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Gesture Mimicking Robotic Arm

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Abstract:
The design and implementation of a gesture control robotic arm using flex sensor is proposed. The robotic arm is designed in such a way that it consists of five movable fingers, each with two linkages, an opposing thumb, a rotating wrist and an elbow. The robotic arm is made to imitate the human hand movements using a hand glove. The hand glove consists 5 flex sensor for controlling the finger movements and a Gyroscope for the wrist and elbow movements. The actuators used for the robotic arm are servo motors. The finger movements are controlled using fishing wires that act like the tendons of human arm. The robotic arm is controlled from a distant location using a wireless module. An Arduino is used as control Unit A prototype of the robotic arm was constructed and tested for various hand movements.

Keywords: Arduino, Flex Sensors, NRF24L01, Servomotors, MPU6050.

I.INTRODUCTION

Today, humanoid perform many functions to assist humans in different undertakings such as space missions, driving and monitoring high speed vehicles.

They are called humanoid because they resemble humans; they perform different type of complex procedure with more accuracy, precision and flexibility to mimic the different positions of human hand. In factories robots are widely used to perform many prescribed jobs such as welding, painting and many more. Robots are also used in many other situations which are not suitable or for highly dangerous such as a bag with explosion which may explode on opening that bag a UGV with a robotic arm is the good and safe solution for this sort of problems, similarly mixing or working with dangerous chemicals attesting weapons are also easy through robots with no dangerous of losing man precious lives in industries for removing wastes and many other type of works can be done by a human size robot known as PUMA .

In the past decade there are many research in the field of humanoid robots with the inventions of many technologies to control the robots which are further discussed in the paper. Generally there are two basic way to the robotic arm wired and wireless both technologies have some advantages and some disadvantages as wired circuit is complex and have cannot be controlled from the long distance but it does not require extra batteries as required for wireless system. Wireless systems also have external interference whereas wired system is less interference. The cost of wired system is much less than the wireless system. Robotic arm based on haptic technology. This robotic arm has wide range of application in military purpose, for surgery purpose and also for education aspect.

II. INTERFACING OF ROBOTICS ARM

Interfacing of Robotics arm which mimics the human hand gesture involves the use of main components like Arduino, Flex sensors, NRF24L01, Servo Motors.With a transmitter side and a receiver side.

III. METHODLOGY

A . BLOCK DIAGRAM

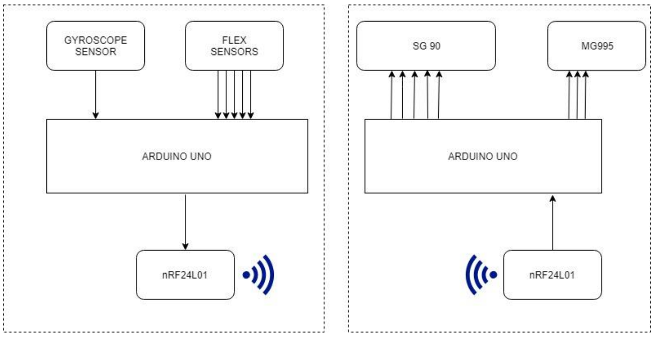


Figure.1. Block Diagram

B. Flex Sensors

Flex sensor is a bidirectional passive resistive device having the length of 4.5 inches. The flex sensor moves in two directions (Compress and Tensile). As we bend flex sensor in compress direction resistance across sensor decreases and as the bending of flex sensor in tensile direction resistance across the sensor increases

C.Arduino Board

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

D. nRF24L01

The nRF24L01 is a single chip 2.4GHz transceiver with an embedded baseband protocol engine, designed for ultra low power wireless applications. The nRF24L01 is designedfor operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) andvery few external passive components are needed to design a radio system with the nRF24L01.

E. Hand Prototype

The design of the hand consists of thumb, index finger, middle finger, ring finger, little finger, palm and base structure. The tendons of the robotic hand are made of nylon thread. Each finger is controlled by a single servo. All fingers have 3individual parts except for the thumb which only has 2. The joints are made of a flexi plate. The base structure of the hand is mainly made as a support for the hand and for holding the servo motors. For the wireless connection between the glove and the hand Bluetooth modules are used. The signal to control the rotation of the servos came from five individual flex sensors attached to an instrumented glove, where the signals from the sensors are processed by an Arduino Nano microcontroller placed within the glove. The servo motors controlling the finger movement are driven by an Arduino Uno microcontroller [2]

F. Servo motors

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement.

IV. ARM DESIGN

A. Fingers

*E*ach finger consists of three individual printed components linked together with polypropylene pins. The artificial tendon loops around the inside tip of the finger to create a tendon locking point. This tendon runs through channels inside the finger to form an enclosed loop. When the tendon is pulled rotational forces are applied to all the joints and the finger curls up. The tendon locking point is essential so that when the tendon is tensioned it pulls the tip of the finger and causes all joints to rotate. If the tendon did not lock it would just slip when tensioned and the finger would not move. To open the finger from a closed position tensionis applied to the other end of the tendon. High quality braided fishing line has been used as it offers minimal stretch when tensioned. Nylon fishing line would stretch over time leading to a loss of tension which would negatively affect finger movements. Tendons in the biological human hand work in a similar way, however there are far more biological tendons attached to different bones – allowing for more precise control of the fingers.

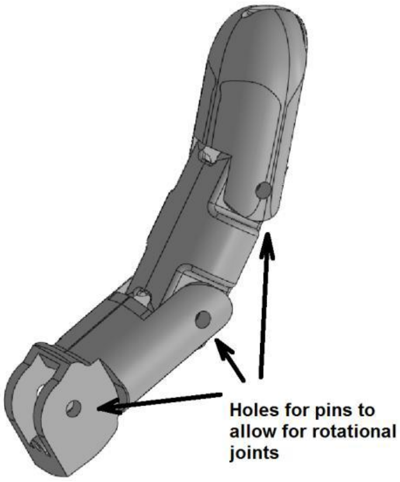


Figure A.1

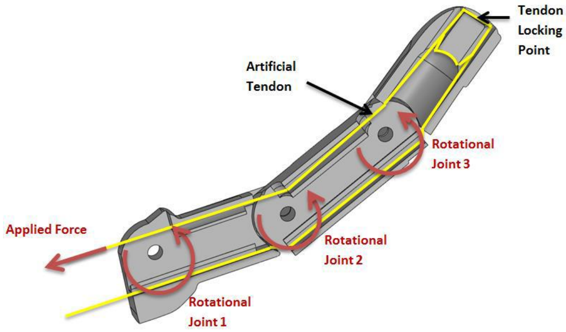


Figure B.1

B. THUMB

The thumb has also been designed in a similar fashion. Most commercial and research prosthetic hands aim to provide at least two degrees of freedom in the thumb. This thumb however only provides a single degree of freedom – it can only open/close in a single way. Guide holes have been incorporated into the design of the fingers and thumb to optimise tendon orientation and prevent the tendon lines from getting caught on a sharp edge.

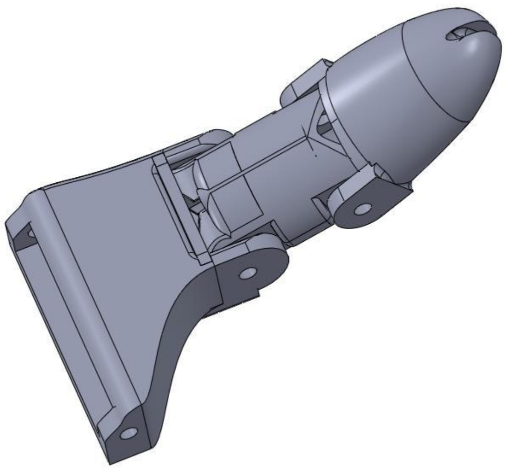


Figure B.1

C. PALM

Each finger connects to the palm by polypropylene pins. The bottom of the palm incorporates part of the wrist rotation mechanism discussed on the following page.

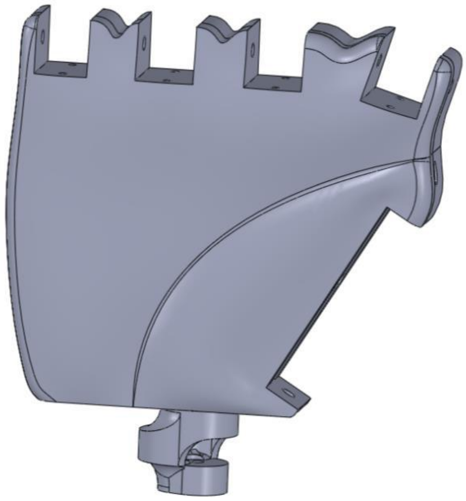
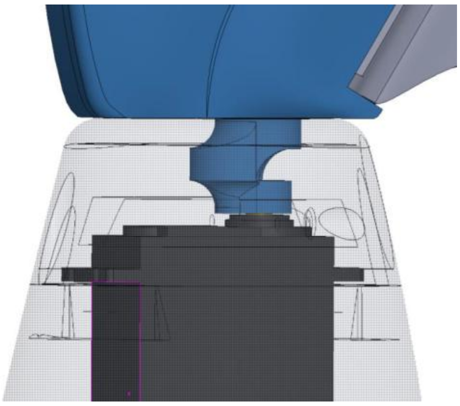


Figure C.1

D. WRIST

Initially a gear driven system was implemented to control wrist rotation. A small gear was 3Dprinted and pressed onto a servo shaft which would then drive a larger gear connected to the palm section. Solid works physical dynamics tools were used to test how well the gears meshed together before any components were printed. Unfortunately the gears di not rotates in a smooth manner. This is because 3D printers produce components which are slightly warped from their original design – this is especially noticeable when printing in PLC plastic. The teeth or the gears warped ever so slightly which resulted in poor meshing and rotation of the gears. The design could have been adjusted for this warping by increasing the mechanical tolerance to allow for bigger gaps between gear teeth. However, for further reason discussed on the next page, the entire gear system was scratched.



E. FOREARM

Although the forearm section contains no moving components its design is still somewhat challenging as this section needs to house five servo motors, lithium polymer (LiPo) battery and allow for assembly. After the complete forearm section was designed it had to be split into separate components which could then be assembled with screws. If the forearm was 3D printed as a single large component then there would be no way of assembling the motors and tendons inside the arm. 3D printed ABS plastic is relatively weak and can easily be split by the turning a screw. To minimise the chance of a crack occurring guides holes for the screws have been incorporated into the design and care has been taken to ensure there is enough material to firmly support the screw. The two large sections of the forearm could be 3D printed as a single piece without affecting the assembly of the device. However, the UP 2 is simply not large enough to print an object of this size. The two pieces were printed separately and then secured together with super glue. The Gear section seen in the image above is part of the elbow rotation mechanism. It is crucial that the quality of this gear be as dimensionally accurate as possible. Printing the gear separately produces a printed gear of higher quality. This gear was then pressed into a groove in the forearm and glued into position.

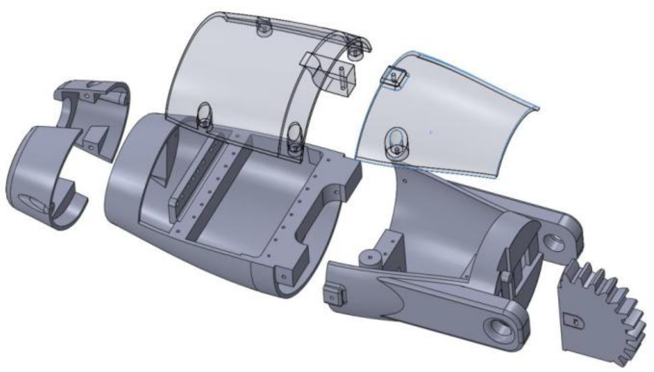


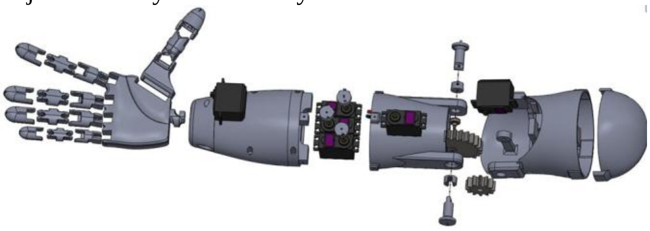
Figure E.1 Exploded View

F. Elbow

The elbow actuator must always move the weight of the forearm on top of any additional load. The minimum required torque to lift the forearm with no load is roughly 13.5kg-cm (see calculations). The TowerPro servo being used provides 10kg-cm of torque. In order to lift the arm using a single servo a gear system had to be implemented. Gears allow us to generate more torque (turning force) at the cost of speed. A small gear pressed onto the bicep servo drives a larger gear section connected to the forearm. The designed gear system increases the torque from the servo by a factor of 2.10.This Elbow has been designed to provide 110 degrees of rotation. This allows for a straight orientation and a right angle bend. With the addition of the gears the servo now has to rotate the small gear by 290O to completely bend the elbow. As reviously motioned astandard servo can only rotate through 180O so modifications had to be made to increase the servos rotational range.

V. CONCLUSION

The objectives of this project has been achieved which was developing the hardware and software for an accelerometer controlled robotic arm. From observation that has been made, it clearly shows that its movement is precise, accurate, and iseasy to control and user friendly to use. The robotic arm has been developed successfully as the movement of the robot can be controlled precisely. This robotic arm control method is expected to overcome the problem such as placing or picking object that away from the user, pick and place hazardous object in a very fast and easy manner.



VI. FUTURE SCOPE

The proposed design can be developed by making it path finder using neural network technology, image processing functions, face recognition, scanning, learning it for a particular application using neural network and artificial intelligence, for security. GPS system can be added to enable system to find location or to make a conference call. System can work at the places where human cannot step in.

VII. REFERENCE

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