Virtual Telepresence Sample Collecting Robot

R. P Muthukumarane, M. H. P. L. Jayarathne, Ama Bandara, Udesh Oruthota*

School of Engineering, Sri Lanka Technological Campus, Sri Lanka

udesho@sltc.ac.lk*

Abstract – The continuous growth of the field of automation technology has created may pathways for the general community to make their lives easier in almost every aspect of their lifestyles. Virtual telepresence is one of the key research components in robotic filed, where the users are interested in controlling the robots though a remote location with enhanced security. A virtual telepresence sample collecting robot design is proposed as discussed in this study for the purpose of collecting distinct samples to be analyzed from remote locations. The design is to be implemented in several stages as the navigation system controlled by the joystick and the robotic arms to be controlled by the haptic gloves. For the purpose of introducing a cost-effective product to the market a specific in-built haptic glove controller design is proposed to be implemented. Each section is discussed in comprehensive details where the final design is to be implemented and presented as a future result of the study.

Keywords: virtual telepresence, navigation system, robotic arm, haptic glove

I. Introduction

In modern world, telepresence could be a considerable necessity as a person cannot be everywhere since the world is rapidly breaking its physical barriers in automation. Thus, a telepresence robot presents an ideal solution since apart from having the telepresence feature, it can be used for a variety of other activities according to the user preference as the robot consists of robotic arms which can be controlled both manually and automatically through a distinct location. The controlling features can be very useful in defences and for scientific research activities along with many more uses as a customised end product.

This project is mainly consisting with a virtual telepresence vehicle [1] and virtual haptic gloves robotic arms. Here the robot is continuously controlled by head movement of the user and since a mobile phone is using as the VR lens, the built-in accelerometer is used to collect the data emerges when the user rotates his head and those data is used to rotate the camera which is built-in the moving robot. Live footages added with live streaming video which are captured by a camera of the robot gives the user real time experience as if he is present at the location. By using the live video streaming, user can virtually tele present in another location. Apart from that robot vehicle consist with a virtual robotic arm, it can be also controlled with virtual haptic gloves. At the end, user will be able to watch the live footages from a remote location and he or she will be able to control the movements of the robot with certain tasks with in their own physical limitations.

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II. Methadology

Prior to the design and implementation, a comprehensive review on various robots [2][3] with virtual telepresence abilities and technologies was carried out to select the most cost effective, energy efficient latest technologies which can be adapted to the design.

Processor: As the total project consists of several key technologies together, it is essential to have a processor with higher capacity. Therefore, developers have used Raspberry pi 3 module as their processor with a built in wi-fi module. Apart from that, due to the higher capabilities it has in terms of processing, RPI module is best matching for real time video streaming as well. The microprocessor used in is the Raspberry Pi 3 Model B+. There have been many significant upgrades made in the latest version of the Raspberry Pi board in comparison to the Raspberry Pi 2, which make it more suitable. The SOC in the Raspberry Pi 3 Model B+ is Broadcom BCM2837B0, which is almost 50% faster than the Raspberry Pi 2. The CPU is also faster, at 2.4GHz, in comparison to the 900MHz Quad Cortex A7 in Pi 2. The Graphical Processing Unit is clocked at 400MHz compared to the 250 MHz Video Core IV in Pi 2. Above all, the Raspberry Pi 3 Model B features an on-board Wi-Fi and Bluetooth, which makes it easier to use in IoT applications. All the peripherals required in [] are connected to the Raspberry Pi 3B+ which contains the programs required for controlling the movements of the robot.

Communication: The communication between the virtual reality (VR) headset and the robot is conducted via the wi-fi technology. VR headset need to be capable of displaying the live footages. Therefore, a higher data rate would apply in communication. Apart from that, radio communication is used when communicating with robot for the navigation.

Navigation: The remote connects to the smart phone via Bluetooth technology and is also used to control the bot's movement. By using the navigation buttons on the remote control, the user can control the motion of the bot. Once the user wears the VR headset, he can control the operations on his smartphone using the remote control. A special button is designed in the remote for asking queries and actively participating in classroom activities.

VR lenses: VR lenses or the VR headset is the main tool which is used to navigate the camera where VR head set is required to display a live footage for the purpose of navigation. Therefore, a smartphone compatible with raspberry pi board is used with the features such as gyroscopes that provide good orientation tracking and accelerometers, cameras, and GPS sensors for position tracking.

Robotic hands: The controlling of the robotic arm is based on fingers and hand gestures. We use the fuzzy logic method to process the input values of several flex sensors, Arduino microcontroller, and hand gestures. The output of the fuzzy logic process is used to decide the robotic arm movement. We use the gyroscope model to determine the slope of the movement of fingers and human hands followed by the movement of a robotic arm. The main construction consists of the component of an Arduino Uno microcontroller, sensors, servo motor, driver, Bluetooth, and power supply. Parts of this robot are composed of shoulders, upper arm, lower arm, wrist, and gripper.

The navigation of the robot is initiated with the use of the VR lens where a mobile phone is used as the screen of the lens. It is compulsory to have a screen for user to observe the surrounding from the point of view of the camera. Camera will transmit the live video footages to the mobile phone where mobile phone's wi-fi module will be able to receive those footages and casted in the screen. There is a camera in the moving robot and it should be rotated and tilted based on the navigation path according to the user requirement. We plan is to rotate the camera according to the VR lens (mobile phone) rotation and tilt to the direction which the VR lens moves vertically. VR lens with mobile phone will act as both an input and output mode of communication. The hardware block diagram of the system model is illustrated in Fig.1.

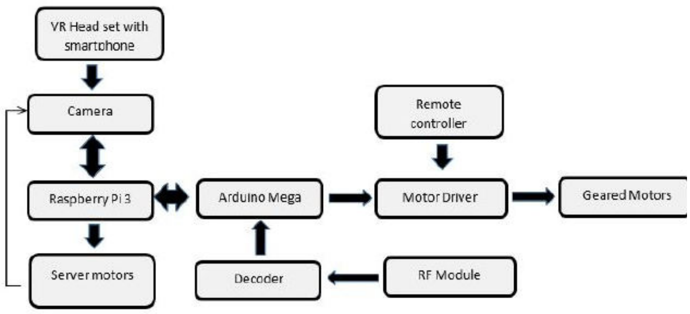

Fig. 1: Hardware block diagram of the proposed system

The basic structure of the moving robot will be built on four wheels and with a camera, two robotic hands and other accessories to measure different measurements. Raspberry pi module is used as the main processor of the robot where the built in Wi-Fi module transmits the live footages. Robot is to be moved by taking the navigational instructions from the received signal. The navigational instructions will be received via a wi-fi module and be processed by the microcontroller itself and navigate the motors through the components. In addition to that, there are different types of sensors to measure the important measurements such as temperature, humidity etc. The readings which are going to collect from those sensors will also be transmitted to the VR lens as well. There will be a lithium-ion battery to supply the power to navigate the robot.

The robotic arms are to be made with a specific controller design. The ability of the flex sensors to be able to measure physical stress and stain lays the foundation of gesture recognition. Parts of this robot are composed of shoulders, upper arm, lower arm, wrist, and gripper. The robot arm will be controlled using fingers and hand movements which are connected via Bluetooth. Several sensors on the fingers and push-button will be used to control the arms which will be processed with fuzzy logic.

Interacting with a computer through a mouse or a joystick can be rather mundane and sometimes (especially in video game play and robotics) it's necessary to encode the movements of our fingers in to electrical signals that a microcontroller can read. Once we can interpret the flexing of our fingers, we can interact with virtual worlds inside a computer or control servo motors to mimic the movements of our fingers. First, we need to be able to read the flexing of our fingers which is by using a flex sensor. Flex sensors are like variable resistors where their resistance changes as they bend and flex. If we can read the resistance of a sensor, we can interpret how much it has been flexed. For that we need to develop the haptic gloves system. As the flex sensors in the market is expensive, we propose to build a home version haptic glove to control the robotic arm using cable ties, core wires, 10k resistors and conductive bag.

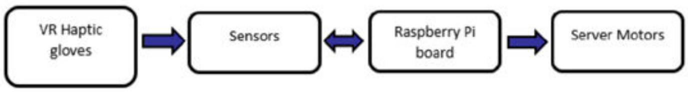

Fig. 2: Navigation of the haptic gloves and robotic arms

III. Results And Discussion

The robot is designed to navigate via a joystick. There will be a camera mounted on the robot and it rotates according to the direction of the moving of the VR lens. The navigation path and a real time footage will be displayed through a mobile phone. By reaching the planned destination, the robotic arm will be controlled with the use of haptic glove and the required samples will be collected. As the design and implementation is in the preliminary stage and with the limited space to illustrate the design, a comprehensive results analysis will be presented in future. By initiation the implementation through the navigation system the movements and the controllers are tested and to be troubleshooted in each stage where the final design is concluded by combining the navigation, robot arm and the haptic glove systems.

IV. Conclusions

A design of a virtual telepresence sample collecting robot is proposed and discussed in this paper included with comprehensive details of the navigation system and the robotic arm to be controlled by the haptic glove. Due to the complexity of implementation, the design is proposed to be implemented in three stages initiated with the navigation system and joystick, robotic arm latter combined with the haptic glove. An optimal system with a haptic glove design is proposed instead of using flex sensors to minimize the cost of the product. With the implementation of the final product an inbuilt screen for the VR lens and proposing a unique processor design with minimal power consumption will be the future pathways of the study to be extended.

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