ELECTRONIC SPEAKING SYSTEM FOR DUMB

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ABSTRACT

We describe an electronic speaking system, designed to facilitate an easy communication through recorded speech (voice message) for the benefit of speechless patients. Generally, a speechless person communicates through sign language which is not understood by the majority of people. This project is designed to solve this problem. Gestures of fingers of a user of this glove will be converted in to a memory address which is used to hit the memory location where voice message is stored 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 PIC (Peripheral Interface Controller) microcontroller which is pre-programmed to speak desired sentences stored in aIVR.

KEYWORDS: *Electronic Speaking System, Motion Synthesis, Haptic Devices, Prosthesis, aIVR*

I. INTRODUCTION

How frequently do we meet a speechless patient in normal life? How visible are they in offices or behind shop counters? The truth is that there is often little room for these people in the workplaces. 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 behaviour of a natural human hand. This project although utilizes a similar approach for the detection of the movement of fingers, however I 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 bioengineering. 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 [1]:

- 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

Project key features are [1]:
- Fully embedded
- Portable
- Less weight
- Single Li-ion battery for longer operation
- Low power consumption
- Less hardware
- Robust

II. RELATED WORK

Many researchers have found out a number of possible solutions. Bhatti et al [3] developed a hand glove with the support of text on LCD display via computer interface with PIC 18F8680 micro controller having DC power supply instead of battery. Edin et al [4] developed a robotic hand for grasping and lifting different object. Wald [5] developed software for editing automatic speech recognition in real time for deaf and hard-hearing people. Simone et al [6] developed a low cost method to measure hand and finger range of motion. Zhao et al [7] developed a five-fingered prosthetic hand system. Aparna et al [8] developed Assistive Aid for Speech Impaired.

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 [2]: (discussing each one of them in detail will be beyond the scope of this paper)

1) EMG (Electromyography)
2) MMG (Mechanomyogram)
3) Load cell
4) Wearable conductive fiber
5) Deterioration of fiber optic cable
6) Sliding fiber optic cable
7) Strain gauge tactile sensor
8) 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.

IV. FLEX SENSORS

Fig. 1. Flex Sensors [1]

Table 1. Electrical characteristics of flex sensors [7]

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 I million life cycles
Temperature	Range -35 to +80 degrees Celsius
Hysteresis	7%
Voltage	5 to 12 V

Flex sensors [7] change in resistance depending upon the amount of bend on the sensor as shown in Fig. I. They convert the change in bend to electrical resistance - the more the bend, the more will be the resistance value. They are usually in the form of a thin strip from 1"-5" long that vary in resistance from approximately 10KΩ to 50KΩ. 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. Its characteristics are described in Table I.

Inside the flex sensor are carbon resistive elements within a thin flexible substrate. When the substrate is bent the sensor produces a resistance output relative to the bend radius. Pragmatically deflection of 0^0, 20^0, 40^0, 45^0, 50^0, 70^0 and 90^0 will give 10KΩ, 14.5KΩ, 18.8KΩ, 20KΩ, 21.1KΩ, 25.5KΩ and 30KΩ of resistances respectively. Its relation is shown in Fig. 2.

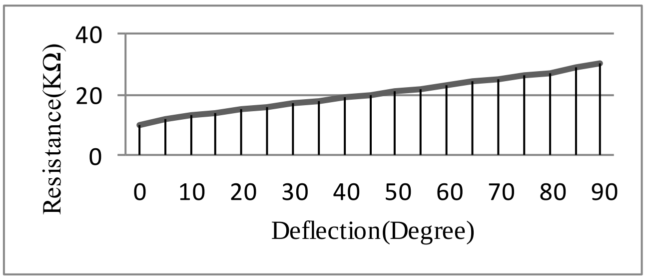

Fig. 2. Relation between Bend and Resistance

V. SYSTEM BLOCK DIAGRAM

The functional block diagram of this system as below

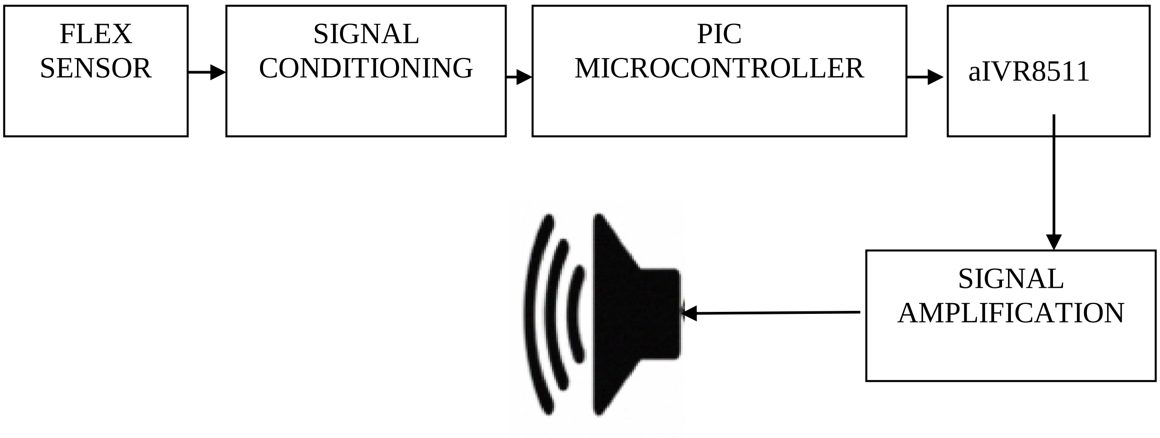

Fig. 3. System Block Diagram [1][8]

5.1. Signal Conditioning

It has been done by the circuit shown in Fig. 4. 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 voltage follower; an operational amplifier (LM324, which is recommended by the flex sensor manufacturer) has been used to boost-up the circuit current, which makes it comprehensible for the PIC microcontroller to proceed further.

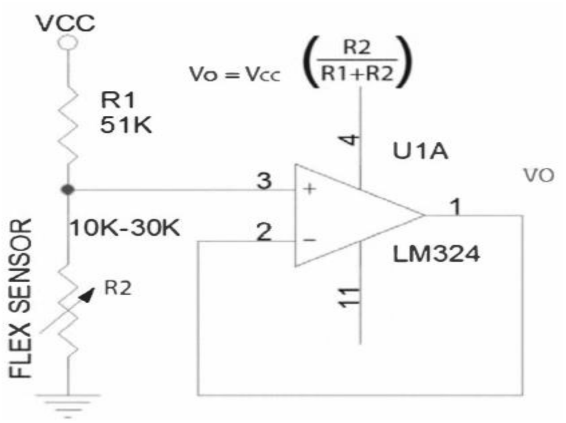

Fig. 4. Flex Sensor Signal Conditioning Circuit [1]

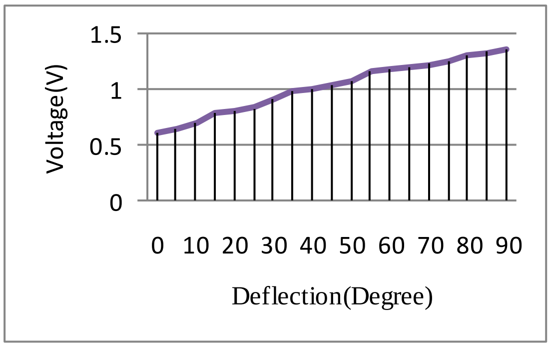

Fig.5. Signal Conditioning Graph (Deflection vs. Voltage)

The corresponding values of graph which is output of Fig. 5.Calculations are as following:

Formula for voltage divider circuit:

$$V_O = V_{CC}\left[\frac{R2}{(R2 + R1)}\right]$$

For V_O minimum when sensor deflection is 0^0 R1=51KΩ, R2=10KΩ and V_{CC}= 3.7V

$$V_O = 3.7V\left[\frac{10K}{(51K + 10K)}\right]$$

$$V_O = 0.60656V$$

For V_O middle when sensor deflection is 45^0 R1=51KΩ, R2=20KΩ and V_{CC}= 3.7V

$$V_O = 3.7V\left[\frac{20K}{(51K + 20K)}\right]$$

$$V_O = 1.04225V$$

For V_O maximum when sensor deflection is 90^0 R1=51KΩ, R2=30KΩ and V_{CC}= 3.7V

$$V_O = 3.7V\left[\frac{30K}{(51K + 30K)}\right]$$

$$V_O = 1.37037V$$

5.2. PIC18F4620

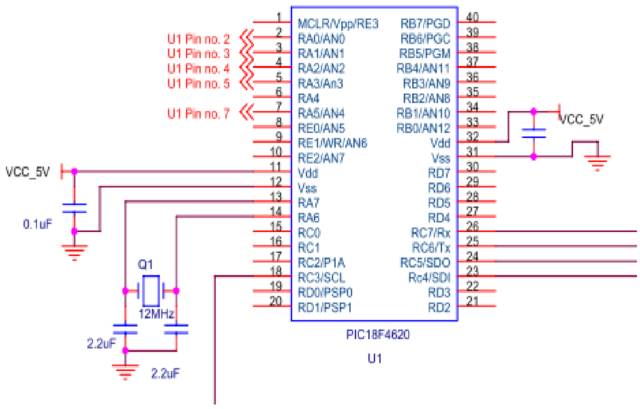

Fig. 6.PIC18F4620 connection

The output of the signal conditioning block is fed to PIC18F4620 (Operating Voltage range 4.2 - 5.5V) on pin number 2,3,4,5 and 7 that is used as analog input for built-in ADC (Analog to Digital Converter).. It has 10-bit built-in ADC which converts 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 bitaddressable 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 that can be seen in Table II has predefined meaning a certain 8-bit code for particular message is sent to aIVR8511 block. This block can be seen in Fig. 3

5.3. aIVR8511

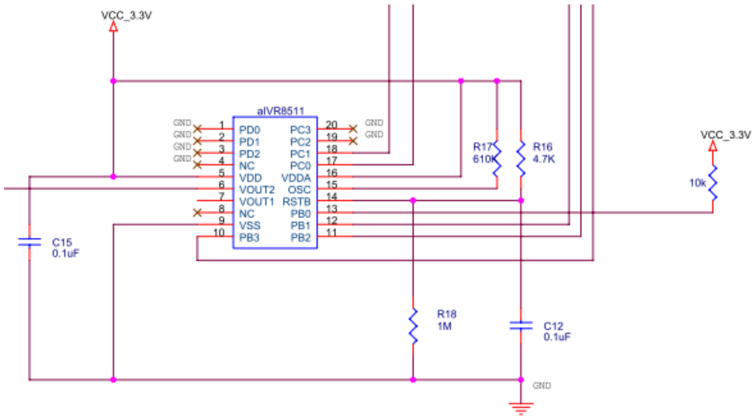

Fig. 7.aIVR8511 connection

Aplus aIVR8511 is a 8-bit MCU based Voice chip. It is fabricated with Standard CMOS process with embedded voice storage memory. It can store voice message with 4-bit ADPCM compression at 6 KHz sampling rate. 8-bit PCM is also available as user selectable option to improve sound quality. There are up to fifteen programmable I/O pins from which PB1, PB2, PB3, PC0 and PC1 are used as input pins which are driven by PIC18F4620. Key trigger and Parallel CPU trigger mode can be configured according to different application requirement. User selectable triggering and output signal options provide maximum flexibility to various applications. Built-in resistor controlled oscillator, 9-bit resolution current mode D/A output and PWM direct speaker driving minimize the number of external components. Volume control for both DAC and VOUT output is available.

5.4. Signal Amplification

The recorded voice output from aIVR8511 is not much audible to human ears therefore; it is fed to an amplifier that enhances its volume. It is configured at the gain that makes it quite natural to human ears; an 8Ω speaker is used to get the final output. Volume of the speaker can be controlled with the help of gain. The gain is controlled using potentiometer connected at the emitter of transistor.

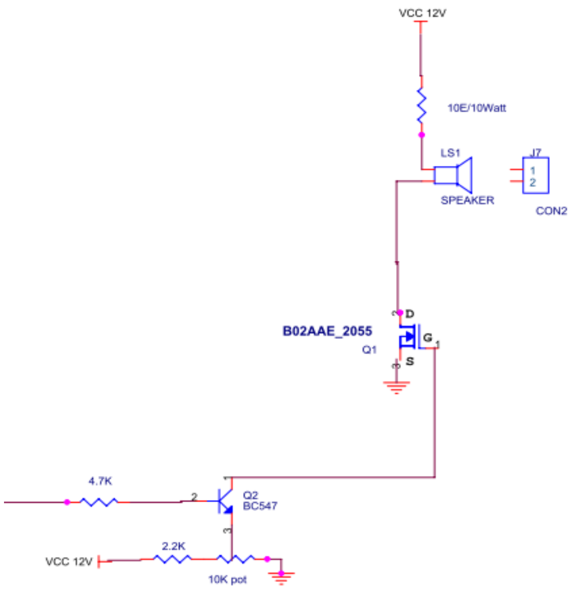

Fig. 8. Amplifier

Table 2. Gestures and messages accordingly

S. #	Bin	Hex	Gestures	Messages	S. #	Bin	Hex	Gestures	Messages
1	00000	00		No Message	3	01110	0E		Call Doctor
2	01101	0D		I need Water	4	01111	0F		I want to go to Washroom

VI. HARDWARE AND SOFTWARE

The hardware of this research project includes PIC18F4620; High performance, Low-power 8-bit Microcontroller and it has built-in 10 bit ADC, RISC Architecture, In-System Programmable (ISP), Watchdog Timer. aIVR8511 is a 8-bit MCU based Voice chip. It is fabricated with Standard CMOS process with embedded voice storage memory. The aIVR Sound Compiler Development System is designed to support Aplus aIVR series Voice chips. This development system serves two main functions:

Compiler – to create a DAT file from user's Voice files Fig. 9.

Writer – to program the DAT file into the aIVR chip.

The Compiler is used to combine the edited voice files into the chip to form the desired Voice Group and to define the playback functions of each Voice Group by selecting different Options and Trigger Modes of each individual Voice Group. The Writer is used to program the voice data into the aIVR devices that resulted from the Compiler Function. A Writer Board connected to the PC via USB port is required.

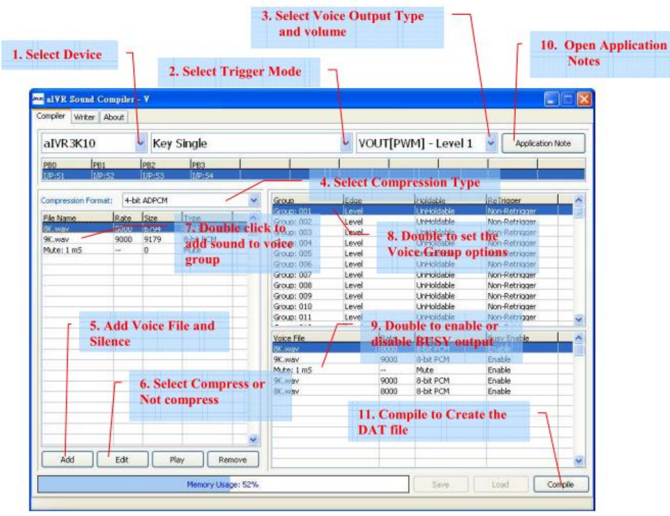

Fig. 9. The compiler window

Voice data and user selectable options must be set up and combined together to create a DAT file for programming into the aIVR chip. The following procedures describe step by step how to compile the voice data and select the options to produce the DAT file for programming. After finishing the compiler steps and the DAT file is created, you can program the DAT file in the aIVR device. Click the "Writer" tab to enter the programming section.

VII. CONCLUSIONS

This project is a useful tool for speech impaired and partially paralyzed patients with any language as his mother tongue which fill the communication gap between patients, doctors and relatives, This project will give dumb a regional 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 and robust gives patient liberty to carry it anywhere at their will.

VIII. FUTURE ENHANCEMENT

To make it 100% waterproof, some protected layers may be fashioned in order to secure the circuit, battery and speaker.

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