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Robotic Arm for Mimicking of Human Motion

Abstract: - The advancement in technology and the research in the field of robotics, has led the development of robots with high precisions and stability. These advanced robots with high precision are been used in industries as well as households to ease the work of humans. The robots are made interactive as well as assistive to help people with disabilities. The gesture controlled robots assist people by performing tasks in extreme environments that are hazardous for humans. In our project we are going to design and develop an assistive robotic arm, which would perform the human skill of writing, by mimicking the human arm motion. This gesture controlled robot will help people with disability in writing due to crippled limb or post accidental surgery, making them not to be dependent on others. The robotic arm will be of 6-DOF (Degrees of Freedom) the arm should constructed with motor at the joint able do a bend action as same as the human hand. It can do difficult movements, such as seven different ways to move, making it useful for a multitasking and can also perform the day to day activities

Keywords: Terms Miniature robotic arm, Servo motors, IMU sensor, raspberry pi

I. INTRODUCTION

The robots are more intelligent device that is employed to perform the task that are monotonous or that are unsafe for human intervention. They are classified into certain categories based on the nature of their controlling such as fully automatic, semi-automatic and manually controlled. They are built upon hardware which that is interfaced with software that provides the significant intelligence to direct its mechanical movements for the accomplishment of a task automating robots is a perplexing task, yet it became easier over the years. A robotic arm is a programmable mechanical arm which can execute the functions of a human arm. The terminus of the robotic arm is called the 'end-effector'. The end effector can perform various tasks such as pick and place, welding, drilling, painting, watering etc. Robots can be operated remotely which helps the end user in manipulating the remote objects using the robotic arms, mainly in hostile environments. A robotic arm is a mechanical device which is interfaced through electronics to carry out precise operations It is designed to execute to undertake many industrial and medical operations

II. EXISTING SYSTEM

The system that uses an IMU (Inertial Measurement Unit) sensor, Raspberry Pi, and a robotic arm to mimic human gestures [2]. Start: The process begins when the user initiates a gesture with their arm [7]. Gesture: The human motion or gesture is performed, which will be tracked by the system [3]. IMU Sensor: The IMU sensor (typically the MPU6050) captures data on the orientation and motion of the arm [1]. It provides data related to acceleration and angular velocity, which will be used to determine the arm's movements [6]. I2C Communication: The IMU sensor transmits its data to the Raspberry Pi through I2C (Inter-Integrated Circuit) communication [5]. This protocol enables efficient data transfer between the sensor and the processing unit (Raspberry Pi) [4]. Raspberry Pi: The Raspberry Pi acts as the central processor, receiving the raw data from the IMU sensor for further processing and analysis [8]. Calibration of IMU Sensor: Initially, the IMU sensor is calibrated to ensure accurate measurements [9]. Calibration removes any offsets and inaccuracies in the sensor data [10]. Filtering of Raw IMU

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Sensor Data: Raw data from the IMU sensor often includes noise and fluctuations [11]. Filtering techniques are applied to smooth out the data, improving accuracy for subsequent calculations [12].

III. BLOCK DIAGRAM

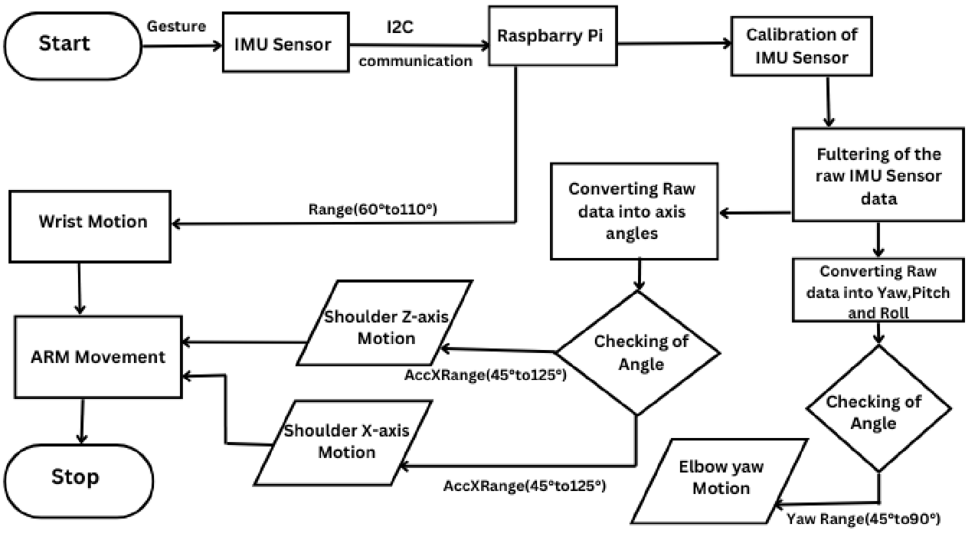


Figure 1. Block diagram of robotic arm

3.1 Raspberry Pi

The Raspberry Pi is an affordable, versatile single- board computer that plays a vital part in robotics and IoT systems, furnishing both the processing power and strictness demanded to handle complex tasks in compact, low-cost systems. Equipped with a multi-core ARM processor the Raspberry Pi, especially in its rearmost performances like the boo Pi 4, can efficiently manage data processing, execute complex algorithms, and handle multitasking, making it ideal for sophisticated operations in robotics, analogous as real- time control, machine knowledge, and computer vision.

Figure 2. Raspberry Pi

3.2 Power Supply

It Provides electrical power to the Raspberry Pi / PCA9685to ensure it functions.

3.3 Driver

The PCA9685 Servo Motor motorist is a protean 16- channel PWM regulator frequently used in robotics to manage multiple servo motors contemporaneously, enabling precise and accompanied control of factors like robotic arms, drones, and independent vehicles.

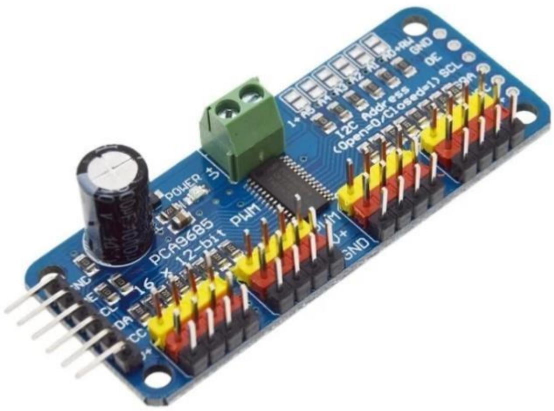


Figure 3. Servo driver PCA9685

3.4 MPU6050 SENSOR

The MPU6050 Sensor is a largely protean, six- axis stir- tracking detector that integrates a 3- axis accelerometer and a 3- axis gyroscope into a single compact module. It's extensively used in robotics, drones, wearable technology, and other operations that bear precise stir seeing. The detector's primary function is to capture and measure both direct acceleration and angular haste across three axes(X, Y, and Z), enabling real- time shadowing of movement, exposure, and position.

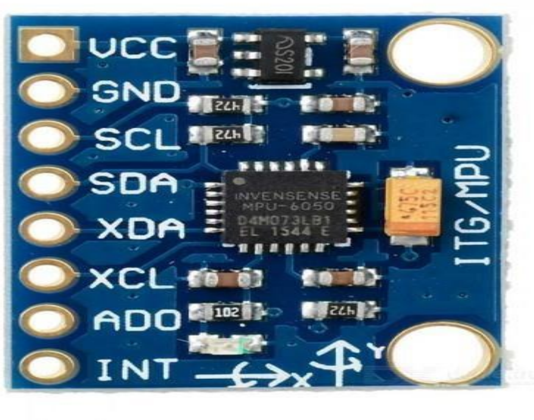


Figure 4. MPU6050 Sensor

3.5 Servo Motor

The MG995 servo motor is a high- necklace, standard- sized servo extensively used in robotics and robotization systems, especially for operations that bear precise control of movement. The MG90S is a small, featherlight servo motor that's generally used in colourful robotics and robotization systems, including robotic arms, drones, and other perfection control systems.

Figure 5. Servo MG995

IV. FUNCTIONALITY OVERVIEW

The raspberry Pi processes data from the MPU6050 to capture exposure and movement of the arm. The servo motors control the arm's joints, while servo motorists regulate motor power and stir. The Raspberry Pi uses data from the MPU6050 to acclimate the servo positions in real- time, mimicking mortal- such like arm movements with precise control.

. V. WORKING METHODOLOGY

5.1 Mechanism

The assistive device developed is controlled making use of the Gesture control methodology. There are different techniques to implement gesture control like the use of kinetic sensors, the use of neuron sensors, using haptic devices and using the IMU Sensors. In this we are making use of Inertial measuring unit sensors for the Gesture control process.

5.2 Mimicking for action

The IMU sensor (typically the MPU6050) captures data on the orientation and motion of the arm. The Raspberry Pi acts as the central processor, receiving the raw data from the IMU sensor for further processing and analysis. Calibration removes any offsets and inaccuracies in the sensor data. Filtering of Raw IMU Sensor Data: Raw data from the IMU sensor often includes noise and fluctuations. Filtering techniques are applied to smooth out the data, improving accuracy for subsequent calculations. The raw data is also converted into specific axis angles for more precise control over the movement of each part of the robotic arm. Checking of Angle: The system checks if the calculated angles fall within specific pre-defined ranges. This ensures that each movement is within the safe or intended limits of the robotic arm. This range specifies the motion limits for the wrist to ensure accurate and safe movement. Movement Assignments Shoulder X-axis Motion: Controls the shoulder's movement along the X-axis within the specified angle range. After processing the angles and assigning the appropriate motions, the robotic arm performs the combined movements to mimic the original human gesture.

VI. WORKING MODEL

This proposed system works with combination of two IMU 6050 sensors which start with default values of X1,Y1,X2 and Y2[X1=-5.245, X2= -2.43,Y1= 1.11,Y2=4.012] are the axis of sensor .The first IMU6050 sensor is used to create or copy the action with depend on the axis are X1 and Y1 this sensor controlling the shoulder action or movement this action can perform with the help of an two servo MG995 motors(M1&M2). The Second IMU6050 sensor is used to create or copy the action with depend on the axis are X2 and Y2 this sensor controlling the elbow action or movement this action can perform with the help of a two servo MG995 motors(M3&M4). The various action of robotic arm is mention in the below figures.

Figure 6. Software Output

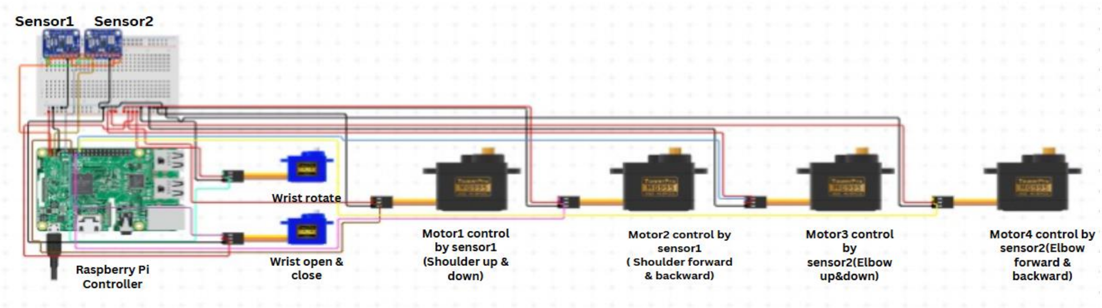


Figure 7. Circuit Diagram

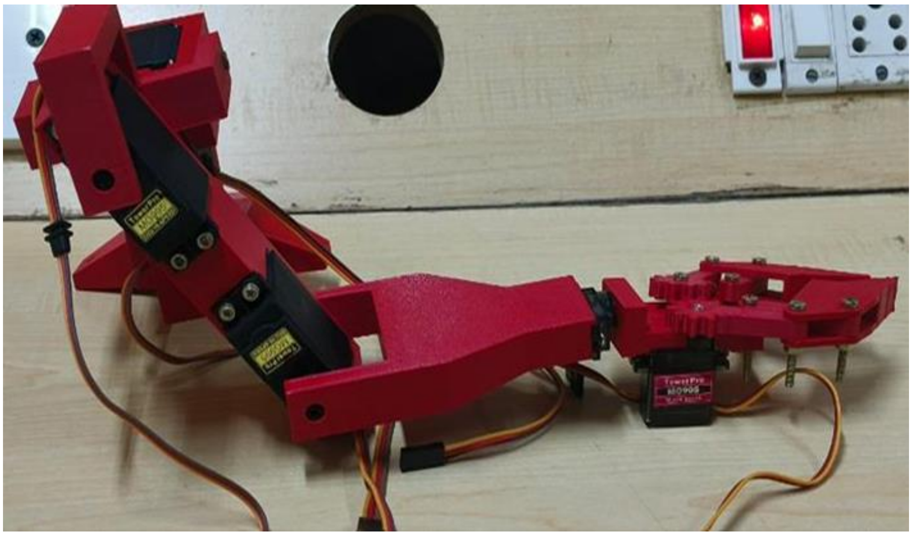


Figure 8. Arm design

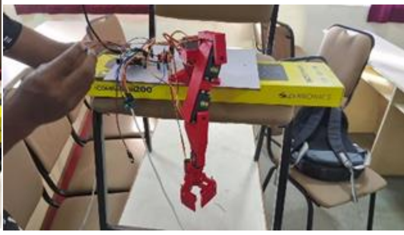
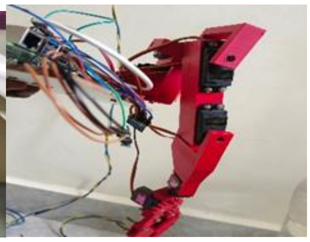
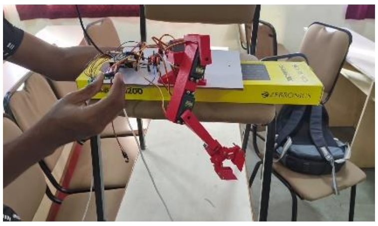
  

Figure A. Elbow forward **Figure B.** Elbow backward **Figure C.** Shoulder forward

X1=-4.8,Y1=1.0 X1=-7.1,Y1=1.2 X1=-7.15,Y1=2.9



X2=-2,7,Y2=4.2
X2=-2.8,Y2=4.0
X2=-2.5,Y2=4.1

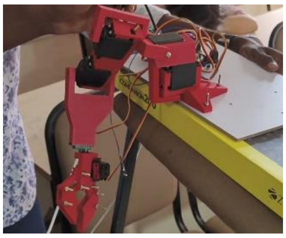


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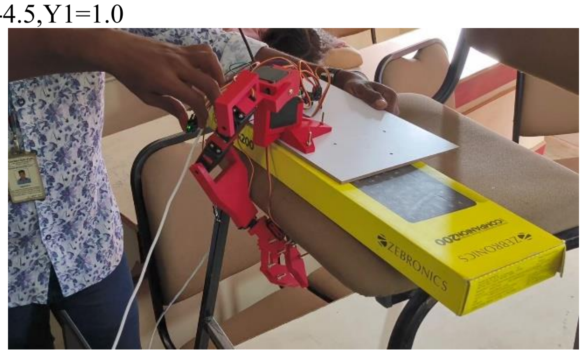
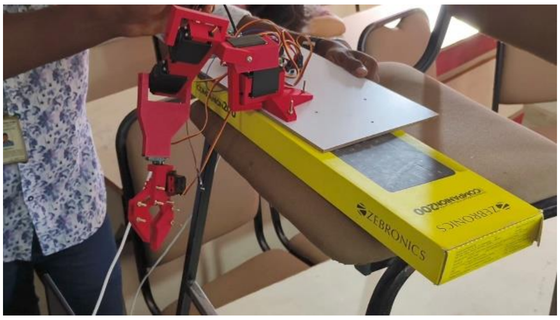
Figure D. Shoulder backward **Figure E.** Shoulder upward **Figure F.** Shoulder downward

X1=-7.239,Y1=-2.3 X1=-4.8,Y1=1.2 X1=-4.5,Y1=1.0



X2=-



2.1,Y2=4.4 X2=-3.9,Y2=2.8 X2=1,Y2=5.5

Figure G. Shoulder Full forward **Figure H.** Shoulder Full backward

X1=-7.2,Y1=-2.4 X1=-7.0,Y1=-2.4

X2=-2.3,Y2=5.9 X2=-2.0,Y2=2.8

VII. FUTURE ENCHANCEMENT

There are few futuristic advancements possible on the developed model to increase the precision and by providing different gesture control in combination with IMU sensor. Item To improve the precision of the degrees of Freedom of the design can be increased

VIII. CONCLUSION

The development of a robotic arm able of mimicking mortal stir, using a Raspberry Pi, MPU6050 detector, and MG995 servo motors, has demonstrated both specialized feasibility and effectiveness in rephrasing mortal movement into robotic action. This design exemplifies how low- cost, accessible factors can be combined to produce a responsive robotic system able of emulating complex mortal movements. The MPU6050 detector played a critical part by landing real- time data on mortal arm movements. When placed on the mortal arm, the detector measured stir across multiple axes, landing gyration, exposure, and acceleration data. This data was reused by the Raspberry Pi the central processing mecca of the system, which restated the raw stir data into control signals. These signals were also transferred to the MG995 servo motors enabling the robotic arm to mimic mortal movements directly.

ACKNOWLEDGMENT

we are working on improving arm technology. The efforts to make the arm mimicking human motion have made more accurate to do the work by combining advanced technology with real time by allowing the machine to move naturally along to process .The arm which reducing the errors. These robotic arms also used to the automation of repetitive tasks, increasing productivity and safety in industry.

REFERENCES

[1] Lu, Yuepin and Liu, Li and Chen, Shuxin and Huang, Qiang, "Voice based control for humanoid teleoperation," *IEEE,* vol. 2, pp. 814-818, 2010.

[2] House, Brandi and Malkin, Jonathan and Bilmes, Jeff, "The VoiceBot: a voice controlled robot arm," in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2009, pp. 183192,2009.

[3] Song, Gang and Guo, Shuxiang "A novel self-assisted rehabilitation system for the upper limbs based on virtual reality," *International Journal of Information Acquisition,* vol. 3, pp. 247--258, 2006.

[4] He, Xuejian and Chen, Yonghua., "Haptic-aided robot path planning based on virtual tele-operation," *Robotics and computer-integrated manufacturing, vol. 25, pp. 798 -- 803, 2009 .*

[5] Khajone, Saurabh A and Mohod, SW and Harne, VM., "Implementation of a wireless gesture controlled robotic arm," *International Journal of Innovative Research in Computer and Communication Engineering,* vol. 3, pp. 377-379, 2015 .

[6] Fang, Bin and Sun, Fuchun and Liu, Huaping and Guo, Di., "A novel data glove using inertial and magnetic sensors for motion capture and robotic arm-hand teleoperation," *Industrial Robot: An International Journal,* 2017K. Elissa, “Title of paper if known,” unpublished.

[7] Bhuyan, Ariful Islam and Mallick, Tuton Chandra ,"Gyro accelerometer based control of a robotic arm using AVR microcontroller," *9th International Forum on Strategic Technology (IFOST),* no. IEEE, pp. 409-413, 2014.

[8] Kumar, K Ashok and Thamizharasi, K., " A Multi-sensor armband based on muscle and motion” Gesture controlled robot using MEMS accelerometer for eradication of weeds," *Indian Journal of Science and Technology,* vol. 8, p. 460, 2015M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

[9] Cannan, James and Hu, Huosheng, “A Multi-sensor armband based on muscle and motion *2012” IEEE International Conference on Robotics and Biomimetics (ROBIO),* pp. 1098 - 1103, 2012 .

[10] McCarron, Brandon, " Low-cost imu implementation via sensor fusion algorithms in the arduino environment," 2013. / Madgwick, Sebastian, "An efficient orientation filter for inertial and inertial

[11] Magnetic sensor arrays," *Report x-io and University of Bristol (UK),* vol. 25, pp. 113-118, 2010 .

[12] Zhou, Lelai and Bai, Shaoping and Hansen, Michael Rygaard. "Design optimization on the drive train of a light-weight robotic arm," *Mechatronics,* vol. 21, pp. 560-569, 2011.