TUNNEL VIEWER: VOICE AND COMPUTER CONTROLLED ROBOT

W. M. L. S. Walisundara and W. D. S. S. Bandara*

Department of Electrical and Computer Engineering
The Open University of Sri Lanka

INTRODUCTION

Voice communication is significant in human-robot interaction and utilizes various communication media. With the developments in communication technologies in the recent past, speech has become an important interface for many systems. Instead of using complicated interfaces, speech offers an easier and more intuitive way to communicate with computers and to control machines and environments.

A method for controlling a robot vehicle by voice and computer commands is proposed here. The proposed voice-operated robot is capable of operating in some tedious work spaces. The voice commands are used to control the movements of the robot and visual feedback is used to command the robot precisely.

Various voices were compared using different sentences for speech synthesis. With synthesis, the robot was able to operate independent of the user. The interfacing was tested and the transmitted commands were received by the microcontroller. The transmitted video was received by the USB receiver. It was possible to achieve a clear voice recognition system and visual feedback to track the movements of the robot.

Various applications like Maze Solving, Tracking and Line Following are possible with further advancements to this Robot System. With reliable, high-speed transmission there is potential to achieve more reliable and higher-quality communications.

METHODOLOGY

The block diagram of the proposed robot and the process flow is shown in Figure 1. The main units of the system are speech recognition unit, PC interface unit, Visual feedback unit and the motor driving unit.

Operation of the System

The robot vehicle is operated in dual mode, i.e., by computer command and/or by voice commands. The speech is received by a microphone and processed on a PC. When a command to the robot is recognized, the PC sends a command message to the robot using zigbee.

The robot receives the signal and takes appropriate action. A camera is mounted on the robot and it can be used to perform various tasks. The camera captures the video and sends visual feedback to the user.

Speech commands were input to the computer by a microphone and the features were extracted and recognized with Microsoft Visual Studio (based on C#) which is an integrated development environment (IDE) from Microsoft. Microsoft Visual Studio is usually used to develop console and graphical user interface applications. The verbal commands were converted to a form which the robot can recognize and when a command for the robot is recognized, the PC sends a command message to the robot using the zigbee wireless

* *Corresponding author: Email -* ***wdban@ou.ac.lk***

technology. The movement is carried out accordingly using the Arduino Software which is an open source electronics prototyping platform based on flexible, easy to use hardware and software.

There are fixed commands which can be used to control basic robot actions such as: forward, backward, right, left and stop. As in the short form, a voice command is received through a microphone, processed in the computer and sent to the robot through a wireless transmission and finally the robot acts accordingly. A special feature of the robot is the wireless camera on it. The camera captures the video sends visual feedback to the receiver wirelessly.

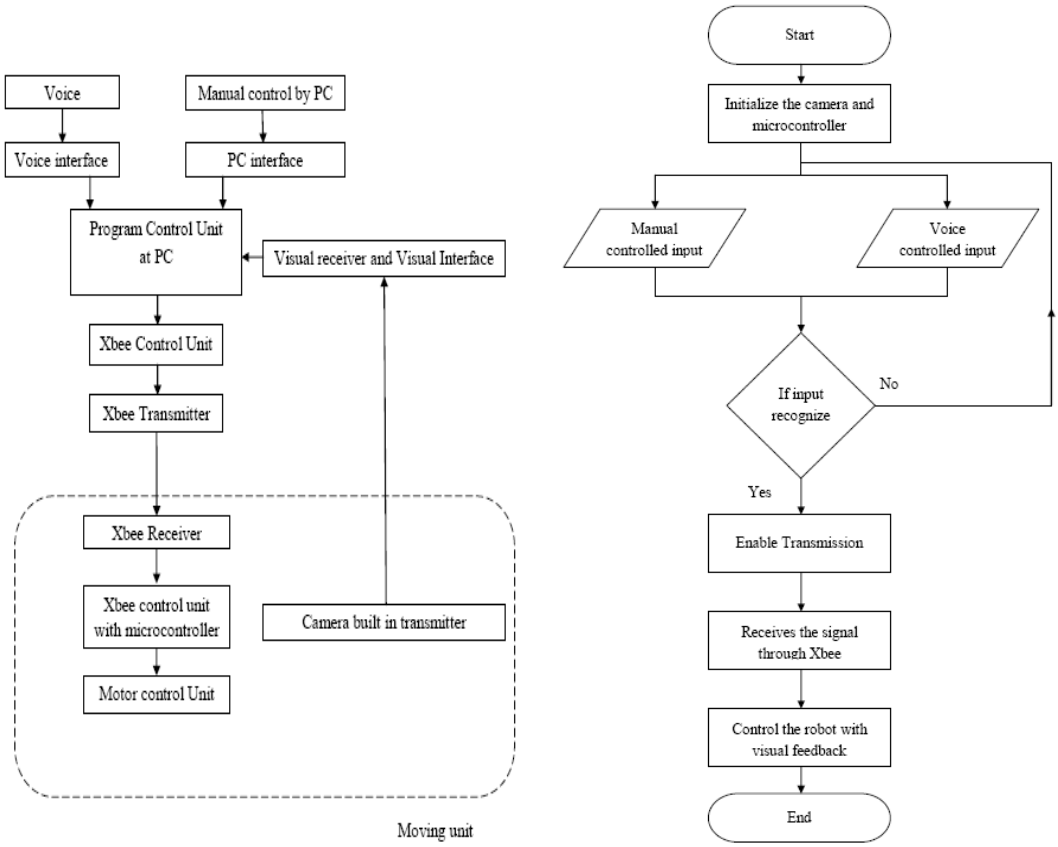

Figure 1. System Block Diagram and Flow chart for main program

The selected camera consisted of a 2.4GHz wireless 4 channel receiver and it is rechargeable. This miniature color video camera is revolutionary in size and it is completely wireless. The camera can be simply placed in a discreet position and to receive video all that needs to be done is to plug the receiver to a computer. Providing clear, quality images in color, the Wireless Hidden Spy Camera is ideal for keeping an eye on the tunnel. Power for the camera can be supplied by a standard 9 volt battery or power adapter. The transmitting range is approximately 100m line of sight and around 30m indoors.

The vehicle can be stopped ion an emergence using voice commands. Two 9V batteries are used for the system. One 9V battery is used to power the Arduino board and other battery is used to power the motors. The speed of the robot vehicle is determined by the rotation of the motor. The speed can be controlled by the PWM technique by using delays. A more efficient way to proceed is by using the pulse width modulation technique to manage the speed of DC motor. The gear motor works well between 3V and 12V. At a ratio of 1:48 it is possible to get some really good torque at 5 Volts and 15rpm output.

The final product is shown in Figure 2.

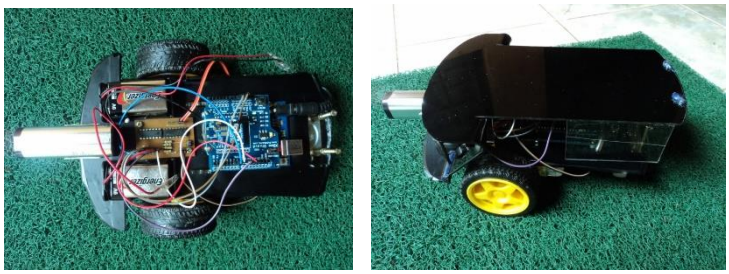

Figure 2. Final product

Dimensions of the system

Table 1. Dimensions of the system

Weight with roof	480g
Weight without roof	385g
Length	25cm
Width	16cm
Height	12cm

Uphill and downhill angle calculation

Using the observed and measured values of weight, speed and other parameters, the maximum angles of uphill and downhill movement were calculated. The calculated values did not have major differences with practical values.

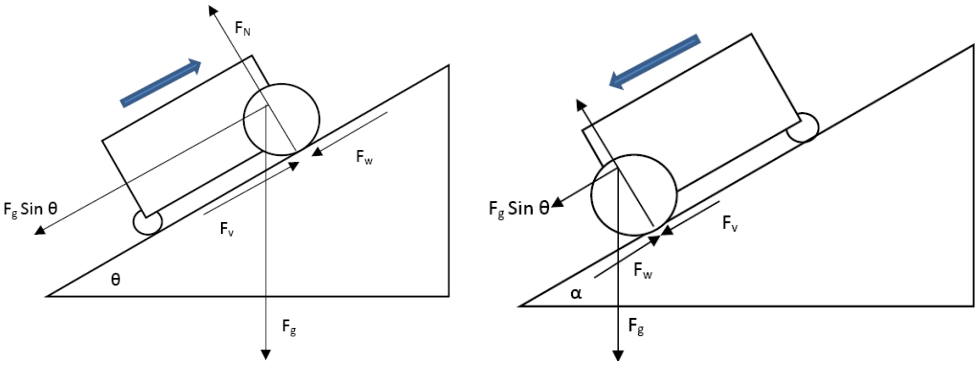

Figure 3. Considering uphill and downhill travel,

the maximum angle the robot vehicle can travelling uphill: $33.410^0$and downhill: 45.099^0

It takes several seconds to transmit the signal to the zigbee receiver due to the delay in serial port reading. But the delay is not more than 2 seconds when it is identified as the correct command. When taking bends the robot uses only one motor and other one is stopped.

RESULTS

The robot vehicle was moved inside a tunnel according to the voice commands and the visual feedback. The diameter of the tunnel was appromimately 24cm.

Figure 4 shows some images taken by the camera while travelling inside the tunnel.

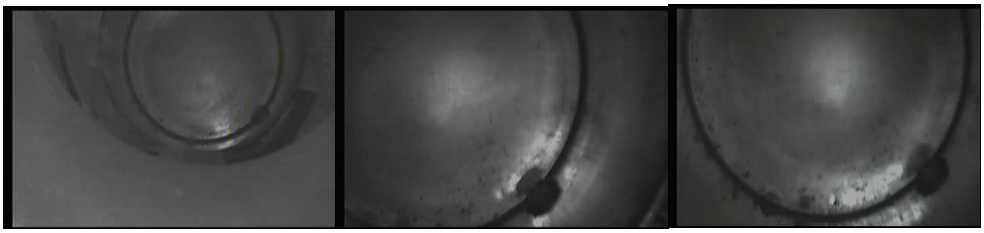

Figure 4. Real time observations: Images taken from the camera

DISCUSSION

For better operation of the system commands should be fast but not too slow and should be clear. Speaking close to the microphone will give better results. The best average is 30-50 cm from the microphone.

Environmental issues can arise because we are unaware of the exact condition of the tunnel interior when the robot vehicle moves. Better information provision can be achieved in two ways: adding a protective insulation cover and adding temperature sensing, humidity sensing, and smoking sensors. These sensor units can be directly connected to the Arduino Unit and can be controlled by the computer program.

CONCLUSIONS/RECOMMENDATIONS

Rotation of the Camera

The system cannot see the entire area very clearly before it takes bends. Rotating the wireless camera can avoid this problem. To do so, servo motors can be used in future development of the system. Servo motors are types of actuators that rotate to a specific angular position. A "robot servo" is a new type of servo that offers both continuous rotation and position feedback. All servos can rotate Counter Wise and Counter Clock Wise. The angular motion of the turning shaft can be measured using encoders or potentiometers. But when this type of motor is added to the system, it will also result in a direct increase in power consumption as well. To mitigate the power consumption issue rechargeable batteries can be placed on the robot vehicle. This will increase the total weight of the system and therefore this should be taken into consideration when deciding on the two dc motors.

REFERENCES

Fatih Aydinoglu, 2011. Robot Control System with Voice Command Recognition, Yıldız Technical University, Department of Computer Engineering.

Grant P. M., 2012.Speech recognition techniques.

Raymond Low and Roberto Togneri, 2013.Speech Recognition Using the Probabilistic Neural Network, the University of Western Australia, Department of Electrical and Electronic Engineering.

Selecting motors and other robotic concepts, 2010. [Online]. Available from: http:// www.migi.com/selecting motors [Accessed date: 5th April 2014]

Zigbee Alliance "ZigBee Specification faq", 2013. Retrieved 14 June 2014.

ACKNOWLEDGMENTS

Authors wish to acknowledge the assistance given by the Department of Electrical and Computer Engineering, The Open University of Sri Lanka, in completing this research project work.