The Drishti Rider

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Abstract : In situations where human monitoring is both dangerous or ineffective or difficult to achieve, mobile surveillance robots are becoming a more common solution. Fixed cameras or manually patrolling with a person generally make up conventional surveillance systems and provide support for only some areas of the monitored area at best and provide no way to adapt to changes in that area. To meet these challenges, this paper presents Drishti Rider, a mobile robot designed to support remote surveillance through smartphone controls. An Arduino microcontroller, an HC-05 Bluetooth communication module, an L298N motor driver, DC geared motors, and an ESP32-CAM camera module are the components of the proposed Robot System. The system can be operated wirelessly using a mobile application that sends directional commands through the Bluetooth device. The video from the camera onboard will be sent to the user's mobile device in real-time so they can monitor the robot's immediate environment continuously. This project's goal was to build a low-cost, mobile, and user-friendly surveillance system, easily deployable for indoor monitoring, educational robotics laboratories, and basic security purposes. Testing shows that the robot operates well and reliably communicates with the controller and transmits video through real-time (live) video from cameras that were operating at the time. The Drishti Rider illustrates that integrating embedded systems, wireless communications, and robotics allows for an efficient surveillance solution. The system also provides a basis from which to enhance the system, such as with Wi-Fi control, robotic autonomous navigation, and artificial intelligence (AI) for object detection, all of which would enhance the capabilities of current surveillance applications.

Keywords: Mobile Surveillance Robot, Arduino, Bluetooth Control, ESP32-CAM, Embedded Systems, Remote Monitoring.

I. Introduction

Robotics and Embedded Systems for Better Surveillance & Monitoring Robotics & Embedded Systems have had a significant impact on the enhancement of surveillance and monitoring systems over the past few years. Traditional surveillance systems typically rely heavily on fixed cameras or having personnel perform manual patrols, both of which typically provide limited coverage and expose personnel to hazardous situations. The fact that fixed camera systems cannot monitor blind spots or freely relocate, renders them ineffective in dynamic environments. Hence, the need for mobile surveillance systems that can provide flexible monitoring and real-time monitoring of an area is expanding.

The use of a mobile phone to operate a surveillance robot for monitoring activities at a distance is an excellent way to ensure security where regular methods may not be effective (e.g., an area too dangerous or difficult to reach via normal means). Mobile surveillance robots operate via a combination of wireless communication technology (e.g., Bluetooth, Wi-Fi) and mobility (e.g., wheels, drones/apparatus) combined with camera-based monitoring systems to observe areas remotely. Users can operate the movement of the mobile surveillance robot and view a live video feed of the area using their smartphone or other mobile communication device. This capability to remotely monitor challenging areas makes mobile surveillance robots particularly useful in various applications such as disaster management, industrial inspection, security monitoring, and educational robotics.

The swift progress In inexpensive microcontrollers and wireless communication modules means cheap robotic surveillance systems can now be created. One easy-to-learn platform is Arduino, which provides programmers with an easy way to control motors; essentially all of the hardware required by your basic robots will fall in the category of these inexpensive components. The use of wireless technology (such as Bluetooth) has allowed users to have remote access from their mobile phones to their robots. There are also camera modules such as the ESP32-CAM that provide real-time video to the person controlling it so the operator can see where they are controlling their robot from.

By retaining a simple yet affordable mobile surveillance robot through the use of an application to control its operations via a Bluetooth connection; powered by an Arduino microprocessor providing control of robotic movement using an electric motor controller along with DC motors; outfitted with a video camera to enable live video feed to user's mobile device enabling the robot to do remote surveillance has been accomplished through mobility along with visual capabilities.

The main goal of this project is to create an easy-to-use robotic device that can monitor things in real time and navigate from a distance. This robot will be used to show how embedded systems, wireless technology, and robots can be used to perform surveillance work. The design of the device will use inexpensive, readily available materials to provide an easily accessible option for education, as well as for small monitoring applications.

While this project provides basic functionality for robotic surveillance capabilities, it also provides a pathway for future functionality improvements. Advanced system integrations beyond what was initially provided in the basic system can include WiFi connectivity, autonomous navigation, advanced artificial intelligence (AI) based object recognition, night-vision (NV) cameras and

other advanced field-tracking system components developed beyond the original system can support more complex robotic surveillance activities, enabling robotic operations over a wider range of environments in the future.

II. LITERATURE REVIEW

In the past several years, there has been an increased interest in developing monitoring systems that are automated using surveillance robots. Surveillance robots are designed to monitor an area remotely from a safe distance – usually, the robot is used where human presence would put the human at risk or make the task impractical or inefficient. There have been various research articles and studies exploring various technologies associated with the development of mobile surveillance robots. The three primary technologies that have been examined in research are: wireless communication, camera-based observation, & embedded control systems.

The early forms of surveillance consisted of fixed locations where cameras would be placed for 24hours to monitor an area, during this time the cameras would only stay in that same fixed position and as a means of surveillance were somewhat limited because although they would provide continuous monitoring, they would not be able to cover different locations, which would cause problems such as restricted coverage and blind spots. Therefore, researchers began looking into the development of mobile robotic platforms that could traverse various environments and send visual data to a remote operator.

Many early robots used Bluetooth-based control systems where either a smartphone or a remote control sent commands through a Bluetooth communication module. When using Bluetooth communication, robots perform basic movements of moving forward, backward, left and right. Bluetooth is used because it is easy to implement, inexpensive, and compatible with the majority of smartphones. However, the Bluetooth communication range is relatively small which limits the area over which the robot can cover. An additional advancement In robotic surveillance is the advent of camera-based monitoring systems using microcontrollers or single-board computers to transmit live video images and stream them over the internet with small camera modules, like an ESP32-CAM. The small size of these camera modules makes it possible to provide live-streamed video from robotic systems that are compact. They also enable an operator to monitor his/her surroundings from a distance by making decisions based on the visual information seen through the camera system.

Numerous studies have been conducted using microcontroller interfaces (such as Arduino boards) to control robotic motion and communication with some degree of success. Due to their relatively low cost, high level of ease of use, and large support community, Arduino systems have become widely adopted for use in robotics. Additionally, these systems enable easy integration of the required motor drivers, sensors, and communication devices into a configuration that is relatively easy to use for the creation of prototype surveillance robots.

While many of those devices can be purchased today, most of the existing robots present their own unique set of disadvantages. Some robots are priced well above the means of most users because of the use of sophisticated sensors and high-end hardware. Many robots require the user to have some type of specialized programming/technical skills in order to operate, which limits access for students and/or inexperienced users. In addition, many of the robots available for purchase today only provide mobility or video surveillance as standalone features (i.e. do not include both features in one unit).

The Drishti Rider project overcomes the challenges mentioned above with an affordable, easy, and integrated robotic surveillance system. The system incorporates a smartphone to control the unit to work across multiple platforms through wireless communication and provides real time video transfer via multiple components. The system is built using readily available components including: an Arduino; Bluetooth modules; Motor drivers; Camera modules; etc. This provides a working solution to mobile surveillance that is also useful for educational and experimental purposes.

III. METHODOLOGY

Drishti Rider Project's methodology provides for constructing a mobile robot remotely controlled by a smartphone with live video monitor capability. The hardware components, wireless communication, and embedded programming together provide both mobility and means of surveillance for the robot. The entire process consists of system design, command transmission, movement control of the robot, and the live video stream.

- **System Design and Architecture:** It was designed using an Arduino board as its central processing unit for controlling how to act based upon commands sent to this Board. Bluetooth technology is utilized via an HCHC-05 module so users can send commands to their robots using a mobile device. Powering the robot's motors are L298N driver chips, which take signals from the Arduinos and provide the performance to turn the motors clockwise or counterclockwise to move the robot forwards or backwards, left or right.

  A surveillance camera (ESP32-CAM) is attached to the robot and produces images and video of the area around it, which can then be sent through real-time video stream using the mobile phone of the user. The addition of an ESP32-CAM provides the operator with the ability to see what the robot is doing while providing movement input.

- **Communication Process:** The user commands the robot by using a mobile application as the control interface, and the communication between the user and the robot occurs via Bluetooth technology. When the user clicks a button on their mobile

- application to request movement of the robot, the command is transmitted via Bluetooth to the HC-05 module, which in turn sends the command to the Arduino board through serial communication.

  The arduino takes the incoming commands and processes them. It figures out how the robot will move, based on the input commands sent to it. After determining how the robot will move based on the command, the arduino sends control signals to the motor driver.
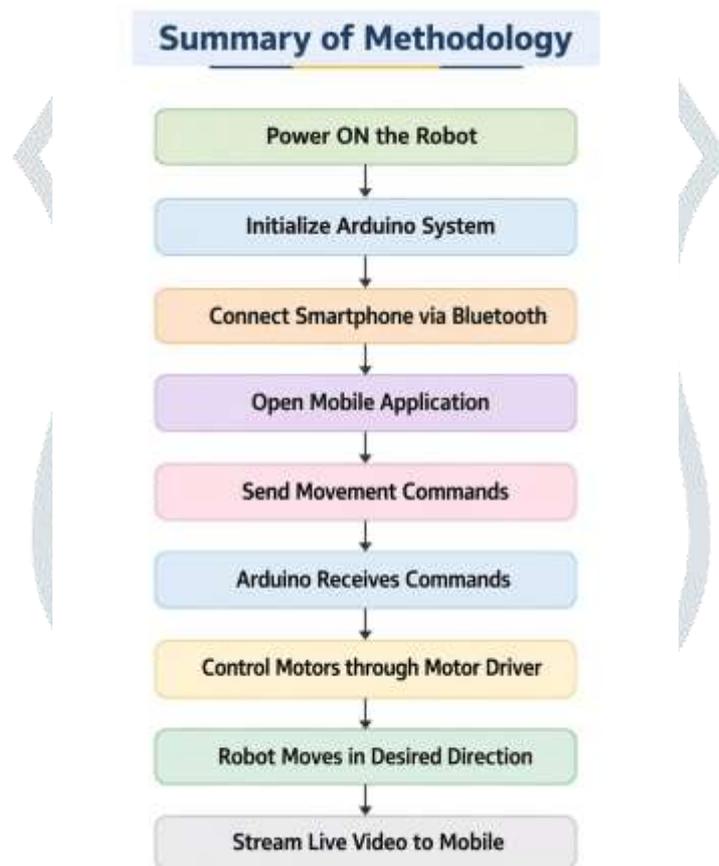
- **Robot Movement Control:** The robot's movement is achieved through four independent dc geared motors directly connected to the four wheels of the robot (chassis). The motor driver controls both the direction and rotation of each motor using the signals sent from the arduino. For example: if an arduino receives an input command to go forward, it will send a signal to the

motor driver activating the motors so that the robot can go forward. The other commands the arduino can receive tell the robot to go backwards or turn left or right.

- **Live Video Streaming:** The camera not only helps the robot to control its movements, but it also records video of its environment. The ESP32-CAM module wirelessly transmits this video stream to the user so that they can view the live video on a smartphone or another device. This wireless transmission of real-time video enables the user to see what is happening around the robot while it navigates through the environment.

- **System Operation Workflow:** A typical operation flow for this system is established through a simple, automated process. Initially, users pair their smartphones with the robot wirelessly through Bluetooth technology. Once a successful connection has been achieved, users send instructions for robot movement via a mobile application. As the Arduino interprets these movement instructions, it activates motors on the robot according to appropriate command sequences. All while this happens, the camera module on the robot continues to stream live video to the user's device. Thus, the robot is capable of both movement and visual monitoring at the same time.

  By using this process, the Drishti Rider system effectively matches wireless connectivity with robotic mobility and camera based visualization to create an overall viable mobile surveillance platform.

- **Summary of Methodology:**

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- Power ON the Robot
- Initialize Arduino System
- Connect Smartphone via Bluetooth
- Open Mobile Application
- Send Movement Commands
- Arduino Receives Commands
- Control Motors through Motor Driver
- Robot Moves in Desired Direction
- Stream Live Video to Mobile

Table1: Comparative Analysis (Comparison Table)

Feature	Manual Monitoring	Sensor-Based System	Cloud Surveillance System	Drishti Rider
Monitoring Type	Human patrol	Motion sensors detect activity	Internet camera monitoring	Mobile robot with camera
Accuracy	Low	Medium	High	High
Human Effort	Very High	Low	Low	Very Low
Alert System	Not available	Limited alerts	Real-time alerts	Real-time monitoring

Internet Requirement	Not required	Not required	Always required	Not mandatory
Response Time	Slow	Moderate	Moderate	Fast
False Alerts	High	Medium	Low	Low
Cost	High (labor cost)	Medium	High	Low
Mobility	Not available	Not available	Fixed cameras	Mobile surveillance
Coverage Area	Limited	Moderate	Wide	Flexible

IV. SYSTEM REQUIREMENT

- **Hardware Requirements:** The Drishti Rider Surveillance Robot comprises multiple hardware units, which enable movement control for the robot (mobile robot), implement wireless communications, and provide real time video surveillance of the area. Each hardware unit plays a critical role in the overall operation of the Surveillance System.

- **Arduino Microcontroller:** The robot's principal control system is the Arduino board. The commands for controlling the robot are received by the Bluetooth module and processed by the Arduino to determine how the robot should be moved. The Arduino then sends signals to the motor drivers (to turn on the motors) based on the command received from the Bluetooth module, activating the motors in the required direction. The simple programming environment and ability to interface with many different electronic modules make the Arduino a popular choice for robotics-related applications.
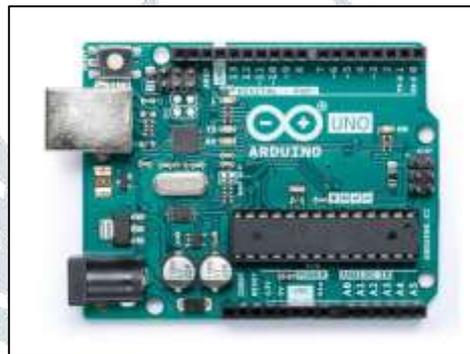
Fig 1: Arduino UNO

- **Bluetooth Module (HC-05):** The HC-05 Bluetooth Module allows for wireless communication between the robot(s) and the smartphone of a user. It communicates to and from a mobile application as well as an Arduino via serial communication with the command received from the mobile application being sent to an Arduino, allowing for remote control of the robot without physical connections.

Fig 2: Bluetooth Module

- **Motor Driver (L298N):** The L298N Motor Driver serves as a bridge between an Arduino and the DC Motors. The Arduino is not able to provide enough current by itself to run the DC motors therefore the Motor Driver controls directions and power supplied to the Motors based on the signals sent to it by the Arduino.

Fig 3: Motor Driver

- **DC Geared Motors:** The movement of the robot results from its use of DC geared motors. The wheels of the robot are connected to these motors and they allow the robot to move forward, backward, and rotate. The gear mechanism acts as an increase in torque to enable the robot to move smoothly over all surfaces even when transporting electronic components.

Fig 4: DC Motor

- **Robot Chassis:** The frame of the robot provides an underlying structure to support the hardware. The four-wheel drive base provides stability as it moves forward. The frame also provides a secure gripper for the motors, batteries, and electronics.

Fig 5: Robot Chessis

- **Camera Module (ESP32-CAM):** It uses ESP32-CAM to take capture and transfer live video. The camera constantly captures the surrounding and broadcasts the video to the device of the user. This will allow the operator to view in real time the surrounding of the robot as she continues to control it.


Fig 6: Camera Module

- **Power Supply:** The robot requires a dependable source of power typically from rechargeable battery packs (Li-ion or Li-Po) to operate correctly. All of the components (Arduino, motors, and camera modules) will work properly together through proper power management and voltage/current regulation.

Software Requirement

To control the Drishti Rider robot, specific software and programming environments are necessary to facilitate communication between the user and the robot.

- **Arduino IDE:** The Arduino IDE is used to develop, compile and transfer code to the Arduino Microcontroller which contains the logic for controlling the motor and communicating with its Bluetooth module. Program development is primarily done with the C/C++ programming language.
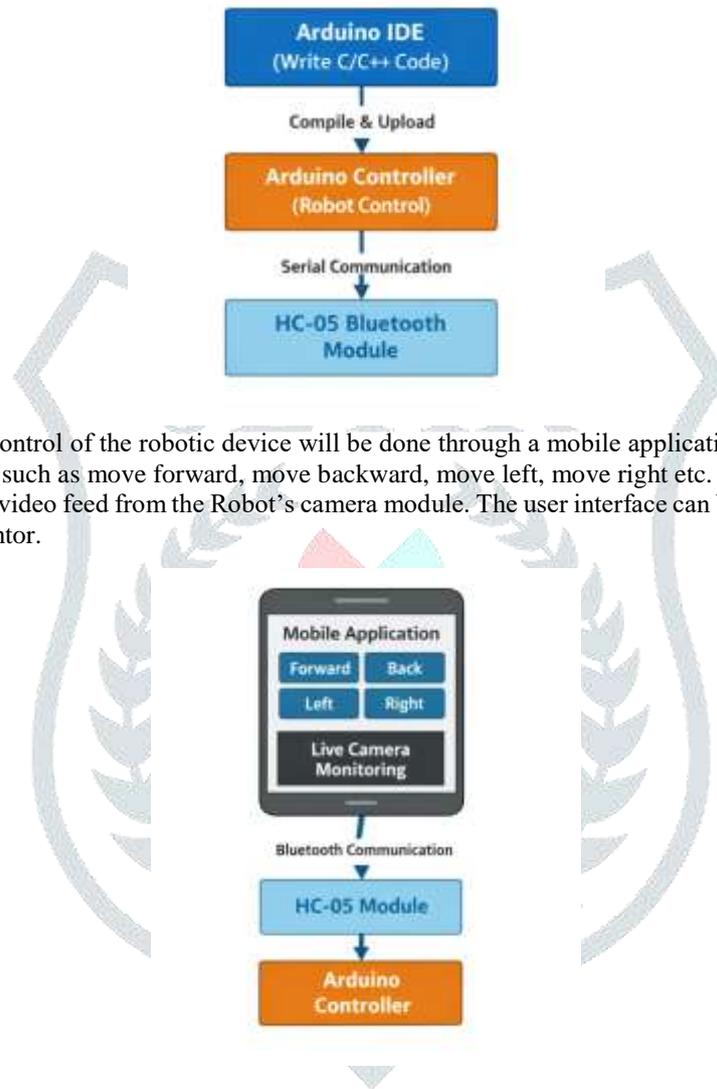
- **Mobile Application:** Control of the robotic device will be done through a mobile application, acting as the user's interface for sending commands such as move forward, move backward, move left, move right etc. The mobile application will also provide the user with a video feed from the Robot's camera module. The user interface can be created by utilizing a platform such as MIT App Inventor.

V. FUTURE SCOPE

Even though the Drishti Rider is working successfully as a mobile surveillance and remote control system, it has many future enhancements available to improve functionality. One enhancement would be integrating wifi communications so that we can provide control at greater distances via the internet, rather than just through bluetooth.

Autonomously navigating using sensors like ultrasonic or infrared sensors. This would allow the robot to identify obstructions and navigate without constant control by a person; improving the system further by implementing AI powered object recognition, allowing for recognition of people or suspicious actions.

By integrating night vision cameras and a cloud based monitoring system, the robots would improve their usefulness in the areas of security and surveillance. These enhancements will broaden the possible use cases of the Drishti Rider system in industrial inspections, disaster management, and advanced security monitoring.

USB and Cellular communication can be added to the system to enhance GPS tracking, enabling larger outdoor operations. Both approaches can also allow for data storage and video recording and support remote analytical work from captured video footage.The continued development of the Drishti Rider could make it usable for border control, environmental monitoring, or remote inspection, allowing the system to be used as a more versatile, intelligent surveillance platform than earlier versions.

VI. CONCLUSION

The Drishti Rider is a mobile-controlled robotic surveillance unit. The Drishti Rider uses low cost embedded technology and wireless communications to create a system for robotic surveillance. The basic building blocks of the robot are an Arduino

microcontroller, a Bluetooth communications module and motor control board, two DC motors, and an ESP32-CAM camera module.

The Drishti Rider can be operated remotely via a smartphone app. The app allows for the robot to be moved in multiple directions while displaying live video from the camera of its surroundings. Therefore, this system can be used in situations where remote human observation is not practical or safe, and is too inefficient for an in-person observer.

Due to the low cost of the components and the simple programmed controller, the robot can be used in an educational setting or as an experimental device.

On the whole, the Drishti Rider project is an example of how robotics, embedded technology (hardware), and wireless communication can work together to offer a practical solution to providing surveillance capability using robots. Further improvements may provide even greater possibilities for developing advanced security and monitoring systems (Wi-Fi connectivity, autonomous navigation, and intelligent detection systems will enable the development of these types of robots).

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