Design and Development of a Wireless System to Measure and Transmit Vital Body Gestures using Bend Sensor Array and MEMS Sensors

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Abstract— The objective of the proposed work is to design and develop a microcontroller based hybrid system to identify and measure the vital body gestures including hand gestures using bend sensor array along with MEMS sensors and send these signals through a wireless media. The bend sensor arrays employ flex sensors and in MEMS we have exploited the accelerometer characteristics. These sensors are wearable in the form of gloves which will help produce signals corresponding to different hand gestures and finger movements. The system is made to read these signals and after signal conditioning processes the digitally converted values are compared with the user predefined values to identify specific hand gestures. The system was built around a widely used eight bit microcontroller. The 8-bit multiplexed channel Analog-to-Digital Converter was interfaced to the microcontroller for the signal conditioning purpose.

Key words: Dumb, Microcontroller, Flex Sensors, MEMS, Accelerometer, RF, ADC, Smart Glove, Gestures

I. INTRODUCTION

The system developed is meant for speech impaired people to communicate more effectively and with greater ease. This system prototype is able to automatically recognize human gestures/ sign language. It's like raising a finger may be a sign of your wish to interrupt. Gestures are meaningful body motions to convey some information and gesture recognition involves tracking of human limbs, interpretation of various orientations and movement of vital body positions. This system will recognize the hand positions as well as finger positions with the help of specially designed gloves that employ an array of flex sensors and accelerometer module. The system has an immense scope in various applications like it can help dumb people to communicate more effectively. The collaborative use of flex sensor array and accelerometer in developing a smart glove will produce multiple gestures to be recognized. The glove can be utilized to control some vehicle, motors, actuators, robots, switching applications, etc.

II. DESIGN METHODOLOGY

In this section, the steps to make sure this project was done successfully will be discussed from the beginning until the project was implemented successfully. The system is implemented as a wearable hand glove that employs an array of flex sensors for each finger. The flex sensors are bend sensors and the resistance of these sensors changes with the bend angle. So bend resistance of these flex sensors can be measured as per the finger movements. The main critical parameters in designing the sensory glove are the glove instability and the misalignments of the sensors with respect to the related joints with usage. The sensor chosen may produce discrete data or continuous data. In our system the flex sensor and MEMS accelerometer chosen produces a continuous set of data's since sign language is encoded into different pattern that are classified. The important issues while designing a glove is calibration, the finger size, height and thickness varies from patient to patient and these inaccurate measurements of parameter leads to overlap of the sign.

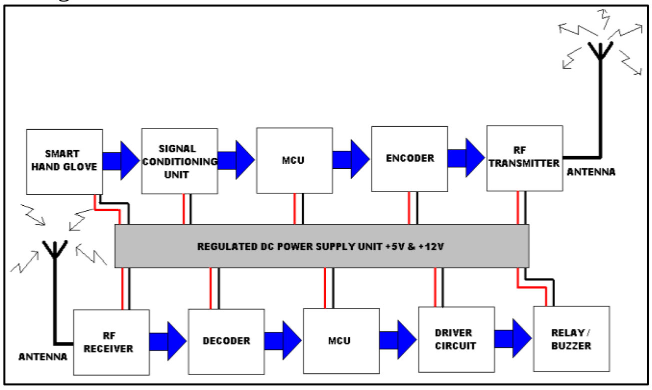


Fig. 1: Block Diagram of Implemented System

In order to meet the aforementioned goals, a compact wireless sensing unit was designed. This sensing unit consists of: sensors, signal conditioning, processor, wireless communications link, power supply and mounting fixture. Sensors used for this project are: a full 6-DOF module of accelerometer and flex sensors. The accelerometer is a micro-electromechanical device that can measure the force of acceleration, whether caused by gravity or by movement. So it measures the speed of movement of an object and can also sense the angle at which it is being held. It measures in meters per second squared (m/s2) or in G-forces (g). By measuring the amount of static acceleration due to gravity, we can find out the angle the device is tilted at with respect to the earth. Flex Sensors are analog Resistors. They work as variable analog voltage dividers. Inside the flex sensors 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. It will only change resistance in one direction. An inflexed sensor has a resistance of about 10K ohms. With a bent of 90 degrees the resistance increases to 30-40 K ohms. Require 5V input and outputs 0V to 5V signals with change in resistance values according to the bend. The Electrical Specifications are as follows: it has Flat Resistance: 25K Ohms, Resistance Tolerance: ±30%, Bend Resistance Range: 45K to 125K Ohms (depending on bend radius), Power Rating: 0.50 Watts continuous. 1 Watt Peak.

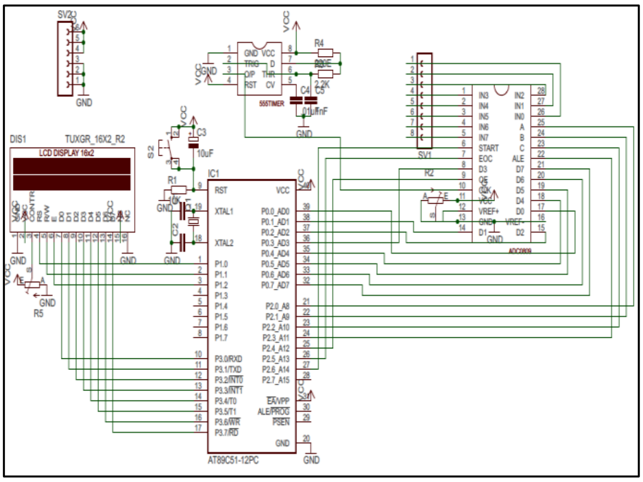


Fig. 2: Schematic Diagram of Implemented System

PCB Layout of the implemented system is given below.

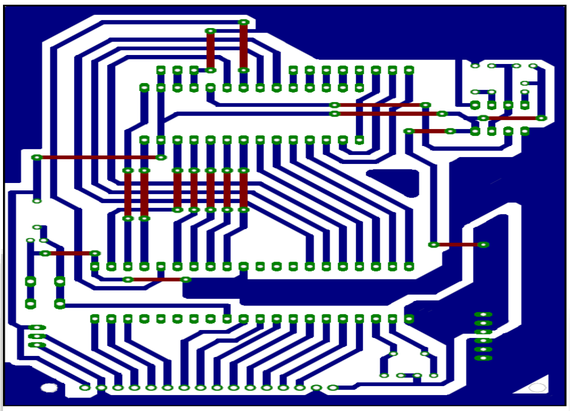
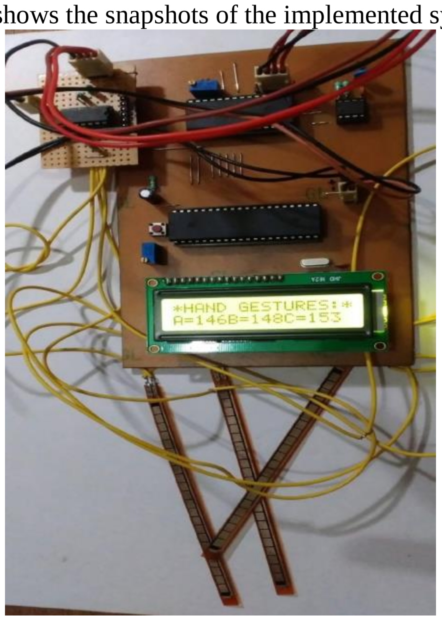


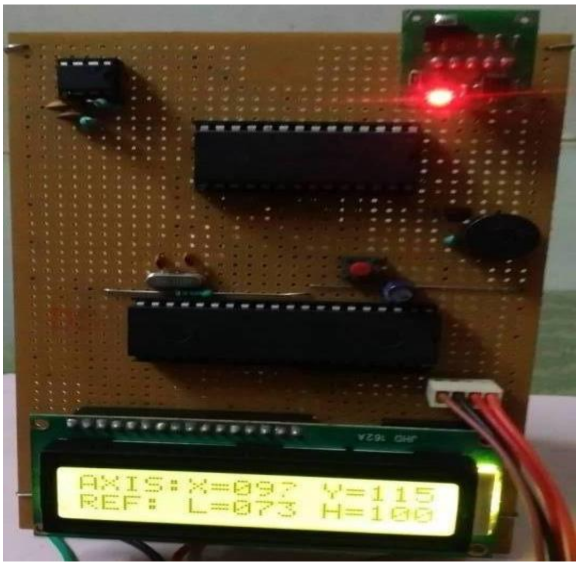
Fig. 3: PCB layout diagram of the system

III. RESULT AND DISCUSSION

The smart glove employs flex sensors and accelerometer to identify the various hand gestures. The flex sensor and ADXL-335 provides digital values to microcontroller inputs with the help of ADC for necessary action and decision making. The microcontroller compares the measured values with the predefined values to make an appropriate decision. Figure 4 shows the snapshots of the implemented system.



(a)



(b)

Fig. 4: Snapshots of Implemented System

The results noted were as per the observation table below:

Sensors	Nominal ADC Value	Predefined Lower Limit	Predefined Upper Limit	Gesture Recognized for
Flex-1	146	133	146	Finger-1
Flex-2	148	135	146	Finger-2
Flex-3	153	89	146	Finger-3
ADXL-33(X-Axis)	85	73	100	Palm Orientation Horizontal
ADXL-335 (Y-Axis)	85	73	100	Palm Orientation Vertical

Table 1: Results

IV. CONCLUSION

This paper describes a person gesture recognition system by using Flex Sensor array and MEMS accelerometer. The recognition system consists of sensor data collection, segmentation and recognition. After receiving bend angle and acceleration data from the sensing devices, a segmentation algorithm is applied to determine the starting and endpoints of every input gesture automatically. The sign sequence of a gesture is extracted as the classifying feature, i.e., a gesture code. Finally, the gesture code is compared with the stored standard patterns to determine the most likely gesture. Since the standard gesture patterns are generated by motion analysis, the recognition system does not require a big database and needs not to collect as many gestures made by different people as possible to improve the recognition accuracy. We note here, however, to enhance the performance of the recognition system; we will need to improve the segmentation algorithm to increase its accuracy in finding the terminal points of gestures. Moreover, other features of the motion data may be utilized for pattern classification, i.e., more recognition methods may be investigated in future work.

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