Research Paper
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HUMANOID ROBOTIC ARM CONTROL USING SERVO MOTORS

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ABSTRACT:

Amputees often suffer from physical difficulties due to their liability to use to their hands or legs efficiently. To aid the amputees in acquiring a functional replacement and at a feasible cost, a prototype prosthetic was created using Flex Hand, a 3D printable hand model, and aurdino, an open source microprocessor. To avoid expensive and frustrating control methods associated with micro electric prosthetics, the Flex Sensors send information to the Aurdino Uno which orders certain servos to activate each figure individually. The simple construction and low cost of materials, as well as the use of Aurdino and Flex Sensors enabled amputees to gain access to new prosthetics with ease.

KEYWORDS:

INTERNATIONAL FEDERATION OF ROBOTICS, ROBOTIC ARM, SENSOR, SERVO MOTORS.

I. INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replace humans especially to perform the repetitive task. In general, robotics can be divided into two areas, industrial and service robotics. International Federation of Robotics (IFR) defines a service robot as a robot which operates semi- or fully automatically to perform services useful to the well-being of humans and equipment, excluding manufacturing operations. These robots are currently being used in many fields of applications including office, military tasks, hospital operations, dangerous environment, and agriculture. Besides, it might be difficult or dangerous for humans to do some specific tasks like picking up explosive chemicals, defusing bombs or in a worst-case scenario to pick and place the bomb somewhere for containment and for repeated pick and place action in industries. Therefore, a robot can replace human to do work. A humanoid robotic hand Prosthetics allows the use of robotics to a next level integrating a human with a robot.

II. ROBOTIC ARM DEFINITION

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 links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is called the end effectors and it is analogous to the human hand. The end effectors can be designed to perform any desired task such as welding, 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. This report deals with a robotic arm whose objective is to imitate the movements of a human arm using flex sensors 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. There are various ways in which a robotic arm can be controlled. In the past there have been many researchers working to control a robotic arm through computer terminals, Joysticks, even interfacing them with the internet so they can be controlled from anywhere in the world. Usually, most of the robotic arms are controlled by a central controller which makes uses of values taken in from the terminal that is entered by the user at the terminal to move the arm to particular coordinates in space. This makes the control very difficult as the control values of the motors are very difficult to predict to achieve a particular movement. This Project represents a simple flex sensor controlled a robotic arm using Arduino UNO R3 powered embedded system as the core of this robot and also a Computer to interface the robot with the sensors. The robot does not require training because the robotic arm is fully controlled by the user. This interfacing is done using wired communication but it can easily be switched to wireless with ease.

III. HARDWARE DESIGN AND DESCRIPTION

HARDWARE REQUIREMENTS:

1. Flex sensors (Sensor)
2. Servo Motors (Actuator)
3. ATmega328 (Data Acquisition and processing)
4. Auxiliary equipment.

The flex sensor technology is based on resistive carbon elements. As a variable printed resistor, the flex sensors achieve great form-factor on a thin flexible substance. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius the smaller the radius the higher the resistance value. Here we use a flex sensor designed by Free scale Semiconductors. This sensor is a low power, low profile capacitive micro-machined sensor featuring signal conditioning, a low pass filter, temperature compensation, self-test, 0g-Detect which detects linear free fall, and g-Select which allows for the selection between 2 sensitivities. We can vary the actual nominal resistance Of the flex sensor to meet the needs. We can produce flex sensor on a variety of materials such as DuPont's capton for high temperature operations. A un flexed sensor Style A has a nominal resistance of approximately 10,000 ohms (10 K). As the flex sensor is bent in one direction the resistance gradually increases. Range of resistances of the FLX-03 Style A sensor may vary between 10K and 40K depending upon the degree of the flex. A un flexed sensor Style B begins with an infinitely high nominal resistance. As the flex sensor is bent in one direction the resistance gradually decreases. Range of resistances of the FLX-03 Style B sensor may decrease to under 10K depending upon the degree of the flex. The flex sensor operating temperature is -45F to 125F.

Salient features of flex sensors include

- High reliability
- Consistency
- Repeatability
- High temperature resistance
- Variety of flexible or stationary surfaces for mounting
- Infinite number of resistances possible
- Can be used as per the requirement
- Infinite number of bed ratios

Various applications of flex sensors are:

- automotive controls
- medical devices
- industrial controls
- computer peripherals
- fitness products
- music instruments
- measuring devices
- virtual reality games
- consumer products
- physical therapy

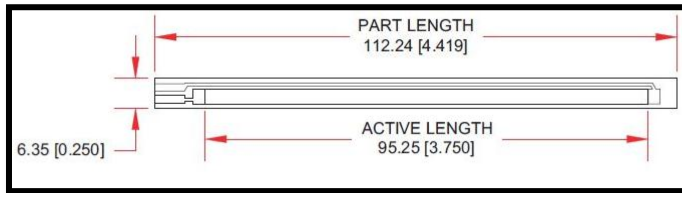

FIG1: PHYSICAL DIMENSIONS OF A TYPICAL FLEX SENSOR.

Data acquisition of the flex sensors circuit is given below in the circuit diagram. Five flex sensors are being used in this circuit and the needed connections are shown below. One of the two cables of a flex sensors is connected to the breadboard where a resistor is placed at the end of the sensor's output cable to match the signal to Arduino board. From there additional cable is used to connect it to the receiver section of the Arduino board. Like this all of the output cables from the flex sensors are connected in the A0, A1, A2, A3, and A4 respectively.The second cable from all the flex sensors are also connected to breadboard. All of those cables are connected to a same line in breadboard. From here additional cable is used to connect it to the Arduino board.

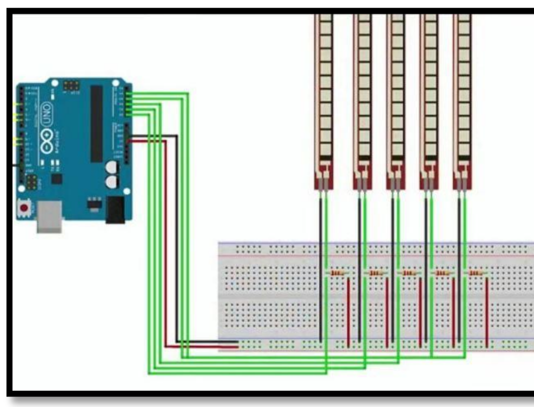

FIG2: FLEX SENSOR CIRCUIT.

Output circuit is given below. Here according to program given to the arduino board and the signal from the flex sensors, an output signal is developed and transmitted to the micro servo motors. To complete the circuit different cables are used to exchange information between Arduino and micro servo motors.

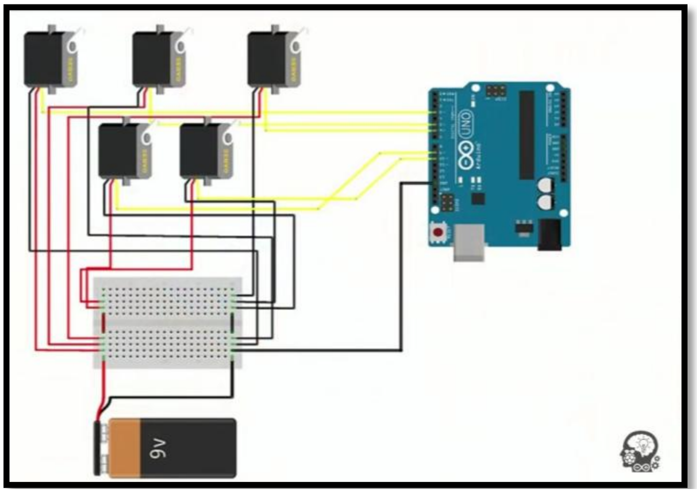

FIG3: SERVO MOTOR CIRCUIT

Here we have micro servo motors. They have three types of cables. Two for energy intake. Here we can use a 9V battery to power the circuit. We have another cable remaining in the servo motor, it is used for information exchange between servo motors and Arduino board. Whenever there is a signal from flex sensor Arduino process it and sends the signal to servo motors. Full circuit diagram of the humanoid robotic arm is shown below. From the above circuit diagram we can see all the peripherals are connected in right order such that the servo motors work as per the program and does the intended work.

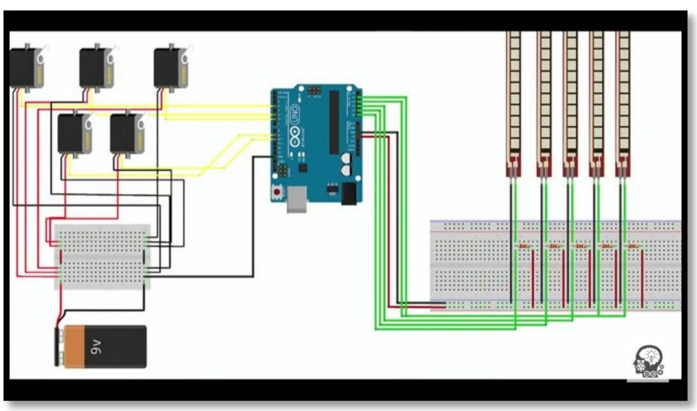

FIG4: COMPLETE ROBOTIC ARM CIRCUIT

IV. IMPLEMENTATION

The flex sensors are connected to the ATmega328 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 ATmega328 development board is connected with micro servo motors through another serial communication channel.

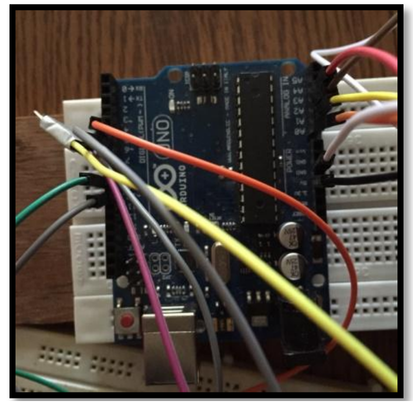

FIG5: ARDUINO BOARD

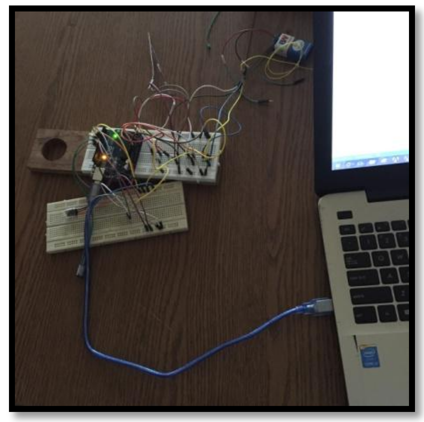

FIG6: CIRCUIT CONNECTED TO LAPTOP.

Arduino board is first taken to make necessary connections. First the flex sensor circuit is built and necessary connections are given to the Arduino board. Now the servo motors are connected using a circuit to the Arduino. For all these connections we need two breadboards. These breadboards are placed on the side and back of the arm using their stick pads. The servo motors are rigidly fixed in a wooden board. This wooden board is then placed inside the structure of the arm. From there it will be easy for the motors to make connection with the fingers of the robotic arm. So when the servo motors are rotated they will wound the wire which is connected to the fingers. Due to the wounding of the wire the string tightens and drags fingers backward i.e. folding. Here we have two motors M1, M2. Motor1 is responsible for the rotation of the arm in forward and backward movement. Motor2 is responsible for the rotation of the arm in horizontal plane.

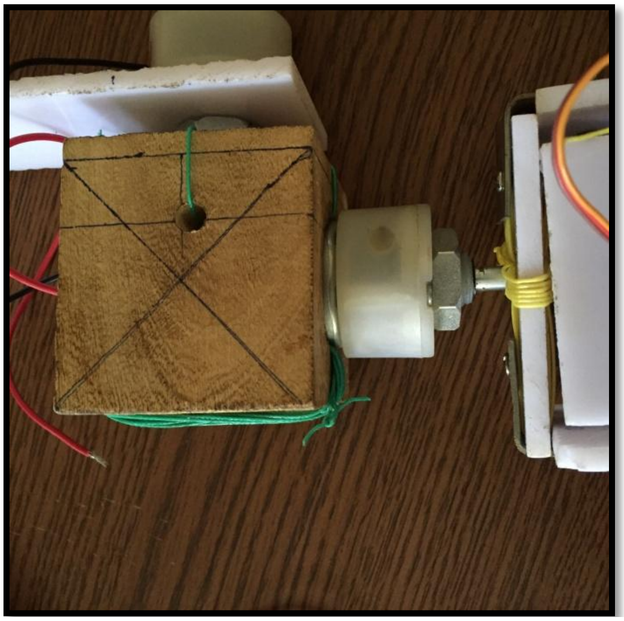

FIG7: ELBOW MOTOR1 (M1)

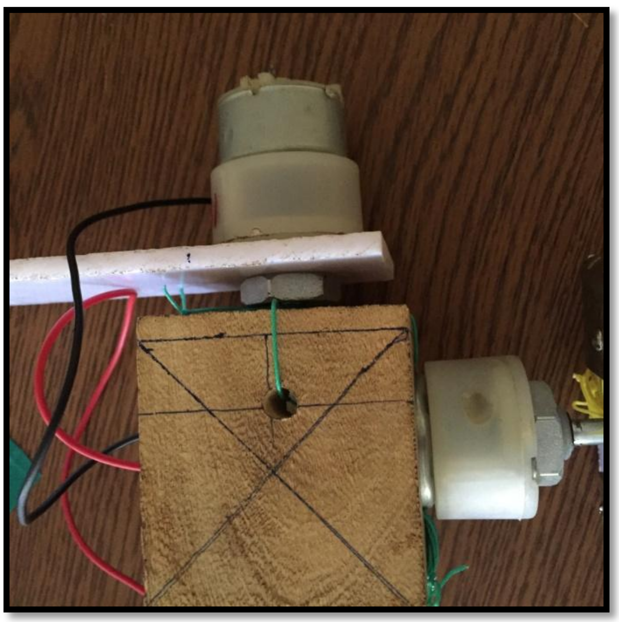

FIG8: ELBOW MOTOR2 (M2)

So that we can have more rotation of the arm. We can increase the rotation of the arm by placing another motor at the shoulder so as to make it more feasible to reach. But here we are fixing the shoulder to a wooden pad to make it more rigid.

V. CONCLUSION

The projects target of achieving the finger motion of the robotic arm component have been achieved. This hand working is completely done by the using software and motor fiving a flexibility to move in many directions. The project clearly shows that its movement is precise, accurate and very easy to control. This robotic hand is expected to overcome the problems such as picking and placing the objects etc. The projects is a base for higher application such robotics end effectors and humanoid robots

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