

Medical Equipment Maintenance Management System with Fingerprint Authentication

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DOI: <https://doi.org/10.30880/eeee.2021.02.01.027>

Received 14 February 2021; Accepted 11 May 2021; Available online 30 April 2021

Abstract: Medical equipment in hospital requires an effective maintenance system to record every maintenance issues, tracking the person in charge for that equipment and the date in and out from the location of that equipment. Hospitals in Malaysia still lacks of systematic equipment maintenance management system where most of the hospitals still using manual methods to record and monitor equipment in and out from the location for maintenance purposes. In fact, manual methods like this are time consuming, prone to errors and loss of records. Considering the importance of a proper system to record the medical equipment maintenance, the purpose of this paper is to accomplish the objectives to develop a medical equipment maintenance management system for tracking equipment for maintenance allows automatically tracking the maintenance history of medical equipment using Microsoft Visual Basic Studio integrated with Arduino IDE for fingerprint identification, consider as a key to recognize the identity of users. Thus, based on the result obtained, it is proved that the accuracy of the fingerprint identification is highly accurate and the probability of having the same fingerprint with somebody else is not likely to occur. The medical equipment maintenance management system developed able to record and store essential maintenance data for future reference.

Keywords: Equipment Maintenance Management, Arduino, Microsoft Visual Basic Studio, Fingerprint, Authentication

1. Introduction

Currently, many hospitals in Malaysia using a manual method to record the list of breakdown machines or medical equipment where the record book will be kept in its old conservative way and only used when it is needed. Even though the list is recorded, however, if the book record were not appropriately managed, the missing data from the book could cause a problem to track the history of equipment maintenance and the person in charge of that equipment. Details of medical device such as asset number and the date when the device is taken out from the ward, are needed by the maintenance

team so that the identification of device belongs to which ward could be done. Each location and floor level in the hospital has its ward room number and purposes for the patient to be treated. All medical equipment and device used in ward, labour room, Intensive Care Unit (ICU), endoscopy room, and other rooms have their asset number for each medical devices used such as syringe pump, defibrillator, and others to avoid confusion between other wards during returning process of the repaired device. The process of handing over the devices usually is recorded in a book. However, users sometimes did not properly record the list of the asset number of the breakdown devices that had been repaired or taken out by a technician or maintenance specialist. Even though each ward has its record book, but it does not provide good security and has a higher chance for the record book to be stolen or missing.

The system that uses a password and ID number might be stolen or forgotten easily. Thus, the system should be improved so that it can provide a more secure method to prevent the difficulty of handing over the equipment and missing data. Fingerprint identification is recommended because it leads to sustainable development when comparing to other systems, easy to verify individual identity, and is also considered the best choice for any identity system as it is reliable and unique [1]. Some qualities such as consistency, distinguishability, high trust matching levels, and ease of acquisition are the main factors for biometrics market dominance of the fingerprint recognition system [2]. Using this biometric recognition system, the fingerprint template is stored in a database and during authentication, this template is compared against the fingerprint that scanned on the device to verify the identity [3].

Nowadays, the database system is widely used to save paper and time [4]. To create a management system for medical asset or equipment maintenance, one of the methods is to use Microsoft Visual Studio. This software use Microsoft Access as their database for updating the medical equipment. Visual Basic is a component of visual studio and it is used to create a Graphical User Interface (GUI) program. This was modified to include several modern and enhanced features of the language. Furthermore, Visual Basic supports multithreading, which are the ability to assign multiple processing threads to individual tasks.

Even though medical device used in a hospital already has their managing system, for example, ASIS, however, it required users IC number to register into the system. This caused some of the hospital staff do not want to register regarding the privacy issues. To overcome the problem, a medical equipment maintenance management system using fingerprint authentication is introduced. This system requires the fingerprint of the user to be scanned on the fingerprint scanner to allow the user to login into the system and record the asset number of the repaired or breakdown equipment, and the date whenever the equipment being taken out or return to its location. This biometric identification replaces the manual method of using passwords thus theoretically reduce the burden for both user and admin [5-9]. Thus to create the medical asset maintenance system through biometric recognition, Microsoft Visual Studio, Visual Basic.NET, Microsoft Access, and Arduino fingerprint module are being used.

2. Methodology

2.1 System Design

The developed system is using a fingerprint as biometric security for user authentication before the user is allowed to enter the medical equipment maintenance management system. This project uses optical fingerprint scanner R305 interfacing with Microsoft Visual Basic Studio.Net to provide a user interface in the system. Users need to place their fingerprint on the scanner twice, first to store the captured fingerprint template into the database and second to make a comparison between the templates captured on the scanner with others template stored in a database. The development of this system is divided into two parts, hardware and software development. In hardware development, the scanner module is connected with Arduino Uno to capture and store the fingerprint template. In the initial phase, a serial monitor is used to make sure the fingerprint module can be detected by Arduino IDE and to allow the process of enrolment and authentication of the module. After the module is detected, fingerprint enrolment and fingerprint matching can be done to store the user's ID template in a module.

Once the ID template of the users is successfully stored and recognition can be accomplished, the next step is to integrate the hardware system with software system design. The system development involves the use of Microsoft Visual Basic Studio which provides GUI framework for the users to access the system. The fingerprint template stored in the flash memory of the device scanner is used to interface with the medical asset maintenance management system which means the asset system can only be accessed when the process of fingerprint authentication of the user is successful. The overall system design flowchart is shown in Figure 1.

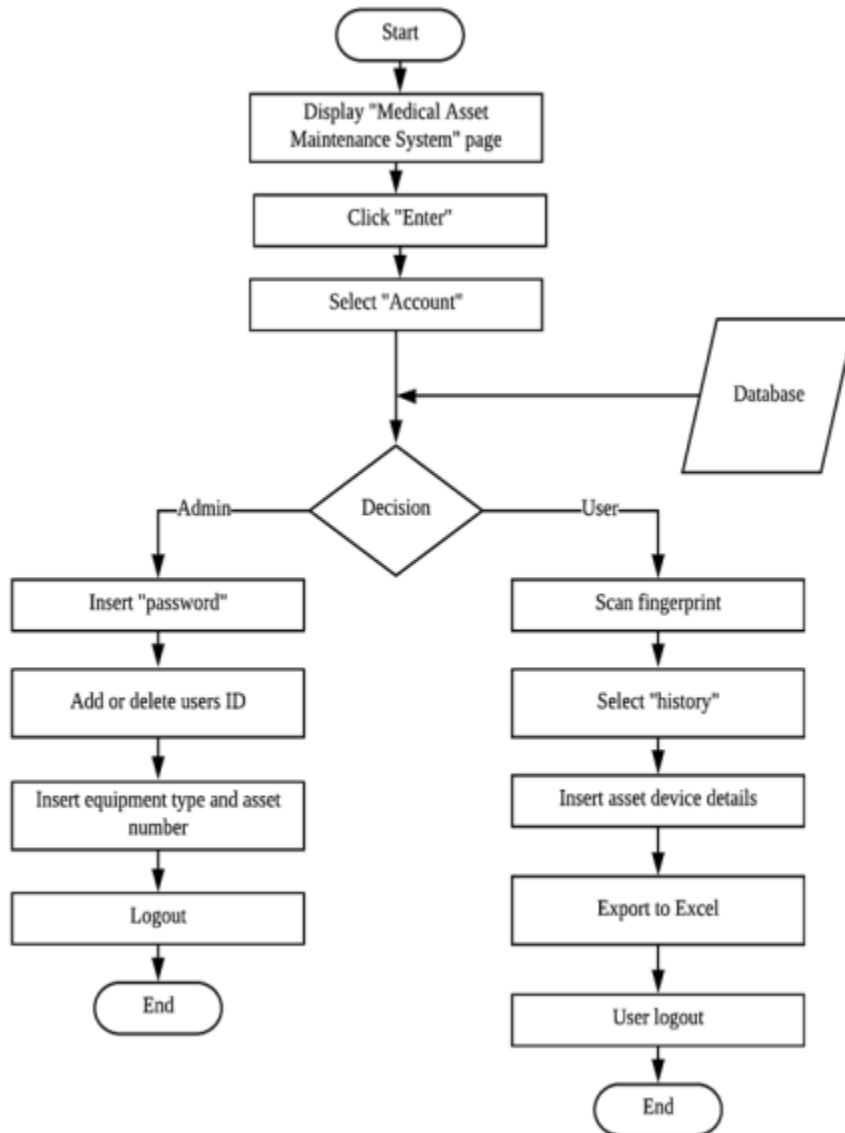


Figure 1: System Design Flowchart

2.2 Hardware Design

This system required biometric identification to access the system. This system is using an optical type R307 Fingerprint Module for user identification. The module enrolls fingerprints, processes images, matches fingerprints, and stores searches and templates. Arduino Uno R3 is a microcontroller board that is used to provide communication between module scanner and computer. The interfacing between the fingerprint module and Visual Basic Studio is required when ID of the user's fingerprint can access into the system. The fingerprint enrolment flowchart is shown in Figure 2 while the connection of the fingerprint device system is shown in Figure 3. The device consists of the Arduino Uno R3 and R307 Fingerprint Module Scanner.

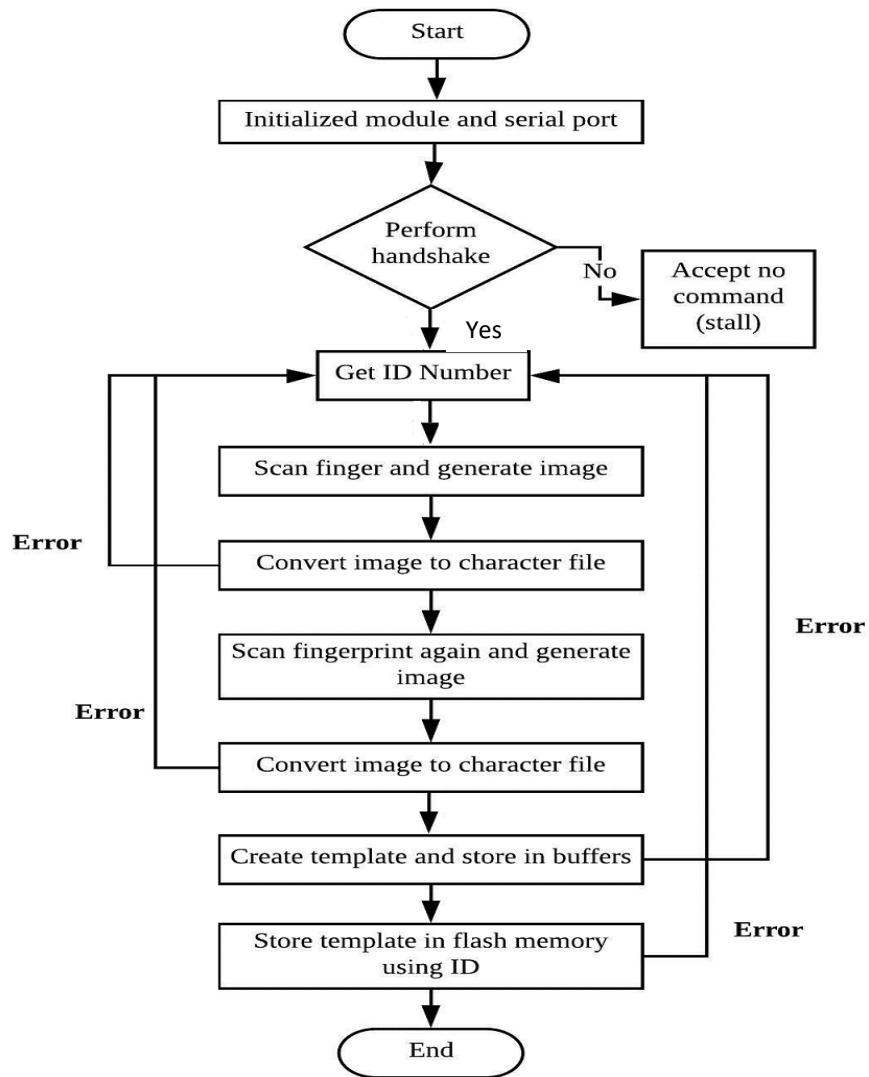


Figure 2: Fingerprint Enrolment Flowchart



Figure 3: The connection between R307 Fingerprint Module and Arduino Uno R3

2.3 Software System Configuration

Visual Basic Studio is used to develop the Graphic User Interface (GUI) between Microsoft Visual Studio and Arduino IDE software. In this project, the GUI required fingerprint identification to allow the users access the medical equipment maintenance management system. This system consists of two parts which are Admin and User. The management of the system is controlled by the admin who responsible for managing the user's information and ID number as well as managing the process of inserting the types of medical equipment used in the ward with their asset number. This is to ensure the users record the accurate medical device details during the process of taking out or returning the device in the system. While the user part requires a user to scan their fingerprint to be able to access the system before proceed with the device recording process. After the user has been recognized by the fingerprint identification, the user can record the asset device in the system and import the data into Microsoft Excel so that the list can be printed out when needed. The admin account is for the admin to manage the system and user account for users to update and record the medical equipment that is taken out for maintenance purposes and then return to the right location.

3. Results

3.1 Fingerprint Identification

The process involves in fingerprint identification is enrollment and authentication to complete the biometric process. During enrollment, a user needs to place their thumbprint twice on the scanner. It is because the first one is to capture the fingerprint template and store it in the device. While the second thumbprint is required for a verification process between captured fingerprint scanned on the device and the one stored in memory. Figure 4 (a) and (b) show the integration result displayed on the serial monitor of Arduino IDE software.

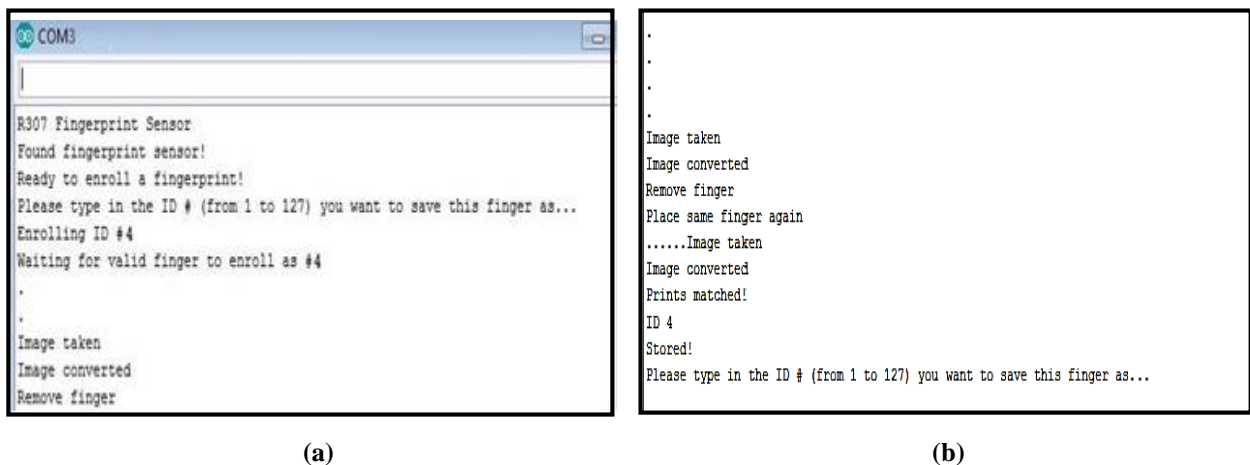


Figure 4: Integration result (a) Fingerprint enrollment; (b) Fingerprint verification

3.2 Visual Studio Basic Interface

Visual Basic Studio is used to develop the Graphic User Interface (GUI) between Microsoft Visual Studio and Arduino IDE software. In this project, the GUI requires fingerprint identification to allow the users to access the medical asset maintenance management system. After running the program, the system displays the first page of the GUI as shown in Figure 5, and by clicking the ENTER, users can proceed with scanning their thumb on the fingerprint scanner module. As stated before, this system consists of two parts which are Admin and User. An admin account is for the admin to manage the

system and user account for users to update and record the asset device. The flow process for both admin and user account are explained in Section 3.3 and 3.4.

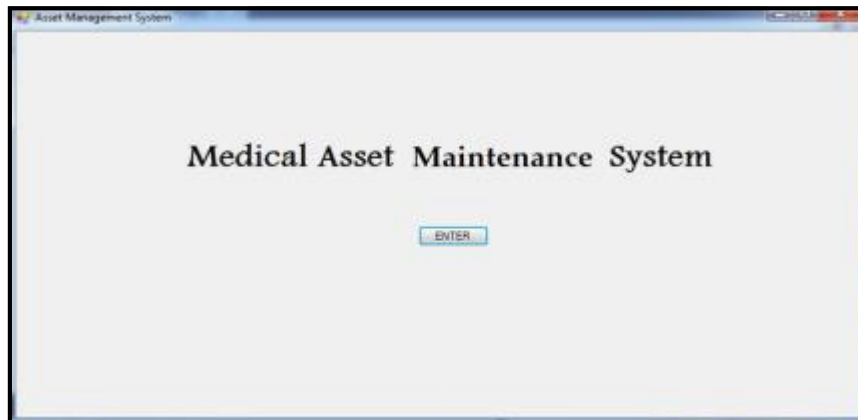


Figure 5: GUI page display

3.3 Admin Account

The admin's account has an advantage in modifying security settings, upgrading software and hardware, accessing all device files, and making changes to other user accounts. In this system, the admin is responsible to manage the user's registration and also updating types of equipment with their asset number into the system. After login into the system, it requires the admin to insert the username and password as shown in Figure 6. An admin account consists of a user tab, to add and delete users ID and inventory tab, to update, insert and delete the medical equipment. User registration is needed for those who do not have their information recorded in the system and this process is important because user's IDs are required before they can access the system through a fingerprint scanner. User ID and inventory tab are shown in Figure 7 and Figure 8.

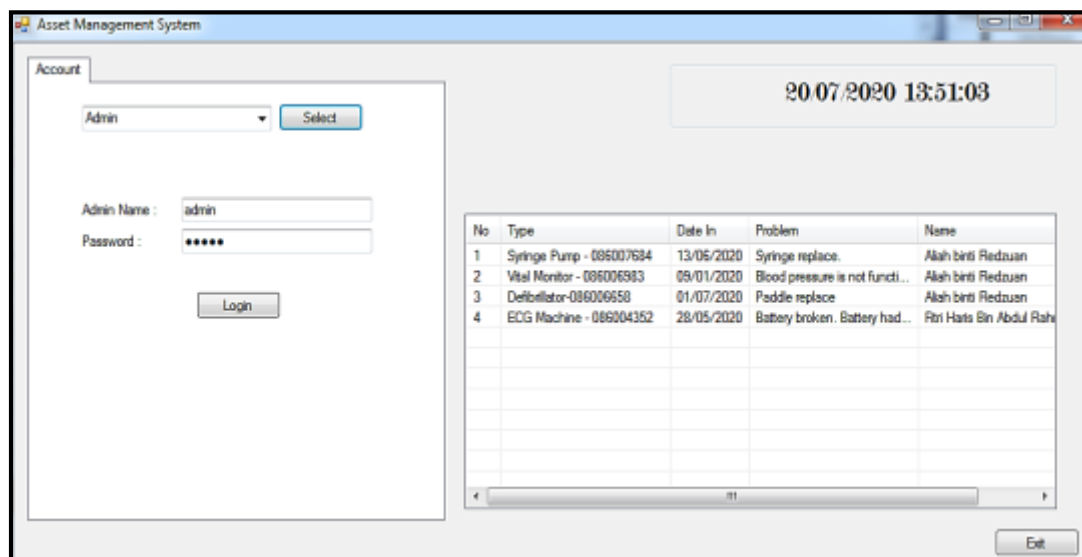


Figure 6: Admin account

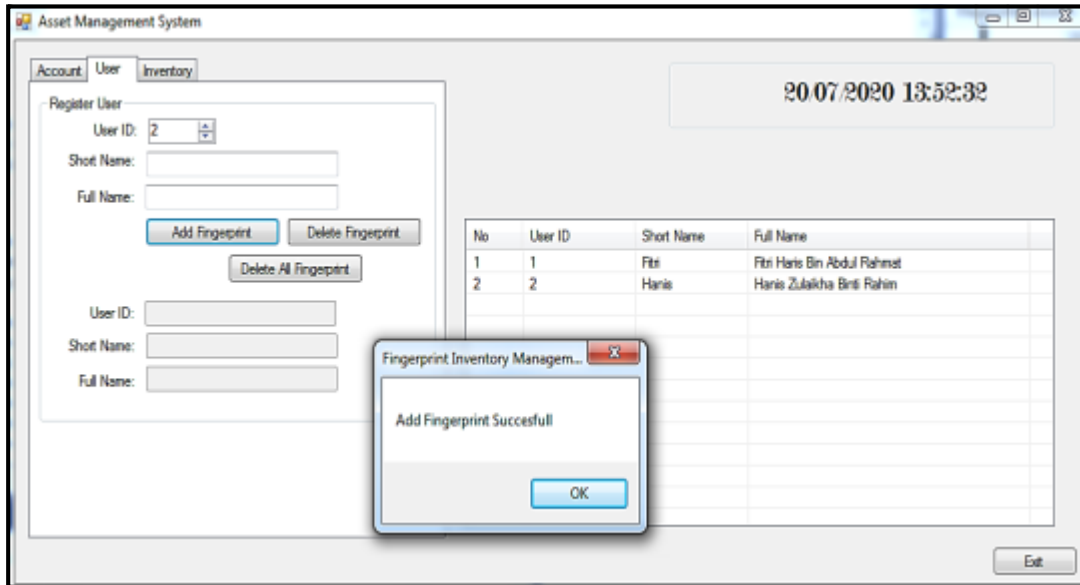


Figure 7: User ID

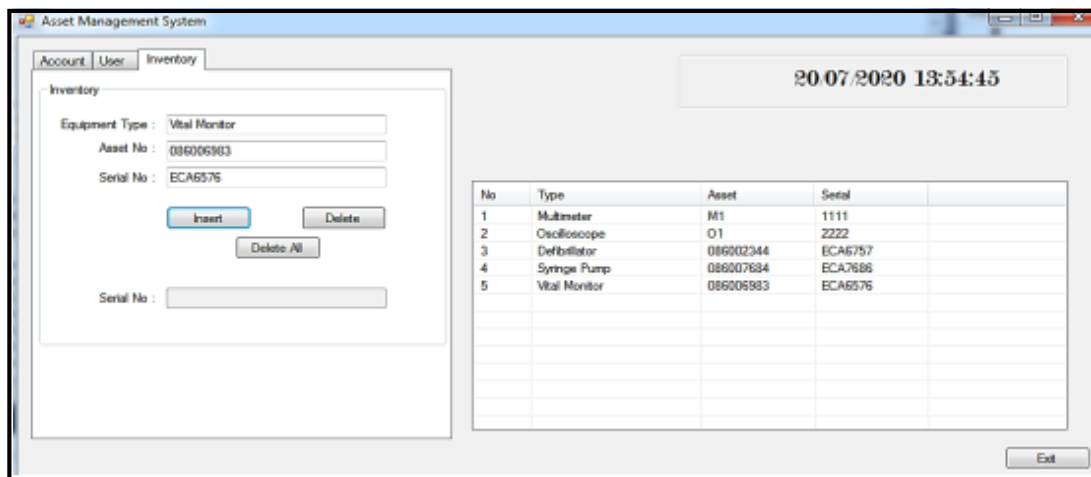


Figure 8: Inventory list

3.4 User Account

In this system, a user account is used by staff in a hospital that is responsible for handling medical equipment and devices. To access the system, a user is required to scan their thumbprint on the fingerprint scanner as shown in Figure 9. The scanner will find the matching user ID template stored in the database and allow the user to access the system if the ID is matched. In case an unknown user tries to access the system, the popup message of the unknown user will appear as shown in Figure 10. User accounts have two history tabs that are functioning to allow users to record and update the medical inventory list, types of problems that are needed to be repaired, and the date when the device is taken out and return. All the lists recorded in the system will be able to export into Microsoft Excel and can print out when needed as shown in Figure 11.

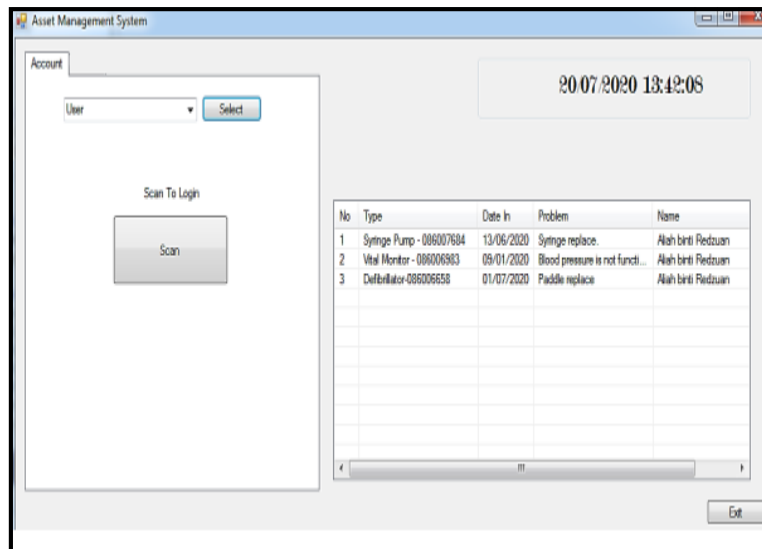


Figure 9: User account

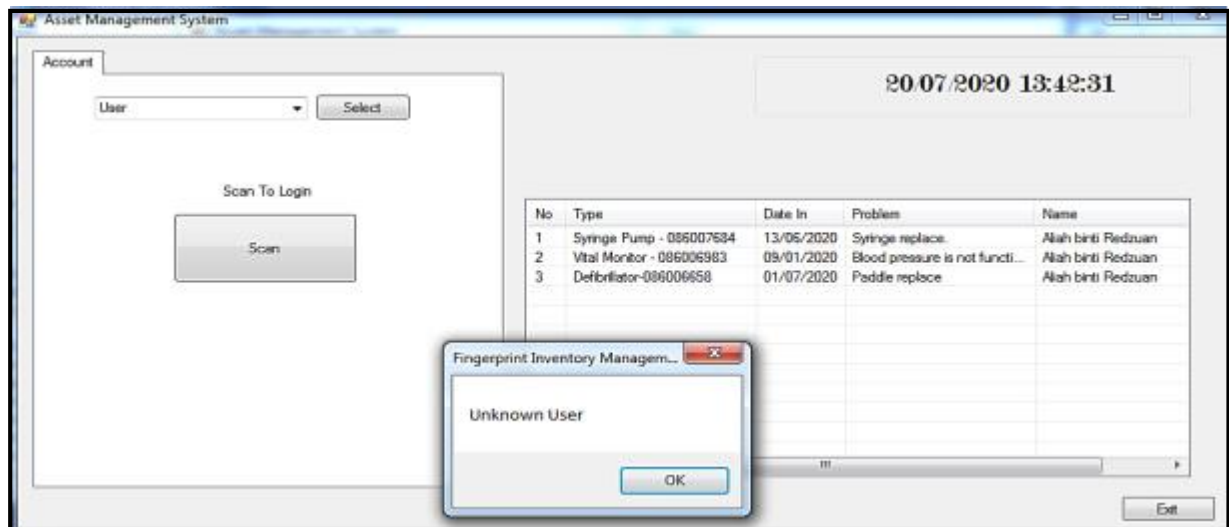


Figure 10: Unknown user message pop-up

	A	B	C	D	E	F
1	No	Type	Date Out	Problem	User Name	
2	1	Syringe Pump - 086007684	30/05/2020	Syringe pump cannot be used	Hanis Zulaikha Binti Rahim	
3	2	Vital Monitor - 086006983	25/12/2019	Blood pressure reading not accurate	Hanis Zulaikha Binti Rahim	
4	3	Defibrillator - 086006658	19/06/2020	Paddle broken and damage	Fitri Haris Bin Abdul Rahmat	
5	4	ECG Machine - 086004352	22/05/2020	Battery damage	Fitri Haris Bin Abdul Rahmat	
6						
7						
8						
9						
10						

Figure 11: History list export to Excel

4. Discussion

The development of the system illustrated the basic principle of automated system to record the history of maintenance of medical devices in the hospital. This system governs the whole process starting with identification of the users, up until the generation of list with recorded maintenance history. The data is guaranteed to be secured because it is integrated with fingerprint identification system to identify the users before entering the system. Each process in this system is interrelated with each other. It will follow the process sequence, so that it will guarantee no mistakes and duplication throughout the entire process. Starting with the admin inserting the responsible users in the system database, the user can enter the system after user verification process is successful. The users can simply entering the data into the system like the date of the devices taken out to be repaired and the date when the devices are returned to the location. Most importantly, the system will keep the maintenance record and display the name of the person in charge for that device. All in all, this system application, can carry out the basic requirements of an automated system to manage the medical devices storage and maintenance record management. This system able to generate lists about the received devices, the person in charge for that devices, the date the devices being taken out and return, also generates the maintenance history lists. The software able to work efficiently with least of human error and the data can be kept safely in the system to replace the previous manual recording system.

5. Conclusion

The main focus of this project is to develop a simple system that helps to keep track of the maintenance history of the medical equipment in the hospital and the person responsible for that equipment. The system is integrated with a biometric fingerprint authentication system to control the access of the system. Based on the result obtained, it can be inferred that it's a user-friendly system that was built to replace the old conservative system. The fingerprint scanner can capture the fingerprint template, enroll, add and store it in the database. The system effectively identifies users and records the equipment through a fingerprint recognition system and medical equipment maintenance management system. The system performance such as data storage, mismatching, and accessibility can perform well. The system is successfully developed to take over the manual recording using a logbook that will prone to damage and being misplaced.

Acknowledgement

The author would like to thanks the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for the facilities especially Mechatronic Laboratory that has been provided to complete this project and for its support.

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