Development and Implementation of Gesture Controlled Automatic Audio System

[1]Lohit Ujjainiya
PG Student

[2]M. Kalyan Chakravarthi
Assistant Professor

[3]Ankit Soni
PG Student

[1, 2, 3] School of Electronics Engineering, VIT University, Chennai, India

ABSTRACT
Gesture based interfaces are widely used in multimedia entertainment due to growing demand of consumer electronics. This research ensures the effective working of infotainment systems in the modern vehicles. The main objective of this research is to design a smart system which works on haptic movements. In the proposed work a smart gesture based audio system in designed which works on the finger movements. The vertical movement of finger is used to increase or decrease the volume of the audio system .The Flex Sensor is used for the sensing finger movement like up or down. A Graphical User Interface (GUI) is developed using LabVIEW as software tool.

General Terms
Sensor gloves, man machine interface, finger movement, audio controller.

Keywords
Flex Sensor, haptic movement, robotic finger, wearable technology, gesture recognition, data acquisition, degree of bend, LabVIEW.

1. INTRODUCTION
Since old times gesture has been an integral part of human interaction. Mainly the gesture control systems uses hand or face to control the system, but that can be done with any part of the body. With the enhancement of emerging technologies many gesture control systems are made and implemented in our day to day life. The increasing demand of consumer electronics results in the development of man machine interfaces.

Embedded technology is the most demanding and popularly used technology for the development of man machine interface. In our daily life we use our hand for interfacing and performing various activities. So research has been started in this field for developing the technology which works on the haptic movements [1] [12]. The development of hand movement acquisition was introduced 30 years ago and advancements are made in this field. The current trend of research is on developing sensor based gloves [1] [5].

Several work have been done by utilizing sensors to measure human body parameters like postures, movement of fingers, wrist movements, knees and to measure bending of all human joints [3] [4] [7]. Previous work used different techniques to measure the bending parameters [1] [4]. For correct measures the sensors must be adhere to the joints. The sensory gloves are equipped with flex sensor which measures the movement of the fingers [2]. But there are certain critical parameters which affects the functionality of the sensory gloves like the glove instability and misalignment of sensors [1]. This is the next generation of infotainment system as it improves the safety of driving without getting distracted on manually operating the system.

2. PREVIOUS WORK
Our hand is the basic primary tool for physical interaction to the external world as many day to day work are being performed by hand. The wearable technology was first introduced nearby 1970s. The first glove based prototype was designed in 1977 which consists of the flexible tube with a light source at one end and photo detector on other one. The bending of glove results in decrease in the light intensity. In 1980 MIT-LED glove was developed by Massachusetts Institute of Technology at MIT Media Laboratory consisting of a camera LED system which tracks the hand movement and a graphic animation is showed on the computer [5] [11]. With the advancement in the technologies different types of sensor based gloves have been developed including both commercial and prototype model. The first Digital Entry Data Glove was designed in 1983 which comprises of different sensors mounted on a piece of cloth. The commercial implementation of Data Glove sensor was started in 1987 which uses 5 to 15 sensors for tracking the hand movement including the wrist movement along with the finger movement.

With the increasing demand of wearable technology in last few years, many commercial products are launched for different work environments. This type of system has a lot of applications [5] in the field of biomedical [8] [12], portable or wearable computers [9], robotics [14], entertainment purposes [13], teaching sign languages [9], tracking body movements [4] [10] [11] [3] [2], industrial manufacturing of CAD/CAM applications and many more. For detecting and capturing human's hand motion many techniques are developed in past few years for sensory gloves which includes acoustic tracking sensor [5], optical tracking sensor [4], magnetic tracking sensor [10] [7], resistance tracking [2] [11] and Hall-effect sensing techniques [10] [5].

Many commercial gloves were then introduced in the market like Sayre glove, MIT-LED glove, Power glove, Data glove and Digital Data gloves. With the advancement of technologies many gloves are introduced which are improvement over the first introductory gloves. The current technology gloves are Cyber glove, Human glove (Humanware Srl, Pisa, Italy), 5DT Data glove (5th Dimension Technologies), Pinch glove, Didji glove (Didji Glove Pvt. Ltd.), Strin glove (Teiken Limited Japan), the P5Glove (CyberWorld, Montreal, QC, Canada), and the ShapeHand (Measurand, New Brunswick, Canada).

These gloves provide high accuracy, high reliability, lower cost and high degree of freedom (DOF) of human hands. Most of the gloves use sensors for better performance, accuracy and due to their reliable nature and lower implantation cost.

3. BACKGROUNG INFORMATION

The demand of wearable technology being used at workplace has increased from last few years. The main objective of this research is to design a smart audio system which works on haptic movements. The pervious works were the implementation of the data sensory gloves. Instead of using whole sensor glove a finger model is trying to be implemented which can used controlling the audio system by sensing finger movements. In the proposed work a smart gesture based audio control system is designed which works on the finger movements [2] [4]. The vertical movement of the finger is used to increase or decrease the volume of the audio system. The system uses flex sensor with NI DAQ card. Bending of flex sensor produces change in the resistance value and this sensor generated value will be used for controlling the volume of the audio system.

4. SYSTEM REQUIREMENT

The system hardware consists of flex sensor which is interfaced with NI-DAQ card (NI USB-6211). The software used for simulation purpose is National Instruments LabVIEW.

4.1 NI DAQ Card (NI-USB 6211)

As shown in Figure 1, the NI USB – 6211 is a multifunctional data acquisition card (DAQ) which has 16 analog inputs (16-bit, 250 kS/s), 2 analog outputs (16-bit, 250 kS/s) and 4 digital inputs, 4 digital outputs with two 32-bit counters. The output range of data acquisition card is -10V to +10V.

Fig 1: NI USB DAQ Card (6211)

4.2 Sensor Module

The advantage of flex sensor is that it is light weight, lower cost, flexibility, easily equipped with other devices and better resistance value. The sensor has long mechanical durability, electric stability and minimal noise factor influence. The sensor is best for tracking the hand movement along with the finger movements.

The flex sensor is an analog resister which works on variable analog dividers. The flex sensor is made of carbon resistive element with thin flexible substrate [6] highly doped with p+ silicon wafer covered with silicon oxide patterned on a metallic layer of aluminium or copper (Al/Cu). The flex sensor has a unique property of changing the resistance when it bends, as shown in Figure 2 and Figure 3. More carbon means less resistance. The change in resistance depends on the amount of bend on the sensor. It is a thin strip of 4.5 inches having a flat/nominal resistance of 25kΩ and bend resistance varies from 45kΩ to 125kΩ from 45° - 90°.

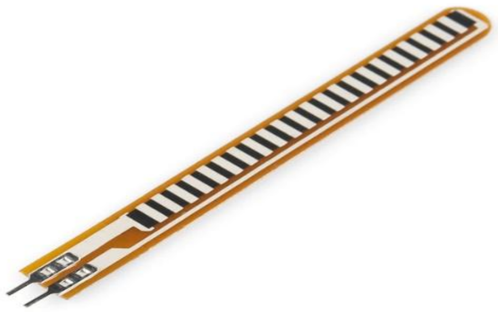

Fig 2: Flex Sensor

When the substrate is bent, the sensor produces the resistance output related to radius of the bent. Smaller the radius, larger will be the resistance value [6]. The resistance value will be higher when it is bent to 90°, as shown in Figure 3.

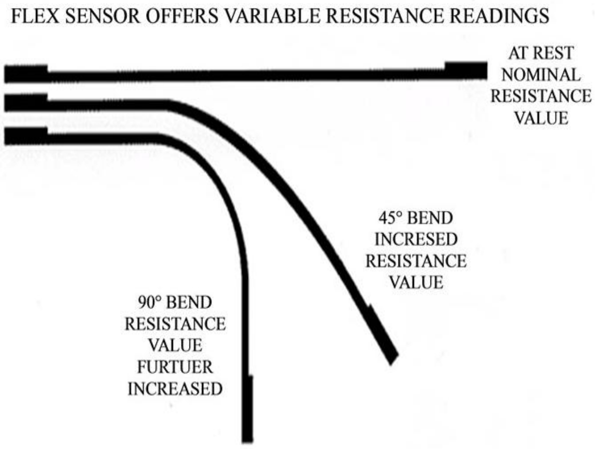

Fig 3: Resistance change during bend

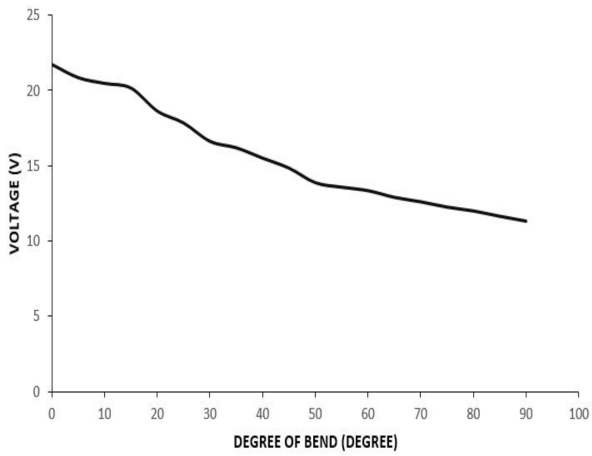

Fig 4.1: Calibration of Sensor

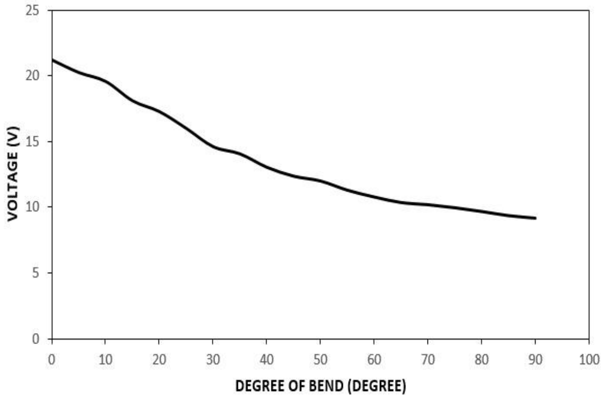

Fig 4.2: Calibration of Sensor

The above Figure 4.1 and Figure 4.2 shows the calibration readings of the sensor. A graph of voltage v/s degree is plotted. The output of the sensor is obtained in milivolts (mV) range which is then converted into voltage (V) by the multiplication of suitable factor. By bending the flex sensor at every 5° the change in voltage range is measured from 0° to 90°. When sensor is in rest position this indicates the 0° bend and maximum value indicates the bend of 90°.

5. HARDWARE IMPLEMENTATION

In this system a controller is designed which fetches the data from the sensor and controls the volume. The flex sensor is imposed on the finger and the vertical movement of finger is used to increase or decrease the volume of the system. A GUI is developed using NI-LabVIEW which senses the bending movement of the finger and controls the volume of the system. The bending of finger like up and down changes the resistance of the sensor [2] [4]. The generated value from the sensor drives the gain controller which in turn controls the volume level in the volume control VI. A 5 volts power is power supply is connected to the one end of the Flex sensor with 10K resistance and other end is grounded, where the flex sensor acts as variable resistance and output is taken. Figure 5 shows the basic configuration of flex sensor.

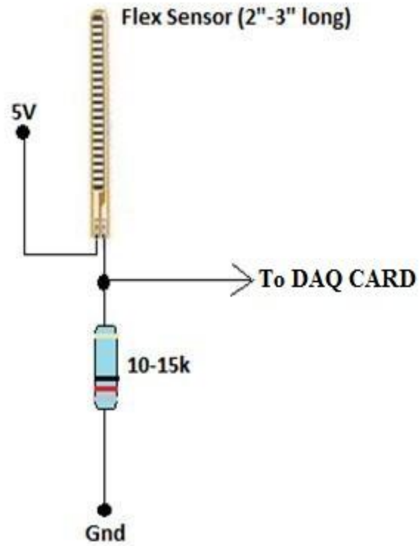

Fig 5: Flex Sensor Configuration

The block diagram of the system is shown in Figure 8 which shows the connection of flex sensor with signal conditioning circuit and Data Acquisition Card (DAQ). The variation in deflection or bending of flex sensor results in the variation of resistance. The signal conditioning circuit is used to detect the resistance change and gives the data to DAQ Card. The DAQ Card converts the data to equivalent digital values. The DAQ card is connected to the computer and simulation is done using LabVIEW. A GUI is developed which shows the working of the system.

Fig 6: Hardware Implementation

Figure 6 shows the prototype model of the controller system. The system owns a sensor implanted on a finger. As the finger bends the resistance of the sensor varies which will be given to the gain controller block which controls the volume of the system. When the sensor is in flat position i.e. sensor is not bent and has an angle of 0° the volume of the system shows 100%. As the finger starts bending the volume gradually starts decreasing and become minimum when the sensor is bent to 90° position.

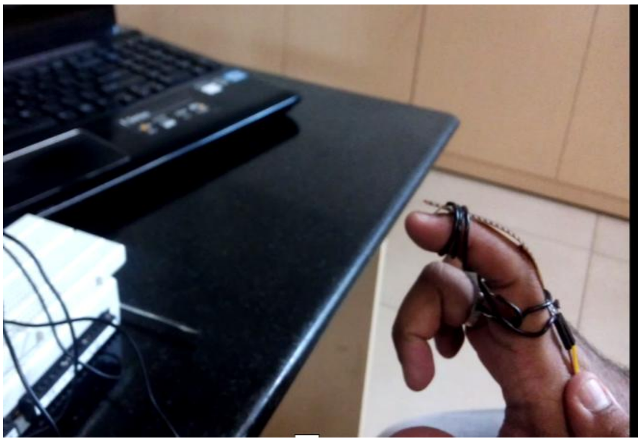

Fig 7: Volume Control by finger movement

The above Figure 7 shows the volume controlling mechanism of the haptic based audio control system, which uses the finger movement in vertical direction i.e. up and down movement of the finger which in turn increases or decreases the volume of the designed controller.

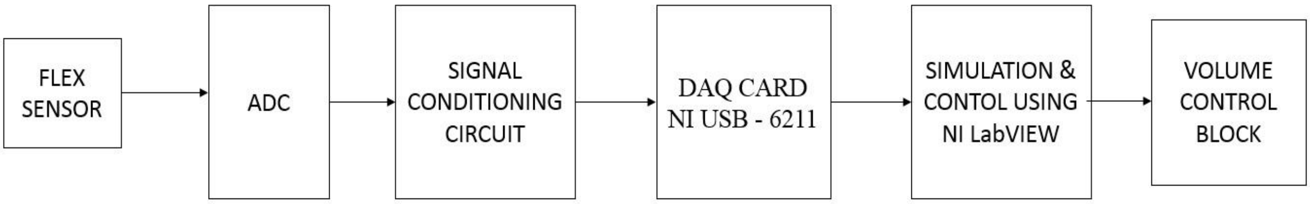

Fig 8: Block Diagram

6. RESULTS

The graph shown in Figure 9 shows the increasing and decreasing value of volume in terms of voltage level. The output of flex sensor is in milli-volts (mV) which is then multiplied with multiplication factor and represented in terms of voltage (V) shown on Y-axis. On X-axis the value 0 to 90 is the degree at which the flex sensor is bent to take the reading. The value is taken at every 5° bend ranging from 0° to 90°. The black line in the graph shows the decreasing value of voltage which means the volume is decreasing and red line represents the increasing values of voltage level which means volume is increasing. When the sensor is in rest i.e. at 0° bend the volume is 100% as indicated in the graph through black line. When the sensor is bent at 5° the voltage level is reduced thus shows the reduction in the volume level. At every 5° bend the voltage level decreases by a specific value and becomes minimum when the senor is bent to 90°. Thus, the volume is minimum when the finger is bent to 90°. Now the finger is released from 90° position to 0°. The volume starts increasing in the manner shown in graph indicated with red line in Figure 9.

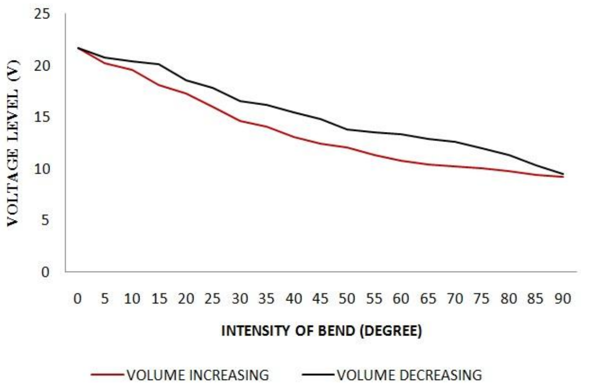

Fig 9: Volume Level Graph

7. CONCLUSION

In this paper, a gesture controlled automated audio system is designed which uses the vertical movement of the finger to increase or decrease the volume of the system. The system reduces the volume at every degree of bend of the sensor as the finger bends. The volume of system is highest when the sensor is flat and as we slightly starts bending the finger the volume level starts decreasing with every degree of bend. The volume is highest at 0° bend and minimum when sensor is bent to 90°.

8. FUTURE SCOPE

The future scope of this work will be designing of complete infotainment system where every functionality will be controlled through the haptic movements by using all fingers.

9. ACKNOWLEDGMENTS

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10. REFERENCES

[1] Giovanni Saggio, A novel array of flex sensors for goniometric glove, Sensors and Actuators A: Physical, ELSEVIER 2014.

[2] Giovanni Saggio, Mechanical model of flex sensors used to sense finger movements, Sensors and Actuators A: Physical, ELSEVIER 2012.

[3] Aminuddin Hamid, Mohd Azmi Ayub, "Force sensor detection and performance evaluation of new active system ankle foot orthosis", International Symposium on Robotics and Intelligent Sensors, 2012.

[4] K. Li, I. Ming Chen, S. Huat Yeo, C. K. Lim, Development of finger motion capturing device based on optical linear encoder, J.R.R.D 2011.

[5] L. Dipietro, A.M. Sabatini, P. Dario, A survey of glove based systems and their applications, IEEE Transactions on Systems, Man and Cybernetics 38, 2011.

[6] K. Haris Jan, Flexible Bend Sensor, Datasheet 2010.

[7] D. J. Sturman and D. Zeltzer, A survey of glove based input, IEEE Computer Graphics Application, vol. 14, no. 1, pp 30-39 Jan 1990.

[8] G. Saggio, M. De Sanctis, E. Cianca, F. De Santis, F. Giannini, Long term measurement of human joint movement for health care and rehabilitation purposes, in: Wireless Vitae09 – Wireless Communications, Vehicular Technology, Information Theory and Aerospace and Electronic Systems Technology,17–20 May, Aalborg (Denmark), 2009, pp. 674–678.

[9] Robert Rosenberg, Mel Slater, The chording glove: A glove-based text input device, IEEE Transactions on Systems, Man and Cybernetics, Part C: Applications and Reviews, May 1999.

[10] C.H. Fahn, H. Sun, Development of a fingertip glove equipped with magnetic tracking sensors, Sensors 10 (2010) 1119–1140.

[11] S. Wise, W. Gardner, E. Sabelman, E. Valainis, Y. Wong, K. Glass, Evaluation of a fiber optic glove for semi-automated goniometric measurements, Journal of Rehabilitation Research and Development 27 (4) (1990) 411–424.

[12] Maria Claudia, F. Castro, Alberto Cliquet Jr., A low-cost instrumented glove for monitoring forces during object manipulation, IEEE Transactions on Rehabilitation Engineering 5(2) (1997) 140–147.

[13] http://en.wikipedia.org/wiki/Power_Glove.

[14] Ahmed H. Mohamad, A. Yusuf, Tele-operated Robotic hand using data glove, Texas A&M University, Qatar.