Development of a system to assist in library to automate the book handling process

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Abstract: The library is the place where one can gain not only knowledge, but also many important aspects of life. The more and more we learn, the more and more we become wise. But nowadays, the books we used to read in library are not returned to their place by us. Instead we drop or return the book in one place. The library staffs are the person, who handles the dropped books and stack it in their allotted place. It is a long process when it comes to multiple floors and multiple books and it is a more time consuming also. This work is aimed at automating the book return process by creating a new mechanism. The main objective of this paper is to return book to its place without any human involvement and to reduce the book handling time and reduce repeated to and fro motion. In order to automate this process a control system is required. The control system is implemented through some physical device; it is usually based on mathematical logic to get desired counts. Arduino mega is used to implement the required control for this project with the help of RFID technology. CAD design is made and the required robot for automation is fabricated. Hence by developing an autonomous robot the time required for handling the book is reduced and the book is handled safely. The material handling cost is also reduced with less man power.

Keywords: RFID, library, automation, material handling, less man power

1. Introduction

Sree Lakshmi et al used radio frequency identification (RFID) to automate the book handling process in the library. They have used passive RFID tags that are capable of electronically storing the information and that can be read with the help of RFID reader. By using this system, books can be issued and returned via RFID tags and the fine associated with the return of books after the due date can also be calculated using the database available with the library [1]. Smarat gosh et al developed a robotic arm working with the help of microcontroller for library management system. They have used Arduino micro controller and python programming micro controller for robotic arm to automatically place the books from the return section to their corresponding place in the rack [2]. Dhanalakshmi et al used RFID in library management syste m for fast transaction and for easy traceability of books. They have employed RFID readers supported with antennas at the entry of the library and at transaction systems, tha are capable of electronically storing the information and that can be read without any physical contact [3]. Yogesh Angal et al developed a robot which is capable of retrieving the book from the stored database. They have employed global positioning system for finding the location of the book. They have witnessed less man power under the supervision of library staff [4]. Sathishkumar et al used RFID and LED to identify the book. The books
are identified using RFID tag and RFID, and the LED in the robot will blink if the searched book is identified [5]. Grover Priyanka et al used RFID for books transaction, their system is designed in such a way that the books are issued and returned using RFID tags, which is also capable of calculating the fine for the books returned after the due date[6]. Bansode et al implemented RFID system in Pune university library and proved that the system is a boon for the library and the time consumed for the book handing and damage of books is also reduced [7]. Faizul Nisha experimented RFID technology at Defense Science Library and found that a bouquet of benefits for librarians, the staff and the users of the library because of automation and less time consumption [8]. Hasan nabi evaluated the performance of RFID technology in libraries by comparison with barcodes and electro magnetic strips and addressed the various challenges and issues associated with the implementation of RFID system in libraries and gave some guidelines to implement RFID system for the libraries [9]. Mayank Trivedi et al conducted a study on success of RFID technology in Indian academic libraries and they described how the RFID technology is implemented and also compared RFID with barcode[10]. Radha made a review on employment of RFID at Indian academic libraries and described some of the best practices in terms of privacy policy, collection limitation, consumer transparency and accountability [11].

It is difficult for humans to handle more number of books in a short time. Hence a robot is developed a robot to do this job. This type of robot will provide the benefits such as repeatability, easy to operate and maintain, faster material handling and low operating cost. In order to automate a process, a control system is required. The control system is implemented through some physical device; it is usually based on mathematical logic to get desired counts. RFID with ARDUINO MEGA is used to implement the required control.

The concern with book handling in library is that, they are stacked in one bin and transferred to its respective floor and sorted and arranged in the book shelf by a person in library. During this process the book may get damaged, due to poor handling or over stacking. It leads to torn pages, separated pages, sections and many more. And also, though it seems quite simple to find the book location, we couldn’t find the book in its place, because it is not re stocked in its allotted space. So, we have to find the person-in-charge of that section and find its temporary location and borrow the book. In order to reduce these many small and complicated problems, we have developed a book handling robot for library. The main objective of this work is to return the book to its place without any human involvement, reduce the book handling time and to reduce the repeated to and fro motion.

RFID technology is employed in many places because of its advantages. Nowadays libraries across the world are also started using RFID for automatic check in and checkout of books and this technology is replacing the barcode technology in a steady phase. One of the main reasons for using RFID is that, it need not be visible, it can be embedded in any place and it has more details such as, position of the book, author, accession number, etc., but barcode is only an identification number. This work describes the study of employing RFID technology with a specially designed autonomous vehicle which is used for automating the book handling process.

2. Components

To automate the process, various electronic components are used. They are used to monitor the position of the robot regarding the block position and to generate and control the movement of the robot according to the requirement. The DC motor acts as the prime mover in this work which moves the robot along the respective axis. The actuation of motors is triggered and limited by the IR Sensors, that gets triggered when get stuck by the blocks on the either sides of the robot. These IR Sensor triggers are fed to the controller that decides which axis motors to be actuated or stopped at correct position using motor driver.

3. Working Methodology

The proposed system is made by assembling the required components and the CCAD model of the required autonomous vehicle is built and then it is fabricated considering the load requirements. The step by step procedure followed to make the required system to automate the book handling process is explained in detail in the following sections.

3.1. Connections
Connections are made as shown in the figure 1 below. The Arduino Mega is connected with IR Array and RFID Reader using bread board connection. The Motor is controlled by motor driver. As the RFID Reader reads any input data from RFID tag it soon detects its position and starts navigating via a path set for it. The IR Array finds any obstacle on either side, if any found it soon reroutes itself into the obstacle less path. For this the power supply is given via a battery, attached to it.

![Figure 1. Connections-Line Diagram](image)

3.2. Block Diagram

The block diagram to automate the process is shown in the figure 2 below.

![Figure 2. Block diagram of the proposed system](image)

3.3. Working

The Line follower robot, first detects the book placed in the box via RFID. Then finds the location of the book and follows its lane via IR Array. The path is preloaded into the line follower hence the robot doesn’t go to any other lanes. After reaching its location, it navigates to its destination and halts there. For now, the loading and unloading of book is done manually.

Initially the Arduino is programmed with the respected software. Then the jumper wires are connected as per the above diagram. The motor drive is used to connect the Arduino to motor. Because the motor wants high power but Arduino works with 5V power supply so the motor is connected to driver circuit. IR array is used for follow the path. Mainly the array is used for more accuracy. All are combined together to make a bot.
4. Developed Model of Library Assist Robot

Design calculations were made and a suitable model of desired robot is designed in such a way that it is capable of handling the book at its best, the figure 3 shows the CAD model of the developed system for automating the process and the figure 4 shows the actual developed system for library automation.

![Figure 3. CAD model of library assist robot](image1)

![Figure 4. Developed library assist robot](image2)

5. Experimental findings

After implementing the developed system in the library it is found that the book handling time is reduced to an extent and the books are exactly placed in its position. It is also evidenced that the damaging of books is also reduced. The
Figure 5 compares the time taken for handling the books before and after implementing the system, from the graph it is evident that the time taken for stacking the books after implementing the system is reduced to an extent. The figure 6 compares the number of damaged books before and after implementing the system, from the graph it is clear that the number of books damaged is reduced after implementing the system in library.

![Figure 5. Time taken for stacking the books](image1)

![Figure 6. Number of books damaged.](image2)
6. Advantages

The main advantages because of implementing the system in the library are requirement of number of person to transfer the books can be minimized to an extent and they may be utilized for some other work. The human involvement in handling the books is reduced and the man power is utilized for some other task where it is unavoidable. There will be more accuracy and effectiveness in stacking the book exactly to its desired position and the damage of books is also reduced enormously. The time taken for stacking the books is also reduced and the valuable time of the readers is also saved as they can locate the desired book easier with minimum time as it is staked exactly in its predetermined position. The cost associated with the maintenance of book is also reduced because of less damage.

7. Conclusion

The RFID technology is one of the important user friendly technologies implemented in most of the libraries because of its effectiveness and efficiency. It is proved to be better than barcode system. Even though the initial investment in implementing RFID is looking higher, after break even period it is the best method for cost efficiency and it is even suitable for medium and small libraries. By implementing this technique one can experience more savings and customer satisfaction. This technology benefitted a lot the library staff and users in provision and service. The increasing volume of books is difficult to handle with man power and it has become a tedious process for stock taking and tracking of books. Lack of skilled person for book handling is also one of the major concerns. This leads to the development of this novel technique using RFID. It automates the book handling process and saves the time of both the staff and reader. Stacking of books become easier and more number of books can be stacked in less time with minimized man power. It also prevents the misplacing and theft of books. At initial stage the cost of implementation may seems higher but it is proved to be one of the economic technology for over years. Because of more experimenting in deploying RFID in libraries for automation, this technology in near future will become affordable for all type of libraries.

8. Future Scope

In future real time robots which consist of obstacle avoidance, automatic floor crossing, searching for a particular book, stock taking with advanced image processing and shortest path finding may be developed. By fully automating the book handling inside the library, the time taken for issue and return of books may also be reduced and the missing books can be found easier and it will also prevent the theft of books.

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