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Electronic Speaking Glove for Speechless Patients

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***Abstract*— An ELECTRONIC SPEAKING GLOVE, designed to facilitate an easy communication through synthesized speech for the benefit of speechless patients. Speechless person communicate through sign language which is not understood by the majority of people. Gestures of fingers of a user of this glove will be converted into synthesized speech to convey an audible message to others, for example in a critical communication with doctors. The glove is internally equipped with multiple flex sensors that are made up of "bend-sensitive resistance elements". For each specific gesture, internal flex sensors produce a proportional change in resistance of various elements. The processing of this information sends a unique set of signals to the Arduino Mega 2560 microcontroller which is preprogrammed to speak desired sentences.**

***Index Terms*— Flex sensor, ATMEGA2560, Speakjet, LM386.**

I. INTRODUCTION

In recent years, researchers have been focusing on hand gestures detections and been popular for developing applications in the field of robotics and extended in the area of artificial or prosthetic hands that can mimic the behavior of a natural human hand. This project although utilizes a similar approach for the detection of the movement of fingers, however we have tried to extrapolate the idea in a slightly different perspective and have come up with a small yet significant application in the field of bio-engineering.

This project is useful for the deaf and dumb, it can also be used for the (speechless) patients with half of their bodies paralyzed and who are not able to speak but are able to move their fingers.

The aims and objectives of this research work include:

- Basic object of this project is to design a portable embedded system.
- Developing an economical and simple solution for the detection of finger gestures.
- Cost effective, reliable data acquiring method and signal conditioning.

II. EASE OF USE

A. *Data Acquisition Methods***:** These methods are EMG(Electromyography),MMG (Mechanomyogram), Load cell, Sliding fiber optic cable, Strain gauge tactile sensor, Flex Sensor.

B. *Conceptual Understanding Of System***:** Elements of block diagram which is Flex sensor, signal conditioning circuit, Arduino ATMEGA2560, Speakjet, LM386,Loud speaker.

C. *Signal Conditioning Of Flex Sensor & Signal Amplification***:** According to circuit diagram as flex sensor bends the voltage decreases evenly.

D. *Hardware and Software:* According to the requirements we are used different components which are enlisted and their supportive software mentioned in this section.

E. *Result and Discussion***:** In this section we discussed about the bend of flex sensor and deflection angle.

F. *Conclusion***:** We concluded that this glove becomes more flexible to used for critical communication purpose for speechless patients.

G. *Future Enhancement***:** It is evident that technological advances in computing, sensor devices, materials and processing/classification techniques will make the next generation of glove devices cheaper, more powerful, versatile.

H. *References***:** There are some references to give the idea about this research.

III. DATA ACQUISITION METHODS

To start with our research, on obtaining a bio-signal from the fingers, which require obtaining a signal proportional to the movement of the fingers. Fingers are able to interpret different hand gestures, research showed that many haptic devices used in prosthesis utilized the conventional method of using EMG signals. Following is the list of possible methods which could be used to sense the hand's movements.

- EMG (Electromyography)
- MMG (Mechanomyogram)
- Load cell
- Sliding fiber optic cable
- Strain gauge tactile sensor
- Flex Sensor

After analyzing all of the above methods for signal acquisition the best solution to use flex sensor in this project as it is comparatively reliable and a cost effective solution.

Flex sensors are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance- the more the bend the more the resistance value. They are usually in the form of a thin strip from 1" to 5" long that the vary in resistance. They can be made unidirectional or bidirectional. Flex sensors are analog resistor. They work as variable analog voltage dividers. Inside the flex sensors are carbon resistive elements within a thin flexible substrate. More carbon means less resistance. When the substrate is bent the sensor produces a resistance output relative to the bend radius(Refer Figure 1).

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IV. CONCEPTUAL UNDERSTANDING OF SYSTEM

The figure 2 conceptually displays the proposed system architecture for our project. Each block represents a different functional unit. Each block will be described below to give the reader a better understanding of this system.

- *Flex sensor*-Flex sensors change in resistance depending upon the amount of bend on the sensor. They convert the change in bend to electrical resistance. According to the bend the resistance value changes. They are usually in the form of a thin strip from 1 "-5" long. They are frequently used in gloves to sense finger movement. The flex sensors are used as input and are placed inside the glove that is to be worn. The sensor is so flexible that it bends easily even with a small bend. As it is very thin and light weight so it is also very comfortable(Refer table 1).
- *Signal Conditioning*-Supply voltage is applied on the divider circuit having 51 KΩ resistance in series with flex sensor as load resistance. When it is bent, its resistance increases that causes increase in voltage on it which is an analog voltage change. That is fed to ATmega 2560 microcontroller to proceed further.
- *Atmega 2560 microcontroller*-The output of the signal conditioning block is fed to ATmega 2560 microcontroller (Operating Voltage range 7-12 V) on PORTA that is used as analog input for built-in ADC (Analog to Digital Converter). By default ADC on the crystal frequency of 16MHz used although most of AVR's instructions work on single clock cycle. It has 10-bit 8 channel built-in ADC but we have used its 8-bits only which convert it into digital form i.e. (binary data). Similarly, it takes data from each finger and accumulates all five fingers data in five 8-bit registers, another bit-addressable register is used to store cumulative data in five bits dedicated for five fingers which consequently gives 32 combinations. Every number which is detected by hand gestures has predefined meaning a certain 8-bit code for particular phoneme is sent through USART (Universal Synchronous Asynchronous Receiver and Transceiver) at baud rate i.e. 9600 to Speak Jet block.
- *Speak Jet*-The output of the ATmega 2560 microcontroller which is serial data at baud rate i.e. 9600 is sent to Speak Jet that has MSA (Mathematical Sound Architecture), predefined allophones that are spoken according to the data received from ATmega controller. Speak Jet needs a definite 8-bit code to speak. It generates synthesized voice that is audible to humans. By combining many phonemes a word is made and by adding them makes a sentence.
- *Signal Amplification*-The synthesized voice output from Speak Jet is not much audible to human ears therefore; it is fed to an amplifier (LM386) that enhances its volume. It is configured at the gain of 200 that makes it quite natural to human ears; an 8Ω speaker is used to get the final output.

V. SIGNAL CONDITIONING OF FLEX SENSOR & SIGNAL AMPLIFICATION

Calculation of signal conditioning-(Refer figure 3)
Formula For Voltage Divider
Vo = Vcc$(R2/(R1+R2))$
For Vo minimum when sensor deflection is 0˚
R1=51KΩ, R2=10KΩ,Vcc=3.7V
Vo(min)=3.7V(10K/(51K+10K))=0.60656V
For Vo middle when sensor deflection is 45˚
R1=51KΩ, R2=20KΩ,Vcc=3.7V
Vo(min)=3.7V(20K/(51K+10K))=1.04225V
For Vo MAXIMUM when sensor deflection is 90˚
R1=51KΩ, R2=30KΩ,Vcc=3.7V
Vo(min)=3.7V(30K/(51K+10K))=1.37037V

VI. HARDWARE AND SOFTWARE

The hardware of this research project includes AVR ATMEGA2560; High-performance, Low-power A VR® 8-bit Microcontroller and it has built-in 10 bit ADC, RISC Architecture, In-System Programmable (ISP), Watchdog Timer, High Endurance Non-volatile Memory segments. SpeakJet IC for Sound Synthesizer is a completely self contained, single chip voice and complex sound synthesizer. It uses Mathematical Sound Architecturetm (MSA) technology which controls an internal five channel sound synthesizer to generate on-the-fly, unlimited vocabulary speech synthesis and complex sounds. The SpeakJet IC is preconfigured with 72 speech elements (allophones), 43 sound effects, and 12 DTMF Touch Tones. Through the selection of these MSA components and in combination with the control of the pitch, rate, bend, and volume parameters; the user has the ability to produce unlimited phrases and sound effects, with thousands of variations, at any time. This is not recorded waveforms or sound fragments but truly synthetic sound(Refer figure 5).

The key features of Amplifier LM386 for voice amplification are:

- Wide supply voltage range: 4V-12V or 5V-1BV
- Low quiescent current drain: 4mA
- Voltage gains from 20 to 200
- Ground referenced input

1.Software used to develop this project are:
- Arduino 1.0.6
- Magnevation Phrase Translator for SpeakJet

2.Electrical Specifications of this project are:
- Power Consumption = 250mW
- Circuit Current = 67.5mA
- Operating Voltage Range: 7-12V

Magnevation has provided SpeakJet Phrase Editor (software) that gives an easy solution to set the voice quality such as pitch, volume and speed, it also helps in generating desired data to be sent to SpeakJet, which can be seen in Fig.8. and Fig. 9. One by One bytes are sent that cause it to speak. The output of SpeakJet is not enough to hear, to solve this problem an amplifier (LM386) has been used that gives quite natural output.(Refer figure 6 & 7)

VII. RESULT AND DISCUSSION

When the substrate is bent the sensor produces a resistance output relative to the bend radius. Pragmatically deflection of 0°, 20°, 40°, 45°, 50°, 70° and 90° will give 10KΩ, 14.5KΩ, 18.8KΩ, 20KΩ, 21.1KΩ, 25.5K Ωand 30KΩ of resistances respectively.(Refer figure 8)

VIII. CONCLUSION

This project is a useful tool for speech impaired and partially paralyzed patients which fill the communication gap between patients, doctors and relatives. This project will give dumb a voice to speak for their needs and to express their gestures. As it is portable, requires low power operating on a single lithium-ion rechargeable battery and having less weight.

IX. FUTURE ENHANCEMENT

Nothing is perfect in this world, always there is a room for improvement. This project can be enhanced further by using memory which would have real voice recorded by humans to generate a huge speaking dictionary and more natural voice could be heard with ease. To make it 100% waterproof, some protected layers may be fashioned in order to secure the circuit, battery.

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FIGURES AND TABLES

Figure 1 Flex Sensor

Figure 2 Basic Block Diagram

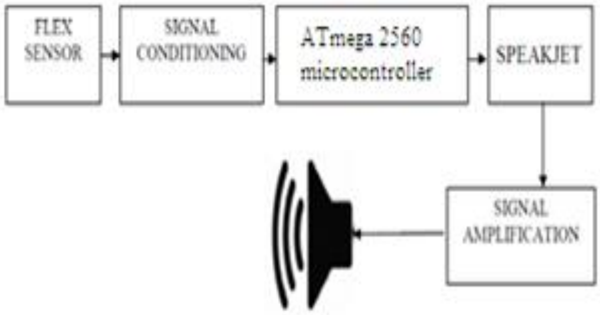

Figure 3. Sensor Circuit With Signal Conditioning

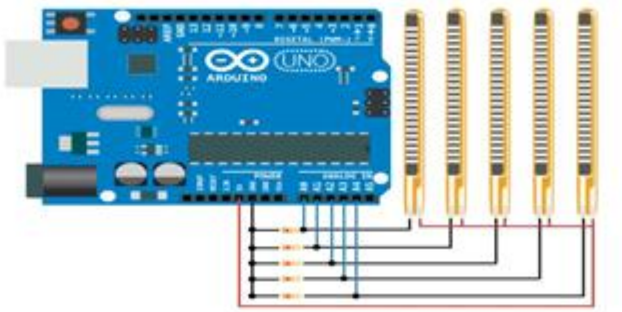

Figure 4 Simulation Of Signal Amplification

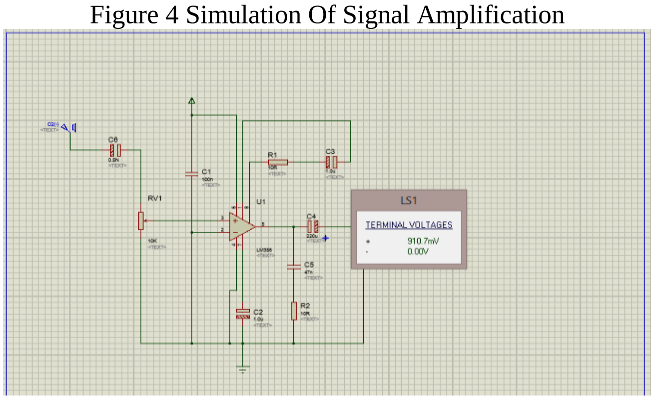

Figure 5 Typical Connection Of Speakjet

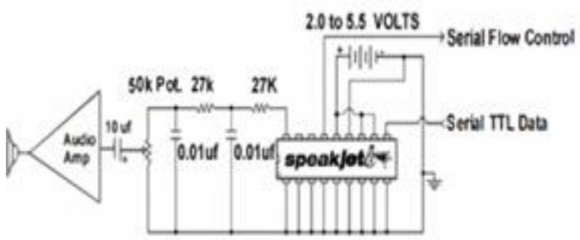

Figure 6 Speakjet Phrase Editior

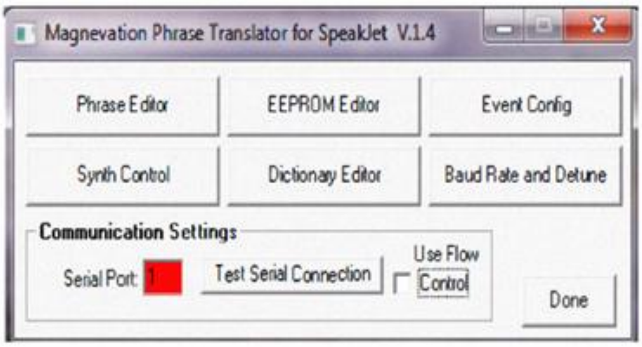

Figure 7 Phrase Editior

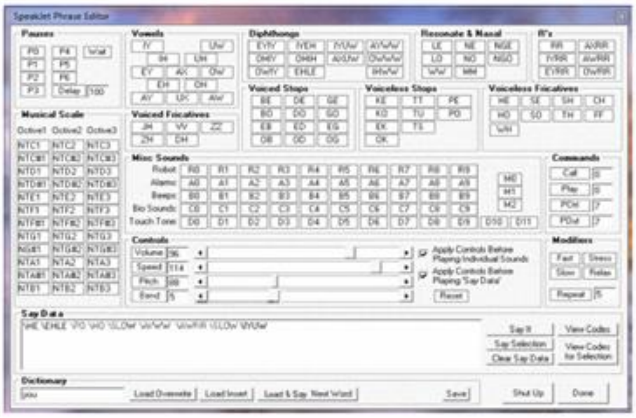

Figure 8 Relation Between Resistance And Degree

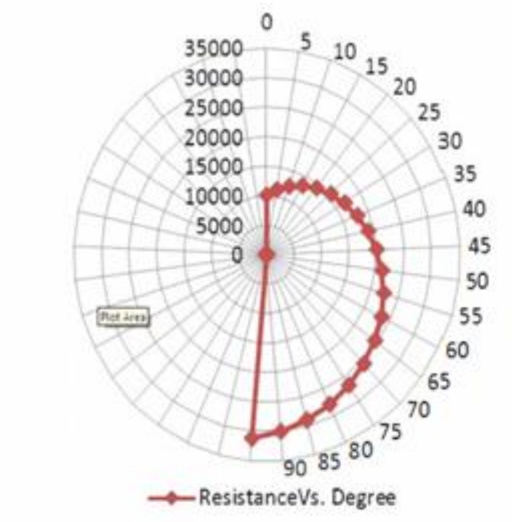

Table 1 Electrical Characteristics Of Flex Sensor

Size	approx 0.28" wide and 1"/3"/5" long
Resistance Range	1.5-40K ohms depending on sensor. Flex point claims a 0-250K resistance range.
Lifetime	Lifetime Greater than 1 million life cycles
Temperature Range	-35 to +80 degrees Celsius
Hysteresis	7%
Voltage	5 to 12 V