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3-Degrees of Freedom Robotic ARM Controller for Various Applications

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Abstract

In this work, we have designed a 3-degree of freedom robotic arm controller for various applications. A general interface is developed for the robotic arm enabling it to communicate with different platforms and performing different tasks. The task is to design a robotic arm that can perform the necessary pick and place actions. The movements are controlled by using servo motor embedded in it.

Deflection in the arm is identified using MEMS accelerometer sensor and a Flex sensor. The work is aiming to develop a robotic arm. The task entails analysis, design and fabrication of the robot.

The Primary Objectives of this work are

- *Hand gesture tracking and reproducing with robotic arm.*
- *The robotic arm shall have at least 2 Degrees of Freedom (DOF).*
- *The robotic arm shall be able to pick up any small object.*

Keywords: *MEMS sensor, FLEX sensor, Aurdino UNO, 3 DOF (Degrees of Freedom), Servo motors.*

Introduction:

Growing demand for natural Human Machine Interfaces and robot easy programming platforms, to control an industrial robotic arm was proposed and implemented successfully.

A 3-axis accelerometer was selected to be the input device of this system, capturing the human arm behaviour to control the robotic arm movement. A flex sensor & MEMS sensor were used to control gripper movement.

When compared with other common input devices like teach pendant, this approach using accelerometers over wireless medium is easier to work.

Block Diagram:

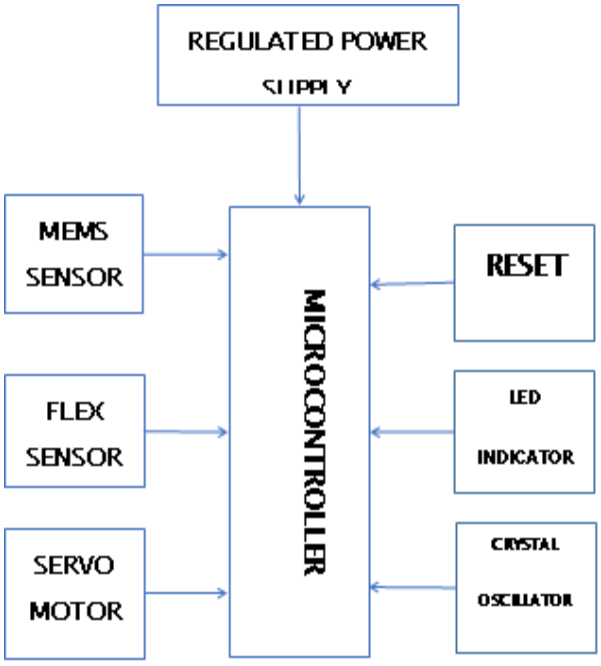

Fig: block diagram of robotic arm controller.

The main blocks of this project are:

- ARDUINO IDE

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- POWER SUPPLY
- MEMS SENSOR
- FLEX SENSOR
- SERVOMOTOR

MEMS sensor MMA 7260 Q:

The MMA7260Q is 3-axis accelerometer. An accelerometer measures acceleration (change in speed) of anything that it's mounted on. Single axis accelerometers measure acceleration in only one direction. Dual-axis accelerometers are the most common measure acceleration in two directions, perpendicular to each other. Three-axis accelerometers measure acceleration in three directions.

FLEX SENSOR:

Flex sensor are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance the more bend, the more the resistance value.

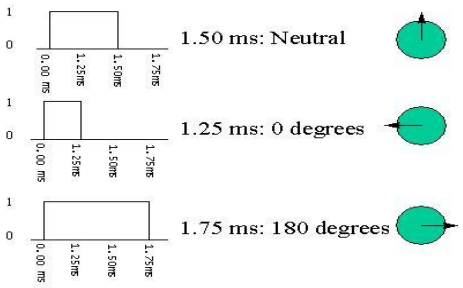
Using this combination of sensors , a non-expert robot programmer can control a robot quickly and in a natural way. The low price and short set-up time are other advantages of this system.

Servomotor:

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

This diagram shows some control signal pulses for a typical servo and the position to which it will rotate in response to the pulse width.

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft.

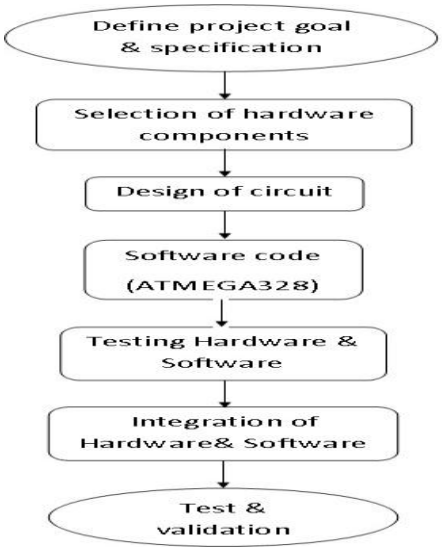


The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Project Flow



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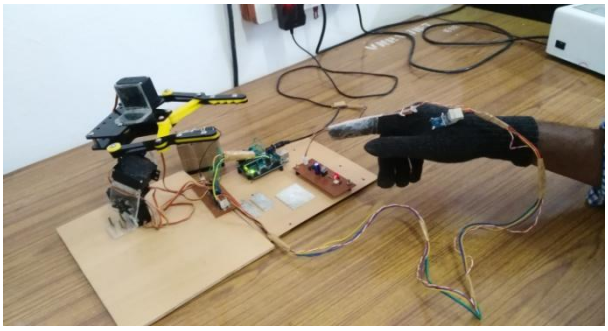
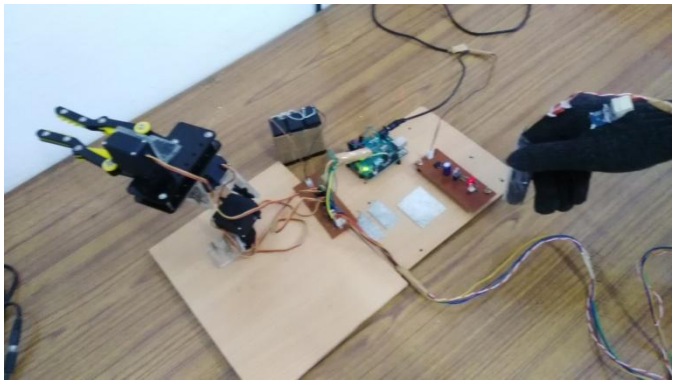
Experimental setup

a)Hardware circuit

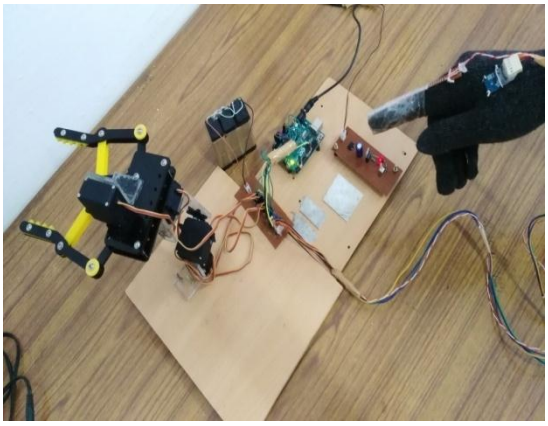
b)arm at minimum position with gripper closed



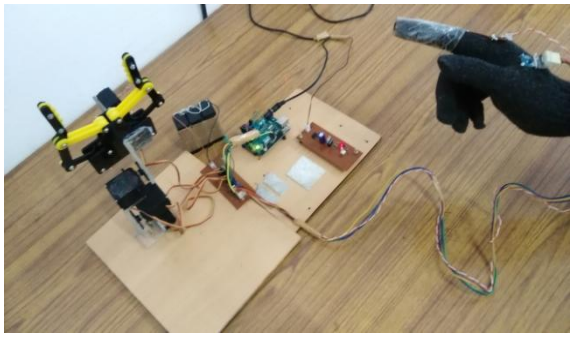
c)arm at minimum position with gripper open



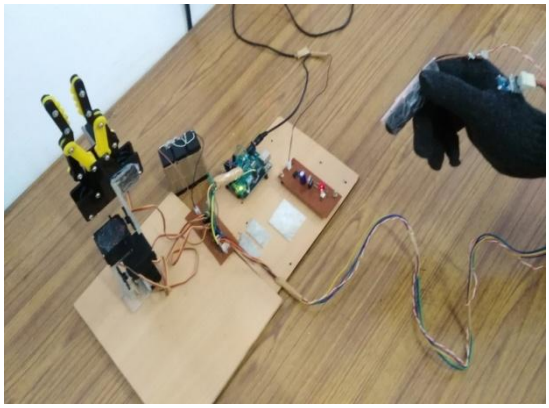
d)arm at maximum position with gripper closed



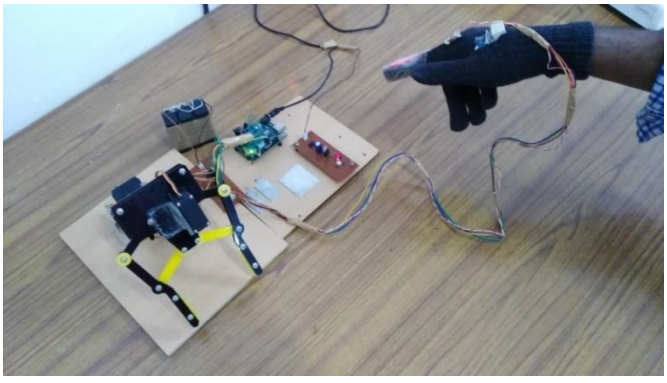
e) Arm at maximum position with gripper open



f)Arm faced up with gripper open



g) Arm faced up with gripper closed



f) Arm at down position with gripper open

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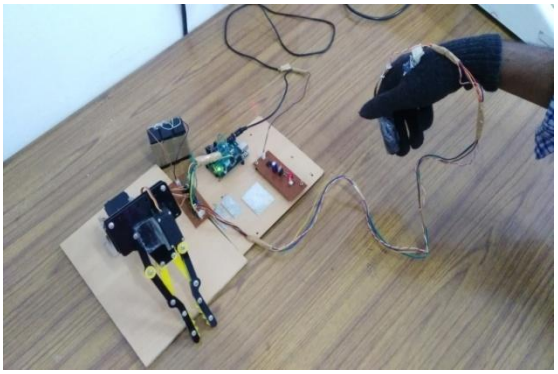
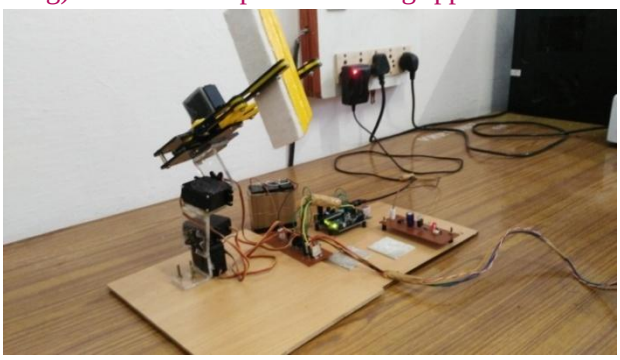
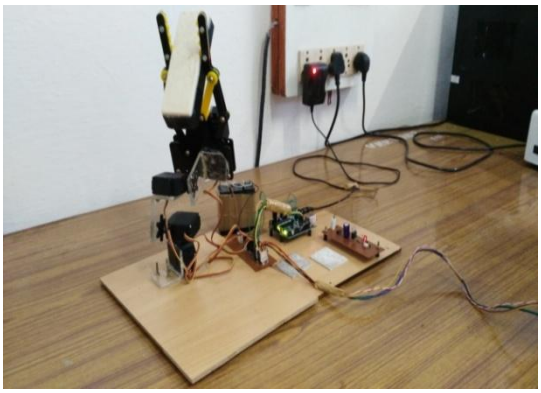


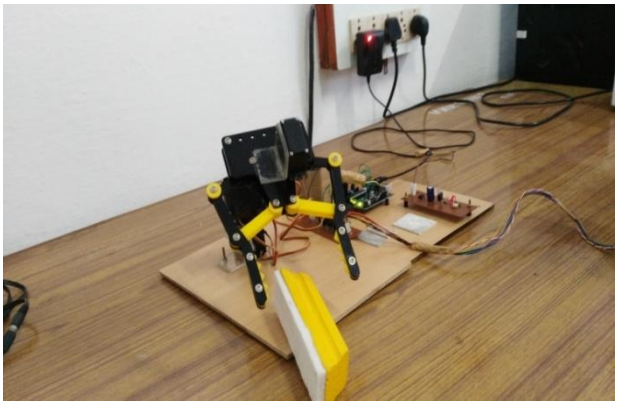
g) Arm at down position with gripper closed



h) Arm picking object



h) Arm rotating object

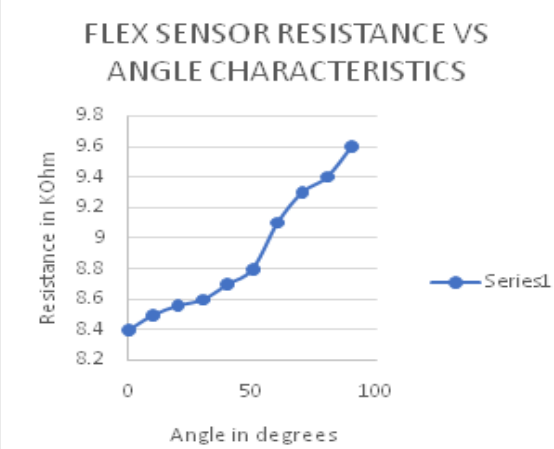


i) Object placed by the arm

5) RESULTS& APPLICATIONS

i)FLEX SENSOR RESISTANCE VS ANGLE CHARACTERISTICS

S.NO	ANGLE IN DEGREES	RESISTANCE IN KILO OHM
1	0	8.40
2	10	8.50
3	20	8.56
4	30	8.60
5	40	8.70
6	50	8.80
7	60	9.10
8	70	9.30
9	80	9.40
10	90	9.60



ii) MEMS SENSOR Y-DIRECTION

S.NO	ANGLE IN DEGREES	DEFLECTION IN VOLTS
1	0	1.60
2	10	1.55
3	20	1.50
4	30	1.46
5	40	1.43
6	50	1.40
7	60	1.39
8	70	1.35
9	80	1.33
10	90	1.30

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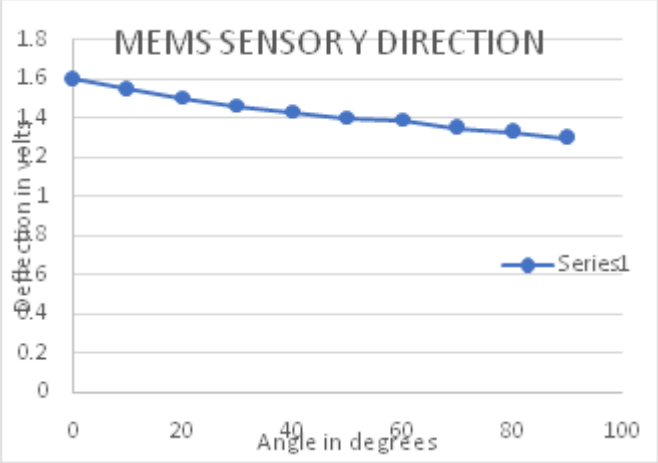
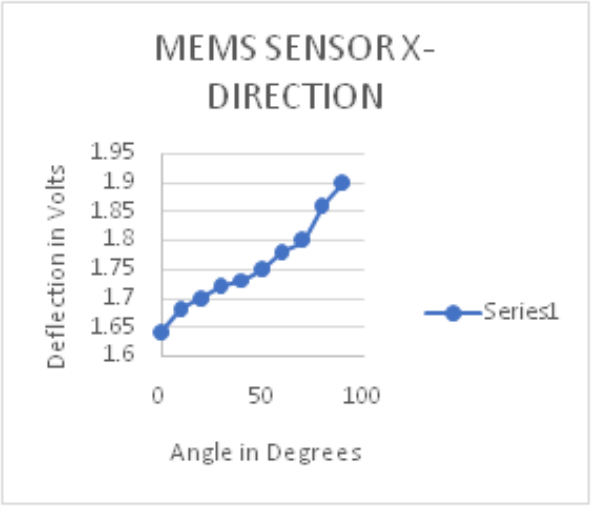


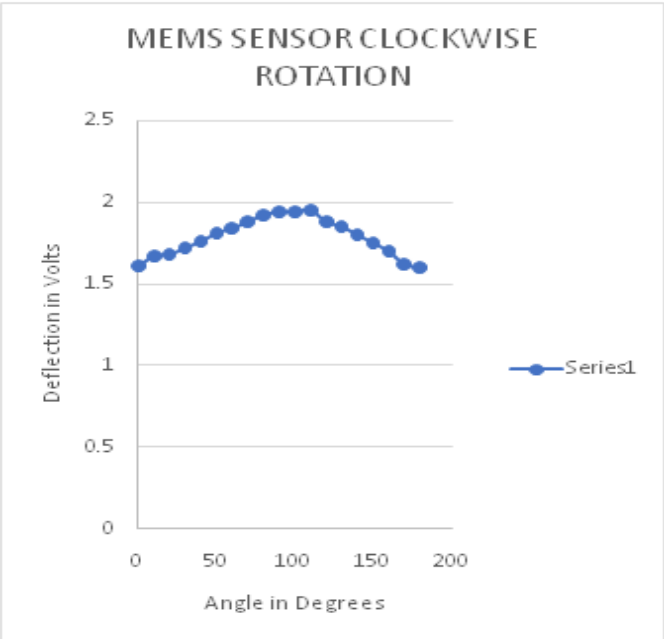
iii) MEMS SENSOR X-DIRECTION

S.NO	ANGLE IN DEGREES	DEFLECTION IN VOLTS
1	0	1.64
2	10	1.68
3	20	1.70
4	30	1.72
5	40	1.73
6	50	1.75
7	60	1.78
8	70	1.80
9	80	1.86
10	90	1.90



iv) MEMS SENSOR CLOCKWISE ROTATION

S.NO	ANGLE IN DEGREES	DEFLECTION IN VOLTS
1	0	1.61
2	10	1.67
3	20	1.68
4	30	1.72
5	40	1.76
6	50	1.81
7	60	1.84
8	70	1.88
9	80	1.92
10	90	1.94
11	100	1.94
12	110	1.95
13	120	1.88
14	130	1.85
15	140	1.80
16	150	1.75
17	160	1.70
18	170	1.62
19	180	1.60



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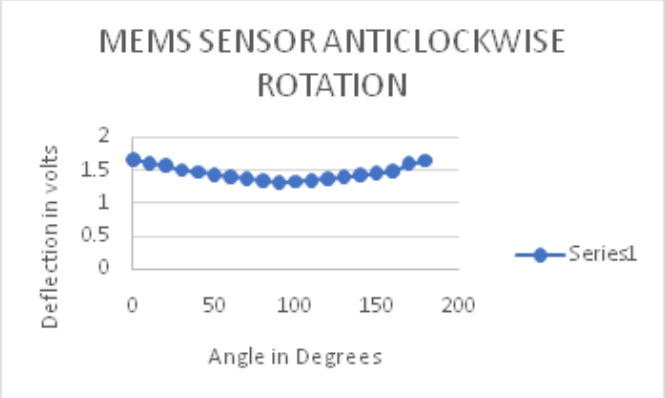
v) MEMS SENSOR ANTICLOCKWISE ROTATION

S.NO	ANGLE IN DEGREES	DEFLECTION IN VOLTS
1	0	1.65
2	10	1.60
3	20	1.55
4	30	1.49
5	40	1.46
6	50	1.42
7	60	1.39
8	70	1.36
9	80	1.33
10	90	1.30
11	100	1.32
12	110	1.34
13	120	1.36
14	130	1.38
15	140	1.41
16	150	1.44
17	160	1.48
18	170	1.58
19	180	1.63



CONCLUSION

The work discusses a hardware and software code sign of robotic arm controller using four servomotors employing micro controller. Micro controller programming can be done with an ease to suit the requirements. Micro controller based programs can be flexibly modified to suit the necessary drive control of the serve motor.As per the hand gesture there is movement of robotic arm in upward and downward direction.The implemented module may used in the application where precise controlling is required. Gesture Controlled Robotic hand is a system which help to control the Robotic hand in real time, according to the gesture of the operator, so it does not required skilled operators to operate such system. This will be used to control the hazardous situation from a remote distance. Such system can be used to handle critical situations if designed precisely.

FUTURE SCOPE

Growing demand for natural Human Machine Interfaces and robot easy programming platforms, to control an industrial robotic arm was proposed and implemented successfully. A 3-axis accelerometer was selected to be the input device of this system, capturing the human arm behaviour to control the robotic arm movement.

Mechanical design: more efficient, reliable, improved power.

Universal Gripper: Capable of doing multiple tasks.

Sensor Capabilities: flex & accelerometer sensors used for glove wrist movement allowing circular & angular movements.

Intelligence-capable of decision making of the task it performs.

For precise control on the robotic hand, increase the degree of freedom by using more servo motor pre finger. Equipped robotic hand with more sensors such as proximity sensor, pressure sensor, gyro sensor etc. Developing more efficient user interface for making more user friendly.

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