

Development of Fingerprint Biometric Attendance System for Non-Academic Staff in a Tertiary Institution

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Abstract

Institutions, companies and organisations where security and net productivity is vital, access to certain areas must be controlled and monitored through an automated system of attendance. Managing people is a difficult task for most of the organizations and maintaining the attendance record is an important factor in people management. When considering the academic institute, taking the attendance of non-academic staff on daily basis and maintaining the records is a major task. Manually taking attendance and maintaining it for a long time adds to the difficulty of this task as well as wastes a lot of time. For this reason, an efficient system is proposed in this paper to solve the problem of manual attendance. This system takes attendance electronically with the help of a fingerprint recognition system, and all the records are saved for subsequent operations. Staff biometric attendance system employs an automated system to calculate attendance of staff in an organization and do further calculations of monthly attendance summary in order to reduce human errors during calculations. In essence, the proposed system can be employed in curbing the problems of lateness, buddy punching and truancy in any institution, organization or establishment. The proposed system will also improve the productivity of any organization if properly implemented.

Keywords: Institution, Attendance, Biometric, Fingerprint

1. INTRODUCTION

Biometrics refers to the automatic identification of a person based on his or her physiological or behavioural characteristics. It includes fingerprint, iris, facial and retinal. Biometrics technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solutions. Today, biometric is being spotlighted as the authentication method because of the need for reliable security (Cappelli et al., 2007). Fingerprint authentication is one of the most well-known and publicized biometrics technologies. Because of their uniqueness and consistency over time, fingerprints have been in use for identification for over a century, more recently becoming automated due to advancements in computed capabilities. Fingerprint reconstruction is popular because of the inherent ease of acquisition, the numerous sources (e.g. ten fingers) available for collection, and their established use and collections by law enforcement and immigration (Jianjiang, 2007). According to Oloyede, Adedoyin and Adewole (2013), many industries are experiencing technological advancement and changes in the mode in which they carry out their business processes. With the rise of globalization, it is becoming essential to find an easier and more effective system to help an organization or company improve their employee's productivity. In spite of this matter, there are still business establishments that use the old-fashioned method of manual process of recording employee's attendance (Yuihotakaishi, 2011). Staff attendance management system is an easy way to keep track of attendance of staffs within an organization. It covers the requirements of the personnel department in terms of day to day monitoring of staffs, calculation of overtime and transfer of relevant information to the payroll system and manpower analysis. Hence, staff attendance is an important issue every organization must take into consideration in order to be productive (Kadry & Smaili, 2010). In addition, a report from the Shropshire council stated that staff productivity is greatly affected by the attendance of staffs (Mycroft, 2011).

According to Clavereau (2011), as stated in Human Resource Magazine (2011) that "*company staff succeed in stealing the company's productivity without the management even noticing through absenteeism and buddy punching*". The use of the traditional methods for staff attendance, for example staffs signing on attendance sheet

on entering the organization also contribute to the poor performance of the company's productivity, though the impact of staff absentee and staff running late vary differently amongst different market sectors. It was further stated that employee absence and buddy punching directly cost the UK economy nearly 17 billion pounds which equates to 27 million working days (Clavereau, 2011). This demonstrates the negative effect of buddy punching and staff absenteeism on a company's productivity which can be solved by the introduction of a system that is based on biometric technology.

The proposed system uses fingerprint verification technique to automate the attendance of non-academic staff in tertiary institution. It has been proved over the years that fingerprints of each and every person are unique (Cappelli et al., 2006).

1.1 Fingerprint Sensor

Fingerprint sensor is an electronic device used to capture a digital image of the fingerprint pattern (Cappelli et al., 2006). The captured image is called a live scan. This live scan is digitally processed to create a biometric template (a collection of extracted minutiae points) which is stored and used for matching. Minutiae are defined as the pattern created and the uniqueness of how ridges end, split and join, or appear as a simple dot. The Minutiae consists of bifurcations, ridge dots, ridge endings and enclosures, to ensure further uniqueness, the minutiae are further broken down into sub minutiae such as pores, crossovers, deltas. The pores are tiny depressions within the ridge on a fingerprint; the crossover creates an X pattern within the ridge of a fingerprint and deltas create a triangle shaped pattern within the ridge of a fingerprint. Identification in a fingerprint technology exists when an individual fingerprint is compared against a known source called the fingerprint template (Chirillo & Scott, 2007). Fingerprint sensors are very intricate and continue to grow more complicated. They are becoming a vital part of the transformation to a more technologically integrated society. Current fingerprint technologies are generally susceptible to acquiring poor quality images due to different skin conditions and environmental effects. These poor quality images adversely affect the ability to accurately determine a person's identity. Poor fingerprint image can be enhanced through several stages of enhancement (Wayman et al., 2005).

1.2 Image Processing and Enhancement

A critical step in automatic fingerprint matching is to automatically and reliably extract minutiae from the input fingerprint images (Hong, Wan & Jain, 1998). However, the performance of a minutiae extraction algorithm relies heavily on the quality of the input fingerprint images. In order to ensure that the performance of an automatic fingerprint identification/verification system will be robust with respect to the quality of the fingerprint images, it is essential to incorporate a fingerprint enhancement algorithm in the minutiae extraction module.

2. RELATED WORKS

Most of the attendance systems use paper based methods for taking and calculating attendance and this manual method requires paper sheets and a lot of stationery material. Previously, very few works have been done relating to the academic attendance monitoring problems.

Biometrics has been used in biological studies, including forestry, for the collection, synthesis, analysis and management of quantitative data on biological communities such as forests. Biometrics in reference to biological sciences has been studied and applied for several generations and is somewhat simply viewed as "*biological statistics*" (Smart Cart Alliance Identity Council, 2007).

According to Jiexun, Wang and Chen (2011) as quoted in the research work of Oloyede et al. (2013), the origin of biometrics has been in the public sector; however biometrics is used for the identification and verification of criminals. Other sectors where biometrics has also thrived are the Banking, Education and Health sectors. For example, emerging application markets include biometrically enabled transactional payment solutions and biometrically enables wireless for business use. Oloyede et al. (2013) carried out extensive research on applicability of biometric technology to solve the problem of staff attendance. However, the researchers did not write any software to address the problems of attendance.

Furthermore, biometric application has been useful in various other sectors which include the Government using it for the purpose of stopping terrorist attacks and fighting crimes. After the 9/11 incident, the Yeager Airport in Charleston introduced the biometrics system, which is used to secure access to its control tower (Dubin, 2011). Moreover, the biometrics system has been very useful in the education sector where it has assisted students in the borrowing and returning of books out and into the library respectively.

A palm scanner which reads a patient's unique vein pattern was implemented in Sharp Healthcare in San Diego for the purpose of stopping patient identity theft, the system was known to be very secure and performed efficiently well for its purpose (Kreimer, 2011). Furthermore, biometrics can be integrated with other systems for it to carry out its purpose of identification. Various homeland security databases require the use a card access system integrated with a biometric technology to gain access. European explorer, Joao de Barros recorded the first known example of fingerprinting, which is a form of biometrics, in China during the 14th century. Chinese merchants used ink to take children's fingerprints for identification purposes.

Marijana (2004) carried out a critical review of the extent to which biometric technology has assisted in controlling illegal entry of travellers into specific country through the integration of biometric passport. The issue regarding how the false acceptance rate can be measured in a border control setting was also looked into. The researcher concludes that the problems associated with biometric technologies such as error rates, spoofing attacks, non-universality and interoperability can be reduced through an overall security process that involves people, technology and procedures. Suggestions were drawn on how the security issues at the border can be improved.

3. METHODOLOGY

This research work is based on the design and implementation of staff biometric attendance system using fingerprint authentication. The proposed system can be used to monitor, identify and check the IN and OUT timings of non-academic staff in tertiary institution. The system requires that all non-academic staff enrol his/her fingerprint for the device to identify and verify if he is a valid staff and also to record daily resumption and closure timings for the staff for a whole month, before payment of salaries are effected. The primary idea behind this is to avoid a situation where staff records fake timings in the manual register and yet receiving full payment for the month. This greatly affects output to input ratio of staffs and in earnest the institution as a whole. The proposed design enhances compilation of each staff's attendance by remote workstations, which are then sent to the central database server at the end of each month for easy processing of salaries and allowances. The result of each staff clocking in and out timing is captured via a fingerprint device at each terminal and stored in the central database server. Each Department remote terminal is interconnected to the central database server via a shared network.

3.1 Proposed System Model

The following assumptions were taken into consideration for effective performance of the design. These assumptions include:

- There should be a stipulated time for resumption and closure of work
- Both entry and exit doors should be fingerprint based
- There shall be a grace period of twenty minutes due to traffic
- There should be a minimum number of total days for monthly attendance summary for all staffs of the institution
- Accept there is a medical report, hours missed by workers should not be calculated during payroll
- The administrator should be able to view daily attendance, as well as monthly summary report for all staff of the institution

Although, this system is developed using Object Oriented Design (OOD) techniques, it will be useful to identify the overall requirements in functional terms, mainly because, as pointed out by Rickman (2005), one of the weaknesses of *OOD* is that OOD methods only build functional models within the objects. From the structural design perspective, it is difficult to get a system wide view of the data. This can lead to requirements being missed because the system to be built must be understood in terms of requirements (Dale, 2005). Ultimately, this

research work uses a process of requirements engineering (RE), to complement OOD modelling using the Unified Modelling Language (UML).

3.1.1 The Functional Model of Staff Biometric Attendance System

UML Use Case diagram for staff biometric attendance system is shown in Figure 1.1. In this figure, the various participants in the system are also detailed.

Actors: Database administrator, non-academic staffs

Non-academic staff: mark attendance, In-time, out-times, apply for leave, and get salary.

Administrator: Keep track of attendance, generate monthly attendance summary, and reports to the Faculty.

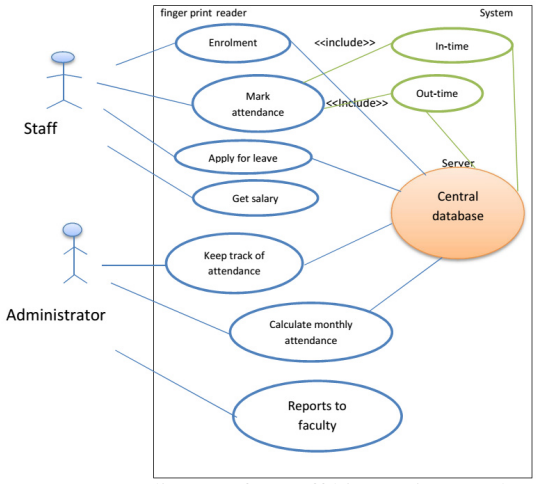


Figure 1.1: Use case diagram for staff biometric attendance system

3.1.2 The System Design Object Model

The object model represented in UML with class diagrams, describe the structure of the proposed system of staff biometric attendance system, in terms of objects, attribute, associations, and operations. The class diagram for the proposed system describes the system in terms of classes, attributes, operations, and their associations as shown in Figure 1.2. In UML, classes and objects are depicted by boxes composed of three compartments. The top compartment displays the name of the class or object. The centre compartment displays its attributes, and the bottom compartment displays its operations (Dan & Neil, 2005). The attribute and operation compartments can be omitted for clarity.

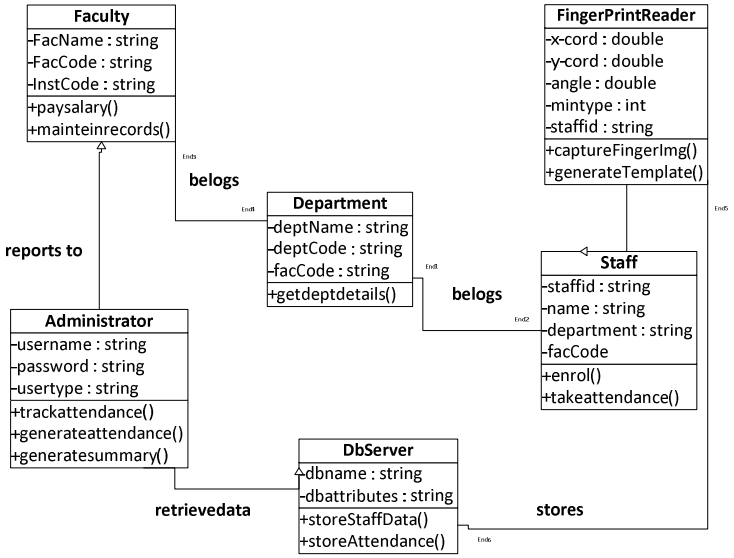


Figure 1.2: Class diagram for staff biometric attendance system

3.1.1 Activity Diagram for Staff Biometric Attendance System

The activity diagram describes the behaviour of the proposed system in terms of activities. Activities are modelling elements that represent the execution of a set of operations. The execution of an activity can be triggered by the completion of other activities, by the availability of objects, or by external events. The activity diagram for staff biometric attendance system depicts activities related to management of staff attendance and this is shown in Figure 1.3. Rounded rectangles represent activities; arrows between activities represent control flow, thick bars represent the synchronization of control flow.

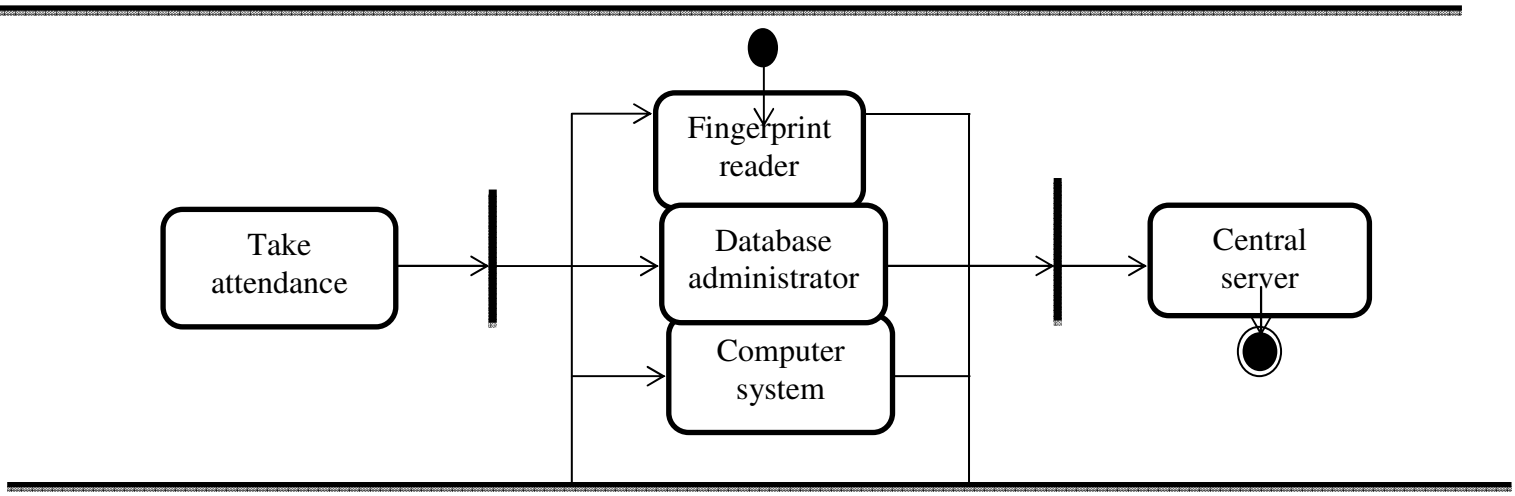


Figure 1.3 Activity diagram for staff biometric attendance system

4. RESULTS AND DISCUSSIONS

The proposed staff biometric attendance system is a system that takes attendance electronically. This system was implemented using Microsoft Visual Basic .Net programming language. It involves the interaction with the central database which contains all records of non-academic staff of the faculty or institution as well as records of monthly attendance taken. In implementing this system, certain criteria are considered. These criteria includes: Only eligible non-academic staff of the faculty can enrol and take attendance. Similarly, no one can take attendance for another. The records of each attendance taken can be retrieved as well as the monthly summary attendance for all staff can be generated and viewed. Furthermore, there is a period of grace within which IN and OUT timings can be taken. The design requirements are met through the use of a fingerprint reader which captures the fingerprint of users and desirable results are achieved, some of which are discussed in this section.

4.1 Enrolment Phase

This aspect involves the registration of eligible non-academic staff of the institution. This is necessary in order to uniquely identify each user of the proposed system. In this phase, each staff is required to register certain personal information like staff fingerprint, names, picture, phone number, email address, sex, marital status, occupation, state of origin, house address, as well as academic information like staff id, department, and designation. The enrolment phase is shown in Figure 1.4 and 1.5.

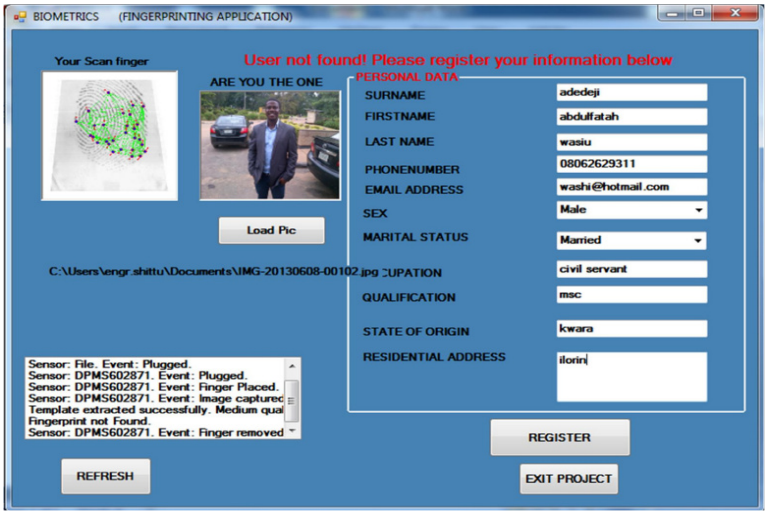


Figure 1.4: Enrolment Phase (personal data)

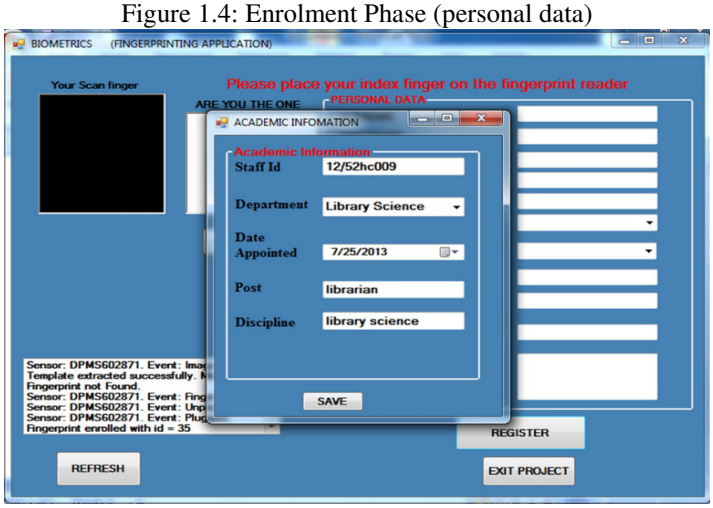


Figure 1.5: Enrolment Phase (academic information)

4.2 Attendance Phase

At the client side, there is a platform for taking attendance by all non-academic staff of the faculty or institution. The client does not have a database, but remotely connects to the server for submission and retrieval of records. No unregistered non-academic staff will be allowed to take attendance. This greatly curbs the problem of buddy punching and impersonation. This interface is shown in Figure 1.6.

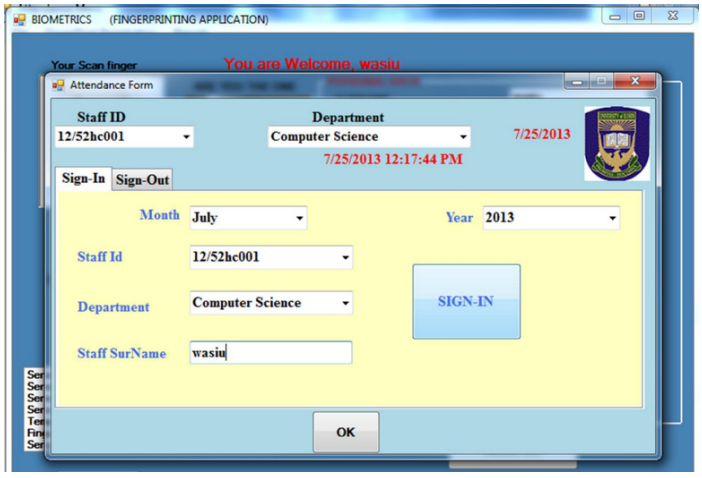


Figure 1.6: Attendance Interface

4.3 Attendance Report

This report interface can be accessed under the report menu, where daily attendance of all staff can be generated. The attendance of each non-academic staff per day is stored on the database and can be retrieved. The system was designed to allow the database administrator to view the attendance report of each non-academic staff as well as a summary report on monthly basis. The interface is shown in Figure 1.7.

Report of Daily Staff Attendance

StaffID	Department	Time-in	Time-out	Date
12/52hc001	Computer Science	7:23:12 AM	4:20:18 AM	23/07/2013
12/52hc002	Computer Science	7:10:11 AM	4:30:28 AM	23/07/2013
12/52hc004	Computer Science	7:53:32 AM	4:50:19 AM	23/07/2013
12/52hc005	Information and Communication Science	7:15:05 AM	4:12:30 AM	23/07/2013
12/52hc010	Computer Science	7:23:12 AM	4:10:17 AM	23/07/2013
12/52hc011	Computer Science	8:00:19 AM	4:34:21 AM	23/07/2013
12/52hc014	Computer Science	7:36:17 AM	4:02:12 AM	23/07/2013

Figure 1.7: Attendance Report

4.4 Attendance Summary

This is used to generate monthly attendance summary of all eligibly registered non-academic staff of the institution. This interface is shown in Figure 1.8.

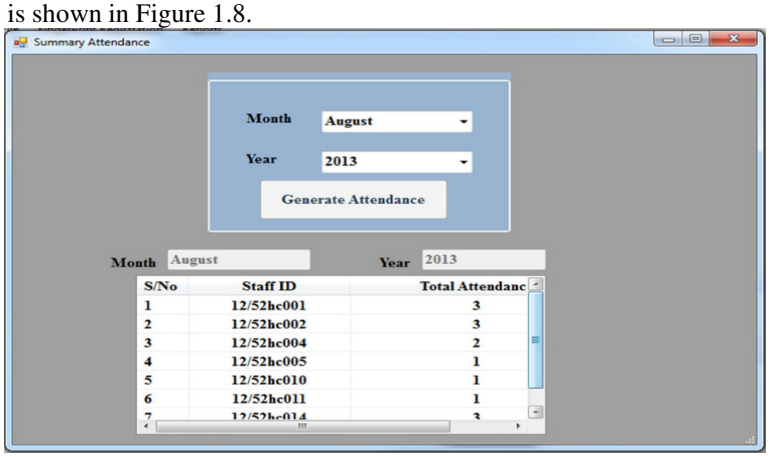


Figure 1.8: Attendance Summary

4.5 Entity Relationship Diagram for Staff Biometric Attendance System

Figure 1.9 shows ER diagram of the proposed system. Administrators can view all non-academic staff attendance or monthly summary attendance. Accessibility of information varies according to the type of user. Assumptions and dependencies of the system is described below:

Assumptions and dependencies

- All non-academic staff of the institution has a unique employee ID for registration.
- The authentication system is fed with the data to identify the admin.
- There is a salary dispatch system in the organization.
- Each staff belongs to a particular Department or Unit
- The captured attendance is stored on the database server and can be retrieved.
- Administrator can track attendance records of any non-academic staff.

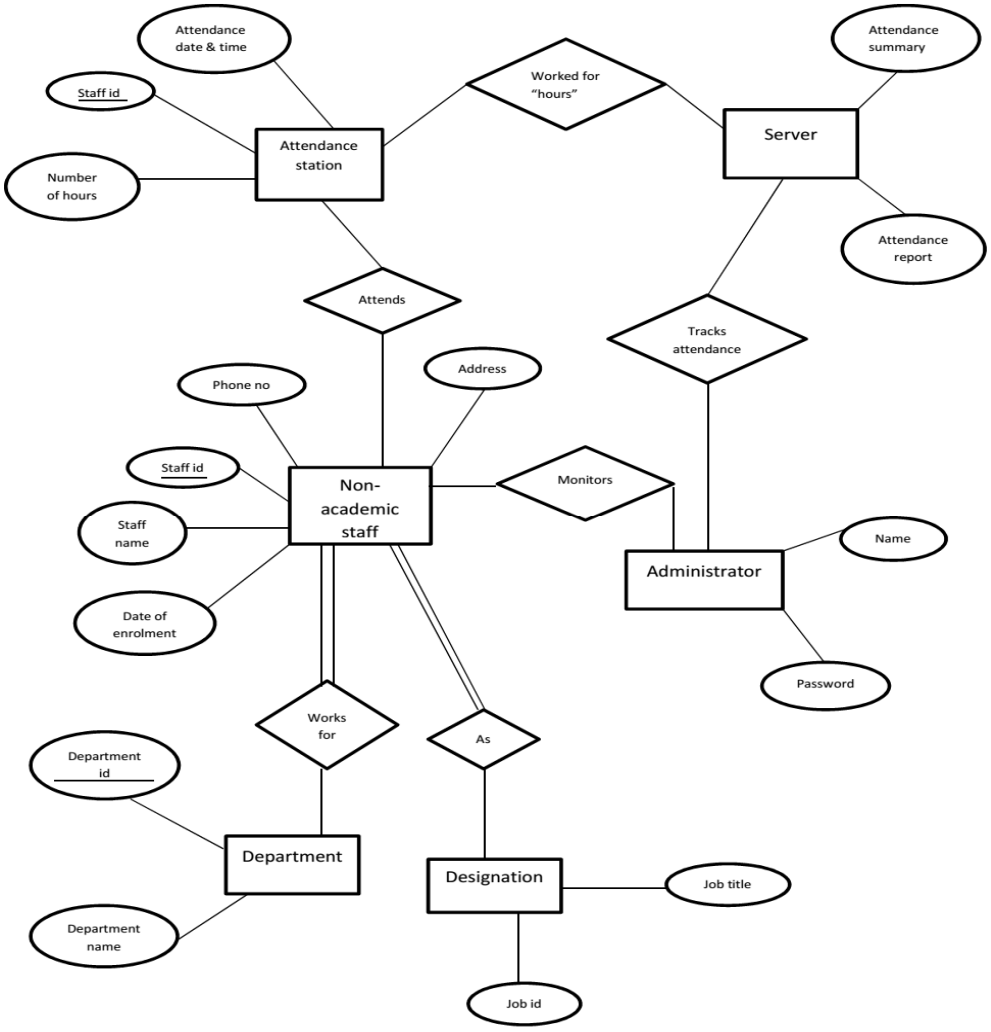


Figure 1.9: Entity Relation diagram for staff biometric attendance system

5. CONCLUSION

Traditionally, staff attendance is taken using the manual method, which involves pen, and paper registers. The implementation of an electronic biometric-based method of attendance management system will greatly assist institutions or any organization and thereby prevents time-consuming processes. Staff biometric attendance system provides the administrator with easy access to staff attendance information as well as easy monitoring of monthly attendance summary. This will improve the net productivity of institutions or any organization. The proposed system is reliable, secure, efficient, and capable of replacing the traditional manual and unreliable method of attendance management. This system ensures security of staff's records; eradicate fake attendance record, saves time as well as reducing the amount of work done by the administrator in gathering staff attendance records. The proposed system can be improved through the integration of multimodal biometric technologies to provide more security for the staff attendance management system.

REFERENCES

Cappelli, R., Lumini, A., Maio, D. and Maltoni, D. (2007). Fingerprint Image Reconstruction from Standard Templates, *IEEE Transactions*, vol. 29, pp.1489-1503.

Cappelli, R., Maio, D., Maltoni, D., Wayman, J., L. and Jain, A. K. (2006). Performance evaluation of fingerprint verification systems, *IEEE Trans. Pattern Anal.*, 28(1), pp. 3-18.

Chirillo, J. and Scott, B. (2007). *Implementing Biometric Security*. Indianapolis: John Wiley Publishing Inc., ISBN: 0 7654 25026.

Clavereau, M. (2011). Absence: time to tackle the root causes. Retrieved 15th October, 2013 from http://www.hrmagazine.co.uk

Dale, M. R. (2005). A Process for Combining Structured Analysis and Object Oriented Design. Retrieved 10th February, 2013 from http://www.dtic.mil/ndia/systems/Rickman2.pdf.

Dan, P. and Neil, P. (2005). *UML 2.0 in a Nutshell*. O'Reilly publication. ISBN: 0-596-00795-7.

Dubin, C. (2011). "Biometrics: Hands Down, ID Management". Retrieved 30th March 2013 from http://proquest.umi.com/pqdweb?index=0&did=2277161341&SrchMode=1&sid=2&Fmt=6VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1304030671&clientId=13314.

Hong, L., Wan, Y., and Jain, A. (1998). Fingerprint Image Enhancement algorithm and performance evaluation, *Computer Journal of IEEE transactions pattern annulus machine intelligent*, 20(8), pp. 777-789.

Jianjiang, F. (2007). Combining minutiae descriptors for fingerprint matching, *Pattern Recognition*, pp. 342 – 352.

Kadry, S. and Smaili, M. (2010). Wireless Attendance Management System Based on Iris Recognition. *Scientific research essay*. Retrieved 12th November, 2012

Kreimer, S. (2011). Matching the Right Patient to the right Record. Hospitals & Health Networks. Retrieved 12th November, 2012 from http://proquest. umi. com/pqdweb?index=0&did=2212480041&SrchMode=1&sid=1&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD

Marijana, K. (2004). *Passport of the future: Biometrics against Identity Theft*. M.Sc. thesis in Information security. Norwegian Information Security Laboratory (NISlab).

Mycroft, R. (2011). Performance and Strategy Scrutiny Committee. Staff productivity. Retrieved 20th June 2013 from http://www.shropshire.gov.uk/committee.nsf/0/5994B308 D8ECC9B48025788C004A5A54/$file/Item%207%20- %20Staff%20Productivity.pdf.

Oloyede, M. O., Adedoyin, A. O. and Adewole, K. S. (2013). Fingerprint Biometric Authentication for Enhancing Staff Attendance System, *International Journal of Applied Information Systems (IJAIS)*, Foundation of Computer Science, 5(3), pp. 19-24.

Smart Cart Alliance Identity Council (2007): Identity and Smart Card Technology and Application Glossary. Retrieved 25th October, 2012 from http://www.smartcardalliance.org.

Wayman, J. L., Jain, A. K., Maltoni, D., and Maio, D. (2005). *Biometric Systems: Technology, Design and Performance Evaluation*, New York: Springer Verlag.

Yuihotakaishi (2011). Attendance Monitoring System Using Biometrics for Security Staff, studymode Inspiring.