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Design and Implementation of Book Tracking System in Library

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***Abstract*-**Library is a vast place which contains increasing number of books. With the growing phase of technology, library needs to be ready for change and should bring the technology in it to retain their student's interest in visiting the library. People often find it difficult to search a particular book and library staff handles a tedious task in sorting. To overcome these obstacles, a smart book tracking system based on Radio Frequency Identification Device (RFID) technology has been proposed. Book tracking system aims in developing an application for the user to track the location of the book in the library. RFID module has been used to locate the book and Arduino controller to control the system. The proposed system uses three modules, the corresponding information is read using RFID reader, the information read is stored in the cloud and finally the cloud information is accessed using android based mobile application.

Keywords*-RFID technology; Book tracking system; Arduino controller; Cloud; Android.*

I. INTRODUCTION

Library is a collection of data/information represented in the form of books, journals, reference materials and services in which it is housed. Library houses not only books but also repositories and it serves as access points for regional maps, geographical prints, or other documents on various storage forms such as microform (microfilm/microfiche), audio tapes, compact disks, cassettes, video tapes, and digital versatile discs. In present technology, most libraries use bar-code method of scanning library items. Bar-code scanning makes the library management easier to some extent. The true automation cannot be obtained with bar-codes, because the labels need to be scanned manually and the barcode scanning requires special in-hand device called barcode scanner.

The process of scanner involves emitting light and collecting reflected light back to decode the barcode. To overcome this disadvantage of barcode scanner, RFID technology has been introduced that gives improved method of ID processing. Barcode scanner is less secure compared to RFID as it can be forged easily. RFID is an electromagnetic identification technique that recognizes data in a microchip which is embedded in a tag through remote antennas. By using this technique, the transaction of books and journals are said to be fast.

The RFID technology has improved the facility of issuing and returning of books. In RFID technique, the data exchange between the RFID reader and the tag takes place by electromagnetic coupling. RFID system consists of two components, a RFID tag which is located within the object to be identified and a RFID reader or writer to read/store the information.

II. LITERATURE SURVEY

A. Review of Literature

Terence Jerome Daim and RazakMohd Ali Lee (2010) have proposed [2] a method of measuring and determining RFID-tagged book location. 3D RFID-based library search system has been discussed and an application has been developed in this method. Here localization process plays a major part in detecting and determining the location of the transponder tagged test sample within the configured laboratory scale system structure. This method is more secure when compared to other methods. It consumes less time to find the location of the book. In worst case conditions locating the books requires more time. In a typical library, the task of locating a book is first to head to the library's search form systems or mobile applications and search the location details of the particular book.

Dong-yang Li et al. (2016) has applied[4] an RFID to the library and uses android-based UHF (Ultrahigh Frequency) mobile reader to build an Internet of Things for library materials management as its entry to enhance library management system performance. User recognition, scanning, self-help borrowing and returning library materials are part of the Internet of Things system for library management. In order to incorporate functions in the future, it should be highly maintainable and extensible. This strategy is simpler and takes less time. It is hard to locate the location of the book in the library once the RFID tag is lost. In order to collect information from RFID tags, an RFID reader is used. An RFID tag is a cornerstone of the RFID system since it stores the specific key information that is connected to the system from the traced objects. The passive tag stores only specific serial numbers as keys to mark various books, DVDs, etc. in the Library Management system.

Haiming Cheng et al. (2016) proposed an RFID scheme based on RFID and wireless networking technology for Wi-Fi[3]. In order to conduct a visual book search and management framework, they have built suitable handheld computer client software. This system not only greatly improves the efficiency of the book search and management but also saves manpower and material resources to a large extent. By using this RFID technology, one can determine the exact location of the book in the library. This method

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reduces the time and also saves energy. By using this method, finding the book is becoming easier in the library. But this technology needs internet connection.

Ganesh K.Yenurkar et al. (2017) have proposed [5] a library management system that is functioning with RFID technology that would allow faster transaction and will make it easier to handle the act of issuing and returning of books from the library. It avoids the culture of manual book keeping to a maximum part. This method adds properties of traceability and security. Their proposed system uses RFID readers and passive RFID tags. The electronic information stored can be read with the help of RFID reader. This method speeds up the transaction flow, i.e., location and traceability become faster, which is one of the major advantages in this method.

Jitendra Pandey, Syed Imran Ali Kazmi,[7] proposed the difficulty of monitoring library transaction details due to a slow system of daily updating of the records. They developed an application called Smart Library Management System using the principles of Radio Frequency Identification to suggest a smart solution for libraries in Oman (RFID). Since the monitoring of the books and checking the status of whether the books are released or are in the library is unreliable, it contributes to decreased system performance. Physical book tracking is often a problem in the current system at the library as students often select the books from shelves and do not position them properly in the right place.

B. Inference from literature survey

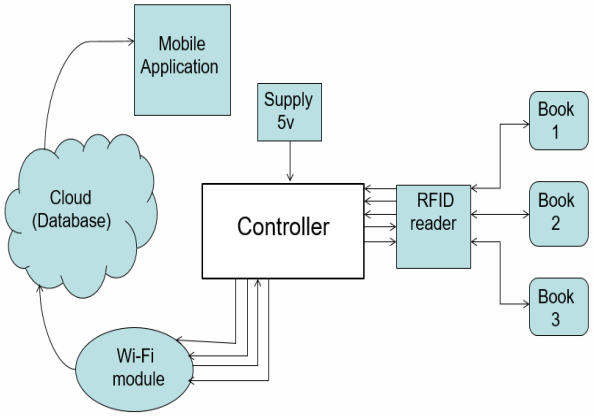
Literature survey of the various papers focuses on the library by providing the book status like issued or available, but the exact location of the book was not focused. This process also involves lot of manual work. Hence in a library management system, the book details should be accessed through mobile application. IOT technology is adopted for displaying the book details like name of the book, book ID, author name. RFID tags are employed for detecting the exact location of the book for easy access.

III. BOOK TRACKING SYSTEM

A. Block diagram of book tracking system

Fig.1. Block diagram of book tracking system

The Fig.1 shows the block diagram of the book tracking system. Every book contains a RFID passive tag which is unique. The RFID readers are placed on either side of the rack for detecting the exact location of the books. It continuously scans the presence of book by making use of RFID passive tag in it. The feedback signal from RFID reader is taken to the controller. A 5V power supply is used to provide supply to the controller to initiate the process of the system. The power supply voltage of 230V is stepped down to 5V by a step-down transformer. Before feeding the transformer voltage to the controller, AC voltage has to be converted into DC voltage using a Bridge rectifier and finally the signal is smoothened by filters and regulators. Now the controller gets an input of 5V and begins to work. All other devices for the proposed system are connected to the controller.



The controller plays a major role in this proposed system. It gets the Unique Id of each book through RFID module and store it in a list (array) form for each rack. This data is uploaded to the cloud using a Wi-Fi module at regular intervals of time (once in 14 seconds). The cloud database forms the information centre which consists of all the details of book in the library. These details were made used by a mobile application through which readers can search the presence and location of book. Using the details in the database, the location of book can be detected

B. Flow chart of book tracking system

The flowchart shown in Fig.2 describes the searching algorithm of book in the library. Initially RFID module in each rack senses the presence of book using the passive RFID tag attached with it. If the presence of book is detected, the RFID tag in each book sends the information stored in it to the RFID transponder and in turn sends to the Arduino micro-controller. This information from the controller is fed to the cloud using Node MCU module every 14 seconds. Thus, the database is updated every 14 seconds. From the contents of the database, the presence of a particular book can be found. This database content is accessed by the mobile application which gives us the desired results.

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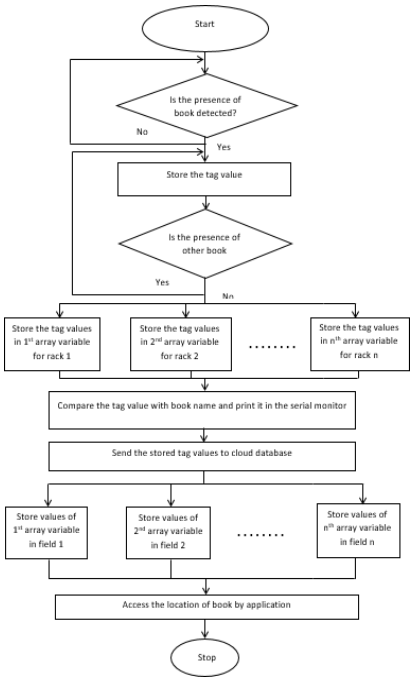

Fig. 2. Flow chart of book tracking system

IV. HARDWARES AND SOFTWARES USED

A. Arduino controller

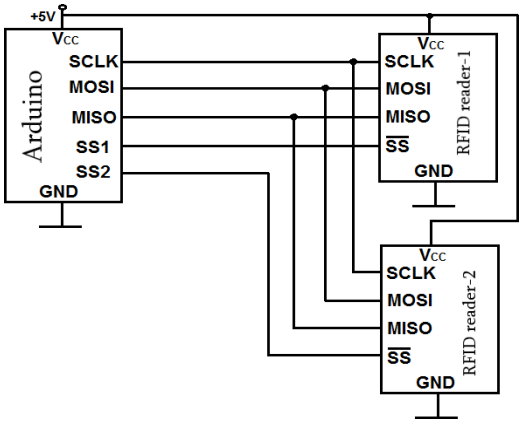

Fig. 3. Interfacing of ArduinoUno with RFID reader

The Arduino UNO microcontroller is found to be an open-source microcontroller board that is mounted with Microchip ATmega328P microcontroller. The board comes with both analog and digital pins that support analog and digital signals respectively through input/output (I/O) pins. The I/O pins are used to interface various expansion boards (shields), sensors and other circuits. The board has fourteen Digital pins and six Analog pins. Arduino IDE (Integrated Development Environment) is used to program the chip by using a type B USB cable. It has 8-bit RISC processor with modified Harvard architecture. The microcontroller makes use of ISP flash memory for read-while-write capabilities thereby enabling simultaneous communication between controller and external device. The capacity of ISP flash memory is 32KB. The microcontroller has 23 general purpose I/O lines, three flexible timer/counters with compare modes, internal and external interrupts. The memory block of the controller constitutes of 32 general purpose working registers, 1024B EEPROM and 2KB SRAM. There are lots of options for interfacing external devices with controller like SPI serial port, USART interface, a byte-oriented 2-wire serial interface and also a 6-channel 10- bit A/D converter. The interfacing diagram of ArduinoUno controller with RFID reader is shown in Fig.3.

The proposed system uses Serial Peripheral Interface (SPI) protocol. It is a synchronous serial communication interface used for small range communication. The devices that are connected in SPI will communicate in full duplex mode using a master-slave architecture. The master (controller) is single and has one or more slave (RFID module) devices.

SPI (Serial Peripheral Interface): The SPI communication is held through pin 10 (SS), pin 11 (MOSI), pin 12 (MISO) and pin 13 (SCK) using the SPI library. These pins are used to connect the RFID module through which it communicates with the Arduino controller. SDA/SS is a data line, which is on the pin headers close to the AREF pin. MISO (Master In Slave Out) line transmits data from slave to master. Whereas, MOSI (Master Out Slave In) line transmits data from master to slave. SCK (Serial Clock) is a clock pulse which synchronizes data transmission generated by the master. When slave select pin of the external device is low, it communicates with the master. When it is high, it ignores the master. This allows us to have multiple SPI devices sharing the same MISO, MOSI and CLK lines.

B. RFID reader(MFRC-522)

RFID stands for Radio Frequency Identification that makes use of electromagnetic waves in the RF region of the electromagnetic spectrum to uniquely identify an object.

The proposed system uses Mifare RC522 RFID reader that operates on a radio frequency of 13.56 MHz with an advanced modulation system. It is designed by NXP Semiconductors at low cost, compact size read and write chip. It also has an advantage of low power consumption. The RFID module uses only 3.3V power supply. It can be interfaced with any CPU board or microcontroller through SPI protocol that ensures

reliable communication for RFID module. Since, the RFID reader (RC522) has features as stated above, the usage of this particular RC522 has been chosen. The interfacing diagram of RFID reader[15] is shown in the Fig.4

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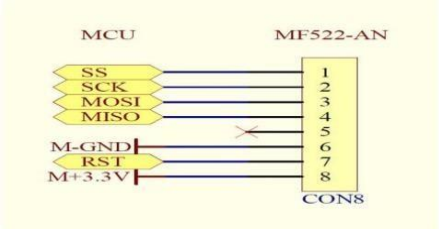

Fig. 4. Interfacing diagram of MFRC522 with controller

C. WiFi-Module(NodeMCU)

The NodeMCU[13] is a micro controller that comes along with in-built WiFi network and is also capable of running self- contained applications. With similar to usual microcontrollers, it also has a built-in USB connector for flashing the chip with code. The data transmission between NodeMCU and other CPU happens with a baud rate of 115200 (faster rate of data transmission). ESP-12E (Wi-Fi module) is used in NodeMCU. Its feature has an ability to embed Wi-Fi capabilities to systems or to function as a standalone application. It is a low- cost solution for developing IoT applications. The NodeMCU will transfer the data from Arduino controller to the cloud database. This wireless communication happens so that the data from each RFID module is uploaded to cloud simultaneously so that to obtain accurate information of books in shelves/racks.

D. RFID tag

The RFID tags are classified into active RFID tag and passive RFID[15] tag. Active tag uses an internal power source for its operation and hence they are battery operated RFID tags. It's range of communication is higher when compared to passive one (has long reading distance). The data from active tag is sent instantaneously when a RFID reader comes in contact with it. But the proposed system uses passive tag because it is compact in size and also low cost. It does not have a power source instead it derives power from reader module through electromagnetic coupling. The transmission of data from tag to reader is comparatively slower in case of passive tag. But increase in the speed of transmission rate is achieved by using higher operating frequency of RFID reader.

E. Arduino software

Arduino IDE is an open source software which is used to write and upload the code for Arduino UNO. It has several packages in-built in it, that supports several operations to be performed. It can also be used for many controller boards that comes under the family of Arduino UNO. The board manager option helps in connecting with various boards. It contains a text editor where the code is written, a console window to display the results with error message, a toolbar with various options and a series of menus on the top of the display window. It is compatible with different operating systems like windows, macOS-X and linux.

F. Appypie

It is used for building android apps and it is built-in support for google cloud platform which enables integration with firebase cloud for messaging purpose. The mobile application is created using android with the help of html (open source). Here html acts as a basic platform for creating app in android, which will convert html codes written for words in the design into android based application.

V. RESULTS AND DISCUSSION

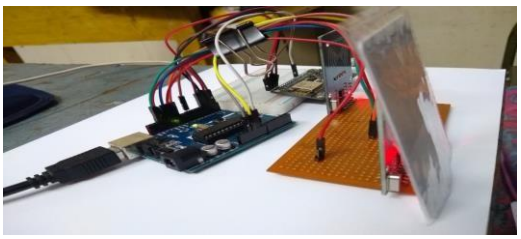

Fig. 5. RFID reader with single tag placed at rack1

Whenever the RFID reader finds the passive tag which is placed on the books at rack1, it will read the tag ID i.e unique ID. Then the unique ID is renamed as DSP by some internal techniques. RFID reader with single tag placed at rack1 is shown in Fig. 5.

The RFID tag ID read from the passive tag is displayed in the serial monitor. Here the tag is placed in the first rack and output is obtained as shown in Fig. 6.

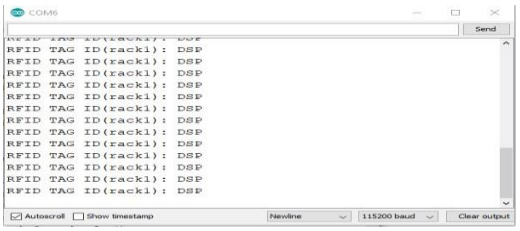

Fig. 6. Serial monitor output-1

Assuming that two books are placed in each rack, 4 different RFID tags are placed in front of the RFID reader. The reader with multiple tags is placed at both the racks as shown in Fig. 7.

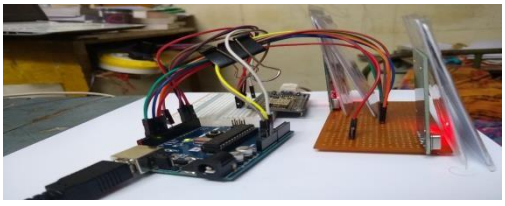

Fig. 7. RFID reader with two tags placed at both racks

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The corresponding output of Fig. 7 is displayed in the serial monitor as shown in Fig. 8.

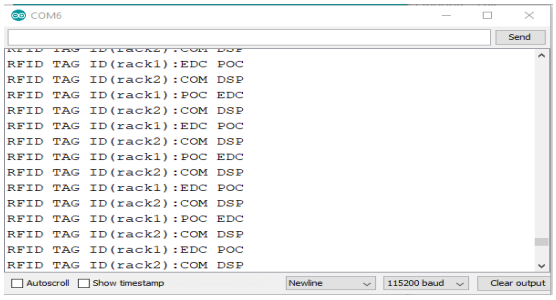

Fig. 8. Serial monitor output-2

Now, the data read by the RFID module is uploaded to cloud database through NodeMCU controller as shown in Fig.9a (displaying 29% of data uploaded) and in Fig. 9b (displaying 100% of data uploaded).

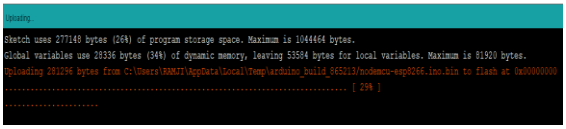

Fig. 9a. Uploading data to Node MCU(ESP8266)-1

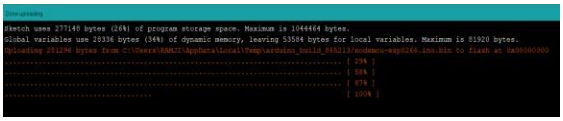

Fig. 9b. Uploading data to Node MCU(ESP8266)-2

The corresponding output of Fig. 5 uploading the book detail to the cloud database is shown in Fig. 10.

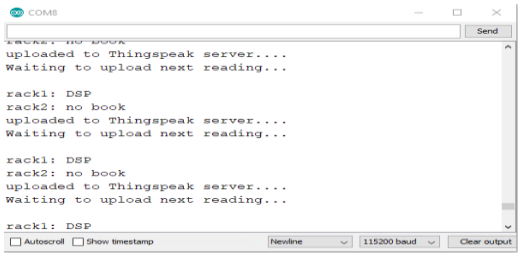

Fig. 10. Uploading rack data to cloud

The data uploaded to cloud database is shown in Fig. 11 considering no books are placed at both the racks.

Fig. 11. Database feed

The front end of the mobile application to search the book in the library is shown in Fig. 12.

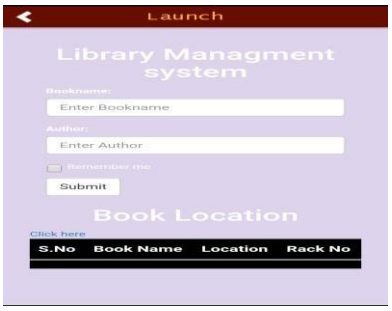

Fig. 12. Mobile application for accessing data from cloud database

The overall circuit diagram of book tracking system with external power supply is shown in the Fig. 13.

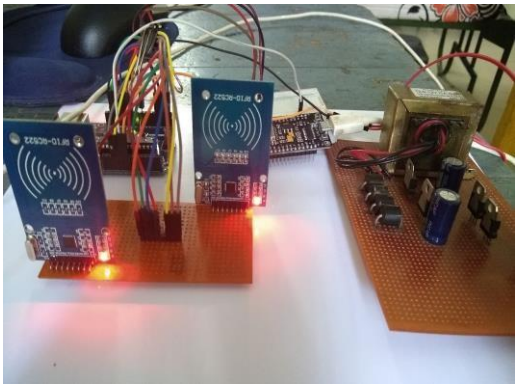

Fig. 13. Entire Hardware Setup of book tracking system

VI. CONCLUSION

As the number of books in the library has been increasing it is difficult to find the required book. To overcome this issue, a low-cost book tracking system has been implemented. The model detects the exact location of the book in the library with the help of android based mobile application. The proposed system comes with intelligent library management that gives better service quality along with quick and effective benefits to librarians and as well as to students. This application can lead to enhance customer service, lower book theft and provide a constant record update of new collection of books.

VII. FUTURE WORK

The mid band frequency has been used in the RFID reader. In future, Ultra High Frequency (UHF) can be used for longer distances and renewing of books can also be done.

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