Novel Ubiquitous Concept of Real Reality Robot Game Controlled by Mobile Server Robot

Byoung Kyu Joo*, Poong Woo Jeon** and Seul Jung***
Intelligent Systems and Emotional Engineering Lab.
Department of Mechatronics Engineering
Chungnam National University, Daejeon, Korea
(+82-42-821-6876, *bkjoo@yahoo.com , **windrainer@hanmail.net, ***jungs@cnu.ac.kr)

Abstract: In this paper novel concept of real reality robot game controlled by a mobile server robot is proposed. Real reality robot game means that two real robots controlled by two human operator through the internet are playing a boxing game. The mobile server robot captures playing images of the boxing game and send them to GUI on the screen of human operators' PC. The human operator can login to boxing game from any computer in any place if he/she is permitted. Remote control of boxing robot by a motion capture system through network is implemented. Successful motion control of a boxing robot remotely controlled by a motion capture system through network can be achieved.

Keywords: Robot server, real reality game, boxing robot, internet based control

1. INTRODUCTION

Recently, internet becomes a necessary and must use tool to live with. Internet provides us with not only fruitful infinite information to help to improve our life styles, but also time saving to operate very remotely located plants. The area of internet based control contributes to unify the global world in terms of the business of internet based conference, internet based surgical operations, internet based global meeting, internet based project, and etc.. Specially, in control system area, internet plays a very important role as a communication channel as well as an operation channel. Successful internet based controls have been reported in the literature. Remote treatment of patients without visiting them has been conducting. Remote mobile robot controls have been successfully conducted.

Further than that, ubiquitous network is planned for future smart homes. Ubiquitous concept is to tie all devices that have control hardware inside into a network and make them communicate each other. Considering smart home structures, there are many electronic devices functioning in our home. Instead of we control these devices individually, they report their states to the central device, control, and manage themselves automatically. Yet, it is not really implemented, but sooner or later, will be popular as internet.

In our previous researches, a boxing robot game controlled by two human operators has been implemented. Human motions are captured by glove sensors [1]. Then exoskeleton typed motion capturing system has been developed to represent human motions [2-3]. The boxing robot has been successfully followed after human motions.

In this paper, as an extension of our previous researches, a network based control is integrated by introducing the novel ubiquitous concept of a real reality robot game. A feasible system of a real reality boxing game through the internet is developed. Here ubiquitous concept is used to make all devices communicate each other. The mobile server robot operated on Linux environment has been built to function as a main server. The mobile server robot captures playing images of a boxing game and sends them to GUI on the screen of human operators' PC. Linux operating system is known as a stable and open shareware. Users can develop their own system using many available resources [4-11].

Boxing robots communicate with the mobile server robot with wireless communication, and the mobile server robot communicates with a host computer with wireless internet. The host computer is connected with network. So anyone can login to the host computer to play a boxing game from any place if he/she is permitted.

Our ultimate goal is to develop real reality robot game that can be done ubiquitously. Real reality robot game means that two real robots controlled by two human operators through the internet are playing a boxing game.

Here, as a prior research, internet based control of the mobile server robot has been developed. The mobile server robot has been successfully controlled by remote control through network. In addition to that, the boxing robot has been tested by the motion capturing system controlled by a remote human operator. The boxing robot follows motions after the human who wears the motion capture system. Successful motion control of a boxing robot remotely controlled by motion capture system through network can be achieved.

Even though the total system of two boxing robot game is not completed yet, it can be easily extended to another boxing robot since internet based control by a motion capturing system has been done for a boxing robot.

2. OVERALL SYSTEM STRUCTURE

The overall system structure is shown in Fig.1. The system is divided into two subsystems: one is a robot system and another is a remote human operator system. The robot system consists of boxing robots, a mobile robot server, computers, and a host computer. The human operator system consists of a motion capture system and a remote computer. Two separate systems communicate with each other through the network by login to host computer. The mobile server robot captures images of a boxing game, store them, and send frame by frame to the remote client PC. This makes a network based closed loop controlled system.

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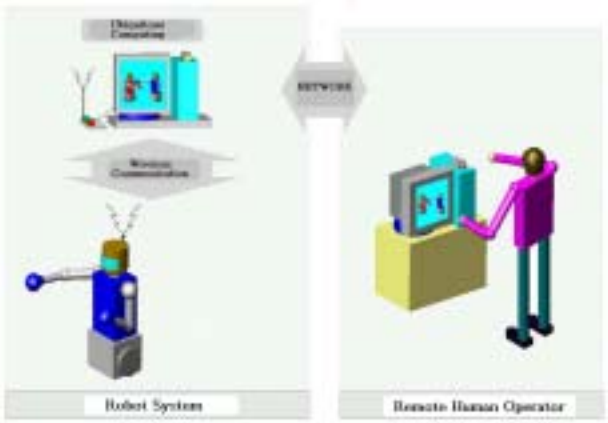

Fig. 1 Overall system structure

3. MOBILE SERVER ROBOT

The purpose of the mobile server robot is to function as a server to control the interface between the boxing robot system and remote human operators Fig. 2 shows the developed mobile server robot. It is a wheeled drive robot that operates on Linux operating system. It has a CCD camera to capture the image of the boxing robot, and transfers them to the client. The client can visualize the movement of boxing robots on the screen of a remotely located computer.

Fig.2 Mobile server robot

The internal structure of the mobile server robot is shown in figure 3. The robot has a main controller, motion controller, communication module, and other peripheral devices.

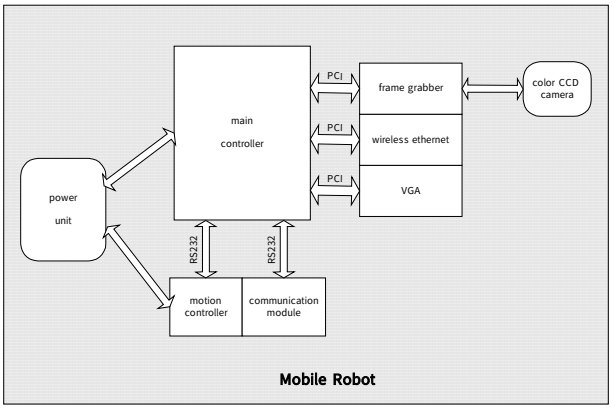

Fig.3 Internal structure of mobile server robot

Geared DC motors equipped with encoders are used as actuators of the robot. The controller Atmega 163 and its driver L298 are used for driving wheels.

For image processing system, a CCD camera is used to capture color images and its driver can be operated in Linux environment.

The robot can communicate with outside worlds by wired/wireless network. The robot has demons such as ftp, telnet, web server, etc for communication. Communication with PC through internet has been done by a wireless LAN card.

4. OPERATING SYSTEM

Operating system of the mobile server robot is Linux. Linux is known as a shareware software that can be implemented as real time OS. Since Linux OS has many open resources on kernels to be used for free, system can be optimized for a certain specific operation.

The mobile robot uses peripheral devices such as basic interface device, image capture device, display device, Ethernet card, and wireless LAN card. In order to use such devices in Linux device drivers are required. Those drivers are available.

In order to have an optimized OS system, compile process of kernel is required. After linux kernel is obtained, a root file system is created. In general, root file systems are generated as directory of bin/ dev/ home/etc/ lib/ mnt/ proc/ tmp/ usr/ var/.

5. INTERNET BASED CONTROL

The structure of an internet based control is shown in figure 4. The motion capturing device communicates with the client PC by wireless communication. The client PC communicates with the mobile server robot by internet. Commands are transferred from the mobile server robot to the boxing robot by wireless communication.

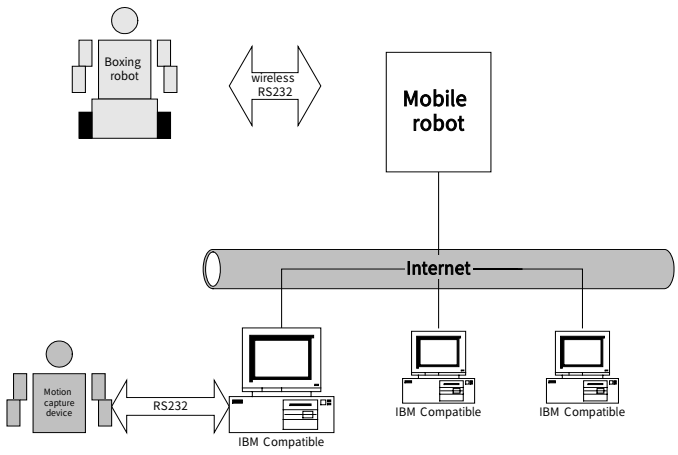

Fig. 4 Internet based control

Control through internet requires network programming such as TCP/IP protocol.

For control GUI, CGI (common gateway interface) Java applet using HTML (Hyper Text Markup Language), and C is used. The mobile server robot has a web server to provide enough contents. A remote user can control the movement of the mobile server robot by a web browser on the client PC.

CGI provides the merit of a web server, flexible interface between resources as well as covering defects of HTML. This means that it provides the interface between HTTP(Hyper Text Transport Protocol) server and resources.

The user has to login to the system to get permission. Based on data base system login ID can be verified. Figure 5 shows the process of verification. A user can login from any type of computers through the internet.

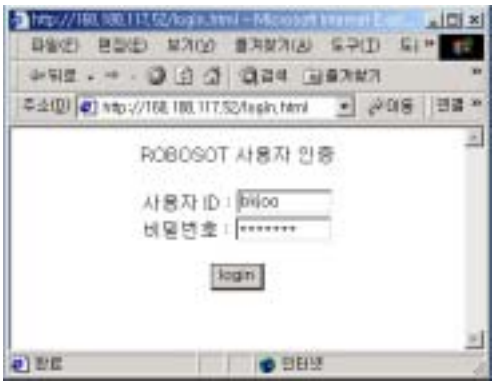

Fig 5. Log in window

Figure 6 shows the functional block diagram of the mobile server robot. The functions of the mobile server robot are mainly divided into three parts: a web server, a server robot control CGI, and a boxing robot control CGI. A server robot CGI allows us to control the movement of the server robot and a boxing robot control CGI allows to control boxing robots.

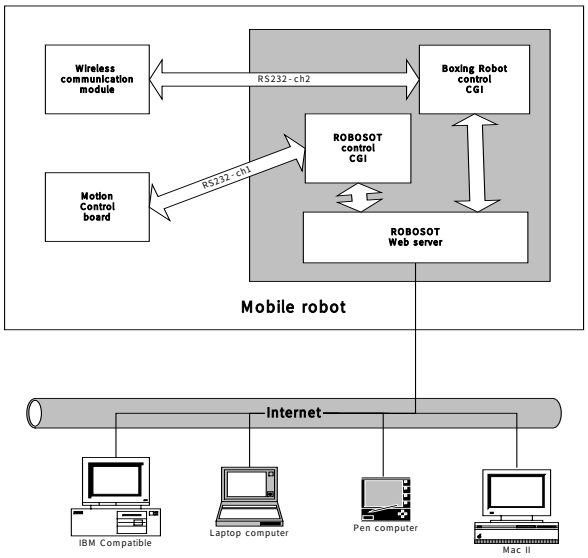

Fig 6. Robot control CGI flow chart

Figure 7 shows the flow chart of robot control CGI.

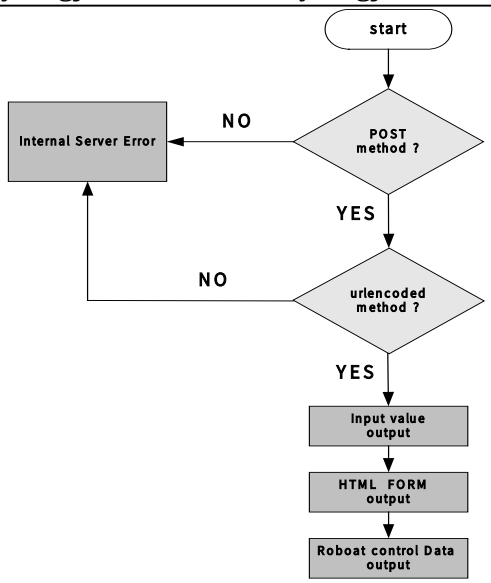

Fig. 7 Robot control CGI flow chart

What you see from the web browser is what the robot sees. Using Java applet, images can be seen. In order to store image files the image processor BT878 for PCI bus is used. Image files can be compressed as JPEG format, and can be sent frame by frame through the web server to the client

Fig. 8 shows the robot control CGI. It shows the image of the boxing robot seen by the mobile server robot. The right hand side shows the menu that controls movement of the mobile server robot.

Fig 8. GUI for control of mobile server robot

5. EXPERIMENTS

5.1 Internet based control of mobile server robot

First, the movement of the server robot is tested. Fig. 9 shows the experimental setups for controlling the mobile server robot through internet. The control panel shown in figure 8 controls movements of the robot. The robot is remotely controlled through the wireless network by the mouse of the client. What the CCD camera of the server robot see is transferred to the screen of the client PC.

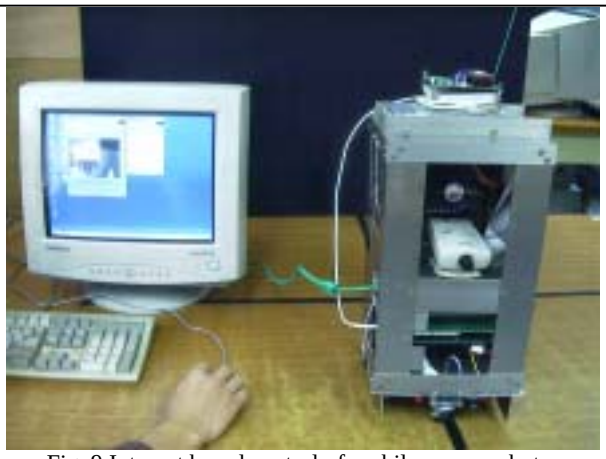

Fig. 9 Internet based control of mobile server robot

5.2 Internet based control of boxing robot

Next is to control the boxing robot. The control panel shown in figure 10 controls the movement of the boxing robot.

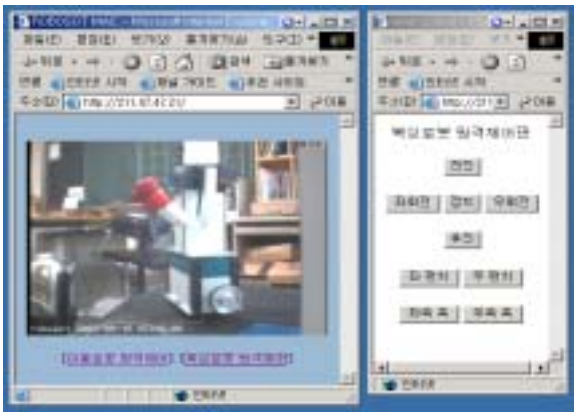

Fig. 10 GUI for control of boxing robot

The control of the boxing robot movement is done by the mobile server robot through wireless communication. Each movement is displayed in figure 11. The boxing robot can move forward, backward, and turn right and left. Since the boxing robot has two d.o.fs, the control panel has two motions for right and left arms.

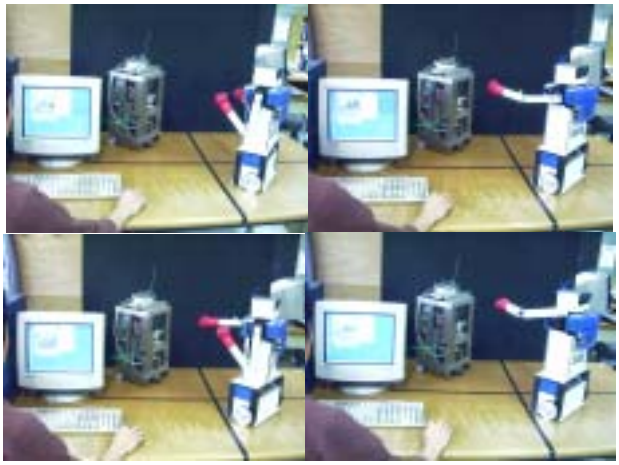

Fig. 11 Internet based control of boxing robot

5.3 Internet based control of boxing robot by motion capture system

Here we have the same experimental setup except the motion capture system. Now, the user uses the motion capture system to generate motions. Then these motions are captured in the client PC, sent to the mobile server robot. Then the mobile server robot generates commands to move the boxing robot. The movement of the boxing robot is captured by a CCD camera built in the server robot. The server robot sends those images to the client through the internet. This closes the loop of network based control.

Fig. 12 shows the experimental setups. Even though they are placed together, they are connected with internet or wireless communication.

Fig. 12 Experimental setups

Figures 13, 14 , 15, and 16 show the experimental data. We can see that the boxing robot follows the motion of a human operator. As the human operator moves his arms, the boxing robot moves after him. The boxing robot has two degrees of freedom while the motion capturing system has six D.O.Fs. Even though the D.O.F of the boxing robot is limited, a minimal boxing motion can be achieved. On the screen of the remote client computer, movement of the boxing robot is displayed. This confirms that network based control has been successfully achieved.

Fig. 13 Experimental result

Fig. 14 Experimental result

Fig. 15 Experimental result

Fig. 15 Experimental result

6. CONCLUSIONS

This paper proposes new concept of real reality robot boxing game by using network based control. Remote human motions are captured and transferred to the mobile server robot through the network to control the boxing robot. The mobile server robot operated by Linux operating system communicates with a host computer to send images of the boxing robot. Successful communication between a human operator and a boxing robot has been achieved. Feasibility of ubiquitous concept applied to robot boxing game has been tested. There are clear problems to be solved in the future. Time delay issue in the network is very common issue.

Real boxing game between two robots is not performed yet due to the absence of the motion capturing device. So, as a future research, the real reality boxing game between two robots is implemented by making another motion capturing device.

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