

Automation of Library Management System

Trishya Angela Babs¹, Irene Rose Mathew², Anit Stanly Johns³, Ben P. Babu⁴

¹⁻³UG Scholars, Dept. of Electronics and Communication Engineering, Govt. Rajiv Gandhi Institute of Technology, Kerala, India

⁴Assistant Professor, Dept. of Electronics and Communication Engineering, Govt. Rajiv Gandhi Institute of Technology, Kerala, India

Abstract - Libraries are the treasure house of books, a place that provides unrestricted access to information of vast multitude in many formats. The systematic management of a huge library and the excessive manual routine work done by a librarian in maintaining the same has led to the idea of automating the entire library. Over the years, numerous library management software have emerged to promote this cause. Starting from cataloguing information about all the books into a database to relying on a library management system with integrated database to monitor all incoming and outgoing services, library automation has developed tremendously. Nevertheless, there is still room for efficiency. Even when the search is automated, the librarian has to handpick the book and deliver it. Through this paper, we present a feasible design solution, the Automation of Library Management System, with a front end of graphical user interface along with its related database and a back end of entirely mechanized shelf. When a person searches for a particular book using the Graphical User Interface (GUI), the location of that book is identified from the database and the shelf automatically delivers that book by the technique of differential motion. Furthermore, the shelf and the database are mutually coordinated using Radio Frequency (RF) communication. This paper puts forth a novel structural model for library shelves to synchronize with the database management system and GUI. The discussed solution can lead to new generation libraries that will be completely automated and error free, with a constantly updating database.

Keywords: Database, Differential motion, Graphical User Interface (GUI), Library Automation, Radio Frequency (RF) Communication.

1. INTRODUCTION

A library as a repository of knowledge houses collection of books, both reference and general, technical reports, periodicals, journals, conference proceedings etc. The primary purpose of the library is to provide resources and services in a variety of media to meet the needs of individuals and groups for education, information and personal development.

In particular, a library easily contains hundreds of thousands of books that are frequently borrowed and returned back to the shelves. Usually a librarian is responsible of keeping track of the books in the library. To facilitate users to easily locate a particular book, books are placed in dedicated areas

and sorted in a running sequence based on their call numbers. Typically during the issuance of a book, the staffs have to pick the books and hand it over to the person to whom the books are being issued or the person itself has to search for that particular book through the entire library shelves. This might be an easy task in case the library floor area is small. Also, to search for the books, humans take a lot of time as many a times the books get overlooked by the human eye. Library staffs have to ensure that the books are placed in order, an extremely labor intensive and time consuming process. They first need to perform shelf reading, i.e., manually search for books that are misplaced in the wrong book sequence, then pick up the book and insert it in the correct location which seems to be tedious. Thus to facilitate the process of book finding and to conciliate the grievous work of library staffs, it lead to the idea of automating library processes from maintaining book database to finding and delivery of the book and same in returning of the book. Other important factors leading to automation of a library system include information explosion, increase in collection of libraries, inability of users to explore the unlimited literature and information of their interest, wastage of user's time in locating the information and advances in the computer and communication technology.

We propose an autonomous solution for efficient library management to tackle all drawbacks of a conventional library. The system aims to search for any specific book in any shelf as per user requirement, and if found, deliver it as soon as possible to the user. And similarly, to return the book in its predetermined position without human intervention. We suggest a complete change to the library as a whole rather than modifying the prevailing system. The proposed system consists of reformed library shelves which are designed to provide a mechanism to retrieve a particular book when the location of that book is given as the input. When a person searches for a specific book in the database, the location coordinates of that book is identified and the shelf mechanically delivers that book. The change in status of each book is immediately recorded in the database. Similarly when a book is returned, on specifying the book details, the location is identified and then the mechanized shelf replaces the book.

In this paper, we first go through all relevant works in this field that has aided our system design. The proposed system with its software and hardware description are detailed in

the immediate sections. We introduce four well established key ideas - Graphical User Interface (GUI), database management, differential motion and RF communication - which are combined in order to describe how the shelf is structured, its precise movement with regard to the coordinates obtained, the change of status of the book, the delivery and return of the book as per requirement, and finally the act of communication with the shelf itself. We conclude with the experimental results obtained.

2. RELATED WORKS

The old way of managing a library was by searching for a book using manual work. A *manual record book* was maintained which had the details of all the books in the library and also another record giving the information of the books lent by the users. Using of manual work in the maintenance of library is hassle as it involves a librarian and many staffs. Also, fast report generation is not possible. For a library containing numerous books, without a central database, information about issue or return of the books are not properly maintained. All of these shortcomings are a cause of frustration to the librarian as well as users.

The quest to exploring mechanized methods for reducing the clerical workload in handling the book loans led to *punch card methods*. The roots of mechanized circulation control can be tracked back to the 1930s when some purely manual charge-out files gave way to the edge-punched card. Shortly thereafter, punched cards called IBM cards, invented by Hollerith in 1880, were also adapted to circulation control. The first IBM machine to be installed in a circulation department was at the University of Texas Library. In 1936, Ralph H. Parker published an article entitled "The punched card method in circulation work" which represented a milestone in the history of mechanized circulation control.

Library automation entered into its second era in 1960s with the advent of computers. Traditional library housekeeping operations were computerized using the *library database* as its foundation. This system is a unified database that can manage all the happenings of the library. Book transactions including book searching, availability of the book, its location and other details like appearance of the book, personal book borrowing history etc. can be very easily handled by this system. Advanced library management software have RF identification and QR code or barcode scanning that eliminates manual entering of data [1] and [2].

The first library management system to be reviewed is the *KOHA library management system*. Since the original implementation in 1999, KOHA functionality has been adopted by thousands of libraries worldwide, each adding features and functions, thereby deepening the capability of the system. With the 3.0 release in 2005 and the integration of powerful Zebra indexing engine, KOHA became a viable, scalable solution for libraries of all kinds. Build on this foundation is LibLime KOHA, the most functionally advanced

open source Integrated Library System in the market today. This Library Management System (LMS) manages to maintain a complete record of library process, but because it is web based it is little security conscious, which in turn leads to easy hacking and loss of integrity.

The recent idea of using robots in library application has gained much interest [3]. The *book picking robot* is a service robot with an arm with some degrees of freedom that can perform tasks such as book finding, picking and delivering it to the reader [4]. The arrangement of books in the library racks are explored with the help of robots operated by Zigbee. The robots are designed using sensors and operating motors keep track of the library book shelf arrangements. The use of robotic arm for picking the book fastens the process tremendously, yet a major disadvantage of using robotic arms is its inability of maintaining many degrees of freedom and failure to support a wide range of weights. In general, librarians are trying to maximize the benefits of automation by extending computer use to as many aspects of library activities as possible by taking advantage of development in hardware and software technologies.

3. PROPOSED SYSTEM

This paper proposes the design of a single reformed shelf in the library. The system consists of a graphical user interface to interact with the user and a database to store library details. On receiving the coordinates of book as per the search, it is transferred to the respective shelf by RF communication techniques and the book is retrieved by mechanical motion of the shelf. A pictorial depiction of the overall system is shown in Fig 1.

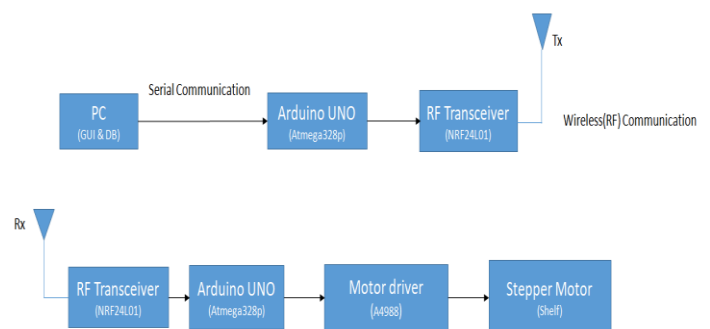


Fig -1: Block diagram of the Automatic Library Management System.

PC with GUI and database communicates the location of the book serially to the Arduino connected which in turn transmits the information of the Arduino at the shelf via RF transceiver module. On receiving the coordinates, motor movement is initiated for the book picking mechanism.

Graphical User Interface and Database Management

For the automation of a library management system, a database comprising of details of students and books is prerequisite. Also, there must be a constant interacting platform through which the user can communicate with the system. This is provided by the Graphical User Interface or GUI. The database consists of information regarding all the books in the chosen library and all the students who are granted with access. Book details include name of the book, its author, number of the shelf on which it is placed, its exact position on the shelf – which includes its rack number and its location on the rack. Information about a student is made up of his or her name, roll number, and the list of books in possession, if any.

The User Interface is created in Java in NetBeans platform, with a reference to work of Asaduzzaman Noor, Md. Sharif Hossen [5], which conveniently facilitates actions like searching a book, lend it, if available, and return the book. The database is exclusively handled by the librarian. Adding and removing a book, managing the student record and book record and handling all the data related to a student or a book are performed by librarian alone. However, all students have access to the available books. He or she can lend an available book or return a previously obtained book. All actions performed will be immediately updated in the database.

Structural Model of Shelf

In this project, a new model of bookshelf is proposed for a precise, yet simple automation. This model of shelf consists of metallic protrusions or rods. The entire shelf is designed considering the average weight of the books it can hold. The books are placed horizontally on each pair of these rods. The entire shelf is clamped to a supporting structure or frame, made up of the same material, upon which the book picking and placing mechanism is facilitated.

The frame comprises of two vertical lead screw steppers at both ends. It holds two other horizontal lead screw steppers. A pair of collars are on the lead screws. All movements are facilitated using a total of four stepper motors. Cylindrical couplers attached at the interface of motor and lead screw provide additional flexibility to the motion. The horizontal lead screws support another 'V' shaped metallic structure, also attached horizontally, that can be moved according to a differential motion performed by the horizontal steppers. This 'V' shaped structure is the core part of the shelf which performs the picking and placing functions.

Searching, Lending, Returning of Book

A student or a user can search any book available in the database using the search option in the GUI. The name of the required book can be used to do so. The entire database is

then searched for a book of that name. The desired book, if available, can be taken by using the lend button. Upon lending, details about the person lending the book is to be given as input. Hence, when a person takes a book, his or her details will be enquired and the book will be entitled to that person appropriately. Also, the book will no longer be available in the search section, but will be linked to the lender's database.

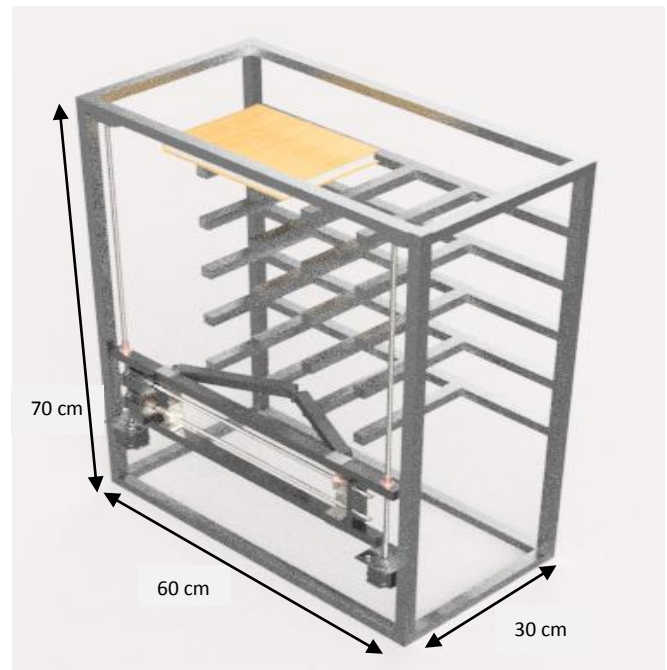


Fig -2: Shelf model 70cm x 60cm x 30cm.

The book is placed on horizontal rods. The shelf is clamped to a supporting structure which contains the mechanism for book picking. The vertical movement is facilitated by two motor attached to lead screw on which resides the v shaped mechanism for horizontal movement.

When a student returns a book, he or she can use the return button where the required details of the book are requested to be entered. Upon completion of data entry, that book is returned officially and the same will be removed from the user's database immediately. Furthermore, the book will be back in the search section, available for lending again.

Transfer of Coordinates - Radio Frequency Communication

Whenever a book is lent using the lend button, the coordinates of the book are to be transferred to the corresponding shelf. In the shelf, these coordinates are utilized to find the exact book and conduct the delivering mechanism. Similarly, while returning a book, the return button transfers the coordinates of the returned book to the shelf. This in turn regulates the returning mechanism.

The transfer of coordinates for both these mechanisms are forwarded through Radio Frequency (RF) communication. A system using two RF transceiver modules provide the necessary communication path between the shelf, where books are kept, and the computer, where the GUI and database are maintained. The RF transceiver module that is connected to shelf's arduino acts as the receiving section. This RF transceiver module receives coordinates from the main RF transceiver at the PC, which in turn is the transmitter. Hence a complete communication path is established.

3.1. Working Mechanism of the Shelf

In a lend action, when the coordinates are obtained, the two vertical lead screws and motors position the horizontal book picking supporting structure at the rack specified by the program. This movement is accurately regulated by specifying the number of turns to be taken by the motor upon receiving the y coordinate value. Further, the horizontal lead screws and its accompanying motors perform a differential motion by which they align with the book position, just below the pair of rods on which the book is placed. This is done with reference to the z coordinate obtained.

Differential movement can be defined as a mechanism having two driving elements (here motors) arranged such that the net motion of the follower (here, the v shaped horizontal frame component) is the difference between the two motions that it would have if either driver acted alone. Upon exactly locating a book, the next step is to lift and carry the book to the empty slot at the bottom right corner, which is set as the delivery / return point. Once the location is determined, the vertical frame component moves up a pre-determined distance (to lift the book from the rods onto the frame) and carries the book to the delivery / return slot. The student or user can take the book from the slot.

If the action is to return a book, the student must place the book in the delivery / return slot, from where the book is taken back to its original slot. The x, y and z coordinates obtained by the shelf enables positioning of the supporting frame at the exact location required. This part is exactly same as the book picking technique. The difference is that, the book to be returned is already on the frame, it has to reverse the action performed to lend. That is, once the location is identified, the frame moves down along a pre-determined distance (to gently put it back on the rods) and the frame recedes to its initial resting state.



Fig -3: Differential movement of horizontal lead screw. The v-shaped structure on receiving the location of book moves to the coordinates, perform a differential motion by which they align with the book position, just below the pair of rods on which the book is placed and ensue the picking of the book.



Fig -4: Book placed at the reference point. The book is brought down to the reference point and placed into the slot.

The entire mechanism always rests at zero point set at the bottom right end slot, which is empty by default. It is called the delivery / return slot from which book can be taken for lend and kept to return. This slot is also preferred when there is an abrupt power loss or any other unavoidable cause due to which the system has to shut down. It serves as a reference point as well as a resting point.

4. EXPERIMENT AND RESULT

Successfully modeled the reformed shelf and verified the structure movement as per the input received. The Graphical User Interface created using Java NetBeans allows the user to interact with the system. GUI opens up into a menu box with the menu bar containing drop-down lists named File, Add, Search and Return as shown in Fig-5. The menu field provides access to certain functions such as adding of student details as well as book details to their respective databases, searching for a particular book in the database to lend and returning of the book. The reformed model of shelf and its movement mechanism using motors and motor drivers pick the required book and deliver it to the user.

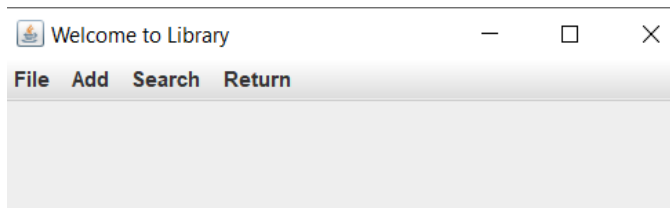


Fig -5: The GUI created opens into the menu box with options to add, search or return a particular book. The drop down list 'Add' contains further options to enter the details of the books available in the library and to enter the student details.

When a user searches for a particular book in the Search Field, it is directed to the Lendbook Field if the book is available. If the required book is not available, a message of unavailability is displayed. The database also checks for authenticity of the entered data, i.e. if the information does not match that of the database, book cannot be retrieved. In the Lendbook field, student is asked to enter his roll number to enable lending of the book. Once the book is lent, the coordinates of that book is displayed and the same gets transferred to the shelf arduino from the GUI database side. At the same time, changes are updated in the database. This book is no longer be available for lending. This initiates a chain of motor movements to retrieve the book. Each book has its own personalized movement mechanism as explained in the previous section.

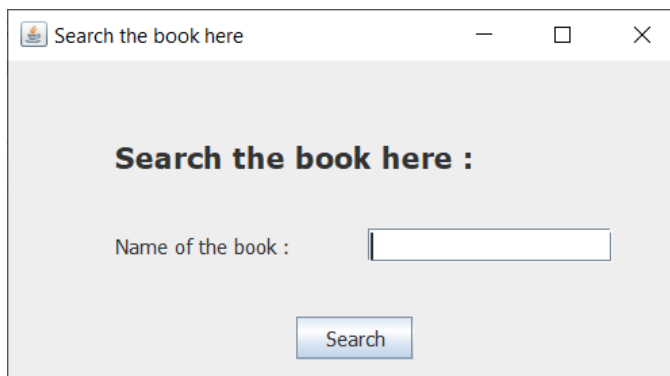


Fig -6: Search Dialog Box. On searching the name of the required book, it displays the coordinates of the book if available and if not, displays an error message informing the unavailability of the searched content.

To return a book, the book is placed in the deliver/ return slot. The return option in the menu bar produces a dialog box in which the student can enter the name of the book to be returned along with his roll number which makes the corresponding changes in the databases. This will initiate events as same as lending in the reverse order to replace the book in its original position.

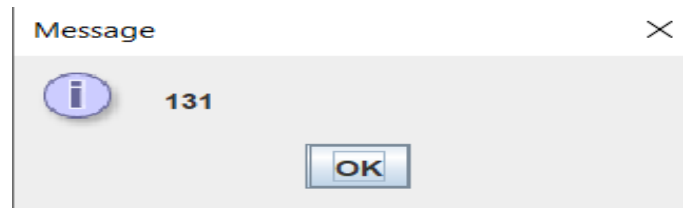


Fig -7: The coordinates of the searched book is displayed upon its availability.

Coordinates of the book which is either lent or returned is communicated from the database side to the shelf via RF transceiver modules to initiate the motor movement for book picking or book returning as per the instructions given.

Sl.no	Hardware Requirements	Software requirements
1.	Arduino Uno ATMEGA328p x 2	JAVA NetBeans IDE
2.	RF Transceiver Module NRF24L01	Arduino IDE
3.	Lead Screw Stepper Motor x 4	Fusion360
4.	Motor Driver A4988 x 4	

Table -1: Component specification. The various software and hardware components used to design and implement the entire system, respectively, are specified in Table.

5. CONCLUSIONS

Automating the library helps in reducing time consumption. A person can easily have access to his/her preferred book by entering the details of the book. The availability of the book is informed through the user friendly GUI developed in Java NetBeans. If the book is available, the position of the book is displayed and it is serialized. Using the two RF transceiver modules placed at the PC and the shelf, the coordinates of the location in the shelf are transmitted serially. The shelf that is specially designed using metallic rods minimizes the material wastage. The differential motion for picking up and placing back the books, reduces the complexity of the mechanical structure. The two simple Arduino boards provide sufficient pins for connecting the stepper motors and the transceiver modules. It also provides an easy platform for programming in Embedded C. Thus the proposed system provides a simple and efficient way of automating the library with less human intervention.

6. CHALLENGES AND FUTURE SCOPE

Although the proposed library management system is useful in easing the work of a librarian, its practical implementation includes few challenges like inefficient communication between the transmitter and receiver module if beyond the

specified range, wearing and tearing of threads of the vertical lead screws due to while horizontal movement but can be avoided by greasing the lead screws occasionally, buckling of the horizontal lead screw can happen, if carry excess weight. These challenges can be taken care of by taking proper measures.



Ben P Babu
Assistant Professor, Govt. Rajiv
Gandhi Institute of Technology,
Kerala, India

Currently the proposed system is designed for a shelf in a small library. This system can be applied to all the shelves in the library using specific number of equipments. The whole process can be made easier by introducing conveyer belts to carry the books from shelf to the person which can save a lot of time and effort in it. The application of the proposed system can be expanded to bigger libraries with large number of books.

REFERENCES

- [1] Sree Lakshmi Addepalli et.al "Library Management System Using Rfid Technology," IJCSIT 2014, Vol.5(6), pg- 6932-6935.
- [2] Lidia J Chungath1, Deepthi U, Aswani C R, Ganesh, Arjun K. " An Innovative Idea for Management of Libraries Using A RFID Based Library Assistant Robot" IJAR in Electrical, Electronics and Instrumentation Engineering 2016, Vol 5, issue 12 .
- [3] Thirumurgan, G.Kartheeswaan, M.Vinoth, and M. Vishwanathan, "Line following robot for library inventory management system" Int.Conf.on Emerging Trends in Robotics and communication Technologies 2010
- [4] Sharath H.K.Shivashankar B.S. "Book Handling Robot for Libraries." IJERT 2013, Vol. 2 Issue 8.
- [5] Asaduzzaman Noor, Md. Sharif Hossen. "A Java based university library management system" IJCA 2018, vol 180- No.29.

BIOGRAPHIES



Trishya Angela Babs
B.Tech graduate, Govt. Rajiv
Gandhi Institute of Technology,
Kerala, India



Irene Rose Mathew
B.Tech Graduate, Govt. Rajiv
Gandhi Institute of Technology,
Kerala, India



Annit Stanly Johns
B.Tech graduate, Govt. Rajiv
Gandhi Institute of Technology,
Kerala, India