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Sign Language Recognition using a Smart Hand Device with Sensor Combination

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Abstract: Communication is primary means of sharing information. For the deaf and dumb, sign language is their means of sharing information. A lay man finds sign language hard to decipher. Hence we propose a hand glove with combination of flex and three axis accelerometer sensors which is to be worn by the deaf and dumb while communicating with the rest of the world. The data collected using the sensors are matched with predetermined values using the technique of template matching using ARM LPC2148. The data that is accessed is then sent to an android app using a wifi module. Here in this system we focus on ASL alphabets. The data that is sent to the Android app is displayed on the screen and a voice output for each character is played.

Keywords: flex sensor, template matching, 3 axis accelerometer, mobile application

I. INTRODUCTION

Humans are given the gift of speech. But, there are certain people who do not possess this gift. The only means of communication for them is Sign language. Sign language is the method of communication using various finger and hand motion. Various sign languages have been developed across the globe (ASL, ISL, etc.) for deaf and dumb to communicate amongst them and with the world. Approximately about 2.4 million people in India are deaf and dumb. These people face many difficulties in various fields as the society cannot understand what they are trying to communicate due to our inability to understand the sign language. In the proposed model, we provide a hand device which can be worn by the deaf and dumb which converts the alphabets of the sign language into a text output.

II. LITERATURE SURVEY

Signs can be recognized using two approaches vision based approach and non- vision based approach. Vision based technique is the more commonly used technique. [1] uses SIFT algorithm to classify the alphabets from A to Z, this technique increases the processing speed but is inconvenient for the deaf as it involves the use of color markers and data glove. In [2] the color glove is used to define specific regions of the hand. A hand is divided into twelve regions and each region has a unique color given to them. It utilizes the CAD model to differentiate the signs. [3] an image is captured to detect the hand region and to determine the number of active fingers. Using a simple scanning method in MATLAB, the number of active fingers is counted. The background light, the processing of images and the distance between hand and camera affects the output given by the approach. Consequently, non vision based approach served as an alternative method for the purpose of gesture recognition. In [4] the data collected from the bending of the flex sensor is mapped to a character set using MMSE learning algorithm. The results are displayed on a smart phone which performs text to speech conversion. [5] developed a glove that is used to track 3D hand motion. This setup uses three 3 axis accelerometers to detect the motion in two different angular positions. [6] attempted to integrate inertial and vision depth sensor within a frame work of HMM algorithm for hand gesture recognition. The data collected from vision depth sensor and inertial sensors are complementary in nature enabling a robust recognition outcome. [7] signs are classified using five 3 axis accelerometers based on orientation of fingers with respect to gravity. [8] uses Bayes linear classifier and an improved dynamic time-warping algorithm to classify large scale gestures involving motion of the hand. [9] uses inertial measurement unit and sMEG to detect gestures by fusing the information from the two. A gain based feature selection schemes is used to select the best subset of feature from a range of available features. [10] uses five unidirectional bend sensors to find the bending angle at the joints of the fingers and generate values for each bending angle usually conducted in a 3D space known as signing space.

The objective of this study is to develop a hand device to recognize ASL alphabets. The hand device comprises of flex sensors, 3 axis accelerometer on a glove. The sensor data is computed using an ARM processor. The final output data is sent to a mobile

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application using a WI-FI module. This mobile application displays the character and also converts the received character to audible speech.

III. EXPERIMENTAL SETUP

The setup comprises of a glove on to which five flex sensors are positioned such that each finger has a flex sensor placed. A three-axis accelerometer is incorporated and is positioned near the wrist. An LPC2148 ARM7 processor is used to integrate these analog sensors and process the data. On processing, a character is derived using template matching technique. The derived character is sent to an Android Smartphone through the Wi-Fi module. An Android application is developed using the Blynk platform for displaying the character.

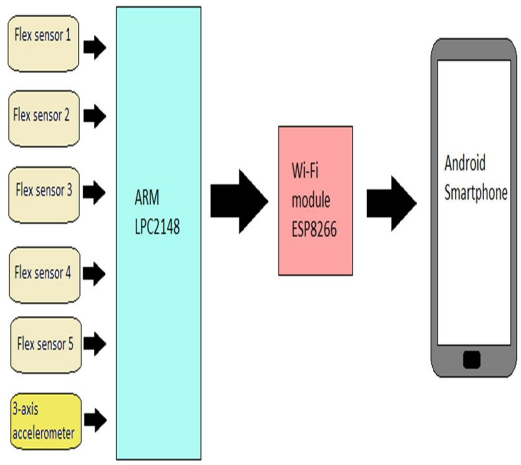

Fig. 1 Block Diagram of the Proposed System

IV. COMPOPNENT DESCRIPTION

A. Flex Sensor

The flex sensor consists of an internal resistor. The flex sensors are bidirectional in nature and hence it can detect change in resistance in both positive and negative directions. The internal circuitry of the flex sensor is a voltage divider circuit which gives different values of voltage based on the amount of bending of the fingers, due to the change in resistance inside the flex sensor.

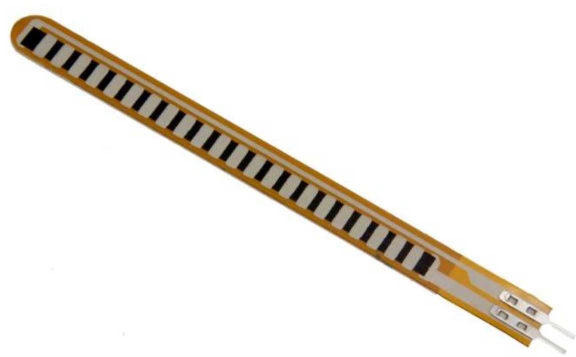

Fig. 2 Flex Sensor

B. Three-axis Accelerometer

The three-axis accelerometer is used to measure the orientation of the hand and fingers. The internal circuit of a three-axis accelerometer consists of one fixed capacitor and one variable capacitor. Due to the orientation or tilt of the hand a change in capacitance results in proportional voltage change.

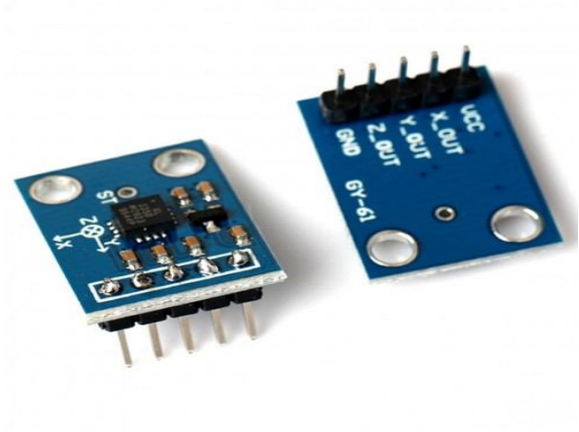

Fig. 3 Three-axis Accelerometer

C. ARM 7

ARM 7 LPC 2148 is a 32 bit processor. It has 64 multi-functional general purpose input/ output pins.

It comprises of two ADCS with a total of 14 channels. Operating frequency is 60MHz with each of the five cores operating at a frequency of 12MHz (12 * 5). It has a 3 stage pipeline architecture which increases the speed of execution.

Fig. 4 ARM7 LPC2148

D. Wi-Fi Module

ESP8266 is a 16 pin is a self- contained networking unit. These are low power devices which works on UART protocols and is programmed using AT commands. Serially the data is sent from the processor to this unit with the help of UART protocol.

Fig. 5 Wi-Fi Module ESP8266

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V. METHODOLOGY

When a particular alphabet is shown using sign language, it involves bending of the fingers thereby resulting in the bending of the flex sensors; there occurs a change in resistance of the flex sensor. A range of voltage values are given for each bend of the flex sensor for every finger. Thus, for every alphabet, each flex sensor is given a particular range of voltage values so as to distinguish it from other alphabets. The tilt sensor is used to measure orientation of the hand and fingers. The angle at which the hand is bent is given a range of values to distinguish alphabets that have similar bends so as to reduce ambiguities. The voltage values generated by flex and tilt sensors are all analog in nature. These analog values are converted into digital format using the ADC of ARM 7. The digital voltage values generated are compared and analyzed with previously stored values in the ARM flash memory. The set of values that matches with the input values is selected and the alphabet corresponding to those values are given as the output of the ARM. This process is known as template matching, where raw input data collected is compared with predefined data to give the appropriate output. The alphabet so generated is transmitted to an Android device using a Wi-Fi module. The alphabet is displayed on the Android device using the Blynk App where different widgets can be dragged and dropped based on the application of the user.

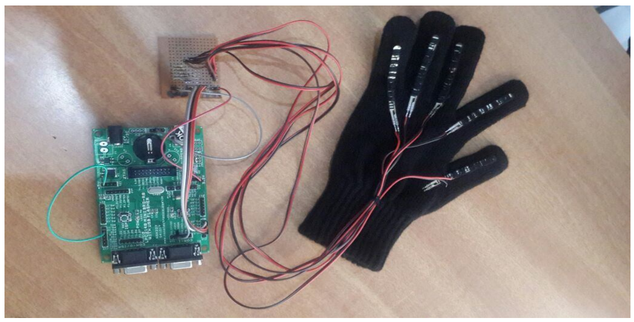

Fig. 6 The Experimental Setup

Fig. 7 Alphabet displayed on the Blynk Application

VI. CONCLUSION AND FUTURE SCOPE

The experimental results are as desired by this setup with an accuracy rate of 82%. This prototype can be further modified to accommodate the sign language gesture alongside with the already existing alphabets. The Android Application can be customized to add further features like incorporation of voice for the sign language gestures and alongside display the history of texts for previously executed gestures.

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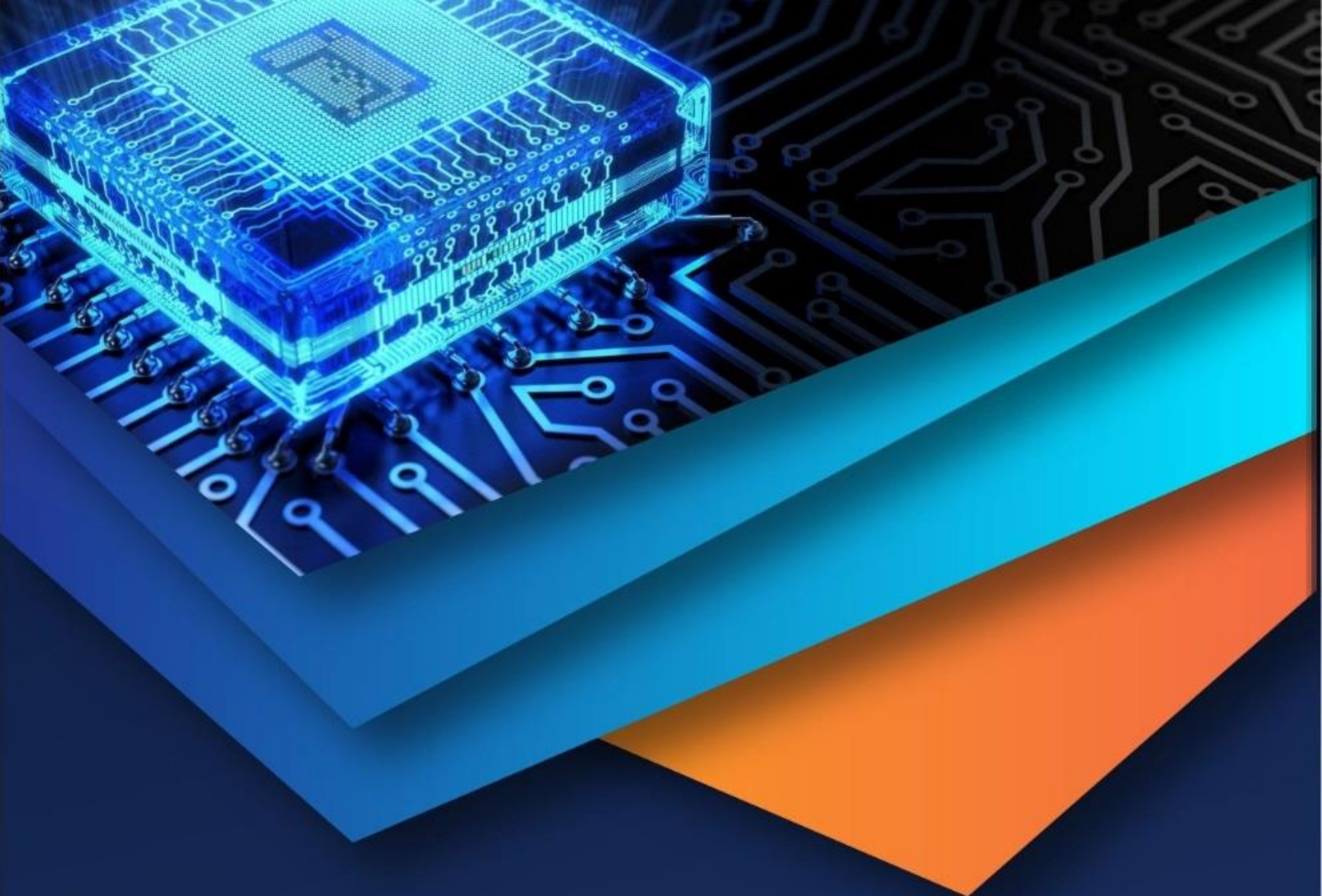

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