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Haptics Based Gesture Controlled Robot

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Abstract

The aim of this project is to build a robotic arm that can be controlled by using MEMS based accelerometer. The accelerometer will be mounted on a hand glove, such that if the hand glove moves or leans in some direction then the robot moves in that direction. The project is based on and adapted from the research topic "APPLICATION OF MEMS ACCELEROMETER IN THE FIELD OF ROBOTIC SURGERY AND NUCLEAR MATERIAL HANDLING". Robotic arm is designed to pick and place a work part. The project is mainly intended to improve the accuracy and precision such that the same could be implemented in testing and monitoring hazardous materials like nuclear fuels and wastes.

1. Introduction

A robotic arm has similar functions to a human arm. In order for a robot or a robotic arm to pick up or move something, someone has to tell it to perform several actions in a particular order — from moving the arm, to rotating the "wrist" to opening and closing the "hand" or "fingers." .So, we can control each joint through computer interface.

We use accelerometer which is interfaced with controller (Arduino) to control the servo and DC motors. Based on the movement of accelerometer, the servo motors sense the tilt and rotate in the corresponding direction. As we mount these motors to mechanical links, it results in the link to move to the corresponding direction to which accelerometer is moved.

Now we mount a gripper at the top of the link so as to pick any object from a particular place and drop it in another place. Also we use DC motor for the 360 degrees of base rotation. Hence the robot can pick the object from any direction and place it in any direction.

The gripping mechanism is actuated by push button which is interfaced with the servo motor connected to the gripper.

The whole setup is facilitated by 1 DC motor for base actuation, 5 servo motors which includes 4 servos for the actuation of links and 1 servo for gripper actuation. The gripper is actuated by push button interfaced with the servo motor.

2. Various Segments:-

The various segments here contain the *hardware* parts and the *program* involved.

3. Hardware part:

The hardware used in this project are as follows:

1. Microcontroller [Arduino Uno]
2. Accelerometer [ADXL 335]
3. Servo Motors [3 kg f, 7 kg f, 10 kg f]
4. DC Motor
5. Pressure Sensor
6. Motor driver circuit & IC
7. Robot arm gripper

4. Programming Part:

The main programming involves the programming of Microcontroller and is done with the help of Arduino 1.0 software.

5. Theory of Operation

The ADXL335 (Accelerometer) is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 *g* minimum. It contains a poly silicon surface micro machined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

The sensor is a polysilicon surface micro machined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration.

Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration.

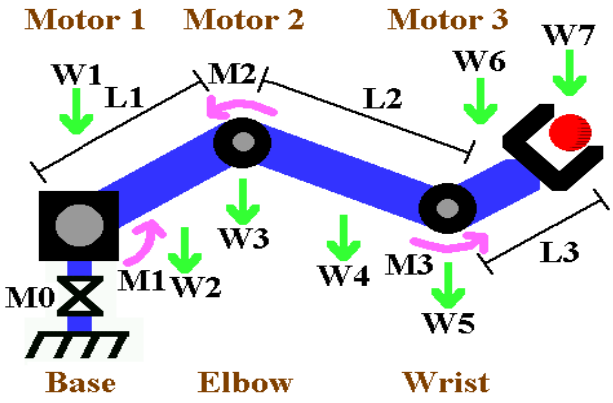
The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal band-width of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

6. Mechanical Sensor

The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes sense directions are highly orthogonal with little cross axis sensitivity. Mechanical mis-alignment of the sensor die to the package is the chief source of cross axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level.

7. Observations and Calculations

Torque calculations are done based on the info given in



(http://www.societyofrobots.com/robot_arm_calculator.shtml)

Arm Lengths

Select inches or meters	
L1	
L2	
L3	

Arm Weight

Select pounds or kilograms			
W2		W4	
W6		W7 (object weight)	

Motor Weight

Select pounds or kilograms	
Base Motor M1	
Joint Motor M2	

Motor Efficiencies

M1		%	M2		%	M3		%

Torque Results

Select Units	
Motor 0 Torque M0	
Motor 1 Torque M1	
Motor 2 Torque M2	
Motor 3 Torque M3	

Base Servo motors used- 10kgf.cm=0.981 Nm
7kgf.cm=0.6867Nm
torque=1.36Nm

Total torque=1.6677Nm
Total torque<theoretical

Link Servo motors used- 10kgf.cm=0.981 Nm
3kgf.cm=0.2943Nm
torque=0.295Nm

Total torque=1.2753Nm
Total torque<theoretical

8. Conclusion

Thus the project was completed successfully. The project is aimed to serve the purpose of handling materials in areas where manual handling can be avoided such as the ones in atomic power plants where handling the materials with human efforts will be at risk due to radiation. In this area, we can go for this kind of robotic arm actuators which serves the purpose of handling the materials operated by human from elsewhere.

9. Future Enhancement

- Robotic arm could be controlled via a communication protocol like zigbee or Bluetooth enabling it to be used in industries.
- Machine vision could be incorporated to improve precision and accuracy.
- Number of degrees of freedom could be increased for improving accuracy.
- The application of MEMS accelerometer in the field of robotic surgery is numerous.
- Similar kind of robot is used for nuclear material handling.

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