Development of a Bluetooth-Based Contactless Automated Attendance Capture System for Large Halls and Auditoriums

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Abstract—The g Attendance capture for large populations still remains a challenge for organizations such as Schools, Universities and Event organizers. This is due to the fact that the attendance capture process is sequential requiring individual identification and autentification process. This process usually takes up a lot of time and generates a lot of inconvenience for the attendees. This process is also subject to manipulations as the most common identification model involves the use of ID cards embedded with either RFIDs or identification methods to tie the user to the card. These cards can be given to third parties for the purpose of taking the attendance. This paper presents the development of a Bluetooth based system and a local identification system for the development of a contactless identification capture system for large halls. The system identifies the user using his fingerprint. When the identification is completed, the data is transmitted to a central data base using the Bluetooth transmission technology. This system will enable a contactless capturing of the attendance in large halls resulting in a system with a very high security level and no inconvenience for the attendees.

Index Terms—Attendance capture, Bluetooth, RFID Technology, Passive Tags, Active Tags

I. INTRODUCTION

Attendance capture for large gathering especially in schools has always been a challenge. This is due to the fact that the processes deployed require individual verification and often times, these systems are only able to capture one person at a time. The attendance capture process consists of a process of identification of the attendee and verification of the attendee. This is achieved traditionally by the combination of the attendee name and signature. The key expectations for attendance capture systems include the need to identify the attendee, verify the attendee presence and also identify the time of the attendance. Several approaches have been deployed by different organizations in the process of attendance capture and each of the system has its areas of strength and weakness. This paper presents a review of these attendance capture systems, the characteristics and weaknesses of each and presents the

design of a Bluetooth based contactless system suitable for attendance capture for large halls and auditoriums.

II. BLUETOOTH TECHNOLOGY

Bluetooth is a short range wireless personal area network technology used to exchange information between wireless devices. The communication range is classified as low, medium and high depending upon power level. The technology is a license-free, robust, low cost technology which uses low power levels for data transfer. The operating frequency band is in 2.4GHz Industrial, Scientific and Medical (ISM) RF Band and uses a frequency hopping Time Division Duplex (TDD) technique for each radio channel [1]. With frequency hopping, data is separated into smaller units called packets such that the transmitter and the receiver are able to exchange packets at one frequency, and then hop to another frequency to exchange another packet. This process is repeated until all the data are transmitted [2].

Frequency hopping technique employed in Bluetooth-enabled devices helps to minimize eavesdropping and interference from other networks that uses the same ISM band [3]. Each of the Bluetooth radio channel has 1MHz bandwidth and hops at a rate of 1600hops/second. It has a capacity to support data rates up to 720kbps [4] and allows various Bluetooth enabled devices to securely share information with one another within a 10meter range [5].

According to Bluetooth Special Interest Group, this wireless technology is the most widely supported, versatile, and secure wireless standard in the market [6].The capability to replace knotty wired electronic appliances together with an invisible low power short range wireless connection provides flexibility and expediency for users, appliances and the workspace surroundings thus facilitating communication. Also, the ability to simultaneously handle both voice and data transmissions by enabling users to enjoy a range of innovative solutions such as a hands-free headset for voice calls is an advantage to this technology.

III. RADIO FREQUENCY IDENTIFICATION

RFID is a wireless technology that operates in an unlicensed ISM RF Band using tags and tag readers to communicate with a backend database system in order to facilitate automatic identification using radio-waves. Although there are several modes of identification, yet the ability of RFID technology to transmit larger amounts of information without being in line of sight (LOS) gives it a major advantage over other identification modes such as barcodes [7].

There are several categories of RFID technology but the requirement of the application involved determines the suitable RFID frequency band and the type of tag to be employed.

Presently, there are two basic types of RFID tags. The first set is known as active tags. They have an internal battery power source which is used to generate a signal in response to a reader. The trade-off is greater size, greater cost and limited operational life, depending on operating temperatures and battery type. The other set of tags is known as the Passive tags. These have no power source of their own, thus, they obtain power directly from the reader transceiver. They are much lighter than active tags, less expensive and offer a virtually unlimited operational lifetime. The trade-off is that they have shorter read ranges than active tags and require a higher-powered reader [8].

Each of these tags have unique frequency ranges has and unique characteristics with different advantages and disadvantages. However in general , a lower frequency means a lower read range and slower data read rate, but increased capabilities for reading near or on a metal or liquid surfaces [9].

IV. ATTENDANCE CAPTURE SYSTEMS

Attendance capture is done to identify the attendees and to ensure that they are not impersonated. It is also done to determine the time of the attendance. There are a number of approaches deployed in capturing attendance of participants at events and these are discussed below.

A. Roll call attendance capture system

The most basic attendance capture system is implemented by means of a roll call where the attendees are identified personally when they respond to the call. The moderator marks the attendee and updates the records for each attendee. This process requires little or no hardware and can be implemented as often as is required. However, this process is only suitable for a small number of persons and the moderator who does the attendee verification must be known all the attendees by face and name. This process is very time consuming as each name on the list must be individually called and the moderator must see each attendee to prevent impersonation of attendees. These limitations necessitated the use of paper based attendance capture systems.

Table I shows the characteristics of the different RFID systems [10]:

TABLE I: CHARACTERISTICS OF DIFFERENT RFID SYSTEMS

Band	frequency	Range	Data Rate	Applications
Low Frequency	125 - 135 KHz	20 - 100cm	Low	car immobilization and access control systems
High Frequency	13.56 MHz	10 - 70 cm	High	contactless credit cards and building access control systems
Ultra High Frequency	868 - 928 MHz	10cm - 3m	Medium	Supply chain management
Micro wave	2.45 & 5.8GHz	3m	Medium	fleet identification and electronic toll applications

B. Paper based Attendance capture systems

The paper based attendance capture systems are implemented by the use of lists with attendee's names where the attendees are required to sign against their names or they write their names and sign. This process without the presence of a moderator is highly insecure as there is no means of verifying identities of the attendees with respect to the names they write down. Students have been known to use signatures comprising of their initials only such that when they are not present at the function, their friends can both write their names and sign for them. The paper based which can also be very cumbersome for large group attendance capture is better used for a small population of attendees where they can be verified as quickly as possible. The verification process is significant especially for statutory functions such as examinations, lecture attendances where the risk of impersonation can be very high in large population. The paper based approach has several limitations among which include the inability of the system to accurately verify the attendee using the signature. The process of updating the attendance is also time consuming as the attendance is either manually processed or it is transferred to the computers for automated processing. This process also introduces an opportunity for attendance manipulations.

C. Radio Frequency Identification Based attendance Capture systems

Radio frequency Identification is another approach currently being deployed for attendance capture. This method requires the use of special cards (RFID enabled) upon which the students picture and other identification metrics are printed and a Reader for reading the information from the card. The reader is connected to a computer system which houses the database and does the processing. The RFID enabled chip contains the details of the students such that when the card is placed in front of the Reader, it identifies the person whose details are stored on the chip embedded in the card. This system provides an automated means of capturing and processing the attendance. This system has a very high processing speed but the attendance capture is still done one at a time and the system has no means of verifying that the card holder is the same as the card owner except if authorized personnel are available to do the verification. The diagram in ''Fig.1'' shows the block diagram of the RFID based attendance capture system.

Fig.1. Block diagram of the RFID based attendance capture system

The key challenges associated with the existing attendance capture systems include

- Long capture times especially for events with large attendees
- Lack of a means of verifying and authenticating the identities of the attendees.
- Opportunities for impersonation of attendees

These three key challenges necessitated the development of an attendance capture system with the following characteristics

- A means of capturing the attendance of multiple attendees at the same time during the program without having to resort to queues. This feature is desired so that attendance can be taken while the attendees are seated for the meeting
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These key requirements led to the development of the Bluetooth based Contactless Attendance Capture system. The Bluetooth based attendance capture system is shown in Fig. 2
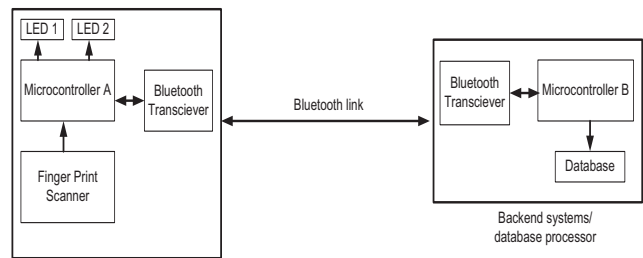

Fig.2. Block diagram of the Bluetooth based attendance capture system

D. System description

The system comprise the ID card holder which carries the finger print scanner, a microcontroller, a Bluetooth transceiver and 2 indicator Light Emitting diodes (LED1 and LED2). All of these components are integrated into the ID card holder and the students ID card is permanently fixed to the card holder. The backend comprise of another Bluetooth transceiver, a microcontroller and the database for storing the students ID. Both units are linked together by the Bluetooth connection.

E. Finger Print Identification

The finger print identification is implemented using a finger print identification module. The module of choice is the more economical version of the GT-511 which has a decreased memory capacity (compared to the GT-511C3). The module shown in Fig 3 can only store up to 20 different fingerprints but is capable of fingerprint recognition and download and upload templates using serial interface. For a recognition system requiring a small number of finger print date, this is the module of choice [11].

Fig. 3. The GT-511 Finger print

F. System operation

The ID card holder and Microcontroller A contains details of the student and the finger print scanned data. In order to conserve battery power, the finger print scanner is also designed to activate the entire system. When the finger print is depressed, the finger print data is acquired and compared with the data stored for the student on the microcontroller memory. If there is a match, it confirms identity of the student and a short burst containing the students ID is transmitted over the Bluetooth link to the backend system. The LED 1 stays on to indicate the finger print capture in progress and blinks to indicate transmission of the attendance date to the backend. The backend on receipt of the data sends out acknowledgement in batches for all the received attendance transmissions. When the ID card holder system receives the acknowledgement, the LED 2 comes on and stays on for up to 5 seconds and goes off indicating a successful attendance capture.

G. System benefits

The benefits of the system include among others, the ability to process a large number of attendees simultaneously without having to interrupt the program. Other advantages include the fact that the system does the authentication of the attendee's identity and this eliminates the possibility of impersonation as the finger print ties the attendee to the ID card and to the venue. The acquired data can be processed almost instantaneously and the presence of the acknowledgement message provides feedback to the attendees that their attendance has been captured.

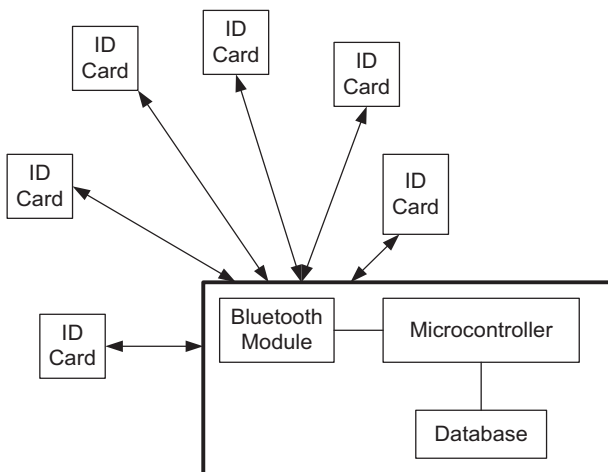The system block diagram is shown in Fig. 4

Fig. 4. System block diagram

CONCLUSION

The process of attendance capture is a vita process as it provides a means for tracking participation at functions and ensuring that only approved persons are allowed to participate. However the increase in the population of the participants at most of these events presents some challenges with respect to the convenience and ease of the attendance capture process and the authentication process for the data acquired in the attendance capture process. The Bluetooth based system presented in this work provides a means of authentication of the participants in a convenient manner such that the attendees are not required to queue or wait in line for the process to be done. It also transmits the data wirelessly from the attendees seated positions and thereby eliminating the need for long queues and time spent on the queues.

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