

Web Server Controlled Rover with Robotic Arm and Object Detection

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Abstract - This project presents the design and implementation of a web server-controlled rover equipped with a robotic arm and real-time object detection capabilities. The system is built on a Raspberry Pi, which handles control, image processing, and object detection using a connected camera. The rover's mobility is facilitated by DC motors, a motor driver, and a robust chassis with wheels, while the robotic arm enables object manipulation. An IP camera provides a live video feed for remote monitoring. Users can control the rover and arm through a web interface, allowing real-time navigation and task execution. This integrated system demonstrates efficient remote operation, autonomous object detection, and versatile robotic control, making it suitable for applications in surveillance, material handling, and exploration.

Key Words: Raspberry pi, Object detection, Remote control, Robotics etc.

1. INTRODUCTION

This project focuses on the development of a versatile, web-controlled rover integrated with a robotic arm and real-time object detection capabilities. Built around a Raspberry Pi, the system handles mobility, image processing, and object recognition through a connected camera, while DC motors and a motor driver provide smooth navigation on a robust wheeled chassis. The robotic arm allows for precise object manipulation, and an IP camera streams live video to a web interface, enabling users to remotely monitor and control the rover and arm in real time. By combining remote operation, autonomous detection, and flexible robotic control, this system offers a practical solution for applications such as surveillance, material handling, and exploratory missions.

2. LITERATURE SURVEY

This paper presents a review of recent developments in robotic surveillance, IoT-based monitoring, and vision-enabled autonomous systems used for intelligent automation and remote operation. Earlier research demonstrated the design of mobile robotic platforms capable of surveillance and environmental monitoring through wireless communication and embedded processing units, enabling remote navigation and real-time observation in hazardous environments. With the advancement of single-board computing technologies, researchers implemented Raspberry Pi-based systems that support live video streaming and web-based remote control, improving flexibility and accessibility without the need for complex hardware configurations. Significant progress has also been achieved in computer vision and object detection, where deep learning-based algorithms enable accurate real-time identification and tracking of objects, enhancing robotic perception and decision-making capabilities. Motion detection and optimized video processing techniques further reduced computational load and storage requirements while maintaining continuous monitoring performance. In addition, studies on sensor technologies improved obstacle detection and navigation reliability using ultrasonic sensing and sensor fusion approaches, increasing operational safety for mobile robots. IoT-enabled robotic systems integrated cameras, sensors, and cloud or web communication frameworks to facilitate real-time data transmission and user interaction through web interfaces with low-latency communication. Recent research has emphasized scalable IoT architectures that allow multiple robotic devices to operate under centralized monitoring and coordinated control. However, many existing systems focus on individual functionalities such as surveillance, sensing, or object detection independently. Therefore, this paper proposes a Web Server Controlled Rover with Robotic Arm and Object

Detection that integrates mobility, real-time video streaming, intelligent object detection, robotic arm manipulation, and web-based remote control into a unified system, providing an efficient solution for surveillance, monitoring, and automated object handling applications.

3. EXISTING SYSTEM

Traditional rover systems are typically controlled via direct RF or Bluetooth communication, offering limited range and requiring manual operation. Object detection and robotic arm functionalities are often either absent or implemented as separate modules, requiring multiple devices and complex interfacing. Live video feedback, if available, is usually restricted to local monitors, making remote operation challenging. These systems lack integrated web-based control, limiting their applicability in tasks that require real-time monitoring and manipulation from a distance.

4. PROPOSED SYSTEM

The proposed system is a web server-controlled rover integrated with a robotic arm and real-time object detection. It uses a Raspberry Pi as the main controller for processing camera data and running object detection algorithms. DC motors with a motor driver power the rover's wheels, while the robotic arm allows manipulation of objects. An IP camera provides a live video feed to the web interface, enabling remote monitoring and control. Users can navigate the rover, operate the arm, and detect objects in real time through the web interface. This model enhances traditional designs by combining mobility, manipulation, object detection, and remote operation into a single, integrated platform.

The block diagram of the proposed system is shown in below Figure 1.

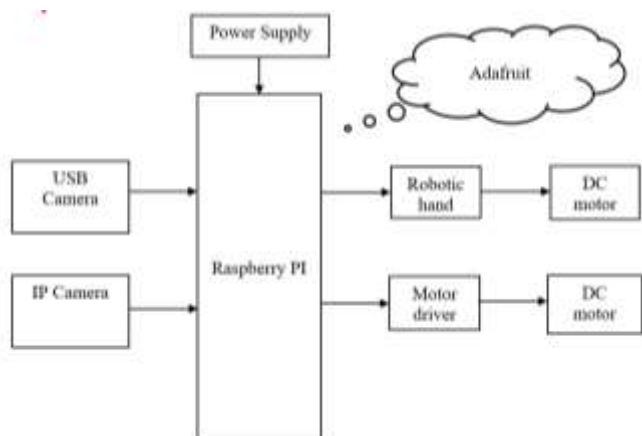


Figure 1 Block diagram of proposed model

The block diagram represents a web-controlled rover integrated with a robotic arm and real-time object detection system using a Raspberry Pi as the main controller. The power supply provides regulated electrical power to all system components, ensuring stable operation. The Raspberry Pi functions as the central processing unit, receiving image data from both the USB camera and IP camera. The USB camera is mainly used for object detection and image processing tasks, while the IP camera enables live video streaming for remote monitoring through the internet.

The Raspberry Pi communicates with the Adafruit cloud platform, which acts as a web server interface allowing users to remotely control rover movement and robotic arm operations. Control signals generated by the Raspberry Pi are sent to the motor driver, which amplifies the signals to drive the DC motors since the controller cannot supply sufficient current directly. The DC motors enable the rover's movement in different directions, while the robotic hand performs object picking and placing operations based on user commands and detected objects. Overall, the system combines computer vision, IoT communication, and robotic control to achieve remote surveillance, navigation, and object manipulation in real time.

The system begins operation when the power supply energizes the Raspberry Pi and all connected peripherals. A USB camera captures real-time images for object detection and processing, while an IP camera provides continuous live video streaming for remote monitoring. The Raspberry Pi processes visual data using computer vision algorithms to identify objects and generate appropriate control signals. The processed information is transmitted through an internet interface, enabling users to monitor and control the rover remotely through a web application.

Based on user commands received via the web interface, the Raspberry Pi sends control signals to the motor driver, which drives the DC motors responsible for rover navigation such as forward, backward, left, and right movement. Simultaneously, the robotic arm performs object manipulation tasks including picking and placing detected objects with precision. The integration of real-time vision, wireless communication, and motor control allows the system to operate efficiently in surveillance, object handling, and remote inspection applications. Overall, the project demonstrates an intelligent robotic system capable of autonomous visual

sensing combined with manual remote control functionality.

Overall, the proposed system offers several advantages, including:

- Remote-control
- Object detection
- Robotic manipulation
- Integrated system

By integrating image processing, embedded computing using Raspberry Pi, motor control mechanisms, and web-based communication technology, the system provides an intelligent, flexible, and scalable solution for applications such as surveillance, industrial inspection, object handling.

5.RESULTS



Figure 2 Experimental Hardware Setup

The Figure 2 shows a web server controlled rover with a robotic arm and camera system. The main controller used is the Raspberry Pi 3, which is mounted on the chassis and connected to various components.

The Raspberry Pi is connected to multiple driver circuits that control the DC motors for movement and the motors of the robotic arm. The rover uses four wheels with DC motors, enabling movement in different directions. The robotic arm at the front consists of motors and a gripper mechanism used for pick-and-place operations.

IP cameras which are used for live video streaming. These cameras send real-time video to the user through applications like V380 Pro. This helps in remote monitoring and navigation of the robot.

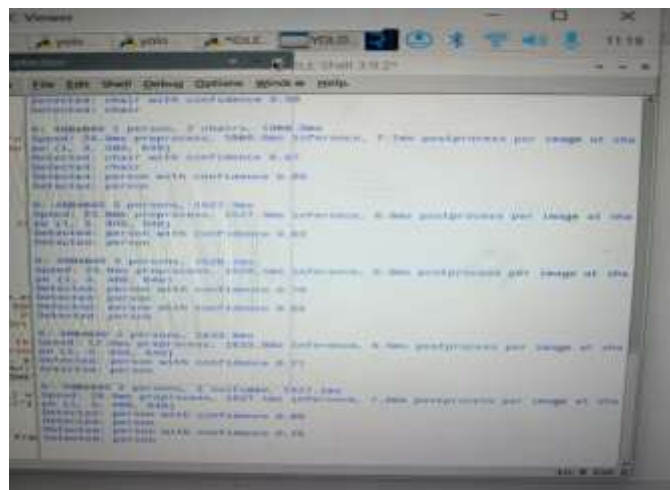


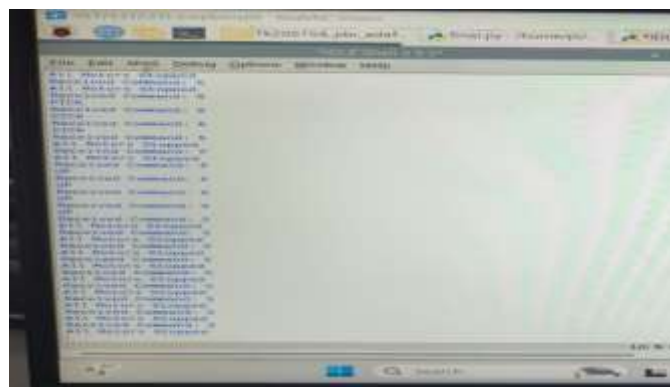
Figure 3 Object detection output

The Figure 4.4 shows the console output of the object detection process using YOLOv8. The output is displayed in the Python IDE running on the Raspberry Pi 3, where the system continuously detects objects from the camera feed.



Figure 4 Robotic arm Picking Objects

The Figure 4 shows the robotic arm picking objects based on commands through Adafruit dashboard. After gripping, the arm lifts the object and places it at the desired location.



The Figure 5 shows the execution output of the Python program running on the Raspberry Pi through the Real VNC Viewer interface. The program is responsible for controlling the rover and robotic arm based on commands received from a web server.

6. CONCLUSION

In conclusion, the web server controlled rover with an integrated robotic arm and real-time object detection successfully demonstrates the seamless combination of remote operation, autonomous sensing, and precise manipulation. Leveraging the Raspberry Pi for processing and control, along with DC motors, a motor driver, and an IP camera, the system provides reliable mobility, accurate object detection, and live video feedback for users. The intuitive web interface allows efficient navigation and task execution, highlighting the system's versatility and practicality. Overall, this project showcases a robust platform with potential applications in surveillance, industrial material handling, and exploratory missions, reflecting the growing capabilities of compact, intelligent robotic systems.

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REFERENCES

1. A. Sharma, P. Verma, and R. Gupta, "Design and Development of Autonomous Garbage Collecting Robot Using Raspberry Pi and Arduino," *International Journal of Robotics and Automation*, vol. 10, no. 3, pp. 145–151, 2021.
2. R. Kumar and S. Patel, "Wi-Fi Controlled Surveillance Rover Using Arduino Nano and NodeMCU," *International Journal of Embedded Systems and Applications*, vol. 9, no. 2, pp. 89–95, 2020.
3. L. Zhang, X. Li, and Y. Wang, "HE-SSD: Improved Single Shot Detector for Accurate Object Detection," *IEEE Access*, vol. 7, pp. 156784–156793, 2019.
4. M. Rao and P. Singh, "Motion Detection Based Live Video Streaming System Using Raspberry

Pi," *International Journal of Computer Vision and Robotics*, vol. 8, no. 1, pp. 55–61, 2018.

5. J. Lee and H. Kim, "Performance Enhancement of Ultrasonic Sensors Using Pulse Interval Modulation Technique," *Sensors and Actuators Journal*, vol. 305, pp. 111920, 2020.
6. S. Verma, A. Mishra, and N. Jain, "IoT Based Smart Surveillance Robot with Cloud Monitoring System," *International Journal of Internet of Things*, vol. 6, no. 4, pp. 112–118, 2019.
7. K. Ahmed and M. Rahman, "Low-Latency Communication in IoT Systems Using WebSocket Protocol," *IEEE Internet of Things Journal*, vol. 8, no. 5, pp. 3724–3732, 2021.
8. T. Nguyen, L. Tran, and D. Pham, "Cloud-Integrated Mobile Robot for Environmental Monitoring Applications," *International Conference on Smart Computing and Communication*, pp. 210–215, 2020.
9. D. Patel and R. Shah, "Multi-Sensor Robotic Vehicle for Obstacle Detection and Environmental Monitoring," *International Journal of Advanced Robotic Systems*, vol. 15, no. 2, pp. 1–9, 2018.
10. Y. Chen, H. Zhao, and J. Liu, "Scalable IoT Architecture for Multi-Robot Cloud Coordination," *IEEE Transactions on Industrial Informatics*, vol. 18, no. 4, pp. 2567–2575, 2022.