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Design and Implementation of Automatic Attendance Check System Using BLE Beacon

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Abstract

As the use of smart devices is being activated in the education sector the introduction of smart education using smart devices is coming into full swing. For universities in 2012 the Ministry of Education, Science and Technology is establishing a smart campus establishment plan and promoting it so that students can use electronic devices including smart devices to learn anywhere and anytime. For it is the study designed and implemented a convenient and practical attendance management system. The suggested system automatically uses the Bluetooth 4.0 communication of the students' smart phones when the student enters the lecture hall of the course to check the location of the Beacon and automatically acknowledges attendance if it is valid location. It is characterized by the fact that there is no action to be taken on the part of the student or professor for checking attendance. Also the system recognizes the student and professor modes using the smart phones' number and registers students and professors. Thus it can be used more conveniently because there are no other actions required.

Keywords: *Automatic attendance check system, QR code, RFID, BLE Beacon*

1. Introduction

As the use of smart devices is being activated in the education sector the introduction of smart education using smart devices is coming into full swing. Already in 2011 the Ministry of Education, Science and Technology promoted the introduction of the smart learning system, and they are encouraging the development of educational smart contents using various smart devices. For universities in 2012 the Ministry of Education, Science and Technology is establishing a smart campus establishment plan and promoting it so that students can use electronic devices including smart devices to learn anywhere and anytime.

Following the development of automatic recognition technology such as RFID, label, and cards and development of biometrics technology such as fingerprint recognition and face recognition, the system that utilizes these technologies to automatically manage attendance of students have benefits of unmanned attendance confirmation, attendance confirmation time reduction, and being able to check attendance on the Internet, but to implement automated systems there are problems of expense due to the requirement of separate equipment such as RFID readers, fingerprint readers, and clickers and there are problems of management due to remote attendance by boring cards or photos.

The study designed and implemented an attendance management system that can more easily and conveniently conduct attendance processing by using the BLE Beacon.

The previous attendance management system has the disadvantage of the hassle of the professor manually checking the attendance of students in the lecture hall and the reduction in lecture time due to attendance checking but the suggested system automatically uses the Bluetooth 4.0 communication of the students' smart phones when the student enters the lecture hall of the course to check the location of the Beacon and

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automatically acknowledges attendance if it is valid location and the advantage is that there is no action to be taken on the part of the student or professor for checking attendance. Although there will be additional costs to install the Beacon to introduce the suggested system but because the current Beacon equipment is being sold at a low price the system can be introduced using small expenses, attendance can be checked and any situations, it can prevent attendance fraud by using the students smart phones, and because there is no additional actions required for attendance it enables fast and accurate attendance checking.

The configuration of this paper is as follows. Chapter 2 of this study will explore related studies to implement the suggested system, Chapter 3 will design the attendance management system using BLE Beacon, chapter 4 will establish the design system, and Chapter 4 will be the conclusion and it will suggest future research projects.

2. Related Works

In this section, we will look into the technology related to BLE Beacon and introduce the technology of attendance and absence system previously developed.

2.1. BLE (Bluetooth Low Energy) and Beacon

Positioning service using Beacons are largely classified into three methods Check Point, Zone, and real-time tracking. Check point method works in a way where signal is received from one Beacon and if a target object passes through the location the data is recorded that target object passed through the location and it is a method where location data is checked when RFID tags pass an RFID reader. In zone method one or more beacons are distributed according to signal range and when the target object is near the specific Beacon the Beacon records data at that the target object is around the Beacon location and most BLE Beacons use this method. In real-time tracking method multiple beacons are distributed according to signal range indoors and the target object transmits ID signal and intensity from three or more beacons to figure out the location [1-2].

2.2. Existing Attendance Management System

The attendance and absence management of the traditional way have used the method of directly entering the attendance status of the students for each classroom in hand writing with an inconvenience of creating a separate attendance book for each corresponding classes. In the case of initial electronic attendance and absence system introduced to implement such inconvenience, the teacher had to enter the hand written details for each classroom into the attendance and absence management system to view the attendance or absence status or to print the attendance book, but it was a hassle that required a double work. Recently, due to the development of auto recognition technology such as RFID [3], label, card, *etc.*, and the biometric technology such as fingerprint recognition, face recognition [4] an automated attendance management system that automatically manages the attendance and absence of students utilizing such technologies are widely studied and developed. RFID based automated attendance and absence system [5] is a system that automatically aggregates the attendance and absence status when the student's smart card attached with RFID tag is recognized by the reader installed in the entrance and it provides efficient attendance and absence management compared to the previous attendance book which was hand written. However, the system is expensive to build and includes problems such as the possibility of loaning the smart card, stealing, dishonest attendance, and disadvantage of attendance not being recognized when the smart card is lost or not in possession and doing the attendance check and leaving the classroom without actually attending the class.

An automated attendance and absence system [6] based on the fingerprint is a system that aggregate the attendance and absence status by recognizing the fingerprint of students

using the fingerprint reader is a trustworthy method that can uniquely identify the person without the problem of being lost, loaned or stolen, but like the RFID based system, it has a disadvantage of being expensive to build. In the student attendance and absence management system using the self-organized type of facial recognition, in order to improve on the point of verifying the actual card holder in the previous smart card based electronic attendance and absence system, a client-server system that automatically manages the attendance status of the corresponding course by recognizing the person's facial information using the self-organization neural network was developed [7].

The clicker [8] is a two-way wireless lecturing system consisting of student responder in the size of remote control and the receiver attached to the computer and it is a useful lecturing support system that enables effective questions and answers between teachers and students as well as automatically checking the attendance and absence. However, the clicker includes cost-occurring problems due to the clicker being a separate terminal which must be provided equally with the number of students and operational problems due to the method of being managed by loaning the clicker after the mass purchase by the college.

Such automated attendance and absence system reduces the time of checking the attendance and absence due to unmanned operation and has the advantage of being able to check the attendance status by themselves over the Internet. However, in order to structure the automated system, there is a costly problem on the installation cost for introducing the system because it requires separate equipments such as RFID reader, fingerprint reader, clickers, *etc.* In addition, there could be problems such as not being recognized of attendance when the smart card is lost or not in possession, loaning of cards or dishonest attendance using stolen cards and a difficult situation of checking the attendance and absence due to equipment failure such as reader error and damaged cards [9].

The proposed system in this paper, enables fast attendance checking, provides various methods where attendance can be acknowledged in any situations, and it provides convenience such as attendance book management. Also the study suggested and implemented a smart phone-based automated attendant system using BLE beacons that have the advantage of low-cost.

3. Design of Automatic Attendance Check System using BLE Beacon

3.1. Design of Proposed System

The system in the study is a design of an automated attendant system using BLE beacons. Figure 1 is the overall system flowchart of the automated attendant system using BLE beacons suggested in this study. The biggest problems of automated attendant systems are problems of system establishment expense and problems of attendance fraud and equipment malfunction.

The characteristic of the system suggested in this study is that it uses BLE Beacon to acknowledge attendance and if the student installs the up on the smart phone and enters the lecture hall the smart phone recognizes the Beacon and automatically processes attendance which means the student does not need to purchase a separate device and because there is no other actions required for attendance it is convenient, time for checking attendance is reduced because attendance is acknowledged as soon as the student enters the lecture hall, and the possibility of attendance fraud is significantly lowered because attendance is acknowledged through personal cell phones. Also it is designed so that attendance check is possible in any situations by providing various attendance acknowledgement methods to prepare for situations where automated attendant check is not acknowledged due to device malfunction and other various reasons.

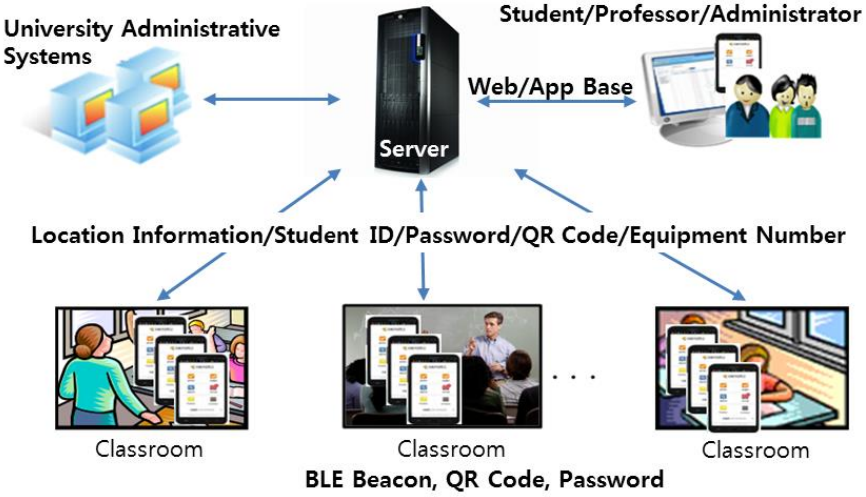

Figure 1. Flow of the Automated Attendant System Using BLE Beacons

The database structure for system configuration is composed of professor_DB, student_DB, course_DB, beacon_DB, attendance_DB, and authentication_DB. Authentication_DB is a table to authenticate if it is valid user, student, or professor, and there is the advantage of convenience because there is no annoyance of logging in every time after initial authentication when executing the program for the first time to use the suggested system.

Course_DB is a table that contains course information, student and professor data. Professor_DB is a table that stores professor information which is a server program user. The corresponding table is a table that stores professor information, responsible courses, and attendance. Student_DB is a table that contains student information and it is used as basic data to list student information in course_DB. Beacon_DB is a database that stores the information of beacons installed in each lecture hall. Attendance_DB is a table to store attendance information, QR code creation number, and information related to attendance and based on the data extracted from the stable the attendant spoke of each course can be written. The overall system structure is represented in Figure 2. AVM is Authentication and Validation Module and SAM is Smart Attendance and absence Module and WGM is Web server and GUI Module.

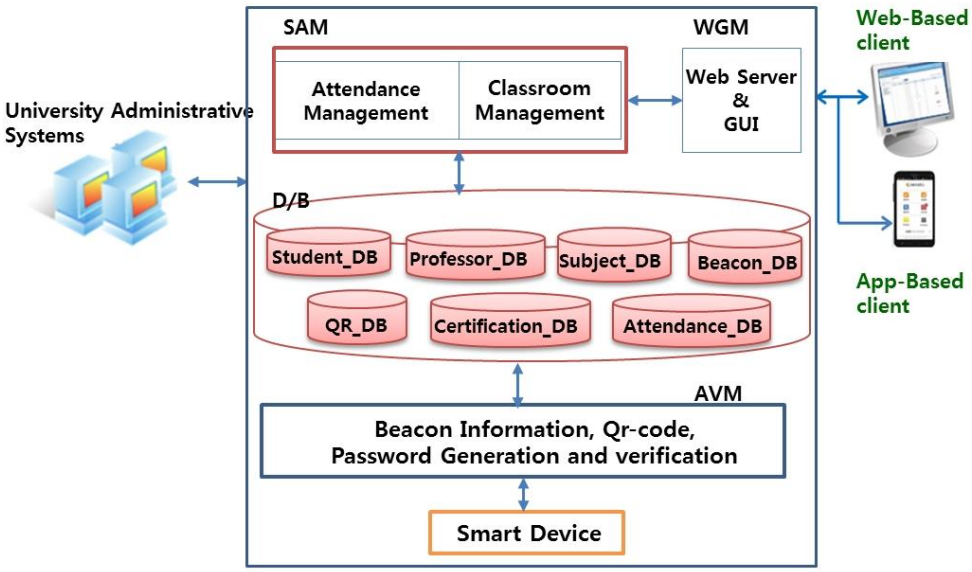

Figure 2. Structure of the Automatic Attendance Check System Using BLE Beacons

3.2. Location Estimation Based on BLE Beacon

The operation principle of the BLE Beacon is as follows. The transmitter of the BLE Beacon transmits identifier information to notify its area, and when the smart device that plays the role of Beacon receiver enters the area of the transmitter it recognizes the identifier information, and it provides corresponding services according to the recognized location.

Figure 3. Operation of BLE Beacon

The Beacon transmitter continuously transmits identifier value that indicates its area and when Beacon receiver enters the transmitter area the callback function is invoked and the corresponding service is provided. Due to these operation characteristics Beacon receivers' service occurs only when it enters the area of the transmitter and even if it stays in the area continuously service isn't provided repeatedly. The method of managing attendance using these BLE beacons is to install beacons in each course lecture halls, Beacon that corresponds to the set area transmitter transmits identifier information according to the start of class, then the smart devices of the students recognizes this and reports the status of attendance to the server to acknowledge attendance.

4. Implementation of Automatic Attendance Check System Using BLE Beacon

The system suggested in this study was implemented into server related program, app for professors, and a program for students. The server related program used Apache server based on Linux, database used My-Sql, and PHP was used to write the web program. The app program used eclipse to develop Android-based professor mode and student mode.

The overall process of the checking of attendance between the app and server in the automated attendant system using BLE Beacon is represented in Figure 4.

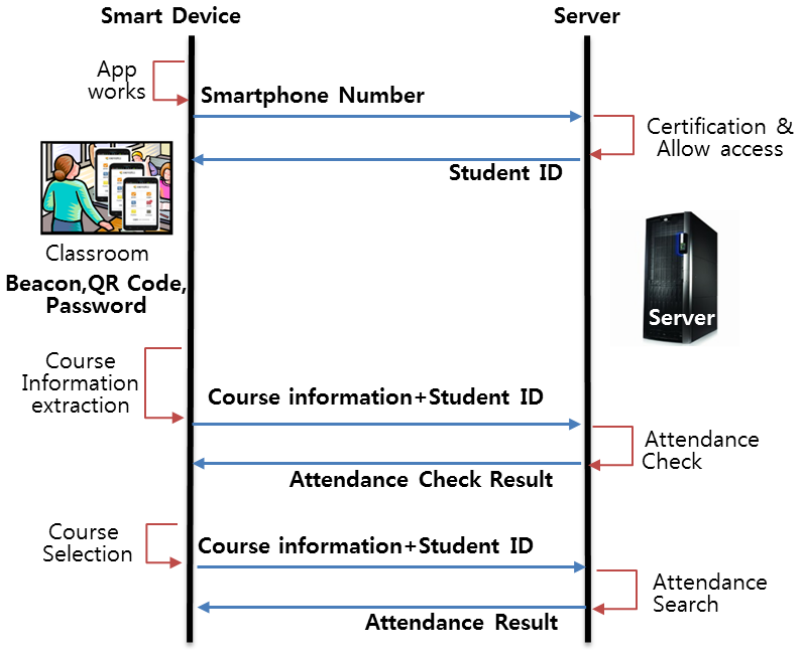

Figure 4. Protocol between Smart Device and Server

User authentication is used once when the app is first executed, authentication processing is done divided into student and professor after checking the smart phone number listed on the Web server, and user that authenticated once does not have to login every time.

4.1. Authentication and Registration of Professor and Student

Figure 5 is the professor and student registration protocol, and it finds the professor and student information on the server to authenticate and register. For identity authentication registration process, the number of the smart phone stored in the education DB and the number of the smart phone that pressed the authentication button is compared and if it is a student the app is executed in student mode and if it is a professor the app is executed and professor mode.

Identity authentication process is processed once when the app is first launched in the authenticated user does not have to login every time the automated attendant system app is executed and automatically the mode that the user belongs to is executed.

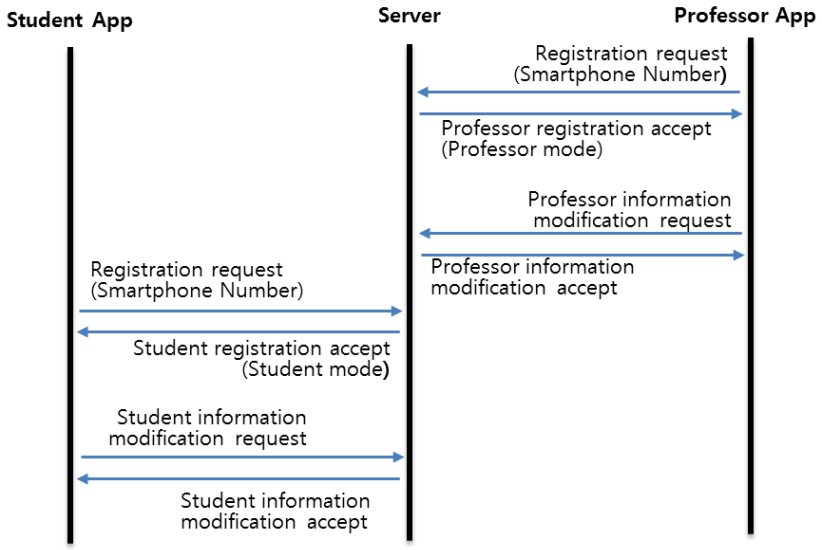

Figure 5. Professor and Student Registration Protocol

4.2. Application Program for Professor and Student

The main screen composition for professor mode is represented in Figure 6. There are buttons for Beacon attendance check, QR code attendance check, password attendance check, timesheet, and attendance book management, and if the button on the top menu is clicked, menu for program exit, student list, and lecture time change appears.

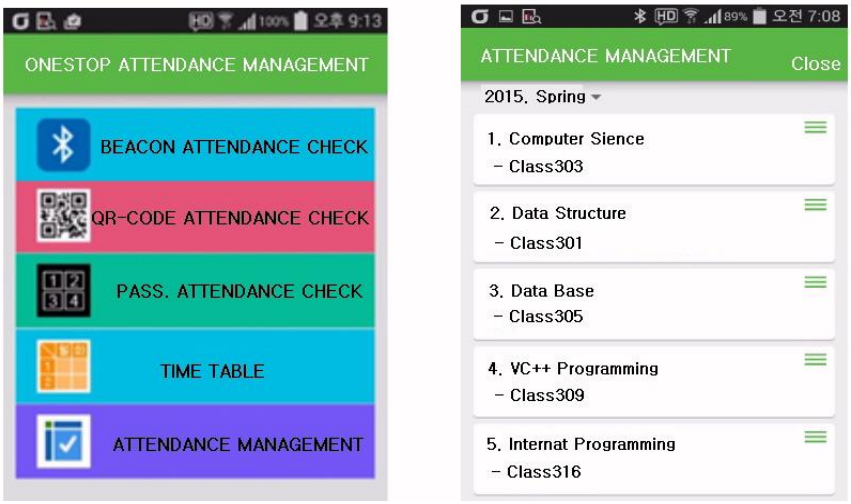

Figure 6. The Main Screen Composition for Professor Mode

Like Beacon attendance check and QR code attendance check in the professor mode, various methods of checking attendance using smart phones and manual attendance check methods such as attendance book management and password attendance check for students who can't use smart phones for any reason was included.

The main screen composition for student mode is represented in Figure 7. There are buttons for Beacon attendance check, QR code attendance check, password attendance check, timesheet, and attendance check history, and if the button on the top menu is clicked menu for help, program exit, and file appeal appears. If the student clicks the attendance check history button attendance related information is shown like right image of Figure 7.

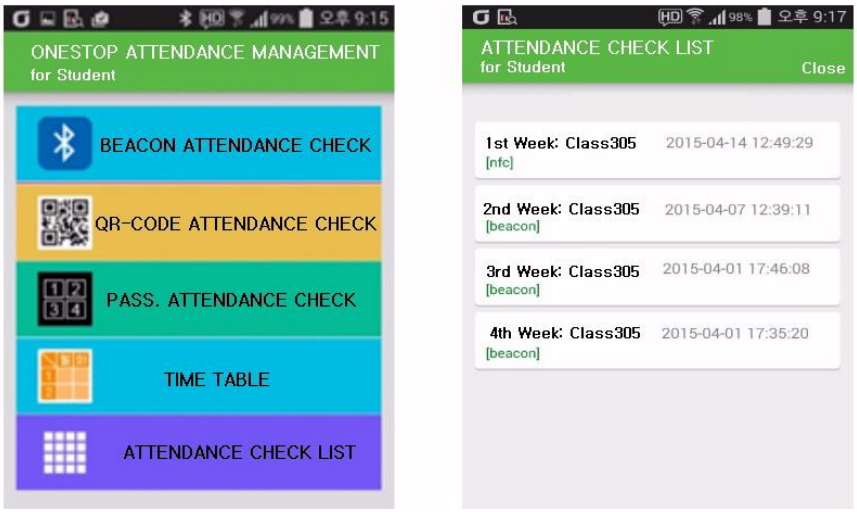

Figure 7. The Main Screen Composition for Student Mode

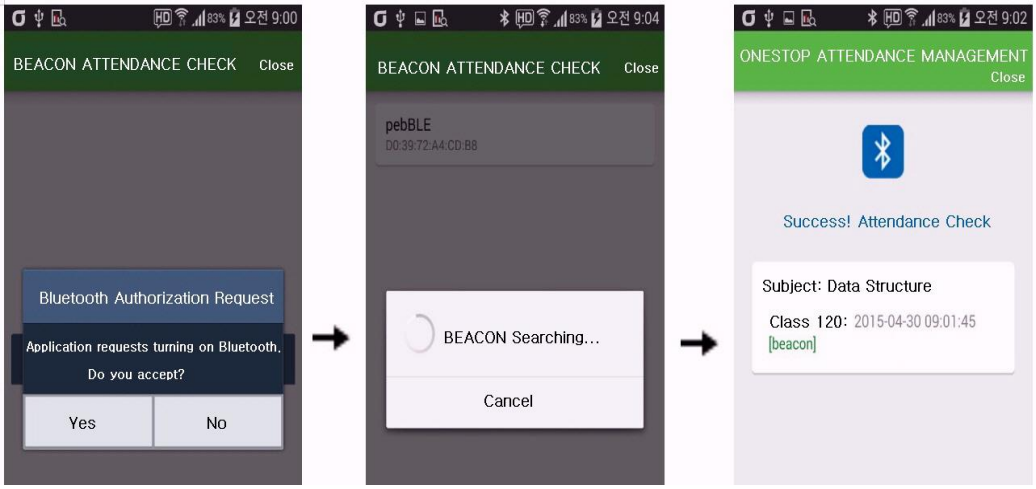

Figure 8. Process of Attendance Check Using BLE Beacon

The process of checking attendance using BLE Beacon is represented in Figure 8. When the student enters the lecture hall of their course, if the Bluetooth is activated the Beacon's search immediately and if it is not activated it activates Bluetooth and then searches to beacons.

The overall function of the automatic attendance check system using BLE Beacon is represented in Table 1.

Table 1. Features of Automatic Attendance Check System Using BLE Beacon

Function	Function details	Student	Professor	Manager
Attendance check	On line attendance check	Support		
	attendance check		Support	
	attendance view	Support	Support	Support
	Lecture schedule view	Support	Support	Support
	Formal objection view	Support		

Class management	Canceled lecture notification	Support		Support
	Canceled lecture management		Support	
	Formal objection		Support	
	Attendance management		Support	
	Lecture management			Support

5. Conclusion

The study designed and implemented a convenient and practical attendance management system. The system was designed and implemented so that using a BLE Beacon automatic attendance check is possible without additional actions or spending time for attendance. For this Beacon transmitter's must be installed in each lecture halls but recently Beacon transmitter costs are relatively low in the system can be established with low cost. The biggest characteristics of this system are that for attendance of the student the attendance is acknowledged as soon as the student enters the lecture hall of their course which means the professor does not have to spend time to check the attendance of the students, and it is convenient and practical because the student also does not have to do any additional actions for attendance.

Also this system recognizes student and professor modes by the smart phone number and it can be used more conveniently because there is no necessary additional action to register as student or professor.

It is planned to use the system designed and implemented in the study on University classes to comparatively analyze the convenience and recognition rates of each attendance method, and it is planned to conduct verification and supplementation about the effectiveness through surveying the students that participated in the lectures.

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