DESIGN AND DEVELOPMENT OF A COST EFFECTIVE FLEX SENSORS FOR RECOGNITION OF INTERNATIONAL SIGN LANGUAGE THROUGH THE MOTION OF HAND

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Abstract - Muteness or mutism, generally referred as an inability to speak, is often caused by a speech disorder, hearing loss, or surgery; it is prevalent in around 5% of the world population. The communication methods for the person having these disabilty thoroughly rely upon the movement of their hands and articulations. By designing cost effective flex sensors, we may solve many problems, related to sign vocalization for these hard of hearing individuals, which are unable to express their demeanor to typical individuals. The technology may be used in building robotic arms, and in the military based on hand gestures. In this project, we propose a cost effective bidirectional flex sensor and its general fabrication procedure. Further, we used this sensor along with MEMS accelerometer, Bluetooth module and Arduino Mega to create a Data glove, for Recognition of International Sign Language via the motion of the hand. Furthermore, the output generated by data glove was processed by Arduino and its related expression after computation was transferred to the mobile phone. In the presented work, we successfully designed two types of flex sensors using different material i.e. Copper & Aluminium. Results obtained with copper as a material were extremely encouraging for designing a sensitive flex sensor for this purpose.

Keywords - Sign Vocalization, MEMS Accelerometer, Arduino, Data glove, Bidirectional flex sensor.

I. INTRODUCTION

Gestures play a significant role in the daily activities of human life, especially it provides easier way of understanding during communication. In different words, Gesture recognition alludes to perceiving essential appearances of movement by a person, involving the hands, arms, face, head as well as body. Among all the gestures performed, assume an imperative part and it encourages us to express more in less time. In this project, we just concentrate on International Sign Language.

Various equipment systems are utilized for gathering information about body positioning; typically, either image-based (using cameras, moving lights etc.) or device-based (using instrumented gloves, position trackers etc.).[1][2][3]In any case, data originating from these devices is persistently spilling and it is an extremely troublesome assignment to process this data into what user need to express. In research paper, we are an endeavoring to tackled these issue by information originating from data gloves when the user needs to talk by utilizing International Sign Language.

The moment of fingers of hand will be monitored by flex sensor which is present in data glove and 3-axis moment of hand will be recognized by MEMS accelerometer which place on the top of hand (knuckle side). The information comes from data gloves will be further processed by microcontroller. When Microcontroller will process on the data, the output will transfer to Smart phone which is connect via Bluetooth. The message will be appeared on Smart phone of user.

II. PREVIOUS WORK

In the field of gesture recognition numerous scientists are working. A wonderful and latest survey of the work done in this field is depicted in Sushmita et al. [4].In Zhou Renet al. [5] we see Robust Hand Gesture Recognition Based on Finger Earth Mover's Distance with a Commodity Depth Camera. In the other paper of Zhou Ren et al.[6]titled as 'Robust Part-Based Hand Gesture Recognition Using Kinect Sensor', Kinect Sensor have provided new opportunities for human interaction. S. W. Lee[7] and M. A. Bhuiyan[8] discuss the gesture recognition for human robot interaction and human robot symbiosis. Sanshzar Kettebekov et al.[9] offers a novel "signal-level" perspective by exploring prosodic phenomena of spontaneous gesture and speech co-production. It alsopresents a computational framework for improving continuous gesture recognition based on two phenomena that capture voluntary (co-articulation) and involuntary (physiological) contributions of prosodic synchronization. Ishikawa et al. [10] discusses different categories for gesture recognition. Markov models are used for gesture recognition by Byung-Woo Min et al.[11] and Andrew D. Wilson et al.[12]. Toshiyuki Kirishima et al. [13] present comprehensive framework that addresses two important problems in gesture recognition systems. An augmented reality tool for vision based hand gesture recognition in a camera-projector system is described by Attila Licsar et al. [14]. A methodology using a neighborhood-search algorithm for tuning system parameters for gesture recognition is addressed by Juan P. Wachs [15]. A novel method is introduced to recognize and estimate the scale of time-varying human gestures by Hong Li et al. [16].

III. IMPLEMENTATION

In this project work execution of the main device was done by the utilization of sensors like 9-Flex sensor, MEMS 3-axis accelerometer as shown in Fig.1. Flex sensors are mounted with all five fingers of the hand and another four flex sensors are mounted on the palm side of the hand. Flex sensors are mounted on each joint of all five fingers. Due to hand movement, the bending of the flex sensor changes the resistance of the sensor and this change in resistance is fed as input to the microcontroller. Here first flex sensor is mounted on the thumb finger, second flex sensor is mounted on index finger on dorsal side of hand, third on the middle finger, fourth on the ring finger, fifth on the little finger and number six, seven, eight, nine are on palm ventral side of hand MEMS accelerometer monitor any tilted position in hand which is mounted on the dorsal side of the hand. As shown in Fig.2 a small circuit is designed to supply the power to these sensors and these are also associated with microcontroller. The data coming from these sensors is input to the microcontroller. In a microcontroller, a program is composed for every pattern such as for alphabet ‘A’ a specific range is decided and this range is decided by doing many experiments. If user wants to tell a word like ‘APPLE’ then he/she must follow International Sign Language (as shown in Fig. 3) in which he/she first draw the ‘A’ sign then after 10 seconds ‘P’ then respective he/she draw the ‘P’ ‘L’ & ‘E’ then user stretch straight the all his/her fingers there must be gaps in between his/her all fingers, and then final is send to Bluetooth which further transfer to smart phone. What's more, the message will appear on the smart phone screen.

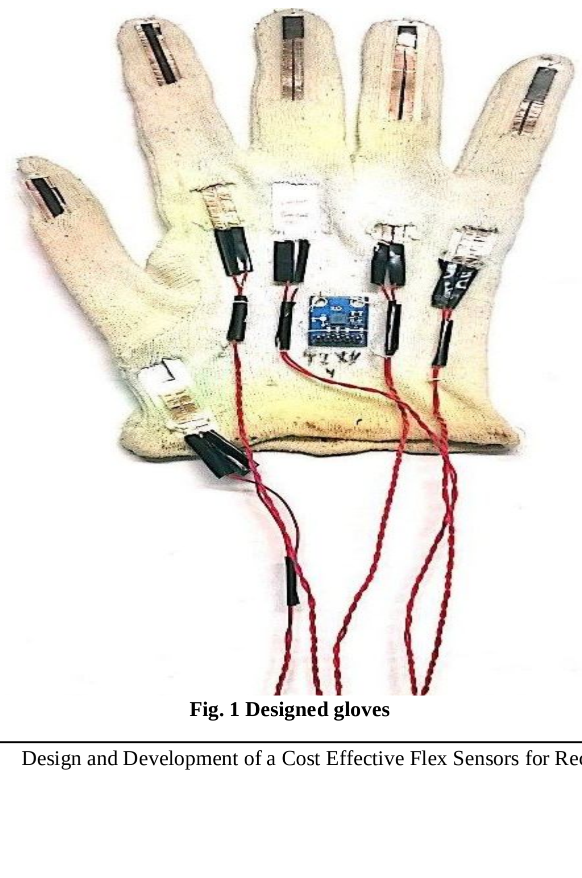

Fig. 1 Designed gloves

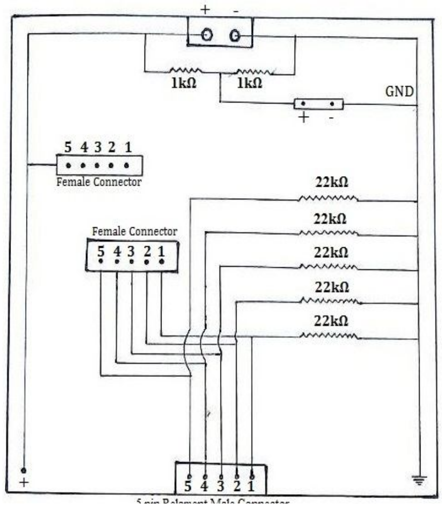

Fig.2 Circuit diagram

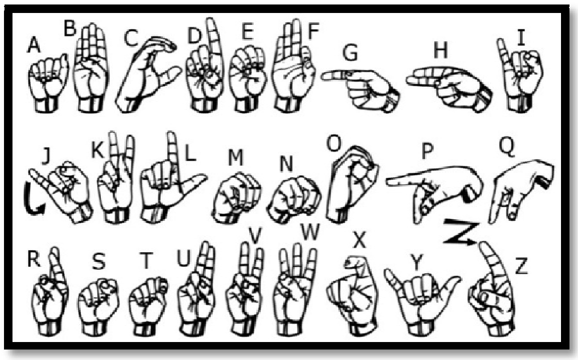

Fig. 3 International sign language

A. Component used in designing of Data Glove
Data glove has consisted of two sensors;
1. Flex sensor
2. MEMS accelerometer sensor

1) **Flex Sensor–**Flex sensors, (from Latin flectere, 'to bend') likewise called bend sensors, measure the amount of deflection caused by bending the sensor. In this project, we designed our own flex using different material like copper and aluminum.
Designing of flex sensor– Flex sensors are passive resistive devices that can be used to detect bending or flexing. We made the flex sensor by using following steps:

Step 1: Components – The materials needed for the construction of the flex sensor is shown in Fig.4 and listed below. The size of the materials listed is only a guideline to the sensor we are constructing in this article. These types of sensors can be manufactured to larger widths and lengths.
1. Copper foil / Aluminum foil
2. Velostat
3. Lamination Sheet
4. Wires
Copper foil is used in the electronics industry to make flexible circuits. We cut out two strips of copper foil from copper tape.

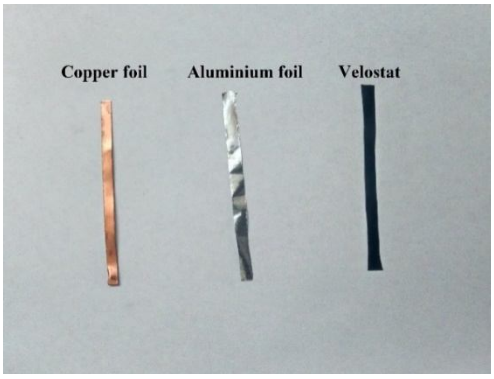

Fig. 4 Material used in making flex sensor

Step 2: Making the Flex Sensor (Sandwich the materials)– The resistive material is sandwiched between the two copper laminates. The copper sides of the laminates are both confronting toward the resistive material. We provide the support structure to the sandwiched materials by wrapping it with cello tape. We leave the small part of the copper laminate unwrapped which will further lead to the soldering process.

We soldered the wires on the same side of the laminates so that when we assemble the sensor, the wires will be positioned on opposite corners allowing the base of the sensor to lay flatter.

Step 3: Packing of the wrapped Sandwich

In this step, we embed this entire wrapped sandwich in laminating sheet (thick plastic). Then laminating sheet consist of the wrapped sandwich is put inside laminator. Finally, we get fully packed sensor which we use in gesture recognition (as shown in Fig.5).

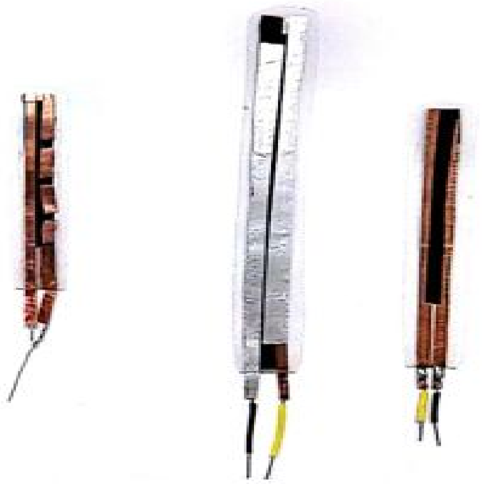

Fig.5 Flex sensors using Cu & Al metals

Step 4: Testing of the Flex Sensor – Weare setting a multi meter to read the value of resistance in ohms. The sensor we built using Cu had a nominal resistance of approximately 22.6 kΩ (Fig.6). As the sensor is bent in one direction (Fig.7) the resistance decreases in the extent to the bend to approximately 4.4 kΩ.

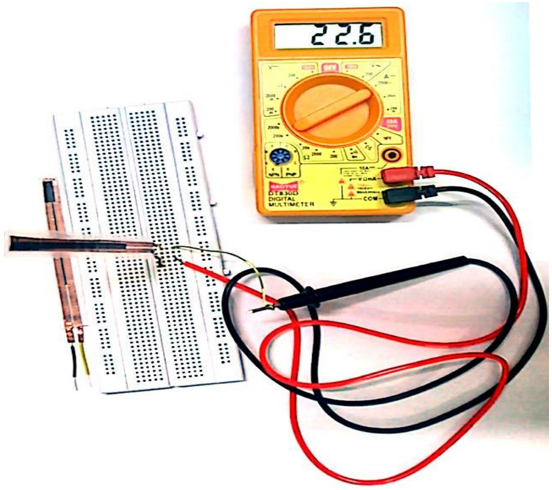

Fig. 6Showing resistance value without bending

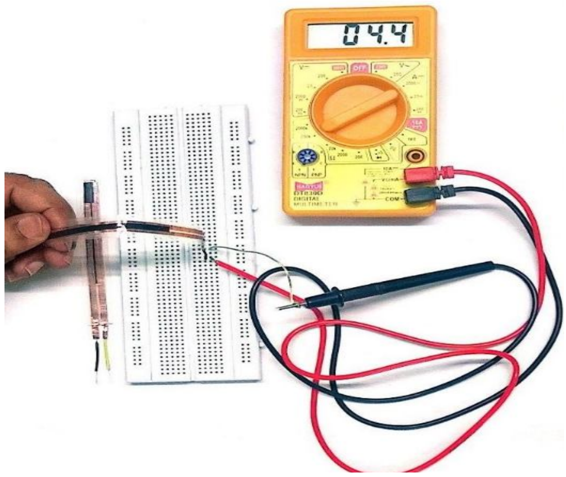

Fig.7Showing resistance value with bending

We found the nominal resistance of the sensor using Al was approximately 17.7 kΩ. During bending of sensor its resistance decreases to 1.7 kΩ. Both The sensors are pressure and force sensitive. The basic sensor can be modified in size and shape to the fit custom applications. The resistive material may also be modified to obtain different resistances and characteristics. The graph shown in Fig. 8 represents changes occurred in the value of resistance of both the flex sensor (Cu and Al) due to bending.

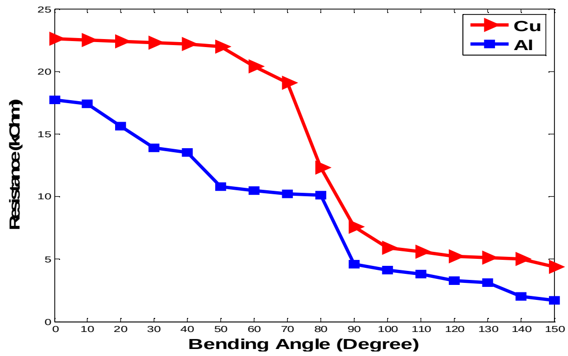

Fig. 8 The relationship between bending angle and resistance of flex sensor of Cu and Al metal

2) **MEMS Accelerometer sensor**– Accelerometer in the Gesture Recognition system is used as a tilt sensor, which checks the tilting of the hand. In this project, we used ADXL335 is a small, thin, low power, and complete 3-axis analog output accelerometer is used in the system. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

IV. BLOCKDIAGRAM

The block diagram of device is shown in Fig. 9. This proposed designed device consist of data glove, microcontroller, Bluetooth module and smart phone so there is one block box for each. The flex sensors and accelerometer present in data glove. These sensors are mounted on glove which is called hand unit and it is worn by the user. Here accelerometer sensor is attached to knuckle side of hand of user that is used to measure the tilting movement of the hand. Output data from these sensors serve as input in microcontroller where processing of data is done. Then transfer to smart phone via Bluetooth module.

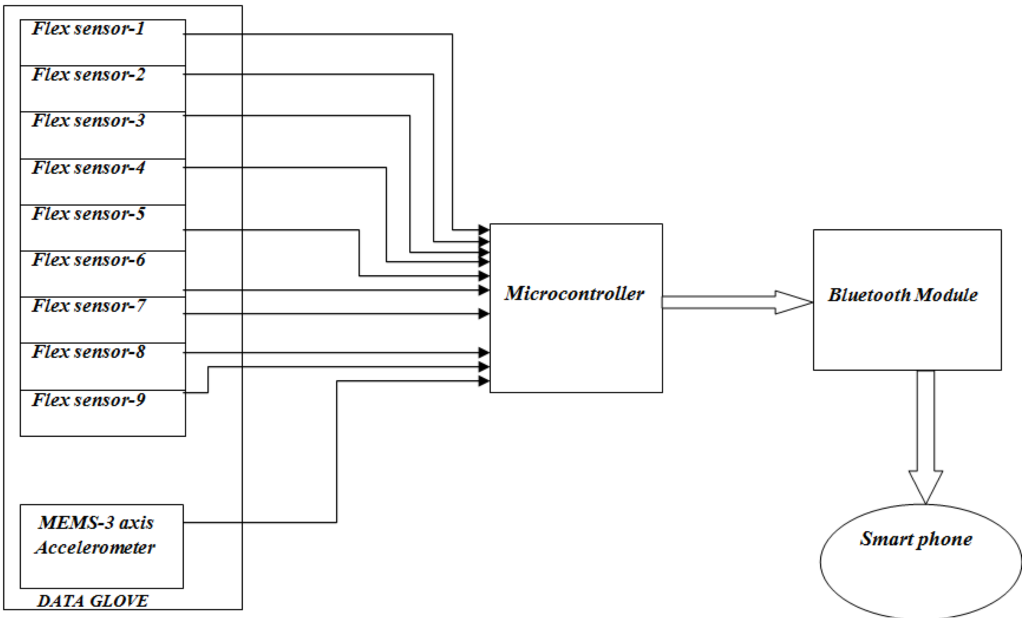

Fig. 9 Block diagram

CONCLUSION

In this research work we designed mainly two types ofcost effective flex sensors using different material like Cu & Al. We are transferring the data generated from microcontroller to smart phone. This designed device will be helpful for disabled people. Regarding future improvement in this project we can make more optimize device for which we require a specific smart phone application (app) that easily connect with microcontroller and receive the data. Then it can process the data and converts into voice.

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