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Development of Employee Attendance and Payroll System using Fingerprint Biometrics

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Abstract

Biometric technology offers an advanced verification of human identity used in most schools and companies for recording the daily attendance (login and logout) and generating the payroll of the employees. This study uses the biometric technology to address the problems of many companies or institutions such as employees doing the proxy attendance for their colleagues, stealing company time, putting in more time in the daily time record (DTR), and increasing the amount of gross payroll resulted of buddy punching. The researcher developed a system for employee's attendance and processing of payroll with the use of fingerprint reader and the webcam device. The employee uses one finger to record his or her time of arrival and departure from the office through the use of the fingerprint reader. The DTR of employees is recorded correctly by the system; the tardiness and under time in the morning and in the afternoon of their official time is also computed. The system was developed using the Microsoft Visual C# 2008 programming language, MySQL 5.1 database software, and Software Development Kit (SDK) for the fingerprint reader and the webcam device. The data were analyzed using the percentage technique and arithmetic mean. The study was tested for 30 employees using the fingerprint reader for biometric fingerprint scanning (login and logout), and 50 employees were recorded and used for processing the payroll, and the proposed system. Results of biometric fingerprint scanning for the login and logout revealed that 90% of the employees have been accepted for the first attempt, 5.84% for the second attempt, 3.33% and 0.83% for the third and more than four attempts, respectively. The result of processing the advanced payroll (permanent, substitute, temporary & casual employees) and regular payroll (job order and contract of service employees) is 17.07 s and 5.08 s respectively. The Employee Attendance and Payroll System (EAPS) showed that the verification and identification of the employees in the school campus using the biometric technology provides a reliable and accurate recording in the daily attendance, and generate effectively the monthly payroll.

Keywords: Biometric Technology; Daily Time Record; Fingerprint Biometrics; Attendance Recording System; Automated Payroll System

1. Introduction

Nowadays, 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 employees' productivity. In spite of this matter, some business establishments, schools, companies are still using the old manual method of recording employee's attendance and processing of payroll [1].

Biometric technology offers an advanced verification for employees used in most schools and companies [2]. This technology involves the identification and verification of individuals by analyzing the human body characteristics and has been widely used in various aspect of life for different purposes. Despite the numerous advantages of the biometric system and its impact to various work sectors across the globe, most users of biometric technology still face the challenge of defining the right and accurate biometric technology system that will be cost effective in solving particular problems in specific environment [1].

In any company or institutions, it is very important to monitor the employee's attendance or time for accurate payroll and discipline. Some companies and schools are using a manual punch card to record the employee's attendance and others are still using a logbook. Using a logbook, employees are writing down their names, time and signature to login and logout in the office/school. In the use of a punch card machine, employees are inserting the time card or punch card into a slot on the Bundy clock as they login or logout in the office. Using these, employees can easily do the proxy attendance of others [3].

The study conducted by Harris Interactive Inc. showed that 21 percent of hourly employees admit to stealing company time. While only 5 percent participated in buddy punching, 69 percent said they punch in and out earlier or later than scheduled, 22 percent put additional time on their time sheet, and 14 percent did not punch out for unpaid lunches or breaks [4].

The American Payroll Association (APA) estimates that time theft, tardy arrivals, buddy punching, lollygagging (wasting time getting to the work area), extended breaks and early departures costs businesses 1.5 to 5 percent of gross payroll, amounting to hundreds of billions of dollars every year. Industry studies support these estimates and in recent APA surveys, employees were reported to be stealing an average of 4.5 hours each week, equivalent to a six-week paid vacation per year. According to a Nucleus Research study, buddy punching is experienced by 74 percent of organizations [5].

Further empirical studies from the USA and United Kingdom show that time and attendance management are closely negatively related to labor cost. A global provider of IT advisory and research services, found that 74% of organizations experience payroll losses that are directly related to 'buddy punching'. Nucleus Research found that organizations can save 2.2% of gross payroll annually on average by eliminating 'buddy punching' through the use of innovative biometric technology [6].

In dealing with this matter, the researcher uses the biometric technology to facilitate the recording of the employees' attendance and generate automatically the payroll. The problems as mentioned in the study conducted by Gale FS [4], Nucleus Research: ROI Evaluation Report: KRONOS Workforce Timekeeper [6], Pajiebar [3] and Parks [5]. This proposed technology minimizes the buddy punching and payroll losses as experienced by the other organizations. The employee uses the fingerprint reader to verify and identify the fingerprint image and record their attendance in the school or company, basis for the generation of payroll. The system generates the daily time record (DTR), computes the tardy and under time of an employee, automates income tax deduction, and manages refunds, allowances and deductions.

The general objective of the study is to design and develop the Employee Attendance and Payroll System (EAPS) for Teaching and Non-teaching Staff in a Tertiary Institution that can be used for recording of the employees' attendance, preparing of the payroll, and managing records and reports of the employees.

Specifically, it aims to the following:

- Develop a module for recording the attendance (arrival and departure) of the employees using the fingerprint scanner;
- Develop a module for processing the payroll and generate an essential reports such as pay slip, and remittances;
- Conduct the testing of the system in terms of biometric fingerprint scanning and processing of payroll.

This study focuses on the design and development of the system for recording the employee's attendance and processing of payroll using the fingerprint scanner for teaching and non-teaching staff in a tertiary institution. The system provides an alternative solution of many companies or institutions for generating the DTR and payroll of their employees. Also, the system uses the network to make the features (recording of the attendance, printing the pay slip, generating of payroll) installed or used by the other departments in the institution.

Generally, it is consists of a computer (server, client), a fingerprint reader, and a webcam device connected in the

network Figure 1. The fingerprint reader is installed in the client computer and used to register and capture the fingerprint image of the employee. The database component is situated at the server computer and used as the repository of data (login & logout, fingerprint image) pertaining to the employees. The webcam device is used to capture an image of the employee in the registration module, and to monitor the users in using the fingerprint reader and the system.

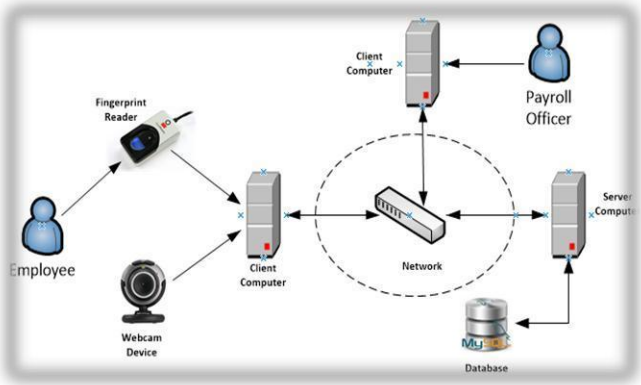

Figure 1: System architecture

The researcher is confident that the results of the study are deemed beneficial to the following stakeholders. These stakeholders are the employees, administrators, and researchers.

The employee can easily perform the recording of attendance (arrival and departure) in the DTR required by the administrators every end of the month. The daily attendance of the employee is recorded correctly by the system by pressing one finger in the fingerprint reader. The payroll of the employees is provided or generated on time by the company.

The administrator can provide quality of service to the employees by adopting biometric technology and payroll system in the company or institution. Thus, the submission of the DTR of an employee and preparing of payroll makes easy, fast and accurate.

This study would enhance the researcher's technical knowledge and understanding of their field of specialization. The difficulties encountered would broaden the researcher's horizon in applying newly gained principles.

This would also serve as an avenue for the improvement of future related studies on biometric technology and payroll system in any institutions concerned. Further, this would serve as vital inputs to future researchers who may embark on the development of biometric technology used for generating the payroll for employees.

Related Works

Similar study developed byRao S and Satoa KJ[7] uses the biometric technology to automate the process of taking the attendance of employees in the organizations. The study aims to develop an accurate, fast and efficient attendance system using the fingerprint verification technique. The fingerprint verification is done by using extraction of minutiae techniques.

Comparable study conducted byOloyede MO et al. [1] focuses on the biometric technology and determines the specific biometric identifier that can be used to enhance their traditional staff attendance system which presently affects the productivity of the organization. The study shows that the fingerprint biometric identifier was found suitable for the staff attendance management of the organization.

Another study developed by Adeoye [8]addresses the problems of various schools and institutions using the biometric technology. The study uses for the students in class absenteeism and debtor during examinations. The system is programmed to record the class attendance, and screening of tuition fee payment before and after examination of the students. In addition, it can also be used to verify whether such students are in debit to the institution or whether the students have paid the required percentage of the tuition before being allowed to take the examination. Also, the system eliminates impersonation during examinations, stress of manual class attendance taking and record keeping.

Additional study developed by Adewole et al. [9] uses the biometric technology for solving the problem of manual attendance. The system employs to calculate attendance of staff in an organization and do the further calculations of monthly attendance summary in order to reduce human errors during calculations. The proposed system employs in curbing the problems of lateness, buddy punching and truancy in any institutions or organizations.

Further study conducted by Ami-Narh et al. [10] investigates the impact of the adoption and usage of biometric time and attendance management systems among the Ghanaian business community in the Greater Accra Metropolis. The result of the study indicates that biometric timekeeping technologies are more secured than traditional timekeeping methods. Moreover, the use of biometric timekeeping technologies has better effect on organization labor cost as compared with the traditional methods.

Methodology

This study employed a descriptive developmental method of research — descriptive method was used in discussing the results of the testing phase while the development method was used during the system development. The data were analyzed using the percentage technique and arithmetic mean after the testing of the biometric fingerprint scanning.

A total of 50 employees were registered their fingerprint images and stored in the database for the system's matching and verification purposes. When the employees place a finger on the fingerprint reader, the device captures the fingerprint image and matches it sequentially on the different fingerprint images stored in the database. Once a match is found, the searching and matching of images automatically stops. Otherwise, a message prompted on screen informing that no match was found.

In recording the employee's attendance, the system provides a security features when using the fingerprint reader, a high resolution camera was attached to the client computer and used to capture the images of the users.

The researcher was recorded a total of 50 employees for testing and processing the payroll. The employees are classified under teaching (instructor), non-teaching (office staff), security guard and service worker of Partido State University, Goa campus. The status of appointment by the 34 employees are regular, temporary, substitute, and casual. Sixteen (16) employees are job order and contract of service (COS). The processing of the payroll was provided, advanced and regular payroll.

The Software Development Life Cycle (SDLC) was used in designing the software application of the system where Rational Unified Process (RUP) addresses the complete software development lifecycle with four cycles— each cycle working on a new generation of the software. These four major cycles of RUP are inception, elaboration, construction, and transition.

The inception cycle was used in the planning stage of system development that fostered biometric attendance and payroll system using the fingerprint reader to authenticate the employees' true identity based on his/her physical attributes. The activities included are the identification of the hardware and software requirements needed in the system development, scope of the project (login and logouttime, DTR, payroll reports), schedule of activities (Gantt chart), and the total budget cost.

The elaboration cycle was used in the requirements analysis needed for the system development. These requirements include the system components, system architecture, contextual diagram, data flow diagram, data dictionary, and entity relationship diagram and system flowchart.

The construction cycle was focused in the user interface design, coding and testing of the program. Microsoft Visual C#.Net 2008 and MySQL were used for the testing and implementation of the system. Additional tools for the software development (SDK) were used for the fingerprint reader and webcam device. Debugging and testing of the program for fixing bugs or errors of the design were also done in this cycle. Finally, in this cycle, the system was released and tested as a beta version while conducting a pilot test.

The transition cycle concentrated on the entire completion of the system, minor refinement was done to integrate corrections of bugs and the users' feedbacks such as fine-tuning the system, and configuring and installing usability issues. In this cycle, the usability of the system to its target clienteles (employees, administrators) was ensured.

The system was tested at Partido State University, Goa campus for assessing the results of biometric fingerprint scanning and processing of payroll for the employees. The researcher recorded 30 employees for one day in using the fingerprint reader. The testing of the system for employees was conducted both morning and afternoon of their official time. The output of the system (DTR) was validated by the Human Resource (HR) office for correct computation of the tardy and under time.

The researcher recorded the time (seconds) in processing the payroll (advanced and regular) for 50 employees. The researcher used the mobile phone application (Clock) to record an accurate time or speed in generating the payroll.

Results and Discussions

The system architecture (Figure 1) composed of the computers (client and server), fingerprint reader, webcam device, network and database for recording the daily time record (DTR) of the employees. The fingerprint reader is used by the employee to record the time of arrival and departure in the school/office. The webcam device is attached to the system to capture the image of the employee in using the fingerprint reader. The network is used to interconnect the clients and the server computer to access the central database of the employees. Finally, the database is used to store employee's information (login and logout, fingerprint image).

Figure 2 shows the sample data of the employee before he/she uses the fingerprint reader and needs for generating the payroll. The employee is required to register one finger in the system, and to capture the fingerprint in four times for verification and identification purposes. The employees are classified into four different job descriptions. These are the teaching, non-teaching, service worker and guard employees. The job descriptions have been set into different official time as basis for the arrival and departure of the employees at the school campus. The salary and rate per hour of the employees are used for processing the payroll. Other details such as Phil Health, Pagibig, and GSIS are used for employee's deductions and contributions. The picture image of the employee can be added using a webcam. All of the employee's information shown in Figure 2 is required during the registration.

Figure 2: Employee's Registration

The employees are classified into four different job descriptions as presented in Figure 3. Each job description contains different official time and uses the same grace period of 15 minutes for morning period (login) only. The official time recorded on each job description was used by the employees as a guide for their login and logout in the system, and used by the researcher as the basis for computation of the payroll and the total number and frequency of tardiness and under time of employees in the DTR.

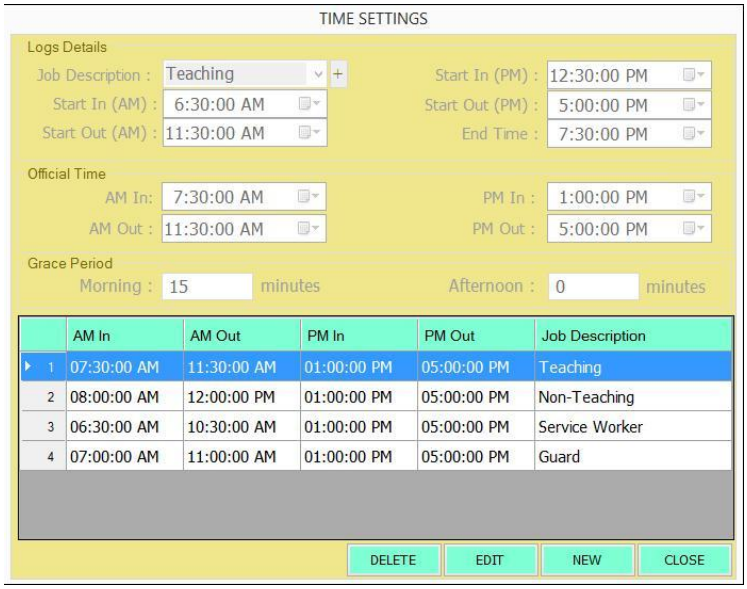

Figure 3: Time Settings

Biometric Attendance (Figure 4) provides the basic information of the employee when the system records his or her attendance (arrival and departure) in the school/office.The system displays the employee's information when he/she performs login and logout both recognized by the system using the fingerprint reader. The employee needs to place his/her finger on the fingerprint reader to capture the fingerprint image. The fingerprint Image captured by the fingerprint reader is used for identification and recognition purposes before the system permits the employees to record the time of arrival and departure in the school/office. The employee is restricted to logged-in and logged-out once for both morning and afternoon and also accepts the tardy and under time for recording the attendance. The date and time shown in Figure 3 are used for recording the arrival and departure of the employees.

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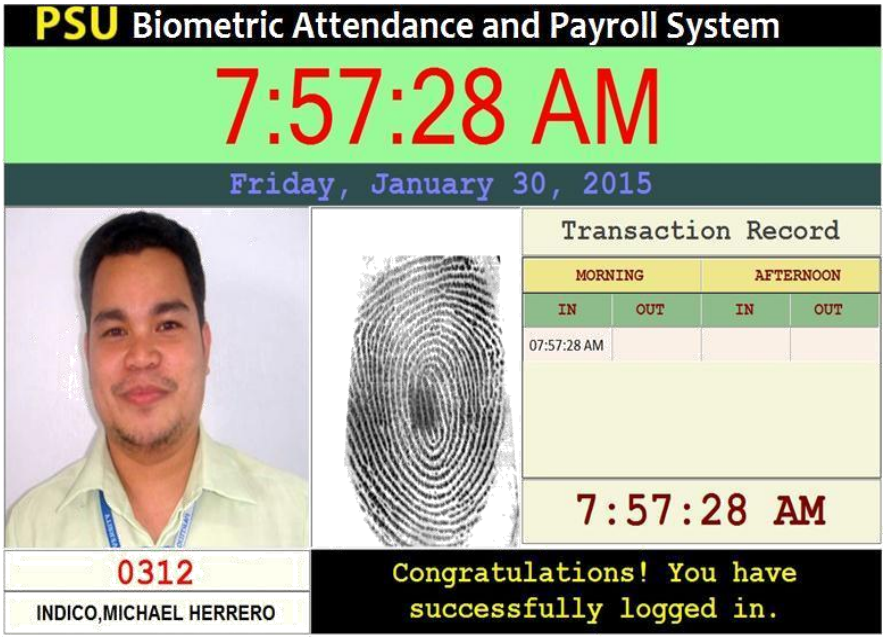

Figure 4: Biometric Attendance

The DTR is the record of arrival and departure of the employee in the school campus and need to generate by the system every end of the month. Figure 5 shows the sample DTR of the employee recorded for the month of June 2015 during the implementation of the system at Partido State University (PSU), Goa campus. The logins and logouts of the employees for morning and afternoon are recorded correctly. However, for missed logins and logouts (morning or afternoon) of the employees, the system marks blank in the DTR. The system excludes for computation of the total tardy and under time in the blank entry of the DTR. The system includes the Sat. and Sun. in the DTR. The list of employees shown in Figure 5 is employees assigned in the colleges or offices. Other employees assigned or working in the different colleges or offices are not visible to the other client computers to maintain confidentiality of records.

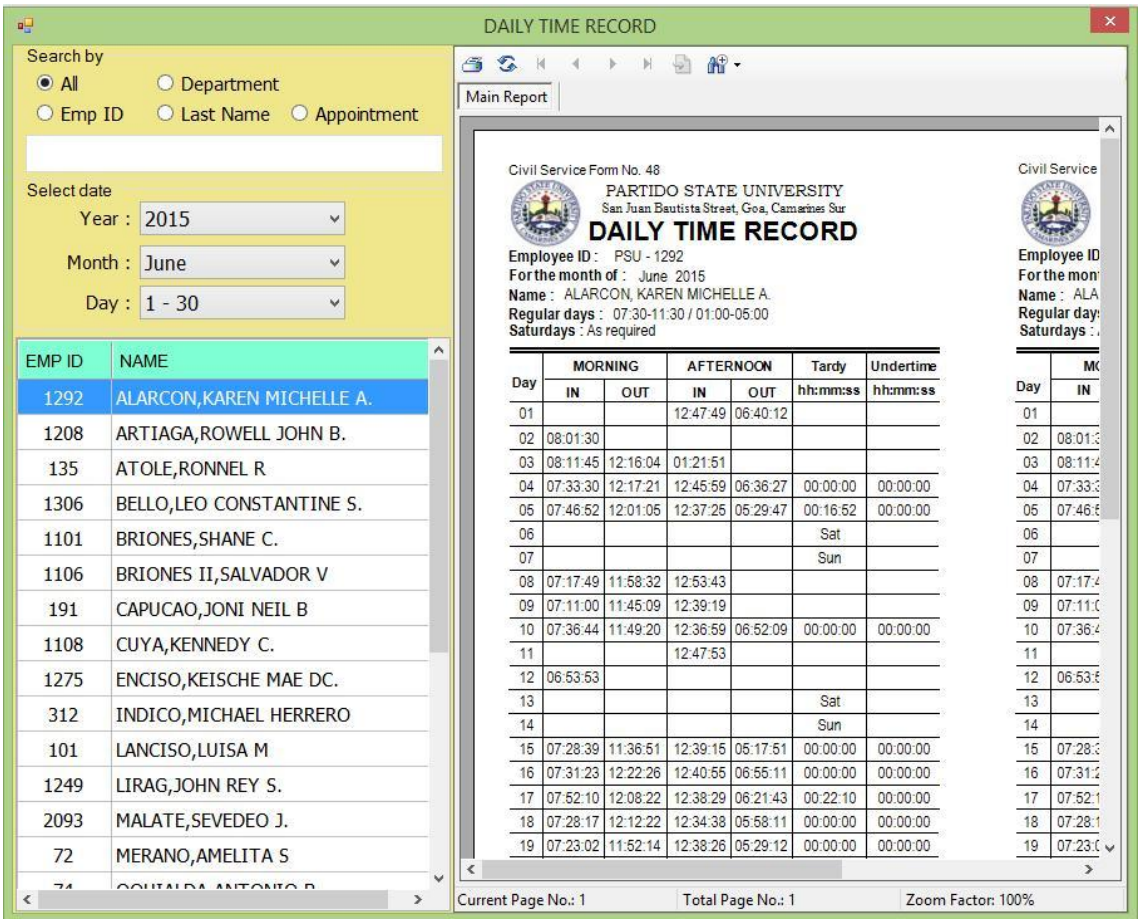

Figure 5: Daily Time Record

The security application of the system uses the webcam to monitor the users (employees) in using the fingerprint reader and the system. Once the fingerprint reader is touched by the employee, the system automatically captures the image of the employee using a webcam. The webcam device was positioned in an accurate angle and distance to clearly identify the image of the user. The security application report of the system is shown in Figure 6. This feature is accessed only by the administrator of the system.

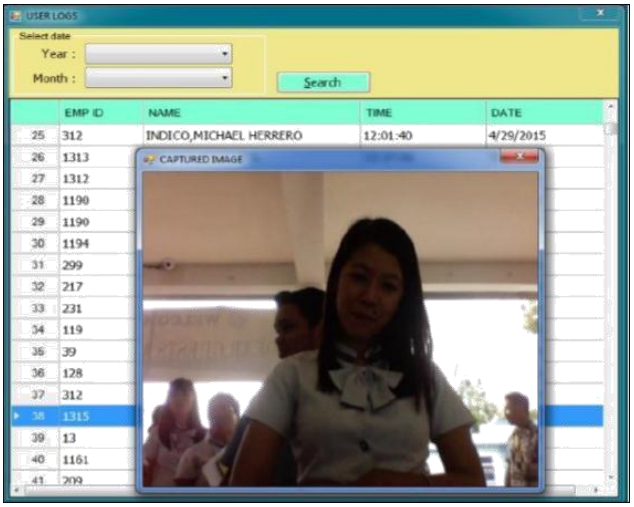

Figure 6: Security Application

Many organizations and institutions provide allowances to the employees. Figure 7 shows the list of employees who are entitled for allowances (PERA and RATA) in the Philippine Government Institution. The amount of allowance, date of start, and end of allowance was automatically updated by the system when generating the payroll.

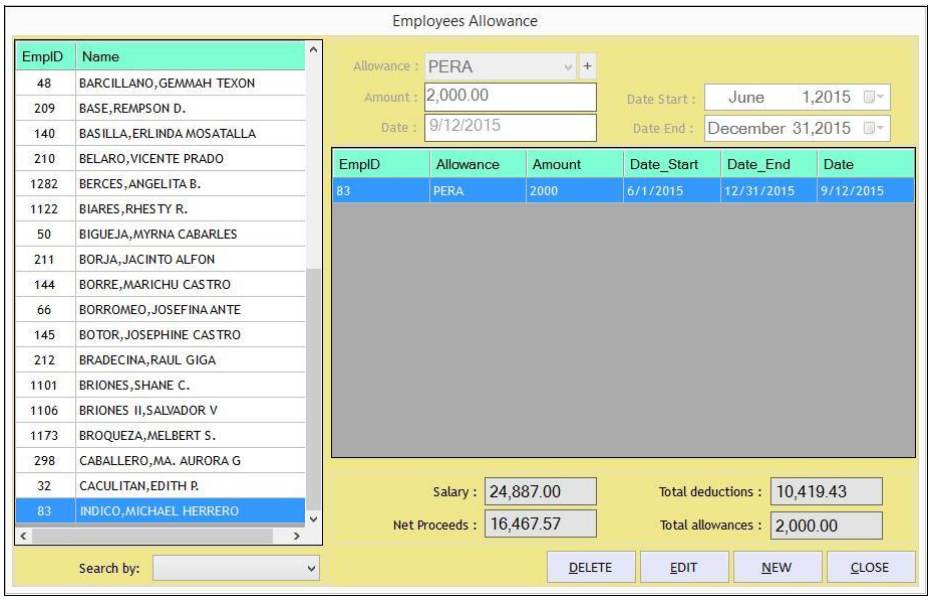

Figure 7: Employee's Allowance

The employees' deductions are difficult to monitor by the payroll officer in some organizations or institutions before processing the payroll. Different employees have different deductions. The payroll officer consumes much time in checking the amount, date of start and end of employee's deduction. Figure 8 shows the 26 deductions of the employee before processing the payroll. The total deduction, allowance, salary and net proceed are shown in Figure 8. The date start and end of deductions are used for generating the payroll.

Figure 9 shows the payroll generated by the system for the month of September 2015. The system computed correctly the deductions, allowances, refunds, salary, and net pay of the employee.

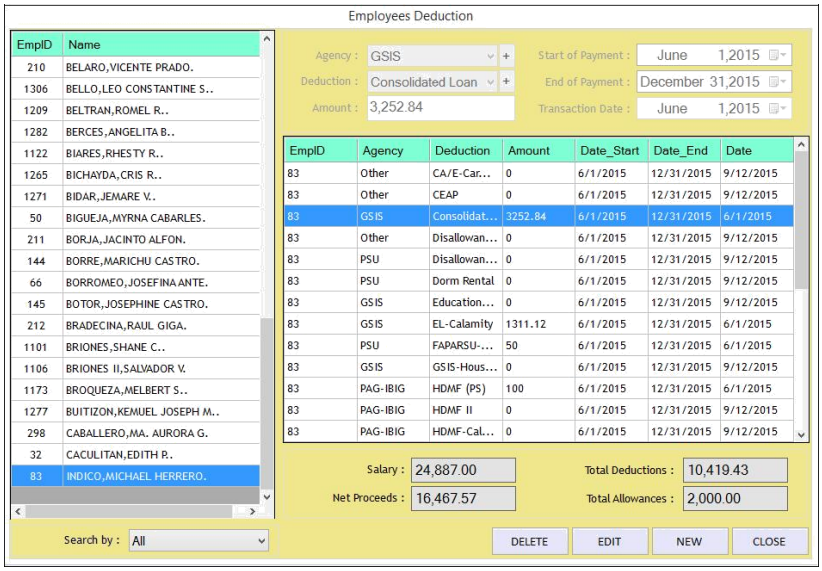

Figure 8: Employee's Deduction

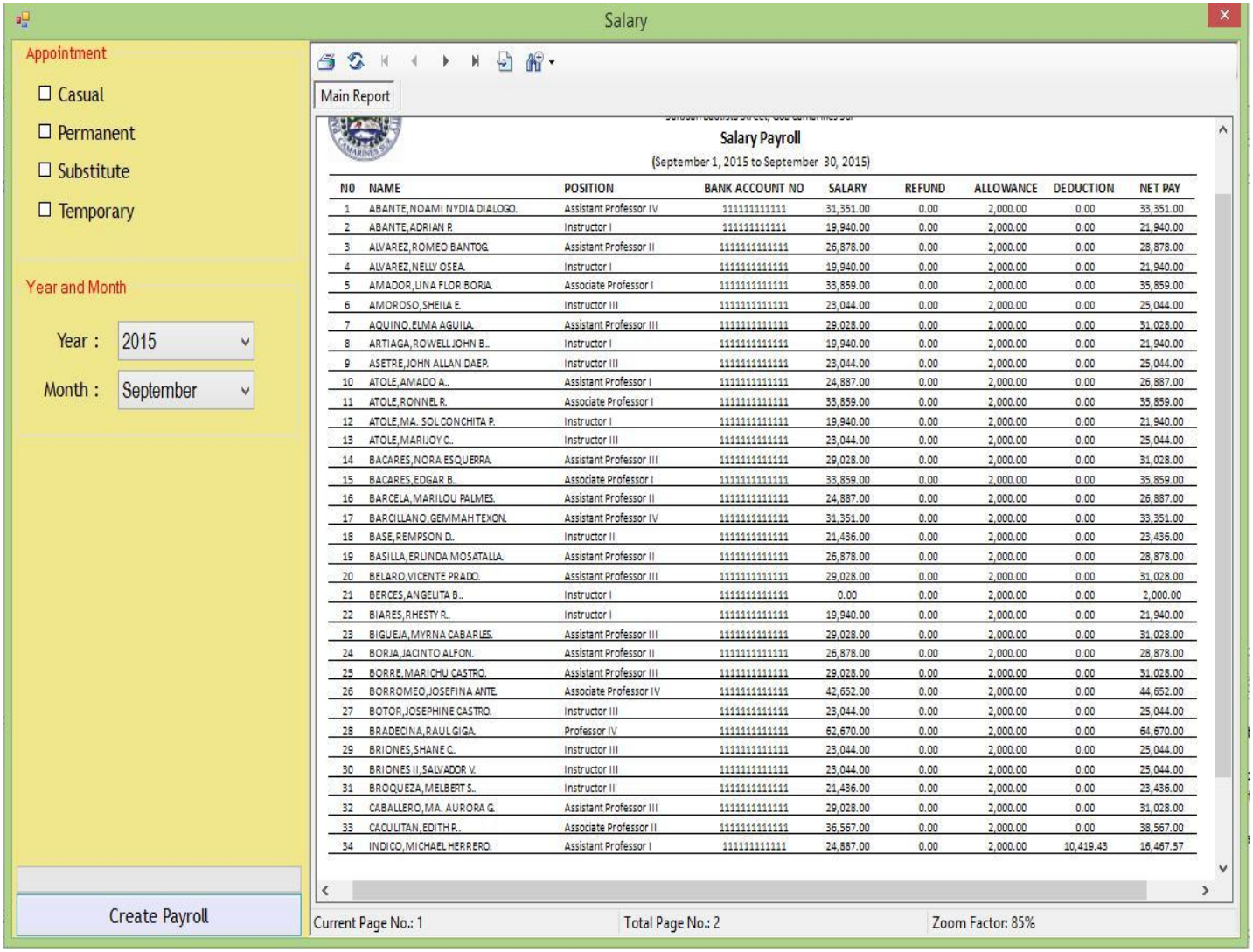

Figure 9: Payroll for Permanent, Substitute, Temporary, and Causal Employees

Figure 10 shows the pay slip of the employee with the details of income for the month of September 2015. The pay slip included the list of deductions, allowances, refunds, basic salary, and the net pay as shown in Figure 10. The payslip was designed only for permanent, temporary, substitute and casual employees.

Figure 11 shows the pay slip of the job order and contract of service employees. The details of pay slip (Figure 11) show only the deductions, no. of days worked, rate per hour, WHT (withholding tax), and amount of salary by the employees. WHT is automatically computed based on the monthly income (salary) and deductions of the employees.

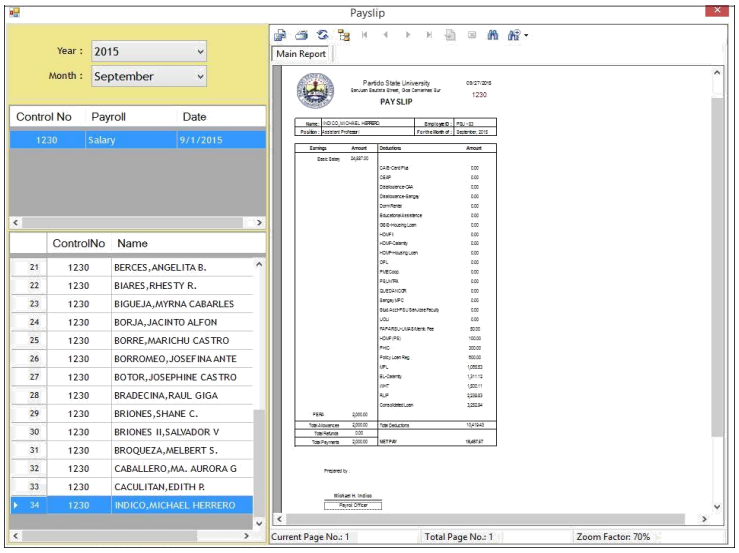

Figure 10: Pay Slip for Permanent, Substitute, Temporary, and Causal Employees

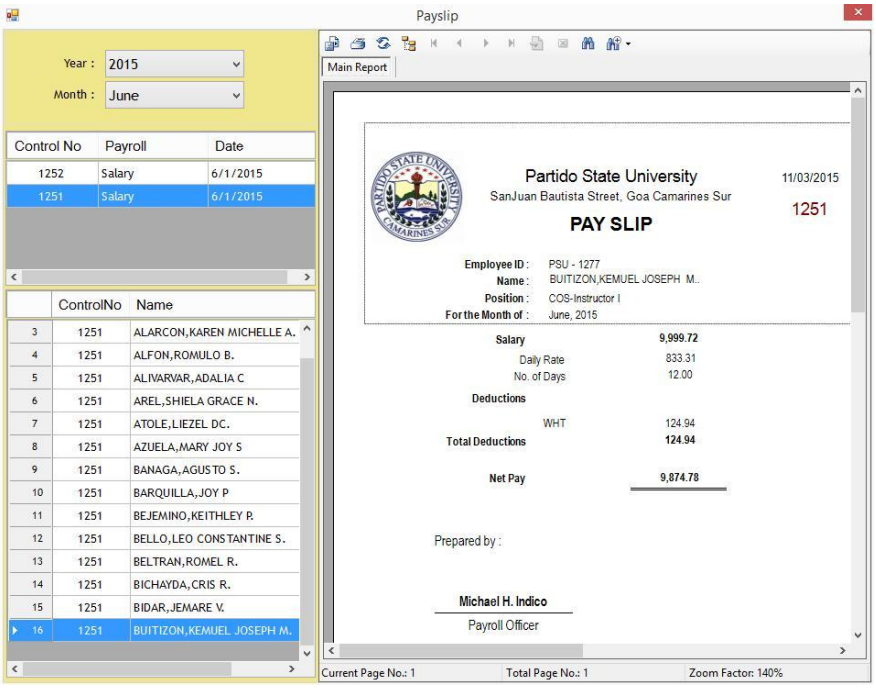

Figure 11: Pay Slip for Job Order and Contract of Service Employees

Figure 12 shows the remittance report of an employee after processing the payroll. The remittance of the employee is generally required by the other agencies (GSIS, Phil-Health, and Pag-ibig) in the Philippine Government Institution for the payment contributions or loans. The system provides the remittance report for the deductions collected from the monthly income of the employee. The options below (agency, deduction, and inclusive dates) are provided to generate specific reports of the employee.

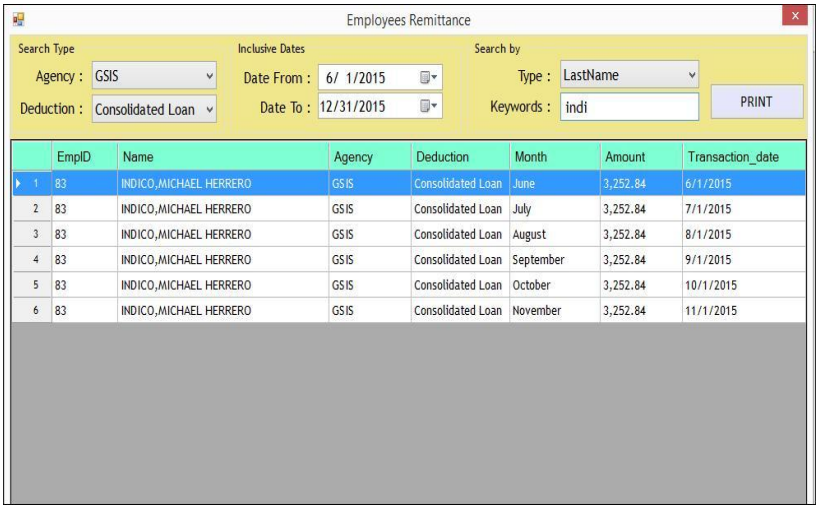

Figure 12: Employee's Remittance

The testing of fingerprint scanning focused on the execution of login and logout of the employees. Table 1 shows the results after conducting the biometric fingerprint scanning for one day (morning and afternoon).

Thirty (30) employees have performed login and logout in the school campus. Of this number, during the login, 88.33 % of the employees were successfully recorded for the first attempt of pressing their finger on the fingerprint reader. The remaining 6.67 %, 5 % of which was only recognized after the second attempt and this was due to improper position of finger. Documentation of the logout was also done. 91.67 % of the thirty respondents were accepted for the first attempt, while 5 % done it twice. The remaining 1.67 % is accepted after the second attempt.

Table 1: Result of Biometric Fingerprint Scanning

Day	Transaction	1st attempt		2nd attempt		3rd attempt		More than 4 attempts		Total
		Total	Percentage (%)	Total	Percentage (%)	Total	Percentage (%)	Total	Percentage (%)	
Morning	Login	27	90 %	2	6.67 %	1	3.33 %	0	0 %	30
	Logout	28	93.33 %	1	3.33 %	1	3.33 %	0	0 %	30
Afternoon	Login	26	86.67 %	2	6.67 %	2	6.67 %	0	0 %	30
	Logout	27	90 %	2	6.67 %	0	0 %	1	3.33 %	30
Average	Login	26.50	88.34 %	2	6.67 %	1.5	5 %	0	0 %	30
	Logout	27.50	91.67 %	1.5	5 %	0.5	1.67 %	0.5	1.67 %	30
	Login & Logout	27.00	90.00 %	1.75	5.84 %	1.0	3.33 %	0.25	0.83 %	30

The system recorded the attendance of the employees using the fingerprint reader with an average of 90 % for the first attempt, 5.84 % accepted for second attempts, 3.33 % and 0.83 % for the third and more than four attempts respectively. The average of 10 % of the employee's attendance had to perform more than first attempt due to improper position of finger, and quality of fingerprint stored in the database.

The testing of the payroll is conducted 3 trials only for the advanced and regular payroll. The advanced payroll includes the month of July 2015 to September 2015 for permanent, temporary, substitute and casual employees. The result (Table 2) showed that the highest process time is 18.11 s and 16.45 s is the lowest. The regular payroll uses only the month of June 2015 for job order and contract of service employees. The highest process time is 5.54 s and 4.63 s is the lowest.

The system processes the advanced and regular payroll with an average of 17.07 s and 5.08 s respectively on a Core i7 Processor with 4GB of RAM.

Table 2: Result of Processing the Payroll

Trial	Payroll	Month and Year	No. of Employee	Process Time (seconds)
1	Advanced	July 2015	34	18.11
	Regular	June 2015	16	4.63
2	Advanced	August 2015	34	16.65
	Regular	June 2015	16	5.08
3	Advanced	September 2015	34	16.45
	Regular	June 2015	16	5.54
Average	Advanced	July 2015- September 2015	34	17.07
	Regular	June 2015	16	5.08

5. Conclusion and Recommendation

The Employee Attendance and Payroll System (EAPS) was designed and developed for teaching and non-teaching staff in a tertiary institution. The system uses the fingerprint reader and the webcam device to facilitate the recording of the DTR and generate payroll for the employees. The DTR of the employee was recorded by the system reliably and accurately, and the system includes the identification of fingerprint image, calculation of the time arrival and departure at the school or office, and printing the DTR. Also, the system generated effectively the payroll and other reports such as pay slip and remittances of the employees. For further improvement of the study, the system needs to include the fingerprint image enhancement for better results of recognition and verification of the system. In matching of the fingerprint image stored in the database, the system requires additional time using the sequential order particularly in a large number of records. However, this could be designed to convert the fingerprint image to a unique equivalent number to lessen the time of searching or matching the fingerprint image.

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