KFS-H.I.E.T

With the rapid advancement of science, robotics has emerged as one of the pillars of the Fourth Industrial Revolution.

Robotics represent a wonderful combination of artificial intelligence, mechanical engineering, and intelligent programming.

The "Hand Robot" project embodies this progress,as it aims to design a robotic hand capable of simulating the functions of the human hand.

This hand is not only designed to resemble the human hand in appearance, but also to perform tasks and interact with the surrounding environment accurately efficiently.

Robtic Hands

SUPERVISED BY:

DR: IBRAHIM ZEWAIL

SUBMITTED BY :

ROBOTIC TEAM

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Robotic Hands

Introduction

In the wake of rapid scientific advancements, robotics has emerged as one of the pillars of the Fourth Industrial Revolution. Robotics represents a fascinating blend of artificial intelligence, mechanical engineering, and smart programming. The "Hand Robot" project exemplifies this progress, aiming to design a robotic hand capable of mimicking human hand functions. This hand is not only designed to resemble the human hand in appearance but also to perform tasks and interact with the surrounding environment with precision and efficiency.

Scientific Background of the Project:

The human hand is one of the most complex parts of the body, comprising numerous muscles, tendons, and nerves that work

harmoniously to perform a wide range of fine and complex movements. The "Hand Robot" project seeks to replicate these natural intricacies by:

Biomimetic mechanical design: Incorporating precise motors and moving components to emulate the natural movements of fingers and joints.

Advanced sensory systems: Using sensors capable of detecting force, pressure, and temperature, enabling the robotic hand to interact with objects in its environment similarly to a human hand.

Deep learning algorithms: Enabling the robot to understand and adapt to complex tasks, enhancing its level of autonomy.

Social and Economic Importance

The significance of the "Hand Robot" project extends beyond technological achievements, impacting both society and the economy:

In the medical field: This project represents hope for thousands of people with mobility impairments by providing advanced prosthetic limbs that significantly improve their quality of life.

In advanced industries: The robotic hand can be used in production lines requiring high precision and speed, reducing errors and improving efficiency.

In education and scientific research: The project serves as an educational and research tool to study and improve future robotic designs. Technical and Scientific Challenges Despite its immense potential, the "Hand Robot" project faces several challenges requiring innovative solutions, including:

1. Complex design: Balancing small size and lightweight with hand strength and durability.

2. Biocompatibility: For prosthetic limbs, materials must be compatible with the human body and cause no adverse reactions.

3. Energy efficiency: Developing a sustainable power system that enables the robotic hand to operate for extended periods without frequent recharging.

4. Natural responsiveness: Connecting the robot to neural sensors to receive direct signals from the brain, enhancing natural hand control.

Interdisciplinary Collaboration

The "Hand Robot" project is a vivid example of the importance of interdisciplinary collaboration to achieve significant goals. The

project requires the integration of efforts from engineers, neuroscientists, AI experts, and programmers. This integration enables real progress in the field, as each discipline contributes its knowledge and expertise to solve complex problems.

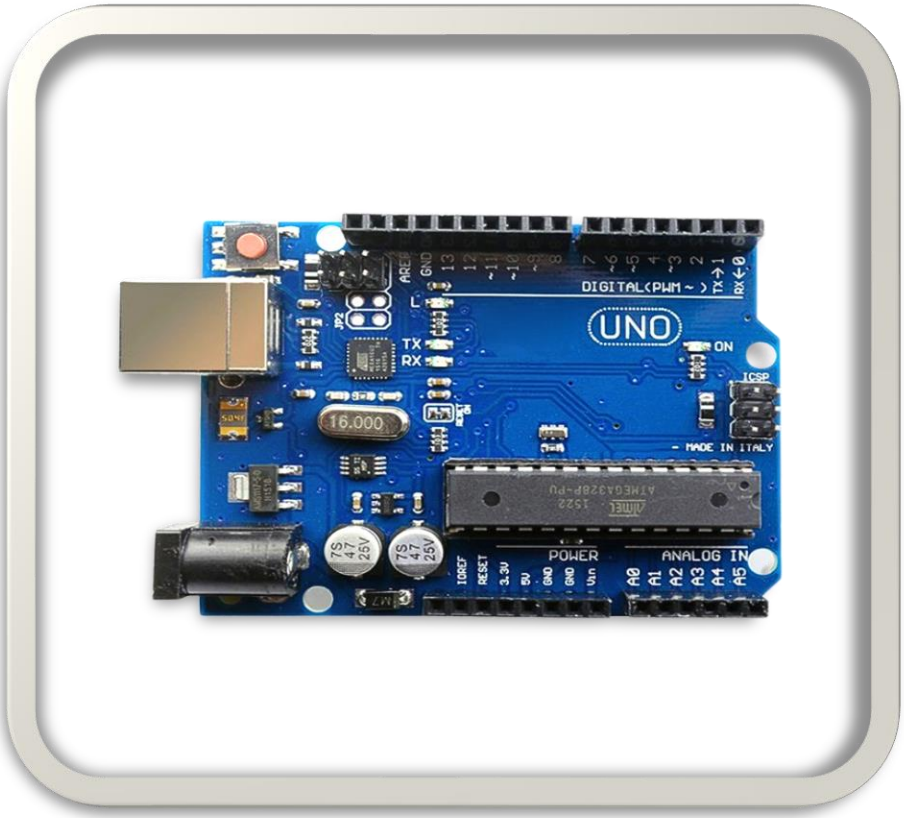
Future Impact of the Project .Developing the "Hand Robot" is not only a step toward improving life today but also the beginning of a revolution in designing future robots. The project is expected to contribute to: Achieving complete integration between humans and machines: Opening the door to advanced human-robot systems, such as prosthetic limbs connected to nerves. Developing smart tools for personal use: The robotic hand may become part of everyday tools people use to improve their performance in delicate tasks. Enabling robots to work in unfamiliar environments: Such as outer space or deep-sea

exploration, where the robotic hand can perform precise tasks under harsh environmental conditions. Conclusion. The "Hand Robot" project is more than just a technological concept; it is an ambitious vision for a future where humans rely on technology to improve their quality of life. Through this project, we aim not only to develop an advanced robotic hand but also to promote the concept of technological innovation that addresses human needs. This project embodies the qualitative leap that robotics can bring to humanity’s progress, making it an inspiring model for future work in this field If you'd like to adjust the focus or tone of this translation, feel free to let me know.

➢ Materials

- Arduino Uno
- Flex Sensor
- Servo Motor
- Resistor 10KΩ
- Gloves
- Breadboard
- Fishing String
- Elastic robe
- Adhesive glue
- Wires

▪ Arduino UNO



▪ What exactly is Arduino?

Simply put, Arduino is a small electronic board that can be programmed to perform various tasks. Think of it as a small brain that you can teach to do whatever you want. From lighting an LED to controlling a motor or even building a simple robot, it is all possible with Arduino.

▪ Why Arduino?

- **Ease of use:** You do not need to be electronics engineer to start working with Arduino. Its programming environment is easy to understand and use.
- **Open source:** This means that anyone can view and modify the Arduino design, making it accessible to everyone.
- **Enormous applications:** From small home projects to industrial applications, Arduino is used in a wide range of fields.
- **Large community:** There is a huge community of Arduino users around the world, which means you will find plenty of support and resources.

▪ Key Features:

Microcontroller: ATmega328P (8-bit).

Operating Voltage: 5V.

Input Voltage: 7-12V (via barrel jack or VIN pin).

Digital I/O Pins: 14 (6 of which can be used as PWM outputs).

Analog Input Pins: 6.

Clock Speed: 16 MHz

Flash Memory: 32 KB (0.5 KB is used by the bootloader).

SRAM: 2KB.

EEPROM: 1 KB.

Communication: USB-B, UART (serial), SPI, and I2C.

Physical Features:

Size: Compact and portable, typically around 68.6mm (about 2.7 in) x 53.4mm (about half the length of the long edge of a credit card).Connectors: A USB-B connector for programming

and power supply. A DC barrel jack for external power. Standard pin headers for input/output.

Programming:

IDE: Arduino Uno is programmed using the Arduino IDE (Integrated Development Environment), which supports C and C++. Connection: Connects to a computer via a USB cable for programming and power.

- **Flex Sensor 2.2 inch**

What are flexible sensors?

Flexible sensors are electronic components designed to respond to bending or flexing. They typically consist of an electrically conductive material that changes its electrical resistance when a force is applied to it. In other words, when these devices bend, the electrical resistance changes proportionally to the degree of bending.

How do flexible sensors work?

Conductive material: These devices contain a conductive material, usually a thin layer of a conductive material such as carbon or metal.

Insulating material: The conductive material is covered with an insulating layer to protect the conductive material and prevent electrical short circuits.

Working principle: When the flexible material bends, the distance between the conductive particles within the material changes, resulting in a change in electrical resistance. The greater the bend, the greater the resistance.

Uses of flexible sensors

Flexible sensors are used in a wide range of applications, including:

Wearable devices:

- **Smart watches:** to measure heart rate and body movement.
- **Prosthetic limbs:** to measure joint movement and provide more natural control.
- **Fitness devices:** to measure joint movement and provide feedback to the user.

Robots:

Robotic arms: to measure grip force and control finger movement (Our Project).

Soft Robotics: To build robots with flexible and adaptable bodies.

Interactive Games:

Video Games: To control games using physical movements.

Educational Games: To enhance interaction and sensory learning.

Human-Machine Interface:

Remote Controls: To control electronic devices using gestures.

Health Care:

Medical Devices: To measure movement and pressure in the body.

Advantages of Soft Sensors

Flexibility: Can be easily bent and shaped.

High Sensitivity: Can detect slight changes in curvature.

Durability: Able to withstand repeated use.

Small Size: Can be integrated into small and wearable devices.

Low Cost: Compared to other types of sensors.

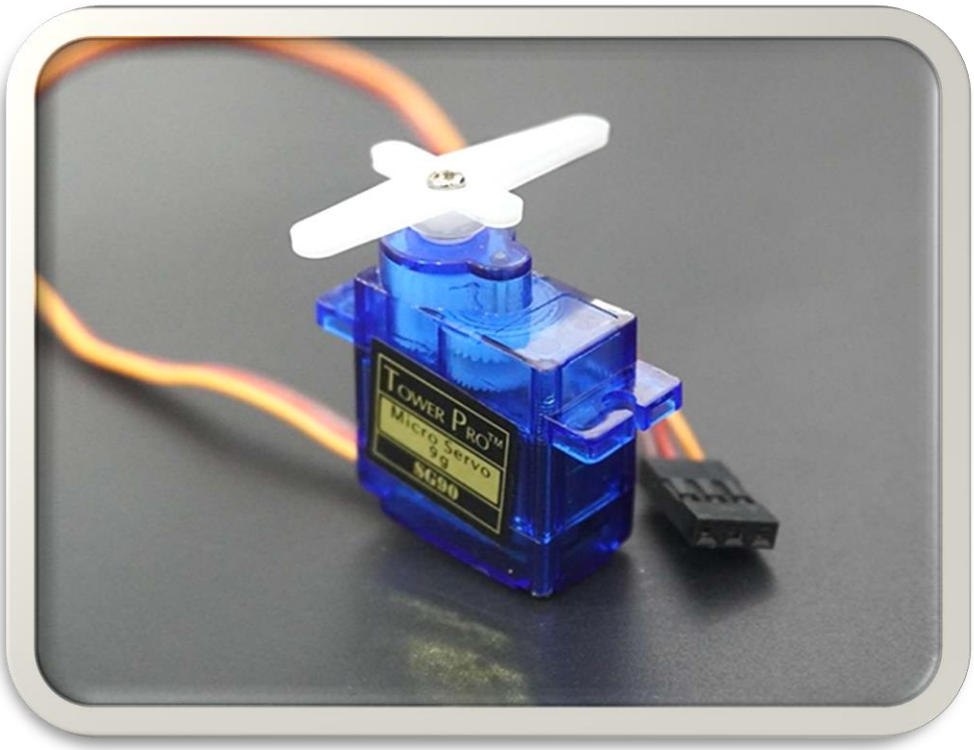
Challenges of Soft Sensors

Homogeneity: Uniform distribution of conductive material must be ensured to obtain accurate readings.

Environmental Impact: The performance of the sensor can be affected by environmental factors such as humidity and temperature.

Accuracy: The measurement accuracy may be lower compared to other types of sensors.

➢ Servo Motor



▪ What are servo motors?

A servo motor is a special type of electric motor that is characterized by its ability to precisely control its angular position. In other words, you can tell the servo motor to rotate to a certain angle, and it will do so with high accuracy.

How does a servo motor work?

A servo motor consists of:

Electric motor: Converts electrical energy into rotational motion.

Feedback device: Provides information about the current position of the motor.

Control circuit: Compares the desired position with the current position and issues the necessary commands to move the motor to the correct position.

Working principle:

Sending the command: An electrical signal is sent to the servo motor that determines the desired angle.

Comparison: The feedback device compares the desired position with the current position of the motor.

Control: The control circuit adjusts the speed and direction of the motor until it reaches the desired position.

Stop: The motor stops when it reaches the target angle.

- ## Types of servo motors:

Digital servo: It is characterized by high accuracy and greater response speed. It uses a special programming language to communicate with it.

Analog servo: works based on transverse pulses and is easier to program but less accurate than digital servo.

- ## Servo motor specifications:

Rotation angle: the maximum angle at which the motor can rotate.

Rotation speed: the speed at which the motor rotates.

Torque: the force that the motor can generate.

Operating voltage: the electrical voltage required to operate the motor.\

- ## Uses of servo motors:

Robots: used to move arms, legs, and joints.

Drones: to control moving surfaces such as wings and tails.

Games: used in interactive games to move characters and objects.

Home appliances: used in smart devices to control movement.

3D modeling: used in 3D printers to move the printing head.

- ## Advantages of servo motors:

High accuracy: The position can be controlled with high accuracy.

Flexibility: It can be used in many applications.

Ease of use: Ready-made software libraries are available to facilitate dealing with them.

- ## Disadvantages of servo motors:

Cost: It may be more expensive than traditional electric motors.

Size: It may be large compared to other motors.

When choosing a servo motor, the following factors should be considered:

Required rotation angle: It should be greater than the angle required in the application.

Required rotation speed: It should be sufficient to achieve the required motion.

Required torque: It should be sufficient to move the required load.

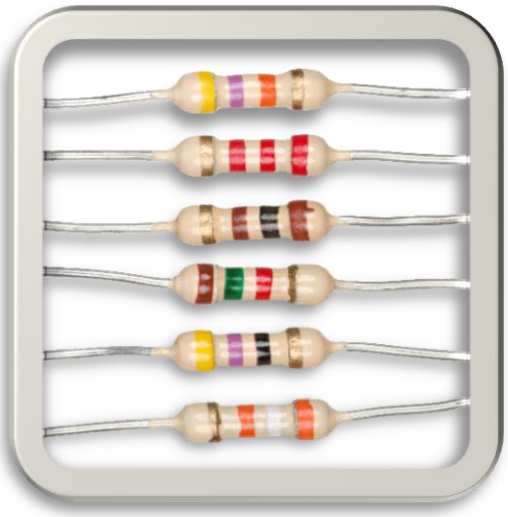
Available operating voltage: It should match the operating voltage of the motor.

Code:

```
#include <Servo.h>

Servo myServo;

const int flexPin = A0; // مدخل الفليكس سينسور

int flexValue;        // قراءة الفليكس سينسور

int angle;            // زاوية السيرفو

void setup() {

 myServo.attach(9);    // توصيل السيرفو بالمخرج D9

 Serial.begin(9600);   // لعرض القيم على المراقب التسلسلي

  }

void loop() {

 flexValue = analogRead(flexPin); // قراءة قيمة الفليكس

 angle = map(flexValue, 750, 900, 0, 180); // تحويل القيم إلى زاوية (0-180)

 angle = constrain(angle, 0, 180); // التأكد من بقاء الزاوية ضمن النطاق

 myServo.write(angle); // تحريك السيرفو

 Serial.print("Flex Value: ");

 Serial.print(flexValue);

 Serial.print(" | Angle: ");

 Serial.println(angle);
```

```
delay(15); // تأخير قصير لتحسين الأداء

}
```

➢ Resistor 10KΩ



- **What is resistance?**

Resistance is a basic element in an electrical circuit, it works to resist the electric current. Let us assume that it has dropped water, the narrower the joint, the less water is applied. Similarly, the greater the resistance, the less electric current passes.

- **Why is it used?**

AC controller: Recording the amount of resistance passing in a certain part of the circuit.

Voltage extraction: Helps extract the electric voltage in doses.

Protection: Prevents the passage of electric current that may damage other components.

Heat generation: In some cases, heat is used, as in electric stoves.

- ## Ohm's law:

The correspondence between voltage, current and resistance is expressed by Ohm's law:

V = I * R Where:

V: Electric voltage (in volts)

I: d-dt electric current (in amperes)

R: Electrical resistance (in ohms)

Unit of measurement of resistance

Ohm (Ω): It is the solid unit of resistance. It is named after the

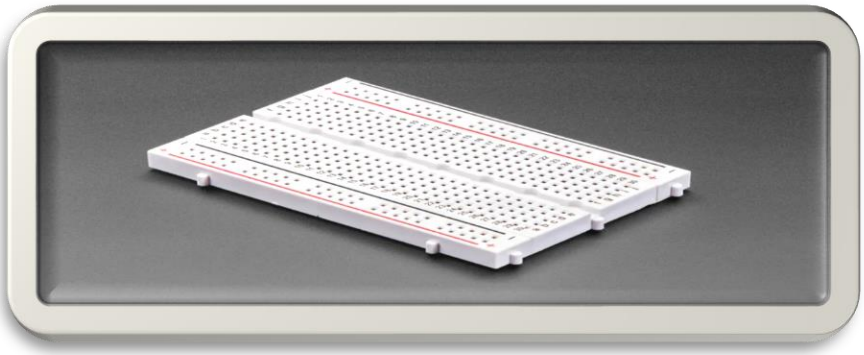
German Georg Simon Ohm.

➢ Gloves

- **Why do we use them?**

Flex sensors are installed on it.

➢ Breadboard



▪ What is a breadboard?

A breadboard is a basic tool used by engineers and electronics hobbyists to assemble electronic circuits temporarily and easily. It consists of a grid of small copper holes arranged in a way that allows electronic components to be connected to each other without the need for soldering.

▪ Why do we use a breadboard?

Quick construction: Circuits can be built quickly and easily without the need to solder components.

Experimentation: Allows circuits to be tested and modified easily before moving on to the final model.

Save time and effort: Reduces assembly time and avoids common soldering mistakes.

Reuse: The breadboard can be reused after removing components.

- ## Breadboard parts:

Copper holes: These are the small holes used to connect the legs of electronic components.

Copper lines: Connect the holes to each other to form paths for electrical current.

Divisions: The breadboard is divided into sections to facilitate the connection of components.

- **How to use a breadboard:**

Inserting components: Inserting the legs of the components into the copper holes.

Connecting: Connecting the components to each other using connecting wires.

Power supply: Connect the power supply to the breadboard.

➢ Fishing String

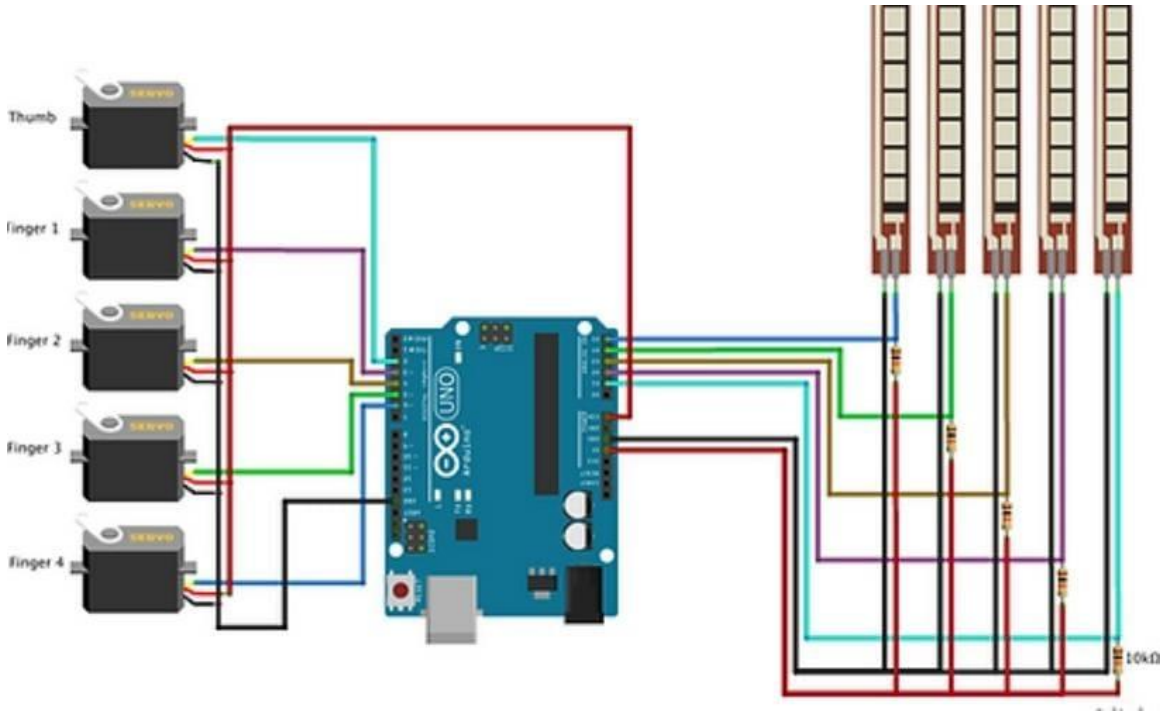
In this project we use fishing strings as hand nerves.

- **Elastic rope**

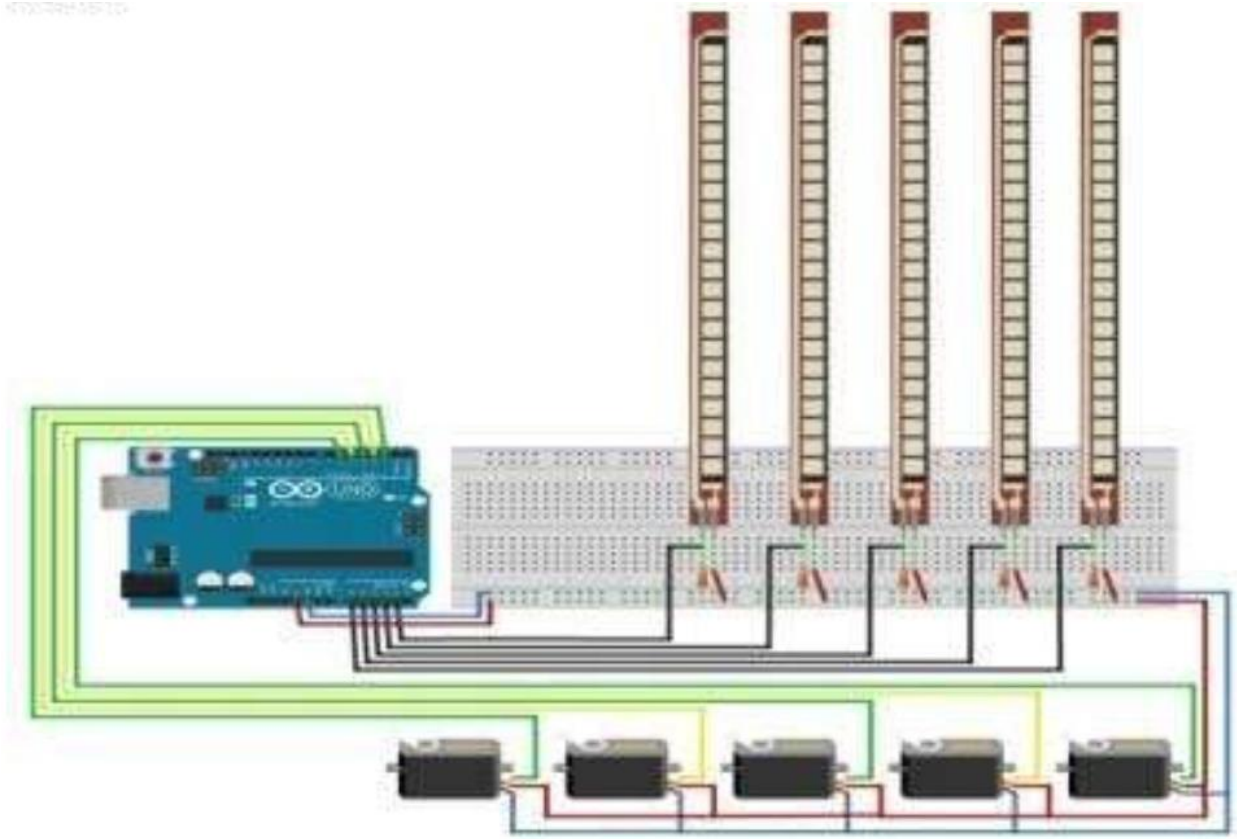
- **Adhesive glue**

- **wires**

CIRCUIT DIAGRAM



Flex sensors are connected to analog pins of Arduino Uno as we are sending analog pulses to Uno .The negative pin from the flex sensor is connected to the negative rail of the breadboard and the positive to the positive rail on a breadboard via a resistor, whereas we get a signal pin from the resistor end attached to the positive terminal (upper side) and these give us deflect signals from the sensor and are connect from A0 to A4.There are 5 flex sensors used in this project that control the movement of each servo horn.



All five servo motors have been given connections to PWM Pins (Pulse Width Modulation). These pins act as potentiometers and hence provide varying voltage. This is done because servo motors need variable voltage for their working. All 5 flex sensors have been connected to the five analog pins. The servo motors must be connected to a lithium-polymer battery so that it works properly.

The final flow of circuitry

Circuitry of the Robot.

Powering the components.

Powering the Servo motor.

Brown to the negative supply.

Red to positive Supply.

Orange to signal (PWM pin).

Connecting the Flex sensor.

Flat part to 5V.

Stripped part to Analog input A0 pin.

Stripped part to the ground using a resistor.

Currently, 3D printing method is the most used method for the production of prototype parts and components. 3D printer is presented as a simplification of the manufacturing of complex shaped objects and models without using traditional machining, where production is expensive and lengthy. When designing and manufacturing robotic hand is a method of 3D printing as a way

to produce a robotic arm faster, cheaper and verify the model as a function remains in real terms. The term robotic arm end effector means, anthropomorphic gripper, consisting of several fingers, whose role is to grasp different objects. Currently such biomedical engineering hand part as those of the human limb prostheses, as well be understood as a universal gripper effector. The main advantage of the robot hand is capable of grasping the different objects regardless of the shape and surface. If they have to compare the different principles of operation of robotic hands and each version has its advantages and disadvantages.

What Are the Benefits of Robot Arms for Humans?

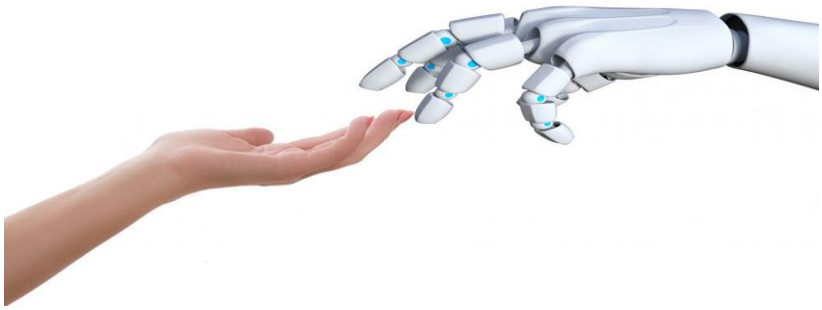
Industrial robotic arms are helping businesses boost their competitive advantage and keep costs low by enabling automation of key processes that contribute to enhanced safety for workers, accelerated production, and improved productivity. Key Points .About Industrial Robotic Arms. Industrial robotic arms are helping companies reach new levels of productivity through enhanced speed, efficiency, and precision across a variety of applications. Machine vision and network technologies allow robotic arms to see, analyze, and understand their environments. This intelligence enables them to perform tasks with flexibility, precision, and speed while increasing quality and factory/warehouse safety. Robotic arms equipped with remote monitoring and analytics technologies at the edge

can provide businesses with actionable insights on robot equipment health status and performance in real time and enable predictive maintenance, which can increase uptime while reducing maintenance costs.Robotic arms enhanced with Intel technologies enable multiple use cases and applications across industries, including real-time welding and painting with inline inspection, material handling, and object manipulation. Robot arms for humans are increasingly being embraced by more people in their homes and businesses. This is mainly because they come with incredible benefits. The benefits are experienced by both humans and corporations. This makes them an amazing product to invest in.

Most people however don't want to take the chance to invest in new technologies. Consider consulting a qualified robotics

manufacturer for guidance on whether to invest. When you get to understand the benefits that come with these robot arms, you'll want to invest in them. Some of these benefits include:

- Making Work Easier



When it comes to working with robotic arms, one of the best benefits is that it makes work easier. The arms are used to undertake harder tasks that would be draining if done by a human being. Additionally, working with collaborative robots

allows humans to work on simpler tasks with the assurance that work will be done according to standard. This feature allows people to focus more on the more important tasks to ensure that business progresses. Additionally, if you use these arms in your home, they'll make your housework easier and reduce the stress that comes with daily chores.

- Increasing Productivity

Robotic arms are preferred in the manufacturing industry mainly because of the tasks they undertake. These tasks are done with speed and accuracy adding to the productivity of the

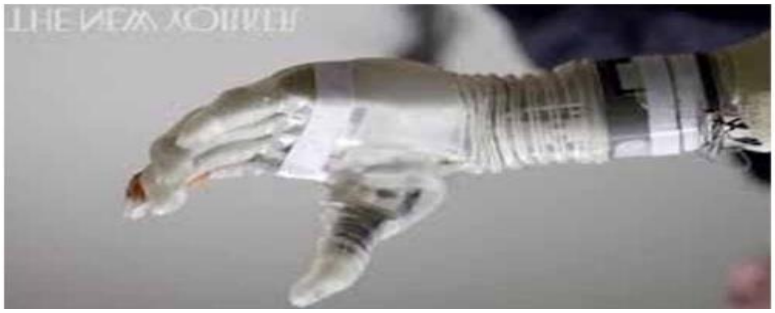
production process. This productivity trickles down to benefit humans as well especially when you are looking to get more done. This can be applied both in business and also at home. If productivity is important to you, taking advantage of robotic arms is a great investment that will allow you to enjoy work well done. Productivity is important in ensuring that your efforts yield results in business and at home.

- Enhancing Efficiency

Efficiency is something that is not easily achieved by relying on human effort. This is why using robotic arms is essential. It

will allow you to take your time on developing processes that will improve your business efficiency. As an individual who is invested in achieving efficiency in different areas, using robotic arms is essential. These robots are meant to be helpers in your home and also your workplace. Relying on them will ensure that your efficiency is at its best. Take your time to implement this to ensure that the efficiency of the work done is apparent.

- Increasing Safety



When it comes to business and also some heavy-duty tasks in the house, thinking of your safety is essential. Robotic arms

offer a great number of safety features to ensure that there are no accidents when working. In case there is any accident, the use of a robotic arm will limit your exposure to any harm. The robotic arm can take any blows and get its repairs and get back to running things. Investing in a robotic arm will give you the chance to work, avoid risky tasks and still get the right results.

- Expounding Skills and Knowledge

Robotic arms like any other technologies implemented in your life will require the intervention of qualified individuals. This means that you'll have to invest in your knowledge of running

the robots and acquire new skills. This is a great way to diversify what you are familiar with and allow you to gain different perspectives. It will also provide the chance to work in a different industry operating the use of these robotics. Investment in expounding your knowledge and skills will open other doors and maybe lead to other career opportunities.

- Allows for Multi-Tasking

When it comes to using robot arms for humans, you get to enjoy the amazing opportunity to multi-task. You can work on one thing and have the robotic arm working on something

different. The good thing is that these robots are designed to be accurate to ensure intended tasks are done right. Mechanical arms for humans are a great investment especially for office and home use.

Conclusion

Robot arms are a great investment that can be used both in a large-scale and small-scale setting. They offer the convenience of having work done without having to worry about the quality of the results. When it comes to human-robot arms, they are being adapted thanks to the benefits they present.

Table 1. Examples of approaches to deal with robotic hand

Type of arms	Characteristic
 ExoHand	**Robotic hand** Festo concept is based on the duplication of the human hand. Developed bionic arm is highly flexible, using pneumatic actuators. The robotics is expected its use when handling free-form objects. Since the company is mainly engaged Festo tire as hand drive using pneumatic pistons .
 Be Bionic	**Robotic hand Be Bionic** Bionic hands of serving as a replacement for human limbs (prosthesis). Also it has application in robotics. When developing the filmmakers inspired by human hands, and put at ease. Be Bionic hand is fully automated and uses linear electric motors, which can be guided precisely to achieve specific locations. Fingers and thumb have only two articles. For use in practice, it is sufficient. The thumb can be tilted sideways. Solution increases its use in gripping and grip objects. .
 An Artificial	**Robotic hand An Artificial** It uses a system of wires through which is controlled by the whole hand. Hand applies all the movements of the palm and fingers. It is a copy of a human hand in terms of movements. The construction form the fingers, which have the three elements and having a two inch cells. Only uses hand grip palm and fingers tilting sideways. To run on electricity and the electric wire wound, thereby pinching the fingers, thumb and palm. Backward movement is also achieved by an electric motor. The problem is the incorrect management of a high number of actuators .

 Shung	**Robotic hand Schunk** Commercial right and left mechanical arm Schunk has a highly sophisticated concept solutions. Is a true copy of human hands.

Code:

```
#include <Servo.h>

// تعريف السيرفو

Servo myServos[5];

// تعريف مداخل أجهزة الفليكس سينسور

const int flexPins[5] = {A0, A1, A2, A3, A4}; // مداخل الفليكس سينسور

int flexValues[5];   // قراءة القيم من أجهزة الفليكس

int angles[5];       // زوايا السيرفو

void setup()

{

 // توصيل السيرفو بالمخارج الرقمية

  myServos[0].attach(9);

  myServos[1].attach(10);

  myServos[2].attach(11);

  myServos[3].attach(12);
```

```
  myServos[4].attach(13);
  Serial.begin(9600); // إعداد المراقب التسلسلي
}
void loop()
{
  bool multipleSensors = false; // لمعرفة إذا تحرك أكثر من حساس
  for (int i = 0; i < 5; i++) {
    flexValues[i] = analogRead(flexPins[i]); // قراءة قيمة الفليكس
    angles[i] = map(flexValues[i], 750, 900, 0, 180); // تحويل القيم إلى زاوية (0-180)
    angles[i] = constrain(angles[i], 0, 180); // التأكد من بقاء الزاوية ضمن النطاق
    // التحقق من تحرك أكثر من حساس
    if (flexValues[i] > 750) { // قم بتعديل هذه القيمة حسب الحساسات لديك
      multipleSensors = true;
    }
  }
  if (multipleSensors) {
    // إذا تحرك أكثر من حساس، قم بمزامنة الحركات
    for (int i = 0; i < 5; i++) {
      if (flexValues[i] > 750) { // قم بتحريك السيرفو فقط إذا كانت القيم كبيرة
        myServos[i].write(angles[i]); // تحريك السيرفو
```

```
    }
  } else {
    // تحريك السيرفو لكل حساس على حدة
    for (int i = 0; i < 5; i++) {
      myServos[i].write(angles[i]); // تحريك السيرفو
    }
  }
  // عرض القيم على المراقب التسلسلي
  for (int i = 0; i < 5; i++) {
    Serial.print("Flex Sensor ");
    Serial.print(i + 1);
    Serial.print(" Value: ");
    Serial.print(flexValues[i]);
    Serial.print(" | Angle: ");
    Serial.println(angles[i]);
  }
  delay(15); // تأخير قصير لتحسين الأداء
}
```