

# Design of a Low Cost Video Capturing Vehicle

Nathan David  
Department of Electronic Engineering  
Faculty of Engineering  
University of Nigeria  
[nathan.david@unn.edu.ng](mailto:nathan.david@unn.edu.ng)

Ayodeji Opeyemi Abioye  
School of Mechanical and Systems Engineering  
Newcastle University  
United Kingdom  
[a.o.abioye1@ncl.ac.uk](mailto:a.o.abioye1@ncl.ac.uk)

**Abstract:** The Video Capturing Vehicle (VCV) is a robotic device that can produce live video feeds with both automated ground mobility and a simulated flight control. The control of the robotic vehicle is achieved using Dual Tone Multi Frequency (DTMF) technique. The VCV is controlled by a Remote Control System which consists of a computer system and the built USB interfaced control device. Software was developed to capture video feed and send control signals to the USB control device. The robotic vehicle consists of an FM receiver, a DTMF decoding circuit, a microcontroller circuit board and an Internet Protocol (IP) camera. The robot while moving, simultaneously captures video feeds using an IP camera attached to it and sends captured video feeds via Wireless Local Area Network (WLAN) to which the PC at the RCS is initially connected to. The received video feed is displayed on the GUI. The video capturing vehicle can be used for several purposes like surveillance (for security reasons), viewing of human inaccessible area, experimentation (monitoring a health hazardous experiment remotely), among others.

**Keywords:** Video Capturing Vehicle (VCV), Universal Serial Bus (USB), Software, microcontroller, Computer Interfacing.

## 1.0 INTRODUCTION

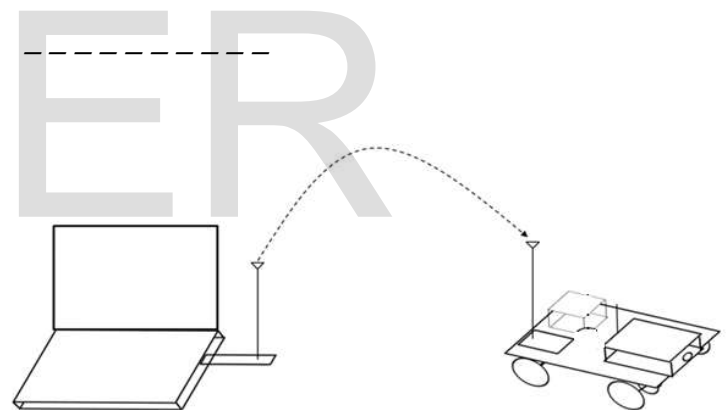
### Project Aim

This project was aimed at building a wireless remotely controlled video capturing vehicle. It involves developing a computer application (to send control signals to device and to view video feeds from device); building a USB interfaced control device [1] and designing and developing the motherboard of the video capturing vehicle (which receives, process, and execute the control signal). The computer system has a GUI application running on it for viewing the video feed (from the IP camera) as well as sending control signals to the control device through button clicks.

### 1.1 PROJECT OVERVIEW

The robot is a vehicle with an antenna, with an IP camera mounted on it. It is remotely controlled from a computer system as shown in figure 1. The computer system has a GUI application running on it for viewing the video feed (from the IP camera) as well as sending control signals to the control device through button clicks [2].

Figure 1: Graphical representation of VCV



The control signals generated are DTMF tones that are received by the RF receiver at the VCV, decoded into BCD codes using a DTMF-BCD decoder and the microcontroller on the vehicle's circuit board interprets each BCD code received and executes the motor control by sending appropriate signals to the motor drivers.

The IP camera on the robot is preconfigured to broadcast to a wireless Local Area Network (LAN). The computer system which runs the control GUI application has an in-built Wi-Fi Module for wireless LAN communication with the IP camera [3].

Video feeds are sent via WLAN from the IP camera on the VCV to the PC remotely situated and control signals are sent via RF link to the VCV from the PC at the remote location. This is illustrated in the block di-

agram of the VCV project shown in figure 2.

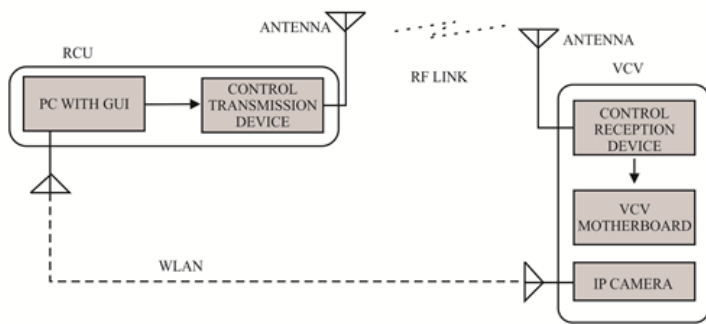


Figure 2: Block Diagram describing the Wireless Remotely Controlled VCV Project

## 2.0 THE VIDEO CAPTURING VEHICLE

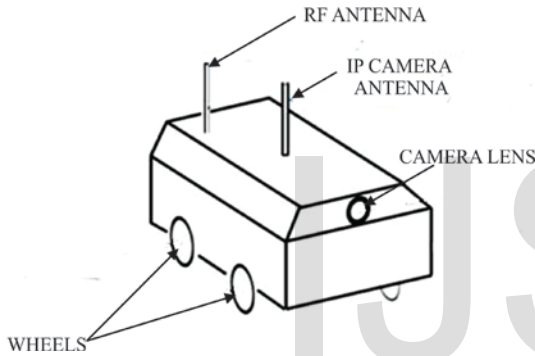


Figure 3: The features of the Video Capturing Vehicle

The VCV is driven by the 2 back wheels propelled by a DC motor that moves in a forward or backward direction as shown in figure 3. The 2 front wheels propelled by a stepper motor which gives the controller the control over the angle or degree of turn (steering). On making a turn, the back wheels will be required to push the VCV in the direction of steer after which the front wheels will be steered to the other direction to keep the VCV straight. The RF antenna receives control signals from the RCS while the IP camera antenna sends captured video feeds to the RCS during operation.

## 2.1 THE REMOTE CONTROL SYSTEM

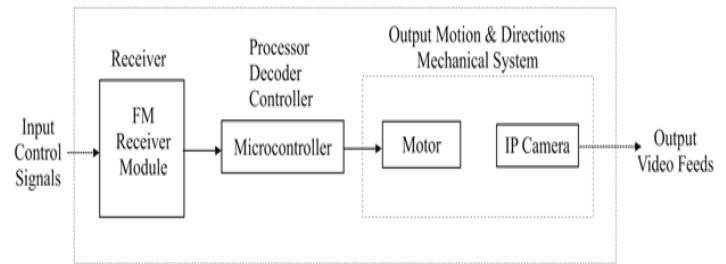


Figure 4: Block Diagram Describing the Remote Control System

The Remote Control System for the VCV consists of a PC and the Control Transmission Device as shown in figure 4. The VCV computer application is required to be installed on the PC. The modified Control Transmission Device is a USB interface device connected to the PC, which receives commands from the VCV computer application via the USB port, and encodes this data into DTMF tones which is used to modulate the transmitter.

## 3.0 DESIGN AND IMPLEMENTATION

The computer system controls the vehicle and captures the video feeds from the vehicle wirelessly from a remote location as shown in figure 5. The range of the video feed capture being the standard 100m radius for WLANs and that of the control signals depending on the efficiency of the RF systems.



Figure 5: Block Diagram Describing the Video Capturing Vehicle

Figure 5 indicates where alterations were made within the control transmission device (Abioye and David, 2013). The BCD output from the microcontroller is fed into a DTMF encoding module to generate DTMF tones to uniquely identify each control signal. These DTMF modifications were carried out because it was discovered that after transmitting a particular signal frequency without DTMF, the microcontroller at the VCV did not receive the exact number of interrupts expected for a particular frequency as observed, in that

the action executed sometimes was different from the signal transmitted. This was due to noise and interference, although a range was provided for, sometimes the range got exceeded.

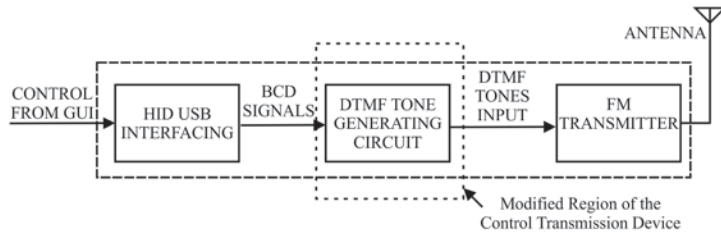


Figure 6: Block Diagram of the Control Transmission Device indicating where modifications were made

### 3.1 IMPLEMENTATION

Incorporating the DTMF encoding module into the control transmission device at the RCS was done using the block diagram in figure 7.

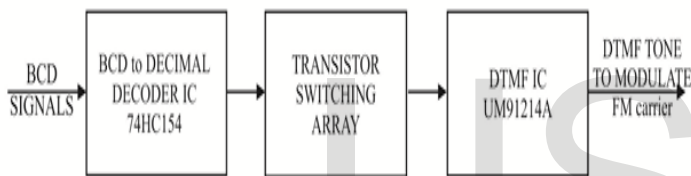


Figure 7: Block diagram showing how the control DTMF tones are generated

Each BCD signal output from the USB interfacing microcontroller PIC 18F2550 is decoded by a BCD to decimal decoder 74HC154 to produce a single output with decimal value as shown in table 1; each output is used to switch a transistor in an array of transistors arranged in the manner of a keypad. Each transistor switched, connects the pins needed to encode appropriately DTMF tones corresponding to the decimal value of the BCD signal received from the USB microcontroller as shown in table 2 using a DTMF generating IC UM91214A which uses a keypad facility to generate DTMF tones in tone dialing circuits as shown in Figure 8.

The DTMF-BCD decoder MT8870 was used to decode each DTMF tone received via FM receiver into BCD codes which are inputs to the microcontroller on the VCV motherboard. The motherboard now uses PIC16F877A, as its microcontroller. This microcontroller is responsible for the processing of the received DTMF decoded signal which is now in BCD and sending control signals to execute the required func-

tion such as motion of VCV or camera view control.

	Column 1	Column 2	Column 3	
Row 1	1	2	3	697Hz
Row 2	4	5	6	770Hz
Row 3	7	8	9	852Hz
Row 4	*	0	#	941Hz
	1209Hz	1336Hz	1477Hz	

Figure 8: Showing DTMF frequencies for rows and columns used in tone dialing

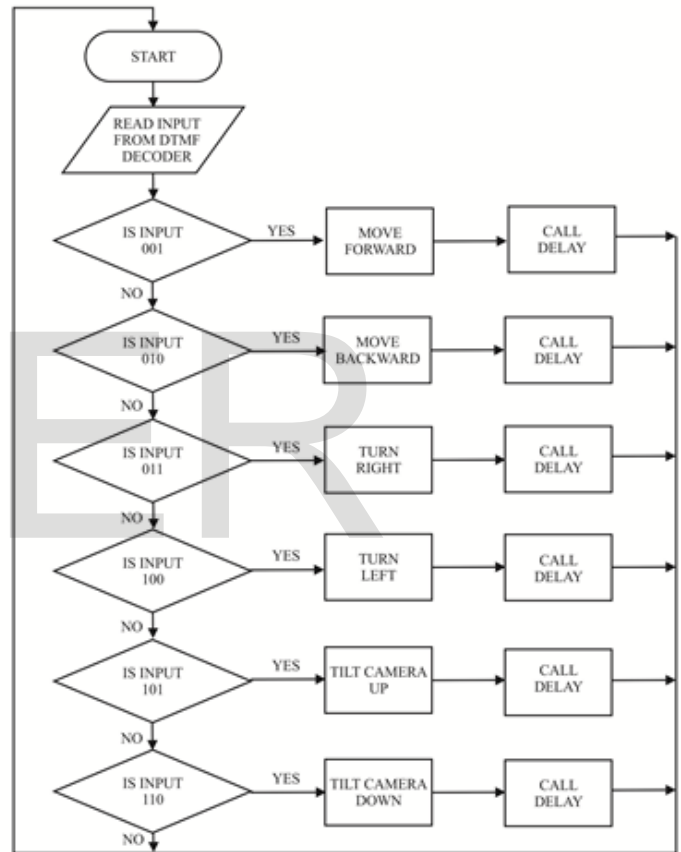


Figure 9: Flowchart describing the VCV firmware algorithm

The microcontroller is the brain of the VCV motherboard. Two L293Ds, a push-pull four channel driver were used to interface one bipolar stepper motor and two DC motors to the microcontroller for controlling the front wheels ( stepper motor for direction steering), back wheels (DC motor for forward and reverse motion) and camera view adjust (DC motor for tilting camera up or down) respectively. The microcontroller sends in the drive patterns to the appropriate driver IC. The PIC 16F877A was programmed using micro C

programming Language, a variant of C programming Language. The flow chart that was used to develop the firmware for the VCV version 2 is shown in figure 9.

### 3.2 COMPUTER APPLICATION

The computer application was build using the visual basic programming language (Visual basic 2008 to be more specific, VB9). Both Visual basic and the Windows Operating System are developed by the same vendor, Microsoft. Building application that would allow communication to the ports of the computer seemed easier to achieve as it would utilize already existing drivers in system and would not require writing a new driver. Axelson describes how to use the visual basic to build an application to interact with the USB ports [4]. The visual basic program (called the VCV Application) runs on the computer system relaying to the control device control instructions from the user.

### 3.3 VCV MOTHERBOARD

The PIC microcontroller, PIC16F84A, was used as the on-board chip of the motherboard. It was responsible for decoding the received signal, interpreting and processing it, and sending control signals to execute the required function such as motion, toggle headlamp, or toggle flight mode. The bipolar stepper motors (used for the wheels) were interfaced to the microcontroller through L293D (a push-pull four channel driver). ULN2003A, a high voltage and high current Darlington transistor array, was used to interface the 12V bulb (simulating the headlamp) and the 12VDC motor (simulating the blades in flight mode) with the microcontroller. Bates explains how to achieve some of these interfacings [5].

### 4.0 CONCLUSION

The Wireless Remotely Controlled Video Capturing Vehicle is a robotic vehicle with full ground mobility and video capturing ability. It is modified and now controlled using DTMF tones generated remotely from Remote Control System which consists of a computer application (GUI) running on a PC and a USB interfaced control transmission device. The robotic vehicle receives and obeys control commands via RF link as well as sends video feeds captured via WLAN to the PC at the RCS.

This system finds application areas such as surveillance, viewing of human inaccessible area, experimen-

tation (monitoring health hazardous areas remotely), military applications as well as other industrial and security purposes.

### 4.1 LIMITATIONS

The range of RF communication between the VCV and the RCS was found to be too small. This was due to the inefficiency of the RF circuits we built which was as a result of time constraints and little experience with RF circuits.

This led us to make provision for the use of a mobile phone for the purpose of demonstration. The VCV now has an earphone connector which connects to mobile phone. The mobile phone is set to automatic answer; when the phone is called and the phone answers the call, DTMF tones can be sent to the VCV from the calling phone. Using this, the VCV can be controlled wirelessly via the GSM network while still sending video feeds to the PC via WLAN.

### REFERENCES

1. Abioye A O, David N, 2013, Computer Interfacing through the USB Port (Building a USB Device), IJERT, 2(9) 2278- 0181.
2. Abioye A O, David N; 2013, Design and Construction of a Wireless Remotely Controlled Video Capturing Vehicle; SJET, 1(3): 98-103.
3. David N, Nmerenu C, Nwosu D, Chineze B, Ogbaga O, Abioye A O, 2014, Design and Construction of a Wireless Remotely Controlled Video Capturing Vehicle II, SJET, 2(2A):142-151.
4. Axelson J, 2009, Detecting Devices, USB Complete - The Developers Guide, 4th ed., Madison: Lakeview Research LLC, Chapter 10.
5. Bates M, 2006, Power Outputs, Interfacing PIC Microcontrollers: Embedded Design by interactive Simulation, Amsterdam: Newnes Elsevier, Chapter 8.