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Smart Glove: Gesture Vocalizer for Deaf and Dumb People

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ABSTRACT: Sign language is a natural way for communication between normal and dumb people, but often they find difficulty in communicating with normal people as we don't understand their sign language. Therefore, there always exists a language barrier. To minimize this barrier, we propose a device which can convert their hand gestures into voice which a normal person can understand. This device consists of a Wireless Glove, consisting of flex sensors and accelerometer. These sensors sense the movement of hands and fingers. This system consists of a speech synthesizer circuit which converts these movements of hand into real time speech output and a display will give the text for the corresponding gesture. The text and voice output being in English. So, this device provides efficient way of communication for both deaf-dumb and normal people.

KEYWORDS: Wireless Glove; Flex Sensor; Accelerometer

I. INTRODUCTION

In the recent years, there has been a rapid increase in the number of hearing impaired and speech disabled victims due to birth defects, oral diseases and accidents. When a speech impaired person speaks to a normal person, the normal person finds it difficult to understand and asks the deaf-dumb person to show gestures for his/her needs. Dumb persons have their own language to communicate with us; the only thing is that we need to understand their language.

Sign language is used by deaf and mute people and it is a communication skill that uses gestures instead of sound to convey meaning simultaneously combining hand shapes, orientations and movement of the hands, arms or body and facial expressions to express fluidly a speaker's thoughts. But most of the time normal people find it difficult to understand this sign language.

The people who cannot speak or have lost their ability to speak in some accident, it becomes difficult for them to convey their message within the society. To overcome this, we have come up with a project called 'SMART GLOVE'.

In this project, Flex Sensor plays the major role. The glove is fitted with flex sensors along the length of each finger and the thumb. The flex sensors give output in the form of voltage variation that varies with degree of bend. This flex sensor output is given to the ADC channels of microcontroller. It processes the signals and perform analog to digital signal conversion. Further the processed data is sent in a wireless manner to the receiver section. In this section the gesture is recognized and the corresponding output is displayed on LCD and simultaneously a speech output is played back through speaker. The portability of this project is a major advantage. Thus with the help of this project, the barrier faced by these people in communicating with the society can be reduced to a great extent.



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II. RELATED WORK

The sign language detection and recognition systems have mainly one of the two following methodologies viz. vision based or image processing technique[6] and sensors and microcontroller based glove[1-5]. In the image processing technique, the camera is used to capture the gestures. These gestures are captured in terms of images and these images are analysed using different algorithms to recognize the meaning of a particular gesture. One such method is discussed in [6], where a desired hand gesture sequence is created by animating the corresponding key gesture frames with the help of extracted information. The disadvantage of image processing based technique is that it requires developing of complex computational algorithms in order to detect the gestures. Further this technique also requires proper lighting conditions, proper backgrounds and field of view limitations.

The next approach is to use Accelerometers and Flex sensors to detect the movement of hands[1]. In [1], the authors did not use advanced microcontrollers and thus a separate ADC design was required to measure sensor readings. Further exclusion of wireless transmitters makes the system complex because of wires. In [2], the logic levels of LCD and MSP430F149 did not match for interfacing purposes. Therefore, the authors used ATMEGA 16 for interfacing LCD. One more approach is discussed in [5] which uses SHAROJAN BRIDGE and several Arduino boards which makes the system little bulky and massive.

III. METHODOLOGY

A. Block Diagram Of System:

- THE PROPOSED SYSTEM CONSISTS OF PRIMARILY TWO SECTIONS:
 1. TRANSMITTER SECTION
 2. RECEIVER SECTION
- THE BLOCKS CONTAINED IN THE TRANSMITTER SECTION ARE:
 1. FLEX SENSORS
 2. ACCELEROMETER
 3. AVR MICROCONTROLLER
 4. RF TRANSMITTER
- THE BLOCKS CONTAINED IN THE RECEIVER SECTION ARE:
 1. RF RECEIVER
 2. AVR MICROCONTROLEER
 3. VOICE MODULE
 4. 16X2 LCD MODULE

B. Description of the Proposed System:

In this system at the transmitter side we use a glove which has to be worn by the user. This glove is mounted with 4 flex sensors each on the 4 fingers of the glove namely thumb, index, middle, ring. The flex sensors give their output in the form of change in resistance according to the bend angle. The output from the flex sensors is given to the ADC channels of the microcontroller.

The processed ADC values from the microcontroller are compared with the threshold values for the recognition of a particular gesture. The particular gesture is recognised & is given to the microcontroller which transmits them through the RF module in a serial manner.

For each value received at RF receiver, the microcontroller gives corresponding commands to the LCD and the Voice Module. Thus we get the voice output for each gesture and display of each gesture in form of text on the LCD display.

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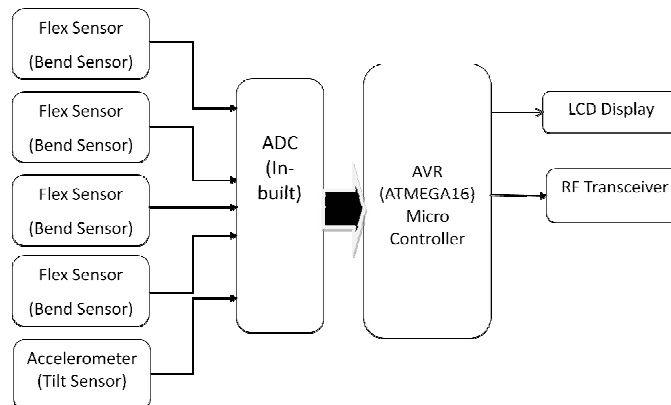


Fig. 1: Block Diagram of Transmitter Section

3.1 AVR (ATMEGA16) MICROCONTROLLER:

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. The ATmega16 provides the following features: 16 Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1 Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run. Hence we used AVR (ATMEGA16) microcontroller instead of 8051 microcontroller.

3.2. FLEX SENSOR (BEND SENSOR):

In this device the hand gestures are recognized using flex sensor. These sensors are attached to the gloves. Flex sensors are similar to potentiometer, i.e. variable resistor. The resistance of the sensor varies according to the amount of its bending, which in turn depends on the movement of finger. In order to precisely measure the bending flex sensor are used. The flex sensors have an average flat resistance about 10k ohms. When the sensor are bent the resistance offered by them increases.

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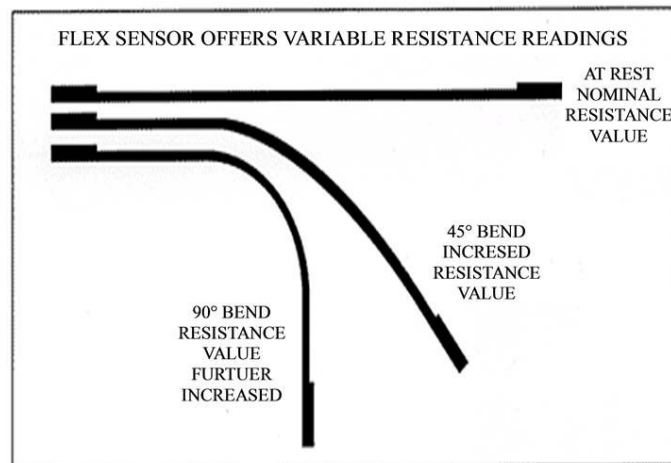


Fig. 2: Flex Sensor

3.3. ACCELEROMETER (TILT SENSOR):

The ADXL335 is a small, thin and low power device capable of measuring complete 3-axis acceleration. The ADXL335 can measure acceleration with a minimum full scale range of $\pm 3g$. It requires less power and gives output signals in terms of analog voltages that are proportional to acceleration. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock or vibration. The three axes' sense directions are highly orthogonal and have little cross-axis sensitivity since it uses a single polysilicon surface-micro-machined sensor structure for sensing X, Y and Z axes.

The user selects the bandwidth of the accelerometer using the Cx, Cy, and Cz capacitors at the Xout, Yout, and Zout pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm \times 4 mm \times 1.45 mm, 16-lead, plastic lead frame chip scale package.

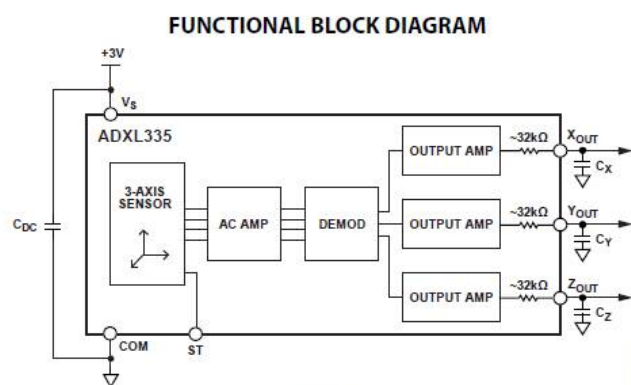


Figure 1.

Fig. 3: Functional Block Diagram of Accelerometer

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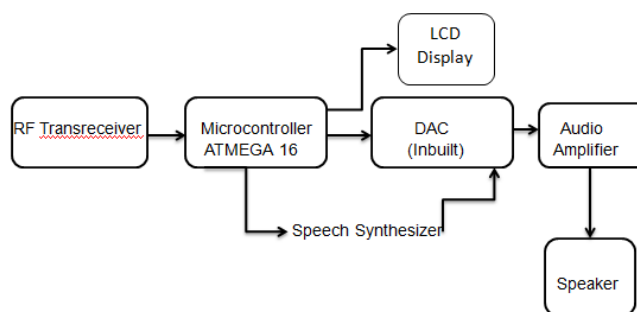


Fig. 4: Block Diagram of Receiver Side

3.4 RF TRANSRECEIVER (CC2500):

The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. With the integration of highly configurable baseband modem, the RF transceiver supports various modulation formats and has a configurable data rate up to 500 kBaud.

It gives 30 meters range with onboard antenna. In a typical system, this trans-receiver will be used together with a microcontroller. It provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication and wake on radio. (eg. RKE-two way Remote Keyless Entry, wireless alarm and security systems, AMR-automatic Meter Reading and control, Wireless Game Controllers, Wireless Audio /Keyboard /Mouse). It could easily to design product requiring wireless connectivity. It can be used on wireless security system or specific remote-control function and others wireless system.



Fig. 5 : RF Transceiver module

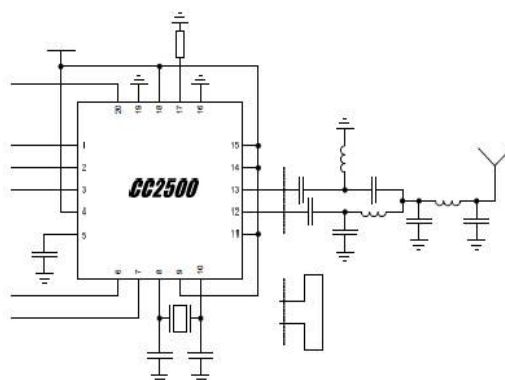


Fig. 6: RF Transceiver

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3.5 VOICE OTP IC (aP8942A):

aP8942A high performance Voice OTP is fabricated with Standard CMOS process with embedded 1M bits EPROM. It can store up to 42sec voice message with 4-bit ADPCM compression at 6KHz sampling rate. Two trigger modes, simple Key trigger mode and Parallel CPU trigger mode facilitate different user interface. User selectable triggering and output signal options provide maximum flexibility to various applications. Built-in resistor controlled oscillator, 8-bit current mode D/A output and PWM direct speaker driving output minimize the number of external components. Using PC controlled programmer and developing software, we can program this IC as per our needs.

IV. RESULT

In our system, the person who wears the glove should hold it for about 2 seconds in order to detect the particular gesture. Every gesture consists of movement and bending of fingers of hand in a particular order with specific angle correspondingly. The sensor values that are being generated by each of the Flex sensors and an accelerometer are fed to the ADC channel of the microcontroller. For every bending of Flex sensors and movement of an accelerometer, these sensors produce different analog values based on positions of these sensors. The different gestures are assigned unique numbers to identify a particular gesture. Once a gesture is identified, it is being displayed on LCD and the same is transmitted via wireless transceiver.

Using a comparison technique at the receiver side of the system, for each value that is received, the microcontroller outputs gesture specific commands to LCD module at the receiver and to the Voice IC simultaneously for giving the speech signal and text accordingly.

The following table gives the different ADC values of each sensor for different gestures.

Gesture	Understand	Smile	Come on let's go	Thank You
Index	<410	<410	<400	<400
Middle	<410	<410	<400	<400
Ring	>500	>500	<400	>500
Thumb	<460	>500	<460	>500
X-axis	>600	>500	>600	>500
Y-axis	>600	>600	>500	>600
Z-axis	>500	>500	>400	>500

Table 1: ADC values for each sensor

When the user does gesture "Understand" as shown in fig.7, the values from sensors are sent microcontroller through ADC ports. The microcontroller receives these values and converts them into digital form and simultaneously displayed on LCD.

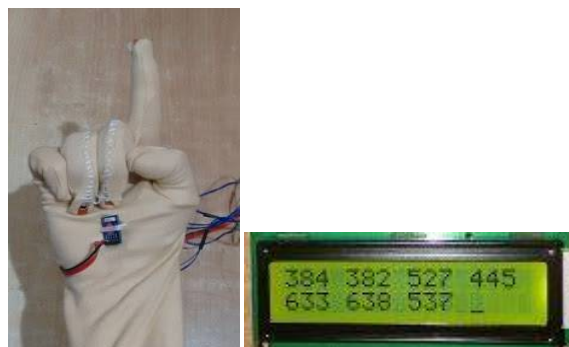


Fig. 7: Gesture-Understand & corresponding ADC values

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When the user does gesture “Smile” as shown in fig.8, the values from sensors are sent microcontroller through ADC ports. The microcontroller receives these values and converts them into digital form and simultaneously displayed on LCD.



Fig. 8: Gesture-Smile & corresponding ADC values

The time lag between the movement of hand gestures and the detection of it largely depends on the accuracy of the user to make a particular gesture.

V. CONCLUSION

This system is useful for dumb, deaf and blind people to communicate with one another and with the normal people. The dumb people use their standard sign language which is not easily understandable by common people and blind people cannot see their gestures. This system converts the sign language into voice which is easily understandable by blind and normal people. The sign language is translated into some text form, to facilitate the deaf people as well. This text is display on LCD. In order to improve and facilitate the more gesture recognition, motion processing unit can be installed which comprises of Gyroscope as well and with the help sensor fusion technique, we can accommodate a number of other gestures as well for better and efficient communication.

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