Abstract—Smart classrooms generally differ from other pervasive information technologies such as RFID. But the academic office is still lacking one effective methodology to collect the 100% student actual attendance in time at the end of every period class. Now, if we consider whether the roll-call function in the smart classroom would be critical especially when they implement the RFID student’s ID card to track the student attendance. And then the roll-call function only can lead to read everyone’s ID card individually which can’t avoid the agent to punch at the beginning of every class. In this paper, we propose an efficient mechanism by IOT architecture, namely, the Smart Classroom Roll Caller System (SCRCS) that installed at every classrooms of university and read the student’s ID card accumulatively to present the total number of the actual attendance on the LED display of SCRCS at the beginning of every class and let the all ID cards be visible on the multiple slots of SCRCS to avoid the student agent’s activities. Finally, the academic office will collect every student’s attendance at every class on time and help students have good study performance.

Keywords: Smart Classroom; RFID Roll Caller; IOT Architecture

I. INTRODUCTION

Reducing the rates of student truancy and chronic absenteeism has been and continues to be an important management goal of every level school systems. Attendance not only affects individual students but also can affect the learning environment of an entire school. In general, the managers of school always ask the tutors and teachers to do the education guidance but it is not the best solution for these chronic absenteeism students. In advance, the teachers would give one warning to the absent students by roll call that would spend about 5 to 10 minutes. Therefore, most teachers could not do the roll call every lesson, since it would spend too much time. The question which we must consider is the operations of roll call for every class in the university could be charged by every teacher who was familiar with this job and spend time in his lesson. In this paper, the radio frequency identification (RFID) technology and internet of thing (IOT) technology are implemented at every classroom in the school to assure that every student lesson attendance record is collected by smart classroom roll caller system (SCRCS).

II. RELATED WORK

A. RFID introduction

Radio Frequency Identification (RFID) technology was first introduced at World War II and used to distinguish where the enemy aircrafts are. Typically, RFID system has three basic parts: RFID tags, RFID readers and the management application system. In general, RFID tags are further defined into two categories: Passive model and Active model. Besides, the system is must specified by tag and reader with the same frequency. In a word, HF reader only can read the HF tags and cannot read other frequency tags. Many schools use HF or UHF RFID card tags as the student’s ID card and integrate many functions into the card such as school dorm security card, library enter card, motorcycle parking card, payment card and traffic card [4].

What has to be noticed is the conceptual working model of roll call system by RFID and IOT technology to confirm all students’ ID attendance and total attendance number in this classroom. The Fig. 1 describes the real case workflow of RFID roll call system in the classroom, such as the RFID access control system which has been implemented in many researches [8-9, 11-13]. In this paper, every student must use their student card to sign and leave it on the RFID board. Teacher could easily call every student’s name by watching the RFID board, since all present student cards are there. There is no chance to do the imposture and we have the confidence to believe that every student have the better performance.

<table>
<thead>
<tr>
<th>TABLE I. RFID TYPES [4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive (without battery)</td>
</tr>
<tr>
<td>Smaller, Lighter</td>
</tr>
<tr>
<td>Shorter range (&lt;3m)</td>
</tr>
<tr>
<td>Smaller data storage</td>
</tr>
<tr>
<td>Lower cost</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Active (with battery)</th>
<th>Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger, Heavier</td>
<td>LF : 125, 135 kHz</td>
</tr>
<tr>
<td>Longer range (up to 100m)</td>
<td>HF : 13.5 MHz</td>
</tr>
<tr>
<td>Larger data storage</td>
<td>UHF : 860-960MHz</td>
</tr>
<tr>
<td>Higher cost</td>
<td>Microwave : 2.4, 5.8 GHz</td>
</tr>
</tbody>
</table>
B. RFID Roll call system

The system uses HF/UHF readers mounted in classroom doorways and passive RFID tags attached to student ID card holders [13, 16]. These researches propose the passive RFID card tag to be student cards and every morning every students use it to be read by the front side RFID reader installed near the entrance of school [8, 9]. Because all students would arrive at school at the same time in the morning and every one need to read their student card, then everyone must spend more than 5 min to 15 min complete today attendance. Another solution about roll call is used to integrate the face recognition [5, 10, 14]. Now the private information is very important issue and protected by personal protection law. That’s why we design the RFID smart roll caller to replace the above face recognition.

Therefore, the active RFID tag also was implemented as student card and setup the location system in the campus [17]. These researches’ result of RFID roll call system lead to a reduction in time spent taking attendance, an increase in student performance, an increase in the fairness and accuracy of recording classroom participation, and an enhanced professor-student relationship [1, 3, 6-9]. Generally, many schools have developed the web roll call system from the student’s database and teachers would use this web system to record the attendances of this class [3, 6, 11-12].

### TABLE II. COMPARISON OF ROLL CALL SYSTEM

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Traditional Teacher/ Checker</th>
<th>RFID Roll Call</th>
<th>Smart Classroom (SCRCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Naming or list paper check</td>
<td>Passive/Active RFID TAG</td>
<td>Passive RFID Tag</td>
</tr>
<tr>
<td>Check Method</td>
<td>Very long</td>
<td>Short</td>
<td>Shortest</td>
</tr>
<tr>
<td>Operation Time</td>
<td>Impossible</td>
<td>Possible</td>
<td>Easy</td>
</tr>
<tr>
<td>Instantaneity</td>
<td>Easy</td>
<td>Easy</td>
<td>Impossible</td>
</tr>
<tr>
<td>Imposture</td>
<td>Easy</td>
<td>Easy</td>
<td>Impossible</td>
</tr>
<tr>
<td>Leave early</td>
<td>Easy</td>
<td>Easy</td>
<td>Impossible</td>
</tr>
</tbody>
</table>

III. METHOD

A. Case Study

In this case study, this smart classroom roll call function for the undergraduate students will implement at every classrooms in the university and aim to solve the complete 100% attendance rate of whole students at any period. These advantages of SCRCBS are compared with traditional method and RFID roll call system (Table II); therefore, this research leads to solve the trouble problems of existing methods that leads to solve the trouble problems of existing methods that are attendance impostor, occupation of lesson time and attendance record in real time. Generally, the RFID is well-known technology in the universities, and Chang Jung Christian University (CJCU) also adopts it as student card tool from 2009 and lets it use in the library and dormitory. There are about 2400 freshmen every year and more than 100 classrooms in CJCU at Tainan, Taiwan.

B. System develop procedure methodology

In this study, we apply the task analysis methodology to the process of SCRCBS in the school and developed three stages on the RFID smart roll caller of classroom: scenario evaluation, system planning, and test/verification. The three stages are discussed below:

1. Scenario evaluation. Define the problem and analyze the student behavior of chronic absenteeism and then build the to-be process setup in the classroom.

2. System planning. Firstly, define the hardware spec of RFID smart roll-caller and operation procedures. Secondly, complete the user interview, system analysis, and system design coding.

3. Test and verification. Install hardware and software system to test all functions and verify every scenario.

Actually, the RFID smart roll-caller was the expanded function from door controller and implemented by HF RFID solution. In this study, we acted as the coordinator and assigned the hardware design to RFID manufacturer at Taichung Industrial zone, Taiwan. In order to assure the 100% reliability for roll call in the school, it could respond every student card’s information of the individual student card by using one-to-many mode. In other words, we install
one HF reader with multiple antennas to cycling scan all student cards on the RFID roll caller in the classroom.

IV. SMART CLASSROOM ROLL CALL SYSTEM

Central to this paper is to try to solve the complete the every undergraduate student’s 100% attendance every day, especially they are often absent at the first lesson of morning or at the first lesson of afternoon. The question we need to consider now is that how to help all students empower their learning by high attendance rate. In fact, these smart students usually ask their classmates to bring their student’s card to roll call for every lesson. Hence, the traditional RFID roll call system [1,3, 7-9, 15-17] cannot void this event; there is no automatic mechanism to confirm the real time attendance or to double check every hour attendance of two/three hours lesson. This paper is intended as an investigation of making roll call for every student’s attendance easily by SCRCS. This system is design to solve the past unsolved problem in every school. In general, the standard operation process of SCRCS is divided into three steps as follows:

Step1: School has chosen this kind HF card Tags as student cards and preload all card Tag IDs into school’s database. Usually every freshmen has got the student ID card at the 2nd week while school open. Then every student would use this card for 4 years in the campus.

Step2: School would install one smart roll caller on each classroom and configure it with IP network. Then the server of computer center would receive the RFID smart roll caller information about students’ attendance. In a word, every classroom is implemented as the IOT architecture by RFID smart roll caller.

Step3: Every students should remember to bring students’ ID card when go to school and SCRCS would read these students’ card to confirm every attendance.

Finally, school would get every student’s attendance after these three steps. The process of this research is demonstrated by the Fig.1 and Fig.2 which explains how these three steps work interactively as the total overview of RFID smart roll caller of classroom. And, Fig.2 illustrates hardware architecture of RFID smart roll caller.

A. Hardware Architecture

We launched the new architecture of SCRCS to collect the right information of every student attendance from every classroom of different education building in school to confirm their learning rights. There are main four parts of SCRCS: LED display, multiple antenna card slots, reader module and embed system. These parts are described as follows (Fig. 2):

Part 1: LED display

SCRCS uses it to show the student’s name when the student puts student ID card into the Part 2 and calculate the accumulative attendant number of this lesson in this classroom.

Part 2: Multiple antenna card slots

SCRCS uses these slots to cycling check every RFID student card to read TAG ID as their student’s number to login into the O1 subsystem.

Part 3: Reader module

SCRCS uses the reader modules to control all antenna card slots and save the student card ID data into the buffer memory. The reader modules deliver the attendance to O1 when they leave this classroom.

Part 4: Embed system

SCRCS uses it to communicate with computer center server by local network environment. In the other words, the IP based SCRCS classrooms are connected with switch network and we call this is IOT case.

B. System Functions

We use Microsoft VB and .NET programming tool to develop the functions of SCRCS on the server installed in the Computer Center of University. The Database is also used by Microsoft SQL 2008 to create and manage student’s card ID and IP’s of RFID controllers in the campus. And then we develop the three functions of SCRCS and the processes which are described as follows:

O1: Office Of Student Affairs

This subsystem records every student’s attendances and saves as the absence rate of every student, and then students, tutors and teachers will receive the last record of attendance at the same time by SCRCS.

O2: Office of Academic Affairs

This subsystem calculates the classes’ statistics, departments’ statistics, and period statistics by SCRCS. This real time information will help everybody to remember to help students go to class.

O3: Computer Center

This subsystem manages every roll-caller installation status and setups the configuration of IP parameters. It also synchronizes the real time clock in every roll-caller and sent back the attendance of every class to Subsystem-A at the same time.

C. Limitations of Promotion

In the process of SCRCS implementation, the first limitation of the SCRCS is that how to educate every teachers to know this new roll call function by this RFID SCRCS. This system not only records every student’s attendance, but also records the presence of every teacher. This is one big constraint for promotion of SCRCS. Another limitation is absence is considered as easy and always happened in the life of university. Therefore, the tutors and teachers must cooperate to propagate the importance of attendance rate continuously.

D. Economic consideration

As far as the total budget is concerned, the manager will spend about 100,000 USD on the hardware of SCRCS (more than 100 classrooms) and $20,000 USD on the software of SCRCS during six-month implementation. Generally speaking, the trade-off issue between the quality of roll-call function and investment budgets have existed, especially the RFID SCRCS solution in campus is more expensive than the manual operation. Thus, once the RFID SCRCS is adopted, we will get more appreciation from parents of students.
In this research, the application of SCRCS is especially designed for the undergraduate students to roll call in the university, since students of nowadays pay less time to learn in the classroom. But this paper aims to solve the problem by automatic methodology that is SCRCS. This is the new school manage rule to record every student’s attendance and help tutors and teachers assist their learning state. We need the tutors to promote the fairness and convenience and increase acceptance of student. Another limitation of this research is about imposture: how to reduce this behavior happened rate and honor them with their attendance. We need the teacher to stay at last moment and watch every one take off the ID cards to leave. But another limitation is that if some students forgot to bring their student cards, SCRCS cannot record the attendance for them. We suggest to design the process to redeem their attendance. After that, we truly believe imposture rate is closed to zero.

VI. CONCLUSION

The smart classroom is design by one innovative RFID roll caller to scan all HF RFID student cards and could response every lesson’s attendance to O1, O2 and O3 subsystems real time. All roles of university would get their needed information by their user interfaces. This research proposes the new solution about roll call automation and saves every teacher’s effort to record everyone attendance. In advance, all students would receive their absent information every day after school. At the same time, the everyday and every lesson’s attendance statistic data were sent to their tutors and teachers after lesson. No doubt this solution would decrease the general absent rate from 30% to 5%. This is one successful tool to help students study well enough to compete after graduation. There is a causal effect of absence on performance for students: missing class leads to poorer performance [2]. It is the most important goal for students and teachers in the university.

REFERENCES


