Design and Construction of An Arduino based Wireless Remote Controlled Video Capturing Vehicle

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Abstract: This research work focuses on achieving a mobile remote controlled monitoring system. The (VCV) is a wireless remotely controlled video capturing device with full ground mobility. The Video Capturing Vehicle comprises the mechanical mobility system, with other devices mounted on it. The other devices include the Arduino Uno R3 microcontroller, which interprets control signals according to the code in it and sends out the corresponding action commands to control the movement of the VCV; the Bluetooth Slave, for wireless control signal reception; the distance sensor, for avoidance of obstacles; the L298N motor shield, which provides the appropriate H-bridge circuit for moving the wheels, the motor drivers and wheels, which perform the actual movement; an IP camera, for video surveillance. The Remote Control System is made up of a Smartphone, on which the control application is developed, and operated from. The Video Capturing Vehicle is aimed at reaching areas inaccessible to humans. It can be used in biologically hazardous areas to gather data, aiding scientific research and control.

Keywords: Video Capturing Vehicle, Mobile Remote Controlled Monitoring, Smartphone, Arduino

1.1 Introduction

Observing or analyzing a particular site for safety and business purposes is known as video surveillance [1]. Video surveillance cameras are used in shopping centres, public places, banking institutions, and around ATM machines. Video surveillance has helped tremendously in fighting crime over the years, but it can definitely do much more than that. In addition to security and crime control, the deployment of video surveillance cameras could also be used in humanly inaccessible locations (such as biologically hazardous areas) to capture experimental data or perform any monitoring action.

Most remote controlled video monitoring systems in use today comprise network cameras fixed at different points to monitor activity in a room. These cameras can only view the portions they are directed towards. At best, they can rotate about their axis to capture different angles of the same portion. Hence, it could be thought of as a static arrangement, and well-trained criminals, more often than not, escape surveillance by taking advantage of the stationary nature of the monitoring system.

When a remote controlled monitoring system is made mobile, a whole new world of possibilities is opened. Such a system has the ability to access any geographical location, and give video feed of the area to the remote operator [2][3]. This increased capability provides more possible applications for the system, such as the Video Capturing Vehicle. For instance, the VCV may be used in archaeological expedition to check out the nature and

conditions of a newly excavated enclosure before allowing staff to enter, and numerous similar applications.

Wireless remote control has been made easier with the advent of modern wireless communication technology such as the Bluetooth technology. Bluetooth is a wireless protocol for device communication; therefore, any suitable receiver can be used to intercept its transmissions. It is a robust technology with low power and cost requirements [4]. The transmission of control signals wirelessly to control the movement of the Video Capturing Vehicle makes for flexibility of movement and increased degree of freedom. Obstacle avoidance is also desired, and is achieved with the use of the Distance Sensor in front of the VCV [3]. A modular approach is taken towards this project to help make the design process smoother. With these objectives in focus, we propose to design a wireless remotely controlled Video Capturing Vehicle system for mobile video monitoring applications.

1.2 Overview of the VCV system

The main component of the VCV control system is the microcontroller, in this case, the Arduino Uno R3. The microcontroller executes the code uploaded into it, depending on the data it receives from external devices which are connected to it. These devices include the Bluetooth Module, the Distance Sensor, and the motor driver IC. A smartphone application is used to control the movement of the VCV.

A Bluetooth module is an external component that enable Bluetooth connectivity for the device it is linked to [5]. The Bluetooth module is configured as a slave, and receives control signals from the smartphone application. Before that communication can work, the smartphone must be paired with the Bluetooth module, and the MAC address of the Bluetooth module obtained. On the smartphone application, the MAC address is entered into the required field to enable connection to the Bluetooth module wirelessly [6]. Control signals are then sent from the application to navigate the VCV in the desired direction. A distance sensor or proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact [7]. It is used to achieve obstacle avoidance for the VCV. It continuously measures the distance between the vehicle and any obstacle on its path, and sends the information to the microcontroller.

The microcontroller does not directly control the motors driving the wheels of the VCV. The use of a motor driver to interface the output of the microcontroller with the rotation of the motors is much preferred due to the H-bridge circuit inside the motor driver. Also, enough power for driving the motors can be supplied through the motor driver for more efficient movement, without causing any damage to the microcontroller, which has a moderate voltage supply rating.

The camera is mounted on the vehicle to obtain live video feed from its location. An internet protocol (IP) camera is used for this purpose. The IP address of the camera is obtained using a computer system, and configured to enable viewing of the video feed on a browser in the computer system.

1.3 Design and Implementation

As the block diagram in Figure 1 shows, the VCV system consists of three interrelated modules or subsystems:

- The Video Capturing Vehicle (VCV)
- The Camera Display System
- The Remote Control System, and

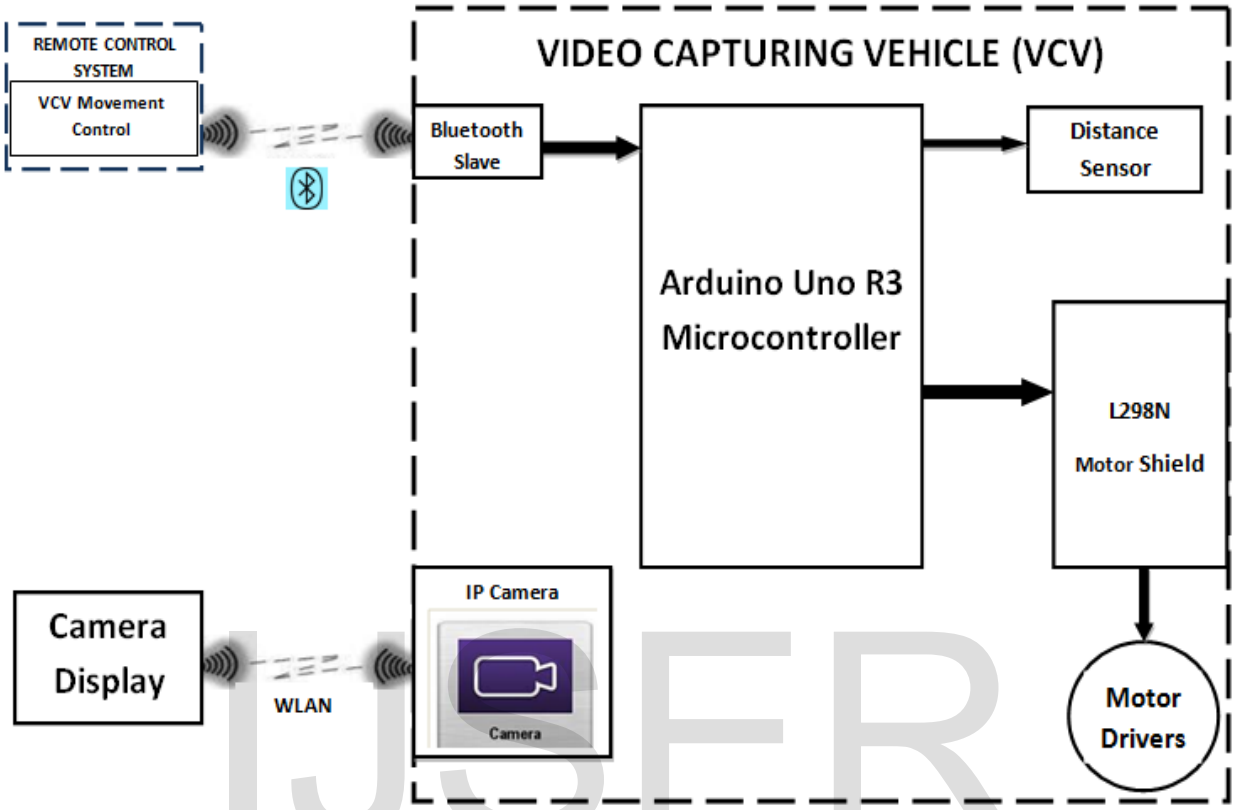

Figure 1: Block diagram of the Video capturing Vehicle system

The Video Capturing Vehicle has a mechanical structure on which the microcontroller and other interconnected devices are mounted. The Bluetooth Slave and Distance Sensor are the input devices to the Arduino Uno microcontroller for wireless control signal reception and obstacle avoidance respectively. The microcontroller sends its output through the L298N motor driver to control the movement of the wheels of the VCV.

The remote control system is the smartphone application, from which control signals are sent to the VCV using Bluetooth technology. There are five (5) control signals used to direct the movement of the VCV. They are the go, left, right, back, and stop commands. The flowchart in Figure 2 shows how the VCV movement works. The IP camera is mounted on top of the VCV for monitoring of locations. The camera display system is the computer system on which the live video feed from the camera is viewed.

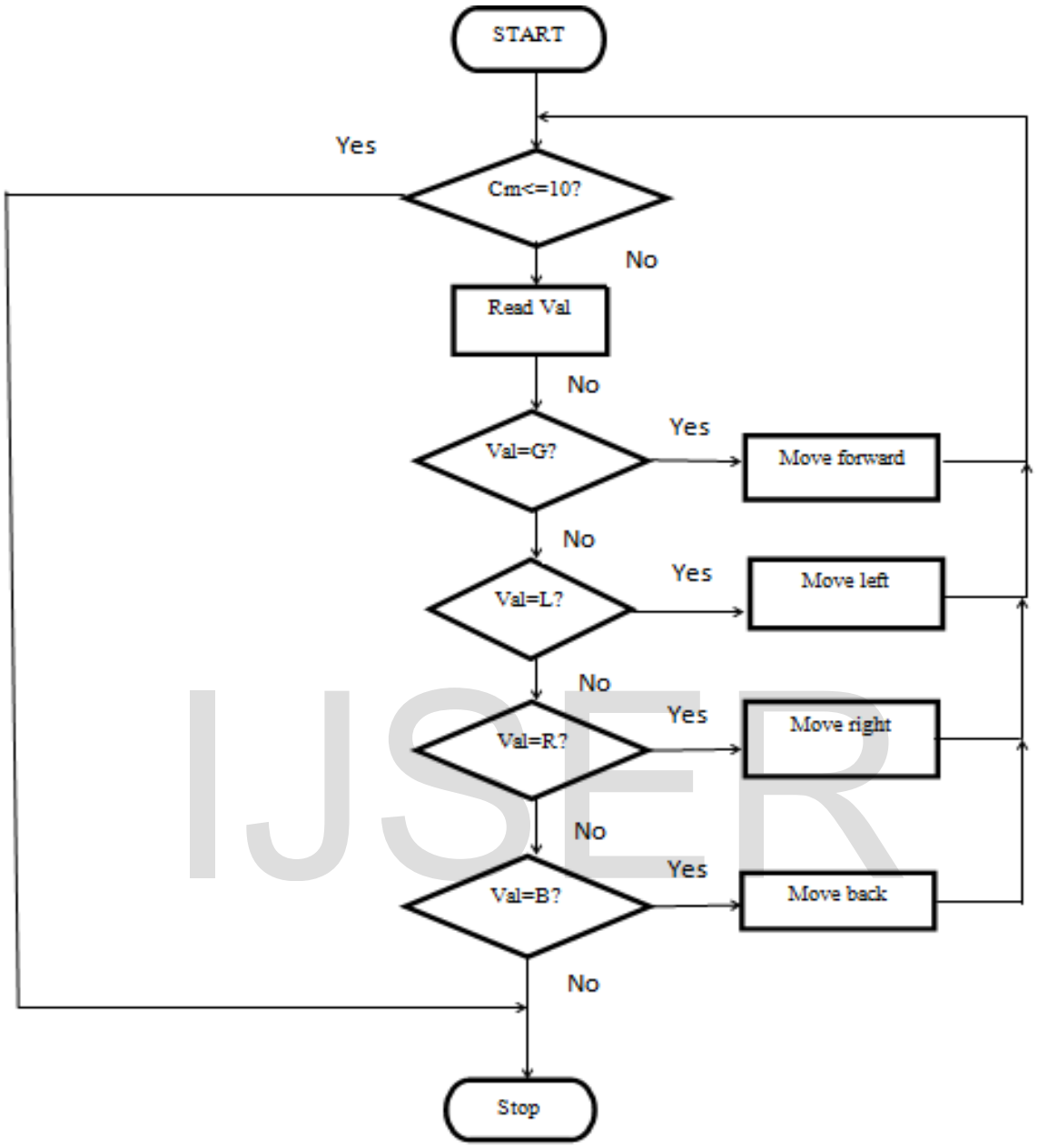

Figure 2: Flowchart showing the movement of the VCV

1.4 Software

The software modules that are used in this project can be divided in two:

- The remote control software on the Android mobile phone.
- The IP camera software on the PC.

The remote control system consists of:

- Smartphone application**:** This is installed on the android mobile phone on which the remote control application is installed and operated. The Smartphone application was built using MIT App Inventor. It is the application through which the Smartphone connects to the Arduino Bluetooth Module, to enable the sending of control signals wirelessly to determine the movement of the Video Capturing Vehicle.
- Bluetooth Slave**:** The HC-05 was used in this work. This receives the control signals through Bluetooth technology from the smartphone application. When it is on and blinking, it implies ready to connect.

The remote control of the VCV is achieved through an Android Smartphone. An application is installed on the smartphone, from which control signals are sent. The smartphone is already equipped for Bluetooth communication by powering the Bluetooth serial communication of the android mobile phone. The VCV application user interface is shown above: in figure llll

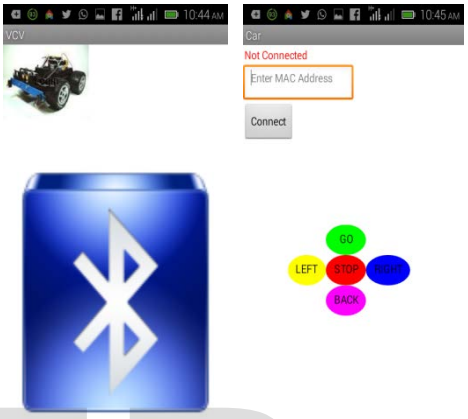

Figure 3: user interface

A scan for Bluetooth devices is performed on the smartphone, and the HC-05 is discovered and paired. On the VCV application, the MAC address of the Bluetooth Slave is input and the application connects to the HC-05.

Table 1: Table showing the parameters for setting up the Bluetooth connection

Bluetooth Setup Parameters	**Values**
Pairing PIN	1234
MAC Address	98:D3:31:60:14:26

When a control button is tapped, a unique character is sent through the Bluetooth connection to the Bluetooth Slave, which receives it and sends to the Arduino Uno. In the Arduino microcontroller code, each character has been defined to trigger a certain action. The microcontroller interprets the input character and enforces the corresponding action through the motor shield to control the wheels in the desired direction. Thus, the movement of the VCV can be controlled from the smartphone application.

The camera display system includes:

- The IP Camera**:** it is mounted on the VCV. It provides video feed of the surroundings and sends them wirelessly to be displayed on the computer.
- Camera display software**:** This shows the video feed from the IP camera. The IP camera used in this project is the Edimax Wireless LAN / Fast Ethernet Motion JPEG Internet Camera (IC – 1500Wg / IC - 1500). This wireless IP Camera uses the IEEE802.11g 54Mbps standard. It is a Centralized IP camera which requires a central Network Video Recorder (NVR) to handle the recording, video and alarm management.

1.5 Hardware

The VCV comprises:

1. Arduino Uno Microcontroller: This is the microcontroller that controls the whole VCV. Every other device on the VCV, apart from the IP camera, is connected to the Arduino Uno. It interprets the control signals sent to it, and controls the movement of the Video Capturing Vehicle, according to the code uploaded into it.
2. HC-05 Bluetooth Slave: This device receives control signals from the remote control device, and sends the signals to the Arduino Uno microcontroller. It is connected to the microcontroller through the transmitter and receiver pins.
3. Distance sensor: This increases the smartness of the VCV by helping it to avoid obstacles on its path of movement. It is also connected to the microcontroller and works according to the distance avoidance code written for it.
4. L298N Motor Shield: This helps in facilitating the movement of the VCV. It contains the much desired H-bridge circuit, which properly aligns the control of the microcontroller with the turning and navigation of the wheels. It is connected to the microcontroller, and the drivers from each wheel are connected to it.
5. Motor drivers: The driving wheels of the VCV have motor drivers attached to them. These drivers are controlled from the motor shield and they provide rotation power to the wheels of the VCV for movement.
6. Internet Protocol (IP) Camera: This is the camera for surveillance. It is mounted on top of the VCV.
7. Mechanical structure: The mechanical structure of the VCV consists of the body and wheels. It is the platform on which all the devices are installed.

1.6 Challenges

- There were certain limitations in the project in the areas of the VCV's mechanical structure and procurement of the IP camera.
- The VCV structure has some imbalance in the Centre of gravity and was not strong enough to carry all the weight intended to be upon it. We tried to arrest this as much as possible by providing additional mechanical supports.
- The Bluetooth serial communication always interfered with the distance sensor communication. Hence the VCV movement will achieve about 90% of its intended movement.
- Powering the Arduino Uno through batteries was problematic, because

the battery cap connection was unstable, hence the power supply fluctuated. We preferred using the USB cable connection to the computer system as our source of power for the microcontroller.

- The L298N, was very power consuming, hence there was heavy use of batteries.

1.7 Recommendations

- More projects like the VCV should be encouraged among students, because such a project helps students to integrate their knowledge in other parts of engineering, such as mechanical and electrical, into their electronic design.
- Modern electronic equipment, such as the IP camera, should be made more available locally, so that students can readily access them, and be familiar with such gadgets and their technicalities.
- A series connection of batteries can be achieved for powering the L298N or a 12V DC battery can be used together with a supportive and robust mechanical structure
- More rigid battery connections can be used to power the Arduino and held down in such a way that fast movements of the VCV will not shake the connection.

1.8 Conclusion

The Video Capturing Vehicle (VCV) is a mobile video capturing device, which is wireless and remote controlled. The focus of this project was to design and implement the VCV's remote control system and comprises the mechanical mobility system, with other devices mounted on it. The other devices include the Arduino Uno R3 microcontroller, which interprets control signals according to the code in it and sends out the corresponding action commands to control the movement of the VCV; the Bluetooth Slave, for wireless control signal reception; the distance sensor, for avoidance of obstacles; the L298N motor shield, which provides the appropriate H-bridge circuit for moving the wheels, the motor drivers and wheels, which perform the actual movement; an IP camera, for video surveillance. The codes for controlling the actions of the microcontroller are all Arduino language codes.

The Remote Control System is made up of a Smartphone, on which the control application is developed, and operated from. The Bluetooth Slave on the VCV is the device through which control signals from the application are directed into the microcontroller.

The Video Capturing Vehicle is aimed at reaching areas inaccessible to humans. It can be used in biologically hazardous areas to gather data, aiding scientific research and control. The VCV can also be used during archaeological expedition to preview the nature of any newly excavated area before sending human personnel in, hence ensuring safety of the staff. It could also find application in remote experimentations, like in the laboratories, for computations and records.

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