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# AUTOMATED LIBRARY ASSISTANT ROBOT

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**Abstract -** *This project is the application of Robots in library management systems. A robot is designed that follows a predefined path to keep track of the library bookshelf arrangements. The robot is controlled using the Arduino MEGA which is programmed with instructions to perform the tasks. The number of the required book is given as input to the robot through the Bluetooth module. The robot uses the line follower technique and reaches the shelves in which the book is present. The robot gets the data of the book by comparing the saved RFID number with the books on the shelves. If the particular book which is to be found out by the robot is matched with the saved book detail, then the robotic arm will get the input. Then the servo motors present in the arm rotates in particular angles and picks the book from the shelf. The robot arm will hold the book using the gripper and return the book to the collection center following the same path. Thus the customer can deliver the book from the collection center. This helps and simplifies the job of monitoring the arrangement of books and also reduces the manual routine work done by the library staff.*

***Key Words***: **Robots, Library management systems, Arduino MEGA, Bluetooth module, Line Follower, RFID, Robotic arm.**

## 1. INTRODUCTION

A library is a curated collection of sources of information written by experts and made available to the people for reference. Libraries range widely in size up to millions of books and other sources of knowledge. Libraries are provided with the service of librarians who are experts at finding and organizing the books or information and providing it to the users. But some needs in the library can be solved using robotics.

Nowadays, we are familiar with the service robots which are used in almost all sectors of society. There are service robots that are mostly used in the industries, performing tasks at home and also helpful for people with disabilities. So, we can also use these service robots for the tasks required in the library.

### 1.1 NEED

Libraries are having issues with career advancements, technical requirements, and tracking performance. The library contains a large number of books that are frequently borrowed and returned to the shelves. Searching for books in the library is a time-consuming and difficult task. Library staffs have to ensure that the books are placed in an order which is an extremely labour-intensive and time-consuming process.

To automate this process of finding and returning the book to the user, we have introduced a library assistant robot using the knowledge of embedded systems, RFID, and robotics. This robot recognizes the required book using the RFID tags and brings it back to the user. It helps to reduce the effort of the librarian or reader in finding the book and also reduces the time consumed for finding the books which make the work fast and easier.

### 1.2 IDEA OF THE PROJECT

The main objective of the project is to introduce automation in the library for finding and providing the book to the users. This is done by introducing the robot with a base and a robotic arm with 3 degrees of freedom which is controlled using the Arduino MEGA. The time-consuming process and effort done by the librarians are reduced by introducing this robotic system in libraries. The library assistant robot consists of various components that have their functionality in locating, finding, and returning the book.

The input to the robot is the number of the book which is given through wireless Bluetooth technology. As it was wireless, the robot can move anywhere up to 10 meters without any interruption of wires. The robot uses the line follower which is done by using the predefined line on the floor and detected by the IR sensors. We use the dc geared motors to run the wheels of the robot whose rotation is controlled based on the line follower. Each rack is defined with different colors which are detected by using the color sensor. All the books in the library are provided with RFID tags with unique RFID numbers. The RFID reader attached to the robotic arm detects the book using the tags inside it. The articulated type of robotic arm is used for picking and holding the book. The robotic arm whose joints are connected by servo motors with 3 degrees of freedom and a gripper is used to handle the book. The Arduino MEGA is the microcontroller board that controls the whole robot by giving instructions to all the other components. The Arduino MEGA is programmed using the Arduino IDE software. As the Arduino IDE uses a GCC compiler, the standard C language is used to program the robot.

The introduction of the library assistant robot into the library will help to reduce various issues faced by the librarians. This reduces the human effort for locating, finding, picking, and returning the book to the user. It is a time-consuming process for the librarian to search for the books

and returning. As robots are used, the work will be more accurate with less time consumption.

## 2. HARDWARE INTERFACE

The library assistant robot consists of various hardware components. Arduino MEGA is the main component that acts as an interface between all the components of the robot. The interfacing of the components inside the robot is discussed with the help of the figure below.

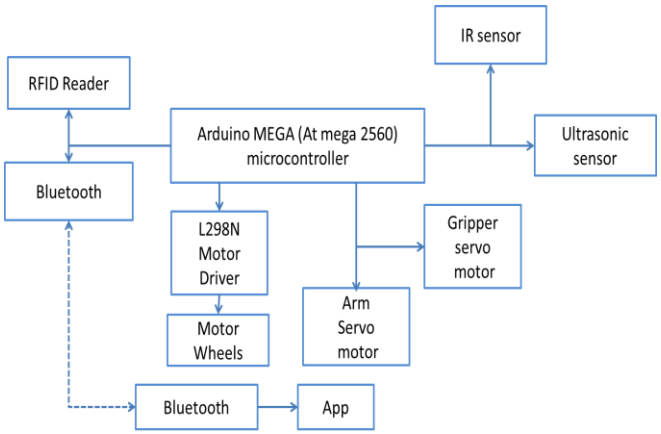


**Fig -1**: Block diagram

The block diagram of the library assistant robot mainly contains Arduino MEGA, Bluetooth module, Robotic arm, RFID reader, and tags. We have used the HC-05 Bluetooth module to provide wireless communication between the robot and the mobile. The information of the book is given as input to the robot through this Bluetooth module. The Arduino MEGA acts as the heart of the robot which takes input from the sensors and Bluetooth. Based on the sensor values, it gives the instructions to control the motion of the actuators (motors). The RFID technology is used to detect the required book in the racks. All the books in the library are embedded with RFID tags. Each RFID tag will have a unique identification number. The book is detected by comparing the identification number of the RFID tags with the saved RFID number of the required book. The articulated type of robotic arm is used for picking and holding the required book.

The various components used for the development of the project are

- Chassis
- Motors
- Wheels
- Robotic arm
- Arduino Mega
- Servo motors
- RF ID
- RF id module
- Motor driver
- Color sensor
- IR sensor
- Battery
- Ultra sonic sensor
- Bluetooth

## 3. SOFTWARE DESIGN

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The required software architecture for Arduino is designed and tested using Arduino IDE in Embedded C.

### 3.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, Mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that is compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in a hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. The board is connected by setting up the board setup and com setup and uploading the code which is shown with the blinking indicator.

**Setup ():** Every Arduino sketch must have a setup function. This function defines the initial state of the Arduino upon boot and runs only once. Here we'll define the following:

1. Pin functionality using the pin Mode function
2. Initial state of pins
3. Initialize classes
4. Initialize variables
5. Code logic

**Loop ():** The loop function is also a must for every Arduino sketch and executes once setup () is complete. It is the main function and as its name hints, it runs in a loop over and over again. The loop describes the main logic of your circuit. The logic defined in the loop will continuously run in the Arduino. The steps that are to be executed only once are written in setup () and the repeated steps are written in a loop ().

We are using the Arduino Bluetooth control android application on which we can send and receive many commands using a single medium of HC-05. We can easily connect the HC-05 Bluetooth module to our android through this application.

## 4. ADVANTAGES AND APPLICATIONS

### 4.1 Advantages of Library Automation

1. Reduce human effort, human error and Save time.
2. Improved Customer Service.
3. Cataloguing Improvements.
4. Easier actions.
5. Collections.
6. Lasting Effects

### 4.2. Applications

- Used in supermarkets as automatic item collector.
- Used in libraries of school, colleges.
- Big book stalls in malls.
- Newspaper printing press for picking bundles of papers.
- Used in paper mills.
- Book exhibition and sales.

### 4.5. Disadvantages

- Problems of mechanical functioning may occur.
- Capability of lifting book is limitation.
- Employee Retrenchment.

## 5. RESULTS AND CONCLUSIONS

### 5.1 RESULTS

Initially, we are at the home position. The required book's number is given as the input in the android application through the Bluetooth module. Then the robot starts slowly from its home position. The IR sensor detects the predefined path drawn to control the direction of the robot.

The below figure shows the line follower circuit used in the robot.

**Fig -2**: Robotic base programmed with Line Follower

The sensor module provides the value into the controller to generate a control signal as per the program. By correcting and following the path, the robot moves to the destination. When the RFID code of the book matches with the tag present in the required book, the robot uses its arms to pick the book. The result for finding the ID number of the tags is shown in the figure below.

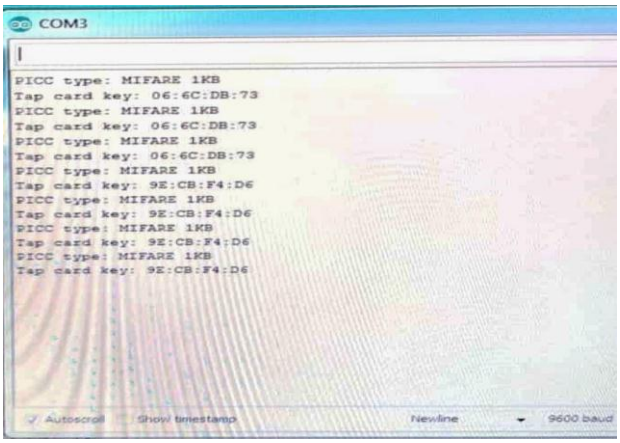


**Fig -3**: RFID key identification output

When the book is detected, the servo motors move in the predefined angles and picks up and hold the book. Then the robot returns to its initial position and gives it to the user. The robot will station at the home position till the next cycle begins.

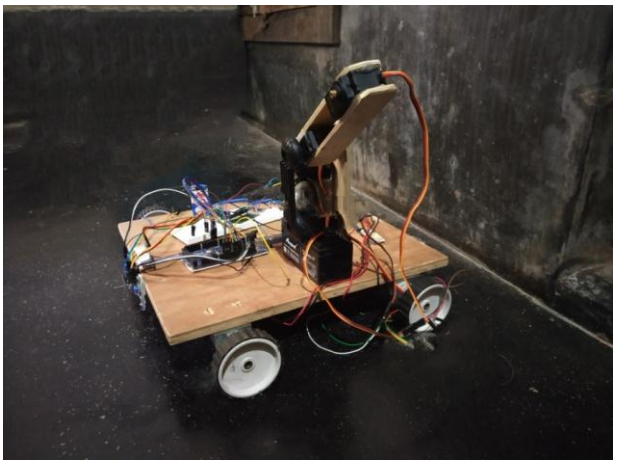

**Fig -4**: Robotic structure with arm

The robot consists of an ultrasonic sensor that is used for obstacle detection. When an object comes in front of the moving robot, it stops moving until the obstacle is removed. It consists of an IR sensor color sensor for following the predefined path.

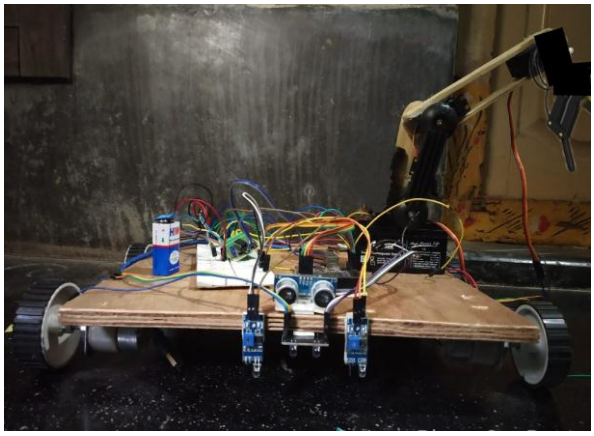

**Fig -5**: Final Robot with different sensors and actuators

### 5.2 CONCLUSIONS

This project is an effective system for automatic library manipulation, it reduces the manual work. The system acts as a basic platform for the generation of more such devices for library management. We have developed a robotic automated library system that will help us to use library resources efficiently, like finding books and showing user profiles. The IR sensors navigated the robot end from its home position to the bookshelf end and back to home after the collection of the required book. It reduces the manual work. Because of the electronic and mechanical automation, the time required for library management tasks is reduced.

This robot reduces human interception so the user will get the book faster and the user can easily check the availability of a book from its place within a campus. This project is the prototype of the automation of the library system with some limitations. These limitations can be avoided in real-time applications by future enhancements. The idea of library automation is often achieved with the assistance of this project.

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