International Journal of IT-based Public Health Management
Vol. 4, No. 1 (2017), pp. 47-52
http://dx.doi.org/10.21742/ijiphm.2017.4.1.09

Proposal for a Smart Block Service that Supports Persons Vulnerable to Transport Walking

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Abstract

Today, although different transport services emerge based on an Internet of things(IoT) and location-based service(LBS), persons vulnerable to transport walking such as visually impaired persons, aged persons, and children are still on a poor urban environment. A new service supporting our transport environment is needed for persons vulnerable to transport walking. This paper aims to propose a smart block service that supports transport walking. This service consists of three parts: a location-based IoT platform, a mobile application, and smart blocks. In this paper, we present a concept of the smart block service and a method to develop it. We are now developing a prototype and will introduce developmental experiences, tests, and evaluation of it in further research.

Keywords: *Smart block service, Persons vulnerable to transport walking, Internet of things, Location-based service.*

1. Introduction

Recently, transport services that use smart devices and smart, connected objects are increasingly emerging with the advance of IoT technology. Nevertheless, visually impaired persons, aged persons, and children, who are vulnerable to these services are still on a poor environment when they use public transport and walk on the sidewalk. Because raised blocks for the blind cannot provide enough information to the visually impaired persons, it is difficult for the visually impaired persons to discern different information from the raised blocks [1]. That is, the raised blocks don't completely function in our urban environments. Moreover, 50.1% of the dead of the elderly traffic accident occurs while walking [2]. Thus, a new service that can support safe walking is needed for persons vulnerable to transport walking.

The objective of this research is to propose a service using a smart block that can help a walking environment for persons vulnerable to transport walking, who need interaction of a new way in our society. As the smart block is a smart, connected object, this smart block can provide diverse urban information such as public transport, facilities, and traffic lights. Moreover, the smart block plays a significant role as a touch-point for online-to-offline (O2O) service that bridges the gap between the digital and the physical through being connected to different IoT platforms [3]. The smart blocks are installed at intervals of 80 meters on the sidewalk instead of a paving block. These smart blocks will help the persons walk safely through obtain various transport information in urban environments.

Article history:
Received (September 21, 2016), Review Result (November 07, 2016), Accepted (December 28, 2016)

ISSN: 2205-8508 (Print), eISSN: 2207-3965 (Online) IJIPHM

This research begins by exploring technologies related to our smart blocks. Through understanding these technologies, we investigate methods to develop the smart block. Based on these investigations, this paper presents an overall system structure and methods to effectively develop smart blocks. We are now developing the smart block proposed in this paper. The developmental experience and evaluation of the smart block will be presented in further research. Thus, this paper contributes to development of new services for a smart city by providing a concept and a method of the smart block service.

2. Location-based IoT service

A LBS can be defined as a service that employs location data in order to provide a desired service to users. Currently, mobile devices with positioning technology can be utilized for a LBS because of being capable of easily obtaining real-time information on people's geographical position through the mobile devices [4][5]. Nonetheless, it is difficult to achieve location accuracy in a LBS.

An IoT is a global infrastructure that integrates the physical world into a digital environment through internetworking physical devices and/or objects [6]. The IoT emerges as the integration of diverse technologies such as Internet, Bluetooth, Wifi, Radio-Frequency IDentification (RFID), mobile phones, sensors, actuators, etc. [7]. "LBS can be a primary service of the IoT" in order to "achieve higher localization accuracy" [8]. Thus, the core of a location-based IoT service is to propose a method to obtain the accurate location information of various objects or devices in order to track people. The location-based IoT service is broadly comprised of a platform and physical objects and/or devices.

2.1. Smart, connected objects

Neil Gershenfeld predicts a world in which "computational powers are embedded into everyday objects" [9]. Everyday objects are transformed into smart, connected objects through "the combination of the Internet and emerging technologies such as near-field Communications, real-time location, and embedded sensors" [10].

Smart connected objects consists of three pivotal elements: "physical components, smart components, and connectivity components" [11]. The physical components functions as output that consists of electromechanical parts. The smart components, which comprise sensors, microcontrollers, and firmware, can increase "the capabilities and value of physical components" through sensing and processing data from our environments [11]. The connectivity components enable the objects to connect to IoT platforms, devices, and/or other objects. This connectivity components function as transferring data sensed and processed in the smart components to desired places.

2.2. Cloud-based IoT platform

An IoT platform enables scalable connection of smart objects to the Internet. This platform allows to properly control smart objects involved in the IoT service through collecting and transiting data. That is, smart objects can be "connected, monitored, and managed by a single system" called an IoT platform [12].

Recently, an IoT platform is developed as a cloud-based platform since "cloud computing promotes the seamless integration of digital and physical devices in the user's lives through device and location autonomy" [13][14]. "The cloud-based IoT platform manages the streams of data flowing from the sensor devices to the cloud where the platform is designed to operate" in order to "monitor and control of certain aspects of the physical world such as

places, real world objects and people" [15]. The cloud-based IoT platform currently enables "end-to-end interactions" between devices and users via the platform in real time [16].

3. Smart block service

Smart Block service proposed in this paper can be effectively developed by the following ways. In this chapter, we present data flow with an overall system structure of this service and how to install the smart blocks that are a core module of this service.

3.1. System structure and data flow

The smart block service proposed in this research broadly consists of three parts: an cloud-based IoT Platform, a mobile application, and smart blocks. The mobile application is used for persons vulnerable to transport walking. The IoT platform can be connected with different urban services such as a transport service, a bus service, and a local information service. The smart block can be effectively developed by iBeacon that is a Bluetooth low energy (BLE, Bluetooth 4.0) device developed by Apple [17][18]. This iBeacon can "broadcast their unique identifiers to nearby portable mobile devices or objects and trigger a location-based action on these devices or objects" without "paired connection with the mobile devices" [19].

In order to use this service, users should firstly turn on Bluetooth on their mobile phone and then their mobile phone receives data from the smart block. The data received by the smart phone is transferred to the IoT platform. The data is processed as useful information in the IoT platform and the information is sent to the smart block via Wifi and user's mobile phone via 3G or 4G. The smart block can include LEDs and/or an LCD as output to visualize information that is received from the IoT platform. Moreover, a mobile phone for the mobile application can be replaced with a smart, connected object that users can carry without difficulty. Thus, the different objects such as a cane and a necklace need to be developed for users. Figure 1 shows data flow with an overall system structure.

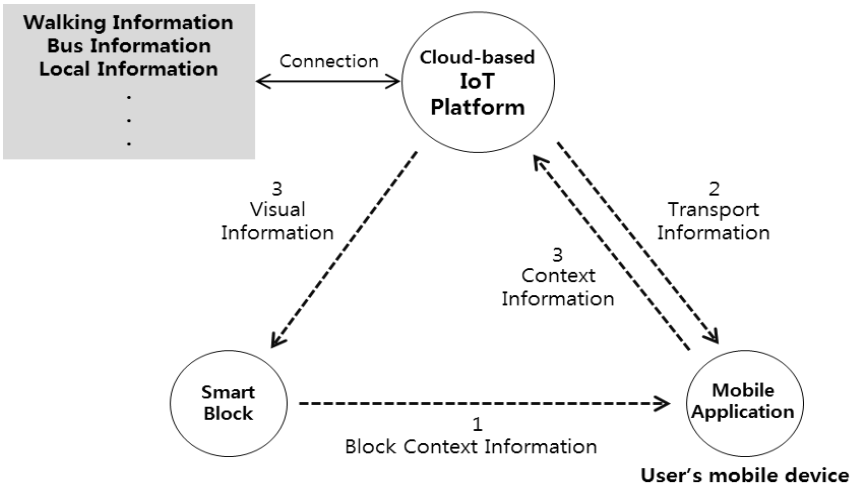

Figure 1. Data flow in the system

3.2. Installation of the smart blocks

The smart blocks are installed at intervals of 80 meters on the sidewalk instead of paving blocks. Moreover, at places such as a crosswalk, a pedestrian overpass, and an underground passage, which require users' accurate locations, one additional smart block is installed on the opposite side of the middle between two smart blocks. Based on this, we can grasp users' accurate locations through a trilateration algorithm. The IoT platform which receives data from users' mobile applications via the smart blocks can send messages to users that jaywalk by mistake. Thus, we can provide a safe urban environment to the disable persons, elderly persons, and children. Figure 2 shows how to install the smart blocks.

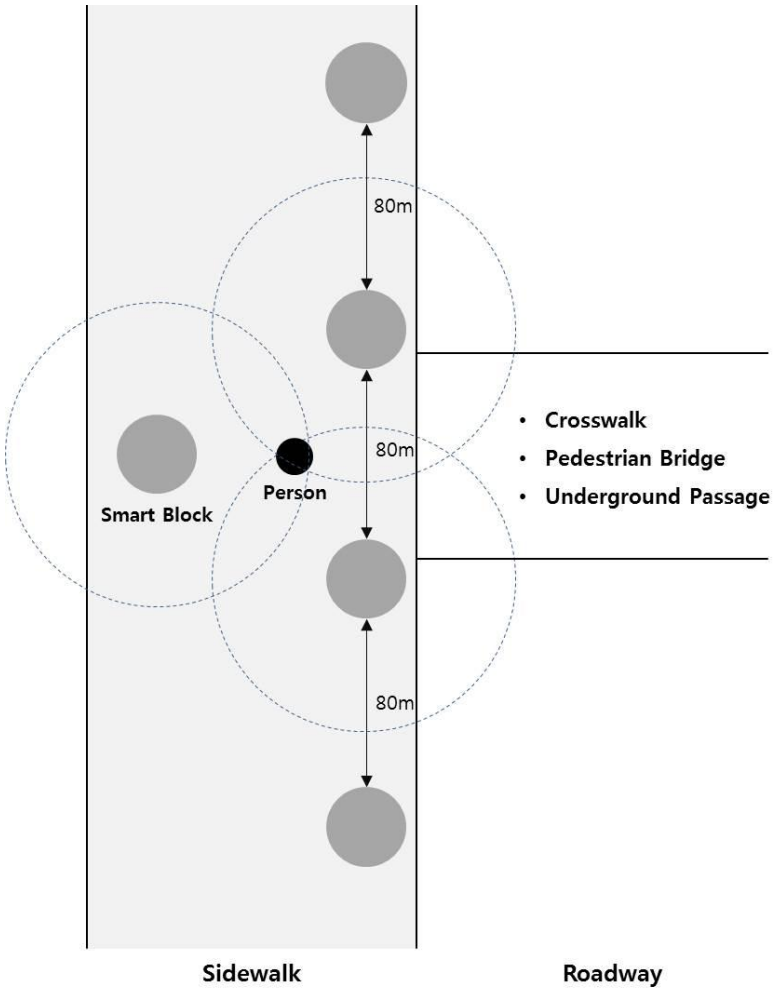

Figure 2. Installation of the smart blocks

4. Conclusion and further research

The objective of this research is to propose a smart block service for persons vulnerable to transport walking. In this paper, we presented a concept and a method of the smart block service. For this research, we explored recent technologies related to this research and investigated ways to apply these technologies. Based on these explorations, we suggested the new transport service using the smart blocks based on iBeacon.

We are now developing the smart block as a prototype. The further work of this research includes: (1) designing and developing the smart block, (2) devising and implementing effective algorithms for the smart block, and (3) evaluating the smart block on a real environment. This paper contributes to development of new urban services by supplying a concept and a method of the smart block service.

Acknowledgements

This work was supported by ICT R&D program of MSIP/IITP. [B0101-16-0264, Development of 3D Contents producing Framework for experiential science education oriented student-ingenuity enhancement.

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