Low cost flex powered gesture detection system and its applications

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ABSTRACT

A hand gesture is a non-verbal means of communication involving motion of fingers to convey information. Hand gesture are used in sign language and are a way of communication for deaf and mute people. Common public most often is unable to understand the sign language. So, in this paper we aim to provide an electronic method for hand gesture recognition which is cost effective, this system makes use of flex sensors, on-board gyroscope and accelerometer. A flex sensor works on the principle of change in the internal resistance to detect the angle made by the user's finger at any given time. The flexes made by hand in different combinations amount to a gesture and this gesture can be converted into speech signals or as a text display to aid physically challenged people. A smart glove is designed which has an Arduino circuit which is equipped with the custom-made flex sensors, an on-board gyroscope and an accelerometer, out of which the last two components are used to supplement the gestures detected by a flex sensor.

KEYWORDS

Flex, resistance, gesture, mute, glove, sensor

I. INTRODUCTION

A system using flex sensors, Arduino, Bluetooth has been developed to aid the user to communicate efficiently with the help of gestures. The detected signal is transferred to an on-glove micro-processor or micro-controller so as to compute the results and to display the text or can be connected to a speaker to output the voice signals. This glove's capability can also be extended to various applications such as virtual keyboard, medical emergency detection and in-home automation where different devices can be controlled using a set of pre-defined gestures. According to a survey conducted by Government of India in 2011, the number of dumb people in India is around 20.02 lakhs out of which 56% or 1,121,120 people and 46% or 920,920 people suffer from speech impairments and hearing impairments respectively. Considering worldwide statistics, as many as 1.33 billion people face challenges in communicating in daily life in which sign language is used to convey the information. The concept of sign language came into existence in 1700's in Europe which is not only used by mute people for communication but is used by people who need to communicate with deaf people because of their hearing impairments. But as time progressed hearing aids and visual aids were introduced to help deaf people but this has considerably reduced the use of sign language with which the difficulty in communication for mute people has increased, so the primary goal of this system is to aid the physically challenged people to communicate with others seamlessly. The gestures shown below can easily be expressed through the flex-powered glove.

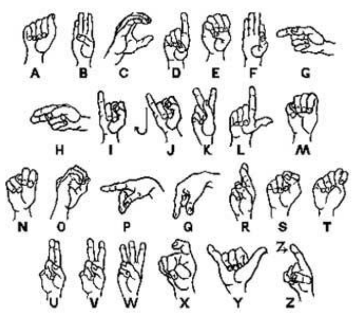

Fig.1. Standard American Sign language

Gesture detection systems which are in prevalent use today use image processing for the detection of made gesture. The computation involved in these systems is high, the processes include web camera, colour separation, morphology, grey scaling and thresholding, binarization, feature extraction, recognition and sign to text and text to speech conversion. But the proposed system has a lot less computation as the processes involved are flex recognition, computation in Microcontroller, communication between Microcontroller and output devices like mini LCD display or speaker. So, the computational time and complexity decreases with the cost of the equipment. Flex sensors are quite apt for these kinds of detection due to robustness, lightness and cheapness, but these also have their fair share of problems such as the values can change over time due the resistance varying over time and when this problem can simply be solved by changing the flex sensors and replacing them with a set of new flex sensors and as these economical they provide a better option than image processing. Flex sensors work on the principle of change in resistance, as sensors is bent the resistance increases and when these flex sensors are combined with a static resistor and voltage divider circuit is formed and these variable voltage values can be read by a micro-controller which converts the resistance values to a corresponding gesture. This flex-based gesture detection system coupled with accelerometer and gyroscope will enable the glove to produce a plethora of gestures.

II. FABRICATION OF FLEX SENSORS

The flex sensors used in this system can be purchased commercially or can also be made at a very cheap cost. For making of flex sensors, few strips of graphite coated paper are required, which can be made by darkening a sheet of the paper with a pencil. The accuracy of the resistance value offered by graphite sheet is dependent on thickness of the graphite film applied to the paper which needs to be placed between two aluminium sheets which can be obtained from aluminium based kitchen wraps which are easily available and very affordable and two single strand wires are stuck to the aluminium foil, one each, enclosing graphite sheet which doesn't contact the either of the aluminium foils. The voltage is measured across these wires, that is, across the aluminium foils which gives the analog values based on the amount of flex detected by the sensor. This sensor setup can be enclosed within OHP or plastic sheets and the ends are taped together such that the single strand wires are firmly held in their positions and the sheets providing flexibility.

III. WORKING OF FLEX SENSORS

A flex sensor is basically a variable resistor. The terminal value of resistance increases when the sensor is bent, this forms the main principle of working of the flex sensors. The flex sensors consist of graphite coated material on both the sides, when the flex sensor is flat it gives out a constant resistance value and when the flex sensor is bent it moves away from the graphite layer on one side and towards the graphite layer on the other side, this causes the resistance value to change and when the sensor is brought back to initial position, the resistance reverts back to the initial value. The flex sensors can convert the flex angle to the resistance value and this value to be used in a circuit it needs to be converted to voltage and this can be acquired by using a voltage divider circuit.

IV. CALIBRATION OF THE HOME-MADE FLEX SENSORS

But these sensors need be to calibrate unlike the manufactured ones as these give different values depending on the darkness of the graphite paper. This problem can be addressed by initially measuring the values of sensors for different angles of flexes made by the finger using the following circuit and then using these values within the software code, this method keeps the cost of the proposed setup even lowers the cost as the sensors can be made with minimal effort with home found items. The designed flex sensors give different values for different sensors and different flexes, this problem arises due to the fact that all the graphite papers do not have same density which causes different resistance values. By using the following we can setup up a calibration circuit. In this type of circuit one of the pin of analogue input is connected to static resistor which is also connected to one of terminals of flex sensors and the other end of static resistor is connected to the ground terminal. The other terminal of flex sensor is connected to 5V input supply. And the values are monitored for different angles of flexes and these values are taken down to so that the sensor can be activated accordingly.

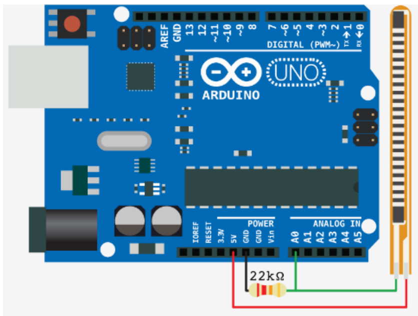

Fig.2. Block diagram explaining calibration of sensors

V. FLEX SENSORS CONNECTION

The flex sensors are connected in voltage divider circuit. One end of flex sensor in connected to a supply of 5V from the Arduino Uno/Nano and other single strand wire is connected to the static resistor (the resistor used here is 22 kilo ohm's). While one end of resistor is connected to the sensor it is also connected to the analogue read pins or input pins and these act as input values which need to be computed. The other end of resistors needs to be connected to the common ground terminal of Arduino or to that of a ground of a battery.

VI. GESTURE RECOGNITION

We can make use of a maximum of 10 flex sensors i.e., 5 fingers of two hands and let us consider that each sensor has been calibrated to detect 3 flexes per finger i.e., when a finger is not bent, when finger is bent at an angle of 90 degrees or half closed and when a finger has bent an angle of 120 degrees or when finger is fully bent, now the number of possible combinations are 310 i.e., we can have a total 59,049 combinations which can be defined according to the user's needs. As we need to represent alphabets, we need only 26 combinations so let us take 5 flex sensors each having 3 different flex angles, so we now have 35 so we have 243 combinations. Out of these 243 combinations 26 need to be assigned to the display of letters according to the gesture made and the rest can be used for assigning any specific gestures, such as water needed, or they can also be used for home automation such as specifying a gesture to switch off or on a light or fan. This system can also be used a virtual keyboard for security reasons as keystrokes can be recorded, this system can directly be connected to the computer and different gestures can account to different letters or symbols or numbers or special characters. This system can be coupled with an on-board gyroscope and accelerometer in order to detect dynamic gestures by determining the direction and the speed of the hand.

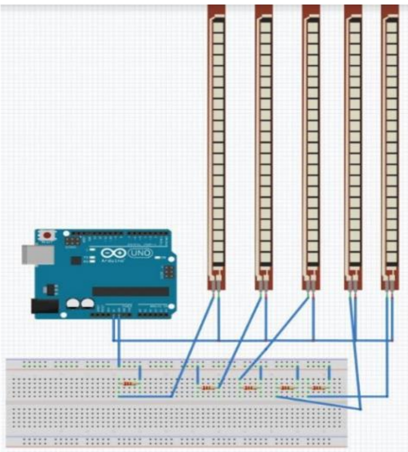

Fig.3. Circuit diagram to recognise the gesture

VII. WIRELESS COMMUNICATION

The flex sensors are connected to the microcontroller, Arduino Uno in this case. we choose Arduino Nano because of its small size and availability of analog pins. This microcontroller receives voltage values from flex sensors and decodes it into angle of bend. We need to transmit this data to another microcontroller which decodes the data into the appropriate sign. We have used a wireless type communication using Bluetooth which is a wireless technology standard for exchanging data over a short distance using radio waves. It typically uses 2.4 to 2.485 GHz of the radio band. This technology has advantages over others in terms of cost, power, and ease of use. The IEEE standardized Bluetooth as IEEE 802.15.1. We used a low-cost Bluetooth module- HC05. This module has a range of about 10m. This module can be powered from 3.6 to 6 volts. The data from all the flex sensors are consolidated into a structure and is transmitted. The microcontroller: Arduino Uno receives the data and decodes appropriately. And displays the messages or reads out the words accordingly.

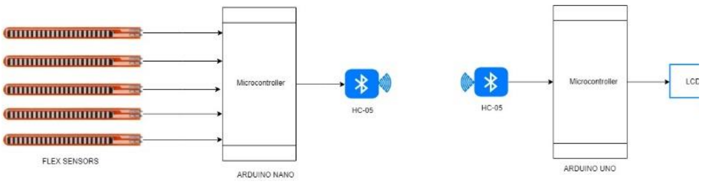

Fig.4. Block diagram of the system

VIII. APPLICATIONS

This system has a very wide scope and areas of application such as: Home automation, in which the user may desire to control appliances and security systems with the gesture at their convenience and Biomedical Applications such as mapping the brain signals with respect to the words spoken with the use of EEG and also in Robotic control applications in which rovers are controlled with the gestures. This system can also be used to augment the abilities, enabling mute and deaf people to communicate effectively and seamlessly.

IX. EEG EXTENSION

Intensity of the EEG waves may vary according to the internal state. The two basic categories of the waves are alpha, and beta waves which occur at 8-12 Hz and 12-30 Hz respectively when measured from the frontal lobe. The system can be paired with the EEG module and the signals from brain can be measured and can be mapped to a corresponding gesture. This way, we could map the brain waves and with the help of machine learning algorithms, the correlated curve for a set of multiple signals for the same gesture can be generated with which we can establish a brain to computer interface system which enables us to control things with the help of a mere thought i.e., the electric EEG pulses. For measuring the EEG signal, we need an EEG device with electrodes, the core of any EEG device is the Instrumentation amplifier (AD620AN is used). In this project, 60Hz Notch filter, 7Hz High pass filter and 31Hz Low pass filter and 3 electrodes are used. Each gesture can be associated with a final correlated and denoised waveform which helps in the mapping of EEG waves to a certain thought or gesture

X. CONCLUSION

The system at the core is designed be cost effective solution and to bridge the communication gap for specially enabled personnel. Though the motto is to be a cost-effective solution, many components can be involved in this to yield an integration of ultimate sensory applications which has the multitude of applications in vast number of fields.

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