International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 06 | Jun 2024 www.irjet.net p-ISSN: 2395-0072

Library Management Using Robotic System(Line Follower Robot)

Sheetal N[1], Chandan M D[2], Mounesh U[3], Vaishnavi V Bidave[4], Anjan Kumar V[5]

[1]Assistant Professor, EIE, Dr. Ambedkar Institute of Technology, Bangalore, Karnataka, India
[2,3,4,5]B. E, EIE, Dr. Ambedkar Institute of Technology, Bangalore, Karnataka, India

---

Abstract –

A project centred on library management leveraging robotic systems encompasses the integration of automation into various facets of library operations. Initiated by identifying the inefficiencies inherent in manual processes like book sorting, shelving, and inventory management, the project aims to optimize these tasks through the utilization of robotics technology. The primary objectives revolve around reducing labour requirements, minimizing errors, enhancing accessibility, and ultimately improving the overall user experience within the library environment. Designing the robotic system entails carefully orchestrating both hardware and software components, including robots equipped with sensors and actuators alongside sophisticated control algorithms. These robots are programmed to execute functions such as sorting books based on diverse criteria, accurately shelving items, and managing inventory. Moreover, they may provide user assistance through intuitive interfaces, aiding patrons in locating books or accessing information. Throughout development, rigorous testing ensures reliability and safety, with user feedback informing iterative improvements. Upon deployment, the robotic system integrates seamlessly with existing library management software, and staff receive comprehensive training to operate and maintain it effectively. The project concludes with an evaluation of its impact on library operations, laying the groundwork for future enhancements and serving as a blueprint for similar initiatives.

Key Words: Microprocessor, Database management system (DBMS)

1.INTRODUCTION

Robots represent a transformative field of technology characterized by their ability to perform tasks autonomously or semi-autonomously, often in environments unsuitable for humans. These machines come in various forms, from industrial robots operating in factories to humanoid robots mimicking human actions and interactions. The key components of a robot typically include sensors for perceiving the environment, actuators for physical manipulation, and a control system governing their behaviour. Robots can be programmed to execute a wide range of tasks, from simple repetitive actions to complex decision-making processes. They have diverse applications across industries, including manufacturing, healthcare, agriculture, exploration, and service sectors. Recent advancements in robotics have led to the development of more agile and adaptable robots capable of learning from their interactions with the environment and collaborating with humans in collaborative settings. However, challenges such as ensuring safety, ethical considerations surrounding their use, and addressing societal impacts remain areas of active research and debate in the field of robotics. Overall, robots continue to revolutionize industries and daily life, offering the potential to augment human capabilities, improve efficiency, and tackle complex challenges.

1.1 PROBLEM STATEMENT

The problem statement for library management using a robotic system addresses the inefficiencies and challenges inherent in traditional manual library operations, highlighting the need for technological intervention to improve efficiency, accuracy, and user experience. In many libraries, tasks such as book sorting, shelving, and inventory management are predominantly manual processes, requiring significant time and labor from library staff. This manual approach often leads to errors, delays, and inefficiencies, hindering the library's ability to provide timely and seamless services to patrons. Additionally, the increasing volume of digital and physical resources in modern libraries exacerbates these challenges, necessitating a more scalable and automated approach to library management. By implementing a robotic system, libraries aim to streamline these labor-intensive tasks, reduce operational costs, and enhance the accessibility and usability of library resources for patrons. The problem statement thus emphasizes the pressing need for innovative solutions to modernize library operations and meet the evolving needs of library users in an increasingly digital world.

2. OBJECTIVES

The objective of implementing a robotic system in library management is to revolutionize traditional library operations, enhancing efficiency, accessibility, and user experience through automation and technological innovation. By introducing robotics technology into library environments, the primary goal is to automate labour-intensive tasks such as book sorting, shelving, and inventory management, thereby reducing the burden on library staff and freeing up their time for more value-added activities. Additionally, the objective includes improving the accuracy and reliability of library operations,

minimizing errors and inconsistencies in tasks such as cataloguing and inventory tracking. Furthermore, the implementation of robotic systems aims to enhance the accessibility of library resources by enabling round-the-clock services and providing innovative solutions for tasks such as book retrieval and patron assistance. Overall, the objective is to leverage robotics technology to modernize library operations, optimize resource utilization, and provide an enhanced and futuristic library experience for patrons, aligning with the evolving needs and expectations of users in an increasingly digital world.

3. BLOCK DIAGRAM

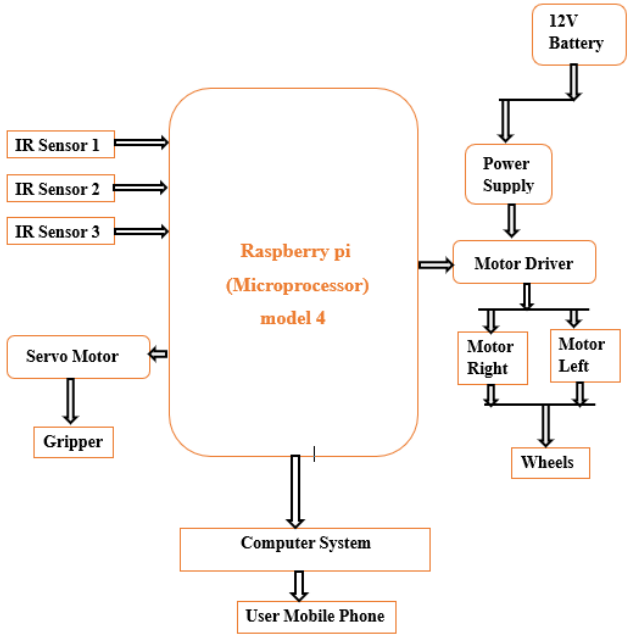

Fig 3.1 Block diagram

4. METHODOLOGY

The basic mechanism of the LIBRARY MANAGEMENT ROBOTIC SYSTEM is to issue and return the books by taking the inputs from the user. The system verifies the identity of the user by scanning their library card through the Graphical User Interface (GUI) using DBMS. The Graphical User Interface has been created using MongoDB from python. First the user enters the details of the book in the system which then access the reference number and the location details of the book.

The robot has the Raspberry pi 4 as the main processing unit and it is programmed using python programming language with the help thorny IDE. Next it will move to the specific location using the line follower algorithm and reach the rack where the book has been placed. The mechanical arm present on the robot has a clamp attached to it.

Robotic arm and then be placed in a basket present on the robot itself after which the robot will return back to the initial position i.e., the point of delivery of the book. The database is updated and the book is issued to the user.

Speed of the Robot:

To determine the speed at which the line-following robot will move with 60 RPM motors, we need to consider the following factors:

1. **Wheel Diameter:** The size of the wheels attached to the motors.
2. **Gear Ratio:** Any gear reduction or amplification between the motor and the wheels.

Calculating Linear Speed

The linear speed of the robot depends on the rotational speed of the wheels (in RPM) and the diameter of the wheels.

1. **Convert RPM to Revolutions per Second (RPS):**

$$RPS = RPM/60$$

For 60 RPM:

$$RPS = 60/60 = 1RPS$$

2. **Determine the Wheel Circumference:** The circumference C of the wheel is calculated using the wheel diameter D:

$$C = \pi \times D$$

(where $\pi \approx 3.141$).

The diameter of the wheel which we have used is 8.5 cm

8.5cm = 0.085m

$C = \pi \times D$

C = 3.14 x 0.085 = 0.266m

3. **Calculate Linear Speed:** The linear speed V of the robot is the product of the wheel circumference and the number of revolutions per second:

$$V = C \times RPS$$

Substituting the values:

V = 0.266 x 1 = 0.266 m/sec.

Gripper length & width:

Servo Angle to Rotation: The maximum angle range of servo motor is 120 degrees.

Lever Arm Movement: When the servo rotates, it moves the lever arm.

The linear movement L at the end of the lever arm can be approximated using the arc length formula:

$L=r \times \theta$

where r is the length of the lever arm and θ is the angle in radians.

Convert Degrees to Radians:

$\theta max = 120$ degrees

$radians=degrees\times(\pi/180)$

$radians = 120 \times (\pi/180) = 2 \times \pi / 3$

Calculate the Maximum Linear Movement:

$L(max) = r \times \pi$

$L(max) = 0.108 \times 2 \times \pi/3$

(r = 108mm)

L(max) = 0.22 mm

Gripper Opening Width:

The total opening width of the gripper is twice the linear movement (since the lever arm affects both sides of the gripper if symmetrically designed)

$W(max) = 2 \times L(max)$

$W(max) = 2 \times 0.22 \text{ mm} = 0.44\text{mm}$

5. RESULTS

The implemented library management system excelled across critical parameters. The Raspberry Pi-based robotic system demonstrated accuracy and efficiency in following the path and holding the book respectively. Additionally, the database management is also accurate in finding out the book location and students data.

Fig 5.1 Line follower

Fig 5.2 Robotic arm

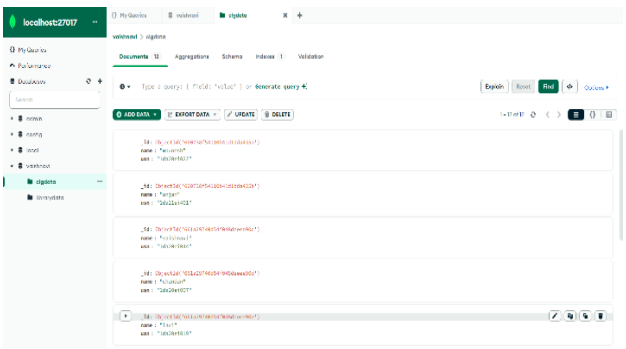

Fig 5.3 Student dataset

Table 5.1

Movement of the robot	Value of the sensors
Forward movement	Middle IR sensor = 1
Backward Movement	Back Middle IR sensor = 1
Right	Right IR sensor = 1
Left	Left IR sensor = 1
To stop the movement of the robot	All 6 IR sensor value = 0
opening of gripper	clockwise rotation of servomotor
closing of gripper	anticlockwise rotation of servomotor
Forward and Backward movement of arm movement	Clockwise & anticlockwise movement of DC motor

6. CONCLUSION

In conclusion, the integration of a robotic system in library management presents a transformative solution that enhances efficiency, accessibility, and user experience. By employing robotics, tasks such as shelving, inventory management, and book retrieval can be automated, minimizing human intervention and reducing operational costs.

Moreover, the implementation of robotic systems can significantly improve accessibility for users with disabilities, ensuring that all patrons can navigate the library effectively and independently.

Additionally, the utilization of robotics opens up opportunities for real-time data analytics and insights, enabling libraries to make informed decisions regarding resource allocation, collection development, and user preferences.

Overall, the incorporation of a robotic system into library management not only streamlines operations but also fosters a more inclusive and technologically advanced library environment, ultimately enhancing the overall experience for both patrons and staff alike.

7. REFERENCES

[1] Mayank Pathak, Manish Pandit, Surbhi Kanthed, and Rohit Sanvaliya, “Library management robot design and fabrication,” International Journal of Engineering Research & Technology (IJERT), vol. 5, no. 10, 2020.

[2] Ekram Hussain, Ambrish Shekhawat, Shubham Saini, Biraj Tamang, Sharath G S developed a model of Cylindrical Robot for Library Application. International Journal of Engineering Research & Technology (IJERT), vol. 5, no. 10, 2021.

[3] Fati, and Suliman Mohamed, "Automated library system using sms based pick and place robot," International Journal of Computing and Digital Systems, vol. 8, no. 6, 2019.

[4] Ester Martinez-Martin, Gabriel Recatala, and Angel P. del Pobil, “Transforming library operation with robotics,” Information Technology Satellite Meeting “Robots in libraries: challenge or opportunity?” Technical University of Applied Sciences, Berlin, Germany, pp. 21-22, 2020.

[5] Deepthi Unnikrishnan, Aswani C R, Arjun K Jayaprakash, and Ganesh S, “Library assistat robots in library management system,” International Journal of Engineering Research & Technology (IJERT), vol. 6, no. 01, 2019.

[6] B.R. Sathishkumar, M. Krishnaprabha, S. Priya, and M.Ragavi, “Automated library system using android based robot”, International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 2, 2020.

[7] Vaishal S. Pande, Suraj Yenurkar, Pranjali Landge, and Kajal Yadav, “Design of smart library assistant robotic system,” International Journal of Scientific Development and Research (IJSDR), vol. 4, no. 2, 2019.

[8]Sharath H.K., Shivashankar B.S. presented Book Handling Robot for Libraries. International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 2, 2020.

[9] Ramanan N.V. and Mr. K. Manoj Senthil, “Library management system to issue and retrieve books from user using autonomous robot,” Asian Journal of Applied Science and Technology (AJAST), vol. 2, no. 2, pp. 707-715, 2019.