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Library Logging System Design Based on Radio Frequency Identification Interface using Arduino Uno Board as Platform

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ABSTRACT

Radio Frequency Identification (RFID) technology revolutionizes the automatic identification of objects. In this paper, library logging system based on radio frequency identification (RFID) interface using Arduino Uno board as platform is proposed and prototyped**.** Technology in Arduino and RFID are reviewed. RFID MFRC522, is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. RFID technology uses electromagnetic fields to transfer data to automatically identify objects. Information of books with RFID tags are registered in the database system. When books are scanned in the RFID reader, the system will automatically give the information of the book and the current date and time. User will input the borrowers' information which will automatically login into the system with the book details. Arduino microcontroller is used as a micro web server and a communications gateway among hardware modules. Design shows that RFID interfacing using Arduino Uno board as platform can make library logging system more efficient and convenient through the automation of workflow processes. To reduce library losses, security and item identification should be combined in a single tag in future designs.

Keywords **—** Engineering processes and systems, Radio Frequency Identification (RFID), Arduino Uno, experimental method, Philippines

INTRODUCTION

Radio frequency identification (RFID) technology is used all over the world. In China, RFID is expected to reach $952 million in 2025 according to IDTechEx. The total RFID market in 2014 was US$1.7 billion covering chips, tags, readers, software/services and system integration. RFID tags take 25% of the total market reaching $430 million in 2014 (PR Newswire, November 22, 2017).

Technavio's analyst forecasts a compound annual growth rate (CAGR) of 38.26% for global retail RFID security tags market during the period 2017-2021. RFID tags are primarily used for monitoring and tracking objects through an RFID reader. In retail operations, RFID tags reduce delivery cycle time, provide transparency, streamline supply chain operations, and help retailers capture data (Report Buyer, 2017). The projected size of the global market for RFID tags from 2016 to 2020 (in billion U.S. dollars) is around 24.5 billion U.S. dollars in 2020 (Statista, 2015).

RFID is used for tracking, access control, supply chain management, smart labels, and more. This technology is composed of a reader and a tag. With read and write capabilities, data in the RFID tags can be changed, updated, and locked. RFID tag is composed of a microchip, antenna, and a battery which can store up to 2 KB of data. Tag is a small device which stores and sends data to RFID reader. RFID system is categorized as active and passive. Active RFID system uses battery-powered RFID tags which provide extremely long read ranges and large memory banks. Battery of tags is replaceable which could last three to five years. Active tags continuously broadcast their own signal to accurately track the real-time location of the object or person. These tags can be used in high-speed environments and much more expensive compared to passive RFID tags. Active RFID system consists of a reader, antenna and a tag.

Passive tags are powered by electromagnetic energy. These tags are used for file tracking, access control, smart labels and other related applications. Passive RFID system consists of a reader, an antenna, and tags. Passive tags have no batteries and depend on RFID reader for operating power. RFID tag has low range and is powered by the energy sent by the RFID reader in the form of radio frequency wave. The RFID tag antenna generates back the electromagnetic

waves to the reader which interprets the information in the form of backscatter. Passive tags cost less which is economically used in many industries. In the future, passive RFID tags can be found in every manufactured object and also in natural resources, animals and people (Borriello, 2005).

Privacy and security technical issues with FRID technology is examined in the study of David Monar and David Wagner, entitled *Privacy and security in library RFID: issues, practices, and architectures*. According to the study, privacy risk of the technology is negligible. Private authentication and security scheme are suggested. This scheme is to build a private authentication with work logarithmic in the number of tags (Molnar & Wagner, 2004).

RFID technology is expected to proliferate in the coming years with the dropping of its cost. This study examines how the scientist deals with privacy protection and integrity issues in the RFID technology resulting to its rapid growth of application (Juels, 2006).

Cheng, Huang, Xu, Hu, and Wang (2016) designed a corresponding handheld device client software for visual book search and management system. This system not only improves the efficiency of book search and management but also save the manpower and material resources.

Younker and Ribaric (2013) presented on how Arduino as platform is used in designing a production portable barcode-scanning utility for in-house use statistics collection at the James A. Gibson Library at Brock University.

In this study, a design in library logging system based on RFID using Arduino Uno board as platform makes library logging system fast and efficient. A visual studio is used in developing a software application program for human-computer interaction. The program is connected to MySQL which serves as the database for the record logs and books. This design will optimize the collection of fines and payments due from students. Library stock-taking of books can be more efficient and fast.

OBJECTIVE OF THE STUDY

The purpose of this study is to design a library logging system based on Radio Frequency Identification (RFID) interface using Arduino Uno board as platform.

MATERIALS AND METHODS

Library Logging System

Library logging system is equipped with RFID MFRC522, which uses electromagnetic fields in transferring data over short distances. Database of the system contains the information of the books with RFID tags. System will give the relevant information of the books when scanned in the RFID reader. Information added by the user will be automatically logged in into the system.

System Architecture

In this study, designing of library logging system based on radio frequency identification (RFID) interface using Arduino Uno board as platform is presented. Arduino microcontroller is the gateway to all hardware and software communication in the system.

The hardware required materials in this design are Arduino Uno, RFID MFRC522, NFCC sticker tags and connecting wires. Arduino as an open-source platform, consist of a microcontroller and a software that is used to write and upload computer code to the physical board.

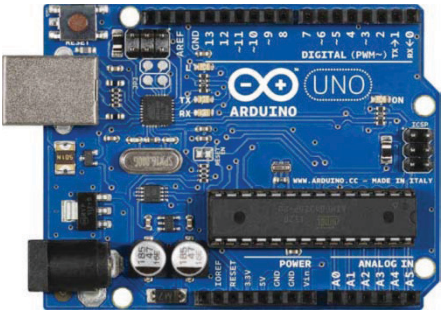


Figure 1. Arduino microcontroller

As shown in figure 1, Arduino Uno is a microcontroller board based on the ATmega328. To get started, this microcontroller can be supplied with a battery, an AC-to-DC adapter and a computer. With reset button, this board has 14 digital input/output pins, 6 analog inputs, 16 MHz ceramic resonator, a USB connection, a power jack and an ICSP header.

Figure 2. RFID MFRC522

RFID tag is made of silicon microchip attached to a small antenna. A reader consists of a scanner with antennas to transmit and receive signals and is responsible for communication with the tag and receives the information from the tag.

There are two types of RFID system. Active RFID system, tag has its own power source like any external power supply unit or a battery. The only constraint is the life span of the power devices. These systems can be used for larger distances and to track high-value goods like vehicles. Passive RFID system, where the tag gets power through the transfer of power from a reader antenna to the tag antenna. They are used for short-range transmission.

Figure 2 shows RFID MFRC522, a highly integrated reader/writer IC for contactless communication at 13.56 MHz. RFID reader as an interface is used to read RFID tags to communicate with Arduino microcontroller. RFID tags contain unique data stored in a chip. Both RFID tags and reader contains coil surrounding them. The chip inside the tag can be powered through electromagnetic induction as shown in Figure 3. When an RFID tag is shown near the reader, electromagnetic induction takes place between the coils which activates the chip inside the tag. This chip sends data electromagnetically to the reader. RFID reader comes with serial output pins which read data using Arduino microcontroller.

MFRC522 RFID reader supports ISO/IEC 14443 A/MIFARE and NTAG. Without additional active circuitry, MFRC522 transmitter is designed

to communicate with ISO/IEC 14443 A/MIFARE cards and transponders. MFRC522 supports MF1xxS20, MF1xxS70 and MF1xxS50 products.

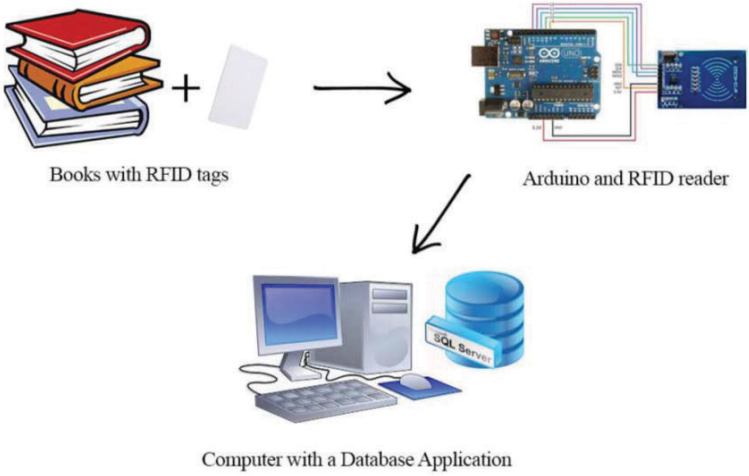


Figure 3. Schematic diagram

As shown in figure 3, the information of the books with the RFID tags will be registered in the database system. When the books are scanned in the RFID reader the system will automatically give the information of the book and the current date and time. The user will now only input the name of the borrower of the book. The information of the borrower and the book being borrowed will be automatically logged in into the system.

The following are the steps in making this design:

Step 1. Setting up the hardware connections.

For setting up this system, wiring connections have to be made between RFID Module and Arduino as shown in figure 4.

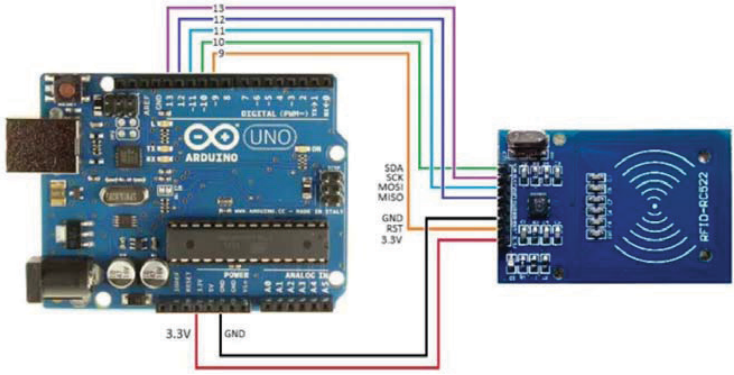
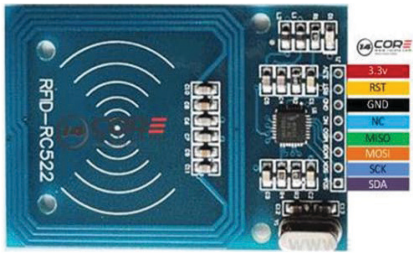


Figure 4. RFID Module wiring connection

MFRC522 module uses SPI (Serial Peripheral Interface) in communicating with Arduino through digital pins 10 , 11, 12 and 13 as shown in figure 5. While the 3.3V pin and ground are connected to the corresponding supply and ground connections. Figure 6 shows RC522 RFID reader testing.

RFID RC522



RFID RC522 MODULE	ARDUINO
3.3v	3.3v
RST	D9
GND	GND
PQ	Not Connected
MISO	D12
MOSI	D11
SCK	D13
SDA	D10

Figure 5. Arduino Pin Out

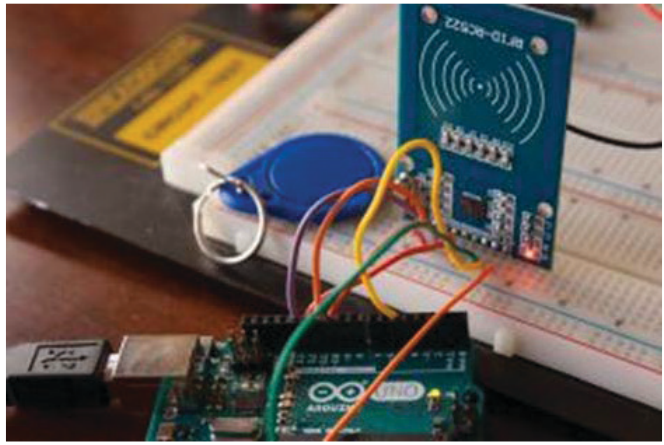


Figure 6. RC522 RFID reader testing

STEP 2. Graphical User interface Development

A graphical user interface (GUI) using visual studio as shown in figure 7 is designed in developing a software application program for human-computer interaction. The program is connected to MySQL which serves as the database of the record logs and books.

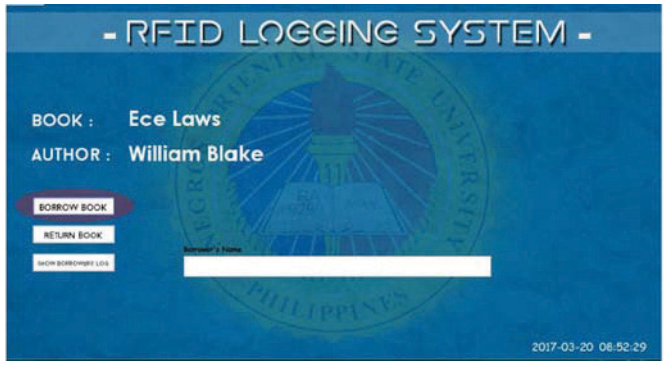


Figure 7. Graphical User Interface

STEP 3. Loading the Arduino Software

Aduino Integrated Development Environment can be downloaded from Arduino. The open source Arduino Software (IDE) makes it easy to write code and compile it to the board. It runs on Windows, MAC OS and Linux. The environment is written in java based on processing and other open source software. The software can be used with any Arduino development board.

The RFID module should be removed from the Arduino board and connected once the upload is complete.

RESULTS AND DISCUSSION

Library management requires laborious activities. To increase efficiency, libraries are deploying RFID to enable automation. In the study of Dwivedi, Kapoorb, and Williams (2013), it was found out that user satisfaction influence person's attitude towards RFID based technology. Using the technology has a positive influence on user satisfaction.

For unique identification of people and assets, RFID technology is used. The study of Singh and Midha (2008) explains the various uses of RFID in libraries. In this paper, a design of library logging system based on radio frequency identification interface using Arduino Uno board as platform is built. The working unit of the proposed system has been successfully developed as shown in Figure 8.

For contactless communication at 13.56 MHz, RFID MFRC522, is used in the designed. RFID technology uses electromagnetic fields to transfer data to automatically identify objects. Information of books with RFID tags are registered in the database system. When books are scanned in the RFID reader, the system will automatically give the information of the book and the current date and time. User will input the borrowers' information which will automatically login into the system with the book details. Arduino microcontroller is used as a micro web server and a communications gateway among hardware modules. Design shows that RFID interfacing using Arduino Uno board as platform can make library logging system more efficient and convenient through the automation of workflow processes.

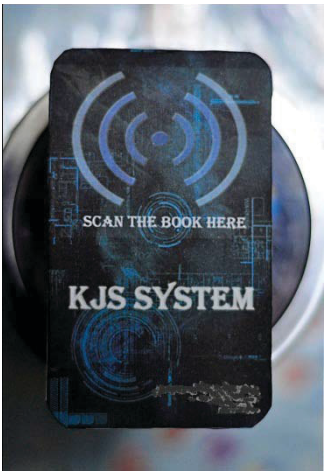


Figure 8 . RFID reader

CONCLUSION

A design of logging system using RFID MFRC552, MYSQL, visual studio and Arduino Uno is successfully developed. A working designed for the system can make library logging system more efficient and convenient. RFID module and Arduino Uno, proved to be very efficient in designing a library logging system with Arduino as platform. It is concluded that the design of library logging system using RFID module, MYSQL, visual studio and Arduino will restructure the library management system. This system enables librarian to manage library resources in a more effective way to save time and effort. This system increase collections management efficiency.

RECOMMENDATION

In this study, library logging system is designed for contactless communication for efficiency and convenience. To reduce library losses, security and item identification should be combined in a single tag in future designs. Tracking library books for longer distance range and ease of laborious stock takes, active RFID tags maybe implemented in future studies.

TRANSLATIONAL RESEARCH

The system design can be introduced at the university library to make logging system more efficient and convenient through the automation of workflow processes. Collection of fines and payments due from library patrons can be more systematic with this record-keeping. Library stock-taking of books can be efficient. The design concept can also be evaluated by stakeholders alike for acceptability and impact.

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