

Web-Based Control and Monitoring Of Telepresence Robot

A. John Paul Antony, Dr. S. Rajpandian

Post Graduate Student, Dept. of IT, Velammal College of Engineering and Technology, Madurai, India.

Professor & Head, Dept. of IT, Velammal College of Engineering and Technology, Madurai, India.

Abstract—Telerobotic is the emerging area of robotics concerned with the control of robots from a distance, chiefly using wireless connections focused on Telepresence and Tele operation. In our paper we designed to develop a telerobotic system for control and monitoring the TechRobot Create® mobile robot that will enhance a user's experience by being intuitive to use, ergonomically friendly, accessible, portable and scalable. Previous applications for telerobotic control were PC based applications that had to be installed as a monolithic desktop application. Telerobotic control involves a series of mouse clicks to direct a robot's trajectory. Each Telerobotic control operations performed from Techbot Web User Interface by using JS and PHP. The Techbot Web User Interface, being a Web application, renders local installation unnecessary, as the Techbot Web User Interface is accessible to anyone over an Internet connection. Thus, users can easily control the TechRobot in anytime, anywhere over an internet connection. The purpose of restricting the number of sessions over the WLAN to a single session is to prevent the streaming of redundant video to multiple parties, thus allowing the wireless channel to carry a single video stream to the gateway with the highest possible frame rate or lowest possible quantization value, depending on the available wireless data rate. Using this design approach, the Techbot Web User Interface we have developed is scalable, portable, accessible and ergonomically friendly.

Keywords— Arduino, Saber tooth, AFMLE, Wowza Media server

I. INTRODUCTION

Telerobotic control is the area of robotics concerned with the control of robots from a distance, chiefly using wireless communications. Telerobotic is a sophisticated form of teleoperation (doing work at a distance) and combines two major subfields: teleoperation and

meaningful way. This is especially true in the case of ground-based control of space robots where the effects of time delays and bandwidth restrictions are extremely significant. In such a space system, the time delays (from the ground to the space station) can be up to 3 seconds and this delay plays a major role in the stability control of the entire system. Bandwidth restrictions limit the availability of video and audio channels. Therefore, less information passes between a user and the space-based robot.

To learn the Telepresence Robot control operation such as forward, backward, left, right and rotate. There are different applications are used in education, medical and military field. This TechRobot controlled from web based UI and streaming video both client and a server application, the major challenge is stream video from one to another PC without time delay. To study the different Web based User Interface and which web server is effective for used to control and sharing the video from server to mobile robot. The challenge of every telerobotic system is to create a user interface that is both ergonomically friendly and easy to use. Many UIs were developed during this research effort. In this Robot designed with low cost and have developing a maximum communication coverage range.

Telepresence Robot control and monitor from web User Interface with in a minimum coverage range. Because there are two major causes occur in this research area. 1. Localization 2.Mapping, many more problems encountered to developed and implements a Telepresence Robot.

A. Incorrect Status being displayed

TechRobot provides certain status information that would be useful for a remote user. Status such as battery capacity, battery temperature, current charge state, voltage and more are all pertinent information when remotely controlling a remote robot. The user would be in a potentially dangerous predicament is a remote robot is not responsive because of a dead battery without being issued any type of information for them to monitor.

II. LITERATURE SURVEY

B. Website pictures not being loaded

Even though the static html code was written correctly, the picture would only load correctly in the Internet Explorer but not the Firefox browser. This problem was inadvertently solved using AJAX methodology. The static html code was being changed to be dynamically created in JavaScript when the website loaded. Now the pictures load correctly in either Firefox or Internet Explorer.

C. Out of order SOAP messages

During test runs it was noted that SOAP messages coming from the Techbot Web User Interface were sometimes arriving out of order. At the time, every SOAP message received by the Techbot Web Application Gateway was blindly processed in the order received. This caused problems because the out of order SOAP messages caused the iRobot to move erratically. For example, with the slider based UI, clicking the left or right button sends two SOAP messages to the Techbot Web Application Gateway. The first SOAP message tells the iRobot to turn, the second SOAP message (which the Techbot Web User Interface sends later) tells the iRobot to drive straight. However, sometimes the Techbot Web Application Gateway receives the second SOAP message before the first SOAP message (see Figure 1).

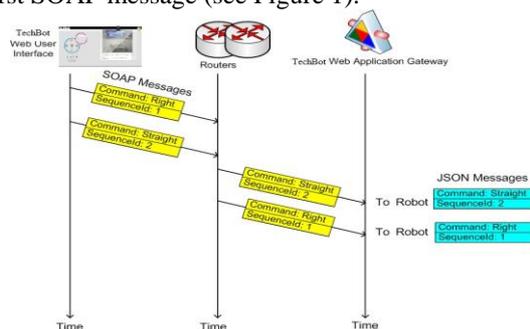


Fig. 1 SOAP request messages being processed out of order

D. Loss of wireless signal

Successful transmission between the TechRobot and the Techbot Web Application Gateway is highly coupled with the wireless signal strength. During test runs it was noted that occasionally, in areas of low signal strengths or areas covered by a lot of metal infrastructure, some messages sent to the TechRobot were never received. Problematic areas tend to be regions containing a lot of metal infrastructure and farther away from the access point. Thus, a remote user would sometimes be required to manually recover the TechRobot from an area of poor signal strength. Using debugging tools it was noted that this problem started to become more frequent as the wireless bit rate got closer to 1 Mb/s. Thus, a mechanism was needed to determine when the TechRobot and the Techbot Web Application Gateway are no longer connected, so the connection could be restarted.

The field of telerobotic has been around for the past 40 years. Many research endeavors have been dedicated to this field. There are many telepresence robot created in these world. At this present using a low cost component for control and monitoring the TechRobot (PetBot 2013) by using a Raspberry pi and Arduino [1]. Computer science and engineering curricula commonly use the TechRobot Create TM Vehicle (the TechRobot) because of its low cost. The TechRobot is particularly attractive because of the easy to learn Create Open Interface (OI) that uses the RS232 serial protocol for sending command packets and is the platform of choice to stimulate student interests and improve retention rates in many colleges. Weiss et al. identified that the TechRobot as an ideal platform for researches seeking affordable and durable solutions for teaching introductory robotic courses [5]. One of the more challenging areas students have focused attention on is the integration of visual classification to automated robot task planning where image profiles consisting of pixel-intensity sums computed across subsets of a streaming video sample can be used for visual odometrical control of the TechRobot, where the use of images taken from the iRobot's surroundings is used estimate change in position over time [8].

Telerobotic is not just used to stimulate student interests but this field also has real world applications as well. The MER vehicles have a very sophisticated suite of autonomous capabilities to explore unknown terrain and automatically collect data, such as scientifically interesting events [9]. The vehicles use hazards to populate a surrounding map of terrain traversability; from this map the best route is chosen to be executed. The vehicles repeat the process of detecting hazards and then executing the appropriate motion command until the goal is reached. In order to maintain a local navigation map the vehicles combine wheel odometry, linear accelerations, angular velocities and optional vision-based pose estimates [10].

III. IMPLEMENTATION METHOD

The purpose of the design phase is to plan out a system that meets the requirements defined in the analysis phase. It defines the means of implementing the project solution. In the design phase the architecture is established. This phase starts with the requirement document delivered by the requirement phase and maps the requirements into architecture. The architecture defines the components, their interfaces and behaviour's. The deliverable design document is the architecture. The design document describes a plan to implement the requirements.

A. Architecture

In a system architecture which consists of Telepresence Robot requirements for both hardware and software. The hardware is based on the electrical, electronics and communication devices. The Software is based on open source platform.

IV.METHODOLOGY

This section elaborately discussed about the step by step procedure for the Techbot robot integration.

A. Techbot Robot Creation

The Techbot Robot consists of all the necessary components which include the following: Arduino, Saber tooth, RS232 interface, Raspberry Pi, 12V battery, WLAN devices such as (modem, Wi-Fi and other networking devices), iPod or LCD display monitor, Ultrasonic Sensor.

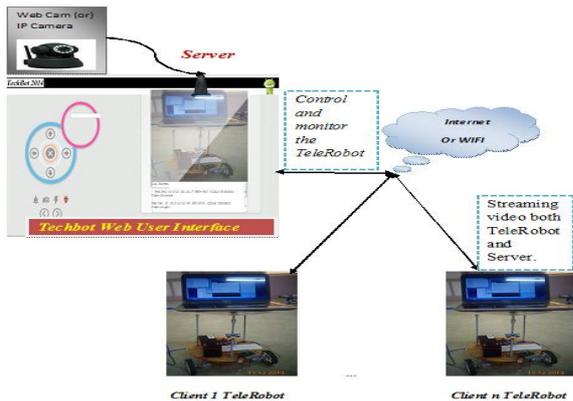


Fig. 2 Architecture Design

There is different major hardware and software components are used to develop a TechRobot such as like Saber tooth or L293D motor drive, Arduino, ultrasonic sensor, Raspberry Pi, DC motor, 12V battery, AFMLE, Wamp server, Arduino 1.5.2, python.exe, and pyserial 2.7.exe and so on. In this architecture to describe how to control and monitor the Telepresence Robot, and what are the functions and operations performed in Web User Interface over an internet. The step by step processes are fully explained in the following of architectural design by using Arduino and Raspberry Pi or Remote PC. The DC motors are controlled on serial communication between Arduino and PC by using sabertooth or L293d motor drive.

When a user logs on to Techbot Web User Interface, the very first thing that needs to be done is synchronize the sequence ID with the Techbot Web Application Gateway. This sequence ID is needed to ensure SOAP Requests are processed by the Techbot Web Application Gateway in the order they were submitted by a user through a browser. Afterwards, the two timers are started; the first timer is used to poll the Techbot Web Application Gateway for the TechRobot status. The status is important because the status contains relevant information (battery temperature, battery charge, etc) a user might need to determine the next best course of action. For example, by monitoring the battery charge, a user could best determine when is the best time to direct the TechRobot to return to the home base to recharge the battery. An unresponsive the TechRobot due to an empty battery is a high nuisance to a user, as they would have to manually retrieve and transport the TechRobot back to the home base to recharge, which would defeat the purpose of telerobotic control.

It is imperative that every mouse movement that occurs within the circle based UI is not translated as a motion command, causing JavaScript to create a SOAP message and send the SOAP message to the Techbot Web Application Gateway. This is because when dealing with any hardware, like the TechRobot, requests that cause physical motion need time to be processed. Otherwise, both servers (the TechRobot and GlassFish running on the gateway server) will become saturated and can malfunction. Localization and mapping is a major cause of problem for control and monitoring of TechRobot and loss of wireless signal over an internet connection.



Fig. 3 Techbot Robot

B. DC motor controlled by using Arduino and L293d motor Drive

Arduino is a micro controller which is used to control the DC motor by using L293d motor drive. The L293d motor drive is used to control the motor in both way directions. L293d motor drive schematic diagram as follows as shown in figure 3

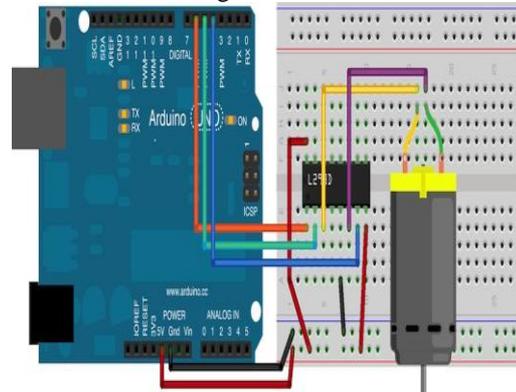


Fig. 4 Arduino and L293D with motor configuration

C. Techbot Robot Controlled by using Arduino and Saber tooth

Saber tooth is one of the motor drive which is used to control the motor in a Techbot robot. The Saber Tooth motor drive control the two DC motors in both way directions. If any fault occurs in a DC motor, the error will be generated in Saber tooth motor drive.

D. Techbot Robot speed Controlled via I/O Socket

In a Transmission Connection Oriented protocol (TCP) to control the speed of the robot via I/O socket. While the robot sensing any obstacle, and then the value will be set as Zero to stop the robot. The value 125 will be set to slower the speed of the robot and the highest value i.e. 250 will be set to speed up the robot operation.

E. Button based UI design

HTML, CSS, Ajax and JavaScript Technologies are used together to build the control interface. There are five buttons is used to control the movement direction of the robot (Forward, Left, Right, Reverse, and break).

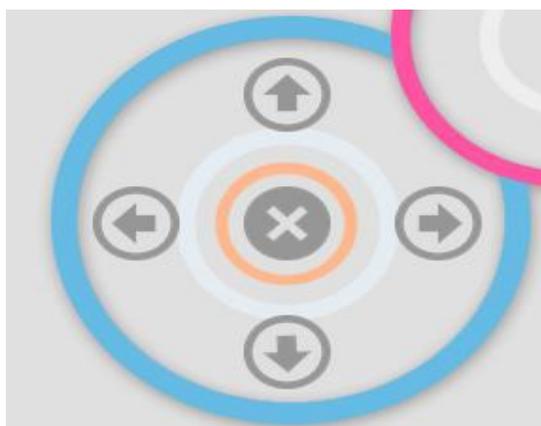


Fig. 5 Movement buttons

F. Robot location

It is a map based on Google maps API which displays the current position of the robot at real time.



Fig. 6 Robot Location

G. Object Detection and Avoidance



Fig. 7 Object detection and avoidance by using Ultrasonic sensor

Integrating Ultrasonic sensor with the Techbot Robot would allow the creation of a fully autonomous robot that can navigate a room without colliding with any rigid object. Once this has been integrated, a user can turn on the Techbot Robot, direct it to a location of the user's choosing and turn on an autonomous feature and let the Techbot Robot navigate the area without having to worry about the Techbot Robot colliding with a rigid object and risk damaging any hardware attached on the Techbot Robot. Furthermore, it could also be beneficial in directing the Techbot Robot away from danger when the Techbot Robot is in manual mode (being driven by user). Should the Techbot Robot detect that the current course of action would result in a collision; the obstacle avoidance algorithm would slightly adjust the current bearing to move the Techbot Robot away from danger.

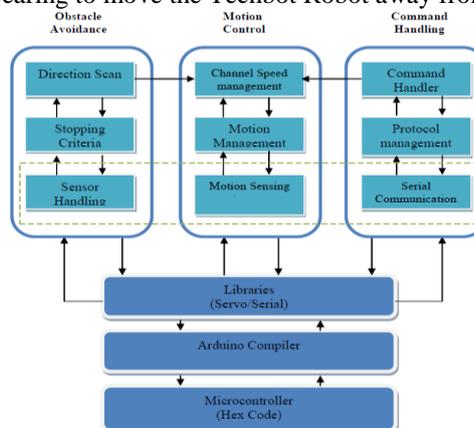


Fig. 8 Functional Diagram for Object detection and Avoidance

H. Integrating video streaming to the webpage

The video is loaded into Adobe Flash Media Live Encoder (AFMLE) Software. Then the URL is set and starts the AFMLE Software. The videos are streamed from UI to Techbot Robot and vice versa by using Justin.TV.



Fig.9 video streaming in to Webpage using AFMLE

I. OpenCV object detection, object tracking, and face detection program Execution

OpenCV is used to detect the faces and calculate the number of faces and displays it on the Techbot web UI. This process is carried out using a camera attached to a Raspberry Pi.

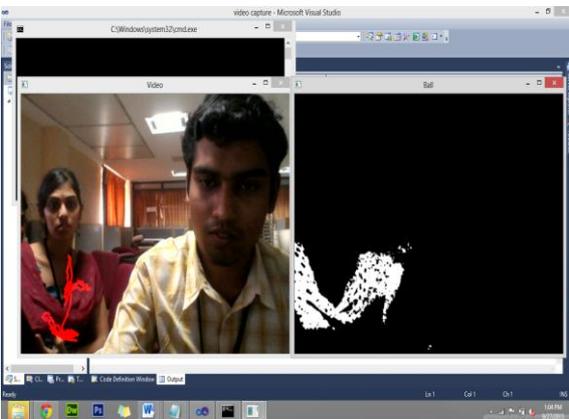


Fig. 10 Object detection and tracking

J. Raspberry Pi and Arduino Integration:

The laptop is replaced by a raspberry pi because it is portable and smart. In order to integrate a raspberry pi to Arduino, GPIO is used.

V. RESULT AND DISCUSSIONS

The objective of the present study was fulfilled through Techbot design for effective control and monitoring of mobile Robot. The resulting system addresses the issues of localization and mapping that robot. The UI, being a Web application allows the UI to be accessed from any device that is connected to the Internet. Being combined with a live video stream makes this UI a true telerobotic control system because a user no longer has to be near the Techbot Robot to control the Techbot Robot. In addition to the user directing the Techbot Robot, many other users were able to log on and view the video as well. This makes this telerobotic system highly accessible to both users who want to direct the Techbot Robot and users who just want to track the Techbot Robot's progress.

During test runs, there were instances where a user directed the Techbot Robot through an area of low signal strength with the local access point. Eventually, the signal strength was too low that the wireless connection was dropped. This happened when the wireless bit rate is around 1 MB/s. However, the Techbot Robot was able to negotiate with another access point on a different WLAN that had higher signal strength. On average, the Techbot

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Robot was able to successfully connect to another wireless network between 7-150 seconds. Low wireless bit rate is not necessarily just caused by the Techbot Robot traveling near the boundary of an access point; it can also be caused by low battery power or the presence of nearby metal objects.

VI. CONCLUSIONS

The design of our UI is based upon using an AJAX methodology, this UI will scale better than when compared to a HTML forms counterpart. The user's browser is responsible for running the code to generate the UI, perform browser-based animations, and receive a live video stream. This frees the Web Application Gateway and the Techbot Robot from having to send HTML web pages to browsers, allowing the Techbot Web Application Gateway and the TechRobot to solely process messages sent by the user. The Techbot Web Application Gateway provided an additional benefit to this system by allowing the TechRobot to only maintain one session, regardless of the number of users. This makes this telerobotic system scalable

During test runs, there were instances where a user directed the TechRobot through an area of low signal strength with the local access point. Eventually, the signal strength was too low that the wireless connection was dropped. This happened when the wireless bit rate is around 1 MB/s. However, the TechRobot was able to negotiate with another access point on a different WLAN that had higher signal strength. On average, the TechRobot was able to successfully connect to another wireless network between 7-60 seconds. Low wireless bit rate is not necessarily just caused by the TechRobot traveling near the boundary of an access point; it can also be caused by low battery power or the presence of nearby metal objects. Without sufficient battery power, there is not enough charge to power the wireless network card to operate at its full capacity. When this happened the wireless bit rate can vary greatly and suddenly drop to the 1 MB/s threshold causing the TechRobot to miss the heartbeat request or response and restart the session with the Techbot Web Application Gateway. Because this Telerobotic system is able to cell hop without any user interaction and operate in any wireless network, this telerobotic system very portable. In future add the modules for robot location identification, Wimax technology integration, Raspberry Pi integration to TechRobot.

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