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Application of a Remote Image Surveillance System in a Robotic Weapon

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Abstract: As one of the major steps toward fully intelligent autonomous robotic weapon, this paper works have accomplished in three major areas: (1) design of the surveillance system by AVR microcontroller, (2) implementation of the mechanism design, and (3) performance of the human machine interface surveillance system via LabVIEW graphical programming environment, such that the supervisor can control the vehicle by keyboard or genius mouse. In order to accomplish all these three achievements, there have been major additions and overhaul in both system software code and system circuit board developments. All these development including the developed algorithm, and hardware implementation are covered in this paper. The experimental results have shown the practicality of the AVR microcontroller, LabVIEW graphical programming environment, and the ZigBee wireless technology applied to robotic weapon.

Keywords: Robotic Weapon, LabVIEW, AVR Microcontroller, Remote scout robot.

I. INTRODUCTION

There are times when the rescue team is unable to enter the scene of the accident due to various shortcomings that might endanger the rescuers lives. In order to overcome these possible obstacles, a lot of researchers have built some various robots that can enter these dangerous sites in place of the rescuers. However, as regards HMI-guided control, few researchers use LabVIEW platform to delve into tracked robots. In 2001, Priya Olden et al. presented an open-loop motor speed control with LabVIEW [1]. In 2006, Prasanna Ballal et al. proposed a LabVIEW based test-bed with off-the-shelf components for research in mobile sensor networks [2].

Hence, we will extend the research in the past [3-7] to implement a weapon robot in this paper. The key feature is the application of an AVR microcontroller applied to design a controller so that all of the design functions can be implemented. Furthermore, the vehicle can be orientated by ZigBee based wireless system. Besides, we design the human machine interface surveillance system via LabVIEW graphical programming environment, such that the supervisor can control the weapon robot by keyboard/genius mouse.

To illustrate the effectiveness of the design, we plan an urban fight space as the scenario setting such that the robot can finish all functions. The experimental results validate the practicality of the AVR microcontroller, LabVIEW graphical programming environment, and the ZigBee wireless technology applied to weapon robots.

II. Self-Made Robotic Weapon

2.1 Mechanism of the Robot

Fig.1 is the vertical view for the platform of the weapon robot. Fig.2 shows the right side view. The structure contains two active wheels and one small assistant wheel. The specification of the robotic platform includes (1) the length is 41cm, (2) the width is 31cm, and (3) the height is 20cm. Fig.3 shows a MP5K electric BB gun. The self-made robotic weapon is shown in Fig.4. We put a MP5K electric BB gun on the platform of the robot and set one camera behind the sight of the gun. The specification of the robotic weapon includes (1) the length is 52cm, (2) the width is 31cm, and (3) the height is 34cm.

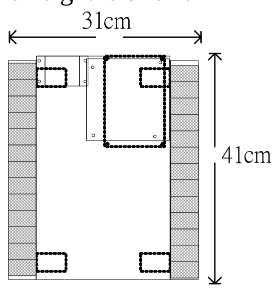


Fig.1. Vertical view of the platform

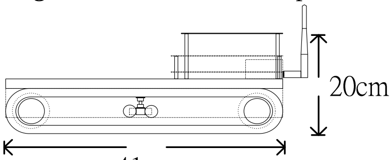


Fig.2. Right side view of the platform

Fig.3. MP5K electric BB gun

Fig.4. Robotic weapon

2.2 Remote Image Surveillance System

The procedures for the image transmission is shown in Fig.5. The system consists of an image receiver, a NI PXI/PIC-1411 board, a wireless camera, and a servo motor (see Fig.6-Fig.8) [7].

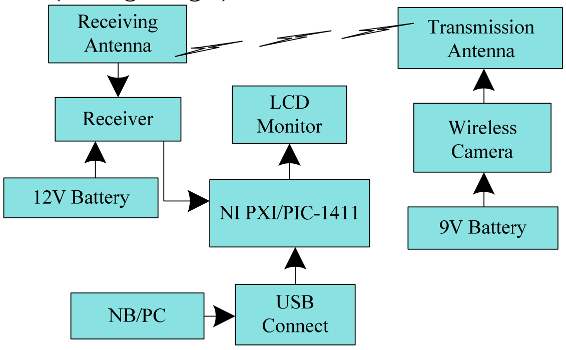


Fig.5. Procedures for the image transmission

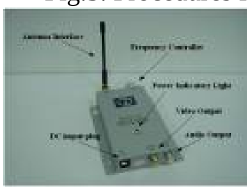


Fig.6. Image receiver

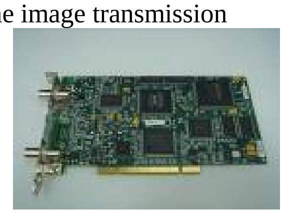


Fig.7. NI PXI/PIC-1411

Fig.8. Wireless camera

2.3 AVR microcontroller

Fig.9 shows the AVR32 microcontroller. The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Moreover, the main function of the CPU core is to ensure correct program execution. The CPU must therefore be able to access memories, perform calculations, control peripherals, and handle interrupts. Besides, the AVR architecture has two main memory spaces, the Data Memory and the Program Memory space. In addition, the ATmega32 features an EEPROM Memory for data storage. All three memory spaces are linear and regular.

Fig.9. AVR32 microcontroller

III. LabVIEW

LabVIEW（Laboratory Virtual Instrument Engineering Workbench） is an easy-to-use graphical development environment which allows users to rapidly develop applications for experiment, measurement and control. A complete system can be constructed very fast with hardware modules for data accomplishment, image processing, motion domination, or communication available from National Instruments (NI) [8]. Each application created in LabVIEW is referred to as a virtual instrument (VI). A VI consists of a user interface front panel and a block diagram. A VI can also be called from another VI, called a sub-VI. The standard LabVIEW package comes with various VIs in the form of libraries and drivers to permit program development rapidly [9].

In this paper, we use LabVIEW graphical programming to design a human machine interface surveillance system [3]. From the transmission of RS-232 and ZigBee modules, the command will be delivered to the controller, placed on the weapon robot so that the vehicle will be arrive at assigned place. The LabVIEW front panel is shown in Fig.10, where contains seven parts. Block 1 is the safety push-button. All of the functions can not be fulfilled if we don't put the button. Block 2 displays a keyboard/genius mouse switch device. We can choose the press-key or genius mouse to control the robot. Moreover, we can set the RS232 I/O port and baud rate by Block 3 and Block 4, respectively. Block 5 displays the character string when the keyboard is pressed. The ASCII code is shown in Block 6. Block 7 indicates the frame of controlling the order through the Genius mouse.

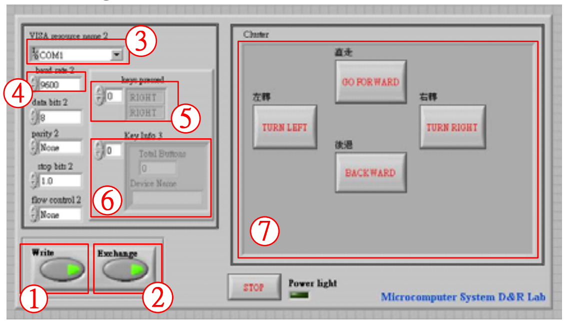


Fig.10. LabVIEW front panel

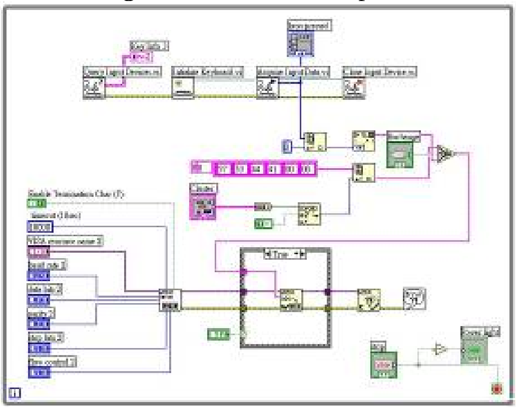


Fig.11. LabVIEW programming block diagram

IV. ZigBee Transparent-P2P Mode

ZigBee has been an intelligent digital protocol, operating at three frequencies, with the commonest one being at 2.4 GHz. At this operating frequency, data rates up to 250 kbit/s are claimed. This is a relatively low bandwidth, compared to other protocols such as Bluetooth. Moreover, the feature of ZigBee contains the robustness and simplicity of IEEE 802.15.4 standard, the versatility of ZigBee Compliance Platform, the low consumption and cost, and the standard-based short-range wireless networking.

In this paper, the ZigBee is developed for point-to-point transmission and area positioning. IP-Link 2220H, shown in Fig.12, provides a host of AT commands to allow easy configuration of key attributes of an IP-Link 2220 module. Users can use any terminal emulation utility or UART communication library on a particular host platform to issue these AT commands to IP-Link 2220.

Figure 13 shows the transparent point-to-point mode. The signal can be transmitted by connecting RS-232 series port and ZigBee transmitter such that the receiver can obtain it. Besides, a Tag (placed on the robot) transmits a continuous signal so that the node (placed on the scenario setting space), which is most close to the robot, can receive the signal and display on the monitor. Then, the supervisor will know the present position of the robot. [6]

Fig.12. IP-Link2220H

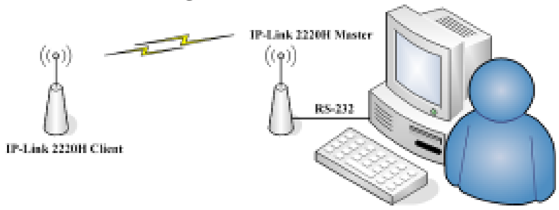


Fig.13. Transparent P2P Mode

V. EXPERIMENTAL RESULTS

For the scenario setting and the experimental test, we plan the indoor orientation diagram, shown in Fig.14. Fig.15 reveals the course that MP5K electric BB gun shot continuously. Fig.16 indicates the actual responses.

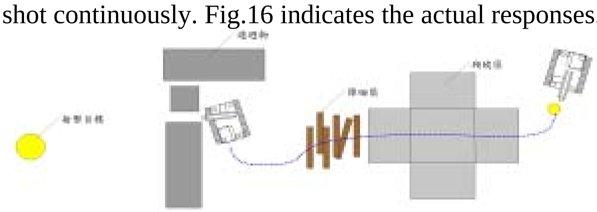
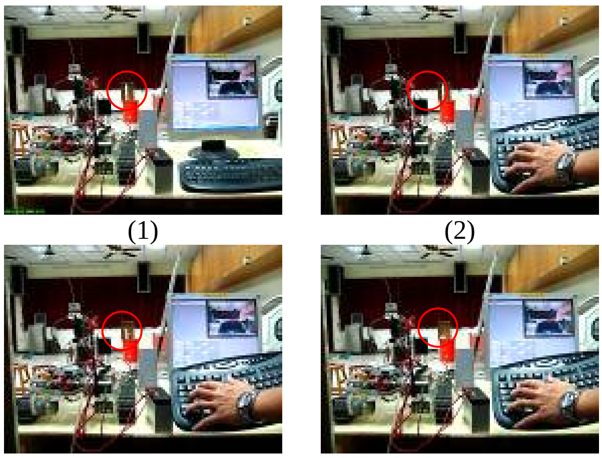


Fig.14. Indoor orientation diagram



(1) (2)

(3) (4)

Fig.15. The course that BB gun shot continuously

(1) (2)

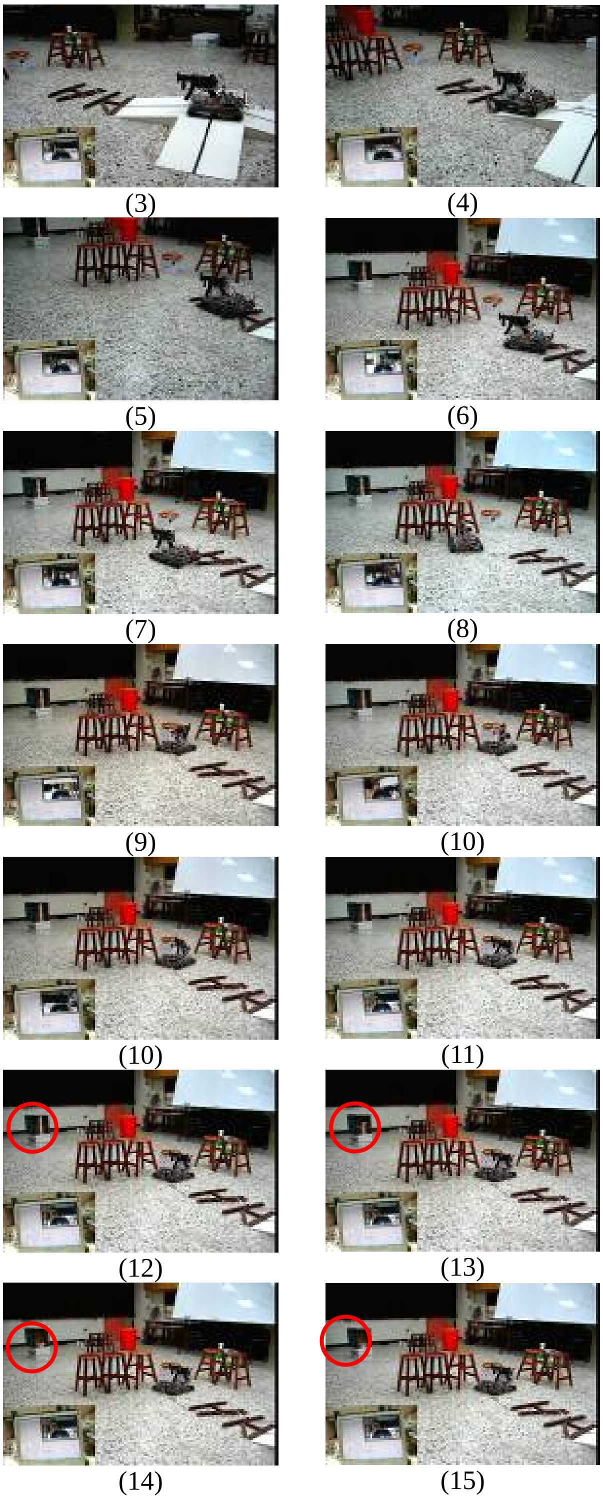


Fig.16. Actual responses

VI. CONCLUSION

In this paper, a weapon robot is implemented. Moreover, an AVR microcontroller is applied to design a controller so that all of the design functions can be implemented. Furthermore, the vehicle can be orientated by ZigBee based wireless system. Besides, we design the human machine interface surveillance system via LabVIEW graphical programming environment, such that the supervisor can control the weapon robot by keyboard/genius mouse.

The experimental results validate the practicality of the AVR microcontroller, LabVIEW graphical programming environment, and the ZigBee wireless technology applied to weapon robots.

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