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DEVELOPMENT OF TELE-OPERATED ROBOTIC HAND OBSERVING MOVEMENT OF THE HUMAN HAND USING GYRO

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Abstract*- This project represent proceed towards the development of a bionic hand (shadow hand) that can follow the motion and position commutation of a human hand. Its first approach is to take reading from Gyro and then uses to change position of the robotic hand. Robotic tele-operation indicates the remote manipulation of a robot by a human operator at a distance. It has a wide range of applications in dangerous and hazardous environments, including space and deep sea exploration, firefighting, heavy object manipulation, simulation, surgery and training. Keyboards and Joysticks are traditionally used for robotic tele-operation, however they are inconvenient, as the user is required to carry a joystick of some form. Situations where a clear view of robotic action is required, keyboard control or joystick control can help a user but proper training is essential to control the devices. An alternative solution may be a wearable device that would have direct control of the robot is very beneficial and may speed up operations. The aim of this paper is to make a system that will establish diametrical control of the robot.*

Keywords: bionic hand, teleoperation, wearable device, Keyboards, Joysticks.

1. INTRODUCTION

The main intention of the project is to design and develop a Robot that can follow the movement of human hand and there will be no wired connection between the human hand and the robotic hand. In the present world, in almost all sectors, most of the work is done by robots or robotic arm having different number of degree of freedoms (DOF's) as per the requirement. These robots are mainly of two types. They are, autonomous and manual, for the autonomous one its motion is predefined or preprogramed. So the operator has no control over the robots movement. On the other hand in case of manual one the operator controls the movements of the robot. For the manual one normally the robot is operated from a distance. Controlling robots using wireless technology is one of the applications which have created interest in production lines to create more space and flexibility. The robots can move freely and work on difficult areas not accessible to human. For example NASA's mission to Mars the Spirit and Opportunity drone and robot device. However, it is realized that several factors impede the rapid progress towards full scale implementation of wireless technology, namely deterioration of signal quality due to propagation effects such as attenuation and dispersion apart from electromagnetic interference from natural and man-made sources. It is important to understand the impact of these factors to the reliability of the system. In recent year, with the increase usage of wireless application, the demand for a system that could easily connect devices for transfer of data over a long distance - without cables, grew stronger. This paper presents the development of a wireless mobile robotic arm. It can move forward, reverse for a specific distance according to the movement of one's hand. Bluetooth technology is used to pass the data from human hand to robotic hand. Presently a vast variety of robust robotic arms are available commercially, some of which are extremely reliable in precision and repeatability. This makes them an ideal tool for research focused on manipulation. However, there is a lack of an easily accessible comparative analysis that can assist researchers in choosing an arm that fits their research objectives. These arms are categorized into four classes: cheap educational arms, low price industrial arms, research oriented arms and modular light weight arms. Computer vision, speech recognition, motion and bionic interfaces, are just a few of the available control technologies that generate very interesting HMI applications [1] [2]. Mastura binti Muhammed in her paper adapted a remote operation system for a robotic arm by using personal computer using Visual Basic environment [3]. Main disadvantage of his work is that, it is confined only to the PC so it can't work like a human hand moves. Mossaab Hariz, Stéphane Renouard and Mounir Mokhtari present a same type in his paper [4]. Currently designers have motivated to combine sensors for a synergistic effect, for instance combining Accelerometer and EMG sensors [5].There are some voice based implementations available[6] but this approaches are impractical for the slow response times to control motion. A good approach to fuse together motion and muscle (EMG) sensors to enhance control came from James Cannan and Huosheng Hu [7]. Their main drawback is that, they have used wired technology to communicate bwtween their fusion band and the robotic hand. Jithin James and P. Ramesh describe a system [8] that represents a gesture control robotic hand. The main disadvantage of their work is it is required a training to control the robot. This paper is going to describe the development of a tele-operated robotic hand which is very simple to use and no training is required to control this hand.

2. MATERIALS AND METHOD

2.1 Background

Gyros and accelerometers are kind of motion devices, which measure rate of rotation and acceleration respectively. These are able to detect motion. The Gyro can measure the alignment of something with respect to ground. It gives values of angles in spherical Coordinate system with the help of gravitational effect on it. Thus by a gyro the position angle of the hand can be measured with respect to ground than this information is sent via I2C bus to the microcontroller.

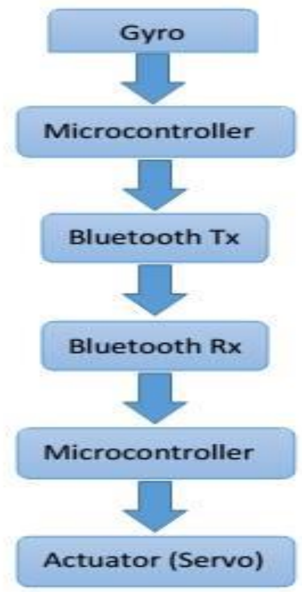

Fig.1: Block Diagram

Microcontroller sends this data to Bluetooth transmitter. Bluetooth Smart technology is a wireless communications system intended to replace the cables connecting many types of devices. Bluetooth technology operates in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485 GHz, using a spread spectrum, frequency hopping, full-duplex signal at a nominal rate of 1600 hops/sec. The 2.4 GHz ISM band is available and unlicensed in most countries [9]. The Bluetooth Receiver receives the data and sends it to microcontroller. Microcontroller controls servo a kind of motor. Servo can be controlled by PWM. The PWM defines the angle. The servo is supposed to create that angle with its reference axis. So, ultimately the angle of servo follows the angle of operator's hand. This whole phenomenon has been shown in Fig.1 through a simple block diagram.

2.2 Design

The project consists of a microcontroller based development board Arduino uno, a 3 axis Gyro meter, Bluetooth module HC 05, servo motor. The MPU-6050 is an integrated 6-axis Motion Tracking device that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor (DMP) all in a small. With its dedicated I2C sensor bus, it directly accepts inputs from an external 3-axis compass to provide a complete 9-axis Motion Fusion output. Fig 2 shows the break out board of the MPU-6050 Motion Tracking device.

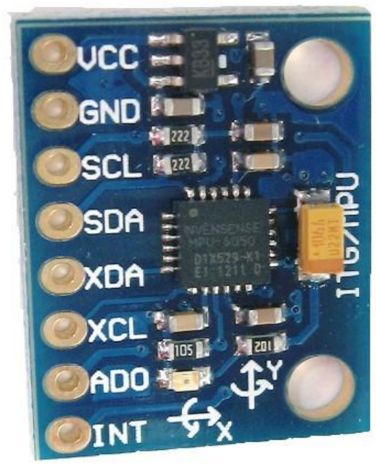

Fig.2: MPU-6050 Breakout Board.

The Arduino Uno is a development board based on a microcontroller of Atmel series, ATmega328. It has a 16 MHz Crystal Oscillator. The HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation

Fig.3: HC-05 Bluetooth Module.

with complete 2.4GHz radio transceiver and baseband. Fig 3 shows the Bluetooth Module HC – 05. The armband is made of elastic, allowing the device to securely attach to the user. The gyro communicates over an I2C link to a microcontroller. A gyro outputs the rate of rotation in degrees, which is linear, and hence does not require significant processing. The achieved data is transmitted to the sending end Bluetooth module through serial communication. The sending end Bluetooth module transmits the data through wireless medium with a 2.4GHz carrier frequency. The receiving end Bluetooth module receives the data and sends it to the receiver MCU. The receiver MCU sends this data as feedback to the sender MCU in the same way so that the sender MCU can compare it with original data and generate a confirmation bit while the data are matched. This process of feedback from receiver to sender will reduce the communication error and effect of noise and garbage value. After receiving the confirmation bit, the receiver generates the PWM signal for the servo motor to move the robotic arm to the angle. The use of an Arduino board simplifies and speeds up the design process, allowing for faster development times. Although limited in its code efficiency, it provides an excellent prototyping structure. The variety of sizes and speeds allows a tailer made design. Fig 4 shows the circuit diagram of the whole system where the sender circuit is in the left side and the receiver is in the right side.

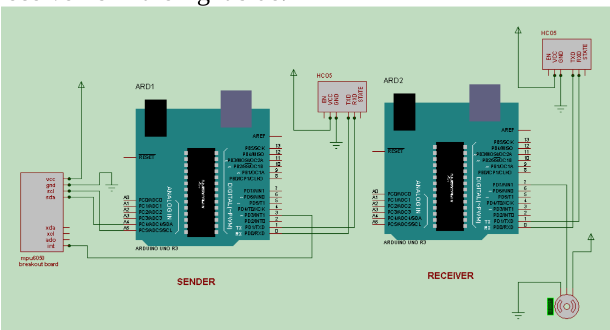

Fig.4: Circuit Diagram

3. RESULTS AND DISCUSSION

Two dimensional movement of human hand has been tracked. So two dimensional movement of a robotic hand

Fig.5: One dimensional movement of bionic hand

is done by moving a servo motor. Fig.5 shows the two dimensional movement of a human hand is followed by a robotic bionic hand. The degree of freedom of the hand can be increased by applying more complex algorithms and more power full processor and sensor. If magnetometer sensor can be added in the I2C buss then the rate of precision can be increased.

4. CONCLUSION

The contributions of this paper include confirming the feasibility of designing a gyro motion controller to create a sensor fusion armband for both disabled and non-disabled users. Controlling robots using wireless technology is one of the applications which have created interest in production lines to create more space and flexibility. The robots can move freely and work on difficult areas not accessible to human and this paper demonstrate a robotic hand that can just work with the movement of one’s hand. Future work involves increasing the accuracy using more gyro, accelerometer and magnetometer, increasing degree of freedom, using flex sensor the movement of finger can be accrued. The range can be increased using Xbee.

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