

Research Article

Design and Construction of a Wireless Remotely Controlled Video Capturing Vehicle

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Abstract: The Video Capturing Vehicle (VCV) is a wireless remotely controlled video capturing device with ground mobility and a simulated flight control. This project focused on designing and building the video capturing vehicle's motherboard and its remote control device. The video capturing vehicle's motherboard consists of a microcontroller (PIC16F84A) to decode, interpret, and execute control signals; motors (dc and stepper) and a mechanical system, for movement and direction control; an IP camera, for capturing the video feeds; and a FM receiver module, for data and control signal reception. The remote control system consists of a computer system (with the Microsoft Windows operating system installed and a built-in WLAN adapter) and the built USB interfaced control device. Computer program software was developed for the computer system to capture video feed and send control signals to the USB control device. The control device uses the PIC18F2550 microcontroller to encode received control signals and modulates a FM transmitter module, which sends the VCV control signals via radio-link. 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.

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 (through which control signals are sent wirelessly to the video capturing vehicle remotely located); and designing and

developing the motherboard of the video capturing vehicle (which receives, process, and execute the control signal).

Project Graphical Diagram

The overview of the project is shown in figure 1 below:

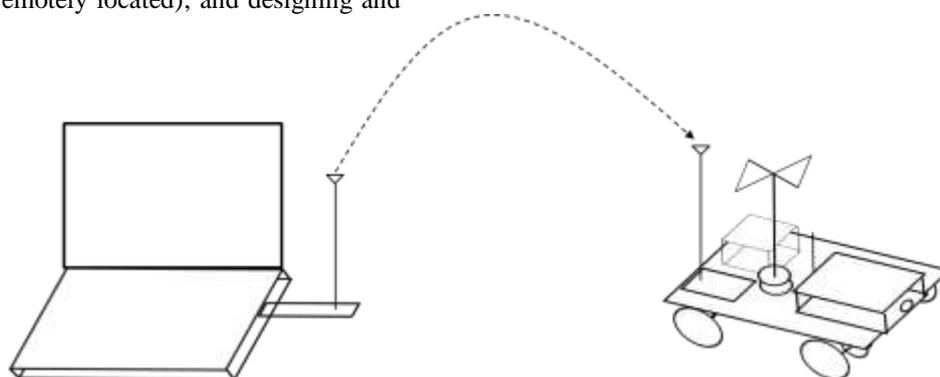


Figure 1: Project Overview Graphical Diagram

A vehicle with a camera mounted on it is wirelessly and remotely controlled from a computer system. The computer system has an application running on it for viewing the video feed (from the IP

camera) and for sending control signals to the control device. These signals are received, encoded, and transmitted by the control device. The control signal is received by the RF receiver at the vehicle, and the

microcontroller on the vehicle motherboard decodes and executes the control.

The remote control for the vehicle consists of a computer system with an inbuilt Wi-Fi module for Wireless LAN communication with the IP Camera; and a USB control device. The USB control device receives control commands from the computer application developed and encodes this signal into frequency which is used to modulate the FM transmitter built.

Thus the computer system controls the vehicle and capture the video feeds from the vehicle wirelessly which is remotely located.

Project Area

This project is an engineering project consisting of two broad fields of engineering, Mechanical and Electrical/Electronic, as shown in figure 2 below:

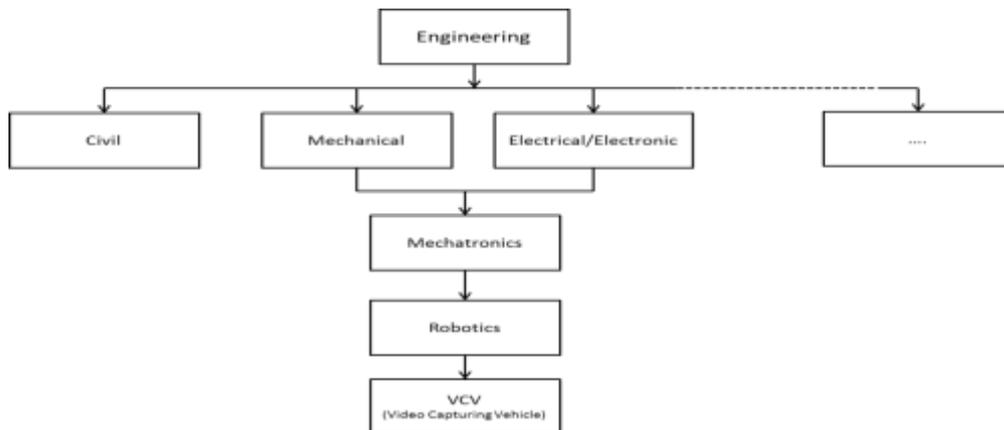


Figure 2: A Graphical Diagram Showing the Area of Study of the Video Capturing Vehicle.

Mechatronics is a sub-field of engineering which combines mechanical and electronic technologies. Robots are mechanical devices which are electronically controlled. This project focused on the electronics of the VCV and so the mechanical system was skeletally built for demonstration of the operation of the electronics.

- Scientific Investigation – as in the explorer on Mars (a robot controlled from earth which is being used to explore the planet, Mars)
- Health hazardous experiment monitoring – laboratory or field experiments that do not favour human conditions can be remotely monitored

Project Application Area

The video capturing vehicle can be applied in several areas where remote video capturing is required. Some of these areas are:

- Security Surveillance

THE VIDEO CAPTURING VEHICLE (VCV)

The Vehicle

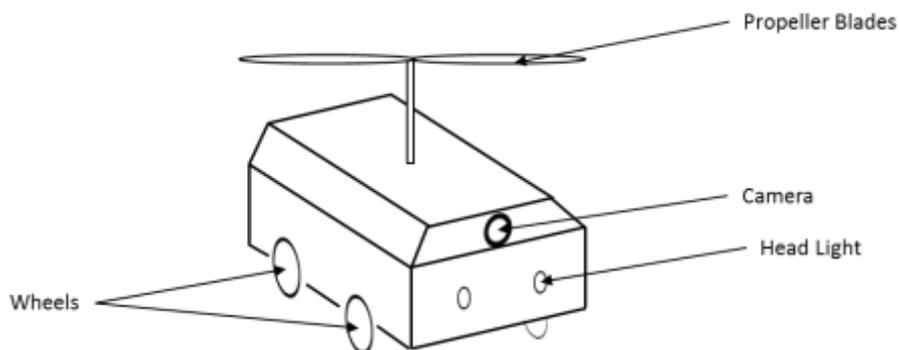


Figure 3: The Features of the Video Capturing Vehicle

Figure 3 above shows the features of the video capturing vehicle. The vehicle is driven by the two front wheels. Turning left or right involves the rotation of only the left or right wheel respectively. This has a tilt or spin like effect on the vehicle causing it to turn an angle to the left or right respectively. The forward

movement is achieved by driving both wheels in the forward direction and the reverse movement by driving both wheels in the reverse direction.

The Video Capturing Camera mounted on the vehicle is a wireless IP camera that transmits to a WLAN

network (infrastructure or Ad hoc). An FM receiver is used to receive the control signals from the remote controller. The motherboard which is embedded in the vehicle is the brain of the vehicle. It has a microcontroller which decodes and execute the control signal received by the FM receiver.

The VCV Remote

The remote for the VCV consist of a Computer System and a Control Device. The VCV computer application is required to be installed on the computer

system. The Control Device is a USB interface device connected to the computer system. It receives commands from the computer application through the USB port, and encodes this data into different frequency which is used to modulate the transmitter.

DESIGN AND IMPLEMENTATION

Project Block Diagram Describing design Approach

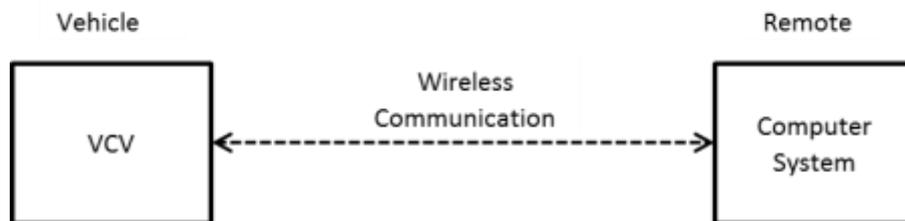


Figure 4: Block Diagram Describing the Video Capturing Vehicle Project

Figure 4 above shows a block diagram describing the whole project. It shows that the overall project consists of the Video Capturing Vehicle (VCV),

its Remote Control (consisting of a computer system and the control device), and a Radio link (wireless communication between remote and device) [11].

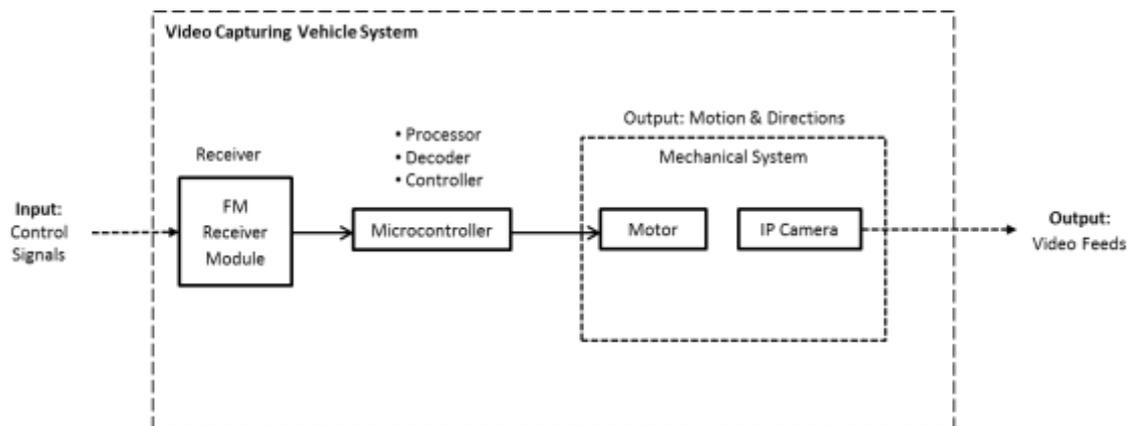


Figure 5: Block Diagram Describing the Video Capturing Vehicle System

The block diagram in figure 5 describes the video capturing vehicle system consisting of an FM Receiver module: to receive encoded control signals; Microcontroller: to decode, interpret, and send control

signals for execution of control functions; and Mechanical System: on which the camera is mounted and is responsible for the execution of the control functions.

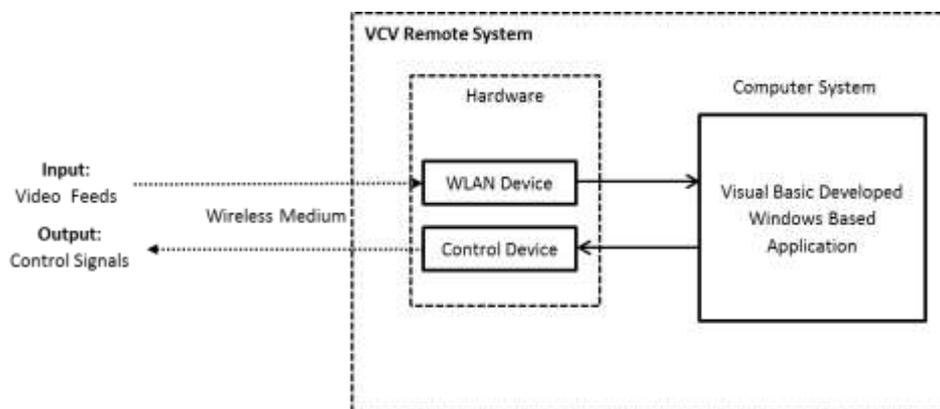


Figure 6: Block Diagram Describing the VCV Remote System

This block diagram (figure 6) shows that the Remote control system for the Vehicle consists of the WLAN device, which is usually part of the computer

system; the control device, which is to be built for this project; and the computer system: on which the developed application is installed.

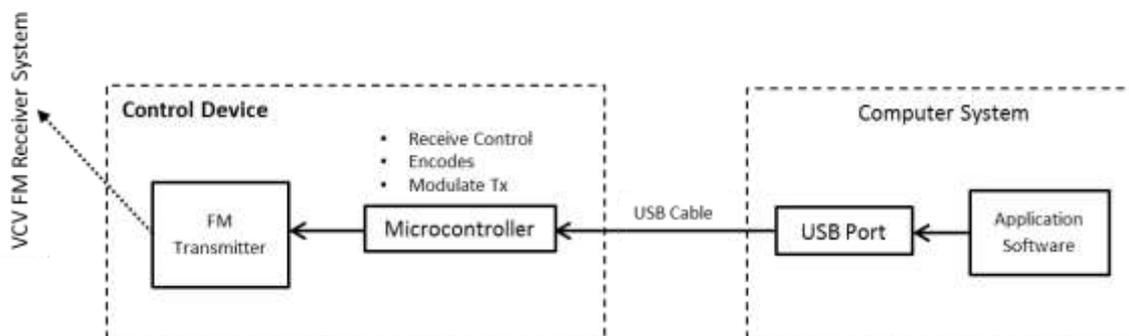


Figure 7: Block Diagram Describing the VCV Remote System's Control Device

The block diagram in figure 7 describes the built control device which was USB Interfaced; has a microcontroller which receives the computer application generated control signal via USB, encodes it, and modulates the RF transmitter appropriately. The FM Transmitter: was also built to transmit the encoded control signal via radio-link to the VCV receiver.

the USB interface device and the building of the FM transmitter section.

Project Implementation

USB Control Device

The implementation of the USB control device was divided into two sections: designing and building

A microcontroller, PIC18F2550, was used to achieve the USB interfacing utilizing the method described by Dogan [1]. The firmware for the microcontroller was developed using mikroC. The USB interface parameters are shown in table 1 below. The USB code parameters where generated using the mikroC USB Descriptor.

Table 1: A Table showing the USB Interface Parameters and Values

Parameter	Value
VID	1234
PID	1
Input Report Length	4 Bytes
Output Report Length	4 Bytes
Bus Power	100mA
Endpoint Input pooling interval	1ms
Endpoint Output pooling interval	1ms
Vendor Name	ECE2012-UNN
Product Name	Video Capturing Vehicle

Control commands from the computer are interpreted by the microcontroller which in turn modulates the FM transmitter appropriately. An 8MHz crystal is used to operate the microcontroller. The actual CPU clock is raised to 48MHz by setting the configuration bits. The command sent by the PC to the Microcontroller is in the following format: $H = xT$ Where H – Header, x - is a unique digit assigned to the specific command to be executed, and T – Tail.

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 [2] describes how to use the visual basic to build an application to interact with the USB ports. The visual basic program (called the VCV Application) runs on the computer system relaying to the control device control instructions from the user.

Video Capturing Vehicle 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 [3] and Predko[4] explain how to achieve some of these interfacings.

RF Communication

An FM transmitter was built for the remote control side of the VCV. The test transmitter was designed to transmit at 95MHz (and found to transmit 102.7MHz). At the Receiver end, a broadcast band radio was expected to receive the signal transmitted. This signal is then amplified and sent to the microcontroller on the VCV motherboard to decode and execute the required function.

Radio frequencies have the advantage of communicating through physical obstacles such as buildings, they need no line-of-sight, and can span longer ranges, among other. The broadcast frequencies were used as against the standard hobby frequency of 27MHz and 49MHz. This was due to the limitations of the available instruments such as an oscilloscope that could measure or detect frequency of this range. The audio broadcast range gave us an option of building a transmitter whose transmission could be detected by a standard broadcast radio receiver. Although, there exist a plethora of RF modules which transmit at 433.92MHz, 315MHz, 868MHz, or 915MHz, we considered building our own transmitter and receiver module because we wanted to go basic. The receiver could not be actualized within the required time frame and so we considered the standard broadcast radio receiver.

Project Resources

In achieving this project, textbooks written by P. Scherz[5], V. Mehta and R. Mehta[6], Gibilisco[7], Boylestad and Nashelky[8], and Rafiquzzaman[9] were consulted to develop the necessary theoretical knowledge required for the Video Capturing Vehicle project. Foxall[10] provided the necessary visual basic programming background in his 2008 visual basic book.

Laidman[12] website gives a good tutorial on stepper motors.

CONCLUSION

The Video Capturing Vehicle (VCV) is a wireless remotely controlled video capturing device with ground mobility and a simulated flight control. This project focused on designing and building the video capturing vehicle motherboard and its remote control device.

The video capturing vehicle consisted of the motherboard with a microcontroller performing decoding, interpretation, processing, and control signal generation functions; motors (dc and stepper) and a mechanical system, for movement and direction control; an IP camera, for capturing the video feeds; and a FM receiver module, for data and control signal reception. The firmware for the VCV motherboard's microcontroller (PIC16F84A) was developed using assembly language.

The remote control system consisted of a computer system (windows operating system based and a built-in WLAN adapter) and the built control device which was interfaced to the computer system through the USB port. Computer program software was developed for the computer system, using visual basic, to capture video feed and send control signals to the USB control device. The control device uses the PIC18F2550 microcontroller. Its firmware was developed using mikroC, a variant of the C programming language for PIC microcontrollers. The control device also has a FM transmitter module, to send the VCV control signals via radio-link.

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.

Limitations

The major limitation of our project was the lack of a good mechanical supporting structure. The mechanical structure was skeletally designed to simulate all the motion conditions of the vehicle including the flight mode, by controlling a dc motor.

Also, the RF communication design was not completed. A long thin wire (two strands of a typical network cable) was used to link the remote to the vehicle.

Recommendation

Mechatronic projects should be encouraged and students embarking on such projects should be advised

to consider working with a fellow mechanical student so as to have a successful and working mechanical supporting structure.

RF communication lectures should be made more practical and simple to understand without avoiding its complexity. This would aid and facilitate the actualization of projects that require either wholly or partly the implementation of RF communication.

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