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Digital Vocalizer System for Speech and Hearing Impaired

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Abstract: Digital vocalizer is a social initiative project that aims to uplift people who are speech and hearing impaired, by facilitating them to have a better communication with the public. It is estimated that there are about 9.1 billion people in the world who are deaf and are have speech impairments. In their day to day life, they face a lot of problems whilst trying to communicate with society. Generally, the deaf and ones who have speech impairments use sign language for communication, but they find it difficult to communicate with others who do not understand sign language. Sign language relies on sign patterns, i.e. body language, orientation and movements of the arm and fingers etc. to convey information between people. This venture is conceptualized to address the need of developing an electronic device that can translate sign language into speech in order to facilitate easy communication between the dumb and deaf and the general public**.**

Keywords: Vocalizer, speech and hearing impaired, dumb and deaf.

INTRODUCTION

People who suffer from speech and hearing impairments use Sign Language for conveying their thoughts to the public. Sign Language involves simultaneously combining hand shapes, orientation and movement of hands, arms/body and facial expressions to fluidly express a speaker's thoughts. They are trained for the same along before they begin their formal school education. While it's easy for the Deaf to communicate amongst themselves using hand signs, the general public often finds it difficult to follow these gestures. Interpreters who have mastered the techniques involved in Sign Language are always needed in such cases. It can be quite frustrating for them to constantly seek the services of an interpreter whilst trying to communicate with their peers.

Sign Language is not universal. A single standard, universally accepted scheme does not exist for Sign Language. When India ratified the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), India made a promise to the world that she would ensure that dumb and deaf people will be treated equally and will enjoy the same rights as other Indian citizens. But the absence of such a common sign language model proves to be a roadblock in the efforts to treat the Deaf and speech impaired people equally.

It was the above factors which prompted to address this key issue through this project. Thus, was conceptualized the Gesture Vocalizer. Gesture vocalizer is a microcontroller based system that makes use of flex sensors and an accelerometer for detecting the finger bend angles and the tilt detection respectively. The said values that correspond to a particular gesture are then played as a voice message as well as text on the LCD screen display.

SYSTEM DEVELOPMENT AND IMPLEMENTATION

Gesture vocalizer mainly consists of sensors (flex and an accelerometer) placed on the hand of the disabled person and a microcontroller to convert the hand movements into audio and visual data through an audio processing unit and an LCD display. The device is built as a wearable glove, which converts the hand gestures into human recognizable audio.Flex sensors are placed on the glove which converts the parameter like finger bend hand position angle into electrical signal and provides it toan Atmega 328 controller. Controller takes action according to the particular gestures.

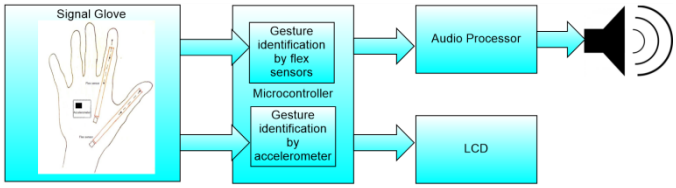

Fig.1: Block Diagram

Here there are two flex sensors for detecting bending of fingers and one ADXL335 3-axis accelerometer for getting the orientation of hand, embedded on the glove for gesture recognition. The APR33A3 audio processor chip is used for storing and playing back audio messages. To facilitate communication for people having hearing impairment, an LCD display is employed which can displays the text messages.

HARDWARE IMPLEMENTATION

GESTURE DETECTION

Data glove is equipped with two flex sensors.They are placed on the thumb and index finger of the hand glove.Flex sensors are sensors that change resistance depending on the amount of bend on the sensor.They are analog sensors.They can be made unidirectional or bidirectional.Even a little bend of the finger can be detected .Now the bending of each finger is quantized into 10 levels.At any stage the finger must be at one of these levels and it can easily determine how much the finger is

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bent.The binary data from the flex sensor is then sent to ATMEGA328. Next step is to combine the movement of each finger and name it a particular gesture of the hand.

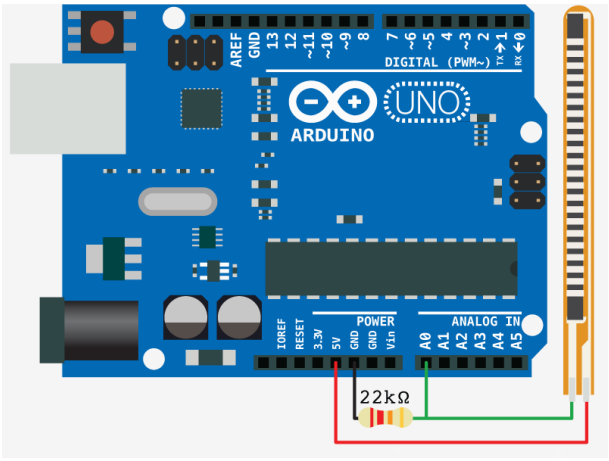

Fig.2: Arduino Uno with the flex sensor

TILT DETECTION

Accelerometer(ADXL 335) in the gesture vocalizer system is used as a tilt detector.Ithas an analog output which varies from 1.5 volt to 3.5 volt.ADXL335 is a three-axis analog accelerometer IC, which reads off the X, Y and Z acceleration as analog voltages. By measuring the amount of acceleration due to gravity, an accelerometer can figure out the angle it is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, the accelerometer can find out how fast and in what direction the device is moving.The basic function of this device is to detect the tilting of the hand and sending some binary data against meaningful gestures,to the microcontroller. Microcontroller receives the data and saves them.

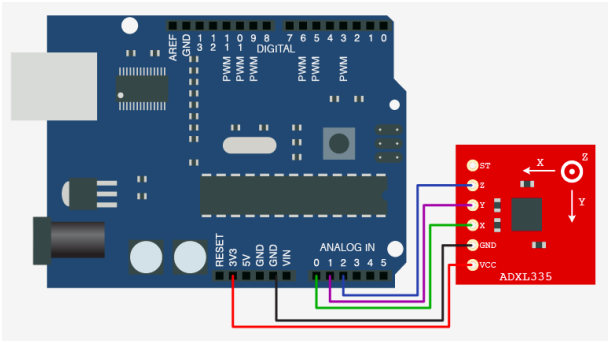

Fig.3: Arduino Uno with accelerometer

SPEECH SYNTHESIS

Speech synthesis is done by an audio processing unit(APR33A3 C2),a MIC,an amplifier circuitry and a speaker.The function of this unit is to produce voice against the respective gestures. The microcontroller receives the 8-bit data from the flex sensor and the accelerometer and compares the 8-bit data with the predefined values. On the basis of this comparison,the microcontroller comes to know that which gesture the hand makes.The last step of the system is to give voice to each gesture.For this purpose,a speech synthesizer IC APR33A3 is used.APR has 8 channels through which audio corresponding to each gesture are recorded. The address corresponding to each channel is sent to the speaker,when the corresponding gesture is shown.

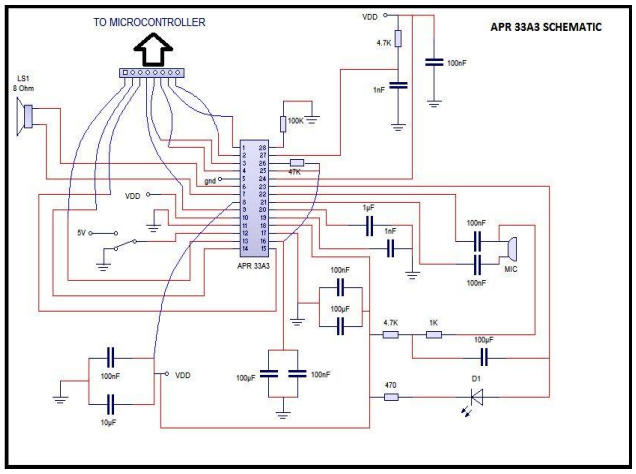

Fig.4: APR33A3 message recording and playback setup

LCD DISPLAY

Flex sensor and accelerometer outputs are sent to the LCD display (16x2).The microcontroller checks each signal and compares it with the already stored value.

On the basis of this comparison the microcontroller takes the decision about what message should be displayed.Having taken the decision,the microcontroller sent an 8-bit address to the LCD. This 8-bit address is the location of first character in the message that the LCD should display.

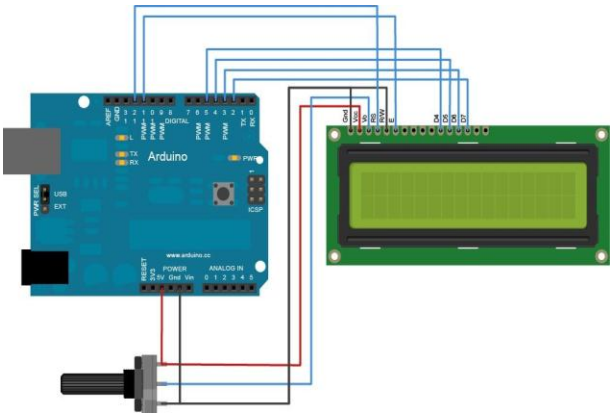

Fig.5: Arduino Uno with LCD

SOFTWARE IMPLEMENTATION

The software development environment employed for the preparation of the project is Arduino IDE. The open source Arduino Software(IDE) makes it easy to write code and upload it to the board.

It runs on Windows, Mac OSx and Linux. This was the software to draft the final code for this project. The environment is written in Java and is based on processing and other open source software.

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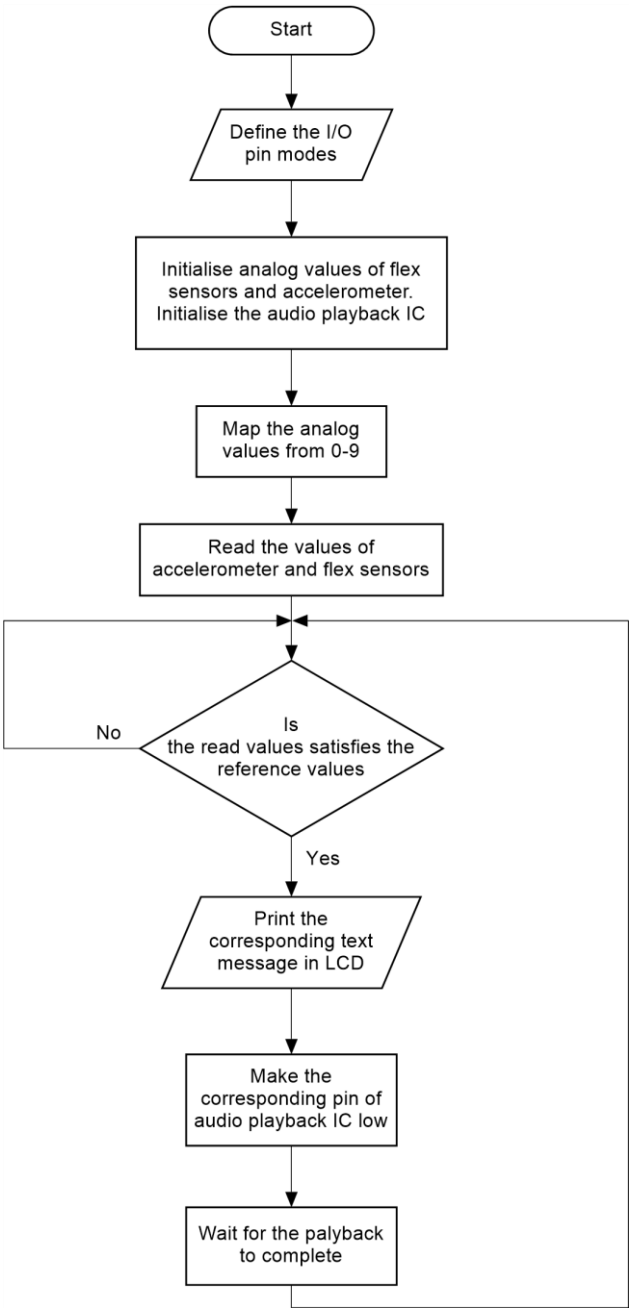

Fig.6: Flowchart of the software implementation

The functional flow of the programme is depicted in the top level flowchart in fig.5. After initialising the peripheral ports of the microcontroller, will enter into an infinite loop. It will first acquire the analog values from the accelerometer and the the set of flex sensors. This at first being converted to equivalent digital values is then compared with the prefixed values. (The prefixed values are obtained after doing a thorough research and trials on the different gestures with this prototype system. The obtained trial values are studied and based on that a table is devised that maps the successful commands with values ranging from zero to nine). If the comparison is a success the system will display the corresponding message in the LCD and play the pre-recorded audio message through the audio processing unit.

Fig.7: The final product

CONCLUSION AND FUTURE EXPANSION PLANS

Gesture vocalizer is a hand gesture based interface for facilitating communication among normal people and people with speech and hearing disabilities. In this system a data glove is used as input device which is normal cloth driving gloves fitted with flex sensors along the length of the index finger and the thumb. In this project, a microcontroller and sensor based gesture to voice converter is created so as to recognise six commonly used gestures and convert them into voice message as well as a text message for the benefit of the Deaf. Flex sensor based data glove can detect all the movements of a hand and the microcontroller based system converts some specified movements into human recognizable voice and text display through the LCD display.

This Digital Gesture Vocalizer is a social initiative project that helps bridge the communication gap between normal people and disabled people. The system can be easily implemented. The compact, portable design is its main advantage. The device can be incorporated in a jacket/vest and can even add on to one's style statement. It eliminates the need for having interpreter. Thus the project contributes to the upliftment of the Deaf community and ensures that they also lead a life that is no different from the rest, thus breaking down the social stigmas which prevail in our society. The output is presented both as voice as well as text message. The main drawback of the project is the high cost of the flex sensors that has been employed. So thenumber of gestures is scale down to six.The completion of this project suggests that these wired gloves can be used for partial sign language recognition. In future work of this proposed system, by fitting flex sensors on all the five fingers of the hand, we can extend its usability by supporting more number of signs and different language mode.One can make this system wireless so that it becomes handy and portable for commercial use.

Designing of a whole jacket, which would be capable of vocalizing the gestures and movements can be adopted to make it more user friendly. Virtual reality application e.g., replacing the conventional input devices like joy sticks in videogames with the data glove can also be realised using a gesture vocalizer. The Robot control system to regulate machine activity at remote sensitive places, tele-operators to perform surgeries with the help of expert surgeons remotely are another useful applications of such an implementation.

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