floor recognition bar on the upper part of the elevator cage that is located to facilitate the power supply in order to recognize the current floor of elevators using RFID. As shown in Figure 5, a floor sensor and a rise recognition bar exist on the upper part of the cage of the elevator. The RFID antenna is attached to the induction sensor for floor detection, and the floor tag of the passive type is attached to the floor detection blocking plate to recognize the current floor of the elevator.

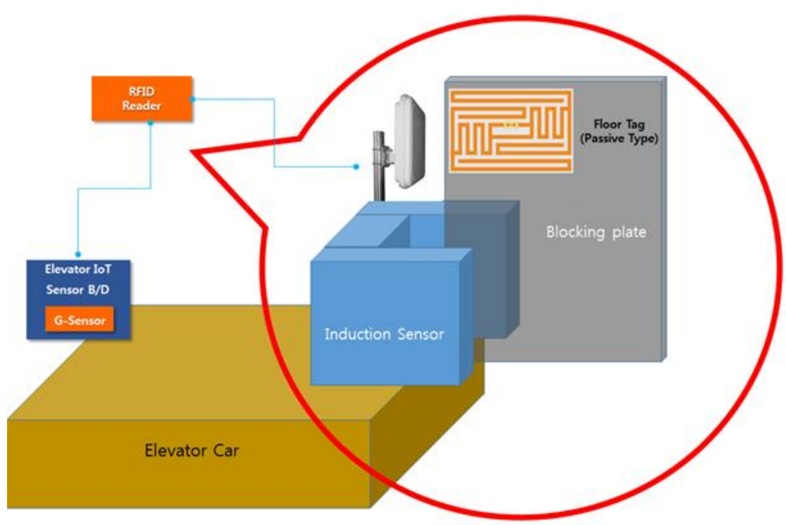

Figure 5. A floor recognition mechanism

G-sensor is a sensor that recognizes the acceleration value of each axis (X-Axis, Y-Axis, Z-Axis) including the current acceleration of gravity. Using this, the current speed can be calculated by fast time sampling integration based on the axis on which the elevator is moved. In addition, it is displayed graphically on the signage to intuitively recognize the direction and operating conditions of the current elevator. The pattern of computed speed is shown in Figure 6.

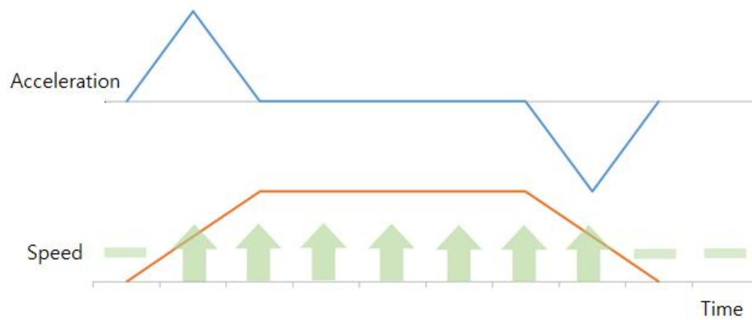

Figure 6. A speed pattern by integral equation

The proposed signage system will be equipped with an independent information control processor based on IoT modules so as not to rely on existing elevator control systems. To cope with, Figure 7 shows the PCBs of set-top box and the IoT module.

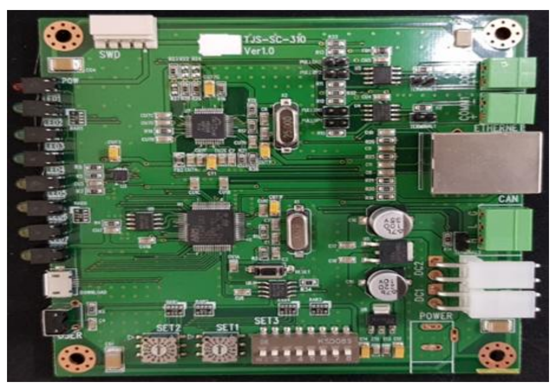

Figure 7. A pcb of the IoT module

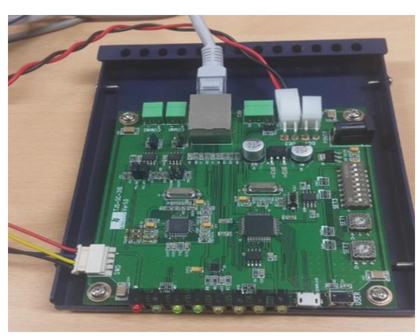

Figure 8. A pcb of set-top box

4.2 The smart signage for elevators

Figure 9 illustrates the configuration of smart signage content services exclusively for elevators. Data collected from the IoT module and transmitted to the set-top box are shown in the smart signage in Figure 9.

The proposed smart signage is divided into five separate areas to provide information to elevator users. Each area intuitively provides real-time operation information of elevators, such as elevator operation floor/direction information, elevator failure, elevator speed pattern graphs, and other real-time operation information of elevators, as well as living information such as date and time, and customized content for fine dust environmental information. In the 16:9 ratio-sized screen commercial image advertisement information window, local advertisement and corporate advertisement are sent, and the commercial image advertisement information is provided at the bottom of the commercial image advertisement information with real-time subtitle news, emergency disaster information or announcements.

Figure 9. The proposed configuration of smart signage

4.3 The signage management server

Signage management server is not only responsible for receiving data from sensors collected from the IoT module PCB and verifying current status, but is also responsible for transmitting media contents between vendors and advertisers.

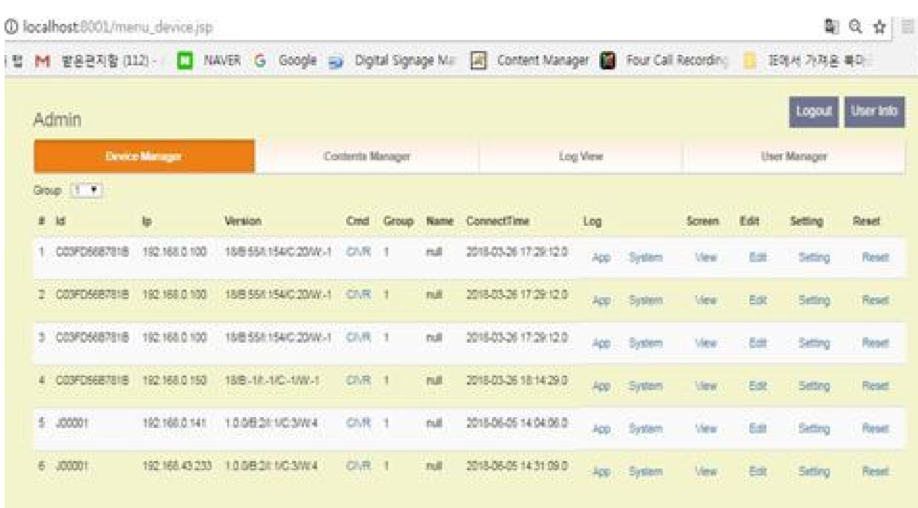

Figure 10. A screenshot of the signage management server

Operational information data of the elevator and measurement data from the sensors collected from the IoT module are kept in the database and checked by the signage management server as shown in Figure 10.

Therefore, the signage management server carries out the operation situation of the elevator or the management of the IoT devices and the management of media contents.

5. CONCLUSION

In this paper, we proposed an elevator-only smart signage system that provides elevator passengers with various customized contents such as elevator operation information, environment information and disaster information by computing various data measured from acceleration sensors, RFIDs, fine dust sensors, etc. as well as simple advertisement information. Because most of elevator signage systems are a single, formalized platform environment, they are not possible to respond flexibly to the expression of diverse content based on consumer or market needs.

Thus, the elevator-only smart signage system proposed in this paper can provide customized content flexibly according to consumer needs. The proposed system computes various data collected from gyroscope sensors, RFIDs and fine dust sensors to provide elevator passengers with a variety of customized content, such as operation information, environmental information and disaster information, in addition to simple advertisement information.

In the future, the smart signage system will be linked to a variety of areas, including disaster, safety, and environment, to effectively express information delivery and advertising at airports, shopping malls and government offices as well as elevators as a future display. More diverse researches are needed for the development and distribution of stable smart signage in the future.

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