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Shape Recognition Applied in a Semi-Autonomous Weapon Robot

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Abstract: A weapon robot with semi-autonomous shooting is implemented in this paper. The principal aim is the application of a shape recognition method so that the MP5K electric BB gun can shoot semi-autonomously. In addition, we designed a human–machine interface surveillance system via the LabVIEW graphical programming environment, such that the supervisor can control the weapon robot by a keyboard or a specially adapted mouse. In order to accomplish all these achievements, there have been major additions and overhauls in both system software codes and system circuit board developments. The experimental results have shown the practicality of the shape recognition, the 89C51 microcontroller, the LabVIEW graphical programming environment, and ZigBee wireless technology applied to weapon robots.

Keywords: LabVIEW, ZigBee, Semi-autonomous shooting, Shape recognition, POB-Basic system.

I. INTRODUCTION

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

Therefore, we extended previous research [3–7] to implement a weapon robot. The principal aim is the application of a shape recognition method so that the MP5K electric BB gun can shoot semi-autonomously. In addition, we designed a human–machine interface surveillance system via the LabVIEW graphical programming environment, such that the supervisor can control the weapon robot by a keyboard or a specially adapted mouse.

In order to accomplish all these achievements, there have been major additions and overhauls in both system software codes and system circuit board developments. To illustrate the effectiveness of the design, we planned an urban fight as the scenario in which the robot could use all its functions. The experimental results validate the practicality of the shape recognition, the 89C51 microcontroller, the LabVIEW graphical programming environment, and the ZigBee wireless technology applied to weapon robots.

II. SELF-MADE WEAPON ROBOT

2.1 Mechanism of the Robot

Figure 1 shows an overview of the platform of the weapon robot. Figure 2 shows the right-hand side view. The structure has two active wheels and one small assistant wheel. The specifications of the robotic platform are (1) length 41 cm, (2) width 31 cm, and (3) height 20 cm. The home-made weapon robot is shown in Fig.3. We put an MP5K electric BB gun on the platform of the robot, and set one camera behind the gun sights. The specifications of the weapon robot are (1) length 52 cm, (2) width 31 cm, and (3) height 43 cm.

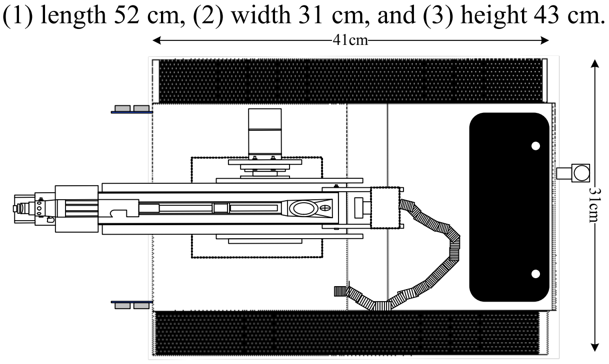

Fig.1. Vertical view of the platform

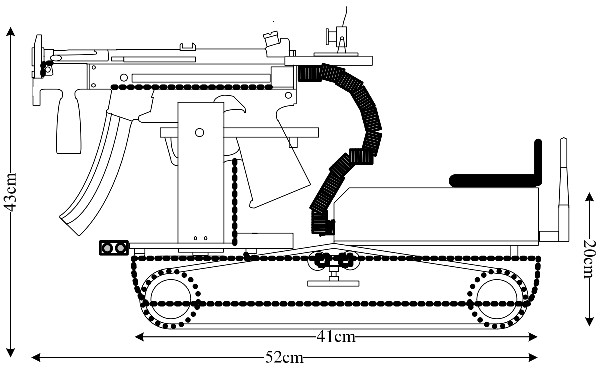

Fig.2. Right side view of the platform

Fig.3. Weapon robot

2.2 Wireless Network Camera and Router

In this paper, an AXIS 207MW wireless network camera, as shown in Fig.4, is applied to take a scene. Figure 5 shows the D-LINK DIR-615 router.

Fig.4. AXIS 207MW wireless network camera

Fig.5. D-LINK DIR-615 router

III. LabVIEW [4]

The Laboratory Virtual Instrument Engineering Workbench (LabVIEW) 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). 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 rapid program development.

Here, we use LabVIEW graphical programming to design a human machine interface surveillance system. From the transmission of RS-232 and ZigBee modules, a command will be delivered to the controller and placed on the weapon robot so that the vehicle will be arrive at assigned place. The LabVIEW front panel is shown in Fig.6. There are eight function-blocks in this figure. Block 1 is the safety push-button. If we put the button, all of the functions can't be fulfilled. Block 2 displays a keyboard/genius mouse switch device. We can choose the keyboard or the 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 mouse. Block 8 displays the scene, taken by the wireless network camera.

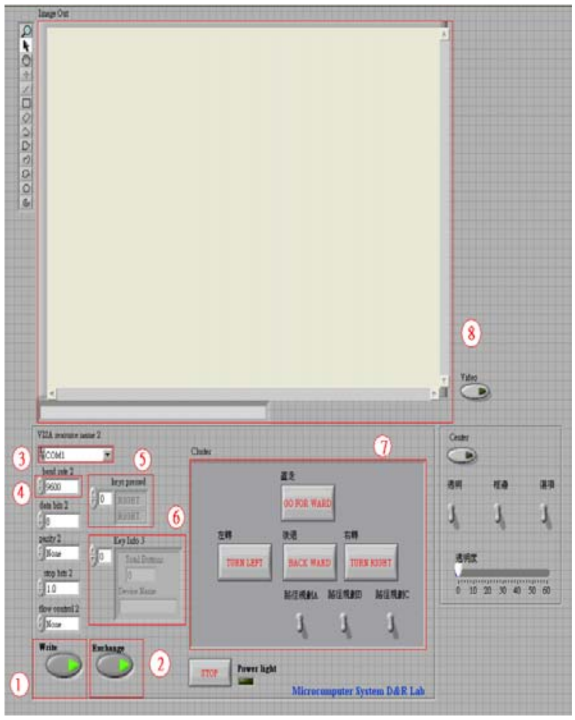

Fig.6. LabVIEW front panel

IV. ZIGBEE TRANSPARENT-P2P MODE

ZigBee is 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. In addition, the features of ZigBee contain the robustness and simplicity of IEEE 802.15.4 standard, the versatility of the ZigBee compliance platform, low consumption and cost, and the standard-based short-range wireless networking.

Here, ZigBee is developed for point-to-point transmission and area positioning. IP-Link 2220H, as shown in Fig.7, provides a host of AT commands to allow easy configuration of the 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 8 shows the transparent point-to-point mode. The signal can be transmitted by connecting RS-232 series port and ZigBee transmitter so that it can be received. In addition, a tag (placed on the robot) transmits a continuous signal so that the node (placed on the scenario setting space), which is closest to the robot, can receive the signal and display it on the monitor. Then, the supervisor will know the present position of the robot.

Fig.7. IP-Link2220H

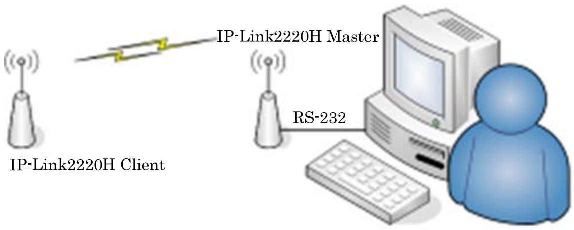

Fig.8. Transparent P2P Mode

V. POB-BASIC SYSTEM AND SHAPE RECOGNITION

In general, a black/white LCD screen uses one bit to color a pixel and the screen displays 8 pixels with a byte, as shown in Fig.9. In addition, the buffer uses 8192 bits (the POB-LCD screen is 128 pixels by 64 pixels) of memory on POB-EYE module. The challenge of this buffer is to have a ration of "1 bit = 1 pixel". The operations on bits are processor-intensive. The advantage of this "1 bit = 1 pixel" ration is that it does not use much memory. In fact, we need to apply a mask in order to change a bit value in memory. Moreover, this mask will be different whether the bit is set to 0 or to 1. Thus this computation can be relatively time consuming because it must be done 8129 times. That is why using the technique "1 bit = 1 pixel" will need less memory space. Another way of drawing a pixel on the screen is to consider that 1 byte draws 1 pixel. In that case they will be no delay or mask when switching on or off a pixel. Nevertheless, such a technique will take 8 times more memory than the previous one. However, for shape recognition, we have to transfer 2-D array into 1-D array, as shown in Fig.10, such that the externals (length, width, and height) of the figure will be stored in the POB-EYE memory.

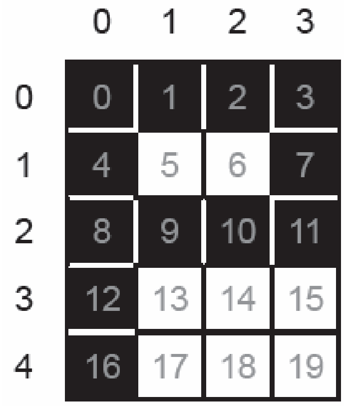

Fig.9. 2-D Array

Fig.10. 1-D Array

Figure 11 and Figure 12 display the hardware of POB-EYE and the main electronic board of POB-EYE, respectively.

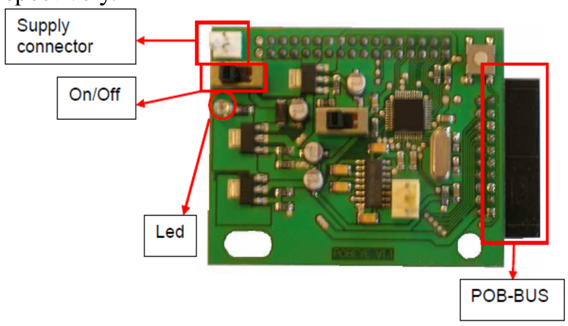

Fig.11. Hardware of POB-EYE

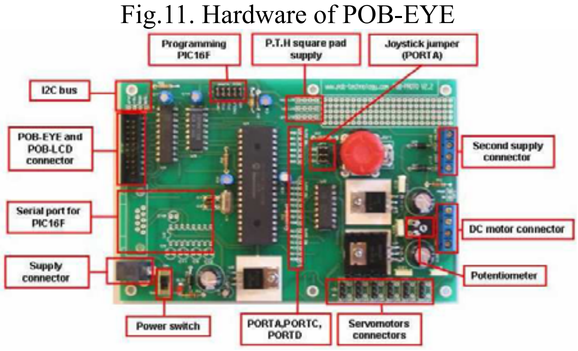

Fig.12. Main electronic board of POB-EYE

The graphics resources can be displayed using the library supplied with the POB-compiler tools. The graphic functions allow us to manage the transparency of the images and to carry out the superposition of images on the LCD screen. Images are displayed using the "DrawBitmap" function, as shown in Fig.13. This function uses a number to display the desired image. For more clarity in our code, POB-Bitmap generates in ".h" a series of "#define" from the image's name. The call to "DrawBitmap" can be becomes (if the name of the file is cross.bmp): DrawBitmap(X, Y, 1, Tableau) → DrawBitmap(X, Y, IDB_CROSS, Tableau).

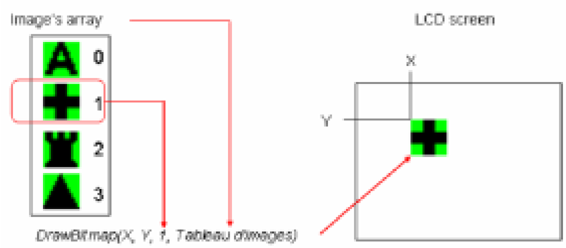

Fig.13. POB-Pattern

VI. EXPERIMENTAL RESULTS

Figure 14 shows the target. The MP5K electric BB gun can shoot the target semi-autonomously via shape recognition techniques.

For the scenario setting and the experimental test, we planned the indoor orientation diagram, as shown in Fig.15. The robotic weapon will look for the objects (balloons), aim at them, and shoot them. Moreover, it can pass along a difficult route and look for that route. Then the tracking vehicle can move toward the objects and shoot them again.

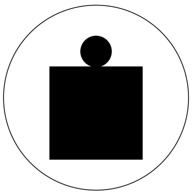

Fig.14. Mark

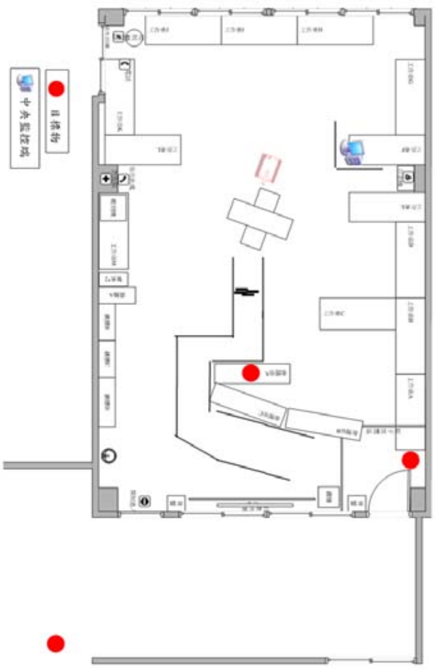

Fig.15. Indoor orientation diagram

VII. CONCLUSION

A weapon robot with semi-autonomous shooting has been implemented. A shape recognition method was applied to design a controller so that the MP5K electric BB gun can shoot semi-autonomously. We also designed a human–machine interface surveillance system via the LabVIEW graphical programming environment so that the supervisor could control the weapon robot by either a keyboard or a specially adapted mouse. The experimental results validate the practicality of the shape recognition, the 89C51 microcontroller, the LabVIEW graphical programming environment, and ZigBee wireless technology applied to weapon robots.

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