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IDENTIFICATION OF BOOK LABELING DESIGN IN LIBRARY USING RADIO FREQUENCY IDENTIFICATION (RFID) SYSTEM

Agung Rachmatullah[1*] , Arif Faizin[2]
[1*,2]Teknik Informatika, Universitas Yudharta Pasuruan, Indonesia

Abstract

The library, as an essential institution in education and knowledge, continually seeks innovation to enhance operational efficiency and visitor services. One technology that has garnered attention is Radio Frequency Identification (RFID). This research aims to identify the optimal design for book labeling in libraries by leveraging RFID systems. This technology offers a potential automation solution for processes like borrowing, returning, and inventory management of books. The implementation of RFID in libraries can yield significant benefits. Key advantages include increased efficiency in serving borrowers, reduced human errors in data recording, and the ability to gather accurate data for book collection analysis and borrowing trends. However, the implementation of RFID also involves several challenges, including initial implementation costs, integration with existing infrastructure, as well as privacy and data security aspects. Additionally, the reading range of the RFID RC522 sensor is limited to 10 cm, which can be reduced to 1 cm to 6 cm if obstructed by objects, and if obstructed by solid objects like metal, it might not be read even at a 1 cm distance due to thickness. A solution that can be employed is using a plastic cover for the sensor with a thickness that is not excessively high.

Keywords
RFID (Radio Frequency Identification), RFID tag, RFID reader, Arduino, book label

Information Correspondance
Agung Rachmatullah et.al
Teknik Informatika, Universitas Yudharta Pasuruan, Indonesia
levi252596@gmail.com

INTRODUCTION

The library is an institution that has an important position in providing access to knowledge and data. In an effort to maximize the management of book collections and facilitate the process of borrowing and tracing books, an effective identification system is urgently needed. One technology that has replaced the Library's method of managing books is Radio Frequency Identification (RFID).

RFID is a technology that allows automatic identification and tracking of books and other items via radio waves. By using the RFID system, each book will be equipped with a unique RFID tag, and the library will be equipped with an RFID reader that can recognize and record every book that enters or leaves the library quickly and accurately.

Labeling of books in some libraries still uses manual writing, written on sheets of paper and attached to the outside, and some book labels use barcodes. In order

to produce a more sophisticated and effective solution, Radio Frequency Identification (RFID) technology has emerged as an innovation promising. RFID enables book labeling by using radio signals to identify and track books accurately and automatically. An RFID system consists of RFID tags that are placed on each book, an RFID reader that reads these tags, and software to manage the information obtained.

One of the interesting implementations of RFID technology is in book labeling design. In this context, RFID can be used to identify and track books in a library or publishing system quickly and accurately. This not only makes it easier to find books, but also improves the efficiency of inventory management and borrowing and returning books.

In this context, this study aims to identify book labeling designs using the RFID system. We will discuss how RFID technology can be applied in libraries to increase operational efficiency, improve security, and provide a better user experience. In addition, we will also discuss the challenges and opportunities associated with implementing this technology in the context of modern libraries.

Thus, this research is expected to provide valuable insights about the use of RFID in book management, as well as contribute to the development of more sophisticated and efficient systems in book management in various environments, both libraries and the publishing industry.[1]

METHOD

The research method contains a description that explains in detail how and what kind of research will be carried out. This explanation can also be used to assess whether the results of a study are valid and reliable, and whether the conclusions of this study can be used for practical or theoretical purposes as a literature review for subsequent research.[2], [3]Following are the stages of the research:

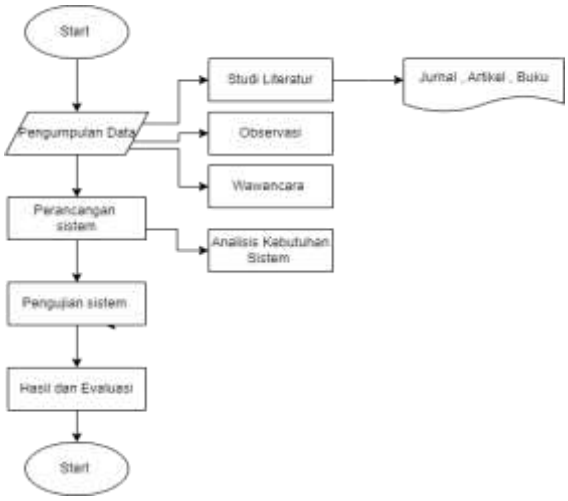

Figure 1. Research Stages

Data collection

The data collection stage is the initial stage before conducting data processing. This stage is carried out by interviews and direct observation at school to obtain clearer information regarding the object under study. as for literature studies to study and collect data and theories with the topic of the problem.[4]–[6]

1. System Design
   After the data collection stage is carried out, the next stage is system design, which includes (system requirements analysis, hardware design, software)
2. System Testing
   System testing includes testing the sensor as a whole by checking and measuring system accuracy and to find out if the system is running well and as expected.
3. Results and evaluation
   After carrying out all the stages, the results of testing the entire system if it is running well then data collection is carried out. Evaluation is carried out if the system is not working or is not good enough, then it is carried out again on the Hardware and Software design.[7]–[9]

Use Cases Diagram

Use Cases diagram is a description of the relationship between the system and the user, the following Use case diagrams are made:

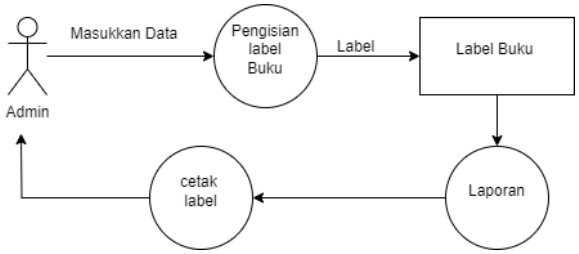

Figure 2. Use Cases Diagram

Figure 2 above explains that the Admin will input the book data that will be labeled which then generates a report containing labeling data which is followed by printing labels and is ready for use.[10]

Relationship Table

The figure below is a relation table that shows the relationship between tables and databases. The relation table aims to set patterns in the database when data changes occur:

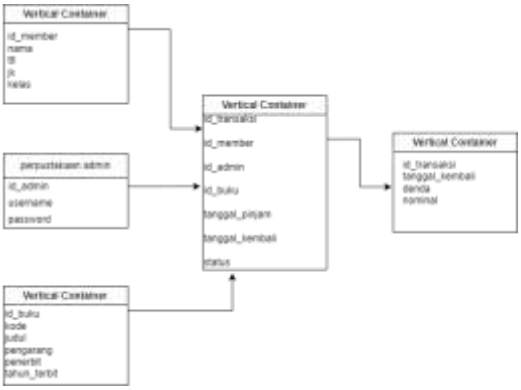

Figure 1. Relationship table

SYSTEM PLANNING

Login Menu Page

The login page will display a login form and navigation buttons to display the start page and the guest book page[11]. The design of the login page is shown in Figure below

Figure 2. Login Menu Page

Admin page

The Admin page displays a sidebar to access the library management menu, including book data management, member data, officer data, visitor data, transaction pages for borrowing and returning books.[12]

Figure 3. Admin view

System Flowcharts

System flowchart that shows a process flow of a system that is being worked on. The flowchart explains the sequence and procedures that are in the system. The

following is the flow of the system from the application of RFID technology to the library book lending system

The flowchart explains the sequence and procedures that exist in the system. The following is the flow of the system from the application of RFID technology to the library book lending system.[13]

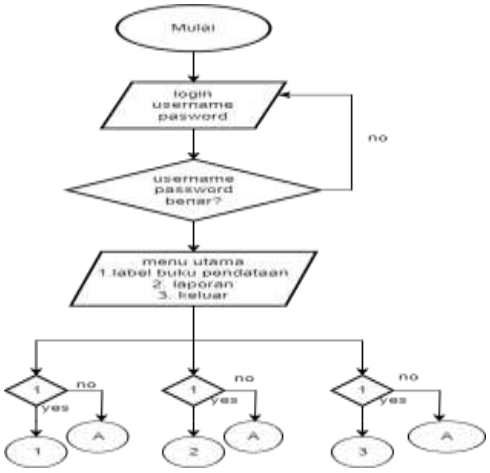

Figure 6. System Flowchart

System application design

Figure 4. Book labeling system application design

As for the system application that is made for Figures when making book labeling by listing the books that want to be labeled.

RESULTS AND DISCUSSION

This chapter describes the results of system design and the results of testing the book lending system using an RFID sensor. The system design process starts from assembling all the components needed, the components needed include the Arduino UNO, the RC522 RFID sensor as an RFID tag reader. The final stage is testing the system by testing the sensors and the entire tool.[14]

Hardware Design Results

OnThis stage shows the results of the design consisting of hardware components to become a system so that it can run properly.

RC522 RFID sensor circuit

At this stage of the circuit the RC522 RFID sensor is connected to Arduino UNO. In order for the RFID sensor to function properly, attention must be paid to the installation of jumper cables and pins so that they can be read and have no errors.

Figure 8. RC522 RFID Circuit

Input Arduino IDE source code

So that the system can be used and can give commands to the RFID sensor, a source code or coding process is needed which is entered in the Arduino IDE application before being configured to RFID. the following is the code made.

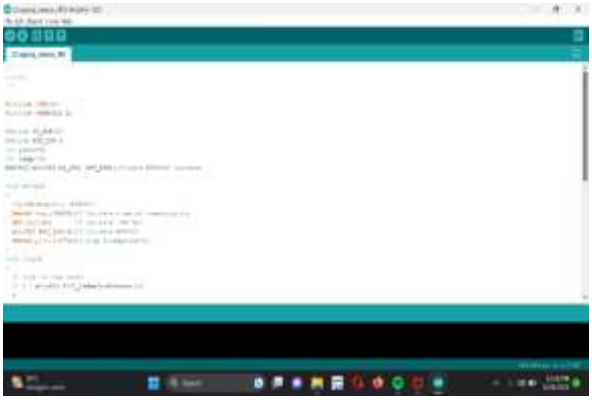

Figure 9. Arduino IDE coding scripts

System Testing Stage

At this stage it is done to find out whether the system that has been designed can run well,[13]the following tests were carried out:

1. RFID Sensor Testing
   Sensor testing is done by testing it by attaching an RFID tag to detect that the sensor is functioning properly.
2. Software Testing
   This test is carried out by connecting to the microcontroller whether it is already connected and the sensor is able to read the attached RFID tag.
3. Overall testing
   This test Software and hardware must all be connected to know that the systematic is running well.[15]

System test table

Table 1. System test table

No	Test name	Expected results	Test result
1	Login form	Can only log in with the registered username and password.	YES
2	Data Management	Can add, change, and delete data on the book menu, officers, members, and visitors.	YES

Table Sensor testing of various types of obstructions along with their distance and thickness

Table 2. Sensor testing of various types of obstructions along with their distance and thickness

No	Barrier Type	Test	thick diameter	Distance (cm)	System
1	Glass	1	7mm	0-5	read
		2			
		3		6	read
		4			Can not be read
		5		7-10	
2	Plastic	1	2.5mm	0-6	read
		2			
		3			
		4			Can not be read
		5	10mm	7-10	
3	Paper	1	2.5mm	0-6	read
		2			
		3			
		4	15mm	0-6	Can not be read
		5	15mm	7-10	Can not be read
4	Aluminum	1	5mm	0-10	Can not be read
		2			
		3			
		4			
		5			
5	Wood	1			

		2			Can not be read
		3	10 – 20 mm	0 – 10	
		4			
		5			
6	Cardboard	1	7mm	0-3	read
		2			
		3	10mm	0-3	read
		4		0-1	read
		5	15mm	2-10	Can not be read
7	Cloth	1	1mm	0-6	read
		2	5mm	0-6	read
		3	10mm	0-4	read
		4		0-10	Can not be read
		5	15 -30mm		

From data above Testing the Sensor against various types of obstacles along with their distance and thickness I draw the conclusion that this RFID sensor is influenced by several aspects (Distance, Thickness, solid objects, and Iron) each aspect has a different level of success.

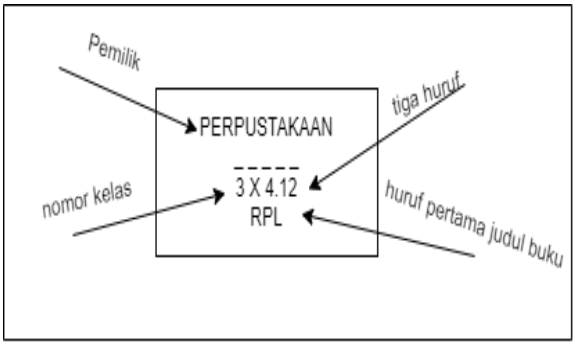

Figure 5. Book labels

Figure 10 is the result obtained from book labeling after data is collected on the book labeling application.

CONCLUSIONS

After designing, testing and analyzing the data, several conclusions can be drawn, namely a) The application of RFID technology in the book labeling system by utilizing the RC522 RFID sensor with other components, namely Arduino UNO, can run as expected. b) Utilizing the Visual Basic Application as a platform for the process of borrowing books automatically and more effectively. c) Using a simple library application service for making book labels. d) The results obtained from the

overall design and testing are that this system has several weaknesses, starting from the distance of the sensor and tag, the type of sensor barrier to the tag, the level of thickness of the barrier and some solid or solid objects.

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