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Sign Language Interpreter for Deaf and Dumb People

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Abstract: For a person with disability (deaf and dumb) faces difficulty in communication with normal person. Because of this, a person who lacks in hearing (deaf) and speaking ability (dumb) is not able to communicate with normal person. This paper aims to lower this barrier in communication. Sign Language is used by deaf and dumb people for communication. A gesture in a sign language is a particular movement of the hands with a specific shape made out of them. A sign language usually provides sign for letters. Sensors in the glove pick up gestures and convert that to text data with the help of Analog to Digital convertor on arduino nano board. This converted text data will be sent wirelessly via WIFI module to a cell phone. The WIFI module transmits the gesture to a smartphone. Using Text to Speech software, incoming text message will be converted to voice. The arduino nano board will recognize the sign language for Alphabets and Numbers and it will display the message on computer and mobile. Sign Language interpreter system recognizes American Sign Language (ASL) alphabets, numbers in the form of letter, word or sentence based on sensor movement. A system is developed that can translate different signs using American Sign Language to text as well as voice format.

Keywords: Gesture using American Sign Language, Sensors , Arduino nano ,WIFI module, smartphone.

I. INTRODUCTION

The main goal of this paper is to develop sign language translation system that can translate sign language into text. Since not every typical people are educated with sign language communication, this system will help them to comprehend the Language of deaf and dumb people to ease their daily tasks.

Communication is the most important part of the life. Loss of hearing and speech can cause people to be lonely and isolated in this world. This cause a worse effect in their both social and working life. The advancement of embedded system, provides a space for designing and developing a translator for sign language to assist in reducing the communication gap between speech and hearing impaired people and normal people. Hand gesture technique is a way to communicate between impaired and normal people. There proposes different models to recognize these languages. In last few years, there has been increased interest among researches in this field of sign language to found a most efficient device for deaf people. Finding an expert interpreter for day to day activities is very difficult and unaffordable. Hence for ease of communication between impaired and normal people there employed various electronics and digital methods. Sign is non-verbal form of language uses gestures to convey our thoughts. For this a particular movement of the hands with a specific shape made out of them. After processing, corresponding audio is produced. Signs are used to communicate words and sentences to audience. The woollen glove fixed with flex sensors along the length of each finger and thumb. Output from the sensor is processed by the micro controller and is transmitted through wireless communication, which will receive in the receiver section. The microcontroller and sensor used data glove helps to lower the communication gap between speech and hearing impaired people and normal person.

II. METHODOLOGY

A. Block Diagram

System is built by using a transmitter and receiver parts to decrease the weight of the glove on the hand and to make it easily for the hand to move. Hand glove fitted with flex sensors and accelerometer sensor to measure the flexion of the fingers, the rotation of the hand. Power source is necessary for flex sensors, accelerometer sensor, arduino nano board. Output of sensors that is hand gestures is processed by arduino nano board and converted into text. This text is transmitted by Wi-Fi module which is received by mobile. The mobile has an android application (Google chrome or any web browser) that present outputted word or letter or sentence in the form of text. Text to speech software in mobile will convert that text into voice.

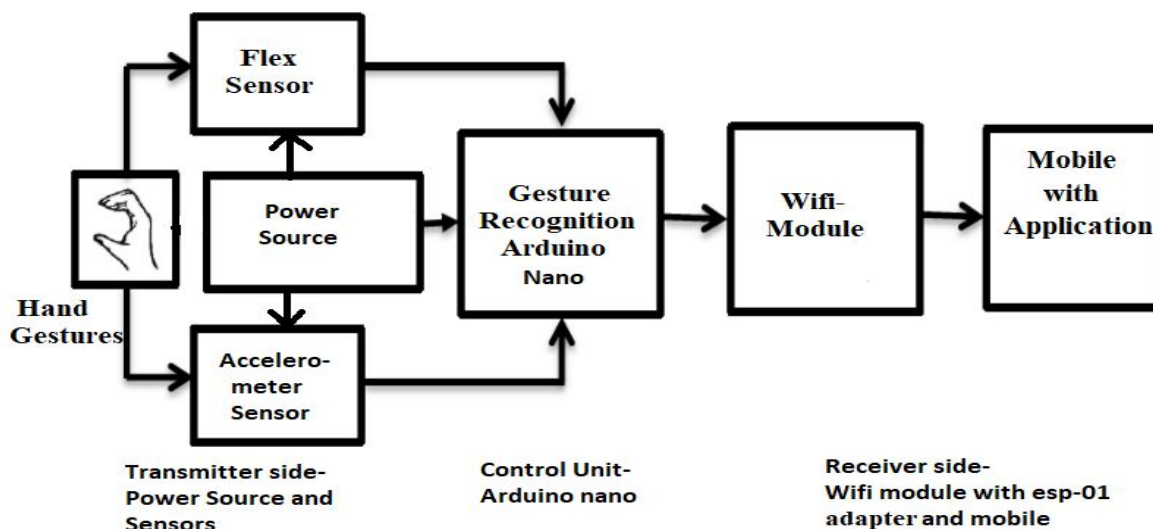


Figure1: Block Diagram of Sign Language converter system

B. Circuit Diagram

The design consists of a glove with several subsystems: a power subsystem, a flex sensing subsystem, a rotation sensing subsystem, a processing subsystem, and the output subsystem.

- 1) **Power subsystem:** 9V battery provides input to 7805 voltage regulator. Output of 7805 voltage regulator that is 5V is given to all flex sensors and accelerometer sensor using PCB. Arduino nano is powered by mini-B USB connection. Wi-Fi module is powered by 5V input pin of arduino nano since esp-01 adaptor is used.
- 2) **Flex sensing subsystem:** 5 flex sensors are used, they are located on each of the finger and the output from the sensors is inputted to the analog to digital converter in the controller. Flex sensors require a 5-volt input to operate and it gives output between 0 and 5 V. When the sensor is kept straight with no force acting on it, it has a flat resistance of around 33k ohm. So series resistor of 33k ohm is used. The 33k resistor is connected on the ground side and flex sensors on 5V side, means as the flex sensor's resistance increases the voltage on Analog pins will decreases.

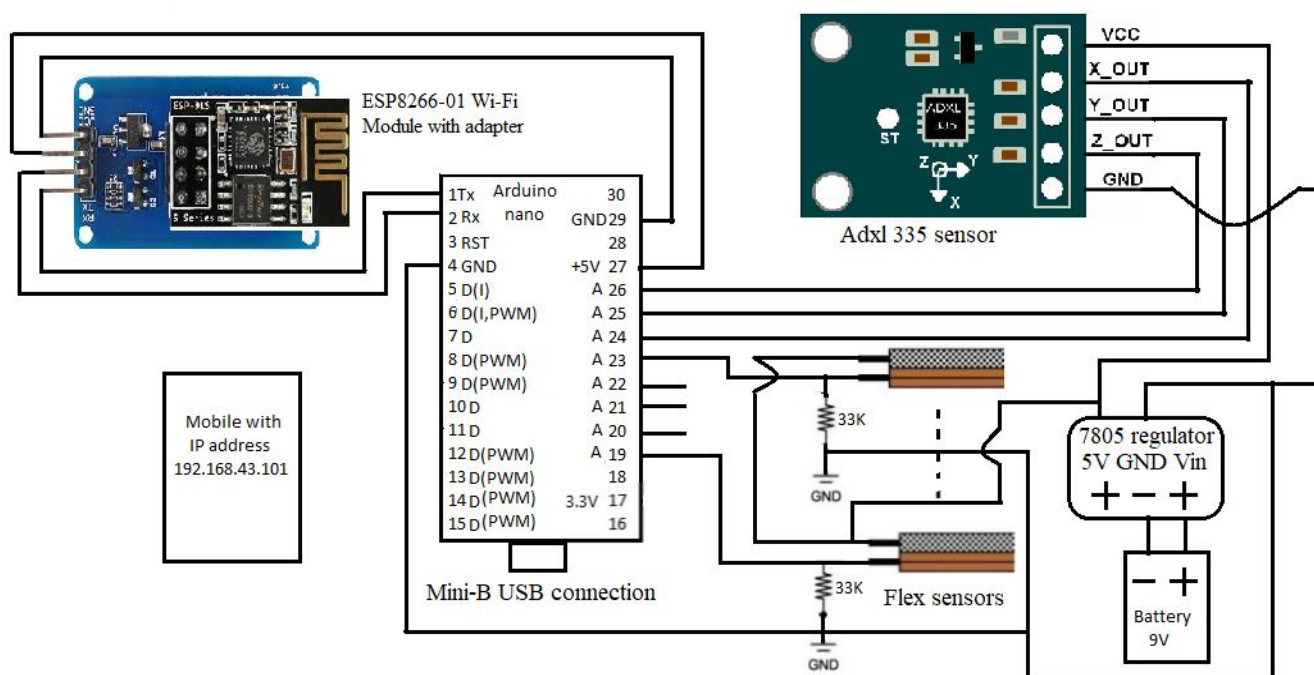


Figure 2: Interfacing diagram of sign language converter system

- 3) *Rotation sensing subsystem:* The Accelerometer sensor is used for the movement and orientation detection and it is mounted at the upper side of the hand. Accelerometer is directly interfaced to the analog ports as it includes the signal conditioning circuit. As per ADXL335 datasheet maximum voltage level at 0g is 1.65V and sensitivity scale factor of 330mV/g. Using these values Roll, Pitch and Yaw angles with respect to X, Y and Z axis are calculated which are useful for programming.
- 4) *Processing subsystem:* Arduino nano board is used for processing since it has 8 analog input pins converting analog data into digital data(ADC).The main source of input for the Arduino nano board is the flex sensor and accelerometer sensor values as they are basically representing the signs. The variable output voltage is then fed to the analog input pin of a microcontroller. Arduino processes the data for each particular gesture made. ADC value received by the microcontroller can be used for comparison and processing. For each character it checks ADC and tilted value. These values of flex sensors and accelerometer sensor are then compared with the predefined range in the controller which has been set after carrying out a series of experiments and then recognizes the corresponding characters. If all the values for a particular sign lies in the range defined for that sign, that alphabet is displayed on the output subsystem. Arduino is used for the processing of the entered data and decides the outputted word or letter or sentence.
- 5) *Output subsystem:* To enable wireless transmission between the controller and a smart phone, a Wi-Fi module is chosen which is based on its capability of being easy to use and its wide compatibility (300m) with today's gadgets. Esp-01 Wi-Fi module inserted on esp-01 adapter so that easily interfaced with arduino nano board. The serial communication is established by TX-RX pins. The controller produces word or letter (an inbuilt ADC converts the input analog signals to corresponding digital signals) and send it to Wi-Fi module connected to the controller to send the data through a wireless medium to an android smartphone. Letter or word or sentence is displayed on the mobile in the form of text on IP address 192.168.43.101.The mobile has an application software which converts these received text signals to corresponding speech signals and thus the desired task is accomplished.

III. HARDWARE AND SOFTWARE IMPLEMENTATION

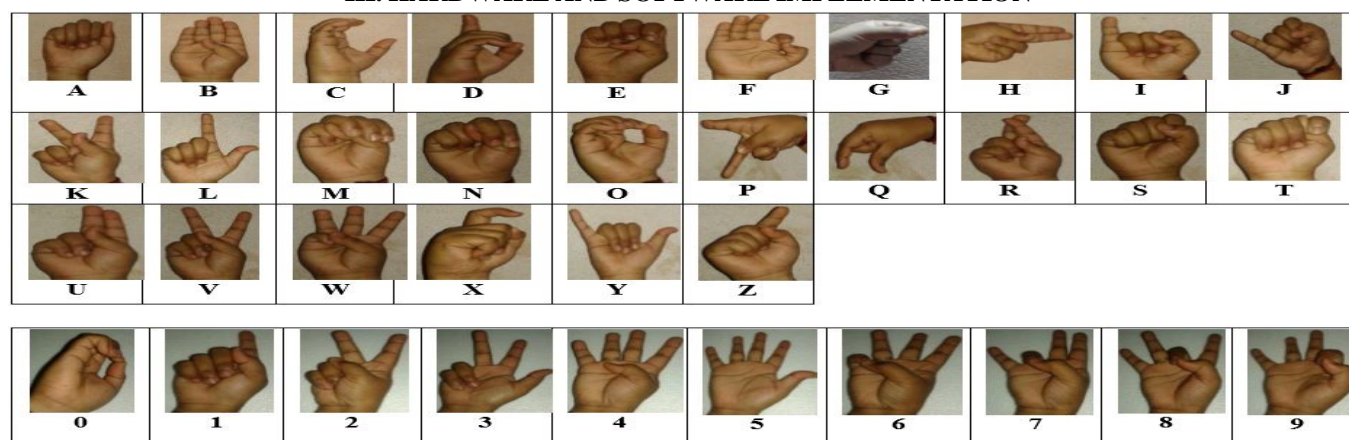


Table 1: Gesture using American Sign Language for alphabets A-Z and 0-9 numbers

A. Design of Glove

Woolen glove is used. Throughout the entire work five flex sensors, one Accelerometer sensor, one Arduino nano board, one Wi-Fi module (esp8266-01) and one ESP-01 adapter are used on a single glove.

Five flex sensors were attached to five fingers on the back side of the hand glove. Accelerometer sensor is attached at the center on the back side of the hand glove. All sensors are normally attached to the glove using needle-thread and tixo tape.

- 1) *Sensor Connection with the Arduino Microcontroller:* On Arduino nano board, the microcontroller is ATmega328. The connection is established by 6 pin connector with wires soldered by metal with the flex sensors. The connector is then inserted into a PCB and from there further connection is established with the Arduino. Each of the flex sensors needed individual resistors which worked as voltage divider in the circuit. Accelerometer sensor is connected to Arduino nano board pins directly using jumper wires. As GND pin of Arduino nano, 9V battery and 7805 voltage regulator is made common, only 5V Vcc and GND pin of Accelerometer sensor is on PCB. The microcontroller is connected to the computer for programming and burning the program inside it. Throughout the entire work Arduino IDE software for writing and compiling codes is used.

- 2) *Arduino nano board Connection with Wi-Fi Module:* Using CP2102 converter program uploading is done on Esp-01 Wi-Fi module and then inserted on esp-01 adapter so that easily connected to arduino nano board. Using jumper wires only connection of arduino board is done with ESP-01 adapter.

B. American Sign Language (ASL)

American Sign Language (ASL) is a one of the sign language which is used by deaf and dumb people for communication. Table 1 shows the gestures for English letters and number used in American Sign Language.

IV. SOFTWARE DESIGN

For roll positive and yaw negative, Letters of category 1-A,C,D,E,F,I,L,M,N,R,S,T,U,V,W,Y,0,1,2,3,4,5,6,7,8,9

For roll positive and yaw positive, Letters of category 2- P and Q

For roll negative and yaw negative, Letters of category 3- J , O , Z, G, H, B, K, X

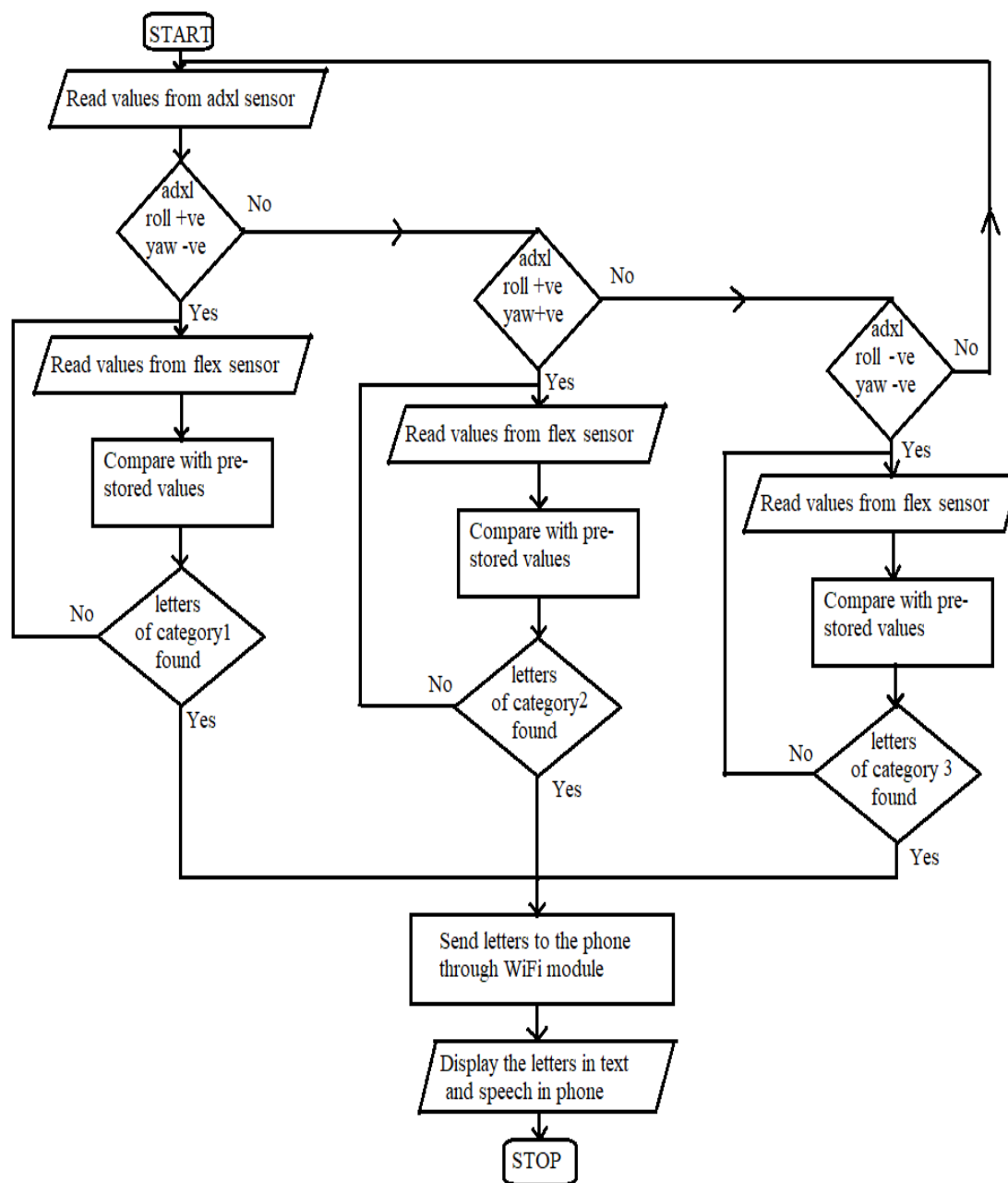


Figure3: Flowchart of developed system

V. RESULTS AND DISCUSSION

A. Flex Sensor

1) *Taking Values from Flex Sensors:* In first stage, raw values of flex sensors are taken. The amount of bending of each flex while showing sign of a single alphabet is measured and recorded those values. The raw values received from the sensors are the reference values initially. These reference values are raw values recorded as the range for each finger in a single alphabet. 0 to 5V is converted as digital in the range of 0 to 1023. The raw value has a huge range and can fluctuate very frequently. So, decided to calibrate the raw values from each flex sensor. For flat finger, flex sensor is showing value above 630 digital value and for bend finger, value below 560. As per finger, digital values are changing.

For Flex calibration

$V0$ = digital value at A0 pin+130

$V1$ = digital value at A1 pin+100

$V2$ = digital value at A2 pin+90

$V3$ = digital value at A3 pin+90

$V4$ = digital value at A4 pin+100

$M1 = ((V0-V1) / (V3-V4)) * V2$

$M11 = ((V0-V1) / (V4-V3)) * V2$







Name of Gesture	Gesture	Thumb finger Reading	Index finger reading	Middle finger reading	Ring finger reading	Little finger reading	Adx1335 reading
0		$550 \leq V0 \leq 605$	$556 \leq V1 \leq 629$	$525 \leq V2 \leq 629$	$V3 \leq 639$	$542 \leq V4 \leq 629$	Roll >0 Yaw <0
A		$606 \leq V0 \leq 630$	$V1 \leq 555$	$V2 \leq 524$	$V3 \leq 639$	$V4 \leq 541$	
P		$V0 \leq 607$	$580 \leq V1$	$610 \leq V2$	$V3 \leq 639$	$V4 \leq 599$	Roll >0 Yaw >0
Q		$608 \leq V0$	$580 \leq V1$	$V2 \leq 609$	$V3 \leq 639$	$V4 \leq 599$	
J		$541 \leq V0$	$V1 \leq 600$	$V2 \leq 550$	$V3 \leq 615$	$600 \leq V4$	Roll <0 Yaw <0
O		$541 \leq V0$	$V1 \leq 600$	$551 \leq V2 \leq 639$	$V3 \leq 615$	$V4 \leq 599$	

Table 2: Gesture with predefined ranges

2) *Classification of sensor values According to Range:* For second stage, this scaling helped greatly for making the dataset and classifying it in the right order. All the data after calibration falls in the fixed range. For classification of the sensor values to know the desired sign a range for each sensor for every sign is fixed. Whenever a sign is portrayed then if the sensor values of the current sign fall within the range of the classified sign then it came to the decision that is this our required sign.

B. Accelerometer Sensor

1) *Taking Values from Accelerometer Sensor:* Using Roll and Yaw formula, values from accelerometer sensor are take.

Roll = (atan2(Ayout, Azout)) *57.30

Yaw = (atan2(Axout, Ayout)) *57.30

2) *Classification of Sensor values:* Roll and Yaw values are taken in the range of -180 to +180 degree.

1st condition-Palm forward, Roll >0, Yaw<0

2nd condition-Palm down, Roll >0, Yaw>0

3rd condition- Palm Sloping, Roll <0, Yaw<0

Using above 3 conditions, orientation of hand is classified.

C. Arduino Nano board

1) *Taking values from Arduino nano board*

All classified ranges are burned on the microcontroller of Arduino board. Thus posture of the hand from these combination of all sensor values is detected.

VI.CONCLUSION

Alphabets A to Z (26) and numbers 0 to 9 (10) gestures using American Sign language (ASL) are converted into text and using mobile into speech. Change in gestures are detected and converted into human understandable form to fill the communication gap between deaf/mute and normal people. With the help of the wireless system, it is convenient to carry the system from place to another. The instrument is of low cost and affordable. It is easily controlled to patients. Embedded systems don't have to be expensive to be effective. The main objective of this device is to detect the change in gestures and convert them into human understandable form to fill the communication gap between deaf/mute and normal people. The designed system is portable, safe to use, can be easily installed. System is tested for detecting alphabets A to Z and numbers 0 to 9 and accuracy of detection is found as 89.16 %.

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