Online Students' Attendance Monitoring System in Classroom Using Radio Frequency Identification Technology: A Proposed System Framework

Rajan Patel[1], Nimisha Patel[2], Mona Gajjar[3]

[1,2,3] *Department of Computer Engineering, Sankalchand Patel College of Engineering,*
Visnagar-384315, Gujarat, India

[1] `rajan_g_patel@yahoo.com`
[2] `nimishaa_25@yahoo.co.in`
[3] `monagajjar_200@yahoo.co.in`

Abstract— **Today students' (class) attendance is become more important part for any organizations/institutions. Recording and monitoring of class attendance is an area of administration that can require significant amounts of time and effort in a school/university environment, largely due to the amount of time required in lectures to get the necessary information. This paper presents the integration of ubiquitous computing systems into classroom for managing the students' attendance using RFID technology. RFID technology can be a powerful tool in helping to manage student's attendance throughout the working school day and also enhance classroom security. RFID technology has been applied to solve problems where it is necessary to take automatically record the movements and locations of students in a classroom of school/university environment. A real time intelligent system is implemented in conjunction with RFID hardware to record students' attendance at lectures and laboratories in a school/university environment. RFID is a technology that allows for a tag affixed on identity card to communicate wirelessly with a reader, in order for the tag's identifier to be retrieved.**

Keywords—**Ethernet, RFID, EPC, Middleware, LAN, Interface.**

I. INTRODUCTION

Due to globalization and easy availability of almost all information on the internet these days, students are less motivated to come to the lecture rooms or laboratory. Why students have to go to school/college for attending a class, there are many reasons that students have to go school and to attend class. Some of the listed here: Something they student miss and never he/she can learn at home without attending school such as discipline, making friends, group learning, learning new things, ideas, motivation etc. Most educational institutions' administrators are concerned about student irregular attendance.

Because of, there is often clear correlation relation between student's attendance and over all academic performance. Absenteeism can cause the institution to lose its reputation as well as resulting in inadequate learning on the part of the student. Higher authority in school/university also demands that institutes concerned with students and education keep a large amount of data, including attendance and absence levels, performance and agreements regarding individual assistance. Traditionally - students attendance made in attendance register, i.e. registration of all students attendance made in paper in class. Due to this, loss of time for students and the teachers, lack of knowing exactly the students who attended a particular class for instant, validation and insertion of data is done manually. There may be chance for tampering data. Due to large community of students and teachers, it is difficult to manage manually.

It is vital for educational sectors to have solutions that simplify and increase the speed of data collection and increase the lectures efficiency. To address these problems, any institution/school must look for a better system such as RFID-based system that could log the student. The important aspect of this paper is to show how RFID can potentially change the way we manage our lives and providing complete solution for a fully automated system. If a school has money to spend on technology, most analyses will show that there are better ways to spend it than on RFID for tracking students [1].

The primary goal is to monitor student's attendance using RFID for administration and notification if student's/faculty's presence record is below specified threshold level.

The rest of paper organized as follows: section II describes brief about RFID, section III discusses the system requirements and selection of RFID components.

Section IV describes the architecture and working principles of system, section V provides basic advantages of system and finally conclusion discuss in section VI.

II. RADIO FREQUENCY IDENTIFICATION (RFID)

RFID is a technology that is used to collect information automatically by radio frequency data communication between a mobile object and an RFID reader [2], to identify, categorize and track them. They are most commonly referred to as tag and reader respectively [3]. To retrieve the data stored on an RFID tag, need a reader [4]. A typical reader is a device that has one or more antennas that emit radio waves and receive signals back from the tag [5]. It is used to read or write information on a tag and passing that information to a system for storage and processing [6]. The basic RFID system components are shown in figure 2.1. [7]: RFID-Tag, Antennas, Reader, and Host (Combined with Middle ware and Application software).
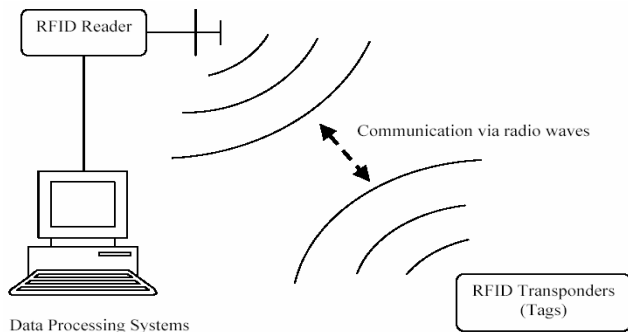

Fig: 2.1. RFID System Components [7]

A. Why RFID Technology?

An RFID technology overcomes the limitations of other automatic identification approaches that use light to communicate, (such as bar codes and infrared technology) because a tag may be hidden or invisible to the eye and can be used in a harsh or dirty environment. Readers can be set to remotely and automatically read without labor-intensive manual scanning of the object as in most bar code systems [8]. A comparison between all Auto-ID technologies are described in table 1 [9, 10], which highlights the strengths and weakness of RFID in relation to other Auto-ID technologies and proves that RFID is the better than other Auto-ID technologies.

III. SYSTEM REQUIREMENTS AND INSTALLATION

In order to automate the whole system of student's attendance registration using RFID, need to build appropriate software application. Affix an RFID tag on student identity card. Install RFID reader per classroom. It is necessary to find a cheaper reader due the large number of classrooms. Connect all readers to the educational institution LAN. Provides RFID readers power by Power over Ethernet (PoE). However this system does not required additional extra cost because it can easily integrate within the existing campus LAN infrastructure, it required only RFID readers and tags.

Two ways to scan the tags, first is using Stationary Readers with external or inbuilt antennas and second is using Handheld Readers such as PDA/mobile device.

TABLE I
COMPARISON OF DIFFERENT AUTO-ID TECHNOLOGIES [9, 10]

System Parameters	Barcode	OCR	Voice recog	Biometry	Smart card	RFID
Data quantity	1–100	1–100	--	--	16–64 k	16–64 k
Data density	Low	Low	High	High	Very High	Very High
Machine readability	Good	Good	Expensive	Expensive	Good	Good
Readability by people	Limited	Simple	Simple	Difficult	Impossible	Impossible
Influence of dirt/damp	Very high	Very high	--	--	Possible	No influence
Influence of (opt.) covering	Total failure	Total failure	--	Possible	--	No influence
Influence of direction and position	Low	Low	--	--	Unidirectional	No influence
Degradation/wear	Limited	Limited	--	--	Contacts	No influence
Purchase cost/reading electronics	Very low	Medium	Very high	Very high	Low	Medium
Operating costs	Low	Low	None	None	Medium	None
Unauthorized copying/modification	Slight	Slight	Possible (audio tape)	Impossible	Impossible	Impossible
Reading speed (including handling of data carrier)	Low ~4 s	Low ~3s	Very low > 5 s	Very low > 5–10 s	Low ~4 s	Very fast ~0.5 s
Maximum distance between data carrier and reader	0–50 cm	<1 cm Scanner	0–50 cm	Direct contact	Direct contact	0–5-m, microwave

Any Readers either stationary or handheld can be placed (carry if handheld reader) around the classroom. During a class, teacher invoke the reader by the single click of the device button of handheld reader like laptop, PDA, PC etc. or automated reader invoke as per predefined schedule. The task of taking a classroom attendance becomes just a "single click" of the device button or fully automated. The reader antennas actively scan all the present tags attached with student identity card. This scanned information forward to central server via campus LAN. Central server will processes the information and publish it in relevant form. In order to aware the parent, administration staff can send E-mail which showing their absence/presence information. Also class teacher/instructor can view who is absent and how many students are present in he/she's laptop or getting message in mobile phone for instant. However selection of RFID components as specially tag and readers play major role in RFID system.

A. Tag Selection

Every tag has an identifier that is used to uniquely identify it. A tag identifier format that is used across many industry sectors is the Electronic Product Code (EPC [11, 12]). The tag identifier format consists of four data fields [13, 14] as shown in figure 3.1. [15].
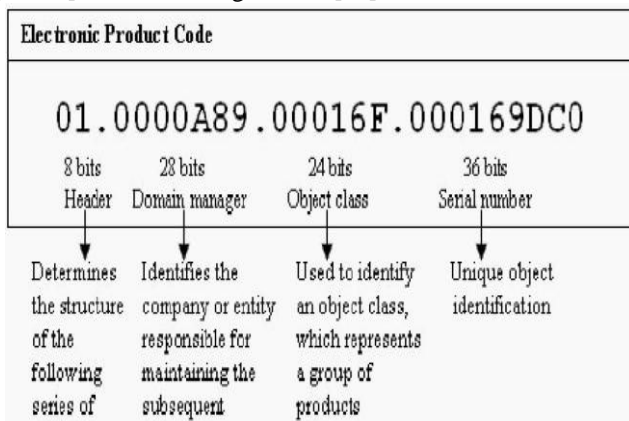

Fig:3.1. 96 Bit EPC Format [15]

The Header, which specifies the EPC type, The EPC Manager ID, which uniquely identifies the organization that is responsible for assigning the object class and serial number bits (often the manufacturer of the item), the Object Class, which identifies a class of objects, such as a certain model of television set, and the Serial Number, which uniquely describes the instance of that class of objects (e.g., a particular television set) [16].

Passive tags do not have an internal power source and need to draw power from an RFID interrogator. The interrogator emits electromagnetic waves that induce a current in the tag's antenna and powers the chip on the tag. When the power to the tag's chip passes the minimum voltage threshold, the circuit turns on and the tag sends the information back to the reader [17]. Semi-passive tags have an on-board power source like active tags but utilize it only when they are interrogated by a reader. Communication on these tags is carried out through reflection as it is on passive tags. The onboard power helps these tags in implementing more computationally intensive functionalities and enhancing their read ranges [18]. Active tags contain their own battery that supplies energy for both to power the chip on the tag and boost the return signal. Compared to passive and semi-passive tags, active tags have wider read ranges, larger memory capacities and faster processing times [17].

This system uses the passive EPC Class 1 Gen 2 tag, because they are small in size, they having lighter weight, any person can carry easily like smart card, cheap in cost, it can easily embed in identity card, does not required battery or backup power.

The main advantage of EPC type coding is that it provides fast searching (indexing) for tag's ID as shown in figure 3.2. It gives the quick result of searching tags' ID in association of any conventional method such as sequence searching which widely using in database system because it is simple method. Assume one organization having two institutes and each institute having 600 students. Each institute having two departments and each department having 300 students. The total numbers of students are 1200 in an organization. All students tag's ID are stored in database server. Now any student's tag ID scanned by reader and it send to server to search and mark the presence in appropriate subject's class. Server will search all 1200 students tag's in worse case using linear searching method. If we use indexing using EPC coding for tag ID than it takes 2 (search for institute) + 2 (search for departments) + 300 (students id) = 304 search required in worse case.
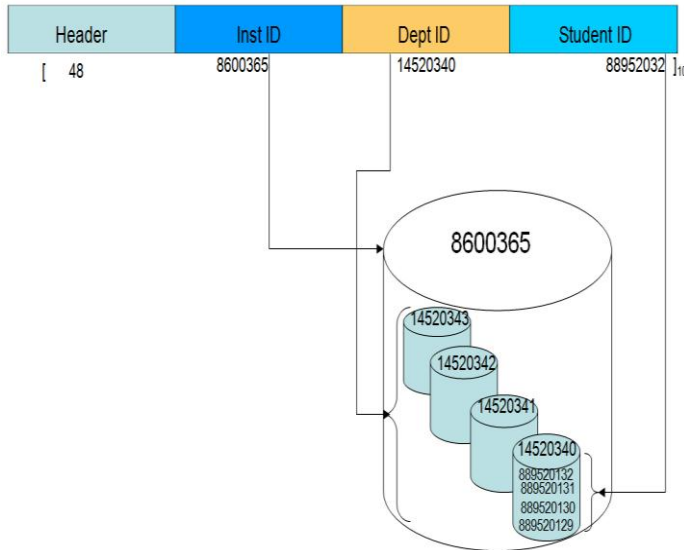
Fig:3.2. EPC Coding

B. RFID Reader (Interrogator) Selection

The reader communicates with the RFID tag via radio waves and passes the information in digital form to a computer system [19, 20].

Read-only: A reader that can only read the information from the tag. Read and write: interrogators that can write information into a tag in addition to reading the information from the tag. Both read-only and read/write interrogators can be either fixed mount integrators or handheld integrators. Fixed-mount interrogators are fixed-position interrogators mounted at specific locations i.e. in the middle of class room though which the tagged items are expected to scan within coverage area. The advantage of a fixed-mount interrogator is that the tags are read automatically as per pre defined schedule. Handheld interrogators are mobile (portable) interrogators, and therefore they contain all the basic elements, including antenna in one device. The information collected from the tags is stored in the interrogator and later transferred to a data processing system.

This RFID system uses Read-only fixed mounted interrogators type, however hand held reader can use where class room is not fix.

C. Configuring The Interrogation Zones Base on Frequency Range and Coverage Area

The interrogator zone is the area around an interrogator within which it can successfully communicate with a tag.

The aim of this system is to read the tags in class room and not read the student away or outside from the class room. For student attendance application can be use both HF (3 MHz to 30 MHz [9]) or UHF (300 MHz to 3 GHz [9]) readers and tags. In this application uses UHF readers because it can automatically identified students in the classroom while in case of HF reader Student need to place his card near the RFID reader to register his/her presence. Use of HF reader any student may scan the other student card, but in UHF the reader automatically scan the all tags and no chance for proxy attendance and latter or at instance instructor/teacher can get the message in his PC/laptop/mobile that how many students are present and who is absents. However UHF reader expensive compare to HF but UHF reader is well suited for this system.

D. Communication With Host Computer

The reader usually sends the scanned tag information to a background application system for further processing. Readers can attach to the systems through any interface (RS 232, USB, and Ethernet). In this system an interrogator connected to the network using TCP/IP interface to the LAN network easily because every campus have the facility of LAN infrastructure.

E. The Role of Middleware

Middleware is software based application which manages the readers, the data coming from the tags, and passes it to the backend database system. Data from tags must go through software (middleware) that can filter, convert, correct and relay it to the appropriate systems. The middleware can reside on a reader or a server [3].

IV. SYSTEM ARCHITECTURE AND ITS WORKING PRINCIPLES

Figure 4.1 show the proposed system architecture, in which it has hardware and software components such as readers, tags, middleware, database server, application server, hosts and local area network infrastructure (LAN).

All RFID readers are mounted in the central of each class room and connected with existing campus LAN infrastructure. RFID readers powered using Power over Ethernet (PoE). All students and faculty members' identity card converted with RFID tag. Software running on application server receives events, which having tag id, date, time, and class room location etc. These information pass through middleware (middleware can placed in reader itself also, which decrease the LAN traffic) which provides the filtering operation.

Fig: 4.1. A Proposed System Architecture

During class or lecture reader automatically invoked on the basis of predefined schedule and scan all the students tags as well as faculty tag during class time. Detected row of RFID data sends to middleware through LAN. Middleware perform filtering operation to remove unwanted and duplicated data, such as multiple same entry of student's tags id, some garbage data etc. In Application server runs special software which search student tag id stored in permanent database with scanned RFID tags, if tag id match then mark the appropriate presence, the system operation is described as below:

Step1. Scan RFID tags in class room.

Step2. Send scanned row of RFID data to middleware through LAN.

Step3. Using middleware perform the filtering operation to remove unwanted field and extract institute id, department id and student id.

Step4. Search student tags id in permanent database with scanned RFID student's tags. Step4.1. Search institute id, if found go to step 4.2. else go to step3. Step4.2.

Search department id, if found go to step 4.3. else go to step3. Step4.3. Search student id, if found go to step5. else go to step3.

Step5. Compare detected student's tag id's date and time with class time table and if match found than go to step6 else go to step 3.

Step6. Check person type and mark the presence.

Step.7 Repeat step 3 to step6 for all row of RFID data.

V. ADVANTAGES OF SYSTEM

This system is fast, fully automated, reliable, accurate, does not required physical site of contact, reducing paper based work, saving the time of attendance call, authentic attendance, no proxy attendance, cannot forged data, students would have a reason to go to class, easy way to let parents know if a child is skipping class, students don't have to carry multiple cards, college management can easily find out the preferred choices of students for instance, simple in use and potential to grow to add new features.

VI. CONCLUSION

It is a generic architecture of an intra-connected network of RFID readers within an educational institution. It is also easy and accurate, fully automated students' attendance monitoring system and providing more services to automate educational institution's processes. It can easily integrate with other campus activity such as RFID base book library, automatic payment system in canteen etc. This system does not required additional cost; it is one time investment and having long life.

References

[1] By Scott McLeod, By Allan Jones, "Should RFID Be Used to Monitor Students?", ISTE (International Society for Technology in Education), November 2006.

[2] Sae Sol Choi, Mun Kee Choi, Won Jay Song, Sang H. Son, "Ubiquitous RFID Healthcare Systems Analysis on PhysioNet Grid Portal Services Using Petri Nets", IEEE ICICS,pp.1255, 2005.

[3] Taimur Hassan, Samir Chatterjee, "A Taxonomy for RFID", Proceedings of the 39th Hawaii International Conference on System Sciences, IEEE, pp.1, 2006.

[4] M. K. Yeop Sabri, M. Z. A. Abdul Aziz, M. S. R. Mohd Shah, M. F. Abd Kadir , "Smart Attendance System by Using RFID", Asia Pacific Conference on Applied Electromagnetic Proceeding, Malaysia, IEEE, 2007.
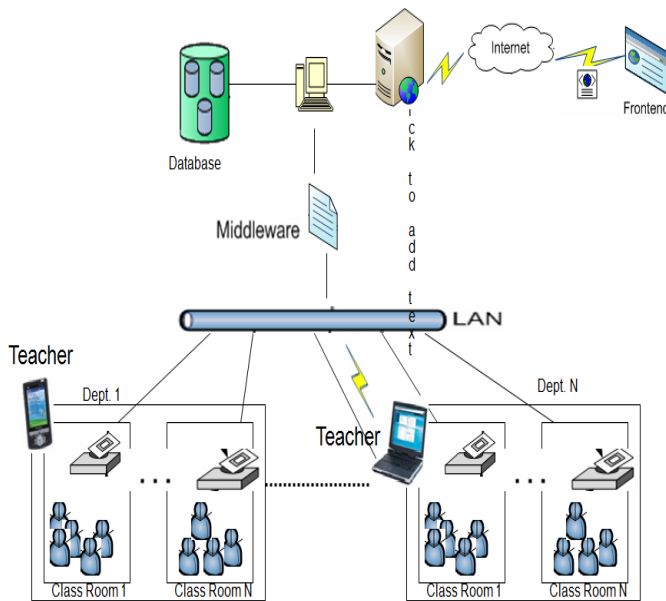
[5] Taesung Kim, Howon Kim, "Authorization Policy for Middleware in RFID System", IEEE, 2006.

[6] Rashid Aziz Faruqui, Ejaz Tayab, "RFID: Importance, Privacy / Security Issues and Implementation", IEEE, 2008.

[7] Geng Yang, Sirkka L. Jarvenpaa, "Trust and Radio Frequency Identification (RFID) Adoption within an Alliance", Proceedings of the 38th Hawaii International Conference on System Sciences, IEEE, pp. 3, 2005.

[8] Aysha Qaiser, Shoab A Khan, "Automation of Time and Attendance using RFID Systems", IEEE, 2nd International Conference on Emerging Technologies Peshawar, Pakistan, 13-14 November 2006.

[9] Prof. Y. B. Thakare, Prof. S.S. Musale, Prof. S.R. Ganorkar, "A Technological Review of RFID & Applications", IET International Conference on Wireless, Mobile and Multimedia Networks, pp.65-70, January 2008.

[10] Klaus Finkenzeller, RFID Hand Book: Fundamental and Applications in Contactless Smart Cards and Identification, Second Edition, Wiley, 2002.

[11] EPCglobal Inc. Radio Frequency Identity Protocol Class 1 Generation 2 UHF RFID protocol for communication at 860Mhz-960Mhz version 1.0.9, 2005.

[12] Il Jung Kim, Eun Young Choi, Dong Hoon Lee, "Secure Mobile RFID system against privacy and security problems", Third International Workshop on Security Privacy and Trust in Pervasive and Ubiquitous Computing, IEEE, 2007.

[13] Madan Mohan, Vidyasagar Potdar, Elizabeth Chang, "Recovering and Restoring Tampered RFID Data using Steganographic Principles", IEEE, pp. 2855, 2006.

[14] Atif Sharif, Vidyasagar Potdar, "A Critical Analysis of RFID Security Protocols", 2nd International Conference on Advanced Information Networking and Applications – Workshops, IEEE, pp.1358, 2008.

[15] Yi Zhi ZHAO , Oon Peen GAN , "Distributed Design of RFID Network for Large-Scale RFID Deployment", International Conference on Industrial Informatics, IEEE,pp.47, 2006.

[16] Tom Karygiannis, Bernard Eydt, Greg Barber, Lynn Bunn, Ted Phillips "Guidelines for Securing Radio Frequency Identification (RFID) Systems", NIST, April 2007.

[17] Qinghan Xiao, Cam Boulet, Thomas Gibbons, "RFID Security Issues in Military Supply Chains", Second International Conference on Availability, Reliability and Security (ARES'07), IEEE, 2007.

[18] Shantanu Rao, Nagaraja Thanthry, and Ravi Pendse , "RFID Security Threats to Consumers: Hype vs. Reality",IEEE, 2007.

[19] Prasenjit Bhadra, "RFREAD: The Generic Framework for RFID Reader Adapter", EAIT (International Conference on Emerging Applications of IT), Kolkata, India, February, 2006.

[20] K.Ganesan, K.Vignesh, "Automated Parking Slot Allocation using RFID Technology", IEEE, 2007.