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Web-Based Remote Navigational Robot For Multiclass Human-Robot Interaction

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Abstract:

Robots and human are inter-related because robots are built to serve human. Mobile robot that is equipped with vision capability and remote navigation is able to fulfill multiclass human-robot interaction (HRI) for various localization methods, interaction modes and human experience of the robot. With the advancement of embedded system and communication technology, robot can run on smaller platform and allow human navigation from distant location.

In this paper, design of a remote navigational mobile robot based on live video streaming and steering control via a web browser over the Wi-Fi network is presented. The robot acts as the server and the client is the remote human operator. The project takes emphasis on building the robot that runs on a compact embedded system board, namely theARM11, for video streaming to remote client and linkage with the client to receive control inputs over the internet.

The microcontroller board then controls the pin electronics for the motor driver. A self-contained mobile robot prototype for indoor navigation was built. Experiment result shows that live video streaming from server to client is achievable at average of 0.67s video lag through the MJPEG-streamer. Robot navigation has been performed with condition that the control tool used by the remote operator has sufficient processing power for online video feed. The hardware components used in the project are Raspberry Pi ARM 11 Board.USB Video Camera & Monitor at one End. Using his own Gesture he (Patient) can Control his Wheel Chair. To communicate this Data to the Wheel Chair We have to Use Some Wireless Technology, Thereby Patient himself can operate his Own Wheel Chair.

Keywords:

Remote Navigational Mobile Robot, ARM-11 processor, live video streaming and steering control, web browser.

I.INTRODUCTION :

In recent years, many researchers have been studying the control of robotics system via the Internet and several attempts have been made to build such web-based robotic systems. The pioneering one is USC's famous Mercury Pmject [1]. Goldberg et al. developed a tele-excavation system which enabled web users to operate a remote manipulator via Internet. Another example is the robotic system described in Simmons et al. [2], an office exploring robot at CMU which is the most complex autonomous mobile robot accessible through the web.

Huosheng Hu et al developed an Internet-based robotic system for tele operation which allows a remote operator to control a mobile robot to explore laboratory or push a ball into a goal. Other examples include the Khep-onthe- web project, Museum tour-guide robot and Ren C. Luo's behavior-based networked robot etc. Although much progress has been made with the research on web-based robotic systems, there are still problems in design and implementation of practical systems.

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Firstly, web based robotic systems nowadays are almost designed for specific robots, and comply with their own specific communication protocols; therefore they are isolated from one another and cannot be constructed for multi-robot cooperative environment easily. Secondly, the existed web-based robotic systems are designed on the view of Internet user's, namely on bow Internet users control the remote robot, instead of consideration on improving the robot performance by utilizing the Internet resources actively or passively. Finally, new perfect mechanisms have not been found yet in current web based robotic systems for transmitting multimedia such as video/state streams, especially for multiple Internet users.

II.INTERNET:

The Internet has become the most important network for communication and the biggest data storage. It connects a million of computers all over the world giving access to communication, data, pictures, videos and even real time images of distant environments. There are several factors that make the internet an attractive medium for tele operation applications [13]. Firstly, the Internet has an extensive geographical reach. An estimated 147 million people and 9.5 million machines are now plugged into the Internet, with the figures doubling or tripling every year.

Tele operated devices can be controlled and operated from any part of this global network of computer. Secondly, the Internet is network and platform independent. This enables computers of different hardware and operating system platforms to be connected and communicate with each other over different kinds of network and physical links. This widens tele operations development on any hardware and software platform to be shared and accessed by a significantly larger audience of computers.

Thirdly, the Internet is standards-based and open. For instance, standards such as HTTP and CGI simplify the development of online applications while HTML provides a means of creating consistent and open interfaces. Tele operation application can be developed with reduced time and effort and be accessed easily from anywhere on the Internet through standard interfaces such as the Web.

Finally, a wave of technological development, from high bandwidth networks to new software technologies, is revolutionizing the Internet. These developments are alleviating constraints and enhancing the capabilities of internet-based tele operations (Web robotics).

III.DESIGN APPROCH:

This paper focused on the basic development of the Internet-based robotics prototype system using a fixed type robot. The basic robot system to be launched in the internet normally has a have a robot system, a camera and a personal computer (PC)/Mobile phone with Internet. Therefore, to integrate and to design the control system programming; the following issues should be considered.

A.Layered Framework:

There are now numerous architectures available for implementing a web-based robotic system. One of the popular architecture used is the CGI (Communication Gateway Interface) mode. Through the HTML (Hyper Text Makeup Language) form, a request can be passed from client to server to launch a progress to perform some predetermined actions in the server. This mode has some shortcomings, such as poor performance, short of interaction and stateless protocol. Another is based on Java technology and can avoid the limitations of CGI. Because Java program is executable within a web page, it requires less bandwidth and enables an interface to be interactive instead of being static. But the Java applet suffers from the connection quantities along with the number of servers and clients. In addition, there are security restrictions associated with Java such as only allowing applets to connect to the host they were served from.

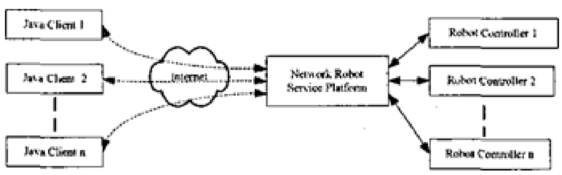

Fig. Layered framework

B. Control Server:

The Control Server is a place that handles instructions and feedbacks to/from robot controller.

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The instructions command should be sent to controller via serial communication port if we want to move the arm and know the position of robot.

C. Image Server:

Visual feedback server means a place that controls the camera images feedback before launching Internet server. So, the program that must be written to capture the real image of robot depends on camera driver type.

D. Web Server:

The web server system consists of three basic services. These three services are login service, system manager service and Common Gateway Interface (CGI) script service. The login service provides communication with the robot system by requesting a password and allows the system manager to get information about established connection. This part is important to allow system manager to arrange the priority user to control the robot system by following the database.

The CGI script is used to integrate with control and visual feedback server before launching to client site through graphic user interface (GUI). The connection of this system into Internet is using Transmission Control Protocol and Internet Protocol (TCP/IP). TCP/IP is a software-based communications protocol and it handles errors in transmission, manages the routing, the delivery of data, and control the actual transmission by the use of predetermined status signals [4].

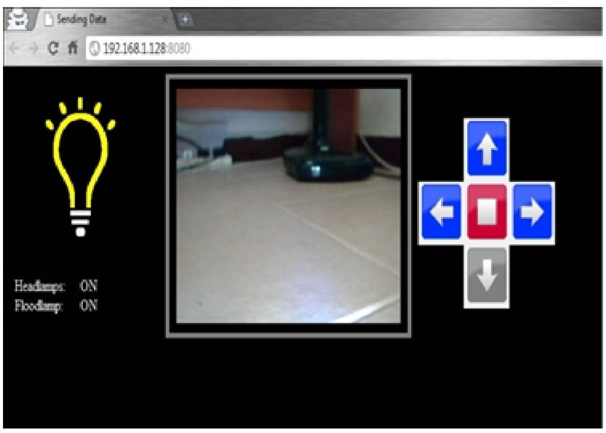

Fig: Web server.

E.CONTROL APPROCH:

Control system for this tele robot is classified as closed-loop system. The closed loop systems are more accurate since they can detect any error in the output and adjust for it. The user at Client PC is able to submit individual or a sequence of moves to the robot by submitting the instructions command to Server PC/Web-Page. The Server PC will send or modify commands if they exceed the robot's workspace to robot controller. Users can view the latest position and live image as a robot feedback action. If no action is shown in live image action, the user must send again the command. The live image from camera is also as a feedback to determine that the robot moves or not.Similarly to robot system, it needs programs to control and produce the control panel interface to the web (internet). There are three parts to be programmed namely robot control program, camera image program and graphics user interface (GUI) which would be developed by following the design approach.

F. MULTIMEDIA TRANSMISSION:

The Internet users would control the mobile robot with visual feedback and a virtual environment map which can supply Internet users with a rich knowledge of remote environment. These feedback streams, which occupy the main body of messages exchanging in a web-based robotic system, are continuous media data from NRSP to Internet users. Collectively, we refer to these information streams as multimedia. Two basic considerations come into play when designing a transmission strategy for multimedia in a web-based robotic system. First, the multimedia information is both loss-tolerant and time-sensitive.

It is not practical to use TCP protocol for transmitting it, since this protocol provides a full duplex stream service with automatic error handling, retransmission, and guarantee of reliable delivery, which would result in unpredictable arrival time of the data. This limitation of TCP protocol can be overcome to a great extent by using the user Datagram Protocol (UDP), which would send data as quickly as possible without blocking. Secondly, the web-based robotic systems allow multiple users to join the system concurrently, so the multimedia transmission needs to send the same data from one host to multiple destination hosts.

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Using unicast the same datagram would be sent numerous times repeatedly. In this case, unicast would not only consume much resources of the server machine, but also waste network bandwidth and result in congestion in some links. Another data communication mode is multicast [I21 which is the transmission of IF' Datagram to a "host group" identified by an IP destination address. IP multicast can decrease the unnecessary retransmissions so as to reduce the aggregate bandwidth required from the network.

The multicast technology based on UDP protocol is adopted in OUT web-based robotic system. From the point of view of Internet users, the multimedia server is the Network Robot proxy because all the multimedia information of one mobile robot is collected on its Network Robot proxy. The multimedia transmission strategy is as follows: The Network Robot proxy firstly builds a multicast group for each multimedia source and sends the corresponding data out using its group address. When Internet user joins this web-based robotic system, the user host would connect to the NRSP and join these groups. With the help of IGMP [I21 protocol it would receive these multimedia data and display them. Or if he leaves from this web-based robotic system, the user host would also leave from these multicast groups.

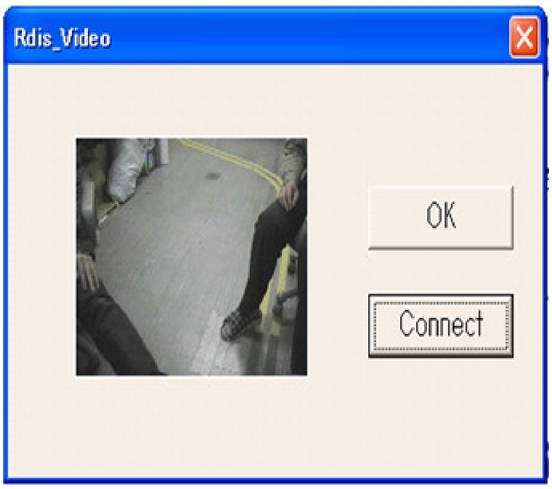

Fig: Video transmission

This transmission strategy nowadays has several drawbacks. First, the applet are not allowed to use multicast communication directly for the l i t a t i o n of security policy, so if Internet user wants to receive the multimedia information, he would change his local security policy passively or actively to support multicast.

Secondly, Network Robot proxy simply transmits multimedia data at the rate at which it was encoded, regardless of the congestion state of the network. This could be the future work of the research. Finally, because of the restriction of some routers and firewalls, the Internet doesn't support multicast technology extensively. But with the growth of MBone [I21 and other network technologies it would not be a problem.

IV. RESULTS:

Manually remote control In the Mechanism 1, the user is able to send direct commands to the mobile robot such as "Go ", "turn your head left/right", "straighten your head", "look up/down/straight", "No (for cancelling of a command)". The user specifies most of the work and he/she has the flexibility to interrupt any commands he/she sends. The tag then must be induced in HTML programming to make mobile robot move. The GUI Will help the robot to Navigate in Different Directions so it enables the user to move the robot in specified direct which generates the user output in visual manner so it would be used for the person to monitoring the ongoing activity.

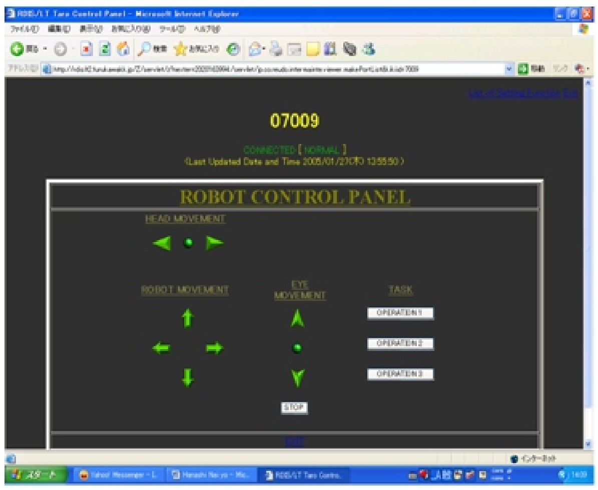

Fig: Web page

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For autonomous navigation control mechanism to be reliable and robust, the image taken by CCD camera will be sent to the user immediately. The volume of data coming from the mobile robot and the frequency of the transmission should be synchronized and controlled in order to make the autonomous control work as in the real world without any information delay compare to dynamic movement of the mobile robot.

V.CONCLUSIONS & FUTURE WORK:

The RNR can be controlled using the web-based control interface created if the client's control hardware specification is adequate to support live video streaming and with condition that wireless network coverage is available. Testing outcomes demonstrated that the human can navigate the RNR remotely over the Wi-Fi network by viewing the robotic environment from the robot's point of view and controlling it from a computer at the client side. Overall, the RNR hardware and firmware discussed satisfy features needed for multiclass HRI. The firmware may also serve as a pedestal for development of applications that requires specific class or multiclass HRI. Hardware prototyping is also emphasized in this project to embrace the embodiment statute for mobile robots based on recent embedded system technology.

Currently, the prototype is suitable for navigation in indoor environment. Nevertheless, the prototype itself can also be improved further in terms of the locomotion design and artificial intelligence. The RNR can be restructured to run on more challenging terrain. The camera's viewing angle or robot's vision degree of freedom could also be increased. More advance video streaming through compression can be employed to reduce bandwidth of video but that would require a main processor that can support video encoding for real-time streaming. Intelligence of the current prototype may also be extended through vision-based autonomous navigation and object recognition executed either on the server or the client.

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