Prototype of an Attendance and Entrance Access Based on RFID for Lab-Based Education (LBE) Learning Model

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Abstract - **In this study, it is made an attendance system and RFID-based access to the entrance by using Arduino Uno as the controller and RFID module RC-522 as a reader. LBE based learning model focuses on research and development activities undertaken by students in the laboratory, the assessment indicator is the amount of time spent by students. RFID technology is used as an access for entering the laboratories and to record personal data at the same time, as well as the time of entry and exit time of the lab members. The difference between the time of entry and exit which will then be recorded and then added together as a whole as absenteeism. RFID Reader is used to read passive tags containing a unique code, which is stored as a unique code for each user ID. Passive tags have no internal power supply and depend on RFID reader to transmit data. In addition, the use Solenoid Door Lock as automatic door locks and Microsoft Visual Basic as the user interface. On the user interface will be calculating the total time each user, which is the accumulated total time difference between the time the user first scans reader and subsequent scans. The system is designed with the state if the ID is registered then Visual Basic will send a signal to the Arduino to unlock and vice versa. Users who registered and then his name will appear on the start menu user interface and the process of counting time will begin until the user begins to scan the tag for the second time. In testing, it is conducted test of reading the distance of the reader with a maximum reading distance of 3cm results, as well as testing the system as a whole which is in accordance with the design.**

Keywords: RFID, RC-522, Solenoid Door Lock, Microsoft Visual Basic, Arduino Uno.

I. INTRODUCTION

Along with the rapid development of telecommunications technology today, it's even easier for people to do various jobs. Jobs that were once done by humans manually can now be done automatically by a system. One example of a system to replace the human role in doing a job is an identification system based on radio waves or better known as RFID, where the technology consists of a reader (reader devices) and tag (device read). RFID technology also does not require direct contact between the reader and the tag in the user process (contactless) [1,2,3].

One example of the application of RFID technology is automated attendance system that is commonly used in schools, offices, and colleges. One of the advantages of RFID-based attendance system is in addition to the efficiency and cost of the design is relatively inexpensive, it also has the flexibility to be adjusted as needed. Flexibility in this case concerning what kind of the data arrangement is desirable in systems such as personal data, the time attendance, and attendance.

II. BASIC PRINCIPLE

2.1 RFID (Radio Frequency Identification)

RFID is a method of identification by using the so-called RFID tags or transponders (tags) to store and retrieve data wirelessly, using radio waves. RFID transmission frequencies can be classified into three, namely LF (low frequency 30-300 kHz), HF (high frequency) / RF (radio frequency 30-30 MHz) and UHF (ultra high frequency, 300 MHz-3 GHz) / microwave (> 3 GHz). [4].

RFID technology is based on the working principle of electromagnetic waves, in which the main components of the RFID tag is a chip and an antenna that serves to supply resources by utilizing the magnetic field of the reader and modulate the magnetic field. Then reused to transmit data to the tag's RFID label. Data received by reader will be forwarded to the host computer database.

There are many different types of RFID systems and can be used for savings or increased efficiency. There are two main categories of RFID systems, the system of active and passive. [5].

2.2 Arduino Uno

Arduino is a microcontroller board based on the ATmega328. This board has 14 digital input / output pins (of which 6 pin can be used as PWM outputs), 6 analog inputs, a clock speed of 16MHz, USB connection, power jack reset button. Pin-pin contains everything needed to support the microcontroller. Arduino Uno uses power that is connected to a computer using a USB cable or external power using the AC-DC adapter or battery.

2.3 Solenoid Door Lock

Solenoid Door Lock is an electronic device made specifically for locking the door. The solenoid will work if voltage is given. Inside the solenoid there is a wire circular in an iron core. When an electric current flows through this wire, then there is a magnetic field to produce energy that will attract the iron core inside. In normal conditions the solenoid lever position lengthwise / locked. If voltage is given than the tension lever will shorten / open.

2.4 Relay

Relay is a series of magnetic switches that work if given supply and is a trigger circuit. The electrical current used in the circuit is a DC current. Construction in a relay consists of a coil of wire (coil) wrapped around a soft iron core. If the wire windings to get the current flow, soft iron core contact generates a magnetic field and pull the switch contacts. Switch contacts experiencing electrical force so that can changed magnetic pole position to another or apart from the polar origin. This situation will persist as long as the current flows in the relay coil.

2.5 Radio Telemetry Kit 433MHz

Radio telemetry device is made based 3DR Radio System, used for remote communication between the antennas. The telemetry system uses full-duplex communication using HM-TRP Hope RF module that has been customized with open source firmware. These devices use traditional TTL interface standard serial or USB 5V FTDI Serial. To update and adjust the settings of the module can use the APM Mission Planner. Configuration can also be done with 3DR Radio Configurator or AT Command.

2.6 Microsoft Visual Studio

Microsoft Visual Studio is complete software which can be used for application development. Visual Studio includes a compiler, SDK, Integrated Development Environment (IDE), and documentation (generally in the form MSDN Library). Interface or the interface of Visual Studio, contains menus, toolbars, toolbox, forms, project explorer and property. Making an application program using Visual Studio is done by making the application on the form, and then given a script program within the required components. Form prepared by components that are in [Toolbox], and every component used must be set properties through the window [Property] [6].

2.7 Programming language VB.NET (Visual Basic)

Microsoft Visual Basic .NET is a tool to develop and build applications on the system that moves the .NET Framework by using the BASIC language. Visual Basic .NET language itself adheres to the paradigm of object-oriented programming language that can be seen as an evolution of the previous version of Microsoft Visual Basic that is implemented on top of the .NET Framework. Many changes made by Microsoft between Visual Basic Classic with Visual Basic .NET and Visual Basic .NET is not compatible with earlier versions. [7]

2.8 Microsoft Access

Microsoft Access is a database management software that works on Windows operating systems. Microsoft Access is part of Microsoft Office released by Microsoft. By using Microsoft Access will facilitate the programmer to manage the database. Microsoft Access can cooperate with a variety of software producers for example Visual Basic program. [8]

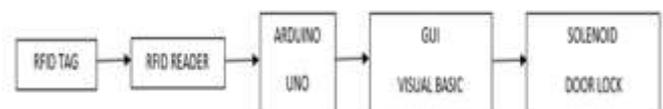## III. DESIGN AND DEVELOPMENT OF THE SYSTEM

3.1 Outline Design

Figure 3.1: Overall System Block Diagram

Figure 3.1 above is a block diagram of the overall system is designed. RFID Tag, RFID Reader Module RC522, Microcontroller Arduino Uno, and Solenoid Door Lock are four main components that will be formed into a shaped system prototype which is then monitored by using Microsoft Visual Basic application as a Graphical User Interface. Overall system prototype will then be called the prototype attendance and access entrances.

Attendance system works by utilizing the timer feature on the GUI, the first scan module and the timer will start counting the next scan will stop the timer counting. When the user to scan the card at an RFID reader, the unique code from the card will be read and then sent via telemetry sender module on the

Arduino Uno to a telemetry receiver module on the com port on your laptop / computer. This unique code will then be processed within the GUI, in this case is the Visual Basic for then matched with the user data in a Microsoft Access database. For users who have registered on the database, solenoid door lock opens, the timer will then work and count the time until a user to scan again for the second time. As for users who are not registered then the system will not do anything, just reading the card's unique code.

3.2 Components

In making this system, used components are as follows:

1. Arduino UNO, serves as the central control system.
2. Module RFID RC522, as an RFID reader.
3. Kartu (Card) RFID, as an RFID tag.
4. Solenoid door lock, as an automatic electric lock.
5. Module telemetry, as a medium of communication between Arduino and the computer / laptop.
6. Relay, as an electrical switch which switch on and off solenoid door lock.
7. Regulator, as the lowering voltage component.
8. Catudaya, as a supply circuit.
9. Computer, as a media interface with specifications (Intel Core i5, RAM 4GB, VGA 2GB)
10. Fiber Glass, as the case of the prototype.

3.3 System Design

The system design is divided into three, namely Software Design, Hardware Design and Prototype Design.

3.3.1 Software Design

i) Programming with the Arduino IDE

Software design is done by software programming on the Arduino Uno. Programming is based on a program flowchart shown in Figure 3.2

This flow diagram illustrates that the system will start when the RFID reader reads an RFID tag, the system will continue to work unless the system is shut down manually. The explanation of this flow chart is:

1. The system will continue mendeteteksi incoming data through RFID reader obtained from the RFID tag.
2. After obtaining the data from the RFID tag, the data will be entered in Arduino uno and will send the data to software Visual Basic.
3. Then Visual Basic will identify and compare the data that is already contained in a Microsoft Access

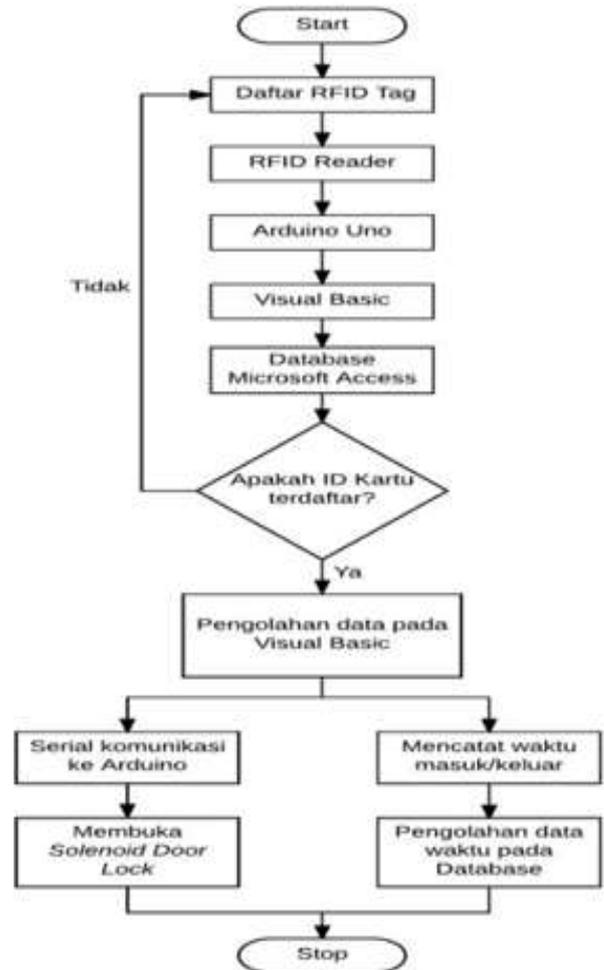database if the data on the card is listed in the database or not.

Figure 3.2: Flowchart of the System in general

4. If the data on the card has been registered in the database, then the visual basic will re-process the data by recording and processing the access time that has occurred and displays a registered member to use the card.
5. At the same time, Visual Basic will transmit data at Arduino uno based processing that has occurred. So that the door lock solenoid will open indicating that the card is registered in the database, and members can access the lab.

ii) GUI (Graphical User Interface) Design

In designing the GUI using Microsoft Visual Studio and using VB.net programming language with a flow chart as follows:
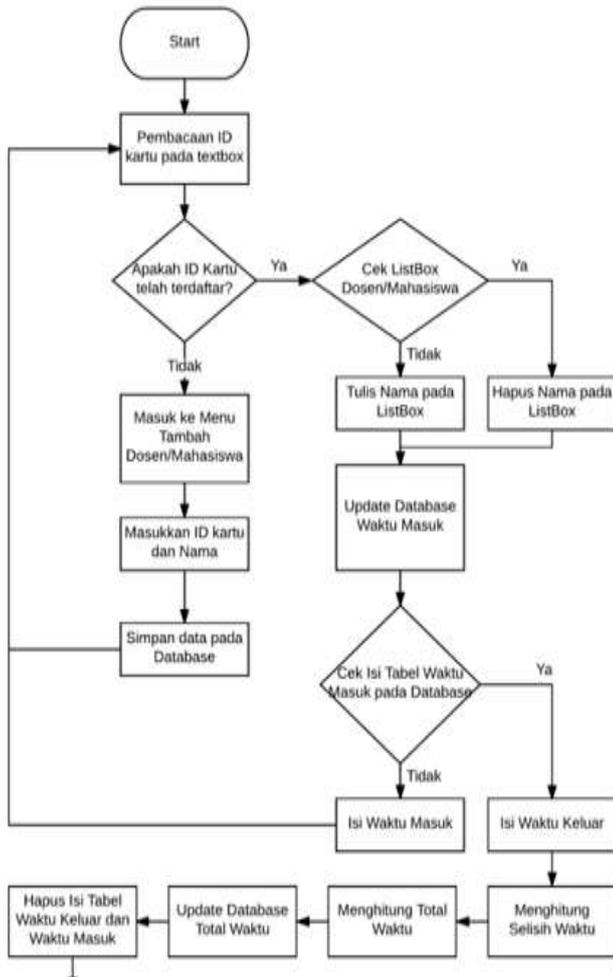
Figure 3.3: Flowchart of the Total Time Table

The explanation of this flow chart is as follows:

1. The system will continue to detect an incoming data through RFID reader obtained from the RFID tag.
2. A unique code or ID from the RFID tag to be read at the main menu TextBox.
3. TextBox then matches this ID with the data that already exist in the database. If the ID card is not registered in the database, then the user must manually enter the Add menu Database / Lecturer and then register ID card and user name. If the ID has been registered, there will be changes to the ListBox.
4. The ListBox displays the name of the card and is divided into two, namely the fields for students and faculty. If the name of the user who scanned yet, the ListBox will display the user name, and if the user name already exists then ListBox will remove the user name.
5. At the same time the program also update the data in the database Time. The tables in a database that will contain a table of time entry, time out, time

difference, and the total time. In the initial settings, all the tables are empty. And when users scan for the first time in time table will be updated with the value of time on the computer when performing a scan. When users perform a second scan, the program will detect that the table has been filled in time and then updated time out according to the time the computer when the user perform a second scan. Difference in time will automatically be calculated when to enter and exit time filled with formula:

$$\text{Time Difference} = \text{Time Out} - \text{Time In}$$

6. Then the total time table will be filled with formula:

$$\text{Total Time} = \text{Time Difference} + \text{Total Time 1}$$

Where the value of the total time 1 is a value equal to the value of the total time table. The total value of time and then updated in accordance with the results of the above calculation. After the total value of the update time, then the program will remove the entire value from the table time in, time out, and the time difference.

In designing the application is divided into six parts or so-called form, where each part has the function of each menu. The first appearances of the form are as follows:

Figure 3.4: Display of Form 1

In the first form, the main menu which in turn consists of a toolbar for navigation menu to another form. In this form there is also a main program that reads the data in the form of RFID tag ID via serial communications sent by the Arduino and then send back data is a 1 or a 0 to the Arduino which serves as a command to mengontol Solenoid Door Lock. In the first form is also a functioning ListBox displays the name of the owner of the card that has been registered in the database.

Form 2 and Form 3 contains a menu to add the ID card and the cardholder name into the database. Once registered in the database, the program can calculate the difference between the

time of entry and exit time of the card in order to obtain the total time spent in the laboratory. Appearance of the form 2 and 3 is as follows:

Figure 3.5: Display of Form 2 and 3

Form 4 and Form 5 contains a menu to view data in the form of ID card and the cardholder's name from the database of lecturers (form 4) and the student database (form 5). This form can be used to confirm whether the user has registered or not registered on the form after form 2 or 3. Display of form 4 and 5 are as follows:
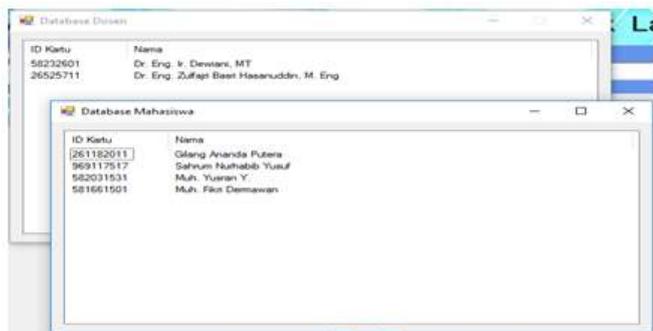
Figure 3.6: Display of Form 4 and 5

Form 6 contains a menu to view data such as the date of first entering the lab; the last time entering the lab, as well as the total time has been spent in the lab within an hour. Appearance of the form 6 is as follows:
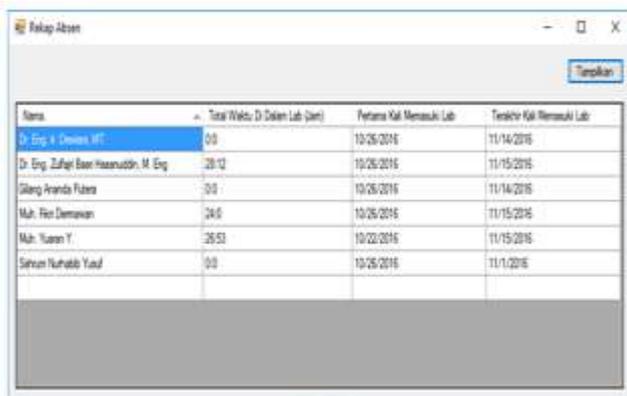

Figure 3.7: Display of Form 6

iii) Database Design

The datas that will be processed in this test all stored in the database in Microsoft Access. This database consists of four tables, namely: Student Database, Database Lecturer, Database Time, Recap Absent. Destination table division into four parts is to facilitate the writing of the code on the GUI. Each table has its own function as follows:

1. Lecturer Database

In this table contains the ID card and the name of each lecturer who has been registered. The contents of this table can be seen on the Database menu and then Database Lecturer, and can also add a new user to the Admin menu and then Add Lecturer.

2. Students Database

In this table contains the ID card and the name of each student who has been enrolled. The contents of this table can be seen in later Database Student Database menu, and can also add a new user to the Admin menu and then Add Students.

3. Time Database

In this table contains the ID card and the name of each student and lecturer who has been registered. The contents of this table in the form of ID card and the name of each user, as well as time data in the form of:

a. Time in, a data table in the form of hour time when the user first do a scan card. Data from the check-in time is obtained using the clock of the computer / laptop user when performing a scan

b. Time out, a data table in the form of hour time when the user to scan the card for the second time. Data from exit time is also obtained using the clock of the computer / laptop user when performing a scan

c. Time difference, the time difference between the time out and time in

d. Total Time, an accumulation of all the excess time in hours

4. Absent Recap

In this table contains the ID card and the name of each of the registered user. The contents of this table can be seen on the menu Recap Absent. In this table there is data in the form of tables First Lab Entering the recording time when the user first scan and entered into the system, as well as the last time table Entering Lab which contains data such as the date of the last time a user to scan.

3.3.2 Hardware Design

The design of the hardware in the preparation of these scriptions is prototype hardware design an attendance system and RFID-based access entrance. Here's a picture of a hardware circuit:
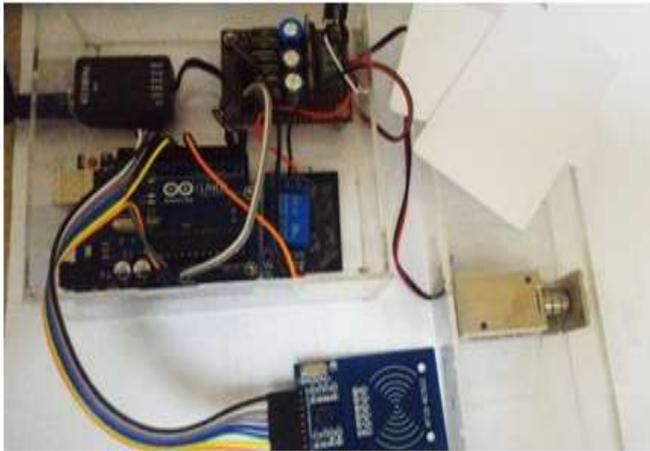

Figure 3.8: Circuit of the Prototype

3.3.3 Prototype Design

The design prototype demo is done to make improvements to this tool in order to resemble real conditions that occur in the field. The design prototype by building on a room door with a tool mounted on the door in order to resemble real conditions, then made room with made of acrylic and has a door that can serve as a real condition.

Figure 3.9: Results of the Prototype design

IV. RESULTS AND ANALYSIS

The data that we collect and analysis in our system is the result of hardware testing and testing the system works as a whole.

4.1 Hardware Testing

4.1.1 Module RFID RC-522 Testing

RFID reader module testing the RC-522 to observe the maximum distance by the card reading module. Tests was conducted in the UNHAS campus AIMP laboratory Tamalanrea. Testing is done by bringing the RFID card with a variety of distances on RFID reader module RC-522 from either the front or back of the module. After a test distance of each RFID card to see the measurement results. Thus obtained the test results are based on the distance range of readings.

4.1.2 Radio Telemetry Kit 433 MHz Testing

Radio Telemetry Kit Testing is to measure the distance of the data transmission that can be done by the telemetry. By theory in the Line of Sight configuration, telemetry can be mutually transmitting data up to a distance of 100m or more. Due to the use of telemetry in this research as a medium of communication between the microcontroller and the GUI are in one room, it was given a limit to the distance to be tested is only up to 50m and with the conditions of non-Line of Sight and the presence of some obstacle in the room.

In the testing of the Radio telemetry kit 433 MHz, the first step is done by placing both parts of telemetry. The first part is connected with Arduino uno and the second is attached to a computer / laptop. After that the indicator lights on each piece of telemetry will be lit continuously, indicating that the two parts have been connected wirelessly.
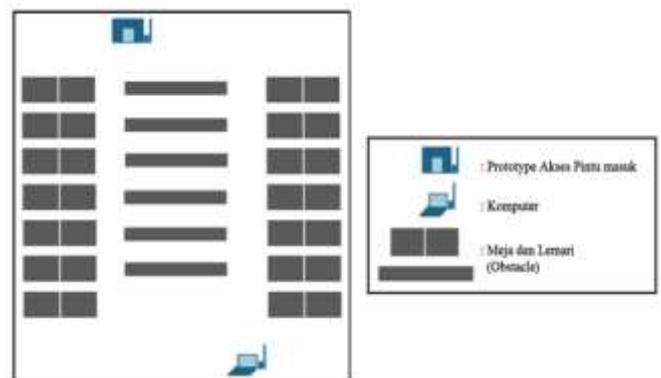

Figure 4.1: Telemetry Kit Testing Scenario

The Telemetry Tests carried out in the Technique UNHAS Gowa campus Library building on 2nd floor with a scenario according to the image above. Measurements were made using the meter to calculate the distance between telemetry in a room with a desk and wardrobe as the obstacle and the second telemetry section was located between the obstacles at a distance of 5 meters to 50 meters.

4.1.3 Solenoid Door Lock Testing

In testing the solenoid door lock, the program data from RFID are sent to a computer will be processed in a computer to transmit data to Arduino to be able to open the door lock solenoid.

The Tests was conducted in the UNHAS campus on the AIMP laboratory Tamalanrea. The test process is to get the RFID card closer to the reader module, the reader will provide data on Arduino and send that data to a computer using telemetry kit for identifying the membership data and subsequently forwarded to the Arduino. Arduino uno which will send a command to open the solenoid. If the data contained on the RFID card matches to the database on the computer, the solenoid door lock will be open for two seconds and provides access to lab members to enter. And so it was at the time to get out of the lab.

Tests on the solenoid door lock is done using 6 RFID card that has been registered in the database, whether the solenoid door lock can function properly in order to provide access to all of the cards listed. Here are the results of performance testing on the door lock solenoid 3 registered RFID cards and 3 unregistered RFID cards, while the results of performance testing table solenoid door lock can be seen in table IV.1 below:

TABLE 4.1
Testing Results of the Solenoid Door Lock Performance

| Tag ID	Card Status	Door Lock Condition	System Status
26525711	Registered	Changed	Correct
58232601	Registered	Changed	Correct
581661501	Registered	Changed	Correct
9651117	Unregistered	Unchanged	Correct
802408117	Unregistered	Unchanged	Correct
963511117	Unregistered	Unchanged	Correct

From the test of the Solenoid door lock above, it is sure that the solenoid can function well unlocking when the card is registered RFID reader hold on either to enter or exit from the lab, and does not unlock the RFID card is not registered. And it proved to all registered RFID card.

4.2 Software Testing

### 4.2.1 Serial Communications Testing

In the prototype system, the communication between the microcontroller and the GUI using serial communication. Communication occurs in both directions, initially started on a unique code reading by RFID Reader RFID cards and processed in the microcontroller and then sent to the GUI to the process. After processing the data in the GUI is complete, the GUI then sends back the data to a microcontroller which implies registered or not the RFID card is scanned.

On the GUI serial data reading begins by selecting a communication port, then connect by pressing the connect button, and after that then the data sent from microcontroller can be accepted, and the GUI can also send data to the microcontroller. Communications port selected in accordance with a USB port that is connected with microcontroller.
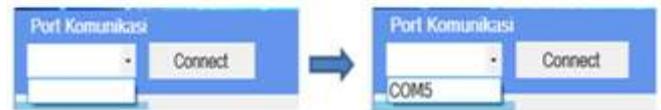
Figure 4.2: Display of Port Communication GUI

After port communication between the microcontroller and the GUI is selected and connected, the next step is to test the data sent from the microcontroller to the GUI, in this case is a unique code reading RFID card.
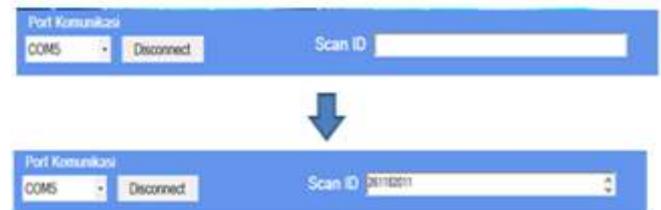
Figure 4.3: Display of a readable ID card

4.2.2 User Addition Testing

The User Addition Testing is to make sure whether the user is registered or not after registering. Tests carried out on two types of users, namely students and faculty on the Admin menu, and then populate the data in the form of ID card and user name on each menu. Once the registration is done the user will then checks the results on the database and on the menu in the GUI checks to compare the results. In this test will be added to a user account students with ID = 123456 and Name = New Students, as shown below.

Figure 4.4: Student Data Addition testing

4.2.3 User Name Status on the ListBox Testing

ListBox on the GUI is used to display the name of the user who scans the card. ListBox is divided into two parts, namely the ListBox to display a lecturer's user, and student user. ListBox is programmed so that when users perform a scan first, then the user name will appear in accordance with the user status of students or faculty. The first scan is likened to that user enters the room, so it can be seen that a user who has the first scan were in the room. Scan both by the same user programmed to delete the user name likened that the user has left the room. In this test the user scans performed students will be tested to twice the scan as follows.

Figure 4.5: First Scan by a Student

Figure 4.6: Second Scan by a Student

From the test results it can be concluded that the system is running well, the first scan is added to the ListBox user name and scan both remove the name. Both ListBox also function according to design, for both faculty and students ListBox.

4.2.4 Total Time Calculation Test

Testing calculation of total time aiming to ensure that the time difference between the first scan (time in) and the second scan (time out) the same user are well documented and recorded in the database. The test results are displayed in the form format (hours: minutes). The test is performed as follows:

Figure 4.7: Beginning of Recap Absent Menu

Figure 4.8: First Scan in the First Test

Figure 4.9: Second Scan in the First Test

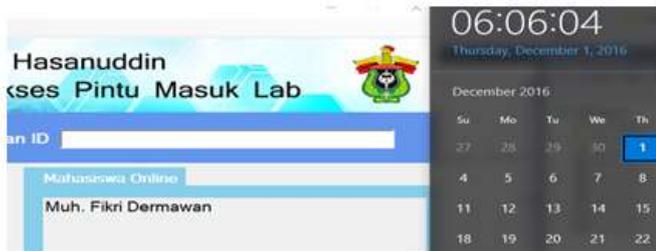**Figure 4.10: Display of the Recap Absent Menu after the First Test**
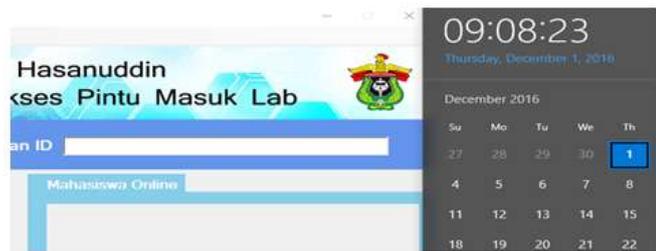
Figure 4.11: First Scan in the Second Test

Figure 4.12: Second Scan in the Second Test

Figure 4.13: Display Recap Absent End

Based on the evaluation showed that the total time is 4 hours and 4 minutes, the system goes well and according to the plan. Total time worked by storing data as temporary data lapse of time and adds them to the difference the next time, and so on.

V. CONCLUSION

Here is a conclusion that can be drawn on this study:

1. The RFID RC522 module can read passive tags at a distance of 3cm both from the front and rear modules.
2. Telemetry 433 MHz can be used as an alternative to cable for communication between the microcontroller and the GUI, with a range of up to 1km on the configuration of the Line of Sight and more than 30m on the configuration of the room with a lot of obstacles.

3. The system is able to make changes to the conditions Solenoid Door Lock in accordance with the status of the card is registered or not.
4. The system is able to perform total recording time and date the last scan the cards of the registered users.

VI. SUGGESTIONS

1. It is expected that over time these systems can be equipped with additional modules such as a fingerprint scanner to further improve the security of the system access entrances.
2. In actual application should use the door lock solenoid 24 V to further enhance the security and the size is more proportionate to the actual door.

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