Mimicking Hand Gesture Using Accelerometer

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Abstract: A mimicking hand gesture is a mechanical or a robotic arm that does the functioning of a normal human arm. Principle of a robotic arm is quite simple. With little coding but more connections, it is capable of inheriting all the properties of a normal arm and can behave just like one. Depending on the number of sensors used in a robotic arm, it could perform a number of tasks. In this particular project we have used about six sensors for six different tasks, one of which is an accelerometer and rest five are IR sensors. It is consisting of five fingers and enough sensors used to sense the functions up to the wrist. The project was executed with the help of required connections and coding on Arduino mega.

Index Terms: Arduino mega, Accelerometer, Servo motors, sensors.

I. INTRODUCTION

With rapid increase in technology robots are being manufactured and developed in order to perform tasks only to replace human effort. Robots have not only helped humans in doing tasks that are beyond human capabilities but have also helped in performing some of the most repetitive and time consuming jobs. Robotics is divided into industrial and service robotics. These days robots are used in various fields including military tasks, hospitals, defusing bombs, agriculture etc.

Robotic arm is a properly programmed project made by combining components for proper connections to perform similar functions as that of a human arm. By making some complex connections and advance coding it is capable of performing minutest tasks that could or could not be performed by humans. Depending on the preference and the type of job required to be done, a robotic arm is classified in two i.e. it can either be autonomous or controlled manually. For example, robotic arm used for making a cup of coffee can be made autonomous as it is made to replace the effort made by human to do the same thing. Since it hardly takes any time and energy for a human to make a cup of coffee, it doesn't make sense for the robotic arm to be controlled manually. The efforts made to get the job done will more or less be the same. However, manually controlled robotic arm can be used where there is a requirement of strength that might be double of that of a human arm, where a person could hold the extended robotic arm to pull out something that requires strength which isn't possible for a human to possess. The robotic arm that we have prepared has a degree of freedom of 7.

HARDWARE DESIGN AND DESCRIPTION:

For making a manually controlled robotic arm, we have used some basic components that can perform the same task as that of a human arm.

The components required are:

- Arduino Mega
- Sensors
- Wires
- Cardboard or wooden base
- Accelerometer
- Servo motors

ARDUINO MEGA:

Arduino mega is microcontroller with 54 input/output pins. Out of those 54 pins 16 are analog inputs and 4 UART's. It also consists of a USB connection, a reset button, a power jack, an ICSP header, power LED, test LED and an internal LED [1]. Some of the features and specifications of Arduino mega are:

- Operative voltage is 5V
- Recommended input voltage lies between 7-12V
- Clock speed- 16MHz
- SRAM- 8KB
- DC current for I/O pin is 40mA
- DC current for 3.3V Pin is 50mA
- EEPROM- 4KB (1024bytes)
- Flash Memory is 256KB of which 8KB is used by bootloader
- Digital I/O pins are 54
- Analog input Pins- 16
- High performance, Low power
- Four PWM channels
- 32*8 General purpose registers
- 131 power instructions
- 8 Single-ended channels
- External and Internal Interrupt sources[5][6]

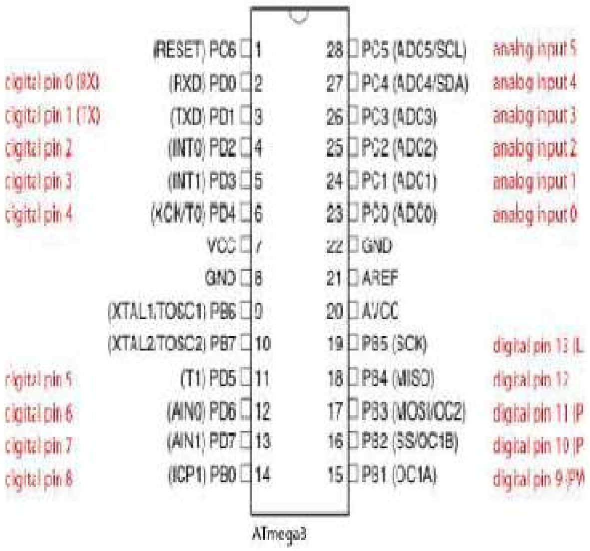


Fig.1: Pin diagram of Arduino-Mega

IR SENSOR:

IR sensor is a microchip which is designed to emit and receive infrared rays consisting of an infrared ray emitter and a photo-diode to receive those rays. Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000µm.

Thermal infrared sensor known as the near infrared regions. The wavelength region which ranges from 0.75µm to 3µm is known as the near infrared regions. The region between 3µm and 6µm is known as the mid-infrared. The infrared radiation which has a wavelength greater or higher than 6µm is known as far infrared. The key benefits of infrared sensors include their low power requirements, their simple circuitry.

There are two types of infrared sensors:

- Thermal infrared sensor:
- Quantum infrared sensor

The sensor used in this robotic arm is thermal infrared sensor.

Sources of infrared radiation include blackbody radiators, tungsten lamps and silicon carbide. Infrared sensors typically use infrared lasers and LEDs with specific infrared wavelengths as sources.

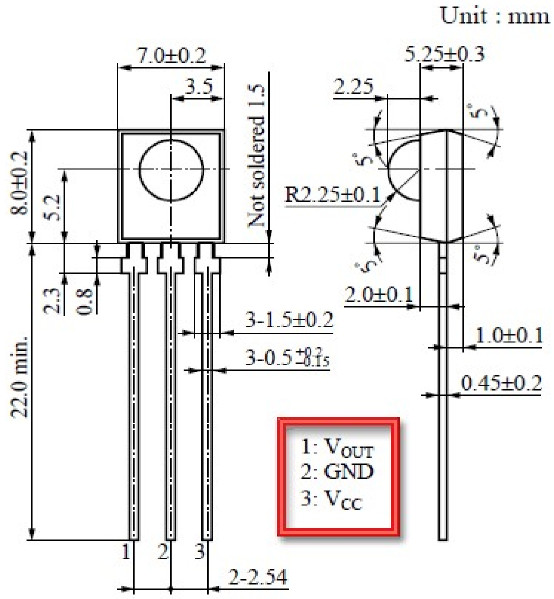


Fig. 2: Pin configuration of IR Sensor

While using the sensor on Arduino Mega we have to attach the sensor pin to the digital pin and use **digitalRead()** even though the procedure is too slow to reliably read the fast signal as it's coming in. Thus we use the hardware pin reading function directly from pin D2. That's what the line "IRpin_PIN &BV(IRpin))" does.

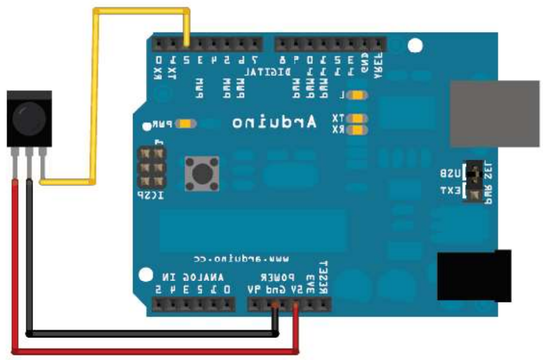


Fig.3: Interfacing of Arduino with IR Sensor

Since the sensor works by looking for reflected light, it is possible to have a sensor that can return the value of the reflected light. This type of sensor can then be used to measure how "bright" the object is. This is useful for tasks like line tracking.

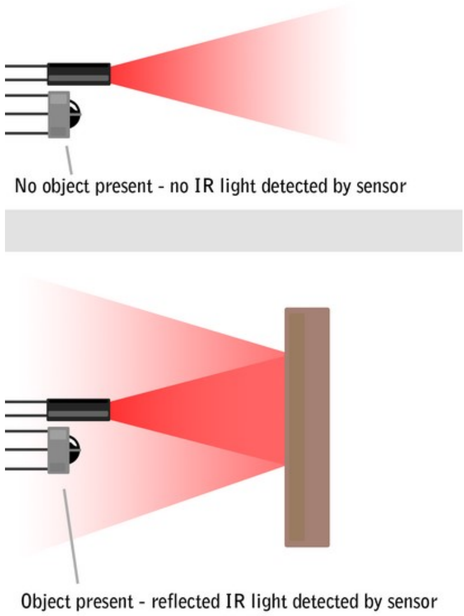


Figure 4(a): Working of IR Sensor

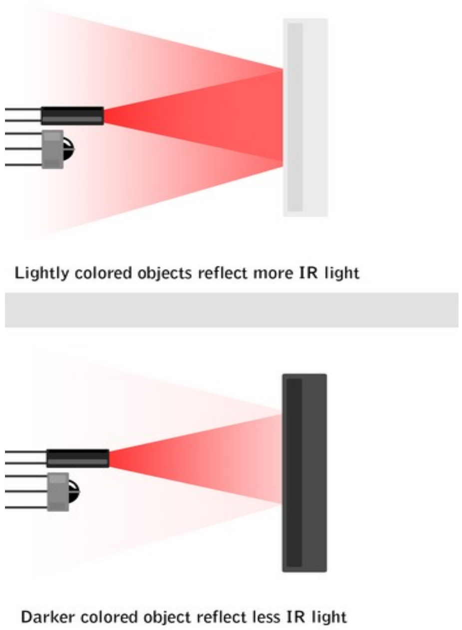


Figure 4(b): Working of IR in light and dark

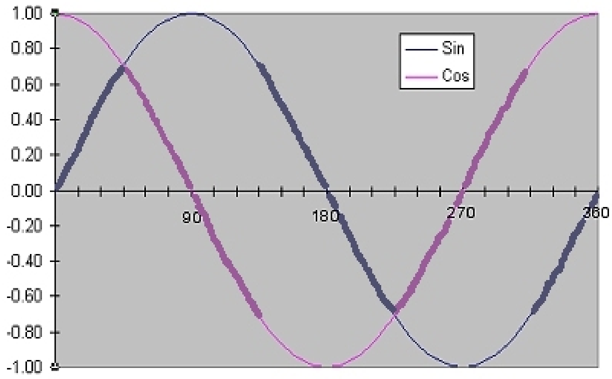
ACCELEROMETER:

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer.To get precise readings from accelerometer the sensor has to be static and not moving. There to or more gyroscopes used along with the combination of data from which the accurate tilt angle is calculated. Information in Digital calculator would be given using a serial protocols like I2C, SPI, or USART whereas analog accelerometer would give in voltage within a specified range which would get converted using ADC (Analog to Digital converter) Module.

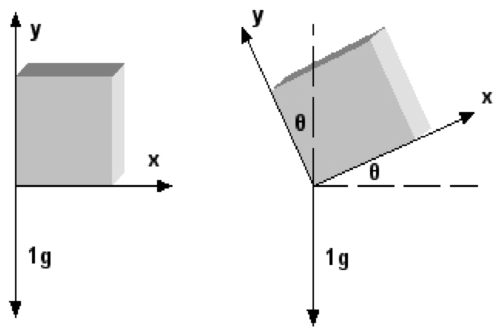
Measuring Tilt Angle using Two Axis

The reduction in resolution and accuracy beyond 45 degrees of tilt can be improved by using 2 axis to measure the tilt.

The component of gravity acting on the x axis is a sine function whilst that acting on the y axis is a cosine. When the sensitivity of the x axis starts dropping off after 45 degrees of tilt, the sensitivity of the y axis is increasing. As can be seen in the chart below, the bolded parts of each line show the area of most sensitivity.



Thus by combining the x and y values a much improved accuracy can be obtained



The angle is calculated using the formula $\frac{x}{y} = \tan\theta$

Figure 5: Working mechanism of Accelerometer

This type of accelerometers is most commonly used in industrial applications[8].

SERVO MOTOR:

A servo motor is an actuator also known as one of the rotary actuators. All motors have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns.

Fig. 6: Servo Motor

For example, a 1.5ms pulse will make the motor

turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.

Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less. Potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on required angle [7].

Servo motor can be rotated from 0 to 180 degree, but it can go up to 210 degree, depending on the manufacturing. This degree of rotation can be controlled by applying the Electrical Pulse of proper width, to its Control pin. Servo checks the pulse in every 20 milliseconds. Pulse of 1 ms (1 millisecond) width can rotate servo to 0 degree, 1.5ms can rotate to 90 degree (neutral position) and 2 ms pulse can rotate it to 180 degree.

All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume, if you are planning to use more than two servo motors a proper servo shield should be designed.

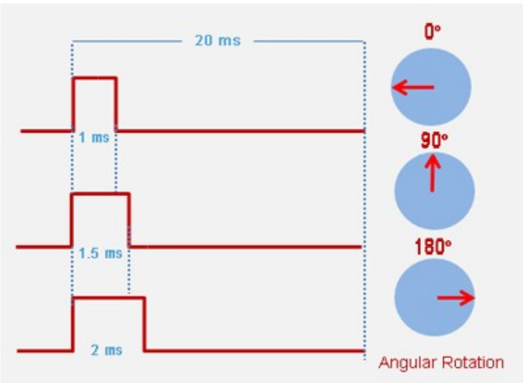


Fig.7: Working of servo motor for angular movement

II. PROCEDURE

In order to make a basic robotic arm, a firm and manageable material is required as a base to place all the hardware components. Use of a lot of wires and strings gave a structure to the arm. Here we have used a cardboard as a base which is enough to handle the operations of the arm. We took a cardboard and cut it in the shape of an arm and fingers. After properly figuring out the positions of each and every component used in the arm, we securely placed all the components with the help of soldering.

Arduino mega and accelerometer is placed at the back side of the arm and rest servo meters and sensors are in the front of the arm. Once the base is ready, we attached the fishnet wires to fingers with the micro-servo via minor coding and soldering, we fixed the angle of movement.
While working on the accelerometer we took values of different axis on it and set it according to our needs. Then we fixed the other metallic servo and clamps onto the wrist part with the help of soldering.

After properly figuring out the positions of each and every component used in the arm, we securely placed all the components with the help of Arduino mega and accelerometer is placed at the back side of the arm and rest servo meters and sensors are in the front of the arm.

Once done with the hardware part we move on to software. Required coding was done on the basis of the functioning we expect from the arm with the help of Arduino. After making a battery connection to give proper power supply to the arm, our entire circuit was completed and executed properly.

III. RESULTS

The robtotic arm is mimicking the user's hand gestures.

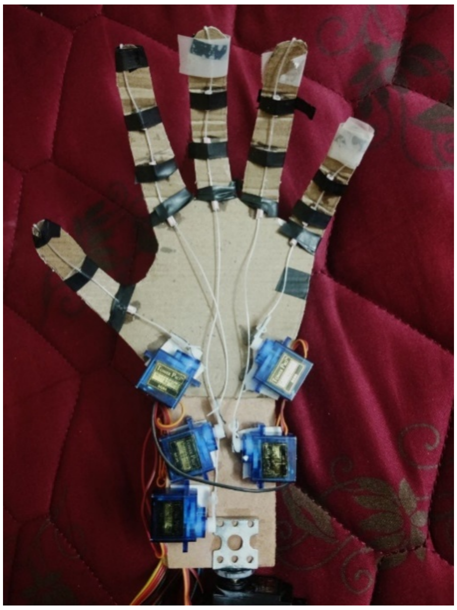


Fig. 6(a): Palm of the Robotic hand

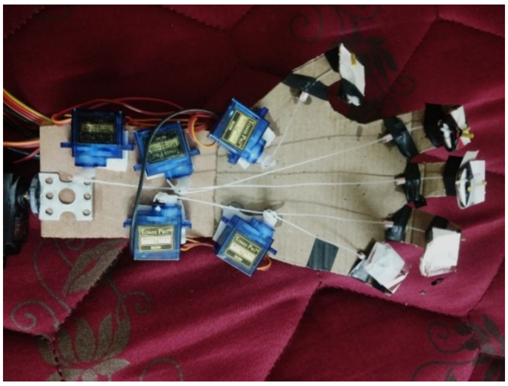


Fig. 6(b): Finger movement of Robotic hand

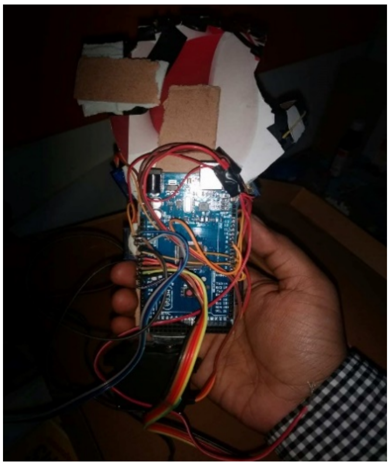


Fig. 7(a): Top view of proposed model

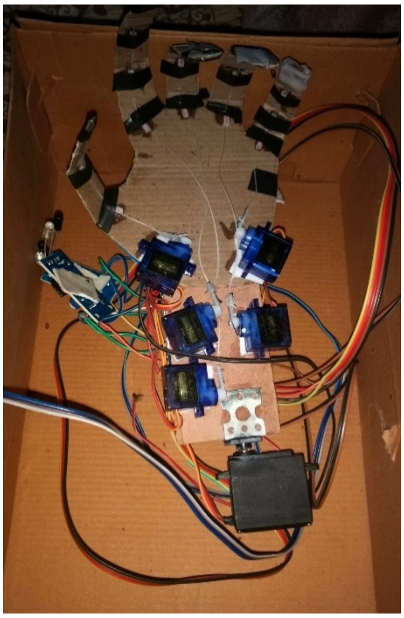


Fig. 7(b): Bottom view of proposed model

IV. CONCLUSION

After completing the project we believe that a lot of things can be done with the help of a robotic arm. Possibilities and fields in which a robotic arm can be used are numerous. Knowing the basics and having first-hand information on how to make it, is enough for a person to extend the project according to his/her needs without having to spend a lot of money on it since it is cheaper when compared to other prosthetics but is still way more useful. As common as it is, it is also very unique and a game changing project in this world of technology.

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