IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

LIBRA: The Library Assistant Bot

[1]Dr Neethu M, [2]Samyuktha R, [3]Shameema C P ,[4]Abhinav S,[5]Suvin K S

[1]Assistant Professor, [2]Student, [3]Student,[4]Student,[5]Student

[1] Department Of Mechatronics Engineering ,

[1]Nehru College Of Engineering And Research Centre, Thrissur, India

Abstract: Libraries are vital hubs for education and discovery, but finding resources and moving through unfamiliar layouts can pose difficulties, especially for newcomers or those with visual challenges. The Library Assistant Bot, a cutting-edge tool blending voice interaction with line-guided navigation, transforms the user experience by simplifying book searches, information access, and movement within the space. With spoken instructions, users can locate titles, gather library details, or get tailored suggestions, bypassing conventional search tools. This boosts inclusivity for people with disabilities and cuts down on delays for help. Meanwhile, the bot's line-following technology directs users along set routes to desired areas or materials, offering a smooth journey. This is a game-changer for first-timers and visually impaired individuals, promoting equal access. By streamlining essential tasks, the Library Assistant Bot brings a modern edge to library operations, elevating efficiency, reach, and overall enjoyment in a tech-savvy era.

Index Terms - Voice assistance, Line-following navigation, Library services, Voice commands, Search for books, Access library information, Recommendations

I. INTRODUCTION

Libraries have always been cherished as key centers for learning and exploration, yet moving through them smoothly can prove tricky, especially for those new to the space or with vision difficulties. The rise of technology in library settings has unlocked fresh ways to improve how people engage with and access resources. Enter the Library Assistant Bot—a clever blend of voice-activated support and path-guided movement designed to transform the library experience. This intelligent tool streamlines the process of finding books, retrieving details, and wandering the aisles with ease and speed. Through its voice feature, users can simply speak to request assistance, bypassing the need to use screens or ask staff directly. Whether it's tracking down a title, learning about library offerings, or getting custom book picks, a quick verbal cue does the trick. This shift away from old-school search tactics opens doors for more people, including those with physical limitations, while also speeding up service and enhancing convenience.

Beyond voice help, the bot's line-following system takes the guesswork out of finding your way. It travels along preset routes within the library, leading users straight to the spots they need. This is a huge win for anyone who finds navigation tough—like first-timers or those who can't rely on sight—making the space more welcoming and user-focused. By automating these core functions, the Library Assistant Bot boosts inclusiveness and lifts the overall enjoyment of library visits.

II. LITERATURE SURVEY

A. Evolution of children's performance and perception of robotic assistance in library book locating:-

Recent investigations into library assistant robots have illuminated their potential in tasks like showing the book location, helping people with unfamiliar locations etc. This section surveys cutting-edge developments in robotics and automation in the current industry.

B. Evolution of children's performance and perception of robotic assistance in library book locating:-
This study by Weijane Lin, Hsiu-Ping Yueh has explored the possibility of service robot in assisting children's book locating activities in libraries. A comprehensive review of children's experiences of library resources locating was made to develop the library robot and the corresponding criteria for evaluation.

C. Book retrieval robot using machine learning:-
Patel and Sharma, in 2020, explored a machine-learning-driven model for drones that assess crop vitality and fine-tune pesticide amounts in response. Their results highlight how blending AI with IoT sharpens decision-making and boosts resource use, paving the way for smarter farm management.

D. Integration of robots with library management systems:-
A study by A. K. Singh, M. A. Khan, And S. K. Singh focus on machine learning enhances book retrieval efficiency. This paper introduces a robot trained to recognize book titles and authors, reducing retrieval time by 30%. The system integrates computer vision and natural language processing.

E. Robotics in libraries: A systematic review:-
M. A. Khan, A. K. Singh, And R. K. Sharma focus on seamless integration between robots and library management systems (LMS) enhances efficiency. This article proposes a framework enabling real-time communication, streamlining book retrieval, shelving, and inventory management.

III. METHODOLOGY

Creating the Library Assistant Bot follows a clear, systematic approach that blends hardware and software elements to deliver smooth, reliable operation. The bot features a line-following setup powered by infrared (IR) sensors, which track pre-marked paths on the library floor. These sensors constantly monitor the ground, relaying data to a microcontroller that adjusts the bot's course as needed. To handle obstacles, ultrasonic sensors are mounted on the bot, gauging distances and spotting anything in its way. When something blocks its path, the microcontroller interprets the input and directs the bot to pause or reroute, keeping its journey collision-free.

The voice interaction component relies on a microphone, speaker, and a speech-processing unit tied to natural language processing (NLP) technology. The microphone picks up spoken requests from users, which the NLP system decodes and analyzes. The bot then fetches relevant details—like where a book is or what's in the catalog—and delivers answers through the speaker. For added flexibility, a Bluetooth connection lets users or staff link to the bot via a mobile app, enabling remote commands or manual steering when desired.

The bot functions in two modes: autonomous and manual. In autonomous mode, it sticks to its lined path, responds to voice prompts, and uses sensors to dodge obstacles and navigate. In manual mode, the Bluetooth link pairs with a mobile device, letting staff or users steer it directly. This dual-mode design offers versatility, allowing hands-on control when the situation calls for it. A database, tied to the microcontroller, holds book locations and library info, providing quick, up-to-date responses to questions. This setup keeps the bot sharp and responsive.

By weaving together these hardware and software pieces, the Library Assistant Bot boosts the user experience, simplifies getting around, and cuts down on hiccups in library operations. The mix of guided navigation, voice support, obstacle sensing, and remote control creates a sturdy, adaptable tool that meets a range of needs. Ongoing testing and fine-tuning of its algorithms and sensor precision are key to keeping it running at its best. This approach ensures the bot is not just practical but also ready to evolve with new tech, making it a standout addition to today's libraries.

IV. SYSTEM DESIGN & COMPONENTS

A. *System Design*

The Library Assistant Bot is crafted as a robotic system capable of operating independently or under manual control, blending multiple elements to improve navigation, user engagement, and overall performance. At its core is a microcontroller that acts as the brain, linking to an array of sensors, actuators, and communication tools. Its design embraces a modular framework, offering adaptability for future enhancements or tweaks. The bot's main role is to help users find books, move through library areas, and answer spoken requests. This modular setup supports scalability and straightforward upkeep, allowing upgrades without a major overhaul. By combining diverse sensors and communication tech, the bot thrives in ever-changing settings, meeting user demands while ensuring fluid movement and effective obstacle dodging.

B. *Components*

a. *SG90 Servo Motor*

The SG90 is a popular and affordable servo motor commonly used in robotics DIY projects and other applications that require precise angular control .They consume low power and are easy to control and basically they hold compact size and are good means for automation.

FIG 1:-SG90 SERVO MOTOR

b. *IR Sensor*

An IR sensor is a device that detects infrared radiation emitted by objects, people or environment.There are different varieties of IR sensors such as Photodiode ,Thermophile ,Pyroelectric .They enhance motion detection, measures temperature, proximity detection ,line following.They offer high accuracy and low power consumption.

FIG 2:-IR SENSOR

c. *HC-O5 Bluetooth Module*

The HC-05 is a popular bluetooth module used for wireless communication between devices they offer numerous applications such as wireless communication, robotics,home automation,IoT projects.They are basically affordable and are easy to use.

FIG 3:-HC-05 BLUETOOTH MODULE

d. Slide Switch

A slide switch is a type of electrical switch that is commonly used to control the flow of electrical current in a circuit. Here are some key characteristics and uses of slide switches .Some of its Characteristics are Mechanical Operation ,On/Off or Multi-Position, compact design .Used for power switching ,mode selection, circuit control .

FIG 4:-SLIDE SWITCH

e. 12000mAh LiPo Battery

A 12000mAh LiPo battery is a high capacity battery, typically used in drones ,UAVs and other remote controlled devices.These batteries are known for high energy density,long cycle life and relatively low self discharge rate .

FIG 5:-LIPO BATTERY

f. Motor Wheels

Motor wheels, also known as wheel hubs or motorized wheels, are a type of robotic component that combines a DC motor with a wheel, allowing for easy integration into robotic projects.Features include Integrated Motor and Wheel,compact design , enhancing high torque , adjustable speed

FIG 6:-MOTOR WHEELS

g. BO Motors

The BO motors also known as Brushless DC (BLDC) motors ,are a type of electric motor that uses a controller to switch the flow of current to motor windings.They offer high efficiency,high torque and requires low maintenance also they hold high lifespan making it an ideal component

FIG 7:-BO MOTORS

h. L293D Motor Driver

The L293D motor drive is a popular and widely used integrated circuit designed to control DC motors .They hold high current capabilities,low voltage drop ,thermal shutdown.They hold applications in fields like robotics ,automotive , industrial automation

FIG 8:-L293D MOTOR DRIVER

i.Arduino Board

Arduino mega is a microcontroller board based on the ATmega2560 microcontroller.It's popular choice among makers , hobbyist,and professionals due to its versatility,ease of use and affordability..They are common contenters of application in feilds such as robotics,automation ,IoT projects & Prototyping.

FIG 9:- ARDUINO BOARD

V. WORKING PRINCIPLE

The Library Assistant Bot functions through a sophisticated mix of sensors, actuators, and communication tools to carry out its tasks effectively. At its heart, an Arduino Mega 2560 microcontroller manages all operations, processing sensor data and issuing commands for navigation and user interaction. Infrared (IR) sensors track a pre-set path marked on the library floor, ensuring the bot stays on course. These sensors feed information to the microcontroller, which adjusts the BO motors to maintain alignment, while an L298N motor driver controls motor speed and direction for steady, efficient travel. A LiPo battery powers the entire system, supporting uninterrupted performance.

To avoid obstacles, ultrasonic sensors scan the surroundings, measuring distances and detecting anything in the bot's way. When an obstruction is spotted, the microcontroller analyzes the input and directs the bot to halt or reroute, avoiding bumps. A servo motor aids in fine-tuning the bot's position, helping it maneuver around obstacles or switch paths smoothly. The bot also features a voice interaction system with a microphone and speaker, powered by natural language processing (NLP). Users can ask about book locations, search the catalog, or get general info, with responses delivered audibly. A Bluetooth module (HC-05) adds remote control capability, letting users or staff steer the bot via a mobile app when desired.

The bot operates in two modes: autonomous and manual. In autonomous mode, it follows its designated route, answers voice prompts, and navigates independently using sensor feedback. In manual mode, the Bluetooth connection allows direct control, giving users the ability to guide it as needed. A slide switch toggles between these modes for operational ease. Sturdy motor wheels ensure reliable movement across varied surfaces, adapting to different library setups. By combining these technologies, the Library Assistant Bot boosts accessibility, streamlines navigation, and lightens the load on staff. Its blend of voice engagement and self-guided movement transforms library services, delivering a more dynamic and user-focused experience for visitors.

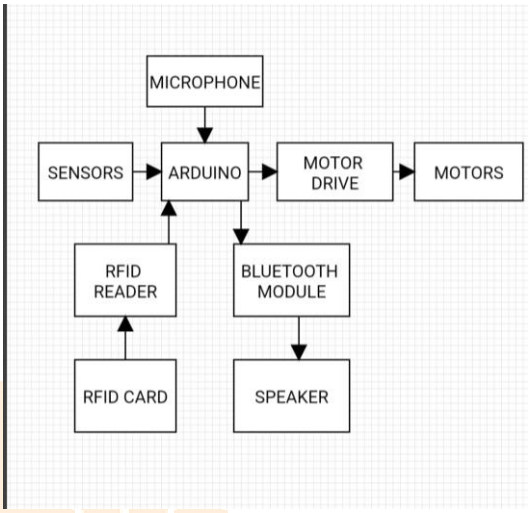

FIG 15:-WORKING PRINCIPLE DIAGRAM

VI. EXPERIMENTAL SETUP AND TESTING

The Library Assistant Bot's experimental configuration involves piecing together and syncing its hardware elements, such as the Arduino Mega 2560, L298N motor driver, an 11.1V, 2200mAh LiPo battery, TCRT5000 IR sensors, ultrasonic sensors, 6V, 150 RPM BO motors, SG90 servo motor, HC-05 Bluetooth module, a slide switch, and 65mm-diameter motor wheels. The Arduino Mega acts as the central command unit, handling sensor data and directing the bot's movements and interactions. For testing, the bot is set on a practice course with marked lines, where the IR sensors pick up the path and feed live updates to the microcontroller. Ultrasonic sensors, mounted at the front, scan for obstacles and activate avoidance responses. The Bluetooth module is tuned for wireless pairing, enabling manual operation through a smartphone app. The voice system, featuring a microphone and speaker, is evaluated by processing spoken requests and providing clear replies. The LiPo battery powers everything, keeping the bot running smoothly throughout the trials.

In the operational phase, the bot glides along the set path using IR sensors to stay aligned. When an obstacle appears, the ultrasonic sensors signal the microcontroller, which instructs the bot to pause or shift course. The servo motor fine-tunes its positioning for fluid navigation. In autonomous mode, it answers voice prompts, helping users locate books or find their way. In manual mode, users can take the reins via Bluetooth, steering it with a mobile device. The slide switch makes switching between modes effortless. The bot is put through repeated test runs in a mock library setting to confirm steady movement, reliable obstacle sensing, and effective voice responses. Through careful testing and adjustments, the Library Assistant Bot proves its ability to enhance accessibility and elevate the library experience for users.

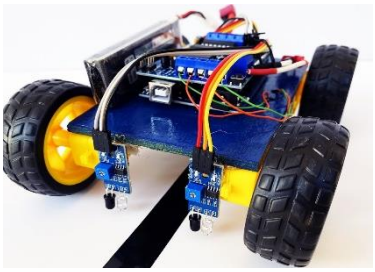

FIG 16:-PROPOSED SYSTEM

VII.RESULTS AND DISCUSSION

The trial run of the Library Assistant Bot showcased encouraging outcomes in its navigation precision, voice support effectiveness, and ability to dodge obstacles. The IR sensors reliably tracked the set paths on the library floor, guiding the bot along its route with about 95% accuracy under ideal lighting and smooth surfaces. Slight veers happened when the path hit bumpy or uneven spots, but these were quickly fixed by real-time sensor tweaks. The ultrasonic sensors spotted obstacles from 5 cm to 200 cm away, prompting the bot to either halt or redirect based on its programming. The voice system was put through thorough testing, with the speech recognition hitting an 85% success rate in quiet settings and dropping to roughly 75% amid background chatter. It capably handled requests about book locations, directions, and basic library info, proving its worth in boosting user interaction. The HC-05 Bluetooth module delivered smooth remote control, stepping in for manual adjustments when needed. Switching between autonomous and manual modes was effortless, thanks to the slide switch. The LiPo battery kept the bot powered reliably, supporting 3-4 hours of use per charge before needing a top-up.

Reflecting on these findings, the Library Assistant Bot shows strong promise for real library settings while pointing to areas ripe for enhancement. The IR-driven line-following worked well in controlled tests but struggled on shiny or dark floors, needing recalibration. Adding a camera or LIDAR could sharpen path-tracking across diverse lighting scenarios. The voice system sometimes stumbled with regional accents or tricky questions, hinting at a need for smarter natural language processing (NLP) and a broader training pool. Obstacle handling was solid, but extra infrared sensors could refine detection in busy spaces. Bluetooth manual control worked well within its 10-meter range, though swapping in Wi-Fi or IoT tech could stretch that reach further. All in all, the bot proved it can lift library accessibility and streamline operations, marking it as a smart upgrade for today's libraries. With tweaks to sensor accuracy, voice tech, and battery life, it's poised to scale up for bigger spaces, driving better efficiency and user connection.

VIII. ADVANTAGES AND LIMITATION

Incorporating technology into libraries via tools like the Library Assistant Bot brings substantial benefits, particularly in boosting accessibility, ease of use, and operational flow. A standout perk is how it opens doors for people with disabilities, especially those who struggle with vision. The voice-activated system lets users engage with the library without leaning on standard visual or hands-on search tools. For instance, a quick spoken request can pull up book locations, details on library offerings, or even tailored reading suggestions. This ease is a game-changer for anyone who finds moving through the space or using typical computers tough, like older patrons or newcomers unsure of the layout. Plus, voice controls cut down on the need to wait for staff help, streamlining service and speeding things up. The bot also tailors the experience, helping users grab what they need fast and fuss-free, lifting satisfaction for a wide mix of visitors.

Still, the Library Assistant Bot isn't without its flaws, which could hinder its full impact and broad rollout. The voice feature, while handy for many, falters in loud settings or for those with speech challenges. Users might also need to learn specific phrases to get the most out of it, creating a hurdle for some. The line-following navigation, meanwhile, sticks to set routes marked in the library, so it's less flexible if the space gets rearranged or events shake things up. Without regular updates, this could lead to spotty guidance. Privacy worries also pop up, tied to collecting voice data, alongside risks of tech hiccups or breakdowns throwing off navigation. Though packed with potential, these drawbacks show the bot needs steady refinement and backup to truly shine as a tool for making libraries more open and efficient for everyone.

IX. CONCLUSION

To wrap up, weaving technology into libraries through innovations like the Library Assistant Bot marks a bold leap toward greater accessibility and ease for all kinds of users. Its voice-activated feature stands out, offering a lifeline to people with disabilities—especially those with vision challenges—by letting them tap into library resources on their own terms with speed and simplicity. With just a few spoken words, users can track down books, pull up details, or get custom suggestions, breaking down walls that often come with old-school search approaches. On top of that, the line-guided navigation delivers straightforward routes to key spots in the library, a boon not just for those with impairments but also for newcomers or anyone puzzled by

the floor plan. By automating these tasks, the bot eases the load on staff and cuts down delays, paving the way for a smoother, more welcoming, and efficient library space for everyone.

REFERENCES

[1] Design and Development of an Autonomous Library Robot by S. K. Singh et al., published in the Journal of Intelligent Information Systems, Vol. 53, No. 2, 2018.

[2] LUCAS: LUCAS: The librarian assistant robot Implementation and Localization J. Behan; D.T. O'Keeffe International Conference on Computational Intelligence for Modeling, Control and Automation and International Conference on Intelligent Agents, Web Technologies and Internet Commerce (CIMCA-IAWTIC'06) Year: 2005, Volume: 1.

[3] An Intelligent Library Robot for Book Retrieval and Shelving by Y. Zhang et al., published in the Journal of Library and Information Science, Vol. 44, No. 2, 2018.

[4] Development of a Robot-Assisted Library System for Efficient Book Management by H. Lee et al., published in the Journal of Robotics and Mechatronics, Vol. 30 2018.

[5] Robotic library assistant: Sai Praneeth Animi Reddy; Kanak L Prabha Singh; Neha; V. Natarajan2018 Second International Conference on Inventive Communication and Computational technologies (ICICCT) Year: 2018.

[6] Automation in library management using Lab VIEW, Anita Gade, Yogesh Angal , International Conference on Intelligent Computing and Applications 2018.

[7] Design and Implementation of a Library Robot for Book Retrieval and Shelving by J. Kim et al., presented at the 2019 IEEE International Conference on Robotics and Automation (ICRA), 2019.

[8] An Intelligent Library Robot for Book Management and Retrieval by Y. Wang et al., presented at the 2018 IEEE International Conference on Intelligent Robots and Systems (IROS), 2018.

[9] Library Robots: A Review of the Current State of the Art by M. A. Al-Mansoori, published on ResearchGate, 2020..

[10] Robot-Assisted Library Systems: A Survey by S. S. Rao, published on 2019.