Human Tracking Robot Using QR Code Recognition

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ABSTRACT

In this project, we will build a robot that can follow a person using QR codes; later on, we will also make it better at avoiding obstacles. The Raspberry Pi 3 A+ acts as the central processing unit (CPU) for the robot. In order to uniquely identify the chosen person, the Pi Camera takes pictures that are then analyzed to identify and decipher QR codes. This gives the robot the ability to move about on its own by precisely following the person in a predetermined area. The Raspberry Pi's computing capacity allows the robot to scan images, regulate its movements, and process data from its sensors all at once, guaranteeing a seamless functioning.

The L293D motor driver, which receives its instructions from the Raspberry Pi, is responsible for controlling the robot's movement. Based on the positioning data from the QR code, this motor driver allows the robot to go forward, backward, or turn with exact control. Users may now remotely monitor and operate the robot using a web interface, providing an easy way to make modifications and keep an eye on it in real-time. Making the system more flexible to diverse contexts or operational needs, this remote feature offers a degree of flexibility by allowing users to intervene or change tracking activities as required.

A useful interface for showing operating data in real-time is provided by the incorporation of an LCD panel. Users are able to quickly evaluate the robot's performance thanks to this display, which provides data from sensors, the robot's current state, and QR codes. Furthermore, the system has an SD card module that acts as a data recording tool. An essential tool for post-operation analysis and troubleshooting, this module retains key information such as tracked history, QR code data, and taken photographs. Users may obtain performance data—critical for long-term system improvement and debugging thanks to the data storage feature.

In the second stage of the project, an ultrasonic sensor is added to the robot's capability, enhancing its ability to avoid obstacles. The ultrasonic sensor makes it easy for the robot to traverse even the most intricate surroundings by detecting and avoiding obstructions. Applications in dynamic areas necessitating the robot's

ability to function autonomously highlight the significance of this characteristic. The robot gains a great deal of flexibility and can now autonomously avoid obstacles and follow its objective in any environment thanks to the integration of QR code tracking with this feature. Combining these two features makes the robot more suitable for use in homes, businesses, and healthcare facilities, where monitoring and security are paramount.

The seamless integration of real-time tracking, obstacle avoidance, and user accessibility results in a robust and versatile robotic system that offers endless possibilities. Caregiving for the elderly, personal help, and autonomous interior navigation are all examples of jobs that might benefit greatly from the robot's design, which prioritizes safety without sacrificing accuracy. This system is a suitable option for many different tasks since it provides great performance utilizing cost-effective technologies like the Raspberry Pi and Pi Camera. Gaining practical experience in the development and programming of intelligent autonomous systems while gaining a solid grounding in robotics, image processing, and embedded systems is another great benefit of this project.

I.INTRODUCTION

A state-of-the-art approach to individualized assistance is the incorporation of QR code-based human tracking into mobile robotics, which enables robots to consistently follow and engage with certain people. QR codes are ideal for real-time navigation and localization since they can be scanned quickly and store a lot of data. Robots are able to continually detect and follow people in ever-changing settings because of the unique IDs encoded into these codes. In settings where precise human engagement is crucial for functioning and service, such as smart homes, retail, or healthcare, this technology improves the robot's capacity to provide tailored assistance.

1.1 Project Overview

The goal of this project is to build a human-tracking robot that can accurately follow people in busy interior settings like airports, hospitals, and retail centers by recognizing QR codes. A camera is used by the system to read and interpret Quick Response (QR) codes that are connected to things or people; these codes serve as identifiers. The robot determines its relative location to the target and modifies its trajectory appropriately to maintain an ideal distance from the subject once the QR code is detected. This approach uses distinct visual identifiers for each item or person to improve tracking accuracy in comparison to conventional motion-sensing systems.

Together with the QR code scanner, the robot will also include a localization algorithm that will tell it where it is in relation to its surroundings, allowing it to navigate with ease. To ensure the robot follows the monitored person with minimum mistake, the navigation module will guide its movement. The robot will be able to handle intricate environments with ease because to the design's obstacle recognition and avoidance features. The incorporation of these technologies allows the robot to function independently in dynamic surroundings, offering a dependable and flexible solution for real-time human monitoring in a range of public and professional contexts.

1.2 Objectives

1. Detection and Recognition of Quick Response (QR) Codes: Develop a reliable system capable of reading QR codes in a variety of environments and lighting conditions.

Second, find out where the robot is in relation to the QR code by combining sensor readings with computer vision techniques. Pose estimation and localization will be made possible by this.

Finally, in Step 3, you'll need to figure out how to navigate and plan the robot's paths so that it may safely follow the tracked item while avoiding hazards.

Fourth, see to it that there is little lag time between the robot's response after QR code detection and the system's operation in real-time.

The fifth section is user interaction and the interface. Create an easy-to-use interface so that humans may start and stop the tracking operation and other robot functions.

Perform extensive testing in various controlled indoor environments to validate the system's functioning and reliability.

II.LITERATURE SURVEY

One important part of the development of mobile robots is the use of QR code-based systems, which provide an accurate and dependable way to locate and follow people in different types of interior settings. An early study by Eimon et al. (2011) presented a robot that could monitor humans using QR code recognition. Their technology recognized QR codes, matched shapes using pattern recognition, used infrared cameras with retroreflectors for auxiliary re-detection, and used robot control mechanisms to keep a safe distance from the target as part of a multi-step process for localization and identification. With a 99.9 percent identification rate for QR codes and strong monitoring capabilities, the outcomes showed great efficiency. Future developments in mobile robots were paved by the successful use of QR codes for real-time dynamic human monitoring.

Expanding upon this, Bach et al. (2023) investigated a more contemporary method for indoor localization by combining QR code recognition with dead reckoning data. This technique substantially reduced the amount of QR codes needed by adhering them to the walls of interior places. The codes included global coordinates. After detecting the QR code, the robot used it to calculate the transformation between itself and the code. To fix its attitude, it employed an extended Kalman filter. By combining QR code detection with dead reckoning, the localization accuracy was improved, as inaccuracies often seen in non-visual data were corrected. According to their research, QR codes are an effective tool for accurate navigation in complicated interior settings when combined with other localization methods.

In a groundbreaking system for indoor navigation using ceiling-mounted QR codes as artificial landmarks, Lee et al. (2015) offered more advancements in QR code-based localization. The QR code recognition and localization capabilities of this system were powered by an Android smartphone that was seamlessly linked with the robot. The mobile robot's global location inside a building was determined by recognizing QR codes on the ceiling. A 3D optical tracking equipment confirmed the technology. This arrangement demonstrated the practicality and advantages of QR codes posted on the ceiling in large-scale indoor venues. It is a cost-effective way for mobile robots to navigate without the need for constant calibration or costly infrastructure.

To improve the accuracy of indoor navigation, Zhang et al. (2015) presented a hybrid system that used laser range finders in conjunction with QR code-based localization. In addition to providing worldwide position references, the QR codes and laser range finders worked together to create a precise map of the area and identify any obstructions in its path. To eliminate any collisions and find the shortest, most efficient route, the Dijkstra algorithm was used for path planning. The findings demonstrated that the robot's operating efficiency in congested or obstacle-heavy areas was significantly enhanced by integrating QR codes with laser range finders, allowing it to reliably and efficiently traverse complicated situations with fewer mistakes.

A novel indoor navigation system for an aid robot was created by Sneha et al. (2020). This system made extensive use of QR codes for positioning and route planning. The setup relied on a Raspberry Pi camera-mounted to identify and decipher QR codes strategically positioned throughout the area. The robot achieved remarkable indoor navigation accuracy by using triangulation for localization and Dijkstra's algorithm for route calculation. A holographic cellular USB modem allowed for real-time monitoring and feedback, guaranteeing the system's responsiveness and dependability. In interior environments like hospitals, workplaces, and shopping malls, mobile robots found an effective and scalable navigation solution using the combination of QR codes and triangulation.

Another major step forward in the area was the 2016 investigation of the possibility of integrating omnidirectional and front-view cameras to improve robot self-localization. Using an all-view camera, the system could swiftly identify and follow many QR code landmarks from all directions. To improve localization accuracy, the front-view camera then supplied long-range, accurate measurements of landmark locations. This combined method outperformed the use of each camera type alone, providing more adaptability and stability in unpredictable settings. Multiple vision system integrations demonstrated the increasing adaptability and dependability of QR code-based systems in mobile robots, showcasing their maturation as a technology.

The increasing significance of QR codes in indoor navigation and human monitoring is highlighted by these advances. One of the numerous problems with robot localization is the need for very precise tracking and navigation in chaotic, ever-changing settings. Quick response (QR) codes provide a straightforward and efficient solution to this problem. Quick response (QR) codes are growing in versatility as a tool for robotic systems, whether utilized as permanent reference points on walls, ceilings, or in the surroundings. They are perfect for mobile robots that will be operating in different interior environments because of their high data storage capacity and quick, accurate recognition.

To sum up, thanks to ongoing improvements in QR code-based technologies, advanced mobile robots with human tracking and navigation capabilities have been developed. The integration of technology like cameras, laser range finders, and sophisticated algorithms with QR code recognition has allowed mobile robots to navigate more intricate settings. Not only do these advancements make human-tracking robots safer and more efficient, but they also help advance autonomous mobile robotics as a whole, which in turn benefits sectors like healthcare, retail, and customer service. Adding QR codes to robots is a great way to boost their performance, making these systems valuable for creating autonomous, intelligent robots that can do real-life tasks.

III.BLOCK DIAGRAM

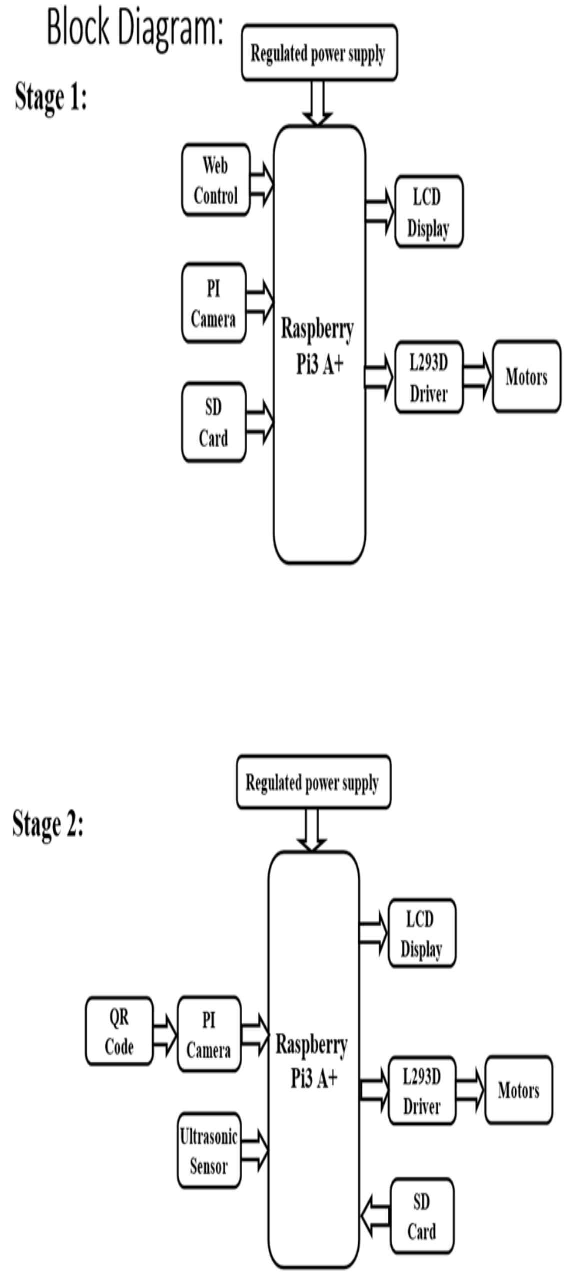
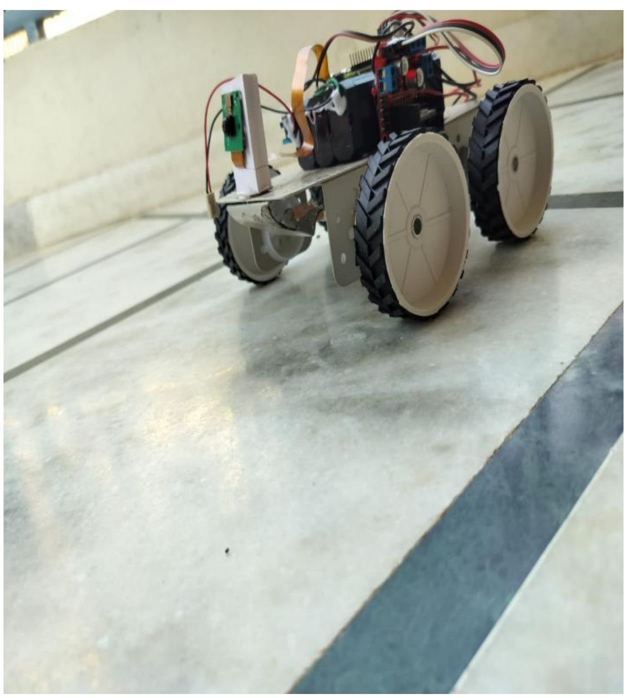


FIG 3.1: Block diagram of Human-tracking Robot Using QR Code Recognition

IV. RESULTS

4.1 Result:

An excellent solution for tailored assistance in varied contexts was successfully produced by this project: a human-tracking robot that uses QR code recognition to follow a selected individual. With the use of a remote web interface, the robot can be controlled with ease, and an integrated LCD screen allows for real-time feedback. Ensuring smooth movement and precise control is the L293D motor driver, while essential operational data may be stored on an SD card module for analysis and troubleshooting. Future enhancements, such as obstacle identification and avoidance, will increase the robot's capacity to traverse dynamic situations with more autonomy, and the system offers a dependable and cost-effective platform for autonomous tracking. The project showcases the real-world use of robotics-related computer vision and embedded technologies.



QR CODE

ADVANTAGES:

Rely on QR code detection for pinpoint tracking.

• Controlled remotely: a web interface makes it easy to operate, giving you more freedom.

Get instantaneous feedback on the progress of your tracking with our real-time data display.

• Data Storage: Snaps pictures and saves information from QR codes to an SD card.

The regulated power supply guarantees dependable operation, which leads to stable performance.

• Adaptable Use Cases: Great for surveillance, interactive assistance, and security

APPLICATION:

• Healthcare: Monitor assets, personnel, and patients at healthcare facilities.

• Retail: Keep an eye on the people working and shopping at malls.

Warehouse staff and shipments may be followed with logistics software.

• Safety: Step up monitoring in high-traffic areas or public places.

CONCLUSION

In conclusion, the QR code-based human-tracking robot accomplishes flawless tracking and navigation by skillfully integrating cutting-edge technology with functional design. Utilizing a Pi Camera, motor driver, and data storage components in conjunction with a Raspberry Pi, the system is able to function with exceptional efficiency and versatility. This design is perfect for surroundings that are always changing since it combines accuracy with the ability to be controlled remotely. The robot will become even more adaptable and sturdy with future upgrades, such as the ability to identify and avoid obstacles. The experiment highlights the possibilities of autonomous robotic systems with low costs that may be used in practical situations.

FUTURE SCOPE

Upcoming work on this project will focus on enhancing the robot's capabilities via the integration of state-of-the-art technology. With improvements like ultrasonic or LiDAR-based real-time obstacle identification and avoidance, the robot will be able to traverse complicated terrain with more accuracy. Its tracking capabilities might be further enhanced with the use of machine learning algorithms, enabling more precise navigation and interaction in dynamic environments. There will be more opportunities for the robot in fields like logistics, healthcare, and security if its capabilities are improved, its energy efficiency increased, and it can follow many people at once. The system will be useful in a broad variety of practical use cases and will be adaptable to varied contexts thanks to continual advances.

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