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Research on an Authentication Algorithm for an Electronic Attendance System in the Constructing of a Smart Campus

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Abstract

This paper presents a proposal for a large-scale lecture authentication algorithm for an electronic attendance system. The utilization rate for existing electronic attendance systems is low. Because it couldn't solve the problems that occur by special conditions of university such as vicarious attendance, bottlenecking during attendance check-in, and attendees departure at intermission. The most important things are not the authentication problems or errors on the technical issues. Instead, issues are related to attempts to check attendance simultaneously by a number of students, failure to prevent vicarious attendance, and the uncertainties of students remaining in the classroom following check-in. The authentication algorithm of the proposed system uses smartphone in attendance check. So it will save time and prevent bottlenecks as large numbers of students will not need to stand in line to check-in their attendance in the wall-mounted attendance device. And, it will minimize, if not eliminate, students who might leave at intermission. Because the instructor can verify attendance many times with the simplicity of the attendance check verification procedure and the short authentication time. Thus, the proposed algorithm will facilitate the implementation of a smart electronic attendance system in the construction of the smart campus.

Keywords: *electronic attendance system, authentication algorithm, ubiquitous campus*

1. Introduction

It has become possible to share information through a network anywhere, anytime, since the development of high-speed internet and wireless communication infrastructure. Specifically, the quantitative growth and mainstream utilization of mobile devices, the effective and commonplace expansion of mobile service, the development of virtualization and the continuing transition to a Cloud computing environment represents a huge change in the education environment, with an emphasis on an information-oriented society based on knowledge. Many universities have switch from traditional educational teaching models to more modern models using ICT and planning a strategy of a U-Campus, setting up an ubiquitous computing environment. Among them, in the case of Electronic Attendance System, that is already a variety of goods and services has been launched.

By incorporating ICT technology, an Electronic Attendance System is differentiated from older (non-electronic) systems and is much more efficient for larger class sizes (60-100 students). A key feature of the system resides in the online aspect, making it possible for users (teachers, parents, students) to check attendance online anywhere and at any time, allowing the Electronic Attendance System to provide better service to its users.

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The Electronic Attendance System allows certification through several channels. There is a certification system based on an RFID tag [1]; a certification system based on a finger scan [2]; a certification system using face recognition [3]; a certification system utilizing an ID/Password [4]-[5]; and, a certification system based on a location determination technology [6]-[7]. While these systems are advanced, a few have issues. The certification system based on an RFID tag and the certification system utilizing an ID/password has serious weakness in relation to vicarious attendance. In addition, the certification system based on a finger scan or using face recognition could have human rights abuse potential. An additional issue arises with these particular systems. When we use the certification system based on RFID tag, the certification system based on a finger scan, or the certification system using face recognition, a bottleneck phenomenon is created because of the large size of the class (60-100 students). Another system, location determination technology, also came into the spotlight as a guide system for location services in a building. But in the beginning of system construction, a radio map or positioning data should be collected using a trilateration method and this required many APs (access point). Because of these problems, in the various systems, all previously introduced Electronic Attendance Systems are hardly used in public.

This paper will show that through the certification algorithm the technical problems and weak points can be solved and I suggest a new Electronic Attendance System suitable for setting up a ubiquitous campus. This U-Campus addresses and solves the issues of vicarious attendance, the bottleneck phenomenon of large class attendance, attendee's departure at intermission, and expensive system installation cost.

2. Related Works

In this chapter various certification technologies in and out will be introduced to explain the Electronic Attendance System, as well as showing the problems that must be solved.

2.1. RFID(Radio-Frequency Identification) System

RFID technology can recognize distant information using radio waves and consists of an RFID tag, a reader, and a server which collects the data. The tag is comprised of an antenna and an integrated circuit. It records information on the integrated circuit and the reader sends the data through the antenna. The tag identifies the data through the attached card. An RFID system is quick to identify data and the ability to identify over distance depends on the frequency. It is available for long-term use and has outstanding performance with data processing. Table 1 compares an RFID tag system with an existing system and the excellence of the data recognition speed and accuracy are shown [8].

Table 1. Comparison with other Technology

	Barcode	IC Card	RFID
Recognition	Contactless	Contact	Contactless
Distance	less than 50cm	Insert type	less than 100m
Speed	4sec	1sec	10~100ms
Accuracy	96%	99.9%	
Transmission	impossible	impossible	possible
Effective life	short	10,000	100,000
Data processing	less than 100byte	16~64kb	64kb
Economy	cheap	expensive	medium
Security	impossible	possible	possible

Today, RFID technology is being used in various areas. It can be used as a tool to check a player's record or trace the history of the production of retail goods. The attached ID card accompanying the tag can save personal information; act as a perception system for an AutoRoute fee or transport card; A tag can be planted under the skin of wild animals to manage and track; theft prevention of goods; or act as a certification system to control access to a building. However, it can be scanned by any reader which can read the same frequency, a potential weak point.

2.2. Facial Recognition System

A certification system based on face recognition uses the process of recognizing the face by using an image of the face and comparing such an image against stored data in order to ascertain the individual's identity.

Determining the extraction area is the necessary step to recognize the face so we can see the quadrangle sensor area for the face on the digital camera and it correct automatically. The process of face recognition extracts a particular area of the face, which can show the characteristics of the face such as the darkness and the lightness of the color of the skin and the location of eyes, nose, and lips. All of these factors help develop the speed and accuracy. In addition, through extracting a similar image it can reduce the amount of data to be searched and find the most similar face image [9]. The face recognition process is detailed below.

(a) Recognition through the shape or the location of the eyes, nose and lips. (b) Regular surface features like facial expression on the face image. (c) The amount of appropriate features (feature value) selected (d) Ability to recognize a combination of good discrimination factors (discriminative factor, DF). (e) A high system combined with accuracy and scalability. At this time there is a variety of variable factors to be applied in the process to determine how to accurately recognize faces [10].

2.3. Wi-Fi Positioning System

Using Wi-Fi in the interior of the building allows the system to show the user's location through a map loaded in the smart device and this can be applied to various services such as indicating current position, indoor mobile route guidance, and emergency evacuation directions. This is accomplished by applying the received signal strength of the wireless LAN measurements (RSSI: received signal strength indication) fingerprint-based method (Figure 1) [11], and the wireless LAN transceiver signal propagation time measurement (RTT: round trip time) based on the ToA (Time-of-Arrival).

RTT-based approach uses only a few APs, yet positioning is possible in a big area and maintenance costs are lower. On the other hand, a radio map RSSI-based approach to estimate the location of signal strength as a number of patterns available many APs must be installed to ensure good performance and positioning information reflected in the environment in order to provide a precise location. However, for additional locations, their deployment, and in the event of changes in the status of the numerous APs that would require updating, the initial cost and maintenance of a radio map system can be expensive.

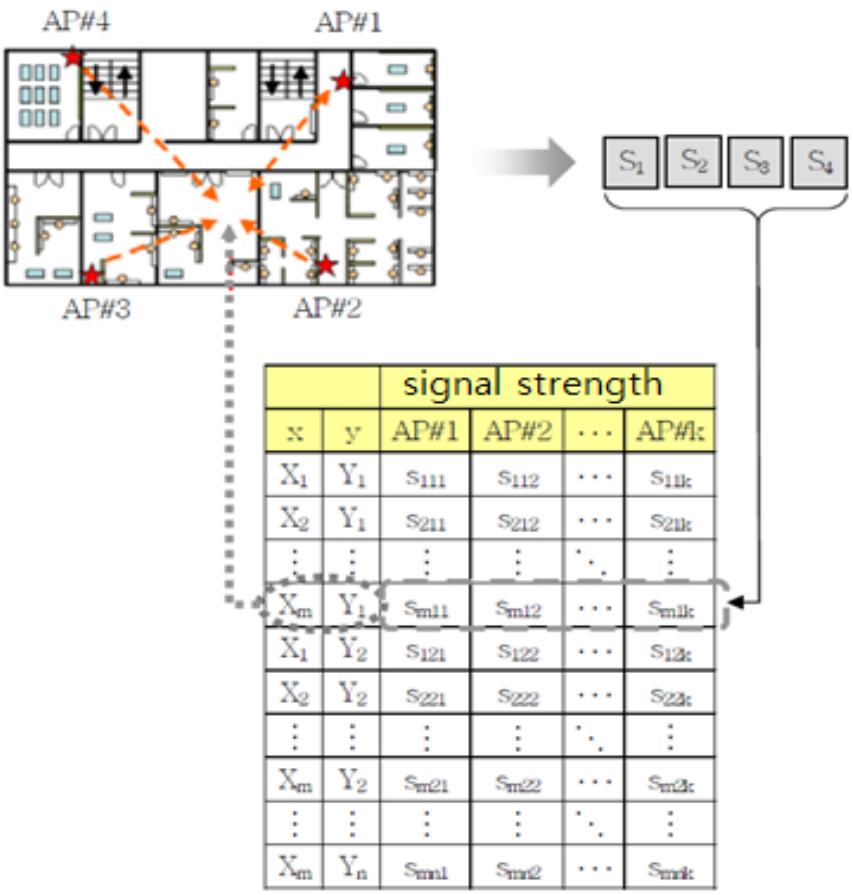

Figure 1. Fingerprinting Method for Positioning

2.4. Problems with Existing Technology

Existing technologies such as RFID tags or finger scan certification are widely used as control systems for identification, tracking the number of people who have had meals in a cafeteria. However when it comes to an Electronic Attendance System in a university, setting and its special circumstances, various problems occur.

2.4.1. RFID-Based Electronic Attendance System Problems:(1) Before the class begins (attendance check), there is a process of double checking to make sure that the procedure is even necessary. (2) After the class starts (attendance check), large classes of students (60~100 students) end up forming a line in which students must wait to be checked in. This is called 'the bottleneck' phenomenon. (3) In the middle of class, a student can arrive late to class and be tagged or a tagging message is sent, interrupting the class. (4) If the students come to the class right before the class starts then they will be checked as a late student. (5) We cannot check the attendance outside or within the classroom itself without an RFID reader. (6) When a class time changes it can become inconvenient for the person overseeing the system, possibly resulting in limited or no service. (7) There is no way to determine if the actual student attended or if their friend "checks" them in as a substitute using the missing student's ID card. (8) If a student fails to bring their student card, they will be recorded as absent.

2.4.2. An Electronic Attendance System Based on Face Recognition Problems: (1) Section 2.4.1 (1) ~ (6) problems are the same. (2) Bio-information (face recognition, finger scan) could become a matter of human right s' abuse, because such certifications contain personal information. (3) These days, a certification system using face recognition does not take long. But in the case of a university, the lecture time is always fixed and the number of students in the class is large. (4) This can cause facial recognition to take too long, as each student must be "check-in" by presenting their face to the camera for the certification process.

2.4.3. Electronic Attendance System based on ID/Password incorporating smart phones: is rarely used. The reason for this is that even though the system can count the student as present, the actually attendee might not be in the classroom, but their phone could be.

2.4.4. Electronic Attendance System Problems with Positioning Technology: (1) This system requires a large number of APs (higher initial cost in building construction). (2) Positioning data collected during the initial deployment is required and when AP structural changes are made, updates of positioning data are needed (maintenance costs). (3) With indoor positioning technology, location-based services essentially provide continuous data for such indoor positioning technology based on the structure of the classroom. Subtle errors could occur depending on this structure, such as an open door. However, there is less margin of error, even if the access points missing students during check-in is a potentially a big problem.

2.5. The Goal of the Proposed System: The Electronic Attendance System is hardly used in public because of its weak points. (1) Stopping vicarious attendance. (2) Resolving the bottleneck phenomenon. (3) Preventing attendee's departure at intermission. (4) Demonstrating that the student is in the classroom. (5) Improvement of weak points of the certificate method based on ID/password. (6) Solve the problem of expensive initial introduction costs and maintenance costs. The interaction potential between the professors and the students, including increased interactive features and improvements (such as scalability) is the most important issue.

3. Suggested System Certification Algorithm

The proposed algorithm can solve the problem of the bottleneck phenomenon with present and future system expansion, introducing unique interaction with each individual attendee and prevent vicarious attendance in order to implement the use of smart phones. The suggested system is consists of an attendance management server system and a client system (Figure 2). The server system is consists of web server, attendance management server, and the database. And the client system is consists of attendance modules for faculty and students.

Web server provides a service for professors and students to check the students' attendance on a PC. The system can print attendance sheets and make management of a large number of students easier, providing output that is easy and convenient to read. The Attendance management server handles all the practical functions of attendance, so when the confirmation request of the student's attendance is made it proceeds to authenticate attendance through the algorithm. It records attendance in the database, and response for all incoming requests from the faculty and student attendance management modules with DB link.

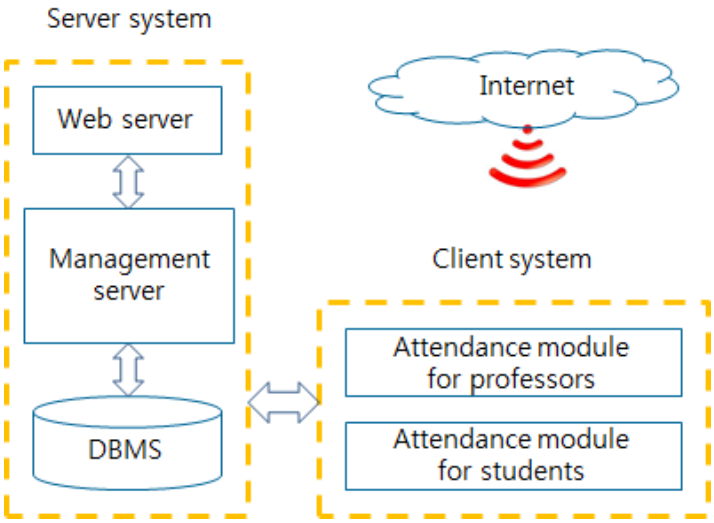

Figure 2. The Proposed System Configuration

The Attendance management module for the professor allows the attendance management server to set a timer and send the wireless AP list, so when the management server allows attendance certification it provides data which can determine whether the class's students are in the same location as the professor. In addition, for those students who don't have a smartphone or forgot their phone that day, the system provides a function to register manual attendance; the system can provide quizzes in class, making the class interactive and it allows students to view their quiz answers. The student attendance management module asks for certification after the sign to check their attendance vocally by the professor; allows students to view their attendance points; and, professors can provide answers to quizzes that are viewable by the students.

Existing RFID, barcode, face recognition, fingerprint recognition based attendance management systems have an authentication terminal that is programmed specifically for a particular lecture room and associated classes in that room. The successful attendance certification of the students is tied to the location of the terminal. Cancellation of a class, rescheduling for a make-up class or a change in lecture's location requires services of a technician to update the terminal to account for the change. The suggested system does not use a separate terminal. Instead, the professor is in charge of checking attendance and determining if a student is present or absent, allowing freedom from a service technician's oversight of a stationary terminal. To certify there is a student in the lecture room with the proposed system we use the beacon frame of the IEEE 802.11 protocol.

3.1. Beapon Frame

IEEE 802.11-based Wi-Fi AP sends information to announce via transmission at certain intervals the presence of wireless networks using beacon frames. A smartphone receives the beacon frame so that to know the wireless AP's SSID (Service Set IDentifier) and MAC address, allowing for an understanding of the encryption coding.

The certification principle of the proposed system proves when professors and students are in the same place, authenticating attendance. The professor is not confined to checking attendance at a fixed time or uniformly. Instead, the professor can check attendance randomly through the attendance certification, determining if students are indeed present in the classroom.

If a student who is absent attempts certification of their attendance through the text message, attempting to authenticate via the wireless AP's SSID and MAC address list. The faculty attendance management module contains a list of common data that is transmitted during the in-class check-in. This is not done without the student actually present and there is no authentication. In addition, when the professor issues a random attendance check, a non-authenticated request is blocked by authentication algorithm and authentication is not performed.

In addition, by using Beacon Frame does not need to keep the continuous connection to a single wireless AP, so there is no need to add additional wireless APs. Therefore, the cost of building the proposed system, which can drastically reduce the problems associated with the existing Electronic Attendance System by developing new devices for authentication, will be higher because of such development.

3.2. Certification Algorithm

The existing Electronic Attendance System certification process uses only one technology and due to the unique environment of a university (numerous authentication attempts by students in the same time period), minor problems occurred. In the proposed system, a two-factor authentication process (time and place) will be introduced to fix the problems of physical limitations (Section 2.5 (1) ~ (4)) and the technical complexity (Section 2.5 (4) ~ (7)) implementation shortcomings. During the determined time of a professor's declaration the attendance check is active (Time), allowing to determine the Wi-Fi AP's MAC address (Place). By matching these factors of time and space, it is proved that students are indeed present in the classroom.

The authentication algorithm proposed system operates in following order:

(1) Professor: Declare to check attendance; Type the valid time of checking attendance; Click the start button, and confirm attendance.

(2) Professor's smartphone: Send scanned the surrounding Wi-Fi AP list (MAC address); Send the expiration time of checking attendance to the system management server.

(3) Student: After the professor declares of attendance, click the OK button to confirm attendance.

(4) Student's smartphone: Send the scanned area of Wi-Fi AP's MAC address lists and phone numbers to the system management server.

(5) Systems Management Server: ① An attempt to confirm attendance after the valid time, the system will ignore the received data for authentication, and will send a notification to the student that attendance has been denied. ② Attendance will be confirmed for students who transferred the MAC address list during the attendance authentication time period and when compared to the professor's list for attendance accepted, if it matches the list, the database will be updated and the student will be sent a notification of attendance authentication. Figure 3 shows the authentication algorithm for the proposed system.

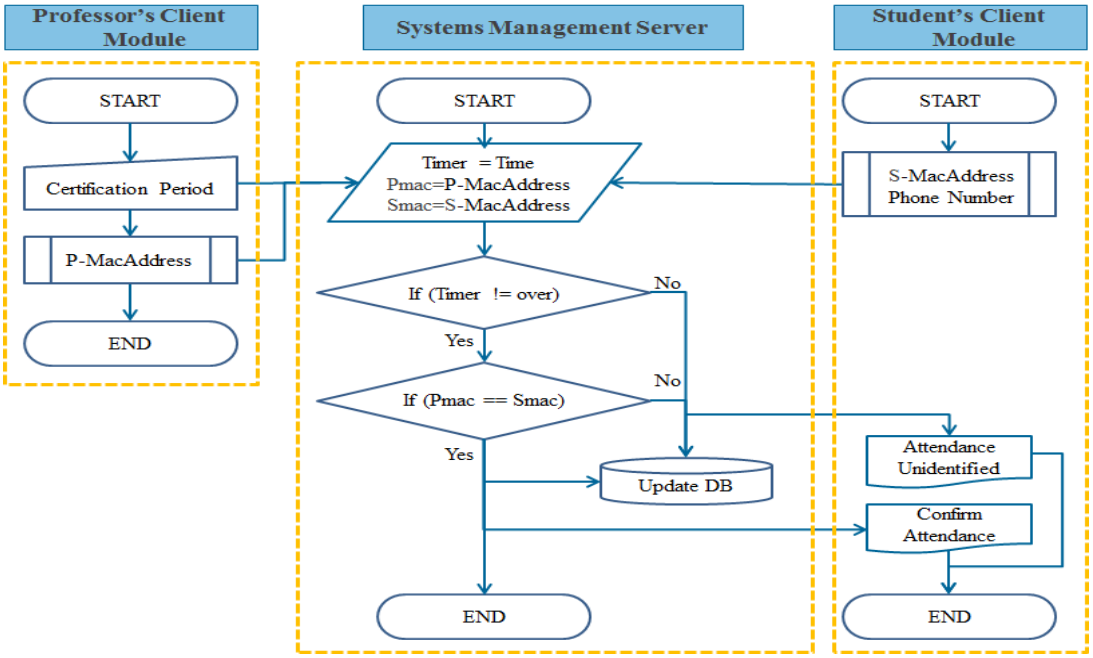

Figure 3. Proposed System Authentication Algorithm

4. Expecting Result and Application Plan

There have been so many different research projects for an Electronic Attendance System with applied techniques, but most of these have focused on the system using only one technique. Even though an organization might invest large funds to develop such a system, due to issues like, but not limited to, vicarious attendance, attendees departure at intermission, and/or the bottleneck phenomenon in a university environment, the practical use of such a system is characteristically low. In this paper the common use of smartphones by most people, coupled with the use of the authentication algorithm, it is demonstrated how such problems can be solved. The table below (Table 2) compares the differences between the suggested system and existing technologies.

The expected effects of suggested system are as follows:

(1) Vicarious Attendance Problem: In the system based on RFID, a student's ID card is only one thing needed to perform an attendance check (not the actual student themselves). With the suggested system the student has to have their smartphone and has to enter the password of smartphone to activate the application, thereby solving the vicarious attendance problem (Privacy, personal information, security).

(2) Bottleneck Phenomenon: When people use RFID cards only one person at a time can check in for attendance tagging. Students have to wait in a line when there is a large number of students present for the class. However, in the case of the suggested system, each student will have an individual smartphone app that will shorten attendance authentication dramatically.

(3) Attendees Departure at Intermission: In the existing system, to check the attendance randomly to discourage early departure, students would have to leave their seat, stand in line and wait to check in. This discourages random attendance checks and it was difficult to determine if students were leaving class prematurely or remaining for the entire period.

However, in the suggested system it takes a short amount of time to check the attendance, so a professor can check it as many times as they like to prevent students from leaving before the class ends.

(4) Reduction of Initial Introduction Costs: There is no a need to place a certification device in every class room, thereby cost savings in the initial introduction of the suggested system can be realized.

(5) Interaction between Professors and Students: The system helps to stimulate the students' participation through the answering of quiz questions and professors can get instantaneous feedback about their students' efforts and comprehension of the class.

Table 2. Comparison with Existing Technology

Troubleshooting	ID/Password-based system	Wi-Fi Positioning System	RFID System	Suggested System
vicarious attendance	No	Yes	No	Yes
departure at intermission	No	Yes	No	Yes
bottleneck during check-in	Yes	Yes	No	Yes
costs of construction	Low	High	High	Low
maintenance costs	Low	High	High	Low
authentication error	Low	High	High	Low

5. Conclusion

In this paper a new algorithm is introduced, as part of an Electronic Attendance System, to be used in tandem with smartphones. This is a severe departure from existing technologies, but provides a solution to many of the biggest problems of Electronic Attendance Systems that result in low utilization of such systems within the special environment of a university. These problems include the bottleneck phenomenon, vicarious attendance, early departure, *etc*.

The suggested system uses smartphones, recognizing that almost all students have their own smartphone, and wireless AP. In addition to these technologies, the system combines the two factors of time and space with an algorithm that proceeds with attendance authentication. Compared to the existing Electronic Attendance System, which needs separate a certification device, construction costs can be significantly reduced. The authentication system is based on a smart phone application for different user requirements to ensure functional scalability.

This paper is a research effort concerning the certification algorithm of an Electronic Attendance System. The paper attempts to address the practical problems in an existing university area and taking into account existing papers on the subject. It needs to be verified by implementation of the suggested system at a future date. In addition, there will be a specific effort required to design the interactive features to be available within the classroom setting.

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