A Study of Performances on a Wireless Robot Based on Various Brands of IEEE 802.11g Standard and Controlled by Notebook

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Abstract: This paper presents a study of performances on a wireless robot based on various brands of IEEE 802.11g standard and controlled by notebook. The robot acts a personal computer (PC) controlling equipments (e.g. motors) through a printer port. OS Windows XP is setup on the PC robot which is received commands from notebook linked through the use of a remote desktop program. The IEEE 802.11g wireless standard is employed for the transmitter and receiver between the notebook and PC robot, respectively. The study of the performances on the IEEE 802.11g wireless-standard robot based on various brands is measured in terms of a distance and a delay time between the robot and notebook. The maximum distance of receiving and transmitting the data is approximately at 40 m. whilst the delay times in case of no images and including images are approximately at 0.1 s. and 0.5 s., respectively.

Keywords: personal computer (PC), wireless robot, various brands of IEEE 802.11g standard, notebook

1. Introduction

Nowadays, applications of telerobotics can benefit from Wireless Local Area Network (WLAN) technology. The development of teleoperated systems has gained considerable attention in recent years due to the new potentia1 applications, such as remote production monitoring, remote exploration and manipulation in inhospitable environments, telesurgery, and remote training etc [1]. Important issues concerning communication channels, random propagation delays, bandwidth limitations, fault-tolerance, synchronization, tele-presence, and the stability of the robotic systems involving human operators have all been taken into account in different works across the literature. Most of them consider Internet as the interconnection network between telecontrolled systems and control stations [1].

IEEE 802.11 Wireless standards can be utilized for many applications depending on characteristics of duties [2]. In this way, there are three wireless standards of IEEE 802.11 (IEEE 802.11a/b and IEEE 802.11g) which are typically popular in existing days. Each type of wireless standards can summarize advantages and disadvantages as follows. For the IEEE 802.11a standard, the operating frequency and the maximum speed of transferred data are at 5 GHz and 54 Mbps, respectively, however: the working radius is a short length and the cost is high expensive, therefore it is less popular [3]. The IEEE 802.11b standard employs the operating frequency at 2.4 GHz and it has the maximum speed of transferred data at 11 Mbps. For the IEEE 802.11g standard using orthogonal frequency-division multiplexing (OFDM) [4], the operating frequency and the maximum speed of transferred data are at 2.4 GHz and 54 Mbps, respectively, as well as the working radius is also higher than that of two previous standards.

A Related research has proposed a wireless robot using IEEE 802.11b [1], however: the radius is short for working area. Recently, effective per-client goodput analysis of access point under full client-utilization has been proposed through the use of IEEE 802.11g standard [5]. In the well open literature, no other researches have been reported for a study of performances on a wireless robot using IEEE 802.11g standard.

In this paper, a study of performances on a wireless robot is presented through the use of various brands of IEEE 802.11g standard and controlled by notebook. The robot acts a personal computer (PC) controlling equipments (e.g. motors) through a printer port. OS Windows XP is setup on the PC robot which is received commands from notebook linked through the use of a remote desktop program. The IEEE 802.11g wireless standard is employed for the transmitter and receiver between the notebook and PC robot, respectively. The study of the performances on the IEEE 802.11g wireless-standard robot based on various brands is measured in terms of a distance and a delay time between the robot and notebook. The maximum distance of receiving and transmitting the data is approximately at 40 m. whilst the delay times in case of no images and including images are approximately at 0.1 s. and 0.5 s., respectively.

2. Proposed Methods

2. 1 Hardware Structure

Figure 1 shows hardware structure for communication between computer/notebook and robot (server). The robot consists of:

1) A camera is used for receiving images and sending them to a computer/notebook, as shown in Fig. 2 (a).
2) A computer is a central processing unit used for display of images, as shown in Fig. 2 (b).
3) A router wireless LAN is used for transmitting and receiving data between the robot and the computer or notebook, as shown in Fig. 3 (c).
4) Four Motors shown in Fig. 3 (d) are utilized for driving four wheels of the robot.
5) Relay circuits shown in Fig. 3 (e) are exploited for controlling functions of the four motors. They will receive signals from not only the computer or notebook but also sensor circuits.
6) Sensor circuits shown in Fig. 3 (f) are used for detecting objects and sending signals through the relay circuits to the computer/notebook.
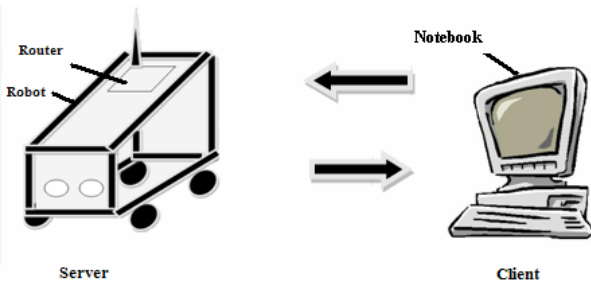
Figure 1 Hardware structure for communication between computer/notebook and robot (server).
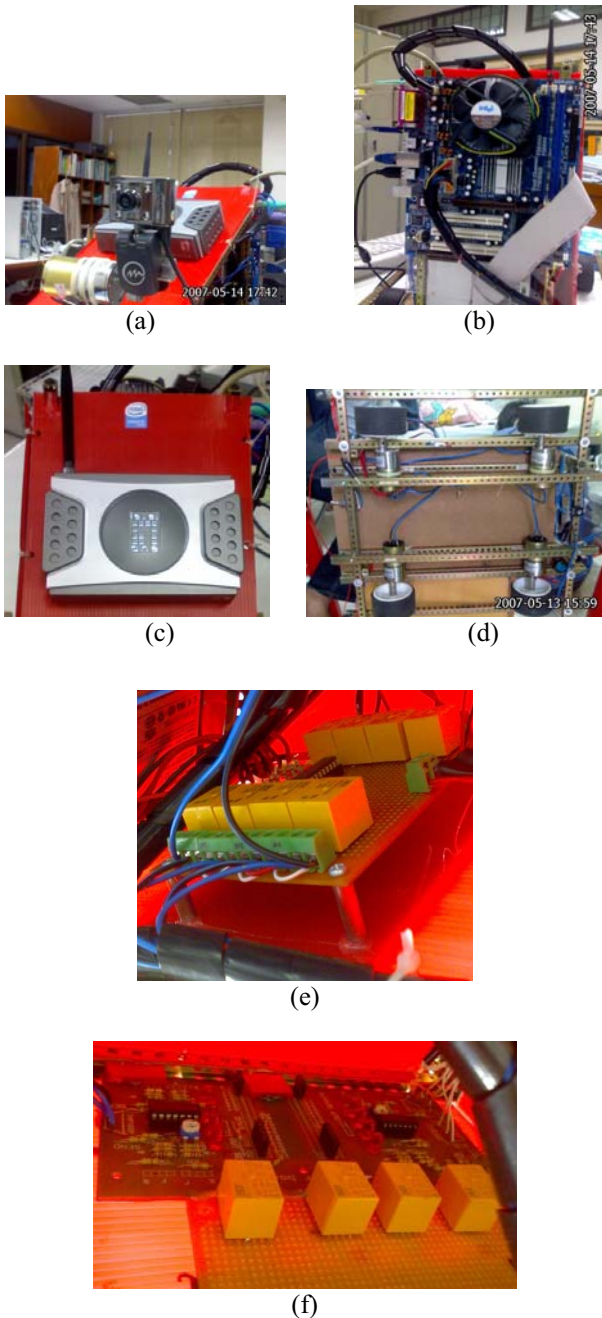

(a)

(b)

(c)

(d)

(e)

(f)

Figure 2 The robot consisting of (a) image camera, (b) main board computer, (c) router wireless LAN, (d) motors, (e) relay circuits and (f) sensor circuits.

2.2 Software Structure

Figure 3 shows software structure for communication between the computer/notebook and robot. The software consists of 3 parts for controlling the robot as follows:

1) Processing for image is the first part of receiving images from a webcam camera and then it will process images through the use of a driver software to connect between the camera and computer or notebook. Finally, display images will be shown in a monitor.

2) Processing for controlling the robot is the second part of receiving input commands from a keyboard and then it will comply such commands and send them to printer port.

3) Processing for sensors is the third part of receiving signals from four sensors and then it will process such signals and display them on the monitor.
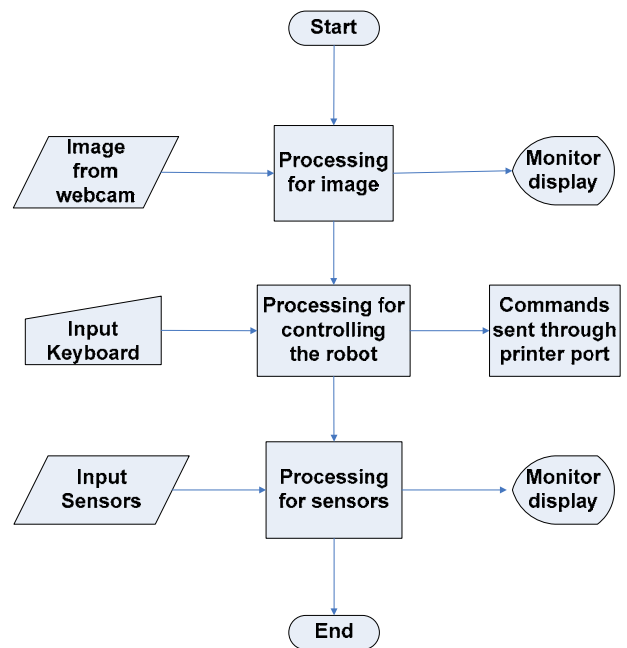

Figure 3 Software structure for communication between the computer/notebook and robot.

Figure 4 shows graphic user interface (GUI) for communication between the computer/notebook and robot. It can be seen from Fig. 4 that GUI consists of 4 parts as follows: 1) image view, 2) robot, 3) camera, and 4) status of four sensors. The first part is to display scene of surroundings when the robot moves from old to new positions where the user can see images from GUI of black screen shown in Fig. 4. The second part is to control directions of the robot such as Forward (F), Backward (B), Stop (S), Right (R) and Left (L). The third part is also to ajdust directions of camera such as Top, Down, Stop (S), Right (R) and Left (L). The fourth part is to display status of 4 sensors which are blink when the robot detects obstacles. As shown in Fig.4, positions of the 4 sensors are located at the front (S1, S2, S3) and the back (S4).

Figure 4 Graphic user interface (GUI) for communication between the computer/notebook and robot.

3. Conditions of the Study of Performances On a Wireless-Controlled Robot

Conditions of the study of performances on a wireless-controlled robot are considered from transmitting and receiving data in terms of end-to-end i.e. the robot is a server and computer/notebook is a controller. This study will focus topics as follows:

1) Strength of the transmitted signals on the air is measured in terms of distances depending on the received data (no loss).
2) Delay time of transmitting images is considered from the robot to compute/notebook whilst the delay time of controlling robot is also measured from the computer/notebook to robot.
3) Computer/notebook can detect the signals of 4 sensors and display on GUI screen in terms of distances.

Other performances such as errors of transmission and stability of controlling robot will be studied by transmitting images from the robot and transferring commands to the robot where data will transfer no loss packets of information. The robot testing will considered under the conditions as follows:

1) Speed of the robot is approximately at 10 cm/s for all movement. (Sometimes, the robot is stop.)
2) Surroundings are emptiness and obstacle of rooms. The air is normal. (Having disturbance of 1 or 2 wireless LAN signals)
3) A rate of transferring images is at 30 frames per second.
4) The robot testing will use various brands of IEEE 802.11g standard (e.g. Asus, D-link and Level-One) to compare performances among them.

4. Experimental Results

The experiment is to study performances of the wireless-controlled robot under the conditions of section 3. For testing the robot, it tries to run on flat floor, it includes the USB Camera having two motor for turning left, right, top and down, as well as, it also includes four sensors to detect the objects. There are 4 tests in this study as follows:

4.1 Controlling the Robot with No Obstacles (No Camera)

Table 1 shows the results of delay time for controlling the robot with no obstacles (no camera) depending on distances. It can be seen from Table 1 that delay time is approximately at 0 second in the range of distances (~1−40 m) for all wireless brands and the wirless signal are faded in the larger than 40 m.

Table 1 Delay time for controlling the robot with no obstacles (no camera) depending on distances

Distances (metre)	Delay time for various wireless brands (second)		
	Asus	D-Link	Level One
~1−40	~ 0	~ 0	~ 0
> 40	Fading	Fading	Fading

4.2 Controlling the Robot Including Obstacles (No Camera)

Table 2 shows the results of delay time for controlling the robot including obstacles (no camera) depending on distances. It can be seen from Table 2 that delay time is approximately at 0 second in the range of distances (~1−30 m) for all wireless brands and the wirless signal are faded in the larger than 30 m.

Table 2 Delay time for controlling the robot including obstacles (no camera) depending on distances

Distances (metre)	Delay time for various wireless brands (second)		
	Asus	D-Link	Level One
~1−30	~ 0	~ 0	~ 0
> 30	Fading	Fading	Fading

4.3 Controlling the Robot Using Camera

Table 3 shows the results of delay time for controlling the robot using camera depending on distances. It can be seen from Table 3 that delay time is approximately at 0.1 second in the range of distances (~1−40 m) for all wireless brands and the wirless signal are faded in the larger than 40 m.

Similarly, Table 4 shows the results of delay time for transmitting and receiving images depending on distances. It can be seen from Table 4 that delay time is approximately at 0.5 second in the range of distances (~1−40 m) for all wireless brands and the wirless signal are faded in the larger than 40 m.

Table 3 Delay time for controlling the robot using camera depending on distances

Distances (metre)	Delay time for various wireless brands (second)		
	Asus	D-Link	Level One
~1−40	~ 0.1	~ 0.1	~ 0.1
> 40	Fading	Fading	Fading

Table 4 Delay time for transmitting and receiving images depending on distances

Distances (metre)	Delay time for various wireless brands (second)		
	Asus	D-Link	Level One
~1−40	~ 0.5	~ 0.5	~ 0.5
> 40	Fading	Fading	Fading

4.4 Detected Objects from Four Sensors

Table 5 shows the results of distances of detected objects from four sensors (between the robot and objects). It can be seen from Table 5 that status of sensors is correctly work in the range of distances (~1−10 cm) and the sensors are not completely work in the larger than 10 cm.

Table 5 Distances of detected objects from four sensors

Distances (cm) between the robot and objects	Status of sensors
~1−10	Work
> 10	No

4.5 Capable Period of the Wireless Robot

Capable period of the wireless robot is not less than 20 minutes and not more than 30 minutes. Power supply will provide electrical power approximately at 200 watt and there is also approximately at 1,200 watt for UPS.

5. Conclusion

The study of performances on a wireless robot based on various brands of IEEE 802.11g standard and controlled by notebook has been presented. The robot acts a personal computer (PC) controlling equipments (e.g. motors) through a printer port. OS Windows XP is setup on the PC robot which is received commands from notebook linked through the use of a remote desktop program. The IEEE 802.11g wireless standard is employed for the transmitter and receiver between the notebook and PC robot, respectively. The study of the performances on the IEEE 802.11g wireless-standard robot based on various brands is measured in terms of a distance and a delay time between the robot and notebook. The maximum distance of receiving and transmitting the data is approximately at 40 m. whilst the delay times in case of no images and including images are approximately at 0.1 s. and 0.5 s., respectively.

6. Acknowledgements

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