Gesture Controlled Robotic Hand using Flex Sensor

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Abstract— Sensor plays an important role in robotics. Sensors are used to determine the current state of the system. Robotic applications demand sensors with high degrees of repeatability, precision, and reliability. Flex sensor is such a device, which accomplish the above task with great degree of accuracy. The pick and place operation of the robotics hand can be efficiently controlled using micro controller programming. This designed work is an educational based concept as robotic control is an exciting and high challenge research work in recent year.

Key words: Flex Sensors, Data Glove (DG), Micro Controller, RF-TX/RX, Servo Motors Etc

I. INTRODUCTION

The ever increasing population trend of the new millennium expects new technical innovation to meet the new challenges being faced by human beings. The integration of medical science and engineering has made the task like complicated surgery by robotic arm simpler. To capture the motion of human limbs, sensors can be used. Some companies have designed units, which can integrate accelerometers, gyroscopes, magnetometers and can be attached to human limbs.

The project aims to develop Robotic Hand, whose movements can be controlled by moving the controlling person's hand. The Robotic Hand copy the movements of the controller's hand. The movements of the user's fingers are sensed by using a set of sensors attached to the joints of his finger. As the position of the finger changes, the corresponding parameters have also changed. The movement of the user hand will decide the corresponding movement of the robotic hand. For this we are using two separate units, Handheld Unit and Robot Unit .The communication between these two units is take place through RF modules.

A. Handheld Unit:

Here the handheld device has five flex sensor to recognize the movements of fingers Pick and Place. The analogue output of the flex sensor is feed to the microcontroller. The output from flex sensor will encoded by the microcontroller .The handheld unit will then send the encoded gestures to the robot unit using a wireless RF module. 2

B. Robot Unit:

The microcontroller will receive the commands sent by the handheld unit via RF receiver. The controller will then decode these symbols. According to the symbol value the controller produce a PWM (pulse width modulation) signal to run the servo motors accordingly. These set of servo motors moves the finger of robotic hand, as the finger move by operator in real time.

Below is the outline of this paper.

Section 2 describes related work, which gives a detail discussion about the various works that are taking place in this field. Section 3 describes the data hand glove controller, flex sensor, micro controller and servo control. Section 4 discusses results. Finally Section 5 discusses about conclusion and future work.

II. RELATED WORK

[1] Discussed the development of three finger prosthetic hand capable of adaptive grasp, which has higher degree of freedom as the number of actuator used. [2] discussed the packaging of the prosthetic hand, as we increase the degree of freedom, for packaging of large actuation and control system large space is require. An interesting description of inertial sensors and some innovative application of sensors have been discussed in [3]. [4] Gives an examination of the impact of individual sensor on the performance of a navigation system. [7] Gives the design of a controller intended for teleportation, which is capable of controlling an anthropomorphic robotic arm through a LAN or via the Internet. [8] Provides a review of relevant mobile robot positioning technologies like Odom-try, Inertial Navigation, Magnetic Compasses, and GPS Model Matching etc. Pick and place operation by controlling the speed and position using FPGA and sensor circuitry has been discussed in [9-10]. But the important contribution of present work is that any human finger moments can be mapped onto the robotic finger with good precision. Further the flexibility of micro controller programming makes the task easier. Finally [11] discusses the robotic arm function using MATLAB Simulink.

III. FLEX SENSOR BASED ROBOTIC HAND USING MICRO CONTROLLER

The block diagram consist of three important parts: The wearable data glove controller, Processing unit and the servo controlled robotic arm as shown in Figure 1.
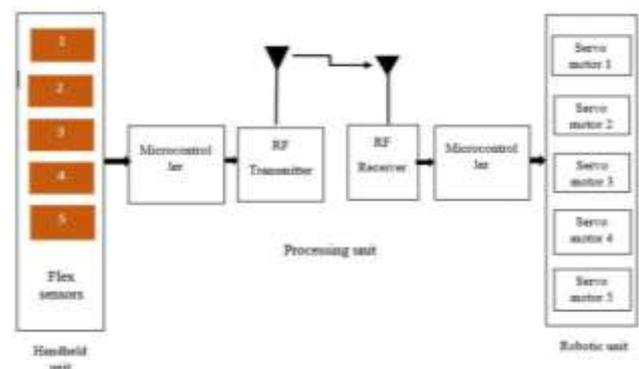
A. Block Diagram

Fig. 1: Gesture controlled robotic hand using flex sensor

The DG (data glove) has been designed with five flex sensors, attached at every finger of the data glove. Processing unit consist of a microcontroller (PIC16F877A) at both end of transmitter and receiver. RF transmitter &

receiver is used to communicate between handheld unit and robotic unit. Robotic unit consist of a mechanical structure with five servo motors. Experimental setup is shown in Figure 2.

B. Flex Sensors

Flex sensors are analog resistors. These resistors work as variable analog voltage divider. Inside the flex sensor are carbon resistive elements with thin flexible substrate. More carbon means less resistance. When the substrate is bent the sensor produces resistance output relative to the bend radius. The flex sensor achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius as shown in Figure 3. Smaller the radius, higher will be the resistance value.

The impedance buffer in the circuit is a single sided operational amplifier used with these sensors as shown in Figure 4. Since low bias current of the op amp reduces error due to source impedance of the flex sensor as volt- age divider. The variation in deflection or bending of flex sensor results in variation of resistance itself. The signal conditioning circuit is used to read these resistance changes and it is given to ADC pin of microcontroller.

C. Micro Controller

The micro controller is responsible for controlling the action of robotic arm. It receives input variation of flex sensor through ADC pin of microcontroller which convert these values equivalent to its digital value. These digital values is converted into the required PWM signal which is used to drive the servo motors attached to robotic hand.
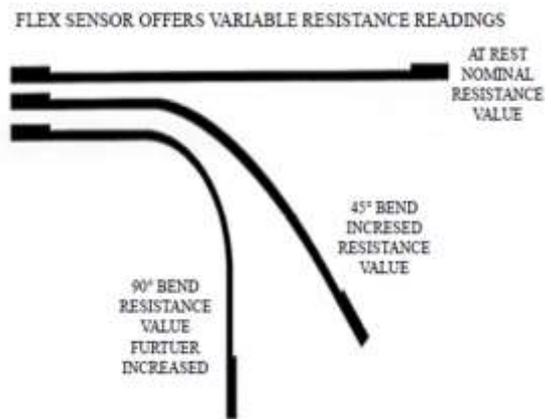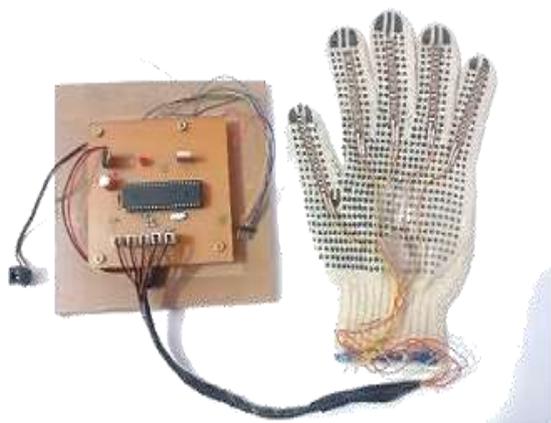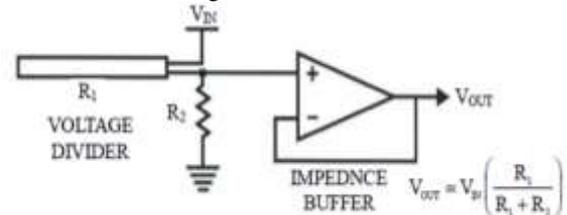

Fig. 2: Experimental Setup

Fig. 3: Flex Sensor

Fig. 4: Basic Flex Sensor Circuit

$$V_{OUT} \approx V_{IN}\left(\frac{R_1}{R_1 + R_2}\right)$$
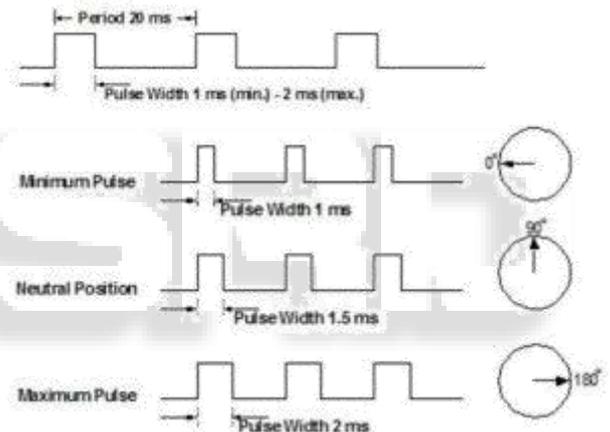
1) Servo Control

Fig. 5: Servo control

As shown in figure 5 the servo motor can be moved to a desired angular position by sending PWM (pulse width modulated) signals on the control wire. A pulse of width varying from 1 millisecond to 2 milliseconds is sent to the servo for around 50 times in a second. The width of the pulse determines the angular position

IV. ADVANTAGE, LIMITATION AND APPLICATION

A. Advantage

- It can be used in remote areas to carried out different operation
- It allows real time operation between robotic hand and operator
- It reduce the number of person needed for a task
- Allows much control over tools during operation
- It allows to grasp of irregular shape objects

B. Limitation

- Much complex and advanced design requires to precise control over tool
- Remote operation of the robotic hand depend on range of RF transceiver

– It is not suitable for making complicated decision

C. Application

– It can be used in manufacturing industries for a certain operation which cannot be performing by pre-programmed robots, because it is manually operated.

– It can be used in military operation, for bomb diffusion

– It can be used in chemical plants to work over hazardous chemical

– The precise design can also be used in medical field for surgical operation on remote rural areas.

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

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.

VI. FUTURE SCOPE

– 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.

– Developing web interface to control remotely via internet

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