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MOTION CONTROLLED ROBOTIC ARM

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ABSTRACT

Nowadays technology has decreased working hours and have made complicated operations more effortless. Robotics is a field that has thrown up some wonderful machines. Typical industrial robots do jobs that are difficult, dangerous or dull. They lift heavy objects, paint, handle chemicals, and perform assembly work. They perform the same job hour after hour, day after day with precision. They don't get tired and they don't make errors associated with fatigue and so are ideally suited to performing repetitive tasks. One of them is the 'scara' type of a robotic arm. This project aims to implement this robotic arm by interfacing it with motion sensors which makes the user interface comfortable. Though the use of a robotic arm is very simplified, the implementation of this arm requires a good knowledge of Engineering Mechanics, Electronics Devices and Embedded Systems as well.

KEYWORDS: Accelerometer, Servo Motor, Atmega-32 Microcontroller

INTRODUCTION

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effector and it is analogous to the human hand.

The end effector, or robotic hand, can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. For example robot arms in automotive assembly lines perform a variety of tasks such as welding and parts rotation and placement during assembly. In some circumstances, close emulation of the human hand is desired, as in robots designed to conduct bomb disarmament and disposal. A typical robotic arm is made up of three metal segments, joined by three joints. The computer controls the robot by rotating individual Servo Motors connected to each joint. Unlike ordinary motors, Servo motors move in exact increments. This allows the computer to move the arm very precisely, repeating exactly the same movement over and over again. The robot uses motion sensors to make sure it moves just the right amount.

SYSTEM ARCHITECTURE

The circuit works on the principle of servo motors. When an object to be picked is in front of the robotic arm, the accelerometer sensor movements are synchronized with the rotation of the servos and the function is performed accordingly. When the accelerometer module-1 is moved downward, the arm-1 connected to the base moves down. When the accelerometer module-2 is moved downward, the arm-2 connected to arm-1 moves down. Vice-versa is also possible. When the arm-2 reaches the object, potentiometer is used to control the picker movements and the object is picked up.

In the robotic arm, three servos of torques 15kg, 6kg and 2kg are used. 15kg torque servo is connected to the base and has the largest amount of weight falling on it. It is a metal servo. 6kg torque servo is connected at the centre. It controls the movement of arm-2. 2 kg servo is connected to the picker and controls its movement. The servo torque ratings are calculated by using Mechanics-Statics. Moment about a point gives the maximum allowable torque for the body to remain stable. The power to the servos is given using a voltage regulator module consisting of IC 7805. The accelerometer module is controlled using ATMEGA-32. Multi-strand and single-strand wires are used on a general purpose board. The robotic arm is mounted on a wooden base using a clamp. A 15kg servo is metal gear high quality servo while 6kg and 2kg servos are plastic gear servos.

FLOW OF THE SYSTEM

Two power supplies are used to give power to the Servos and the Accelerometer modules. These supply values are provided on the Arduino Development Board. If one feels that an external supply should be used it can be done by connecting the ground terminals of the Arduino and the external supply and an external supply can be used. As it can be seen from the block diagram a supply of 5 V is required for the Servo Motors and a 3 V Supply is required for the Accelerometer Modules. The Potentiometer is also given a max voltage of 5 V.

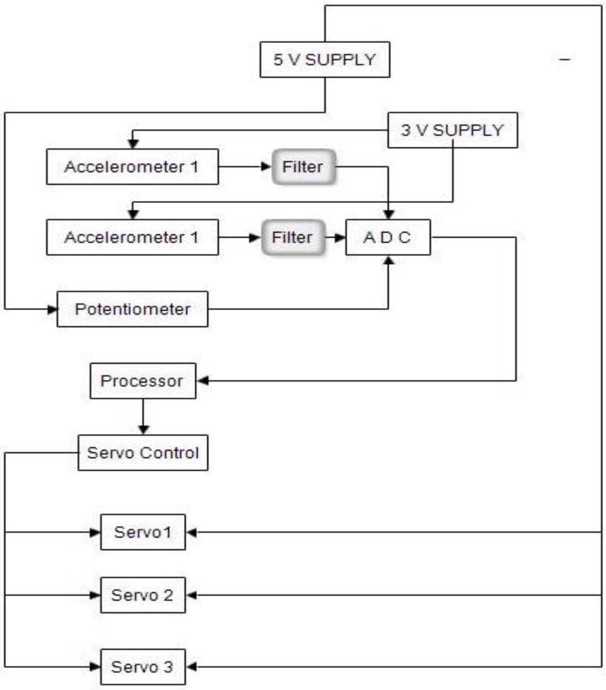

Figure 1: Block Diagram of the System

The Output of the both the accelerometers is given to the Analog Input Pin of the Arduino Board which is further given to ADC embedded on the Arduino board. The Potentiometer jockey or the variable voltage pin is given to the Input Pin on the Arduino Board. The Atmega 328 IC is the processor of the Arduino Board. The ADC gives the output to the processing section. This output is digital. According to the value of this digital output the Servo Controller varies the Servo Angle as per the instructions given to it by the processing unit. The servo controls all the three servo motors simultaneously. Sometimes the accelerometer can generate certain errors due to external noise signal which can be filtered off by using a filter circuit at the output of the Accelerometers.

FLOWCHART

The flowchart indicates the flow of control and how the control transfers to different servos according to the input of the different sensors. It describes the movement of the robotic arm when accelerometer is displaced or tilted. The change in angle will be sensed and servo motor will move the servo motor i.e. joint by its equivalent degree.

There are three servo motors used – two of which are controlled by accelerometer and one is controlled by the potentiometer. When the knob of pot is rotated, the resistance changes, resulting in rotation of servo motor controlling the movement of the gripper.

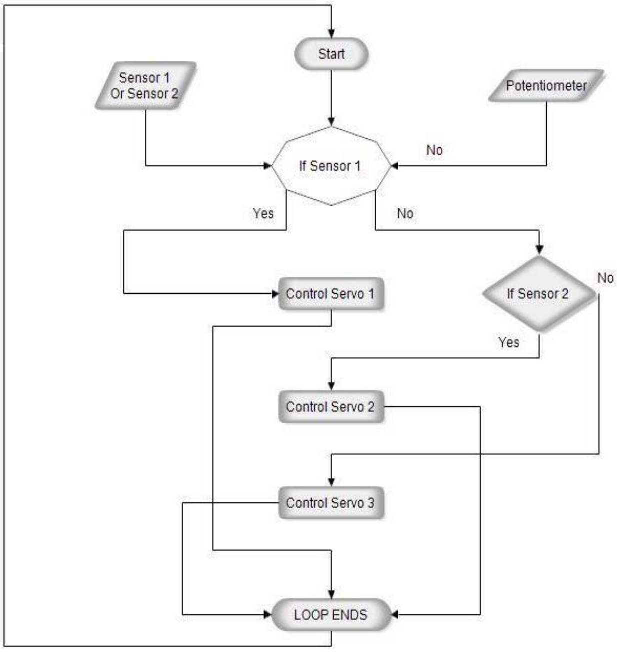

Figure 2: Flowchart of the System

RESULTS

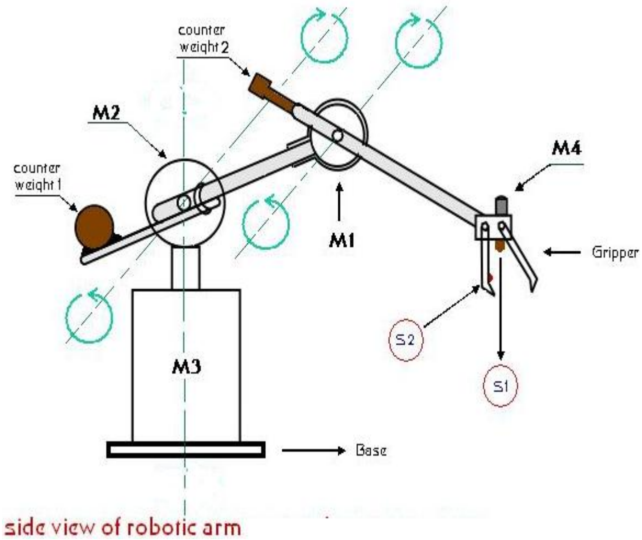

Figure 3: Free Body Diagram of the Robotic Arm

Before implementing it practically the robotic arm was analysed by using Statics. As mentioned in the beginning it requires some knowledge of Engineering Mechanics as well. Before constructing the Arm, the maximum torques or forces on each of the Servos is calculated. The free body diagram is made to analyze all the forces acting on different servo joints. After analyzing the Free Body diagram of the Robotic arm, the servos of the required specifications are used accordingly. There are many Servo manufacturers providing the standard specifications out of which we can select the one satisfying our requirement. The hardware of the arm was made by using PVC Plastic for making the arm lightweight. The Gripper was constructed using PVC plates of desirable shapes or else there are manufacturers which provide a readymade Gripper.

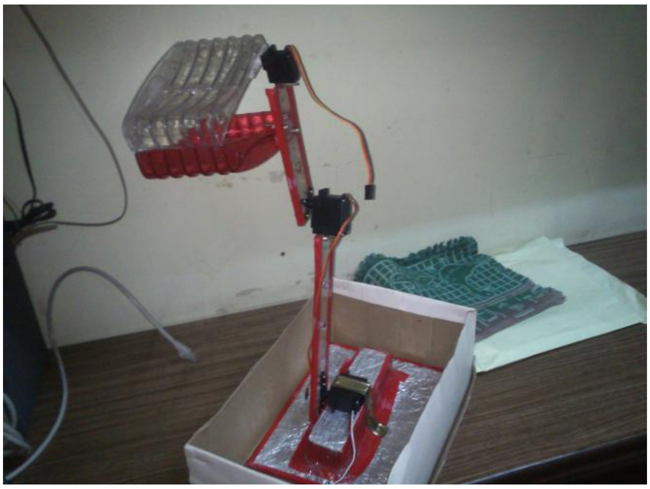

Figure 4: Image of Robotic Arm

The Robotic arm was successfully controlled using the accelerometer and the gripper was able to pick the assigned weight without any difficulties.

It was observed that when the accelerometer output was not passed through the filter section some noise interference was generated which can result into error. The current rating of the supply should be good to get best results from the Servos.

ADVANTAGES AND LIMITATIONS

Advantages

The advantage of using a Motion Sensor leads to an easy control on the robotic arm. The use of complicated mechanisms like Gears, Press Buttons can be avoided. Applications are performed with precision and high repeatability every time. This level of consistency can be hard to achieve any other way. With robots, throughput speeds increase, which directly impacts production. Because robots have the ability to work at a constant speed without pausing for breaks, sleep, vacations, they have the potential to produce more than a human worker. Robots increase workplace safety.

Disadvantages

The wiring can be very complicated after certain level or at an Industrial Level. The initial investment in the robotic arm is significant, especially when business owners are limiting their purchases to new robotic equipment. The cost of automation should be calculated in light of a business' greater financial budget. Regular maintenance needs can have a financial toll as well.

FUTURE SCOPE

The Robotic arm can be made more efficient if a strong chassis and Servo Motors with a high torque values are used. If the Power Supply used for the Servos gives a good current value the servos will perform to its best. This Robotic arm is only 2-Dimensional. With some modifications and additions the motion along the third dimension can also be implemented in this project.

This arm can also be taken to a higher level by changing the sensor. A Voice Controlled Robotic arm is possible to implement. The research is on and it is possible to control the robotic arm through direct connection with the nervous system and will be extremely beneficial for the Handicapped. This type of a robotic limb can become the most sophisticated of its kind in the world, recreating virtually every movement of a natural arm -- and all of it controlled by brain power.

CONCLUSIONS

We have concluded that Robotic Arm if constructed accurately and in a systematic way then can be used for a long list of applications. The construction is little difficult as it involves lots of wiring and connections. The Accelerometers should give noise less outputs and should be handled with care because of the delicate structure. Overuse of the servos should be avoided because of the Melting of gears due to high level of friction.

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