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Gesture Controlled Virtual Presence Robot

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Abstract- Robotics is on considered as one the enabling technologies in industrial revolution 4.0. This paper is about the cumula ve extension of the already existing robot surveillance technology, which improvises research and exploration through robots in distinct terrain. The task of the robot is to explore the distinct on replacing humans, an a empt is made to improve this explora on capability by encompassing virtual presence application and hand gesture based mo on of the robot. A handheld device is used to sense the gesture and VR headset with moon sensor within, measures head movement. Ini al design results are also presented in this paper. The technologies presented in this paper suggest a wide domain of possibility as to a wide variety of users.

I. INTRODUCTION

Robots are characterized as mechanical crea ones that can mimic human behavior or carry out human du es. Complex programming and knowledge are needed to construct a robot. It's all about crea ng systems and connec ng components like cables, motors, and sensors. The design and development of a robot that can move to execute surveillance tasks on a surface are covered by the gesture controlled virtual presence robot. In addi on to these control signals, control signals for the robot-mounted camera's mo ons are also delivered, these control signals are dependent on the user's head gestures that a headset records. A virtual presence may be experienced with a VR headset. Virtual presence refers to a user's percep on and feeling that they are physically present in a virtual space. The perceptual illusion of presence in virtual reality frequently depends on the impressiveness-enabling technology. As previously said, a virtual loca on might be a simulated se ng or a genuine one using live cameras. Based on the la er is this project. This robot's primary goal is to force users to study their surroundings holis cally by giving them the op on to observe any area in its en rety by rota ng the camera 180 degrees. DC motors, a castor wheel, a microcontroller, sensors, a camera module, and a Bluetooth module are all used by this robot. The project's primary component is the micro-controller. Programming for the micro-controller allows it to control every component of the robot. Based on the perspec ve of the user VR headset, the user moves this robot by using hand gestures. The user must adjust his head posi on like he would in a real-world situa on if he wants to look anywhere other than the camera's preset direc on. This altered head posi on is regarded as a gesture, and a wireless control signal

indica ng the degree of gesture is delivered to the smartphone that is inserted into the virtual reality headset so that the user may feel virtual presence.

The goal of this research is developing a special robot that can be used to provide an experience of virtual presence for be er analyzing and understanding of the loca on to make up for the issues like climate change, uncomfortable environmental condi ons and vulnerable terrain, to name a few. Virtual presence becoming more and more popular as their poten al is inves gated, developed, and used, in reaching inaccessible regions for inves ga on may be a step toward evolu on and a significant advancement in scien fic study. By using a VR headset, one may experience a remote environment from anywhere in the globe and have the sensa on of having a pair of mobile eyes thanks to con nued development of virtual presence.

The remaining part of this paper is organized as follows. Literature review is presented in Sec on II, while the proposed methodology is elaborated in Sec on III. design results obtained are contained in sec on IV followed by the conclusion, which ends this paper.

II. LITERATURE SURVEY

The technological progress in the field of robo cs is at its epoch. It's not surprising to see that a lot of work has been done in the field of gesture controlled robots. A method to manipulate 3D models by hand gesture using finger plates and hand shadow is reported by amato et al [1], Here the user is needed to make a shape of a 3D model which is already trained in the algorithm. A er the recogni on of the made 3D model or gesture is done the robot is controlled correspondingly. This system was found to be easy as users became familiar quickly.

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Y. Jia et al.[2] proposed a model in which users use a smart pad to tele-operate everyday objects by enabling robots to touch the objects visible in live video, streaming from the robot's environment. This proposed model runs at approximately 10 frames per second on a laptop, including image s tching, object recogni on, localiza on and tracking etc. F. Sorgini et al [3].reports a bidirec onal communica on system to achieve mul -sensory tele presence during gesture control of an industrial robo c arm. This research is complemented with experiments simula ng different and more complex ac vi es such as precise manipula on tasks of small objects. H. Z. Jahromi et al.[4] proposed a model for examining the impact of bandwidth, delay and packet loss rate impairments on the operator's quality of experience (QOE) when using a TPR in an office context. The aim is to inves gate the viability of different QOE models and frameworks in the domain of VR and gaming to be er characterize and predict QOE.

III. METHODOLOGY AND WORKING

The MCU, ESP32, uses the ADXL335 and MPU6050 sensors to detect any movement. The videos will be recorded using a Esp32 camera module, which will then broadcast them through wifi to a smartphone a ached to a virtual reality (VR) headset. The robot's camera can be moved using the user's head movements, allowing the user to observe the surroundings by simply rota ng their head and feel the presence visually and in real me. The ADXL sensor, which monitors the dynamic accelera on brought on by mo on of the user's head, is used to measure head mo on. The camera is mounted on a servo motor that rotates in accordance with the user's head movement so that their respec ve angular displacements are constantly synchronized.

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A. Block diagram

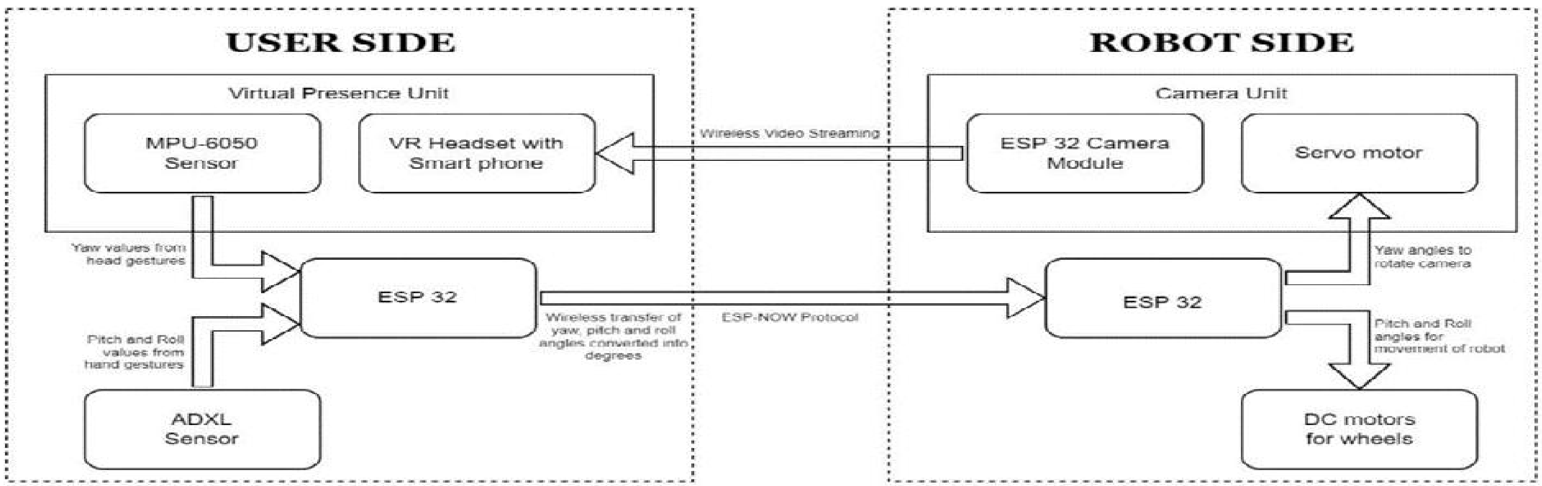

Figure 1. Overall block diagram

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B. On the user side

The user side, shown in figure 3, consists of a virtual presence unit, ADXL sensor and an ESP-32. The virtual presence unit consists of an MPU-6050 sensor and VR headset with a smartphone. MPU-6050 sensor uses MEMS technology for mo on sensing. The VR headset enhances the user experience. The VR headset with a VR compa ble smartphone gives the virtual presence feel as if the user or wearer of the VR headset is in the loca on where the robot is while the user can be anywhere in the world. ADXL sensor is also a mo on sensor without a gyroscope and a sensor which only consists of an accelerometer whereas MPU-6050 has both a gyroscope and accelerometer.

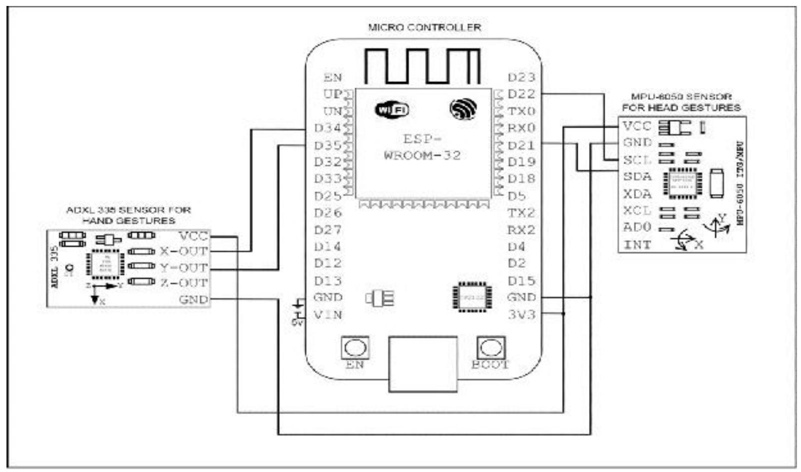

Figure 2. Circuit diagram of sender side

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C. On the robot side

The robot side consists of a camera unit, DC geared motors and an ESP-32. The camera unit has an ESP-32 camera module and a servo motor. This camera module is placed on the servo motor which will be rotated when a user rotates their head and the posi on of the servo motor will always be in sync with the posi on of the user's head. The DC geared motors are used for wheels to move the robot and these are driven by a dual h-bridge motor driver.

D. Working

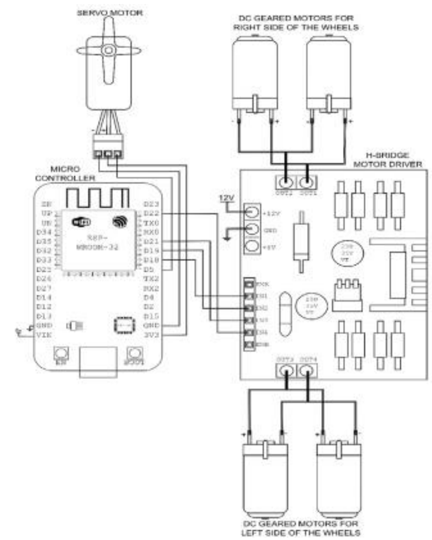

Figure 3. Circuit diagram of robot side

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The MPU-6050 sensor is placed on the VR headset to sense the moon of the user’s head. The MPU-6050 can sense the mo on in all three angles but ESP-32 reads only the yaw movement. The user’s head movement which includes le and right rota on of the head is called yaw movement. This is shown in figure 4. Whenever the user turns their head to their le , the servo motor on the robot will turn le to the exact angle of the user’s head posi on. Similarly, this happens with the right turn also.

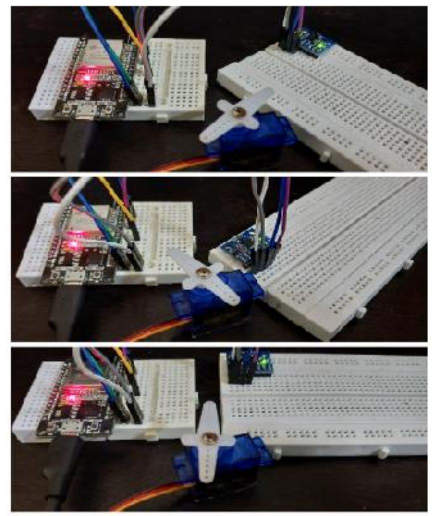

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Figure 4. Interfacing servo motor with mpu-6050

The controlling of the servo motor on the robot based on the commands of the angular rota on of head turns is simply called head gestures. This is done to turn the camera which is mounted on this servo motor. Hand gesture is similar to head gestures where the command is given by the different types of rota ons done by hand which are unique to each other. The different types are up-down and le -right lts. Pitch, roll and yaw are the three different types of degrees of mo on. Pitch corresponds to the up and down mo on. Roll corresponds to the l ng mo on towards the right or le .

The ADXL sensor is placed on the hand glove as shown in figure 5, this senses the hand gestures performed by the user to control the movement of the robot. The mo on towards the upward direc on in pitch degree of freedom is the command for the robot to move in the forward direc on. The downward gesture is to move in the backwards direc on. The le lt in the roll mo on is to turn the robot to the le and the right lt is to turn the robot to its right.The ESP on the user side reads both MPU-6050 and ADXL sensors for head and hand gestures respec vely. The outputs from these sensors are raw values and these sensor data must be converted into a useful form. The ESP uses the map func on to convert these raw values into degrees. The en re implementa on of this project deals only within 0 to
180 degrees and therefore only those sensor values corresponding to angles within 0 and 180 degrees are converted.

IV. Results

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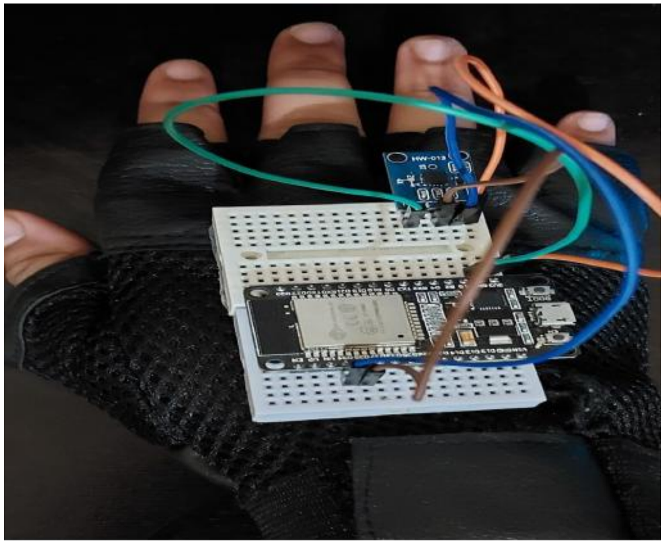

Figure 5. ADXL sensor mounted on hand gloves

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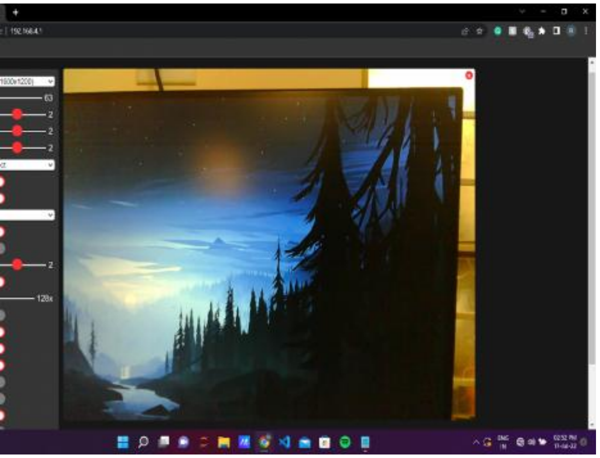

Figure 6. MPU-6050 mounted on VR Headset

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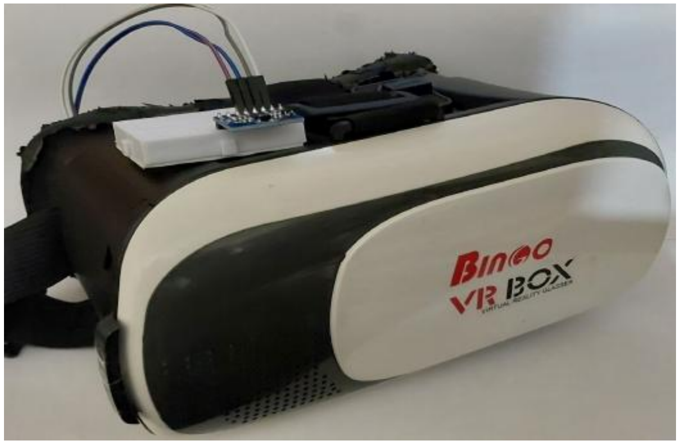

Figure 7 : Live video streaming from the camera module placed on robot

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Figure 8. Pitch, Roll and Yaw values being transmi ed from ADXL-335 and MPU-6050 to ESP32 module

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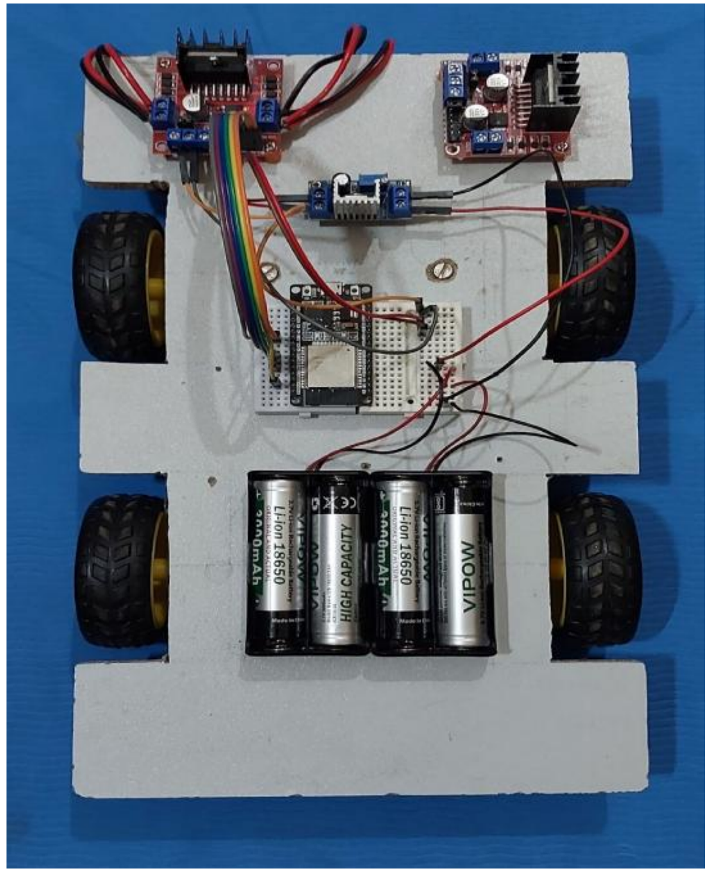

Figure 9. The Prototype

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V. conclusion

In this paper, a novel method to create a unique robot surveillance model is discussed, which allows its controllability through user's gesture for improved, efficient and holis c perceiving ability of users. Robo cs applica ons are becoming very essen al in many of the research fields, it may be extra-terrestrial terrain, underground caves, high mountain ranges etc. which doesn't support physical human presence completely. With this already exis ng robo c model, an add-on was a empted to make the robot mo on controlled through hand gesture and providing the user with 'virtual presence' experience, by making the robot's camera movement aligned with the user's head movement. Further research includes the integra on of obstacle avoidance and collision detec on systems. There is also a huge scope to improve the braking mechanisms of the system on which research is underway.

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