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American Sign Language Detection

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Abstract-Sign language: a natural, linguistically complete and a primary medium for the humans to interact. Nowadays, this language is prevalent amongst the deaf, dumb or blind individuals. However, with the conventional sign language not known to the signers, it adversely affects their interpersonal relationships in the society. There is a need of much more sophisticated method than communication through interpreters or writing. Our aim is to design a system in which sensor glove is used to capture the signs of the American Sign Language (ASL) and translate them to English displayed on a LCD.

Index Terms- American Sign Language (ASL), sensor glove, Flex sensors, gesture recognition.

I. Introduction

This system results from a walkthrough in different areas; a rudimentary notion developed into a full-fledged scheme.

"American Sign Language Detection" is a project implementation for designing a system in which sensor glove is used to capture the signs of American Sign Language performed by a user. The glove comprises flex sensors which detect the position of each finger by monitoring the bending of the flex sensors mounted on them. The sensor circuit output is then sent to Microcontroller through ADC. The pre-stored database of letters is then activated and displayed on the LCD as and when making the hand gestures. These data will provide a medium for normal as well as deaf people to communicate more easily in the society.

The sign language used or detection is the American Sign Language (ASL) which is considered as the standard for communication among deaf/dumb people. The gestures are displayed in text format (English) which is easily accessible to a major group of normal people.

II. RESEARCH AND COLLECT IDEA

The preliminary stature of the research arouses from several different ideas clubbed together to fashion a system which can be devised into practical applications. The sensor gloves were previously used in gaming, constructed using different types of gloves made from different materials.

The American Sign Language (ASL) is a standard convention for communication amongst the deaf/dumb. A gesture for each alphabet is pre-decided. The Figure 1 shows the ASL.

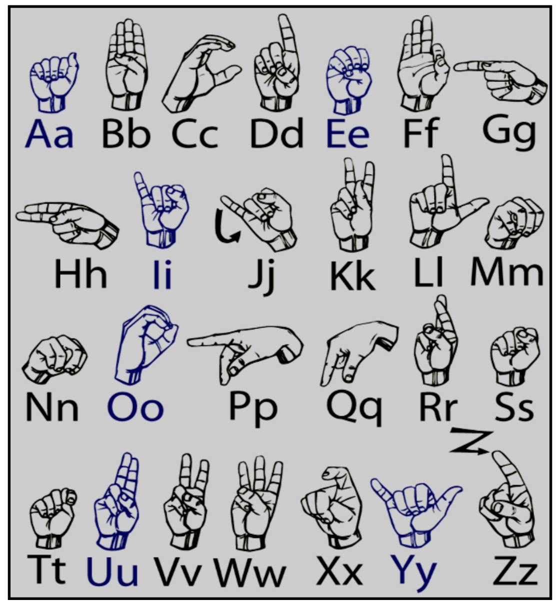

Figure 1: American Sign Language

A paper referred has been published based on sensor glove. It examines the possibility of recognizing sign language gestures using sensor gloves. Previously sensor gloves are used in applications with custom gestures. This paper explores their use in Sign Language recognition which is done by implementing a project called "Talking Hands"[1].

Sensor gloves for measurements of finger movements are a promising tool for objective assessments of kinematic parameters and new rehabilitation strategies. Here, a novel low-cost sensor glove equipped with resistive bend sensors is described and evaluated. This paper, "Development and evaluation of a low-cost sensor glove for assessment of human finger movements" examines the above mentioned aspects [2].

While working on the specified topic, several components like sensors, controllers were studied which are the building blocks of the system.

III. PLATFORM AND LANGUAGE STUDY

The platform study deals with the kind of hardware and software used in the system. The software used in the proposed system consists the software used for PCB designing, micro-controller programming and circuit simulation. Here, the software used for PCB designing is "Express PCB". The software used as Editor and debugger is "AVR STUDIO" and that used for burning the program is "SINAPROG". The language supported by the Microcontroller Atmega-16 is "Embedded-C". Additionally, PROTEUS was used to carry out certain simulations.

The Microcontroller used is ATMEGA-16. Five Flex sensors are used which are used to detect the specific gestures of the fingers produced by the glove.

The language studied for usage in the proposed system is the "Embedded-C language". Embedded C is a set of language extensions which is used for the C Programming language for different embedded systems.

IV. BLOCK DIAGRAM

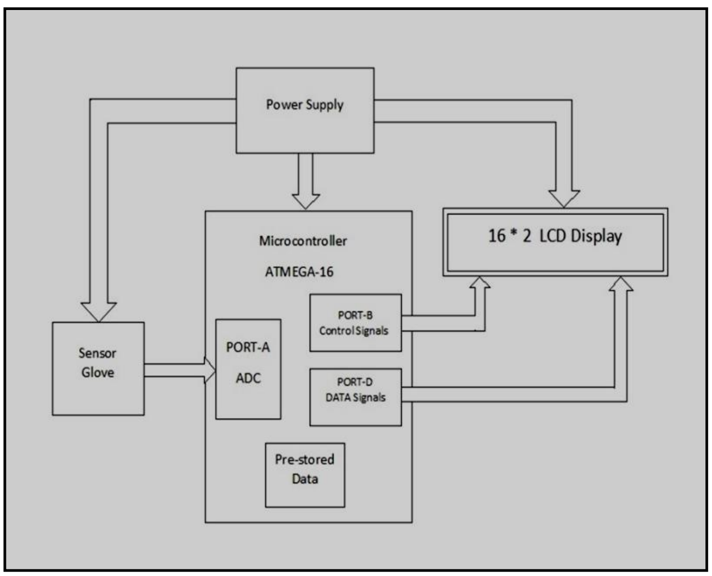

Figure 2: Block diagram representation

Every single block explanation in detail with its working in the project along with detailed flow of each block is described with the help of the Block diagram representation.

.The block diagram in Figure 2 of the proposed system mainly contains the following blocks:

- Microcontroller (Atmega-16)
- Sensor Glove

The detailed description of the components is given as follows,

- **Microcontroller Unit (MCU)**

The MCU Atmega-16 is a 40 pin IC by Atmel family supporting Embedded-C Language. A small on-chip computer which has a processor core, memory and, programmable input/output peripherals with 16K Bytes of In-System Self-Programmable Flash ROM memory and 1KB of internal SRAM. It also has an inbuilt ADC of 8-channel, 10-bit resolution i.e. each analog input is converted to its 10 bit equivalent output.

- **Sensor Glove**

A Sensor glove is prepared with a flex sensor mounted on each finger as shown in the Figure 3 below. The material of the glove is latex which is non-conducting. It detects the position of each finger by monitoring the bending of the flex sensors on it. Accordingly, depending upon its output, gesture of the hand will be recognised and will be displayed on the screen.

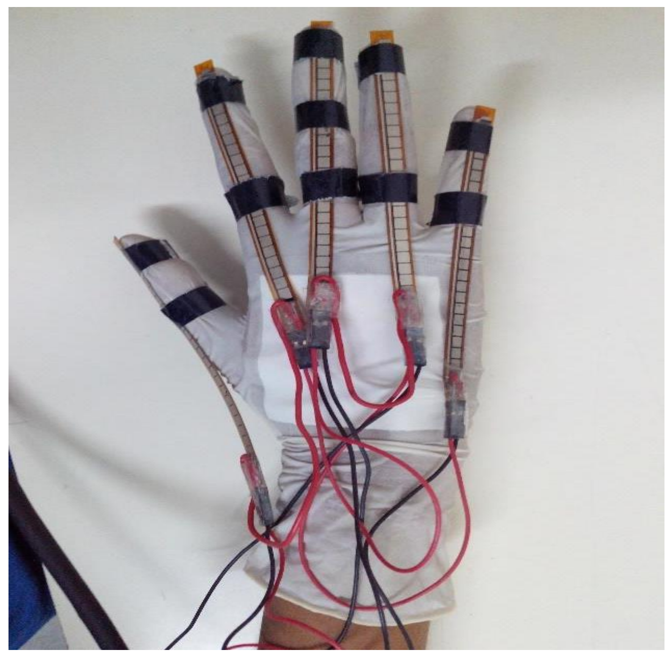

Figure 3: Sensor glove

V. SIMULATIONS

The software used for circuit simulation is PROTEUS 7.7. As the sensors can't be shown over here, two switches are used to represent them by providing three different sorts of inputs as three different gestures as shown in the following Figures 4-6. The two switches SW1 and SW2 provide inputs for three gestures A, B and C as:

- A (VCC, VCC, VCC, GND, GND)
- B (VCC, VCC, GND, GND, GND)
- C (VCC, GND, GND, GND, GND)

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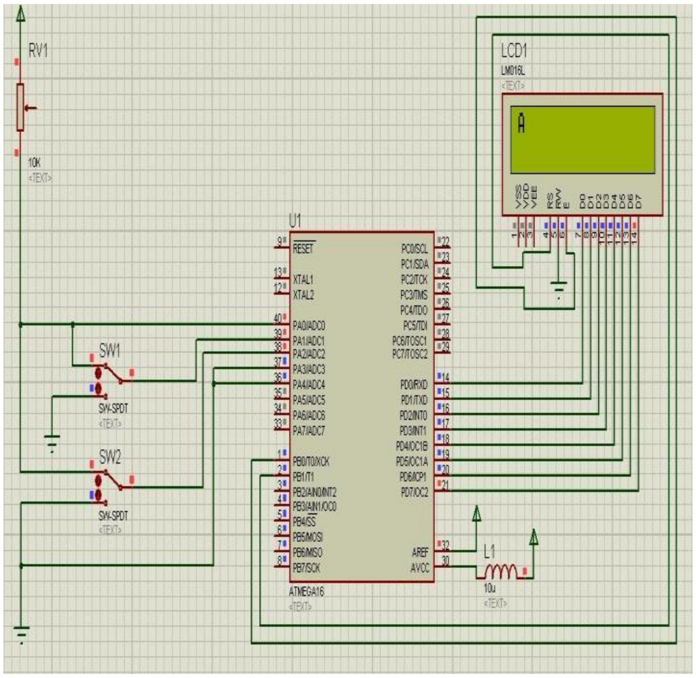

Figure 4: Simulation results for gesture A

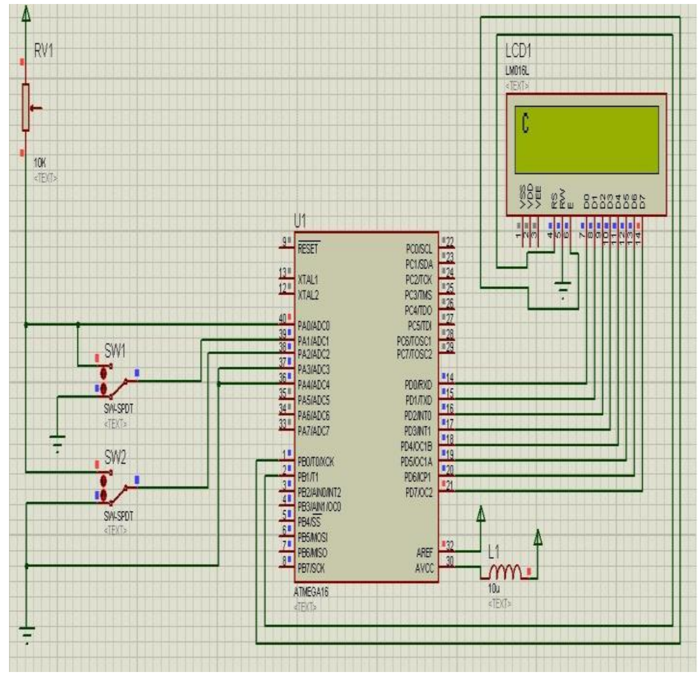

Figure 6: Simulation results for gesture C

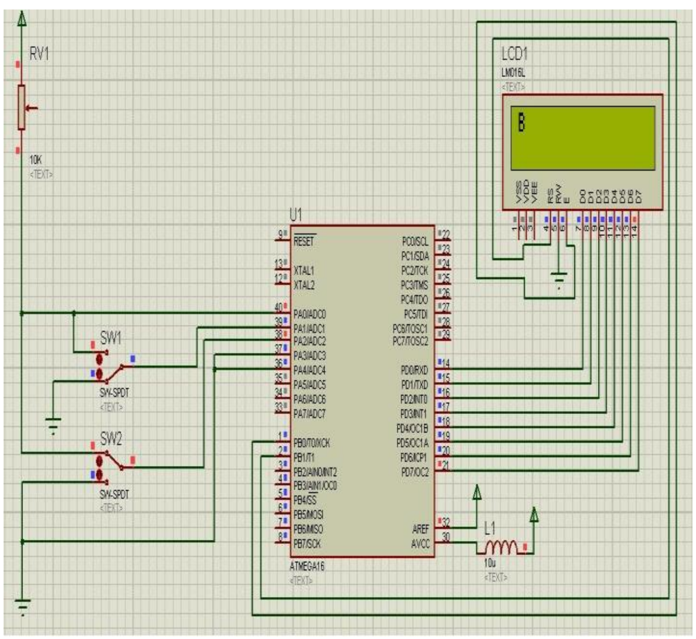

Figure 5: Simulation results for gesture B

While simulating, random input values are fed to the input port pins of the microcontroller (Port A). The analog inputs are fed here. This analog data is converted to equivalent 10-bit digital data by the A/D converter of ATMEGA-16. The digital output is calculated as an example for ‘A’ as,

Digital output = (Analog input*1023) / (VREF)

For VCC (5V), D (1) = (5V*1023) / 5V = 1023.

For GND (0V), D (0) = (0V*1023) / 5V = 0.

Therefore, for ‘A’, the final output is ‘1023’ digital value for first three fingers and ‘0’ for last two fingers. This input / output values are random, concerned with simulation only and not related to actual gestures.

Similarly, the values for B and C are calculated.

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VI. FLOWCHART

This section, Flowchart explains the basic working of the system in a simple way. Initially, the gestures from the gloves are accepted. This analog output is then converted to equivalent 10-bit digital output by the ADC of the micro- controller ATMEGA-16.

This output is then compared to the previously stored data of letters for the corresponding gestures and it is checked for validity. If the gestured value matches any of the pre-stored value, the corresponding value from database is displayed on the LCD or else it goes back in the loop. The figure 7 below illustrates the Flowchart of the system.

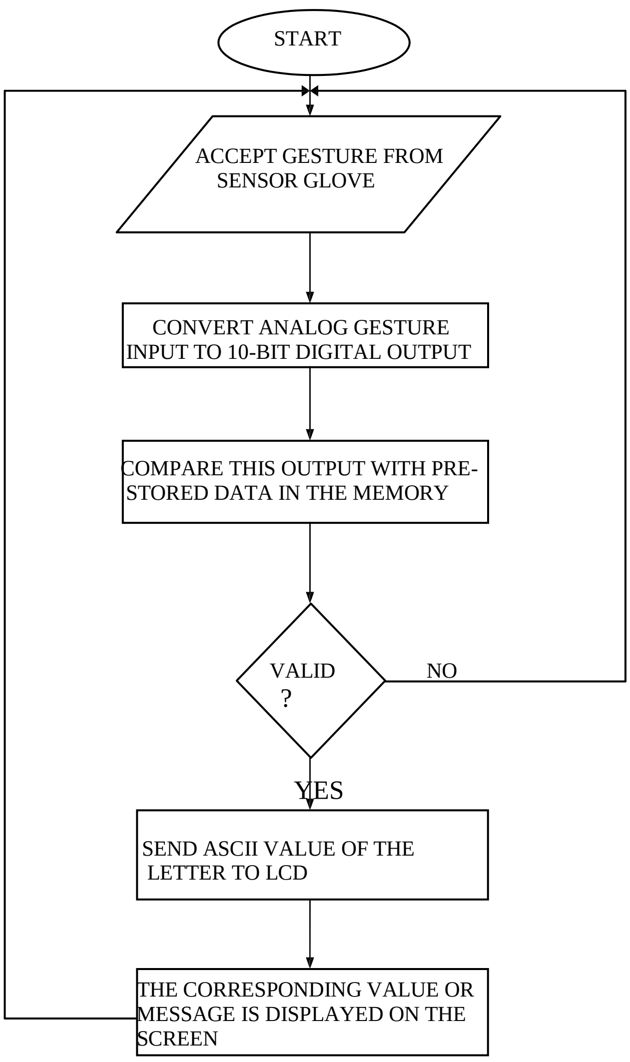

Figure 7: Flowchart

VII. SYSTEM OVERVIEW

The proposed system, **"American Sign Language Detection"** is the prototype for establishing easy communication between deaf/dumb people and normal people. The conventional sign language, widely used over the world for communication by signers is known only by a handful amount of the normal people. Due to this, they face a communication gap in the society as their gestures cannot be interpreted. To overcome this problem, this system has been implemented. By implementing this, the redundant factors like need of a mediator for dumb/deaf people can be eliminated. This will surely help them to be independent and confidently express them. As the prototype is compact and portable, it can be carried to almost anywhere they go.

Initially, for the implementation of the glove, a glove of latex (surgical glove) is used. It being tight, serves the purpose of proper alignment of the sensors on the fingers. Gestures, stated in Figure 1, are captured from the sensor glove. Each finger is associated with one flex sensor. The change in resistance of the flex sensor with respect to bend is captured and data is fed to the MCU. These five analog values from five fingers each, are given to five different pins of Port-A (PA0-PA4) of the MCU. Then, the MCU converts each analog input to its digital equivalent, and average of all the digital values is taken. This will give a value corresponding to the gesture made giving each gesture a unique value. Values for all the gestures are tested and calculated in advance and pre-stored in the MCU. This will create a database of the 26 alphabets and an additional gesture for 'space'.

For a better and sophisticated implementation, a matrix technique has been implemented. Here, each sensor bend is divided in three distinct parts, viz. Complete Bend (CB), Partial bend (PB) and Straight (S). Range of values, associated with each bend of the respective sensor is calculated and its digital equivalent is found out. Table 1 below, depicts the Bend characteristics corresponding to each of the five fingers, viz. thumb, index, middle, ring and little. Though the corresponding values are not same for all the sensors, it illustrates the general concept behind the idea of the matrix technique. The CB, PB and S values for each sensor are calculated and the range is specified.

Table 1: Bend characteristics

BENDS / FINGERS	CB	PB	S
1. THUMB	<=550	<=550	>550
2. INDEX	<=380	381-500	>500
3. MIDDLE	<=340	341-450	>450
4. RING	<=390	391-480	>480
5. LITTLE	<=460	461-500	>500

Then, a matrix of the corresponding alphabet as to its value for each finger is found out. Hence, bends for each gesture are carried out.

One more, extra gesture for a 'space' is added. All these min and max digital values are stored in the controller memory, and corresponding alphabets are also stored. Hence, the range in which the value falls is having one alphabet, which is to be

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displayed. The LCD is interfaced with the MCU which is used to display the corresponding output. The Table 2 below illustrates the matrix implementation for all the alphabets and extra gesture(s).

Table 2: Entire matrix implementation

FINGER / LETTERS	THUMB	INDEX	MIDDLE	RING	LITTLE
A	S	CB	CB	CB	CB
B	B	S	S	S	S
C	S	PB	PB	PB	PB
D	B	S	CB	CB	CB
E	B	PB	PB	PB	PB
F	B	CB	S	S	S
G	B	S	CB	S	CB
H	B	S	S	CB	CB
I	B	CB	CB	CB	S
J	B	CB	CB	CB	PB
K	S	S	S	CB	CB
L	S	S	CB	CB	CB
M	B	PB	PB	PB	CB
N	B	PB	PB	CB	CB
O	B	PB	PB	PB	S
P	S	S	PB	CB	CB
Q	S	S	CB	CB	S
R	B	S	PB	CB	CB
S	B	CB	CB	CB	CB
T	S	PB	CB	CB	CB
U	B	PB	S	CB	CB
V	S	PB	PB	CB	CB
W	B	S	S	S	CB
X	B	PB	CB	CB	CB
Y	S	CB	CB	CB	S
Z	B	S	S	CB	S
Space	S	S	S	CB	S

These implementations give a thorough idea of the system. In the Proteus 7.7, certain simulations for the gestures for the alphabets A, B and C are carried out. Similarly, using the sensor glove, the practical implementations are carried out. The Figure 8 shows the implementation of an alphabet 'A'.

Figure 8: Gesture for A

The following Figure 9 shows the final System.

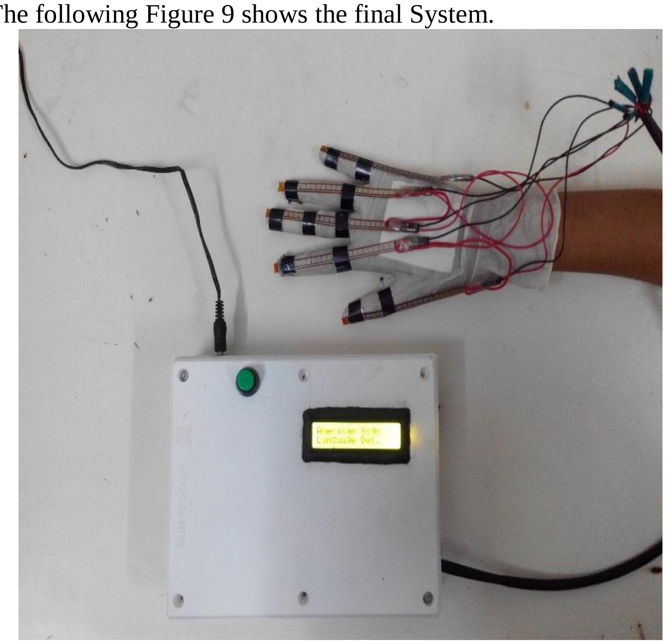

Figure 9: System

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VIII. CONCLUSION

A full-fledged system for communication between the deaf/dumb and normal people is developed. Simply by monitoring the hand movements, the respective data fed to the microcontroller is compared and the designated output is displayed. LCD serves the purpose of displaying. From this system we have achieved communication with the help of finger gestures. It exhibits a fluent communication mode between normal and deaf/dumb people. The gesture glove prototype is used for such purpose and experimented successfully.

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