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# Microcontroller Based Robotic Arm Development for Library Management System

**Shivam Katiyar[1], Shelendra Raghav[2], Arman Shah[3]and Ved Prakash Sharma[4]**

[1234]*Student, Dept. of Electronics and Communication Engineering, IMS Engineering college, Uttar Pradesh, India*

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**Abstract -** *With the advent of robots, automation in various industries and processes has become increasingly common. The project aims to introduce an automated library system, which focuses on achieving the goals of automatic book acquisition of books, arranging returnable books on racks and automatic renewal of the library. The proposed system is based on Arduino microcontroller and microcontroller based robotic arms are used to download books or return books to various libraries in the library. The library website is updated after the action has been completed. The diversity of the proposed system lies in the fact that it can be used in any existing library and can handle individual books rather than bulk. The program aims to provide a new dimension to the library's automation concept.*

***Key Words***: **Robotic arm, Library management system, Microcontroller, Automation**

## 1. INTRODUCTION

The effects of a misplaced library have been felt by almost everyone. May it be in the wrong place to return the books or the inability to find the desired documents, anything left distorted will come back to light, in time. This project aims to solve this problem in a modern, highly technologically and innovative way.

The robot arm is used to receive letters from students and return them to their various locations in the racks. The controller is used to keep the records of the returned books, sort the book according to the algorithm set, thus determining the address on the rack where the book will be placed by the arm. A member of the library can access the website at designated forums and any document requested in this forum will be downloaded by robot with a retractable process. The system can have a wide range of implementations, basic to medium-sized libraries, where manual handling becomes difficult. The flexibility of the proposed system lies in the fact that it can be added to existing libraries instead of designing a separate standalone library. Research has already been done in the field of library automation [14]. One example of an existing system of automatic storage & library system at Macquarie University, Sydney, Australia. It is a Radio Frequency Identification and Data collection (RFID) system [5-6] that maintains a digital library of books and online books are downloaded by bringing the entire bin (same class container) to the reader. Story et. al. [7] have proposed a kiosk system with a pedestrian enclosure, a selection panel that interacts with the multi-stage storage system, issues literature and accepts returns. Ostwald et. al. [8] developed a two-dimensional system consisting of two-dimensional components containing media cartridge storage cells and media cartridge players. In [9], Ehrenberg et. al. we introduced Lib Bot, an RFID reader-enabled robot, which automatically performs the learning process on the shelf in person and automatically detects books placed in the wrong place. Dhanalakshmi et. al. [10] have proposed a system that allows for the identification of large quantities of marked objects such as books, using radio waves. The system contains a transaction module that manages the delivery and retrieval of documents, and updates details; gate guard module that monitors inbound and outgoing bags; and a search module that provides navigation guidance for users within the library to find the app in real time. The system allows for rapid flow of library activity and will prove immediate and long-term benefits for the library in tracking and security. The major shortcomings of our proposed systems and procedures are as follows; Systems deal with one task at a time, namely retrieving books or arranging returned documents. In this paper the most advanced system is designed to manage both functions simultaneously while updating the library database. The systems launched for sale cannot deal with each book, instead dealing with blocks or stacks of a few books. In our proposed project, each book is handled in a timely manner.

### 1.1 Design of the system

The major components required for this project are microcontroller (Arduino Uno), RF Module (434 MHz), IR LEDs and Motors (150 rpm), Motor Drivers (L298), Raw Materials for Mechanical Arm Construction (PVC, Wood, Copper-clad boards),DC power is required for the system to work. The power is supplied using a linear, regulated DC power supply (designed for the project) which is composed of a rectifier circuit, filter circuit and a regulator circuit.

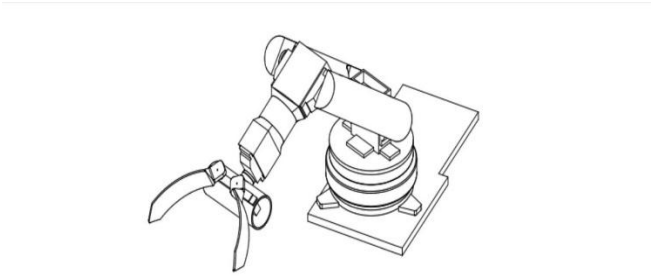

**Fig.** Robotic Arm

## 2. Proposed Algorithm

The flowchart of the proposed work is shown in Chart -1. The proposed system is based on a microcontroller that controls the action of some actuators based on a series of inputs. The principle by which books are accepted into the library and arranged on the shelves is discussed first. The process begins from a barcode scanner that scans every book that is returned to the library by the readers. Considering the case of one particular book, the input from the barcode scanner is sent to the microcontroller via an RF module. The microcontroller then processes this information, and sorts the book according to a set algorithm (based on perhaps alphabetical arrangement according to title, author, genre etc.) and determines a unique address for it on the shelves. The arm then takes the book to this address, the grabbing process being controlled by inputs from piezo sensors mounted on the grabber to account for varying widths. The arm can either be mounted on the floor directly, or on a set of rails hung from the ceiling. The ceiling mounted rail system is used here as the floor mounted system has some difficulty in case of tightly packed libraries or in case of high shelves. The direction of movement of the arm is changed using rotating turn-tables, which can either be operated by the arm itself, or be separately operated by a set of microcontrollers, the latter scheme is chosen for this project. This scheme is chosen to set up a controllable network of rails that can accommodate and efficiently manage the movement of multiple arms in a same library simultaneously (similar to a railway network). On the shelves, there are mechanical grabbers (either, spring operated tong like structures; or alternatively, simple slot arrangement) arranged at optimal distances which serve to hold the books in their place, so that they do not fall and consequently, obstruct the placement of any other book. Each of these „positions" at which these grabbers are located are the addresses which the books are kept at. The optimal distance between successive grabbers is so adjusted that widths of books to be kept is accounted for. One way to do this is to dedicate lower shelves for thicker books with more intermediary space, upper shelves for thinner books with lower intermediary space. There are IR emitters at every position, and an IR sensor mounted on the arm. These emitter-sensor pair from the required input for determination of position of the arm during movement and thus enable the arm to move to the desired location. After placing the book in the designated location, the arm then returns to the initial position and goes on standby. Similarly when a reader queues for a particular book, the address is searched in the system and the arm then goes to this address and retrieves the book for the user. This is a very simple extension of the above described process. A DC power supply (24 V, regulated and linear) is used to supply power to the micro controller as well as several motors and drivers.

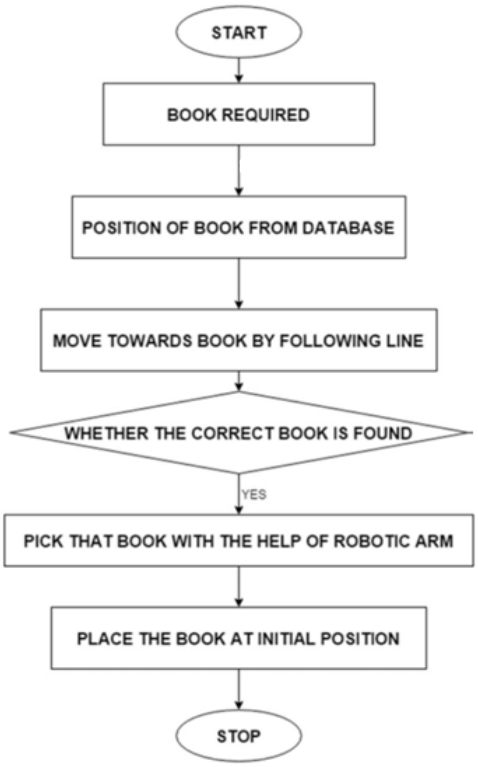


**Chart -1**: Flowchart of the work

## 3. EXPERIMENTAL RESULTS

The power supply was tested and provided for a DC-controlled power outage(24V). The drivers of the L298 vehicles, which were attached to the Arduino board, were tested for motor driving. The observed voltage fluctuations were satisfactory, i.e. the performance of 19-34 V. IR sensors was also tested by connecting them to the transmission circuit (main: 6V, 0.1A; second: 240V 50Hz, 6A) and was effective. After this they successfully joined Arduino. Vehicle performance testing according to sensor input, which is the real concept on which the project is based, is also performed with satisfactory results. After the entire system was assembled, tests were performed and the system was able to detect and extract books.

## 4. CONCLUSIONS

The proposed system has brought an efficient way to manage libraries. One of the most notable things about it is its versatility, as it can be easily integrated into any existing library, and the cost is proportional to the task load. Smaller libraries can be handled by cheaper microcontrollers while large-scale management can be done using PLC (especially if the system is applied to store house maintenance in industries). The system can be effectively implemented in medium and large sized libraries for easy and efficient management. It can also find application in other inventory management with minor changes in programming. The described system reduces time, labor and brings safe and innovative ways to manage libraries.

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