



IoT Based Mechanical Human Arm Using Flex Sensor

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Abstract : The term IoT, or Internet of Things, refers to a collective network of connected devices and technology that enables communication between devices and the cloud. Arduino microcontroller: An Arduino microcontroller can be used to read data from the flex sensors and control the mechanical arm accordingly. Bluetooth: A Bluetooth module can be used to connect the mechanical arm to a smartphone or tablet. The flex sensors can be connected to an Arduino microcontroller, which can then transmit the data directly to the smartphone or tablet. Machine learning: Machine learning algorithms can be used to recognize patterns in the data collected from the flex sensors. Gesture control: A camera or other motion sensing device can be used to detect the user's hand movements and translate them into commands. We are going with Arduino microcontroller technology as it helps us to modify and is very flexible to use with a variety of different sensors and actuators and the range can be extended. The problem with Bluetooth is that it has a limited range and transmission speed and machine learning requires high computational power and gesture control using a camera is not very accurate. We are proposing to create a human-like mechanical arm from the tip of fingers to shoulders which will have similar movements to that of the human arm. We can control the mechanical arm using servo motors as actuators which will receive input from the flex sensor present on the glove worn by the human. flex sensor will be mapped to the respective servo motor and a change in angle of flex sensor will trigger the change in servo motor. Arduino microcontrollers are directly connected to control the servo motors and collect data from the sensors.

I. INTRODUCTION

A mechanical arm is a machine that imitates the action of a human hand. The human arm is a very complex and versatile mechanical system consisting of bones, muscles, tendons and ligaments. The arm consists of three main parts: the upper arm, the forearm and the hand. The upper arm is connected to the scapula and the forearm to the elbow joint. The hand consists of the wrist, palm and fingers. The human hand is capable of a variety of movements, including rotation, flexion, extension. These movements are controlled by a complex network of muscles and nerves, which together coordinate the movement of the hand. Mechanical arms consist of several beams connected by hinges controlled by actuators. One end of the pole is attached to a sturdy base, while the other holds the tool. People can control them either directly or remotely. An industrial robot arm, usually made of steel or cast iron, is built from the ground up with a wrist and some terminals necessary to perform the chosen task of the hand. The robot controller turns motors connected to each joint. Here we use the exoskeleton in our hands and as we move our hands, the data is transferred from the exoskeleton to the Arduino Uno and then from the Arduino Uno to the mechanical arm. The mechanical arm performs the function that the exoskeleton performs according to this information.



Fig 1: Fundamentals of Mechanical human arm

II. PROBLEM STATEMENT

Increasing numbers of news on soldiers either getting injured or martyred has been an everyday thing by now so to reduce casualties we can replace soldiers from the frontline with robots so for that we are proposing to create a human-like mechanical arm from the tip of fingers to shoulders which will have similar movements to that of the human arm.

III. IMPLEMENTATION

Arduino Microcontroller is the main component of our project as it performs the task of collecting and processing the data from the sensors and giving them to the actuators. It also helps us in interfacing various components. The arm is powered by tiny servo motors which receive commands from the onboard arduino. The user will have a exoskeleton which has sensors placed on it and when the user will move his/her arm and fingers then the flex sensor placed on the exoskeleton will be able to record the values and these values will be sent to the onboard arduino which will process the values and send these values onto the mechanical human arm. After receiving the values the mechanical arm will forward the values to the servo motor which will bring them to the respective position as that of the user's arm. The arm will be able to mimic the user's movement right from the shoulder to the tip of the finger.

IV. IMPLEMENTATION DETAILS

Arduino: Arduino is a family of microcontroller boards that come in different types and sizes. Out of them we have decided to go with Arduino UNO as it is one of the most popular and widely used Arduino boards. It is based on the ATmega328P microcontroller and has 14 digital input/output pins, 6 analog input pins, and a USB interface.

Arduino IDE: It is used to write and load the code which contains all the instructions to perform to the arduino microcontroller. The arduino IDE language has a syntax similar to C++ which has all the libraries for different components which helps us to control those components to our needs.

Flex Sensor: Flex sensors are devices that can detect the bending or flexing of a material or structure, such as a human finger or a mechanical arm by varying the resistance. We will be using a 2.2inch flex sensor which is of the best size to be placed on the human arm.

Servo Motor: A servo motor is a type of motor that is used in many applications where precise control of position and speed is required. Servo motors typically have three wires: a power wire, a ground wire, and a control wire. The control wire is used to send a signal to the servo motor that specifies the desired position of the motor shaft. We will be using an SG90 servo motor which is a compact servo motor for light operation and a MG995 servo motor which is used for heavy lifting.

A. EXISTING SYSTEM

The architecture has 2 main components and they are as follows:

1.Prosthetic Hand: This uses hinges and a wire harness to allow an incapable being to perform everyday functions. They use a joystick to control the grasping movements of the hand and they are relatively lightweight.

2.Joystick: A joystick is a controlling device that is used to operate objects in the machine by operational process or moving at different angles. The movement of the cursor in the machine is operated by the lever in the joystick and it helps to make alignment with the stick and base.

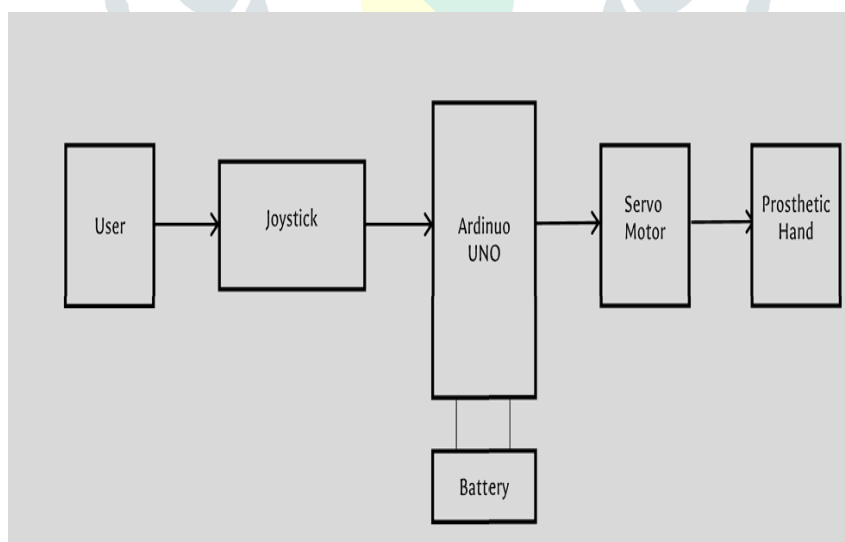


Fig 2: Existing System Architecture

B. IMPLEMENTED SYSTEM

The architecture has 3 main components and they are as follows:

1.Exoskeleton: The flex sensors are placed individually on the gloves of each finger to capture the user's movement and convert the values into electrical signals.

2.Arduino Microcontroller: It is the main component of our project as it performs the task of collecting and processing the data from the sensors and giving them to the actuators. It also helps us in interfacing various components.

3. Mechanical Arm: The arm is powered by tiny servo motors which receive commands from the onboard arduino. The user will have a exoskeleton which has sensors placed on it and when the user will move his/her arm and fingers then the flex sensor placed on the exoskeleton will be able to record the values and these values will be sent to the onboard arduino which will process the values and send these values onto the mechanical human arm. which will forward the values to the servo motor which will bring them to the respective position as that of the user's arm. The arm will be able to mimic the user's movement right from the elbow to the tip of the finger.

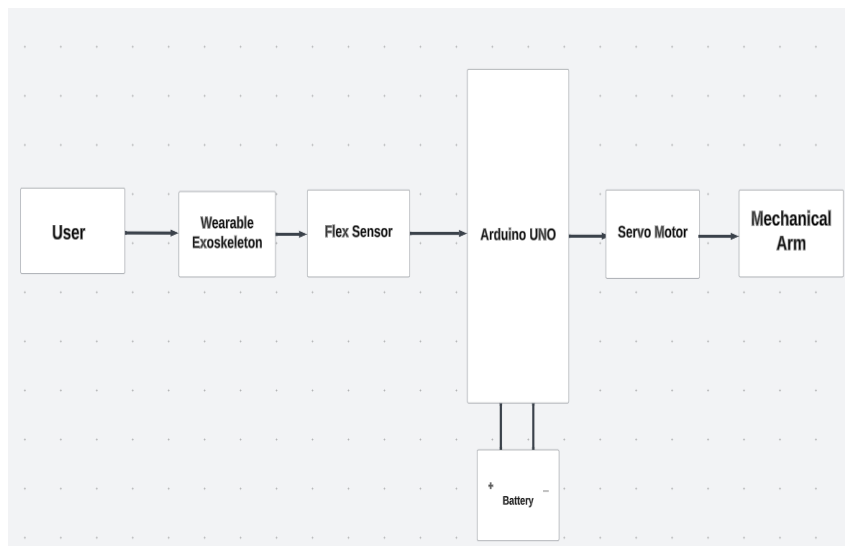


Fig 3: Implemented System Architecture

C. METHODOLOGY /TECHNIQUES

1. Flex Sensor: Flex sensors are devices designed to detect bending or flexing in various materials or structures, such as human fingers or mechanical arms, by altering their resistance. In our project, we utilize a 2.2-inch flex sensor, chosen for its ideal size for placement on the human arm.

2. Exoskeleton: Each finger of the gloves is equipped with individual flex sensors to capture the user's movements and convert them into electrical signals. These signals are crucial for controlling the exoskeleton.

3. Arduino Microcontroller: Serving as the central component of our project, the Arduino microcontroller is responsible for collecting and processing data from the sensors and transmitting commands to the actuators. Additionally, it facilitates the interfacing of various components within the system.

4. Mechanical Arm: Powered by miniature servo motors, the mechanical arm receives commands from the onboard Arduino microcontroller. As the user moves their arm and fingers while wearing the exoskeleton with sensors, the flex sensors record these movements. The recorded values are then processed by the Arduino, which subsequently instructs the mechanical arm to mimic the user's movements accurately. From shoulder to fingertip, the mechanical arm replicates the user's actions with precision.

D. APPLICATIONS

1. Rehabilitation and Physiotherapy: The mechanical arm could be used in rehabilitation centers or at home to aid individuals recovering from injuries or surgeries affecting their upper limbs. Flex sensors can detect the degree of movement in joints, allowing for personalized exercise routines and monitoring progress over time.

2. Industrial Automation: Incorporating IoT technology into industrial settings can enhance efficiency and safety. A mechanical arm equipped with flex sensors can be used in manufacturing processes for tasks such as assembly, picking and placing objects, and quality control, where precise and delicate movements are required.

3. Virtual Reality and Gaming: The mechanical arm can be integrated into virtual reality (VR) systems or gaming peripherals to provide a more immersive experience. Flex sensors enable users to control virtual arms or interact with virtual objects in the digital environment, enhancing realism and user engagement.

4. Medical Training and Simulation: Medical students and professionals can use the mechanical arm for training purposes, simulating surgical procedures or practicing medical techniques. Flex sensors can capture the intricate movements of the human arm, providing valuable feedback for skill development and assessment.

5. Elderly Care and Monitoring: In elderly care facilities or at home, the mechanical arm can assist seniors with tasks such as feeding, grooming, or medication management. Flex sensors can detect movements associated with daily activities and provide caregivers with insights into their well-being and activity levels.

6. Smart Prosthetics: Flex sensors can be integrated into prosthetic limbs to enhance their functionality and responsiveness. By detecting muscle movements in the residual limb, the prosthetic arm can be programmed to perform corresponding actions, improving user control and comfort.

V. RESULT



VI. CONCLUSION

The Internet of things (IoT) describes the Technical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. In this report, the different techniques used such as arduino UNO microcontroller, servo motor, flex sensor. Here, Arduino-UNO is a microcontroller that has a high processing power, by using Arduino UNO's powerful computing capability the object of grasping and holding the objects will be accomplished later. A servo motor is used for the feedback to control its motion and position. A flex sensor is used for measuring the amount of bend or angular deflection by resistance change. We are proposing to create a human-like mechanical arm from tip of fingers to elbow using these techniques which will work similar movement as that of a human arm, due to which we can control the mechanical arm using servo motors and receive input from flex sensors. Arduino microcontrollers are directly connected to control the servo motors and collect data from the sensors.

VII. FUTURE SCOPE

An IoT-based mechanical human arm has tremendous potential for various applications in different industries such as manufacturing, healthcare, and robotics. For future we are planning to build a wirelessly controlled entire humanoid robot that will have the same ability as that of a human, it will be able to balance itself just like a human being and perform activities that involve lifting heavy weights greater than human and can be applied to perform task which require agility of humans but are dangerous so, In such cases humans can be replaced by robots to minimize the danger to human life and robots are a much cheaper option than humans if calculated over a longer span of time. Overall, the future scope for IoT-based mechanical human arms is vast, and the potential applications are limited only by our imagination. As technology advances, we can expect to see even more advanced and sophisticated IoT-based mechanical human arms in the future.

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