Design and Implementation of Hardware and Software Gesture Controlled Robotic Arm

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ABSTRACT:

Aim and Objective: Gesture means the movement of hand and face of humans. The main objective of this project is to control the robotic arm using human gestures. Most of the industrial robots are still programmed using the typical teaching process, through the use of robot teach pendant.

Methodology: Sensors plays an important role in Robotics. Sensors are used to determine the current state of the system. Robotic applications demand sensors with high degrees of repeatability, precision and repeatability. Flex sensor is such a device, which accomplish the task with great accuracy. Here the human gestures are sensed with the help of a flex sensor, a microcontroller is used in transmitter section. It is coded in such a way that required actions for the human gestures are done. These sensed signals are processed and then transmitted to the robotic arm at the receiver using relay to the controllers in robot. Thus the robotic arm performs required movement.

Result and Discussion: A robotic system has been developed which works according to your hand gestures with the help of flex sensors. The proposed system can perform the various tasks like pick and place, bulb fitting etc , square frames matrix operation, etc. that helps the human to communicate with effectively . The performance of a robotic arm was checked using different hand movements.

Keywords: Gesture, A robotic system, Flex sensor

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1. Introduction:

Robots are increasingly being integrated into industries to replace humans especially to perform the hazardous tasks. A robot is an electro-mechanical machine capable of carrying out a complex series of actions automatically or under human supervision. These are used in various fields such as industries, military, healthcare and research. It might be dangerous for humans to perform some specific tasks like working with explosive chemicals, defusing bombs and other hazardous works. Therefore, humans can be replaced by robotic arm to perform the operations. A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. The robot arms can be autonomous or controlled manually and can be used to perform a variety of tasks with great accuracy.

Gesture recognition technology is used to control the robotic arm. Gesture recognition enables humans to communicate with the machine and interact naturally without any mechanical devices. Gesture recognition is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. Gestures can originate from any physical motion or state but commonly originate from the face or hand. Gesture recognition enables human to communicate with the machine and interact without any mechanical devices. Hand gestures are extensively used for robotic control applications and robotic systems can be controlled naturally and intuitively with such robotic communication.

2. Literature Survey:

Robotics is a flourishing field in research and everyday life because of its many applications in the military (defence and transportation), industries etc. In factories robots are widely used

to perform many prescribed jobs such as welding, painting and many more. Robots are also used in many other situations which are not suitable or for highly dangerous such as a bag with explosion which may explode on opening that bag a UGV with a robotic arm is the good and safe solution for this sort of problems [1], [2] similarly mixing or working with dangerous chemicals attesting weapons are also easy through robots with no dangerous of losing man precious lives in industries for removing wastes and many other type of works can be done by a human size robot known as PUMA [3]. In the past decade there are many research in the field of humanoid robots with the inventions of many technologies to control the robots which are further discussed in the paper. Generally there are two basic way to controlled the robotic arm wired and wireless both technologies have some advantages and some disadvantages as wired circuit is complex and have cannot be controlled from the long distance but it does not require extra batteries as required for wireless system. Wireless systems also have external interference whereas wired system is less interference. The cost of wired system is much less than the wireless system.

Robotic arm based on haptic technology. This robotic arm has wide range of application in military purpose, for surgery purpose and also for education aspect [4]. The structure of the arm rehabilitation training robot and simplifies the arm models and also It establishes a united dynamics model of rehabilitation robot and arm with Mechanics in Mat lab/Simulink as well as analyses the dynamics issues of the two driven joints of the robot [5]. It developed an an thropomorphic robotic arm which was very flexible and could perform dexterous hand movements. But due to flexibility there was a risk of electrical cables getting caught in the gears while in motion [6]. It also developed a

3DOF robotic arm using tendon drive and easy motor control [7]. It proposed a force magnification drive appropriate for cable driven light weight robotic arm using flexion drive and force magnification drive. The design ensured that the robotic arm automatically adapted to the shape of the object that it grasped [8]. It designed a four finger gripper having four DOF, but it was costly as it required 32 independent tendons and pneumatic actuators [9].

The generation of the human-like manipulation motions has been implemented and also tested successfully for the 4 degrees of freedom (DOF) arm of the humanoid robot [10]. A robotic arm with four degrees of freedom is designed and is able to pick the objects with a specific weight and place them in a desired location. To facilitate the lifting of the objects, Servomotors with a torque of 11 kg are used [11]. The main objective of the project is to design and develop the Robot that is used to move using wireless system by recognizing hand motion that is controlled by haptic technology for virtual environment & human-machine systems capable of haptic interaction [12]. This is an autonomous robot arm with a three dimensional reach which could automatically detect and pick an object. Then it could place it in a destination and change the orientation as specified by the user [13].

A low cost computer vision system that can be executed in a common PC equipped with low power USB web cam was one of the main objectives of our work, which has been implemented successfully. We have experimented with around 30 hand gesture images and achieved higher average precision [14]. It provides a better way to control a robotic arm using accelerometer which is more intuitive and easy to work, besides offering the possibility to control a robot by other wireless means [15]. An automated robot has been developed which works according to your hand gesture. The robot moves wirelessly according to palm gesture [16]. Development of a cost-effective technology demonstrator was successfully designed to bring

together the concepts of anthropomorphic manipulators, real-time distributed processing networks for micro-controllers and haptic feedback [17].

This system will reduce the hectic interfaces like keyboard, mouse or any other equipment. Hand gesture recognition technique can provide user-friendly human and machine interfaces. Lifetime of gesture recognition system is high with greater precision and with efficient size [18]. Design for an untethered motion capture system based on inertial sensing. The functionality of our system was demonstrated through experiments in tele-operating the NASA Robonaut. Our motion capture system has been presented as a cost-effective and unencumbered means for extending motion collection beyond structured environments [19].

Design a novel controller for an automated robotic arm. A discrete Proportional Integral Derivative (PID) control technique is being used to replace the complex electronic circuitry, which would greatly reduce the cost and size of the controller [20]. LAB View controlled robotic arm was successfully designed. The robotic arm was found to be user friendly and the integration of accelerometer was much helpful in attaining the feedback regarding the position of the arm [21]. A robotic arm with 2DOF is designed and implemented which is to be used in a tree climbing robot, specifically for coconut tree climbing [22].

To achieve the wireless capability we use many wireless module under the IEEE standards such as ZigBee, Bluetooth, infrared and radio packet controller may be use each of them with different ranges and data handling capabilities. In this paper we have three sections in first section we will study about the different technology adopted with its advantages and disadvantages in the second part we will study the standards for the wireless communications and in third sections we will conclude over paper.

There are many ways and methods to control a robotic arm having different shapes and sizes depending upon the type of work required. It may be a Cartesian robot /Gantry robot, cylindrical robot, Spherical/Polar robot, SCARA robot (Selective Compliance Assembly Robot Arm), Articulated robot and may be are parallel robot all of above robots has different properties and function and also have totally different controlling [23]. Digitally Operated and Programmable Robot technology was invented by George Devol an American inventor in 1961 named as Unimate. It was first industrial robot used in General Motor used for die casting handling and spot welding [24], [25]. It was first robot that replace the human from industries because it was more accurately and reliably, than humans. This robot was come into being after the invention of micro-controller, DAC and ADC it was a simple robot with the program of its working fed in its micro-controller or computer attached to it. It basic drop edge was it has less degree of freedom and because of micro-controller it have less memory so large program cannot be fed in it. To get different works from the same robot we need to reprogram the whole robot but it is also a cheap and best for the industrial purpose [25].

3. Implementation:

The proposed system will perform the certain task which is already predefined to the robotic arm, according to the gestures given by flex sensors that are arranged on the user hand with the help of glove.

The flex sensor is mounted on the user hand with the help of glove. Here we are using two flex sensors. The working of flex sensors is shown below.

The flex sensor is a type of sensor used to measure the amount of detection or bending. The sensors works on the bending strip principle which means whenever the strip is twisted then

its resistance will be changed. This can be measured with the help of any controller .
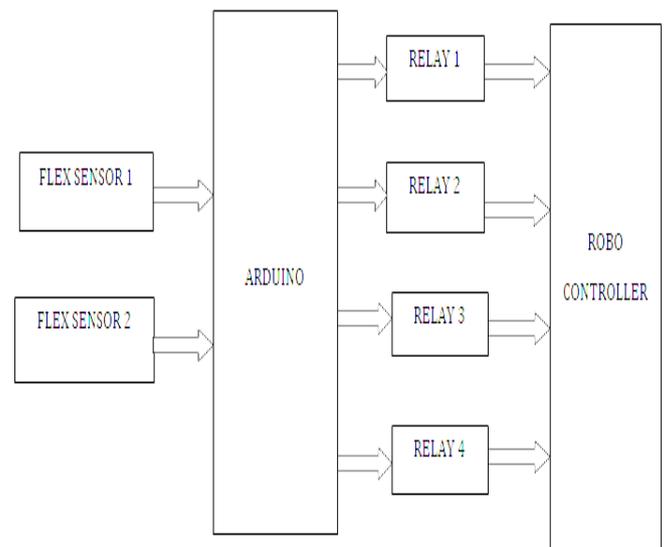

Figure 1. Block Diagram

Here the four cases arises , when the sensor is placed normal at flat position i.e,0 degrees and the resistance at that case is around 60kΩ , another one is when we bent at 45 degrees and the resistance is 65kΩ, next one is 90 degrees with the resistance of 70 kΩand the last one is 180 degrees with the resistance of 75kΩ . In this project we are taking two conditions when at 0 degrees and 180 degrees.

These resistance values are given as input to the arduino and processes by it to get the desired analog value.

These resistance values from the both flex sensors are read by the microcontroller by using "analog Read()" function.

When the position is 0 degrees the analog value is less than 1000 and the position is 180 degrees the analog value is greater than 1000. The four output combinations of flex sensors are given below.

By using "if conditional statement" these two values are compared by using relation & logical AND operator in 4 different ways.

1. Value 1 >1000 and value 2 > 1000
2. Value 1 <1000 and value 2 > 1000

3. Value 1 >1000 and value 2 < 1000

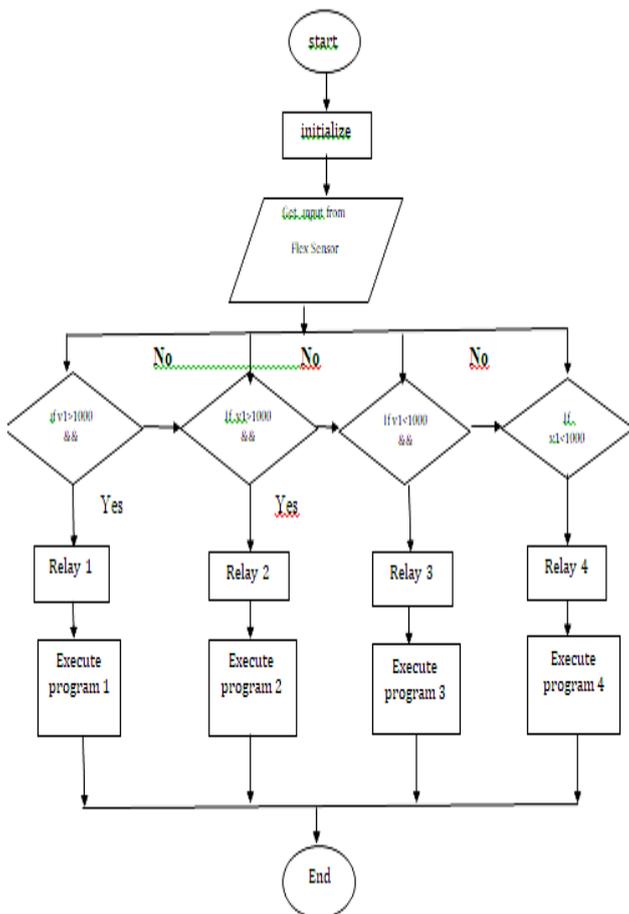4. Value 1 <1000 and value 2 <1000

Based on these condition status particular relay is set to ON (5v). Here we are taking four relays, when particular condition is satisfied that relay gets input supply and turn on or off the digital pin of robot controller that triggers the robot tasks which is pre-defined . It is shown in the following flow chart.

The robot is programmed with some tasks like pick and place, matrix operation, square frames and bulb fitting etc.,

Figure 2. Flow Chart

4. Result:

A robotic system has been developed which works according to your hand gestures with the help of flex sensors . The proposed system can perform the various tasks like pick and place , bulb fitting etc , square frames matrix operation, etc that helps the human to communicate with effectively . The performance of a robotic arm was checked using different hand movements .

Figure 3. Experiment Setup of Flex Sensors With Arduino

Robot controllers take the input of 24V from the relay.

Figure 4. Overview of Gesture Control Robotic Arm

5. Conclusion:

The objective of this project has been achieved which was developing the hardware and software for an flex sensor controlled robotic arm. From observation that has been made, it clearly shows that its movement is precise, accurate, and is easy to control and user friendly to use . The robotic arm has been developed successfully as the movement of the robot can be controlled precisely. This robotic arm control method is expected to overcome the problem such as placing or picking object that away from the user, pick and place hazardous object in easy manner . The primary objective is to make the robotic arm, which comprises of stepper motors, to interface with the arduino Uno. It provides more interfaces to the outside world and has larger memory to store many project is to design the robotic arms that able to carry out certain task. The revolute robotic arm is able to move similar to human arm. The main objective of this project is to pick and place the objects. The arm needs to be as light as possible in order to maximize the payload. This system would make it easier for man to unrivalled the risk of handling suspicious objects which could be hazardous in its present environment and workplace.

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