Applied Mechanics and Materials Vols. 764-765 (2015) pp 768-772
© (2015) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMM.764-765.768

Submitted: 2014-07-01
Revised: 2014-08-11
Accepted: 2014-09-27
Online: 2015-05-28

Development of an Unmanned Combat Vehicle with its Training System

Shih-Sung Lin [1, a*], Yu-Wei Liu [1,b]

[1] Department of Electrical and Electronic Engineering, Chung Cheng Institute of Technology, National Defense University, R.O.C

[a*]shihsunglin@gmail.com, [b]zxzxcool@gmail.com,

Keywords: Unmanned Ground Vehicle, Combat, Training System.

Abstract. By using image processing and automatic control technologies, this study designs an unmanned ground vehicle (UGV) that can be operated by various control devices, such as laptops and joysticks. A camera is set up on the UGV to capture the sight around it, and then can send the video to the back end system in a wireless manner. Besides, we design an attacking system that allows users to do the zeroing correction for shooting the target precisely. Moreover, a shooting training system is designed to improve the convenience for target practice. It not only can send the result to the back end system immediately but also can simulate the enemy movement to make the training more reality.

Introduction

A lot of unmanned ground vehicles (UGVs) are developed for difference purposes in recent years [1, 2]. However, the development of UGV now faces many challenges. The situation on the ground is more complicated than in the air. Therefore, how to identify the enemy or foe is very important in the battlefield. In addition, the signal of command may be interfered or shielded by other factors [3].

Recent years, variety of modern vehicles used for war drills and relief mission, but people usually face the dangerous road or forest deep in the mountain that hard to move forward. When natural disaster destroy the road leading to the deep mountain, the communication between the mountain and the ground become much more important. So we need to build a communication relay station to connect both sides. In urban operation, soldiers will be threatened by the enemy hide in the dead space or bunker. The UGV can be used as a reconnaissance vehicle. Not only collect the intelligence of enemy, but reduce the injuries of friendly forces.

The purpose of this article is to design an unmanned vehicle with low case. The radio frequency (RF) communication module is used to transfer control commands and live screen of wireless camera. The remote weapon station and the data of sensors can also be controlled and display by the user inter-face in the laptop. We focus on the technique of image transferring, motor control and the sensor data transferring. With simple manipulate and rapid response, we can build an initial model of a multifunctional unmanned combat vehicles.

System Architecture

The system architecture of this research is shown in figure 1. We divide the system into 5 parts: control circuit, power circuit, motor drive circuit, wireless module and video module. In the same user interface, we can use the laptop to control the movement of vehicle and monitor the condition. All the units use the same power supply.

We choose Arduino UNO development board as the main core of control system to control motor driver and sensors. The L298N chip, shown in figure 2, can output the PWM signal to adjust the rotation speed of the motors. With two relays, we simulate the H-bridge circuit to control the motor of gun for elevation adjustment. To support the power for all parts of the system, we choose the Li Battery because of the durability, the reusable and the stability. We choose APC220 2.4G wireless transceiver module as the intermediary between laptop and control system, mainly to control the

motor circuit. The modules connected to the Arduino UNO and the laptop are shown in figure 3 and figure 4 respectively.

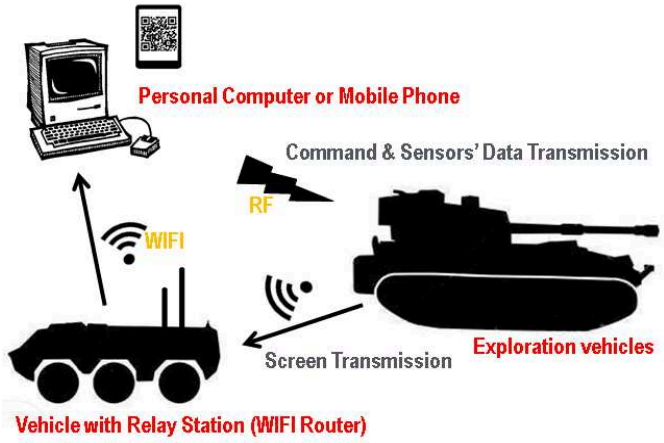

Fig. 1 System architecture

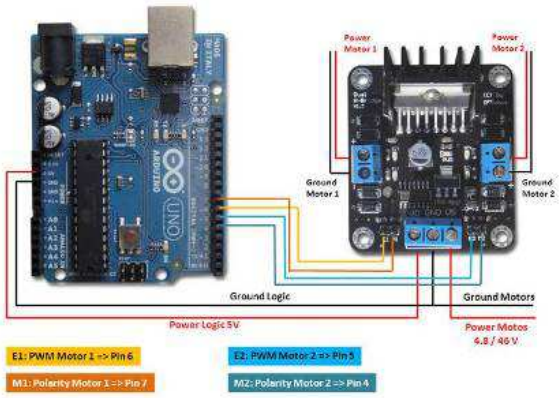

Fig. 2 L298N module

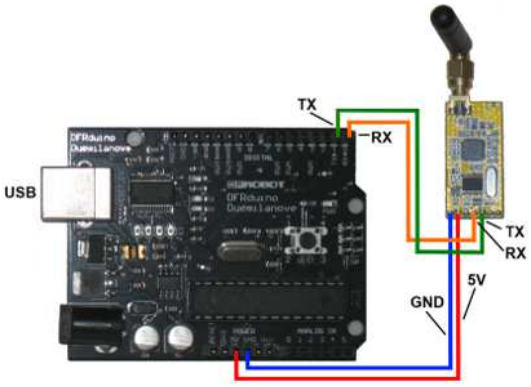

Fig. 3 APC220 connect to UNO board

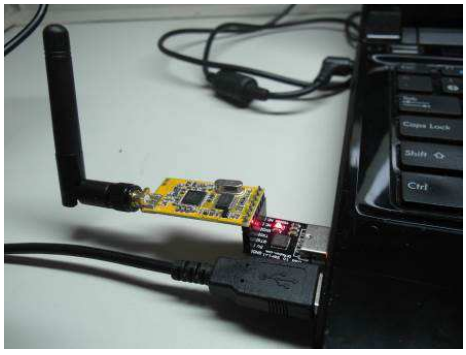

Fig. 4 APC220 connect to the laptop

We use the 5.8G RF wireless video communication module to transfer the live screen from vehicle to the laptop through video adapter or Wi-Fi Router. To lighten the single Arduino's load, we use the I2C bus to connect two Arduino boards. The master board is in charge of control system managing and sensor data catching from the slave board. The connection chart is shown in figure 5.

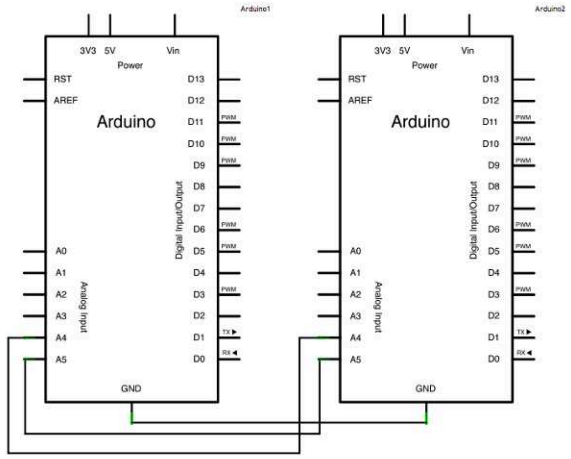

Fig. 5 I2C bus connection between two Arduino boards.

We use Digital Compass IC (HMC5883) to help the vehicle indicating directions. It can measure both the direction and the magnitude of Earth's magnetic fields from 1 milli-gauss to 8 gauss. Then, we choose HC-SR04 ping sensor to detect obstacles in front of the vehicle. According to the speed of sound in the air, we can calculate how far the obstacle away from the vehicle. To allow the users to operate the UGV through a graphic user interface (GUI), we use Microsoft Visual Studio .NET as the development tool to construct the application with C# programming language. The GUI is combined with serial port transceiver, vehicle movement control, live screen transceiver and sensor data display. We also designed a Win32 scoreboard program to detect whether the target was been hit or not. The target sensor can automatically transfer the shooting result to another Arduino board. Then, the Arduino board can tell the result to the laptop by the serial port. The shooting training system is shown in figure 6.

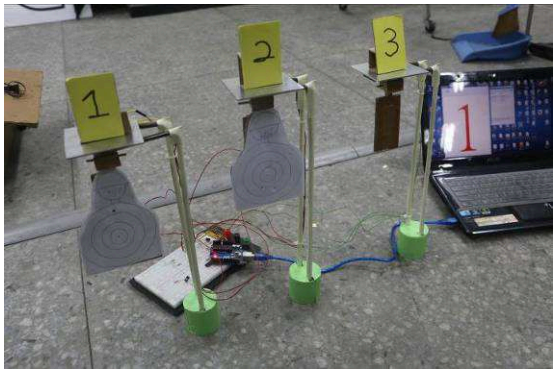

Fig. 6 The shooting training system

Achievement

We lower the vehicle's center of gravity and insert the DC motor with large torque output to rotate the gun. We can not only click the button or push the keyboard, but also use the joystick to control the vehicle. In the target interface, when all the targets were hit, the scoreboard program will stop the timer and display the time we cost. The fastest one will replace the highest score currently. The function of zero shooting testing on paper is available, shown in figure 7. After that, there is no ballistic offset phenomenon. The snapshot of actual testing for the training system and the user interface on the laptop is shown in figure 8.

Fig. 7 The snapshot of zeroing correction .

Fig. 8 The user interface on the laptop

Conclusion

Technical characteristics of the system are as follows:

- Using Visual C# Programming language to develop the interface software, combined with RF communication and Wi-Fi camera screen transformation.
- Using open-source Arduino electronic prototyping to design the Control circuit.
- The structure of the vehicle is simple and can be reassembled on different purpose.
- The user can input command by using keyboard on the user interface and then send the command to control the vehicle by wireless communication.

Table1 The evolution of the system.

Category	Contents
C# Vehicle control command	Serial Port transfer single character→ Thread transfer multiple characters → Serial Port transfer multiple characters
Video catching equipment	WebCam → Router+IPCAM → IPCAM + Router → 5.8G module
Video catching program	Embedded VLC Player catch rtsp stream→ Timer catch mjpeg stream→multi-thread mjpeg catch stream→AForge catch 5.8G video stream
Elevation adjustment of gun	Servo Motor→ DC Motor→ DC Motor + H-Bridge circuit simulate by 2 relays
Arduino Communication	Single thread → I2C bus
Power supply	Dry cells → Li Battery →18650 Rechargeable Battery DC stabilizer

The innovation and contribution of the UGV and its Training System are shown as follows:

- A high degree virtual reality of vehicle control system: simulate the real armored vehicles control panel to make the user experience more reality.

- Sophisticated structure and operation mode of the system：Simulate the real armored vehicle's structure and stabilizer to make the shooting and movement more smoothly.
- Scalability and versatility：The structure of the vehicle and targets can easily to reassemble and carrying. It can also be the equipment of national defense exhibition experience.

The image recognition of the current program is still in the testing stage, the future should focus on the combination of fire control and image processing to make the zero correction more perfect. Power system will integrate all the batteries into one unit to make the power structure simple. Video transmission has already changed into 5.8Ghz wireless transmission module to make the live video screen more detailed and immediacy.

References

[1] P. Papadakis: Terrain traversability analysis methods for unmanned ground vehicles: A survey, Engineering Applications of Artificial Intelligence, Vol. 26 (2013), pp.1373-1385

[2] H. Moon, J Lee, J.H. Kim, and D. Lee: Development of Unmanned Ground Vehicles Available of Urban Drive, IEEE/ASME International Conference on Advanced Intelligent Mechatronics. (2009), p.786 - 790.

[3] C.K. Kim, Y.M. Han, B.H. Bae, and J.H. Kim: The research of path planning algorithm considering vehicle's turning radius for unmanned ground vehicle, 11th International Conference on Control, Automation and Systems, (2011), p. 754 – 756.

[4] STMicroelectronics, A.T.2000. L298 Dual Full-Bridge Driver in Website. (2014).

[5] DFRobot, A.T.: 2008. APC Series Transparent Transceiver Module APC220-43" in Website. (2014)

Modern Design Technologies and Experiment for Advanced Manufacture and Industry
10.4028/www.scientific.net/AMM.764-765

Development of an Unmanned Combat Vehicle with its Training System
10.4028/www.scientific.net/AMM.764-765.768