WLAN ROBOT VERSION 2 FOR MOVING BOMB AWAY FROM CROWD IN THE THREE SOUTHERN PROVINCES OF THAILAND

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Abstract

This paper presents a building WLAN robot version 2 for moving a bomb from crowd in the three southern provinces of Thailand. Also, the comparisons of the robot version 1 and 2 with several features are proposed. This IP robot is built according to requirements of Royal Thai Army with simple machine which each element is in common use. Thus, one advantage of the proposed IP robot is that it is lower cost comparing to others, especially overseas robots. This enables Royal Thai Army to product the robot for moving the bomb with high volume and low price. Typically, Radio jamming for disrupting the car bomb in the three southern provinces is in Low Frequency (LF) and High Frequency (HF). WLAN is in 2.4 gigahertz (GHz) transmissions which are in the Super high frequency (SHF). From experiment, it is proved that the robot version 2 can works in conjunction with a jamming signal device. It also has a better performance than robot version1 in several features.

Keywords: WLAN, IEEE802.11n, Robot, Bomb, Jamming Signal

Introduction

In past ten years, many Thai solider and people in the three southern provinces of Thailand died due to bomb. Therefore, this paper presents a WLAN robot for moving the bomb from crowd in the three southern provinces of Thailand since the oversea robot is very expensive (up to $100,000), large size, and heavy. From interview with Colonel Jatuporn Soonthonnont and his team on October 2007, they said that a weight of the oversea robot is more than 80 kg and its width is larger than 75 centimeter as shown in a figure 1 (Sanon 2008) . It should be noted that a width of the basic door is about 75 cm. This results in trouble for carrying this robot. Moreover, there are about six bombs per day for their responsibility. Therefore, Thai soldiers often have to move the bomb by themselves as shown in a figure 2 (left) and injure may be appeared as displayed in the figure 2(right). IEEE 802.11n (draft 3.0) proposes the potential of throughputs beyond 200 Mbps, based on physical layer (PHY) data rates up to 600Mbps (Paul et al. 2008). Marcelo Atenas et al. 2010 tested the performance of the IPTV over IEEE 802.11n, which can be used for IPTV service provider. In an IPTV network, the video and audio streams are sent in MPEG through Real-time Transport Protocol (RTP). Haifeng Zheng et al. 2010 investigated the performance of video transmission over IEEE 802.11n using frame aggregation mechanism. A. Matsumoto et al. 2009 tested the throughput performance and the coverage range of IEEE 802.11n devices in vehicular networks. Syh-Shiuh Yeh et al. 2008 proposed the comparison between ZigBee and IEEE 802.11g and then implemented ZigBee on the rescue robot in order to transmit data over longer distances. Markus Johnansson et al. 2008 implemented the Intelligent ZigBee and WLAN enabled robot car. ZigBee was used for transferring of the robot car controlling commands while WLAN was used for in-car image transmission to the controlling computer. The proposed robot car with Zigbee and WLAN is shown in a figure 3 (left). Christof Rohrig and Frank Kunemund 2007 presented a method to estimate position and heading of mobile robot in an indoor scenario, which this method for localizing the mobile robot is based on the use of receive signal strengths value of WLAN access point. A mobile robot Pioneer3-AT manufactured by ActivMedia as shown in a figure 3 (middle) is used for the experiment. Rescue robot is typically not designed for moving an object therefore it has not a hand for capturing the object as shown in a figure 3 (right).

Figure 1 (left) shows the oversea robot http://www.theoldrobots.org/images3/military-bomb-disp.JPG. Figure (middle) shows the oversea police robot http://science.howstuffworks.com/police-robot1.htm. Figure (right) displays the oversea bomb defusing robot http://www.engadget.com/2006/11/17/chicago-invests-in-bomb-defusing-robots-cant-climb-up-two-step/

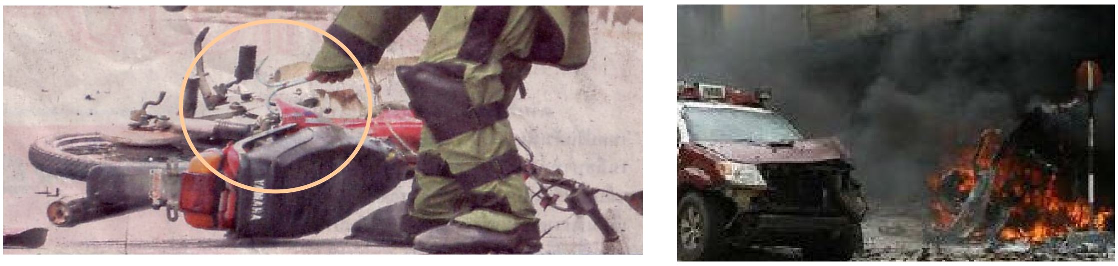

Figure 2 (left) displays the moving of motorcycle bomb by Thai solder in three southern provinces of Thailand, which is endangered. Figure (right): Many Thai soldiers are injured due to moving the bomb.

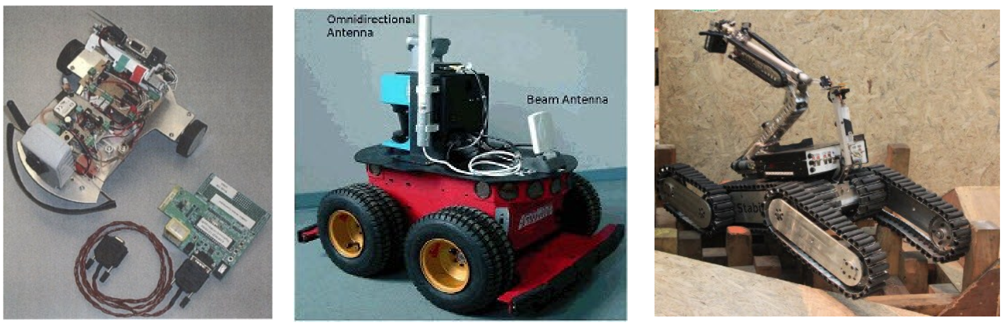

Figure 3 (left) displays Zigbee and WLAN enabled robot car (Johansson 2008). Figure (middle) shows the mobile robot equipped with four wheels (Rohrig 2007). Figure (right) shows the rescue robot of Rajamangala University of Technology Phra Nakhon (RUMTP) got the award of Thailand Rescue Robot Championship 2011.

The previous work as shown in a figure 4 is a robot version 1 presented in a proceeding of Inceb'08 (Sanon 2008), which is a WLAN robot. This robot does not use ZigBee to transfer the robot controlling commands like (Syh et al. 2008; Johansson 2008) since both video streams and the robot command are sent via WLAN IEEE802.11g. This results in reducing a complexity of both hardware devices and software for the remote robot control. It should be noted that the robot controlling command of the robot v.1 consumes a very low bandwidth since it is based on the Telnet protocol. The robot v.1 is built on three basic requirements as follows: its weight is lower than 50 kg, its width is smaller than 75 cm, and able to lift up and carry on 12 kg. It should be noted that a basic bomb's weight in the southern provinces is about 5-12 kg. Several machine designs represented in order to compare their performances. This robot contains simple machines and its elements are easy to buy in Thailand in order to allow the maintenance and repair to be convenience. Additionally, a jamming signal device which produces a noise signal for troubling a remote signal of the car bomb is preferred for avoiding damage caused by the remote bomb. From some report of Thai solider found that the remote signals for the car bomb are basically in a Low Frequency (LF) and a High Frequency (HF). Thus, the robot version 1 with a technology of WLAN in 2.4 gigahertz (GHz) transmission (Sanon 2008) is desired in order to enable the IP robot to support the radio jamming device. However, the limitation of the robot version 1 is follows as: 1) when there are two IP cameras, the remote control is available in a short distance due to consuming of bandwidth usage. 2) Its moving system is based on 4 wheels thus it is not appropriate on a rough road. 3) Power system is available in 20-30 minutes. 4) There is some error coding for the moving control.

The robot version 2 is developed to solve such limitations. IEEE 802.11n is implemented on the robot v.2. The performance of two IP camera transmissions over 802.11n is investigated. Additionally, the jamming signal device is implemented on the robot version 2. From experiment, it is found that the signal of WLAN IEEE802.11n and the jamming signal device does not interfere with each other's transmissions.

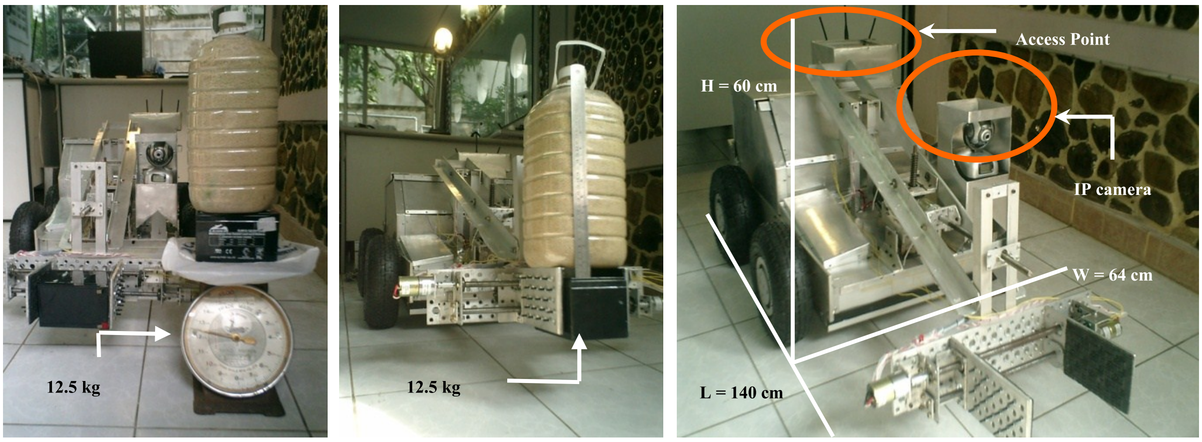

Figure 4 (left) and (middle) display objects with totally 12 kg that can be lifted up by the robot v.1 (Sanon 2008) according to the Thai army requirement. Figure 4 (right) shows the robot version 1, which is equipped with four wheels and IEEE802.11g presented in (Sanon 2008).

Methodology

The propose Robot V.2 diagram

The proposed WLAN robot consists of two main parts: WLAN robot and the remote notebook. In the first part, a microcontroller (ET-BASE 51 AC3) is used to control WLAN robot by using Basic Programming. Two IP cameras are implemented on the WLAN robot. Access Point IEEE 802.11n is used to communicate with the remote notebook. A diagram of the proposed WLAN robot is displayed in a figure 5. For the other part, it is a notebook for the remote robot control, which is called as "remote notebook" in this paper. A program for the robot control uses C# programming, which is installed on the remote notebook. Figure 6 (left) displays the C# program that there are 4 windows for displaying the streaming videos and button controls from two IP cameras. The windows 1 and 2 used for streaming video are represented as "1" and "2", orderly as displayed in the figure 6 (left). The windows 3 and 4 used for button controls are represented as "3" and "4", respectively. Figure 6 (right) shows streaming videos that are open on the windows 1 and 2.

The robot version 2 is developed to solve the limitations of the robot v.1 as mentioned above.

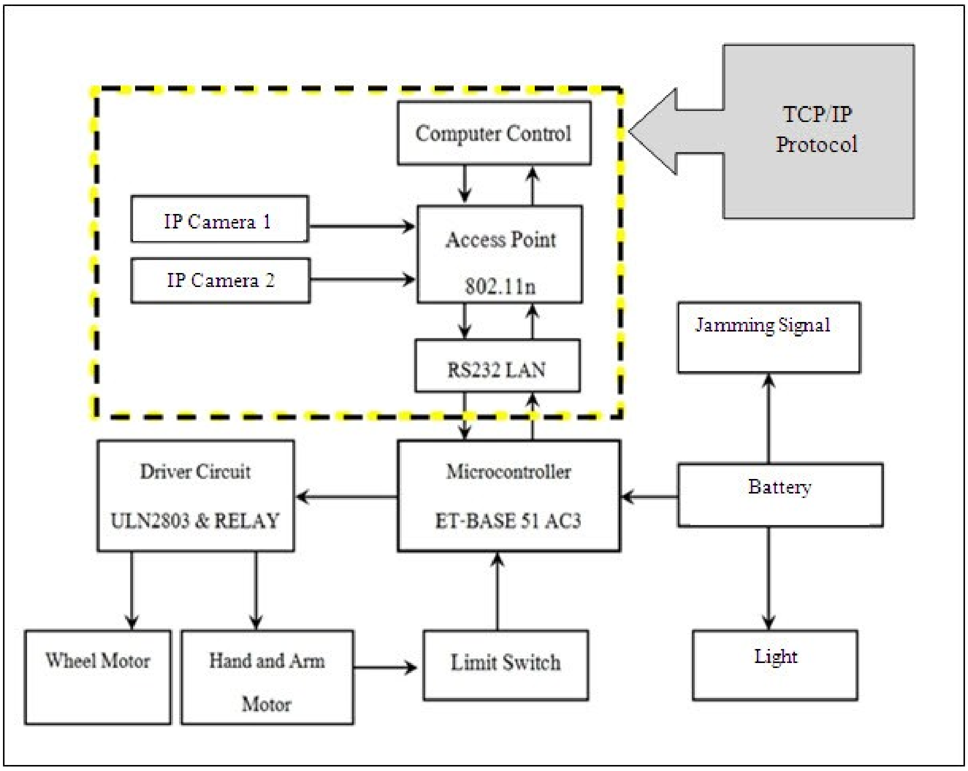

Figure 5 displays a diagram of the proposed WLAN robot, which shows how to connect between TCP/IP and Microcontroller.

To solve the limitation of two IP cameras

There are two steps. On the first step, IP cameras on the robot have two types of transferring data to the remote notebook. First is the packet trains caused streaming video of IP cameras as shown in a figure 7 (right). The other is the packets caused control buttons of IP camera as displayed in a figure 7 (middle). When these packets are sent to the remote notebook, the large bandwidth is required. Therefore, when two IP cameras are enabled at the same time, the large bandwidth consumption is double. This problem can be solved by modified C# programming on the remote notebook. The control panel is used to open or close the streaming videos as shown in a figure 7 (right) and the control buttons of two IP cameras as shown in a figure 7 (middle). This panel as shown in the figure 7 (left) consists of 8 buttons. The streaming videos and the control buttons will be displayed when they are enabled. Thus, the large bandwidth consumption caused from enabling 4 windows simultaneously can be alleviated.

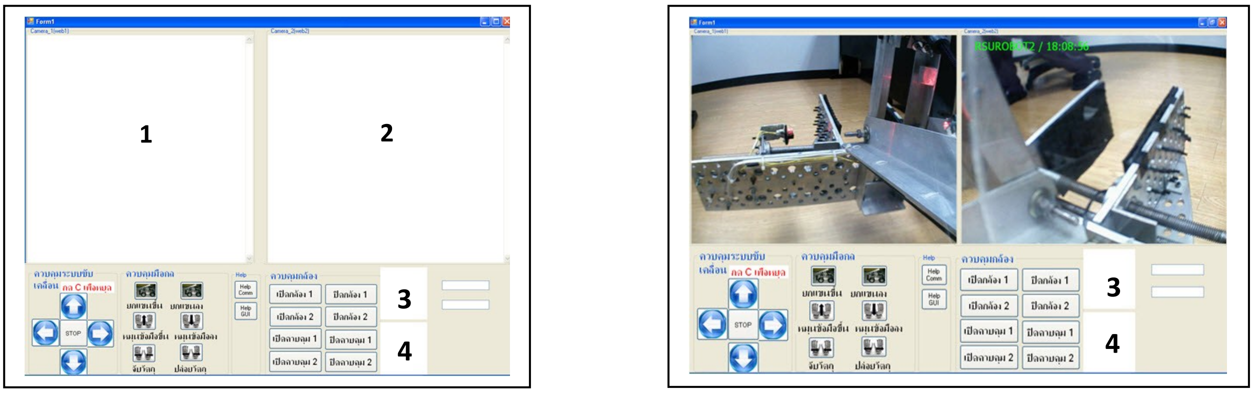

Figure 6 (left) displays a program for controlling robot based on window application on the remote notebook, which four windows are disabled. Figure (right) shows the streaming video from two IP cameras when they are enabled.

Figure 7 (left) displays the control panel for enabling and disabling the streaming video from two IP cameras, which two camera controls are disabled. Figure (middle) displays two camera controls when are enabled. Figure (right) shows the video stream from one IP camera when is enabled.

```
private void button15_Click(object sender, EventArgs e) // enable IP camera 1
        {
           string web = "C:\\camera_1.html";
           webBrowser1.Navigate(web);
        }
private void button16_Click(object sender, EventArgs e) // disable IP camera 1
        {
           webBrowser1.Stop();
           string web = null;
           webBrowser1.Navigate(web);
        }
private void button19_Click(object sender, EventArgs e) // enable a control of IP camera 1
        {
           string web = "C:\\camera_1_control.html";
           webBrowser3.Navigate(web);
        }
 private void button20_Click(object sender, EventArgs e) // disable a control of IP camera 1
        {
           webBrowser3.Stop();
           string web = null;
           webBrowser3.Navigate(web);
        }
```

Figure 8 shows the example C# code which is used to avoid the problem of the consuming large bandwidth. This allows user to select to enable the windows on the program for IP cameras.

On the other step, the IEEE802.11n access point (Paul et al. 2008) implemented on the robot version 2 can support such large bandwidth usage, which the more detail of performance evaluation can be found in a result section.

To solve the limitation of the moving on a rough road

The moving system of the robot version 2 is based on the caterpillar tractor, which its speed is nearly the same as the robot version 1 as shown in a figure 4. The new design can solve the problem as mentioned in (Sanon 2008). This means that the robot v.2 can run on the rough road.

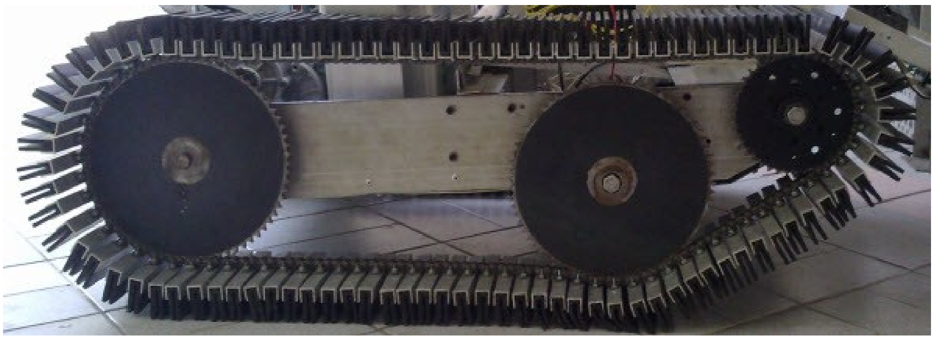

Figure 9 displays the moving system of the proposed robot, which is based on the wheel dozer. This enables the robot v.2 to run on the rough road.

To other limitations

To solve the limitation of the power system, a car battery is used instead of a dry battery in (Sanon 2008). The error coding is solved for both MSC51 (robot) and C# (remote robot controlling notebook). Additionally, the jamming signal device is implemented on the robot version 2 as shown in a figure 10 (right).

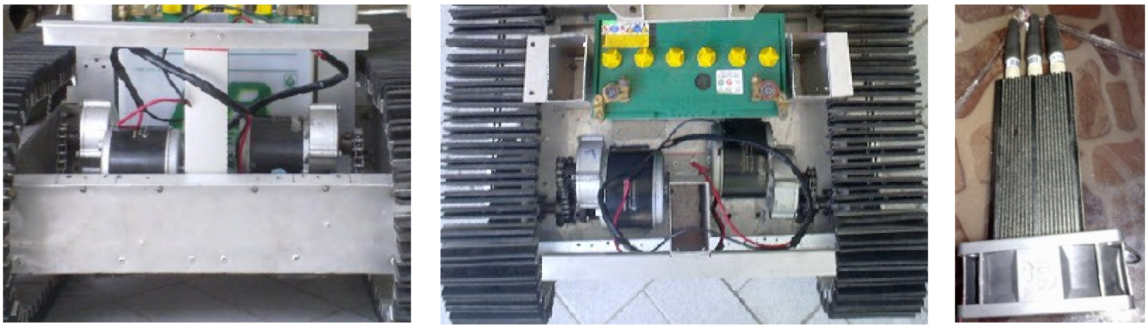

Figure 10 displays the car battery which allows the robot work long time. Figure (middle) also shows the two motors that are used for driving the caterpillar. Figure (right) shows the jamming signal.

Results

There are three experiments: Performance evaluation in raising object, remote control via WLAN using a notebook, and speed.

Experimental result 1

Table 1 Performance evaluation in the raising object.

Object	Velocity (second)			
	Lift up		Lift down	
	Robot 1	Robot 2	Robot 1	Robot 2
No (0 kg)	18.02	10.6	17.8	10.2
5kg	22.4	13.7	20.5	12.8

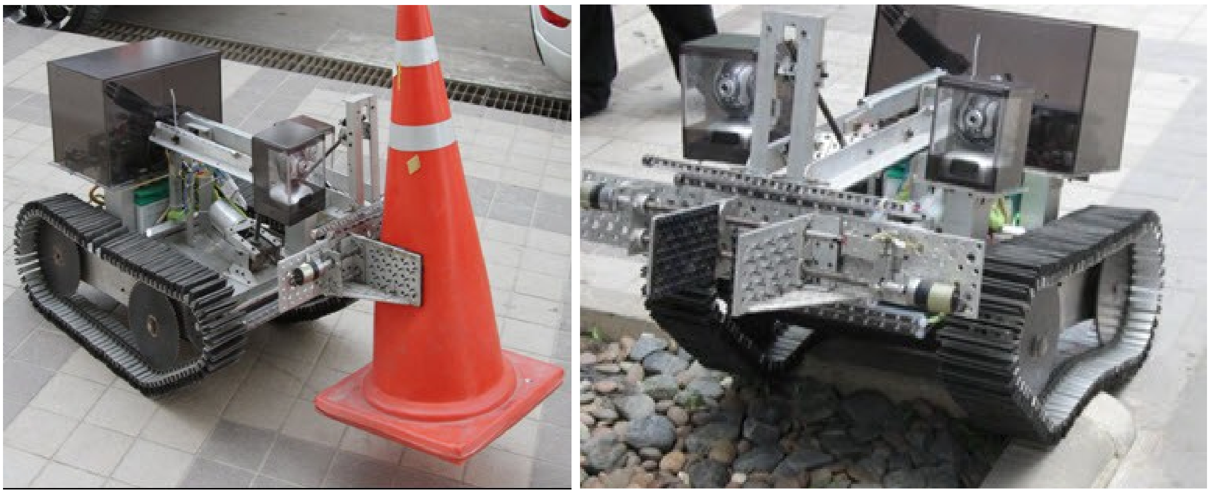

Figure 11 (left) displays the proposed robot v.2 carrying the object. Figure (right) shows the robot v.2 moving on the rough road.

From experiment, it is found that the raising object of the robot v.2 is faster than the robot v.1 as listed in Table 1. It should be noted that the arm robot of the robot v.1 and the robot v.2 are the same. More detail can be found in (Sanon 2008).

Experimental result 2

There are four type of Linksys access point as follow: Typical Linksys WRT54 G (best seller), Linksys WRT54 G with two Linksys 7 dB antennas, Linksys WRT54Gx ver.2 that is MIMO technology with three antennas, and Linksys WRT320N that is IEEE 802.11n.

Figure 12 shows the access point implemented in the WLAN robot for performance comparisons.

Table 2 Performance comparison in the remote robot control via WLAN using a remote controlling notebook is listed.

	Type of access point	Distance	Distance when cameras are open
1	Linksys WRT54 G	123 m	18 m (Jitter delay appears)
2	Linksys WRT54 G with two Linksys 7 dB antennas.	138 m	25 m (Jitter delay appears)
3	Linksys WRT54Gx ver.2 (three antennas)	174 m	49 m (Jitter delay appears)
4	Linksys WRT320N	210 m	120 m (Jitter delay appears)

Experimental result 3

Table 3 Performance evaluation in the robot speed

Distance (m)	Speed (second)		
	Robot v.1	Robot v.2	Robot v.2 with 5kg
10	6.2	7.4	8.3
15	8.8	10.6	11.4
20	11.6	13.3	14.7
30	18.8	20.1	21.8

Discussion and Conclusion

The proposed WLAN robot v.2 can solve the limitations of WLAN robot v.1. From experiment, it is shown that the performance in lifting up the object of the robot v.2 is faster than the robot v.1. The performance in remote control of the robot v.2 with IEEE802.11n is far than the robot v.1 implemented IEEE802.11g up to nearly 3 times. Additionally, the robot v.2 can support two IP cameras at the needed distance. The robot v.2 can run on the rough road. However, the speed of the robot v.1 is slightly faster than the robot v.2. Finally, the robot v.2 can be satisfied for Royal Thai army requirements. However, the robot v.2 has a limitation of turning right or left on the rough road and leads to the dozer maybe fallen. IP camera performance on the WLAN robot should be studied in future work.

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