IMPLEMENTATION OF SPATIAL AUGMENTED REALITY TO CONTROL HUMANOID ROBOTIC ARM

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Introduction:
With technology advancing at an astronomical rate, we are witnessing events today that a few years ago were only conceptualized in movies. From humanoid robots to the Virtual Reality, the possibilities are endless. Leap Motion is an example of ground breaking technology that has the potential to change the way we control the machines and therefore, how we control our world! Leap Motion is a sensor that is currently used to navigate through a personal computer with just hand gestures. We have used this technology to control a physical robot arm.

For the second part of this project, we used SolidWorks to design a six degree of freedom robot arm with five human-like fingers and printed it using Flash Forge Finder 3D Printer. The robot was designed to be controlled by Leap Motion, with human hand gestures as the input. It utilizes all of the sensor’s features, including the simultaneous control of all five fingers. The robot also has special sensors like Temperature and Humidity Sensor and Force Sensor to read the surrounding environment and also the force applied on the object. It sends these data to the user. During any dangerous situations, these sensors help the robot to prevent any damage. The robot could be used for virtually any application, including research or service in the medical or military fields.

Objectives:
- This prototype can provide a wide range of applications in the field of Industry where direct interaction of the human is difficult.
- It can be used as multi-functional manipulator to move materials, parts, tools, or special devices through variable programmed motions for the performance of a variety of tasks.
- This arm can assist a lot in search and rescue operations. In case of natural disasters, technology like this can come to a great aid.
- Other areas of interests include military, medical, IT etc.
- This project primarily focuses on pick and drop operations of various objects.
- In this project, we make use of Spatial Augmented Reality setups which is achieved by leap motion sensor, using shadows as the interaction input. And the readings of the leap sensor are processed by the system and is transmitted using a RF module. The signals are received by the Arduino with the help of the RF module which is placed far away from the transmitted site. These signals are further mapped to servo motors which are connected to the tip of the arm, which mimics the gestures captured by leap motion sensor.
• We design the structure by including the detailed surface features such as joint shapes and tendon insertion sites. The rubbers are used to mimic the soft tissues which support mechanical properties that match the skin.
• Parameters like Force, Humidity and Temperature are measured using respective sensors to control and provide data of the environment around the arm.

**Methodology:**
In this project, we have two major subparts - Controller and Robotic arm. The controller used here is a Leap Motion sensor used to control the robotic arm, which mainly provides tracking of human hand in spatial domain. The hand has five fingers similar to a typical human hand. If the actuator is same as the number of joints, and given many sensors, the robotic arm may be able to realize operations nearly like human being. Therefore, many robotic hands have many actuators, many sensors and a complex control system.

In our project, for each finger two strings are attached and connected to servo motors. One string provides the front backward movement while the other is responsible for every nodal movement. And between the bones and muscles, there are two groups of tendons in the human hand. The ones straightening the fingers are called extensor tendons; the ones bending the fingers are called flexor tendons. Similarly, the 3D printed has three patches of laser-cut rubber sheets that are used to mimic the elastic pulley mechanism. By this the precision of holding the objects increases and becomes application efficient. Also the circular motion of a servo motor is converted to a linear motion using strings which helps in movement of fingers. Elevation and row of arm is controlled by other servo motors.

These above components constitute a robotic arm and it is controlled by a microcontroller (Arduino) which gets the control signal via a RF receiver.

At the transmitter side, the human arm gestures (user arm gestures) are recognised by a sensor (Leap Sensor) and are fed to a computer, where the system performs API process on the gesture and outputs analog readings which are then sent to the arduino. In the arduino the analog values are processed to make it compatible to servo motors which provide the specific movements as per the user arm gesture captured. These values are then transmitted wirelessly to the arduino board at the receiver side making use of RF transmitter.

At the receiver side, the transmitted values are received by the RF receiver. The receiver sends the values to the Arduino which are processed and interfaced with the servo motor to output the expected gesture.
Conclusion:

A robotic arm which is similar to the human arm is built which is not limited to one set of tasks. This robotic arm can hold objects like knife, bottle, ball etc., thus reducing human efforts. The existing robotic arms are not very cost effective. We have designed a model which is much cheaper than other robotic arms available in the market. It can also be used in bomb defusal which reduces the risk of human life. The robotic arm makes use of temperature and humidity sensor to measure the temperature and humidity of the environment it is operating in. If it is exposed to any hot object, the system is aborted.
immediately. We are using a force sensor in each finger to measure the maximum force that can be applied to prevent the object from breakage or damage. Thus, the proposed system is interfaced with Leap Motion Controller which makes it advantageous for multiple applications. The system is incorporated with safety measures to prevent physical damage to the robotic arm. With the help of force sensor, the amount of force applied to object is also displayed.

**Future scope:**

The future scopes for the project that can make it give a better performance. We have three major subparts – Live Video Transmission to VR mount, Controller and Robotic arm. The controller used here is a Leap Motion sensor used to control the robotic arm, which mainly provides tracking of human hand in spatial domain. User will be wearing the VR mount which has display with Gyro sensor, the gyro readings are transmitted to Robotic arm side, where camera is mounted on the 2-axis servo to mimic the movement of the user head, so user operating the robotic arm will feel the Virtual field around him and which make him to operate the device very efficiently and conveniently. Live video transmission will be done using RF Module up to 2 km.