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Robust Attendance System using RFID and Human Detection by Image Processing

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ABSTRACT

Schools and university administrations pay a lot of attention to the attendance of their students since it relates directly to the academic performance. Many systems have been developed in order to ensure an accurate attendance taking, but every system has its shortcomings in terms of ease of use, accuracy, privacy, or cost. In this paper we discuss the development of an automated attendance system that ensures accurate attendance taking without human intervention from the student or the teacher and with respecting their privacy and no interruption. In this system we used RFID technology to identify the student and then verify the attendance using image processing algorithm utilizing the camera system in the classrooms. Under testing the system proved to be accurate and sensitive to the situation in the classroom. The automation was successful in producing attendance results that can be used by the administration to make decisions.

1. INTRODUCTION

Attendance of students in the classroom is very important to universities and schools. Attendance of the students is an important factor in the academic performance because it relates to many factors like finishing the curriculum and awareness of the students of all the academic activities in the class. Many academic

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institutions have developed attendance policies that governs how much time the student can be absent from any class. And many of these institutions do not allow the student to continue attending if his absence passed certain threshold. To manage this issue, universities and schools try to implement different systems to manage attendance automatically in order to minimize errors and paper work in the process (Nandhakumar, kumar, Vijay, & Sriram, 2020) (Kariapper, 2021) (Rjeib, Ali, Farawn, Al-Sadawi, & Alsharqi, 2018).

Different attendance management systems have been developed based on different technologies. Most of the system uses radio frequency identification system (RFID) for initial identification of the student. Due to the shortcomings of using RFID technology such as swapping cards or loosing cards by the students, many systems try to augment the system design with other methodologies. For example some systems would use a different method to enhance the identification such as face recognition or fingerprint (Rjeib, Ali, Farawn, Al-Sadawi, & Alsharqi, 2018) (Wahab, Kadir, Yusof, Sanudin, & Tomari, 2009) (Manoj, Nethra, Manjunatha, GirishKumar, & & Nayak, 2016).

When combining different methodologies to improve the attendance management system for any academic institution, it creates different problems in design and implementation. Some of these problems could be related to privacy and face identification; some other problems could be related to infrastructure and cost (Shariff, Jadhav, A., Babu, & Hussain, 2016) (Abdullah, Al-Dabagh, & Alhabib, 2018).

RFID based attendance systems might not be enough to take attendance accurately but adding other components must also take into account the problems that come from using these different methods. Therefore, in the system we proposed in this research paper, we use the RFID technology for student identification in order to take attendance but to verify the attendance we used image processing inside the classroom in order to count the students and then check with the database and verify the number. The reason for this method is that it does not create privacy issues such as in face recognition and is also easier for any institution which has a camera system in place.

In the most recent RFID based attendance systems, there is a tendency to combine new technologies such as IoT concepts with RFID to develop a more accurate and

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robust attendance system. Nandhakumar, Kumar, Vijay, and Sriram, proposed a new system combining RFID and arduino microcontroller to develop an attendance system. The author's goals for developing such system were a secure, portable and ready to deploy RFID-based attendance. The system provides a practical and efficient solution for monitoring student attendance on a large scale. The proposed attendance monitoring system uses the concept of IoT to log and fetch data on the server/cloud and make it available for the user anytime and anywhere.

In another more recent paper, the author (Rkar Kariapper) in (Kariapper, 2021) proposes a more advance approach for the attendance system. The proposed system combines a two way system for the attendance system. The first system uses RFID and IoT. On the other part of the system it uses machine learning techniques. In this system a microcontroller, GSM module, RFID tag, an RFID reader are used for first step verification. In the second phase of verification a camera with Multi-task Cascaded Convolutional Network model is used. When the two phases of verification are met then the student is considered not absent.

The rest of the paper is organized as follows: section two explains the system design, section three explains the RFID technology, section four explains the image processing methodology used, section five talks about the system testing and results, and finally section six is the conclusion.

2. SYSTEM DESIGN

The proposed system in this research paper consists of two subsystems and the system core. The first subsystem part is the RFID based attendance taking system which consists of an identification card for each student with embedded radio frequency tag in order for the system to recognize the student and register the attendance. With the identification card there is the card reader which is installed at the door of the classroom and can automatically pick up each card at the time of the entry from a distance.

The second subsystem part of the system is the camera which is installed inside the classroom in an angle where it can take images for the entire room. This subsystem is connected to the module where the image processing is done. The taken images are

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processed to perform human detection and then count how many students are attending the class

The core of the system consists of two major parts. One part is the database which contains the student's records and it's designed in a way that can register the student as present when his or her card is read by the card reader at the door.

The other major part of the system core is the control module which runs the control software that connects all the major subsystems with the database and the interface. This control software controls the student registration as attending using the RFID module and then verifies the attendance through the image processing module by checking the actual number of the attending students in the classroom (Nwokeji, Olagunju, Apoorva, Frezza, & Tang, 2017) (Hameed, Saquib, Hassan, & Junejo, 2015) (Pandiselvi, Renuka, Sabure Peer Hussaima, Shenbagam, & Dhiviya, 2017) (Patel, Merchant, Tailor, & Trivedi, 2013).

The interface shows the attendance for each class so the teacher can check if everything is recorded correctly. The system design is shown in Figure 1 below.

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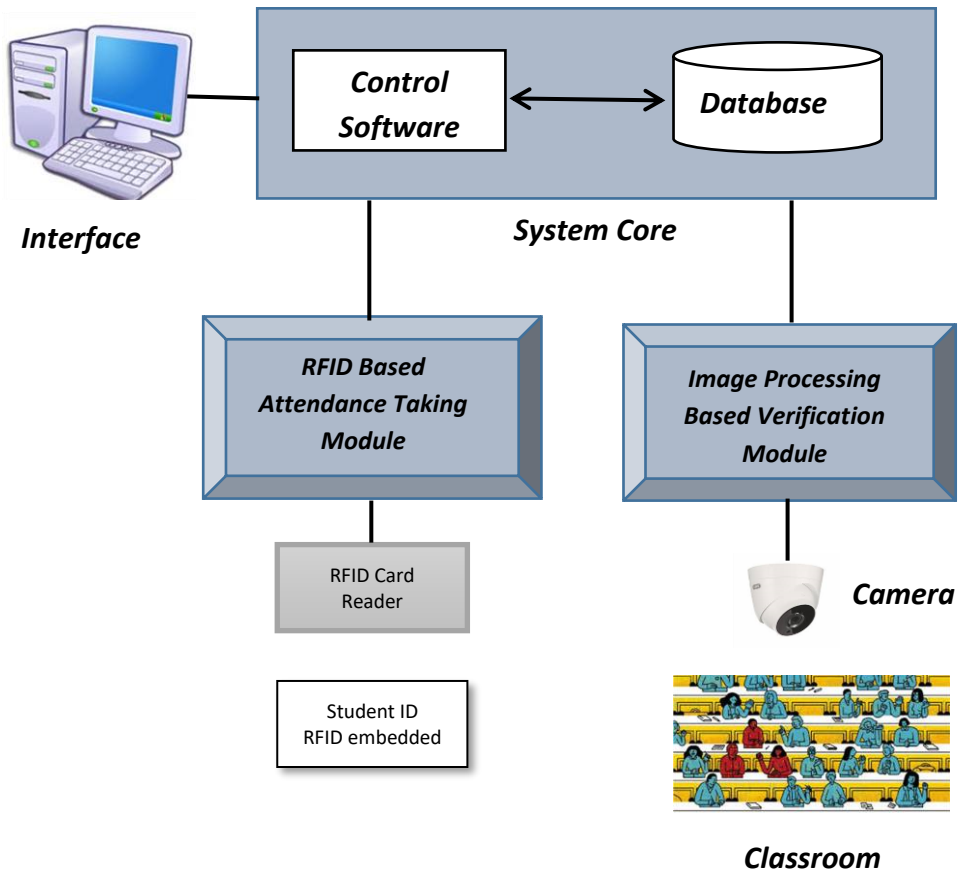

Figure 1: Attendance System Architectural Design

3. RFID TECHNOLOGY

Radio frequency Identification is a technology that has been around for some time. It was not used widely until recent years. The RFID technology uses radio waves to identify people or objects from short distances to long distances. The identification is automatic since the RFID reader detects the signal from the RFID tag attached to the object or carried by the human such as student ID card. This technology has been used for many purposes such as retail stores, manufacturing, identify environmental parameters such as temperature, etc. Unlike the bar code in the stores which require proximity to the item in order to identify, the RFID does not require the item to be next to the reader (Want, 2006) (Felstead, 2012).

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There are two types of RFID tags: Passive and Active. The main difference is that in the active tag there is a source of power like battery. RFID tags consist of microchip, antenna, and case in the case of the passive tag. And it is equipped with a battery in the case of the active tag. There is a big difference between the passive and active RFID in terms of size, cost, and distance of signal because the battery requires size and it is costly. Some of the applications of the the active RFID include the transponder attached to the planes for identification and the device attached to cars with GPS to find it when is stolen (Want, 2006) (Felstead, 2012) .

Using the RFID system does not relate only to the tags and the reader but it must have a backend database with control software and an interface in order to save the items and their description. In the student attendance system the information that are stored in the database are the information about each student with the identification ID which will be stored on the tag. A general system design using an RFID technology is explained in the Figure 2 below:

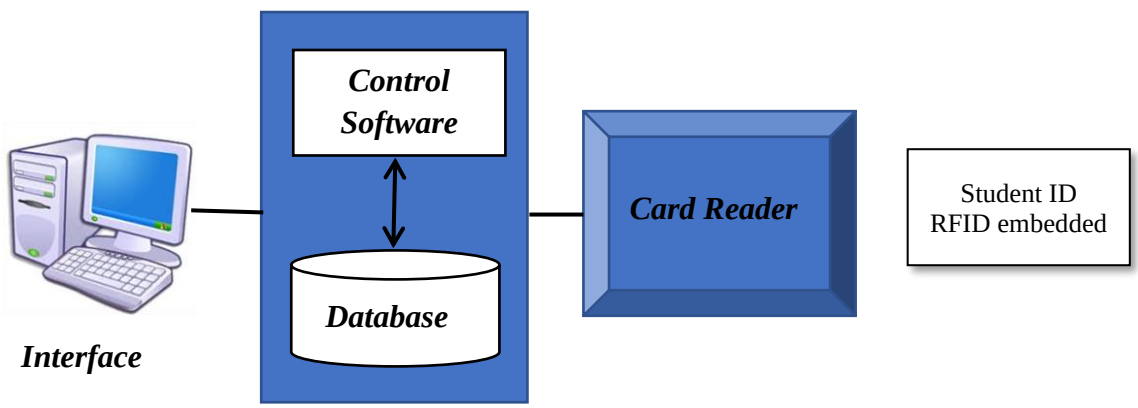

Figure 2: A typical RFID system

4. IMAGE PROCESSING

The purpose of the image processing module is to verify the attendance which is an important part of the proposed system. The image processing of this system is performed on the students upon entering to the classroom and the number is

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counted and cross checked with the database at the time of registering the attendance.

The image processing module follows five steps. In the first step, optional global image normalization equalization is used to minimize the influence of illumination effects. In the second step, first order image gradients are calculated. This step captures contour, silhouette and some texture information, while providing further resistance to illumination variations. In order to generate an encoding that is sensitive to local image content while remaining resistant to small changes in pose or appearance. The adopted method pools gradient orientation information locally in the same way as the SIFT (Dalal & Triggs, 2005) (Lowe, 2004) feature. The image window is divided into small spatial regions, called “cells”. For each cell we accumulate a local 1-D histogram of gradient or edge orientations over all the pixels in the cell. This combined cell-level 1-D histogram forms the basic “orientation histogram” representation. Each orientation histogram divides the gradient angle range into a fixed number of predetermined bins. The gradient magnitudes of the pixels in the cell are used to vote into the orientation histogram.

The fourth stage calculate normalization, which takes local groups of cells and contrast normalizes their overall responses before passing to next stage. Normalization introduces better invariance to illumination, shadowing, and edge contrast. It is performed by accumulating a measure of local histogram “energy” over local groups of cells that we call “blocks”. The result is used to normalize each cell in the block. Typically each individual cell is shared between several blocks, but its normalizations are block dependent and thus different. The cell thus appears several times in the final output vector with different normalizations. This may seem redundant but it improves the performance. We refer to the normalized block descriptors as Histogram of Oriented Gradient (HOG) descriptors. Final step collects the HOG descriptors from all blocks of a dense overlapping grid of blocks covering the detection window into a combined feature vector for use in the window classifier. The outpout of the system is shown in the figure 3 below:

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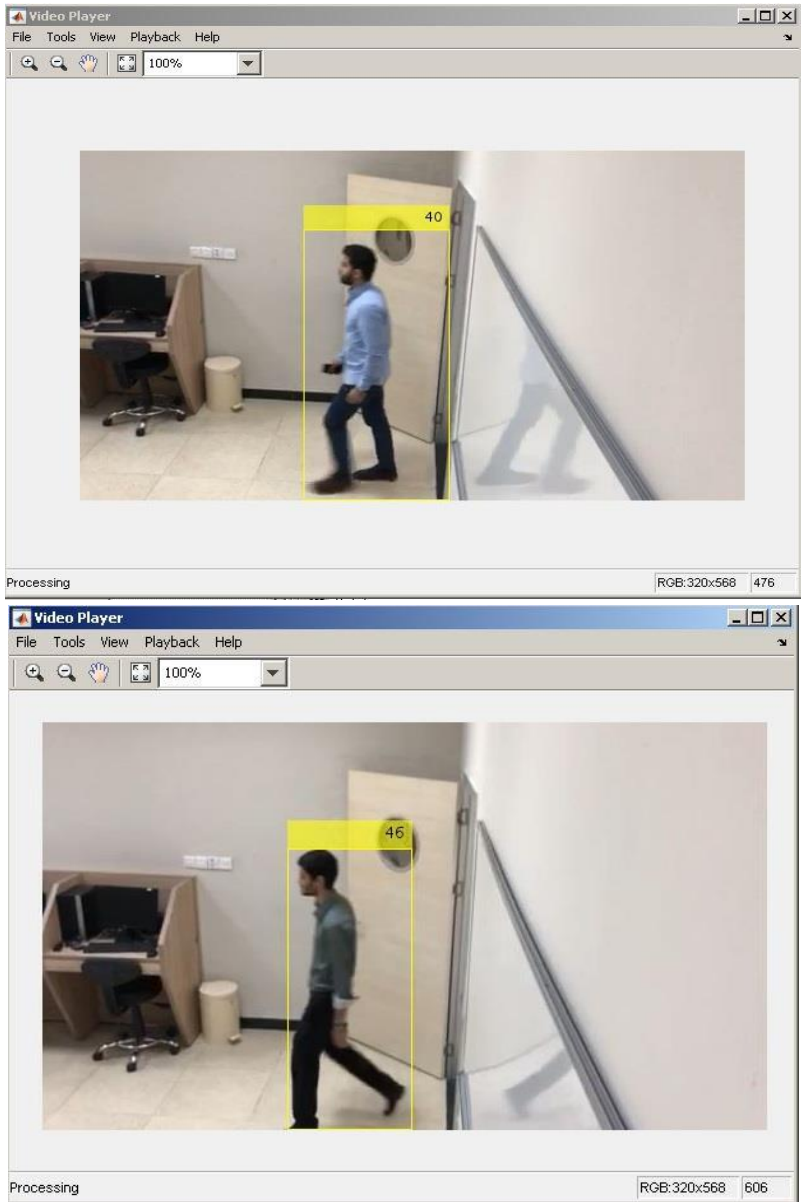

Figure 3: The output of Human detection system

5. TESTING AND RESULTS

The automated attendance system proposed in this research paper was implemented in a classroom in a university. It was implemented on one classroom where the

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students were provided with RFID cards with tags and then a card reader was installed at the classroom door in order to read the cards and register the attendance of the students in the classes. The classroom was equipped with a camera that we used to take images of the students when entering the classroom.

For the database records, all the students' records were entered into tables that have the student ID, class name, class date and time, and a field for registering the attendance. When a student enters the classroom the RFID card reader picks up the student card and sends it to the system were the attendance date and time is entered into the table.

At the same time, when students enter the classroom the camera takes video from the classroom and sends that to the image processing unit where students are identified and detected using a human detection algorithm. The number of students entering the classroom is counted against the database and this will verify immediately the number of attendees. This process is crucial to verify the correct attendance.

This implementation of the system was tested on the classes for the first stage of the department of computer science students. All the classes for one semester was taken into account. In the implementation process, some calibrations were needed in order to make the performance better; eventually the system was performing very well under the real time condition of the class attendance.

6. CONCLUSION

Student attendance management systems are essential tools for monitoring the academic development of a student in any academic institution. Many universities has attendance policies to encourage students to attend classes like maximum percentage that a student can be absent from a class and then the students will be subject to penalties. Many system designs have been proposed and developed for student attendance systems using RFID technology in combination with other technologies in order to verify the attendance to solve the problems that comes from the shortcomings of the RFID technology. Some of the proposed technologies include face recognition, biometric identification, fingerprint, etc. Most of these methods have some drawbacks.

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In our proposed system in this research paper, we used human detection methodology as an image processing tool to enhance the RFID based student attendance system. In this methodology, the algorithm is simple where we detect students in the classroom for the purpose of knowing the exact number of attendees and verify that with the database that is using RFID tags to register the attendance. This is easier to implement the face recognition

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نظام حضور قوي باستخدام RFID والكشف البشري عن طريق معالجة الصور

الملخص:

تولي إدارات المدارس والجامعات اهتمامًا كبيرًا لحضور طلابها في الصف الدراسي نظرًا لأنه يتعلق مباشرة بالأداء الأكاديمي. تم تطوير العديد من الأنظمة من أجل ضمان دقة الحضور ، ولكن لكل نظام عيوبه من حيث سهولة الاستخدام أو الدقة أو الخصوصية أو التكلفة. نناقش في هذه البحث تطوير نظام الحضور الآلي الذي يضمن الحضور الدقيق دون اي تدخل البشري من الطالب أو الاستاذ مع احترام خصوصيتهم وتعمل بشكل مستمر دون الانقطاع. في هذا النظام ، استخدمنا تقنية RFID للتعرف على الطالب ثم التحقق من الحضور باستخدام خوارزمية معالجة الصور باستخدام نظام الكاميرا في الفصول الدراسية. أثناء الاختبار ، ثبت أن النظام دقيق وحساس للوضع في الفصل الدراسي. نجحت الأتمتة في إنتاج نتائج الحضور التي يمكن للإدارة استخدامها لاتخاذ القرارات.

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سیستەمیکی بەهێز بۆ ئامادەبوون بە بەکارهێنانی RFID وە ناساندنی قوتابیان بە ڕێگای پرۆسێسی چارەسەری وێنە .

بەریوەبەرایەتی قوتابخانەکان و زانکۆکان گرنگەکی زۆریان داوە بە ئامادەبونی قوتابیەکانیان لە پۆلدا چونکە بەستراوە بە ئەدای ئەکادیمی خۆیان . وە زۆر سیستەم دروستکراون وە پەرەپێدراوون بۆ بەدی هێنانی ئامانجی ئامادەبوون بە ڕیژەیەکی زۆر بەرز . بەلام گشت سیستەمەکان کەموکورتیەکیان هەیە یان لە ڕووی ئاسانی بەکارهێنان یان لە ڕووی دقەی دەرەنجامەکان یان لە ڕووی تێچووەوە . بەلام لە تۆێژینەکەمان باسی پەرەپێدانی سیستەمیکی ئۆتۆماتیکی نوێیی ئامادەبوون ئەکەین کە زامنی دقەی دەرنجامی ئامادەبوون دەکات بە بئ ئەوەی دەستی کەسێك پێیی بگات لە قوتابی یان مامۆستا وە بە کارکردنێکی بەردەوام .

لەم سیستەمەدا تەقەنیەکی نوێمان بەکار هێناوە کە خودی قوتابی ئەناسێتەوە کە لە پۆل ئامادەبوە یان نا بە بەکارهێنانی خوارزمیەی پرۆسێسی چارەسەری وێنەکان بە سیستەمی RFID بە بەستنی کامیراکان لە پۆلەکانی وەرزی خوێندندا . پاش تێستکردنی سیستەمەکە بۆمان دەرکەوت کە سیستەمەکە زۆر وردە لە دەرەنجامی ئەنجامەکان ئامادەبوونی قوتابیان لە پۆل دا .

سیستەمی ئامادە بونی ئۆتۆماتیکی زۆر سەرکەوتو بووە لە بەدیکردنی دەرەنجامەکان بە ڕاست و دورستی وە ئەتوانن ناوەندە کارگێریەکان لە زانکۆکان و دانیشگاکان و قوتابخانەکان بەکاری بهێنن وە بریاری گۆنجاو لە سەر دەرەنجامی قوتابی نەهاتوەکان بدەن .