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Design and Implementation of Smart System for Interaction Between Blind, Deaf and Mute People

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Abstract— Difficulties faced by the deaf and dumb people and the blind people to communicate among themselves is the major motivation for the proposal of this project. The project aims at bridging this communication gap by means of an cost-effective electronic device. This is done by using a prototype hand worn glove which converts hand gestures and Braille codes into speech and text, thus enabling speech-impaired and visually impaired people to effectively communicate with everyone. MEMS sensors are used to recognize the gesture sign given by the deaf and dumb people. The gesture input is sent as an audio file which is understandable to the people. The input given by the blind people is in Braille language which is converted to text using scale-invariant feature transform (SIFT) algorithm and decoded to text and voice output through Artificial Neural Networks (ANN) by means of Back Propagation using Supervised Learning. So this ensures two way communication between blind, deaf and dumb people.

Keywords: glove, MEMS, SIFT, ANN, Back propagation, Supervised Learning.

I. INTRODUCTION

Communication plays a vital role in the present data driven society, not only in extreme situations, but also in everyday life. Most of daily activities of a normal person depend on reliable communication. A nation's defense system require an authenticated communication. Speakers of American Sign Language (ASL) face challenges to communicate verbally, which limits their interaction with the rest of the hearing world [4]. In order to use certain public services, such as the doctor's office or local government, an interpreter could be hired to alleviate some of the frustration and confusion of the communication barrier. However, hiring an interpreter can be expensive and time consuming thus making the challenge of bridging the communication gap difficult. On the other hand it is difficult for normal people to recognize Braille language and at the same time it is difficult for the deaf and dumb population to communicate with the blind people. So this project aims at bridging the communication gap between blind, deaf and dumb people and their interaction with the normal people [7].

II. PREVIOUS WORKS

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A. Existing system:

Most of the existing systems in gesture recognition usually follow image-based approaches which require sophisticated image processing platforms. Camera should be in front of the object to capture the gestures; this limits the mobility of the system. Power consumption is an important task to be considered. Joystick, trackball and touch tablet can be used to capture the gesture. Technologies that use vision system or a data glove are relatively expensive. Template- matching, dictionary lookup, statistical matching, linguistic matching, and neural networks are the most common methods for pattern recognition [2]. The three different gesture recognition models include,

1) Sign-sequence and Hopfield based gesture recognition model.

2) Velocity-increment based gesture recognition model and

3) Sign-sequence and template-matching based gesture recognition model

B. Limitations of existing system:

Ambient optical noise is a major problem the existing system. The dynamic response of the system is not faster and there is a necessity to collect excess of data to process, train and test the vision based system. Micro Inertial Measurement Unit was used in this work. Though the cost of the measuring unit is less, the accuracy of the data collected is significantly high. This device detects the accelerations of hand motions in all three dimensions [6]. Although the extensive use of sensors throughout the arm is helpful for providing a more complete understanding of a signed gesture, many components would very likely be too cumbersome to be used and also very expensive.

III. PROPOSED SYSTEM

The proposed system utlize Microelectromechanical system based acceleration sensors. MEMS sensors were used to measure the acceleration, rotation and tilt of fingers detecting various hand movements. The extent to which an boject bend and the rate of change of velocity can be measured by these sensors. The orientation of the finger of a hand can be measured using the MEMS accelerometers. The sensors are placed on the fingers to measure the orientation of the fingers.[2]. The signal is processed by a PIC microcontroller. The processed output can distingush different gestures. Many parameters decide the analysis process such as the analog and digital pins of the microcontroller, expenditure and viability. MPLAB software was used to implement the algorithm. It helps to configure the input and output pins for each sensor. It also setup a clock speed, configure communications with the Analog-to-Digital Converter (ADC) and to implement the algorithm. The blind give their input in written form and the Braille input images are decoded using scale invarient feature transform (SIFT) algorithm and Artificial Neural Networks (ANN) and is obtained as text and voice output [5]. This project use MATLAB for running the image processing algorithm. This project involves a sensor network that differentiates various gestures of hand movements that are used in the American Sign Language (ASL). This sensor network was connected to a microcontroller. Hardware components and the software are intefaced by a Printed Circuit Board (PCB). A algorith was developed to distinguish sensor signals. The signals are stored in a code library. This signal matches the standard ASL Sign. The proposed method could store five vital signs and the outputs are viwed through liquid cristal display and a speaker. System Design

The block diagram for the entire framework is illustrated above. The entire framework is divided into two modules

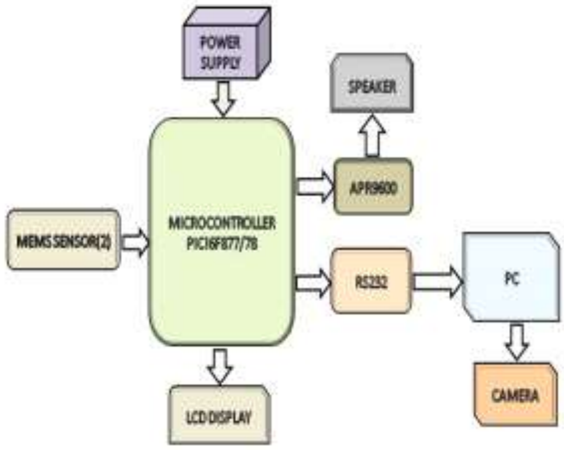


Figure 1: Block Diagram

Module 1-This module focuses on the inputs given by the deaf and dumb individuals and their interaction. The heart of this module is the PIC16F877/78 microcontroller which processes the decision making algorithm which matches the given gesture input with the predefined database of inputs and decodes the desired output which is obtained as voice and text using LCD and voice processing module (APR9600) which is connected to a speaker. This module involves the deployment of MEMS sensor on each of the fingers for measure the acceleration, rotation and tilt of fingers detecting various hand movements. MEMS sensors measure the amount of bend by an object and its acceleration. For the proposed prototype project two MEMS sensors are deployed. They are fixed to the middle and index finger. Orientation and rotation of these finger can be measured using this sensors. They are chosen for this project because when they are fixed to each finger of the hand, they can be used as a measure of finger orientation and rotation. Thus detecting and sensing of gesture inputs becomes easier.

Module 2-This module focuses on the inputs given by the blind, The Braille code images are scanned using a camera and the desired output is decoded using SIFT algorithm and Artificial Neural Networks(ANN). The MATLAB software is used for processing the braille code image.

IV. IMPLEMENTATION OF MODULE - 1

A. Hardware Requirements:

Regulated power supply, MEMS sensors ADXL337, APR9600, PIC Microcontroller 16F877A, Speaker, and LCD.

B. Software Requirements:

MATLAB R2014a and MPLAB.

C. Basic Methodology:

The proposed gesture recognition system is implemented based on MEMS acceleration sensors. Usage of gyroscopes for inertial measurement will lead to heavy computation and hence it is not used for motion sensing. The proposed system is based on MEMS based accelerometers [3]. The architecture diagram given below (Figure 2). It illustrates the proposed gesture recognition system based on MEMS accelerometers. MEMS based accelerometer senses the acceleration in all the three axes. The output of the accelerometers were signal conditioned and are fed to microcontroller. The incoming signal is compared with the trained values that are already stored in the microcontroller. [4]. Eacht channels present in the voice chip are fed with the commands that corresponds to different gestures. When the test signal matches the stored data, one of the corresponding channel will be enabled. The LCD will subsequently display the commands. The output of the voice chip is of low amplitude and hence an ampifier is required. The amplifier amplifies the signal and feed the signal to the speaker system. Thus, the command displayed will also be heard [9].

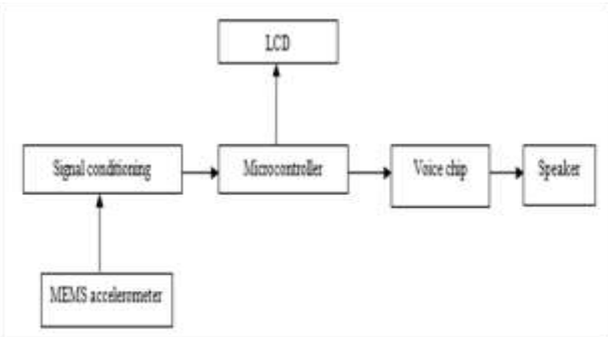


Figure 2: Proposed System Architecture

The simulated output for the entire framework is obtained using Proteus software is represented in the below image.

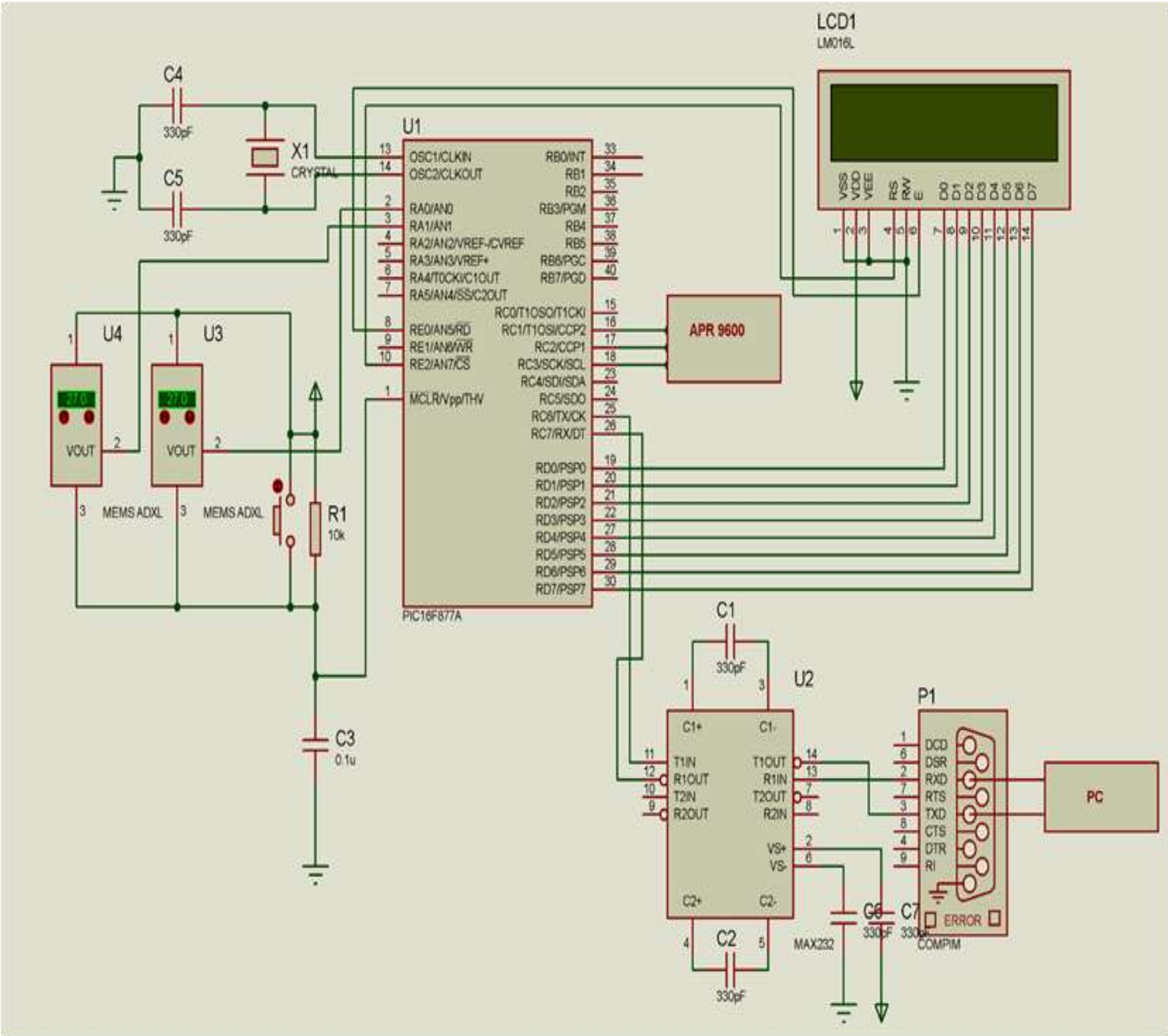


Figure 3: Simulated circuit diagram

D. Sensing Device:

ADXL337 is a slim, low power, tiny, complete 3 - axis (X, Y, Z) accelerometer. The thre axes are orthogonal to each other and hence cross – axis sensitivity is less. Full - scale range of ±3 g is used to measure the acceleraton. It measures both inert as well as active acceleration [3]. Three axes are highly orthogonal to each other and thus have little cross-axis sensitivity. The sensors are suspended over the surface of the wafer with the help of polysilicon springs. The spring present a resistance against acceleration forces [4]. Differential capacitor measures the deflection of the accelerometer structure. The fixed plates of the capacitor are driven by means of 180° out-of-phase square waves. The acceleration deflects the moving mass. This in turn reduce the balance between the differential capacitor. Hence the output magnitude of the sensor is propotional to the acceleration. Magnitude and phase of the acceleration are determined by phase perceptive demodulation techniques.

E. Data Processing:

MEMS base accelerometer produces analog signals than corresponds to rate of change of velocity of the three axis. A lookup table present in the PIC microcontroller stores the acceleration of eight gestures. Acceleration corresponding to the input gesture is compared with the stored data for all the three axes. Tolerance Each incoming gesture values for all the three axes are compared with every axis value in the table. The tolerance level was set to ±5. Whenever a match is found between the test gesture and the stored data, a channel in the voice chip is activated. LCD displays the command corresponding to the gesture. Audio signal that could help blind people was played by a eight channel APR9600 voice chip through the speaker. The proposed method rely only on the acceleration values. Hence any person can use this smart system. Also gesture motion analysis was not required. This purge the need for training the consumer [9].

F. Output:

The controller programming was implemented using Embedded C. Proteus-Lab center Electronics software is used in this prototype for simulation. The accelerometers can be used independently with an embedded processor.

Accelerometers can be connected wirelessly to any mobile devices. In simulated model, potential divider (crimp port) is used as input device as a substitute for MEMS accelerometer.Accelerometer values can be changed using this crimp port.

The entire implementation of the setup is represented in the snapshot below

Figure 4: Prototype model of the proposed system with microcontroller, LCD, Voice chip and speaker along with MEMS accelerometer

V. IMPLEMENTATION OF MODULE - 2

Artificial Neural Network is the trending practice for machine learning process to recognize the patterns. Training and testing algorithm can discriminate the static and dynamic gesture. Input from Braille language codes can be classified. This methodology is followed to decode Braille text to voice and text output.

A. Procedure for implementation1. From video, frames are obtained by using image acquisition toolbox and after converting video into frames those frames are processed using image processing toolbox.

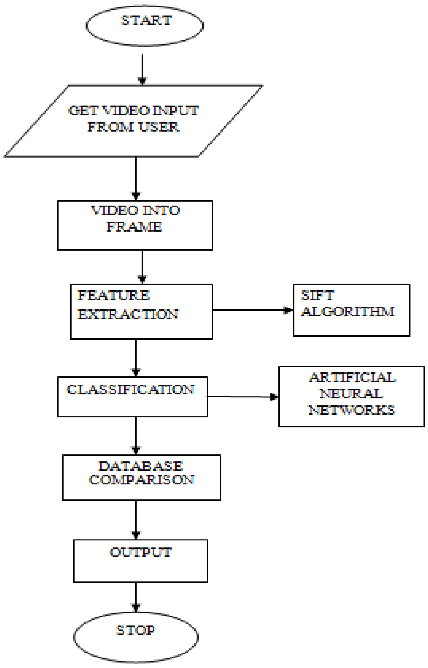
2. SIFT features are extracted using a SIFT feature extraction technique

3. Those features of them are trained using artificial neural network technique by Supervised Learning through back propagation

4. Live images taken using web camera and convert it into frames from frames a SIFT feature is extracted.

Live image features are then compared with the trained neural network features and then the result is produced using neural network technique.

B. Flowchart for implementation:



VI. RESULTS AND OUTPUTS

A. Outputs for deaf and dumb interaction system

Outputs for deaf and dumb interaction system along with the corresponding representation snapshot are illustrated in the table below. The table represents the two axis accelerometer values for five input words and their corresponding output snapshot

EXPECTED OUTPUT	ADC1	ADC2	ADC3	ADC4	OUTPUT SNAPSHOT
HELLO	332	288	298	298	
NAME PLEASE	399	324	313	314	
YES	332	404	400	400	
NO	331	403	295	291	
TWO	335	405	269	270	

Table 1: Display of output results

B. Output Screenshots For Braille Code Recognition:

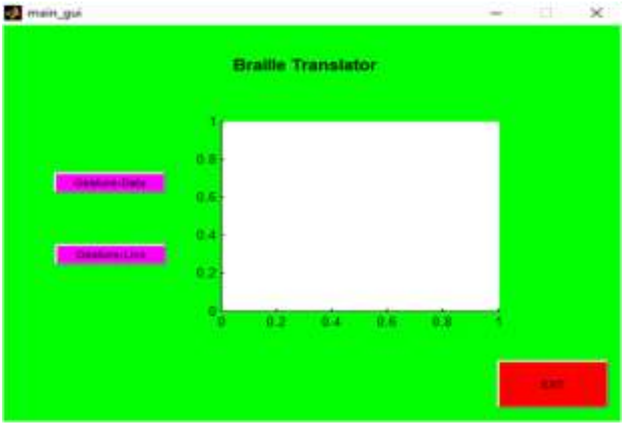


Figure 5: GUI Window for getting database and live inputs

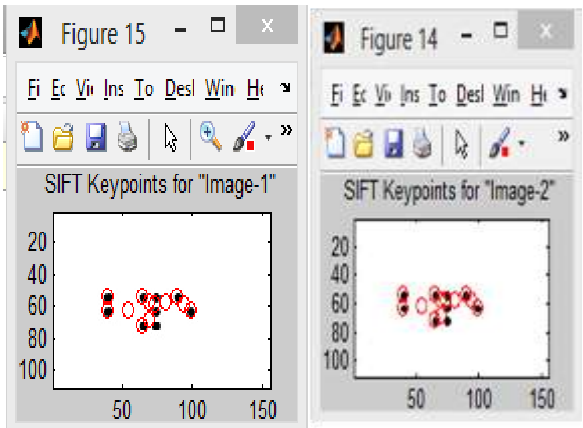


Figure 6 & 7: SIFT key points for the database input (image1) and live image (image 2)

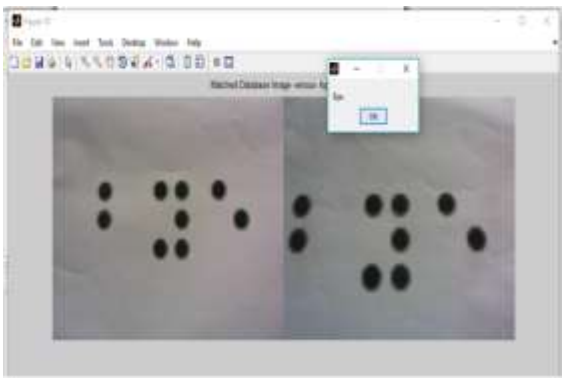


Figure 8: Comparison and output screenshot

VI. CONCLUSION

The proposed work illustrates gesture recognition through the use of MEMS accelerometers and Braille code recognition through Image Processing by means of SIFT algorithm and ANN. Accuracy of the system is improved using 2 axes acceleration values. Two ADXL337 accelerometers were used for sensing the hand posture. A microcontroller and a display unit with speaker is also a part of the system. The input acceleration value for each gesture were compared that of the pre - stored templates. Standard gesture patterns were alone analysis and hence huge data base and complex recognition systems are not required. There is no need for collecting many gestures made by different people. The image processing part was simple and accurate as it uses feature extraction by means of SIFT algorithm which is scale and rotation invariant. Advantages of this approach are the potential of mobility and reliability to all individuals. MEMS based accelerometers are easy to wear and are user friendly. In future, more gesture patterns can be trained and efficient algorithm may be developed for pattern recognition.

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