Developing a User Monitoring System for the LPU-Laguna Library

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Abstract: *- The study aimed to develop a computer program that monitored the library users by means of capturing their attendance through radio frequency identification (RFID). A Radio Frequency (RF) reader, RF tag, web camera and computer were utilized to develop and perform the system's operation. The researcher used developmental method to fulfill its objectives. The system was able to capture the attendance of the library users with the aid of their identification card. The system is acceptable based on the test and evaluation made by the students during system implementation in the library. Several recommendations in connection with the tapping of identification card, the full utilization of capturing device, database update, client-server application, interface design and display of unreturned books.*

Keywords: *- radio frequency identification (RFID), program development, and developmental process*

I.   INTRODUCTION

Radio Frequency Identification (RFID) is one of several recognition technologies used today. According to Ratto (2011) RFID is an automated identification technology that uses radio waves through antenna on small computer chips attached to objects so that such objects may be identified. The RFID system involves an RF tag, an RF reader and a database. A reader scans the tag with the use computer program and transmits the information to the computer. The captured information will be processed for intended use. Wireless transmission of identification data rather than by manual transcription increases the quality and speed of data transmission and reception.

Lyceum of the Philippines - Laguna, an institution of higher learning, inspired by the ideals of Philippine President Jose P. Laurel, was founded by Dr. Sotero H. Laurel and Mr. Feliciano L. Torres last January 18, 2000. Its vision is to be the leading institution not only in the CALABARZON but also in the Asia pacific region.

Presently the library of Lyceum of the Philippines-Laguna is using a traditional system wherein students and employees will have to write their names in the log sheet for their attendance in the library. With the current system, the librarian has a hard time in determining the statistics of the library users. Moreover, it is hassle for the users to log in the logbook and most of the time they forgot to log in. This continuously observed situation led the proponent to investigate and find ways on how to address the need of technology. The application of radio frequency identification would be a good solution.
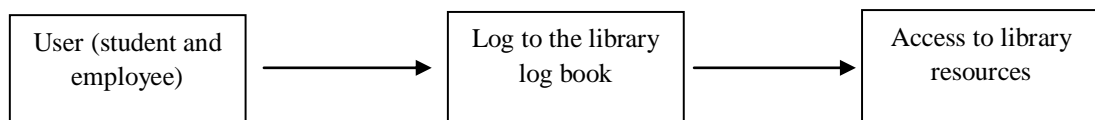
| User (student and employee) | → | Log to the library log book | → | Access to library resources |

Figure 1. Block diagram of the process of existing system

II.   LITERATURE REVIEW

Radio Frequency Identification Overview

From RFID Journal (2002), RFID is identified as generic term for a technology that uses radio waves to identify people or objects. Several methods of identification are made, but the most effective is to store a serial code that serves as an identifier of a person or object, and other information, on a chip attached to an antenna. The chip and the antenna together is called RF tag. The antenna enables the chip to transmit the information to an RF reader. The RF reader converts the radio waves into digital information that can then be passed and converted by computers to be used. There are two varieties of tags, one is a passive tag and another one is an active tag. Active RFID would function with the aid of a battery while passive RFID uses the radio frequency energy transmitted from the reader to power the tag. Active RFID can be used from monitoring objects over larger areas. These include scanning of several packages through dock doors or collection of real-time data in a warehouse. Active RFID tags have a storage capacity of 128 K bytes with a larger range of

communication and the capacity to collect data from multiple tags at a very fast pace. Passive RFID can be used for applications for a low-cost option and limitations in terms of data storage. It can be used where large amounts of data are not required and there is constrained asset movement like identification cards of students and employees. Both Active and Passive RFID can be used for in several applications of supply chains.

History of RFID

From the content of the study entitled "An Analysis of Adopting RFID in the Brazilian Air Force Uniform Sales System" by Ratto (2011) is an automated identification technology that uses radio waves. It was first developed during World War II by the British military, and its first commercial available in the 1980s. In recent years, RFID has been widely studied and applied in many areas, such as medical care, asset tracking, warehouse management, and retail businesses. There are many large-scale applications of RFID in both enterprise and client and customer side due to affordability of the chips, physical size practicality and practical shape of RFID. In response to growing interest in RFID, several publications, online and newsletter provide clear information on RFID. Also several standards bodies and organizations have been developing standards for RFID applications. The EPCglobal, American National Standards Institute, and International Organization for Standardization are one of the standard making bodies to deal with different utilizations and standards of RFID technology aiming to come up with a design with system compatibility.

According to Garfinkel & Holtzman (2005) the RFID reader sends radio signal to the tag and listens for the tag's response in the form of digital signal. The tag detects this energy and sends a response that contains the serial code of the tag. In a very common operation of RFID systems, the RF reader's pulse of energy functioned as an on-off switch; in more complicated systems, the signal of the RF reader can contain commands to the tag either to read or to write from and to the memory that the tag contains. An RFID reader is designed to read only particular information of tag and the multimode tag can read many different kinds of tags are becoming increasingly common application. RFID reader is usually in execution, continually transmitting radio energy and awaiting any tags that enter their field of coverage. However, for some applications, this is unnecessary and could be undesirable in battery-powered devices that need to conserve energy as the cards for toll gate is being used. In this application, there is a possibility that the RFID reader could send radio pulse only in response to an immediate event leading that may lead to conservation of energy. For example, most tollgate collection systems have the reader constantly powered up so that every passing car will be recorded. In veterinarian offices, RFID scanners are frequently equipped with triggers and power up the only when the trigger is turned on. Like the tag themselves, RFID readers come in many size. The largest readers might consist of a personal computer with a special card through protected cable. Such an RF reader would typically have a network connection as well so that it could report tags that it reads to other computers. Smallest RF readers are the size of a postage stamp and designed to be integrated in mobile phones. Nowadays, lots of RF tags are sold with multiple brands such as Mifare, Hitachi, and Philip. Because of the major applications used worldwide, many systems require the use of more than one operating frequency. Most systems available on the world market operate at one of the following frequencies or frequency ranges: below 135 kHz (125 kHz, 134.2kHz for example), 13.56MHz, UHF (860/960 MHz), 2.45GHz and 5.8GHz. The operating and control characteristics are different for each of these frequencies, and therefore each of them is more appropriate for certain types of application.

A study of Newman-Ford, Fitzgibbon, Lloyd, & Thomas (2008) concerning the introduction of RFID in attendance checking one year after its introduction revealed positive results for retention rates. From 2005 to 2006, 391 students were surveyed on their attendance. 98% responded; 60% returned to the class and 38% visited an advice shop (guidance office in common). Results revealed that majority of students have appreciated the concern shown by the university with several confirming that, had they not been contacted, their removal from the university would have been about to happen.

Several studies had been conducted on the use of the RFID. The study of Balba (2010) reveals that the attendance of the student can be monitored by means of text messaging in several available networks. Dellosa (2007) developed a Radio Frequency Identification (RFID) Interface System. Abebe & Elmuti (2005) explored the role of Radio Frequency Identification (RFID) system in improving the performance of supply chain management. The strategic advantages of integrating Information Technology (IT) into the global supply chain system are also addressed in the paper.

All of the mentioned related literature and studies revealed that the possibility of developing the system would achieve a good output. Ratto (2011) talks about the history of RFID and its standards. Garfinkel & Holtzman (2005) had mentioned several applications of RFID while Newman-Ford, Fitzgibbon, Lloyd, & Thomas (2008) introduced the RFID application in attendance checking in a school and found that the system has a positive result to the students.

The study of Balba (2010) was focused on the RFID application in a school as well as Dellosa (2007) that developed a Radio Frequency Identification (RFID) Interface System. Abebe & Elmuti (2005) mentioned the application of RFID in supply chain management

Conceptual Framework

The study is anchored on the input-process-output model since an attendance system for library program will be developed.

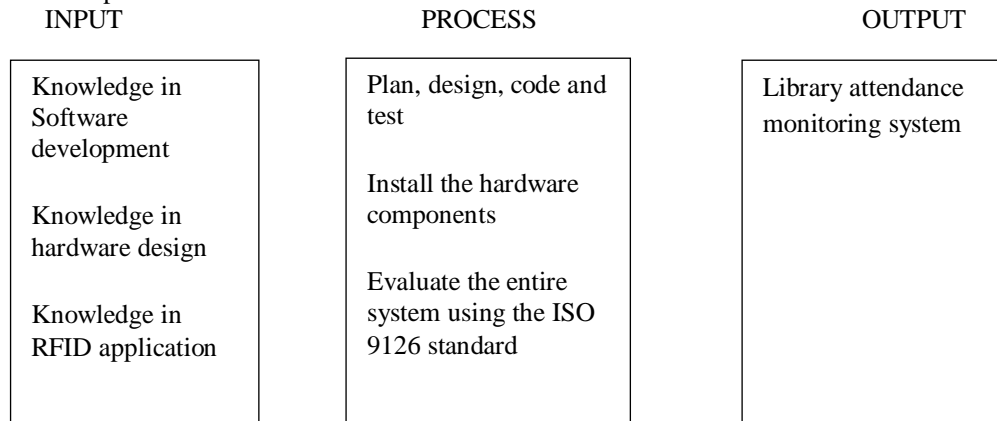| INPUT	PROCESS	OUTPUT
Knowledge in Software development Knowledge in hardware design Knowledge in RFID application	Plan, design, code and test Install the hardware components Evaluate the entire system using the ISO 9126 standard	Library attendance monitoring system

Figure2. Developmental Framework

The input includes the knowledge in software and hardware design, which includes the descriptions and components of the computer program, specifically the smart card reader and the software capability to record the data from the smart cards. The system will be developed following certain accuracy measurements and when finally developed, the accuracy of its use will be verified. The ISO9126 standard will be used as part of the process to evaluate the entire system.

Objectives of the Study

The general objective of the study is to be able to develop a system to record the attendance of the library users with the use of a computer program, RFID and computer.

Specifically, the study aims to:
1. develop a computer program that will record the attendance of the library users
2. test and evaluate the entire operation of the system
3. implement the system in library of Lyceum of the Philippines-Laguna

D. Scope and Limitations

The study was conducted at Lyceum of the Philippines – Laguna last March 2012 to December 2012. The users of the proposed system were the students. It was conducted for nine months which include development, deployment and evaluation. One low frequency Advanced Card System reader will be used for the system that is pre-assigned at the library space. The system was written in Microsoft Visual Basic 6.0. The database that was incorporated with such is MS Access. It will execute only in platforms running Windows Operating System. Other unavoidable circumstances, such as power interruptions, speed of access, and security issues of RFID Technology are no longer part of the study.

E. Significance of the study

The library will benefit from this study since it provides an easier mechanism of tracking the statistics of library users.

The library users will benefit from this study since it provides a convenient way of recording of their name as requirements before entering the library.

The student and future researchers will also benefit from this study since it can be a reference study guide for those interested in developing similar application.

III. METHODOLOGY

A. METHOD OF RESEARCH USED

This study utilized a developmental type of research. It also used experiential and interview method of data collection. The data gathered using experiential and interview method were collated. Numerical data were tabulated and presented accordingly. In developmental methodology, four stages were used. These were design, development, utilization and maintenance stages. Design stage includes problem definition, planning and setting up of objectives. Development stage on the other hand, is the process of achieving the objectives in order to solve the problem. The utilization and maintenance stage includes series of test and evaluation for possibility of deployment and implementation.

B. Locale of the study
The study was conducted at Lyceum of the Philippines-Laguna. It is located at Km. 54, National Highway, Makiling, Calamba City. There are six colleges in this institution namely College of Computer Studies, College of Engineering, College of Business and Accountancy, College of Nursing, College of Arts and Sciences and College of International Tourism and Hospitality Management with approximately 3000 enrolled students every semester.

C. Respondents
Respondents were group in to three, the library employees, the students and the stakeholders. The respondents were interviewed concerning the problem definition and how the system worked during the trial period.

D. Research Instrument
An interview guide questions was used at the initial stage of the system development. Key informant interview was performed with the librarian, the library staff and students. To facilitate proper transcript of interview, a recording device was used. For the testing part, the frequencies of successful tests were tabulated to the testing form. An evaluation of the system was done based in the ISO 9126 software evaluation.

E. Validation of research instrument
Through the guidance of the research statistician a pretest was conducted to ensure that the interview guide questions were valid and reliable. For testing part, the tabulation of the success and failure of log in and log out attempts were recorded as patterned to the one used by Dellosa (2008). For the evaluation part, since the ISO 9126 is the standard for software evaluation there is no need to validate, however, the selection of intended questions will be utilized to effectively come up with an appropriate result.

F. RESEARCH PROCESS
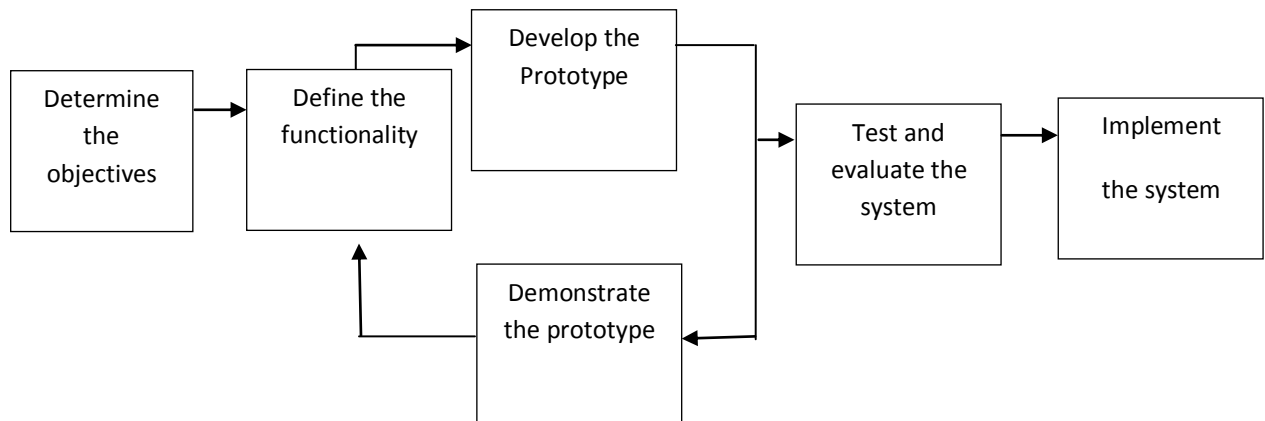The following procedure presents the developmental process:

Figure 3. Flowchart of activities

Figure 3 shows the flowchart of activities representing the software development model used in the study. The prototype model was used since the user is involved through out the development process. Gathering of correct user requirements is important to lessen the time of development.

1. Determine the Objectives
In this stage, the proponent identified the hardware and software requirements for the system that are needed to meet the objectives of the study.

2. Define the Functionality
The function of the entire system was able to capture data from a source (RF Tag) without direct contact. When signal is received the system will record the serial number of the RF tags which represent the student identity. The researcher will use ACR 122U NFC Contactless Smart card reader as a receiver of data and Mifare (RF tag) as a transmitter of data. The ACR122U NFC Reader is a PC-linked contactless smart card reader/writer developed based on the 13.56 MHz Contactless (RFID) Technology. Compliant with the ISO/IEC18092 standard for Near Field Communication (NFC), it supports not only Mifare® and ISO 14443 A and B cards but also all four types of NFC tags. ACR122U is compliant with both CCID and PC/SC. Thus, it is a plug-and-play USB device allowing interoperability with different devices and applications. With an access

speed of up to 424 kbps and a full USB speed of up to 12 Mbps, ACR122U can also read and write more quickly and efficiently. The proximity operating distance of ACR122U is up to 5 cm, depending on the type of contactless tag in use. (courtesy of Advanced Card Systems Ltd.)

In order to maximize the use of the specified functionalities stated above, the researcher performed the following activities.

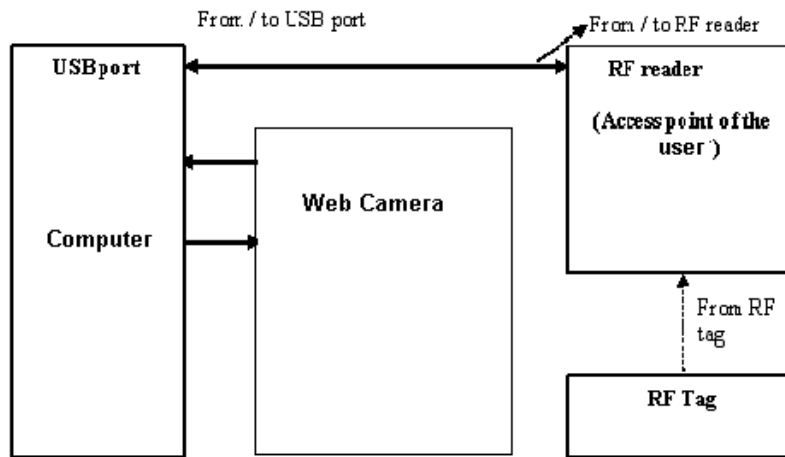### a. Formulate the block diagram of the entire system.

Figure 4 Block Diagram of the entire system

b. Describe the block diagram

The device is composed of a computer, RF reader, RF tag, web camera and computer speaker. The use of the web camera is to capture the image of the user of the library and the computer speaker will be able to produce an audible sound for announcement purposes.

c. Define each component of the blocks

Computer was used to process data from the access point of the student through port connection such as USB. With the aid of computer program the RF reader, Web camera and computer speaker will function as expected. Access point of the library user is the ACS122U reader is placed in appropriate location together with the computer and the monitor. RF tag is a medium used to log on the system. The RF tag was integrated in the identification card of the students.

3. Develop the Prototype

This stage focuses on the realization in terms of hardware components. The components are as follows:

RF Reader (ACS 122U NFC Contactless Reader) is used to read the serial codes and other information in the RF tags with corresponding software application. The RF reader through a computer program will read serial code of the RF tag.

RF Tag (MIFARE) is used as a key of individual's information located in the database as being assigned initially. This contains unique serial code that read by the RF reader in case of access.

Computer Program is the software to be used in developing the system. Visual Basic 6.0 and Microsoft access was used. The objective of this stage is to develop the software that will capture and record the logs of the library users. The following were needed in developing the software.

1) SDK software from ACS 122u reader
2) Microsoft Windows Operating System –for the operating system
3) Microsoft Visual Basic 6.0- for the programming language
4) Microsoft Access – for the database

To accomplish this stage, there are several components to be considered which are as follows:

1. ACR 122u (Service Development Pack) and Visual Basic 6.0 Professional Edition was also installed in the computer.
2. Start the software development by creating a database that stores information. The following presents the data dictionary of the system.

Data dictionary

The data dictionary is applicable to the registration phase and monitoring phase.

Table 1 Registration data definition

Field name	Field Size	Data type	Description
seidrecordnumber	255	Text	Student/ employee number
seidrecordserialnumber	255	Text	Smart card unique serial number
seidrecordimagefilename	255	Text	Image of the student/employee (.jpg)
sedataentry	50	Text	Date where the registration hashappened

Database name: **idsystemforregistration.mdb**
Tablename: **seidrecord**
Source of record: **Registration (where the ID making occurs)**
Use: **Repository of gathered record of ID number with corresponding unique serial number (smart tag)**

Table 2 Monitoring (student) data definition

Field name	Field Size	D ata type	Description
serecordnumber	255	Text	Student ID number
serecordname	255	Text	Student name
serecordcourseposition	255	Text	Student course
serecordcollegedept	255	Text	Student college/dept belong
serecordtype	50	Text	Description of the entry (Student)

Monitoring part:
Database name: **idsystem.mdb**
Tablename: **serecord**
Source: **ERP system (manually harvested by by MIS officer)**
Use: **Repository of student data from the ERP system**

Table 3 Monitoring (student attendance) data definition

Field name	Field Size	Data type	Description
seattendanceidnumber	50	Text	Student ID number
seattendanceserialnumber	50	Text	Assigned card serial number
seattendancename	50	Text	Student name
seattendancecourseposition	50	Text	Student course
seattendancecollegedept	50	Text	Student college/ dept belong
seattendancelogdate	50	Text	Student log date
seattendancelogtime	50	Text	Student log time
seattendanceimagefilename	255	Text	Student imagefile name
seattendancetype	10	Text	Description of the entry (Student)

Database name: **idsystem.mdb**
Tablename: **seattendance**
Source: **From the system as it collects and record entry access of students**
Use: **Repository of entry access**

4) Demonstrate the prototype
The demonstration happened with the presence of the library employees as the user of the system and some of the library users for the initial test. Determination of the possible problems must be considered for further improvement before testing and evaluation.

5) Test and evaluate the system
A series of test were conducted to determine the reliability of the system. This includes the test of the logs of students by tapping their ID's with RF tag. After the test, the system evaluation was placed for any possible modification of the entire system.

6) Implement the system
Implementation will follow after all the objectives were being satisfied. The library employees were trained for the system operation but there is always a room for them to suggest for the improvement of the system.

IV.   RESULTS AND DISCUSSIONS

The following present the result and discussion of the library user monitoring system for the LPU-Laguna.
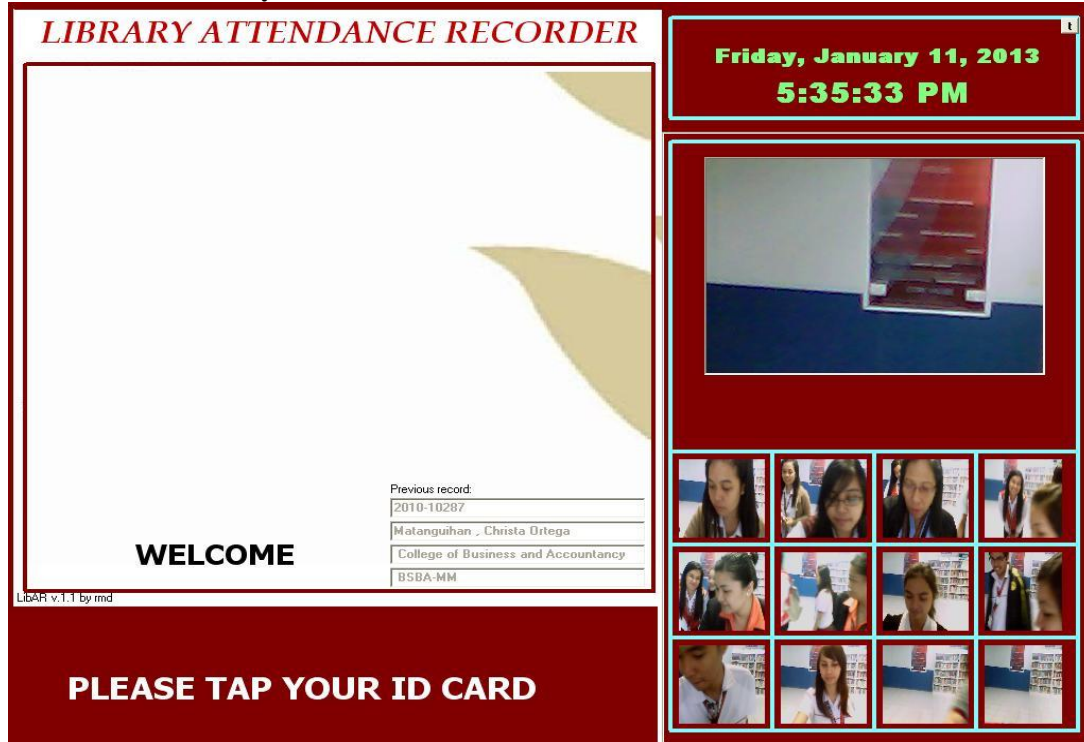
A. The screen shot of the system

Figure 5. Screen shot of the system

The above figure shows the screen shot of the system. Prior to using the library facilities, the student will be tapping, his/her identification card to the terminal. The terminal is composed of computer, RF Reader and video camera that will facilitate the capturing of information. Once the student has already tapped his/her identification card, the system is capable of capturing the image and the information of student is stored in the database.

B. The Registration module

This is installed at the Office of Student Services where the students' IDs are processed.

Figure 6. Registration form

Figure 6 shows the registration screen shot of the system. The assigned personnel at the Student Services should follow a step-by-step procedure in order to register the student in the database to be used as a reference data of student. This process will capture and store the serial number of the ID card of student in the database.

C. Results of testing and evaluation

There are 18 students who evaluated the system. Majority of the respondents (90%) tapped their identification cards every time they entered the library. It was also observed that the web cam is not utilized well and the identification card can be tapped every time you want. The observation was also address by system modification conducted by the researcher. There is a high acceptability of the system from the librarian and students point of view because of its accuracy.

Table 4 Mean evaluation of the RFID system

	Mean
1. The system performs the required tasks	3.00
2. The system responds quickly	3.25
3. Library assistance is available	3.34
4. The system interface looks good	3.01
5. The system can handle errors	2.87
Composite Mean	3.09

Verbal Interpretation: 1.0-1.49 Strongly disagree, 1.50-2.49 Disagree, 2.50-3.49 Agree, .50-4.00 Strongly agree

The student-respondents suggested the display of the image of student should not be dependent on the captured image from the camera. Other suggestions include the additional information that indicates the enrolment of the student for the current semester. Moreover, it was also suggested that the attendance of student should be captured once a day only and the interface should be improved.

D. Actual set up
The deployment of the system happened last June 1, 2012. Figures below reveal the project output in action.

Figure 7. The attendance monitoring setup in the library

Figure 8. The actual tapping of ID card

V.   CONCLUSION AND RECOMMENDATION

Summary of Findings

The developed computer program was capable of capturing attendance of students with the use of their identification card. Likewise, the image of the student can be captured and recorded. The system can capture and record information about the students like student number, name, course, year, time and date of entry in the library, college and program. Majority of the respondents (90%) tapped their identification cards every time they entered the library. It was also observed that the web cam is not utilized well and the identification card can be tapped every time you want. There is a high acceptability of the system from the librarian and students point of view because of its accuracy.

VI.   CONCLUSION

The development of computer program that were able to record the users of the library was successfully done. The system was acceptable based on the test and evaluation of students and the implementation of the system in the library.

Recommendations

The future researchers with inclination on this research may consider the following recommendations:
1) The possibility of face recognition so that the captured image of the web camera will be verified
2) The interface maybe developed in other compiler to advanced its functions
3) The alert of unreturned books may be displayed in the screen to alert the concerned student
4) The use of other database maybe considered. The limitation of Microsoft Access may affect the operation.
5) Client-server application may be considered to duplicate the terminals.

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