Winter Research-Internship Project Report

Gestured Controlled Four Degrees of Freedom Robotic Arm

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Certificate

This is to certify that the dissertation titled "***Gesture Controlled Four Degrees of Freedom Robotic Arm***" submitted by ***Mr. Sarthak J Shetty [1RV15ME095]*** in partial fulfillment of the requirements for the award of degree of ***Bachelor of Engineering*** in ***Mechanical Engineering*** of **R.V College of Engineering, Bangalore,** is a bonafide of the work carried out by him under my guidance and supervision during the stipulated internship period.

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1.0 Introduction to Robotic Arms

1.1 What are Robotic Arms?

1. A robotic arm is a programmable, mechanical arm, synonymous to the human arm in both functioning and design.

2. They are classified primarily on the basis of Degrees of Freedom or DOF for short, depending on the number of axis for rotation that is available for the control of the robot in different directions.

3. Robotic arms are usually equipped with end effectors, such as :

- Mechanical grippers

- Tools: Welding Torch, Paint Guns, Measurement Probes.

1.2 Working of Robotic Arms

- Robotic arms usually comprise of joints, which are functionally similar to the shoulder and elbow joints in human beings.

- Similar to the human hand, robots are equipped with functional end effectors as mentioned before. These effectors can be in the form of grippers or tools.

- The movement of the arm is controlled by servo motors, whose rotation dictates the movement of the arm.

1.3 Applications of Robotic Arms:

- Industrial Robots find applications in automating manufacturing lines, by employing them to carry out a series of tasks ranging from assembly to different machining processes in quick session.

- Using industrial robots in production lines, massively increases the productivity of the shop floor and drastically reduces the time required to manufacture batches of products.

- It reduces the hazards involved with different manufacturing processes as it is a substitute for human workers.

- The efficiency of the manufacturing process stands, improved and the degree of optimization also increases drastically.

2.0 Gesture Controlled Robotics

2.1 What are Gesture Controlled Robots?

- Gesture controlled robots rely on human gestures to control the different components of a mobile or immobile robot.

- Gestures are often integrated into the control of the robot as they are intuitive to us human beings.

- Gesture based Controls also form a great method for interfacing with robots as the robot or system can be controlled even by an inexperienced user.
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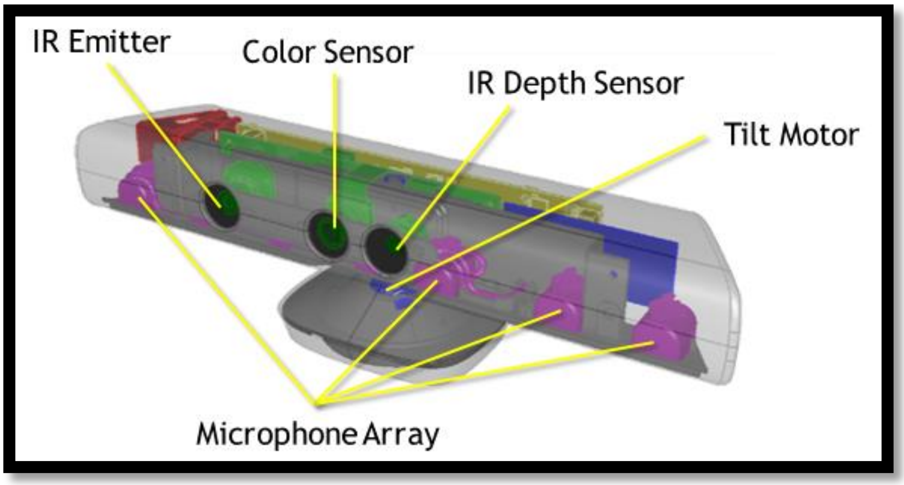
2.2 Advantages of Gesture Controlled Robots:

1. As mentioned earlier, the primary advantage of such robots is that even inexperienced users can operate and command the robot to perform tasks, with no requirement of explicit programming languages or technical know-how.

2. Gestures are intuitive and hence the control of these complex machines is made significantly easier.

3. A wide array of commercially available sensors can be integrated with existing control systems for the detection of human gestures.

3.0 Microsoft Kinect Sensor for Xbox 360



(Fig. 3.0 Kinect Sensor)

- The Kinect sensor is a multi-purpose device comprising of a wide array of sensors, which perform different tasks as per the requirement.

- The Kinect comprises of:

    1. Microphone Array
    2. Colour Sensor
    3. IR Depth Sensor
    4. IR Emitter
    5. Tilt Motor

- The Microphone Array has the ability to capture sounds from an angle of nearly 135 degrees.

- The colour Sensor perceives different colours detected, and returns an appropriate RGB value to the program requesting for the data.

- IR Depth Sensor provides the Kinect with the ability to perceive the depth of different objects and hence return the distance of the object from the sensor.

- IR Emitter is used to beam a large number of IR Rays towards the scene presented, which is subsequently returned to the IR Depth sensor to gauge the distance of the object from the sensor.

- Tilt Motor adjusts the inclination of the sensor with respect to its base.

4.0 Implementation of Gesture Controlled Robotic Arm:

- The robotic arm being developed for this project incorporates the use of a Kinect V1 Sensor to detect the human gestures, relay the angles obtained from the skeletal data to an Arduino developmental board, which will in turn rotate the motors of the arm to produce the necessary movements.

- The angles between the joints are detected using the array of sensors on board the Kinect. The angles are determined from the video being captured through a skeletal data library called OpenNI, which stands for “Open Natural Interaction”.

- These angles are then fed to the Servo motors which power the different joints of the robotic arm, which then mimic the movements of the user.

- There are four degrees of freedom, as follows:

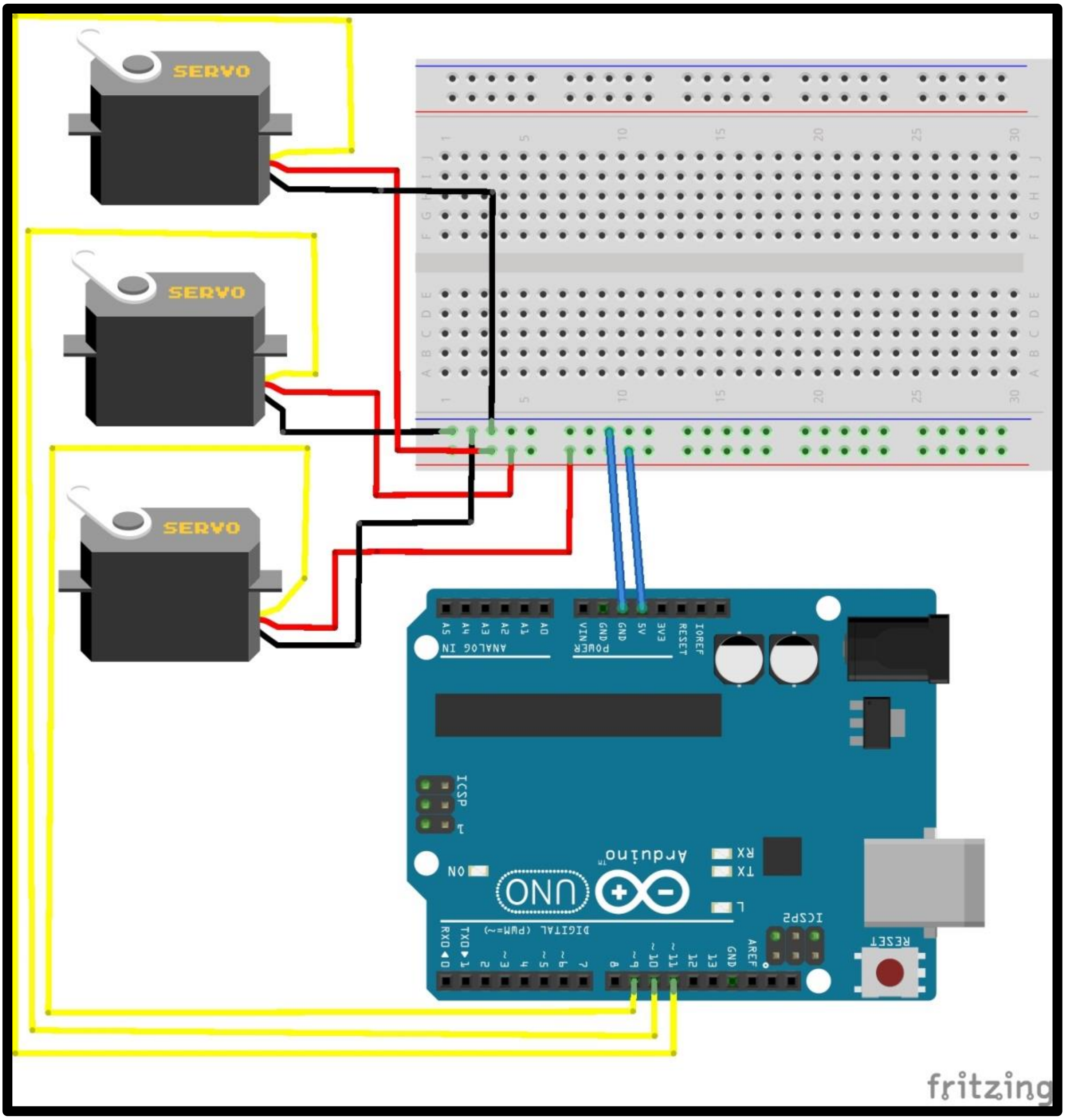
    1. The right arm shoulder movement controls the shoulder joint movement of the robotic arm.

    2. The right arm elbow movement controls the elbow joint movement of the robotic arm.

    3. The left arm shoulder movement controls the basal movement.

    4. The left arm elbow movement controls the gripper movement.

4.0 Wiring Diagram:



(Fig. 4.0 Fritzing-Circuit diagram of Arduino Setup)

6.0 Setup of Robotic Arm:

1. Clone the Github repository using the following command:

   git clone https://github.com/SarthakJShetty/Arm

2. Note that a combination of Arduino and Processing code is present in the downloaded package.

3. Once the electronic components are wired up as shown, the Arduino sketch is uploaded to the board.

4. Once the sketch has been uploaded, the Processing code is run, which will open a new window with a display of the camera input (from the Kinect)

5. The code is provided with a latency of about 10 seconds to detect the skeletal features of the user standing in front of the Sensor, after which a stick-figure based skeleton is overlaid on the user, for the purposes of representation.

6. The top left corner of the display consists of data related to the different angles between the joints. This data is relayed to the Arduino through the mentioned COM port and is then translated to the actuators (servo motors), which in turn produce the necessary movements.

7. We can observe that the robotic arm mimics the movements produced by the human operator, which was the goal of the project.

7.0 Scope for Further Development:

- The robotic arm requires an intermediate system, in this case the computer to run image processing and computer vision algorithms. The primary goal of successive projects based on this project is to develop algorithms which can be run on computationally lightweight systems.

- The degrees of freedom can be increased in order to improve articulation of the robot, and hence improve dexterity of the robot.

8.0 Additional Resources:

Additional resources (circuit diagram, layout, build log, commits), can be obtained in the Github Repository for this project, here.