

A review of Fingerprint Recognition Based Automatic Attendance System

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Abstract: Our paper aims at designing a student attendance system which could effectively manage attendance of students at institutes like NIT Rourkela. Attendance is marked after student identification. For student identification, a fingerprint recognition-based identification system is used. Finger prints are considered to be the best and fastest method for biometric identification. They are secure to use, unique for every person and do not change in one's lifetime. Fingerprint recognition is a mature field to- day, but still identifying individual from a set of enrolled fingerprints is a time taking process. It was our responsibility to improve the fingerprint identification system for implementation on large databases e.g. of an institute or a country etc. In this paper, many new algorithms have been used e.g. gender estimation, key based one to many matching, removing boundary minutiae. Using these new algorithms, we have developed an identification system which is faster in implementation than any other available today in the market. Although we are using this fingerprint identification system for student identification purpose in our paper, the matching results are so good that it could perform very well on large databases like that of a country like India (MNICPaper).

This system was implemented in Matlab10, Intel Core2Duo processor and comparison of our one to many identification was done with existing identification technique i.e. one to one identification on same plat form. Our matching technique run $\sin O(n+N)$ time as compared to the existing $O(Nn^2)$. The finger print identification system was tested on FVC2004 and Verifinger databases.

Keywords: Attendance Management Systems, MATLAB, Fingerprint Recognition, Matching Techniques

I. INTRODUCTION

Designing a student attendance management system based on fingerprint recognition and faster one to many identification that manages records for attendance in institutes like NIT Rourkela. Every organization whether it be an educational institution or business organization, it has to maintain a proper record of attendance of students or employees for effective functioning of organization. Designing a better attendance management system for students so that records be maintained with ease and accuracy was an important key behind motivating this paper. This would improve accuracy of attendance records because it will remove all the hassles of roll calling and will save valuable time of the students as well as teachers. Image processing and finger print recognition are very advanced today in terms of technology. It was our responsibility to improve fingerprint identification system. We decreased matching time by partitioning the database to one-tenth and improved matching using key based one to many matching.

Biometric Identification Systems are widely used for unique identification of humans mainly for verification and identification. Biometrics is used as a form of identity access management and access control. So use of biometrics in student attendance management system is a secure approach. There are many types of biometric systems like fingerprint recognition, face recognition, voice recognition, iris recognition, palm recognition etc. In this paper, we used fingerprint recognition system. A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. The endpoints and crossing points of ridges are called minutiae. It is a widely accepted assumption that the minutiae pattern of each finger is unique and does not change during one's life. Ridge endings are the points where the ridge curve terminates, and bifurcations are where a ridge splits from a single path to two paths at a Y-junction. Figure1 illustrates an example of a ridge ending and a bifurcation. In this example, the black pixels correspond to the ridges, and the white pixels correspond to the valleys.

When human finger print experts determine if two fingerprints are from the same finger, the matching degree between two minutiae pattern is one of the most important factors. Thanks to the similarity to the way of human fingerprint experts and compactness of templates, the minutiae-based matching method is the most widely studied matching method.

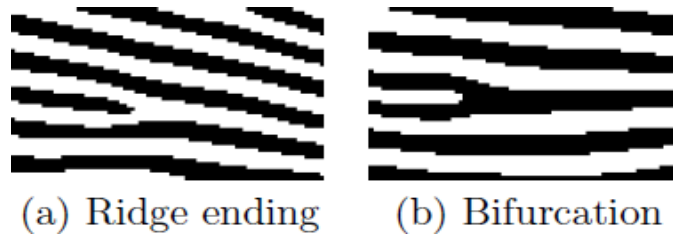


Fig 1: Example of a ridge ending and a bifurcation

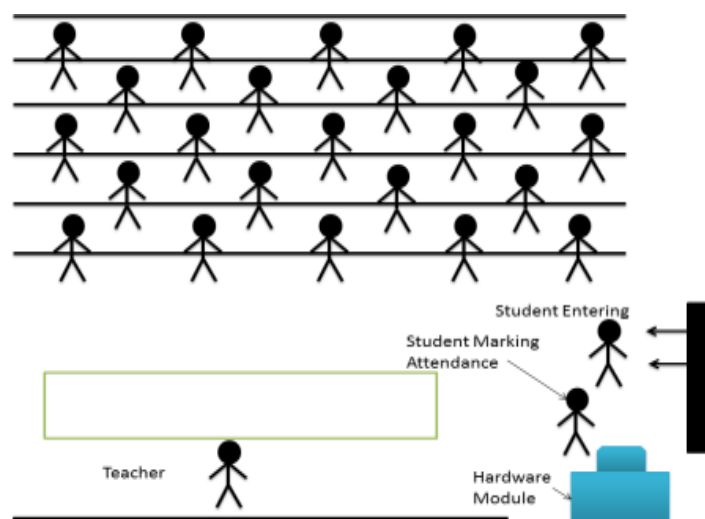
Fingerprints are considered to be the best and fastest method for biometric identification. They are secure to use, unique for every person and do not change in one's lifetime. Besides these, implementation of fingerprint recognition system is cheap, easy and accurate up to satisfiability. Fingerprint recognition has been widely used in both forensic and civilian applications. Compared with other biometrics features, fingerprint-based biometrics is the most proven technique and has the largest market shares. Not only it is faster than other techniques but also the energy consumption by such systems is too less.

II. USING FINGERPRINT RECOGNITION SYSTEM ATTENDANCE MANAGEMENT

Managing attendance records of students of an institute is a tedious task. It consumes time and paper both. To make all the attendance related work automatic and on-line, we have designed an attendance management system which could be implemented in NIT Rourkela. It uses a fingerprint identification system developed in this paper. This fingerprint identification system uses existing as well as new techniques in fingerprint recognition and matching. A new one to many matching algorithm for large databases has been introduced in this identification system. This paper has been organized into introduces with our paper, explains the proposed design of attendance management system. Explains the fingerprint identification system used in this paper, explains enhancement techniques, explains feature extraction methods, explains our database partitioning approach work. Explains matching technique, explains experimental work done and performance analysis, includes conclusions and introduces proposed future work.

III. ATTENDANCE MANAGEMENT FRAMEWORK

Manual attendance taking and report generation has its limitations. It is well enough for 30-60 students but when it comes to taking attendance of students large in number, it is difficult. For taking attendance for a lecture, a conference, etc. roll calling and manual attendance system is a failure. Time waste over responses of students, waste of paper etc. are the disadvantages of manual attendance system.



Moreover, the attendance report is also not generated on time. Attendance report which is circulated over NITR webmail is two months old. To overcome these non-optimal situations, it is necessary that we should use an automatic on-line attendance management system. So we present an implementable attendance management framework. Student attendance system framework is divided into three parts: Hardware/Software Design, Attendance Management Approach and On-line Report Generation. Each of these is explained below.

Hardware - Software Level Design

Required hardware used should be easy to maintain, implement and easily available. Proposed hardware consists following parts:

- (1)Fingerprint Scanner, (2) LCD/Display Module (optional), (3) Computer, (4) LAN connection

Table 1: Estimated Budget

Device Name	Cost of One Unit	No. of Units Required	Total Unit Budget
Scanner	500	100	50000
PC	21000	100	2100000
Total			21,50,000

Fingerprint scanner will be used to input fingerprint of teachers/students into the computer software. LCD display will be displaying rolls of those whose attendance is marked. Computer Software will be interfacing fingerprint scanner and LCD and will be connected to the network. It will input fingerprint, will process it and extract features for matching. After matching, it will update database attendance records of the students.



Fig 2: Hardware present in classrooms

Estimated Budget Estimated cost of the hardware for implementation of this system is shown in the table 2.1. Total number of classrooms in NIT Rourkela is around 100. So number of units required will be 100.

This part explains how students and teachers will use this attendance management system. Following points will make sure that attendance is marked correctly, without any problem:

- (1) All the hardware will be inside classroom. So outside interference will be absent.
- (2) To remove unauthorized access and unwanted attempt to corrupt the hardware by students, all the hardware except fingerprint scanner could be put inside a small cabin. As an alternate solution, we can install CCTV cameras to prevent unprivileged activities.
- (3) When teacher enters the classroom, the attendance marking will start. Computer software will start the process after inputting fingerprint of teacher. It will find the SubjectID, and Current Semester using the ID of the teacher or could be set manually on the software. If teacher doesn't enter classroom, attendance marking will not start.
- (4) After sometime, say 20 minutes of this process, no attendance will be given because of late entrance. This time period can be increased or decreased as per requirements.

Database for attendance would be a table having following fields as a combination for primary field: (1)Day, (2)Roll, (3)Subject and following non-primary fields: (1)Attendance, (2)Semester. Using this table, all the attendance can be managed for a student. For on-line report generation, a simple website can be hosted on NITRourkela servers, which will access this table for showing attendance of students. The sql queries will be used for report generation. Following query will give total numbers of classes held in subject.

Network and Database Management

This attendance system will be spread over a wide network from classrooms via intranet to internet. Using this network, attendance reports will be made available over internet and e-mail. A monthly report will be sent to each student via email and website will show the updated attendance.

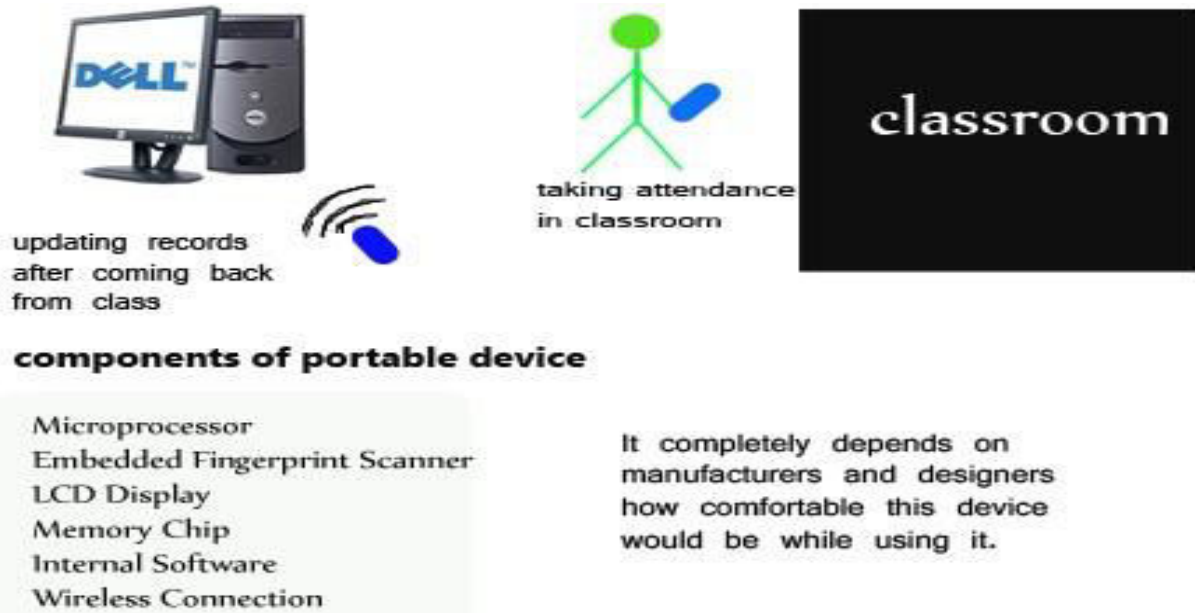


Fig 3: Classroom Scenario

Entity relationship diagram for database of students and attendance records.

In ER diagram, primary fields are Roll, Date, SubjectID and TeacherID. Four tables are Student, Attendance, Subject and Teacher.

Using wireless network instead LAN and bringing portability

We are using LAN for communication among servers and hardwares in the classrooms. We can instead use wireless LAN with portable devices. Portable device will have an embedded fingerprint scanner, wireless connection, a microprocessor loaded with a software, memory and a display terminal, see figure2.5. Size of device could be small like a mobile phone depending upon how well the device is manufactured.

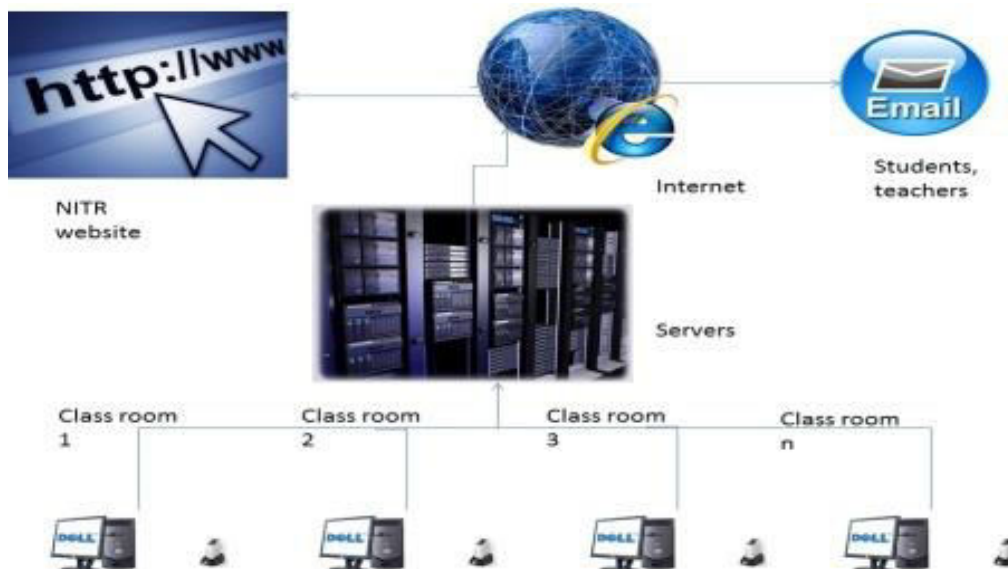


Fig 4: Components of Portable device

This device should have a wireless connection. Using this wireless connection, attendance taken would be updated automatically when device is in network of the nodes which are storing the attendance records. Database of enrolled fingerprints will be in this portable device. Size of enrolled database was 12.1 MB when 150 finger- prints were enrolled in this paper. So for 10000 students, at least 807MB or more space would be required for storing enrolled database. For this purpose, a removable memory chip could be used. We cannot use wireless LAN here because

fetching data using wireless LAN will not be possible because of less range of wireless devices. So enrolled data would be on chip itself. Attendance results will be updated when portable device will be in the range of nodes which are storing attendance reports. We may update all the records online via the mobile network provided by different companies. Today 3G network provides sufficient throughput which can be used for updating attendance records automatically without going near nodes. In such case, the need of database inside memory chip will not be mandatory. It will be fetched by using 3G mobile network from central database repository. The design of such a portable device is the task of embedded system engineers.

The device may either behaving touch screen input/display or buttons with lcd display. A software specially designed for the device will be running on it. Teachers will verify his/her fingerprint on the device before giving it to students for marking attendance. After verifying the teacher's identity, software will ask for course and other required information about the class which he or she is going to teach. Software will ask teacher the time after which device will not mark any attendance. This time can vary depending on the teacher's mood but our suggested value is 25 minutes.

There are various other kind of student attendance management systems available like RFID based student attendance system and GSM-GPRS based student attendance system. These systems have their own pros and cons. Our system is better because first it saves time that could be used for teaching. Second is portability. Portability has its own advantage because the device could be taken to any class wherever it is scheduled. While GSM-GPRS based systems use position of class for attendance marking which is not dynamic and if schedule or location of the class changes, wrong attendance might be marked. Problem with RFID based systems is that students have to carry RFID cards and also the RFID detectors are needed to be installed. Nonetheless, students may give proxies easily using friend's RFID card. These problems are not in our system. We used fingerprints as recognition criteria so proxies cannot be given. If portable devices are used, attendance marking will be done at any place and anytime. So our student attendance system is far better to be implemented at NITR.

Matching

Matching means finding most appropriate similar fingerprint to query fingerprint. Fingerprints are matched by matching set of minutiae extracted. Minutiae sets never match completely, so we compute match score of where q_j and p_i are the coordinates of j^{th} minutiae of database minutiae set and i^{th} minutiae of query minutiae set respectively. Using these $\langle \delta x, \delta y, \alpha_k \rangle$ values, whole query minutiae set is aligned. This aligned minutiae set is used to compute pairing score. Two minutiae are said to be paired only when they lie in same bounding box and have same orientation. Pairing score is $(\text{number of paired minutiae}) / (\text{total number of minutiae})$. The i, j, k values which have highest pairing score are finally used to align minutiae set. Existing Matching Techniques

Most popular matching technique of today is the simple minded n^2 matching where n is number of minutiae. In this matching each minutiae of query fingerprint is matched with n minutiae of sample fingerprint giving total number of n^2 comparisons. This matching is very orthodox and gives headache when identification is done on large databases.

One to Many matching

Few algorithms are proposed by many researchers around the world which are better than normal n^2 matching. But all of them are one to one verification or one to one identification matching types.

IV. CONCLUSION

In this paper, we have presented a fingerprint-based attendance management system.

The developed system is an embedded system that is part of a fingerprint recognition/authentication system based on minutiae points. The system extract the local characteristic of a fingerprint which is minutiae points in template based. Templates are matched during both registration and verification processes. For improved quality control during the registration or verification process, a matching score was used to determine the success of the operation. The matching score was specified so that only sets of minutiae data that exceed the score will be accepted and data below the score will be rejected. Therefore, Fingerprint Recognition using Minutia Score Matching method was used for matching the minutia points before attendance is recorded.

The developed system is very helpful in saving valuable time of students and lecturers, paper and generating report at required time. The system can record the clock in and clock out time of students and workers in a very convenient manner using their fingerprint to prevent impersonation and reduce level of absence. Also, it reduces most of the administrative jobs and minimizes human errors, avoids proxy punching, eliminates time-related disputes and helps to update and maintain attendance records.



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