Motion Controlled Robotic Arm

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***Abstract*— In this paper we have presented a model to control robotic arm through human gestures using flex sensors. A three-axis flex sensor is mounted on human hand in order to perform the action of robotic arm according to the action of human hand. Flex sensor is connected to the Arduino Uno, which is programmed to take analog readings from flex sensors and transmit them using RF transmitter to the receiving unit at robotic arm. Movements of the robotic arm are achieved through Servomotor. They are a type of electromechanical actuators that do not rotate continuously like DC/AC or stepper motors; rather, they are used to position and hold some object. Servo motors are used where continuous rotation is not required. The main aim is to control the robotic arm using human gestures wirelessly with smooth movement over a range [1].**

***Keywords*— Motion controlled, servo motors, Arduino Uno, Arduino Nano, Servo Motors, Three Axis Rotation.**

I. 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 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 suchas 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 the same movement repeatedly. The robot uses motion sensors to make sure it moves just the right amount.

A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. 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 end effectors can be designed to perform any desired task such as, gripping, spinning etc., depending on the application. The robot arms can be autonomous or controlled manually and can be used to perform a variety of tasks with great accuracy. The robotic arm can be fixed or mobile (i.e. wheeled) and can be designed for industrial or home applications. In some applications controlling robotic arm precisely is of utmost importance. Currently, such robotic arm is controlled using joystick which is wired to arm. To make control of an arm more precise like human beings we designed an arm which is wirelessly synchronized to human arm and can emulate the movements of a human arm. Robotic arm whose objective is to imitate the movements of a human arm using accelerometers as sensors for the data acquisition of the natural arm movements. This method of control allows greater flexibility in controlling the robotic arm rather than using a controller where each actuator is controlled separately. The processing unit takes care of each actuator's control signal according to the inputs from accelerometer, in order to replicate the movements of the human arm [2].

II. COMPONENTS USED

A. *Arduino Uno*

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

B. *Arduino Nano*

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.

C. Flex Sensors

A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. Usually, the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. Since the resistance is directly proportional to the amount of bend it is used as goniometer, and often called flexible potentiometer [3].

D. RF Module- 434 Tx & Rx

In generally, the wireless systems designer has two overriding constraints: it must operate over a certain distance and transfer a certain amount of information within a data rate. The RF modules are very small in dimension and have a wide operating voltage range i.e. 3V to 12V. Basically the RF modules are 433 MHz RF transmitter and receiver modules. The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus consume significantly low power in battery operation. When logic one is sent carrier is fully on to about 4.5mA with a 3volts power supply. The data is sent serially from the transmitter which is received by the tuned receiver. Transmitter and the receiver are duly interfaced to two microcontrollers for data transfer.

E. Servo Motors

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc.

F. Connecting Wires

Connecting wires allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it can move. Most of the connecting wires are made up of copper or aluminum. Copper is cheap and good conductivity. Instead of the copper, we can also use silver which has high conductivity, but it is too costly to use.

G. Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

III. WORKING

The circuit works on the principle of servo motors. When an object to be picked is in front of the robotic arm, the flex 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 flex sensor is moved downward, the arm-2 connected to arm-1 moves down. Vice-versa is also possible.

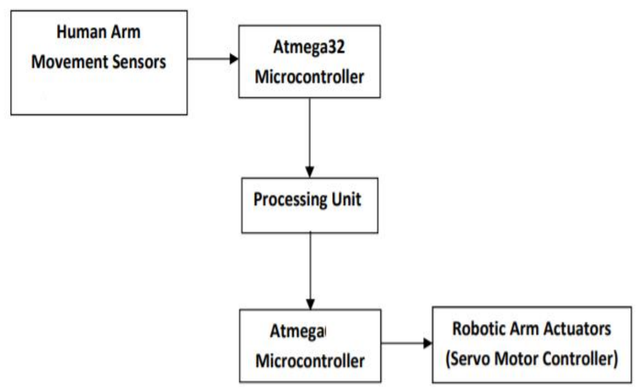

Fig1. Block Diagram Representation of the Proposed Robotic Arm System [4]

The Flex Sensors are connected to the ATmega32 development board which is then connected to the Computer via serial communication. Now the data received by the computer is processed to remove as much noise as possible. Again, the ATmega328p development board is connected with the computer through another serial communication channel.

Here we used RKI-1064 Rx-Tx pair based on amplitude shift keying. The operational frequency is 434 MHZ & transmission occurs at a rate of 1Kbps - 10Kbps. Codes corresponding to different sets of ADC values are transmitted and checked at receiving end. If the code received is correct than corresponding PWM value is used to drive the motor at specified angle. The communication between the transmitting and receiving end is done using RF transmitter-receiver pairs. The flex sensors require a circuit in order for them to be compatible with Arduino. It's a voltage divider: the flex sensors are variable resistors, and when paired with resistors of a static value, a change in resistance (in this case bending the sensor) can be sensed through the change in voltage between the resistors. This can be measured by the Arduino through its analog inputs. The schematic is attached (red is positive voltage, black is negative, and blue goes to the Arduino). The resistors in the photo are 22K. The main GND (ground) wire, which is connected to all the individual GND wires from the sensors, gets plugged into the Arduino's GND. The +5V from the Arduino goes to the main positive voltage wire, and each blue wire gets plugged into a separate analog input pin.

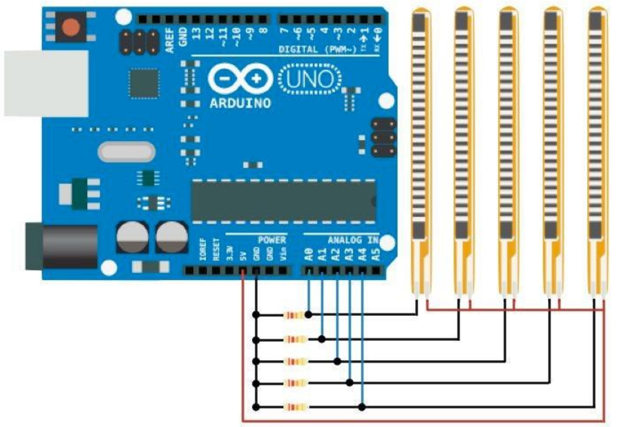

Fig 2: Connections of Flex Sensors and Arduino Uno

Now it's time to mount the sensors and their circuit onto the glove. First, drill a tiny hole in the plastic of the sensors (at the top, once the resistive material has ended). Be sure not to hit the resistive material! Then, put on the glove and pull it tightly to your hand. On each finger, with a pencil or pen, make small lines over the tops of each joint/knuckle. This will tell you where to sew the sensors. Sew each sensor tip to the area of each finger just above your fingernails (use the hole you just drilled). Then, loop the thread around each sensor above both joints in each finger.

IV. *CONCLUSION*

The objectives of this project has been achieved which was developing the hardware and software for an motion 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 a very fast and easy manner. 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 can 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.

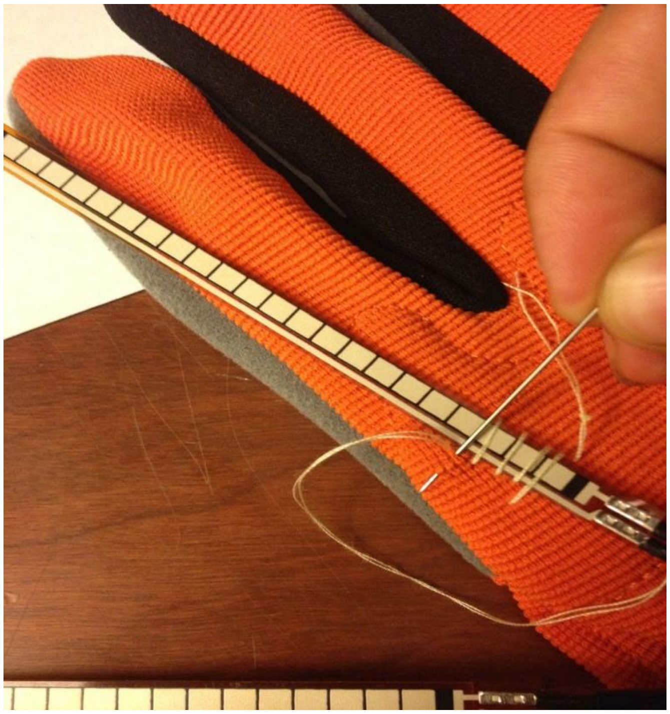

Fig 3: Sewing Flex Sensors in glove [5].

Connect each positive wire of the servo (usually red) to one of the rails on the breadboard, and the negative wire (usually black or brown) to another rail. IMPORTANT: remember to connect the negative rail on the breadboard to the Arduino's other GND: all the GNDs in a circuit need to be connected for it to work. Upload the program to the Arduino and make sure all the connections to the glove and servos are correct. Put on the glove and turn on the Arduino. The servos should rotate based on how much your fingers are bent. If this is the case, it's working.

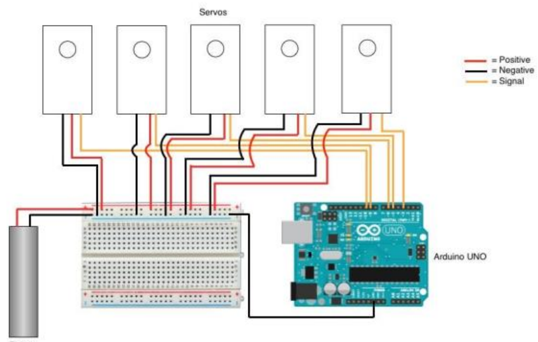

Fig 4: Servo motors and Arduino Uno Connections

To calibrate each servo ring so it flexes and relaxes its finger when you want it to based on the input, first plug in your Arduino and servo battery and run the program. Put on the glove and flex the finger that corresponds to the servo you're working on. Adjust the servo pulley so one hole is closest possible to the fingers and pull the "relax" string of that finger as tightly as you can without bending the finger. Put it through the closest hole of the ring and glue it in place. Then, straighten your finger and pull and secure the other string into the other hole. Repeat this process with each finger. It's important to make each string taut [6].

V. 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 [7].

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