



DESIGN OF LOW COST AND EFFICIENT SIGN LANGUAGE INTERPRETER FOR THE SPEECH AND HEARING IMPAIRED

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ABSTRACT

The hearing and the speech impaired people generally communicate with others using sign language. The normal people are not familiar with the sign language and hence they find it difficult to understand. This paper aims at bridging the communication barrier between the speech and hearing impaired people, and the normal people. A set of five flex sensors are used which are fixed on a glove along the length of each finger. The hearing and the speech impaired people can use the gloves to perform hand gestures and it will be converted into speech so that normal people can understand what they are trying to convey. There are various signing conventions that are used around the world but all the conventions in common use gestures, orientations and movement of the hands or body and facial expressions to convey lithely a speaker's thoughts. The processing of these hand gestures is done by using an Arduino Uno. The information to be displayed is sent either wirelessly using a Wi-Fi shield or using XBee technology and is displayed in a Smartphone app or a LCD display.

Keywords: sign language interpreter, speech and hearing impaired, flex sensors, gloves, gestures.

1. INTRODUCTION

There are about nine billion people in the world who have speech and hearing impairment. These people find it very difficult to communicate with normal people than what a visually impaired people face while communicating. The hearing and the speech impaired people communicate with other people using the Sign language [1]. Sign language is a non-verbal form of communication which is used amongst the hearing and the speech impaired people around the world. Although the hearing impaired people can communicate, it is difficult for them to interpret what other people say. Hence sign language is required for both the communities of the people. There are various signing conventions that are used around the world but they don't have a common origin [2]. The Sign language convertor is a device that converts the sign language that is being signed and displays their English translations on a Smartphone app or any LCD display using wireless modes of data transmission.

The hand gesture recognition can be classified into two types - vision based and sensor based [3]. The vision based techniques make use of complex algorithms for data processing and hence they do not offer greater

mobility. The sensor based techniques offer greater mobility and hence it is ideal for designing the Sign language convertor [4].

The American Sign Language is the most commonly used signing convention around the world [5]. Using flex sensors that are attached to a glove, different hand gestures of the American Sign Language are made and their translations are displayed on a wireless display unit. For each hand sign made, a signal is created by the sensors corresponding to the hand sign and the controller matches the gestures with pre-saved inputs and exhibits the related output [6].

2. MATERIALS AND METHODS

Communication is a challenge for people who are mute and hearing impaired. This paper intends to develop a novel cost effective Sign Language Translator system that decodes the hand gestures into equivalent English alphabets or sentences based on the mode of operation. As per the convenience of the user, this communication is achieved either by using Arduino cloud using WiFi module or through wireless LCD display using XBee technology. The entire block diagram of Sign Language convertor is shown in Figure-1.

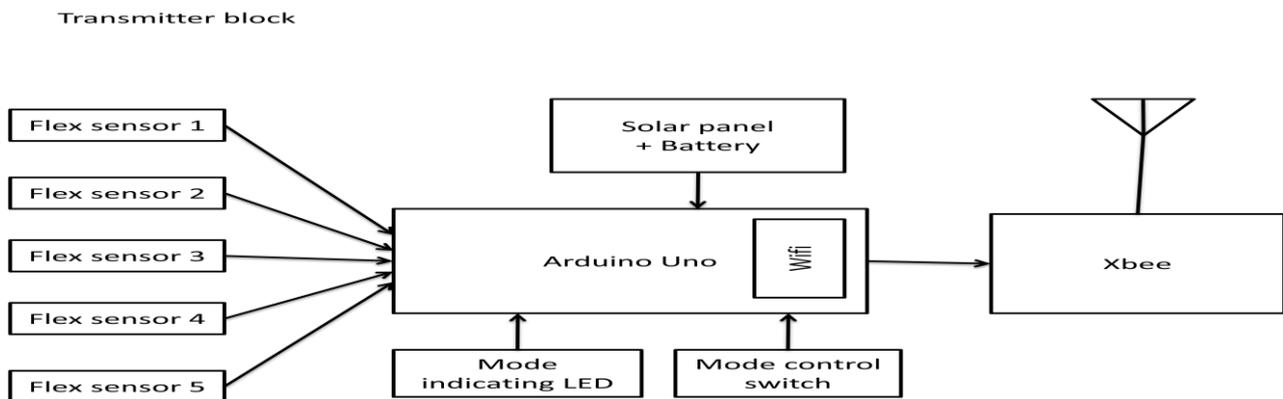


Figure-1. Block diagram of sign language converter.

The controller used in the device is an Arduino Uno. The Arduino is used for processing the data for each gesture. Five flex sensors are used to measure the degree of bending of the Fingers. The flex sensors are interfaced with the controller. A Wi-Fi module is used to enable wireless connectivity between devices [7]. A mode control switch is used to switch between the two modes in which the device is configured. One mode is used for displaying the commonly used sentences when certain hand gestures are made. The other mode is used for displaying the characters serially by using 26 different hand gesture combinations. A mode indicating LED is used to indicate the time interval between the transmission and reception of data. An Xbee module is used to transmit data in case if there is no internet connectivity available.

ARDUINO UNO

The Arduino Uno is a microcontroller in which the controller used in the device is Arduino duemilanove with inbuilt Atmega328 in it. Atmega328 has 32KB on-chip flash memory for storing codes of which 2KB used for boot loader. It also includes a 2KB of SRAM and 1KB of EEPROM. The program that is developed is stored on the flash memory of the controller. The Arduino software includes a serial monitor that displays the data that is sent or received from the Arduino pins.

FLEX SENSOR

Flex sensor is a resistive sensor which changes its resistance as per the change in bend or curvature of it into analog voltage. By increasing the curvature from 0° to 90° , resistance changes from $45K\Omega$ to $75K\Omega$. An unflexed sensor has $10K\Omega$ resistance and when bent the resistance increases to $30K\Omega$ at 90° . The sensor is about $\frac{1}{4}$ inch wide, 4.5 inches long as shown in Figure-2.



Figure-2. Flex sensor of 4.5" length.

Wi-Fi MODULE

This module can be used to connect any microcontroller to a Wi-Fi network. This module has a powerful sufficient on-board processing and storage functionality that permits it to be integrated with the sensors and various application precise gadgets through its General-purpose inputs/outputs (GPIOs) with minimal development up-front and minimum loading in the course of runtime. In this paper, the Wi-Fi module (Figure-3) is used for sending the data wirelessly from Arduino Uno to the Smartphone application.



Figure-3. Arduino compatible serial Wi-Fi wireless transceiver module.

XBee MODULE

The XBee module is used for providing wireless end-point connectivity to devices. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are intended for high-throughput functions requiring low latency and expected communication timing. The Xbee module is used for transmitting the data from Arduino Uno when there is no internet connectivity available. In such cases a wireless



display is used for displaying the data that is received from the XBee module.

LCD

The LCD (Liquid Crystal Display) is an electronic demonstrate module that is used in various devices and circuits. These components are chosen over seven segments and other multi segment LEDs. The grounds being: LCDs are cost-effective, easily programmable, have no limitation of displaying special and even custom characters.

IMPLEMENTATION

The designed Sign Language Converter device has five flex sensors mounted on a glove as shown in Figure-4. The outputs of all the five flex sensors are given to five analog ports in Arduino Uno board.



Figure-4. Sign language converter.

As the resistance of a flex sensor changes with the amount of bending, different hand gestures can be made using it. Depending on the resistance value that is obtained from the flex sensor a threshold value is maintained which is either set to 0 or 1 [8]. The value 0 denotes that the finger is not bent and the value 1 denotes that the finger is bent. The values from the five sensors are obtained and they are represented in binary format of five bits [9]. In this way all the 26 alphabets or 26 different sentences can be encoded as shown in Table-1. This encoded five bit binary equivalent is transmitted either to the Smartphone app using a Wi-Fi module or to a wireless display unit using Xbee module as shown in Figure-5 and Figure-6.

MODES OF OPERATION

There are two modes of operation depending on the position of the mode control switch. They are:

- a) Character mode
- b) Sentence mode

SENTENCE MODE

In this mode the user can store any of the 26 most frequently used words in his daily life, so that it makes him easy to communicate. The user can access this mode by tripping the mode control switch to on state and the mode indicating led gets turned ON indicating the mode of operation is in sentence mode.

CHARACTER MODE

In this mode the mode control switch will be in off state, led will also be in off state, indicating the mode of operation is in character mode and the any gesture formation will result in the transmission of a single character using the Table-1. This mode is used when the user wants to transmit a word which is not a part of Sentence mode. Thus using this mode the user can generate any word or sentence by the formation of gestures [10].

**Table-1.** Interpretation of digital pattern.

S. No	Digital pattern	Character mode	Sentence mode
1	11111	A	HAI
2	01111	B	HOW ARE YOU
3	11100	C	I AM FINE.
4	11010	D	WHERE ARE YOU GOING?
5	10110	E	CAN YOU GIVE SOME FOOD
6	01110	F	GET ME SOME WATER
7	11001	G	MOM
8	10101	H	DAD
9	01101	I	GOOD MORNING
10	10111	J	GOOD NIGHT
11	01011	K	THANKYOU
12	00111	L	SEE YOU AGAIN
13	00011	M	BYE
14	11000	N	HOW WAS YOUR DAY
15	10001	O	HAPPY
16	00101	P	WHY ARE YOU SAD?
17	10000	Q	WHAT ARE YOU DOING?
18	00001	R	NO...
19	01010	S	YES!
20	10010	T	WHAT?
21	10011	U	DO YOU UNDERSTAND?
22	00100	V	DO IT RIGHT!
23	00110	W	ARE YOU COMING WITH ME?
24	00010	X	I DON'T THINK SO
25	10111	Y	I DON'T LIKE IT
26	11110	Z	I DON'T KNOW ANYBODY
27	11011	BLANK SPACE	BLANK SPACE

3. TRANSMISSION MODES

A. Transmission using wi-fi module (IoT)

In this method the Sign Language Interpreter will turn off the Xbee module and make use of the Wi-Fi shield to push the data to the into the Arduino cloud. The Arduino cloud is connected with the Smartphone app and the data are displayed in it [11]. So a common person can download that particular mobile application to understand what a hearing or speech impaired person wants to convey to him. The block diagram of this transmitter and receiver is shown in Figure-5.

B. Transmission using XBee technology

In this method the Wi-Fi shield is turned off and the data is transmitted to the wireless display through XBee which is given to the person to whom a hearing or speech impaired person wants to communicate. The receiver display module given to the ordinary person receives the data through XBee from the transmitter. The received binary data is then decrypted by a special algorithm using the decryption table1 at the receiver and the message is displayed in the LCD display. The block diagram for Transmission using Xbee technology is shown in Figure-6.

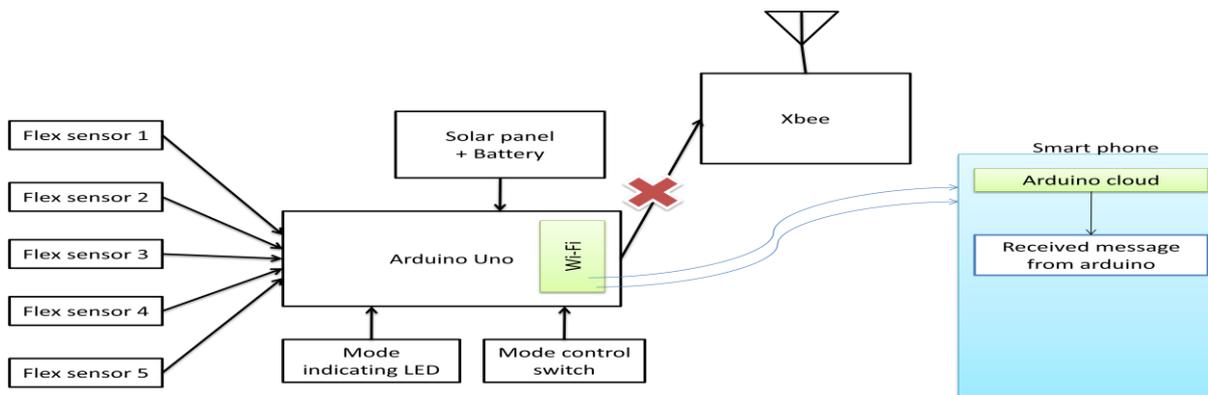


Figure-5. Transmission using Wi-Fi module.

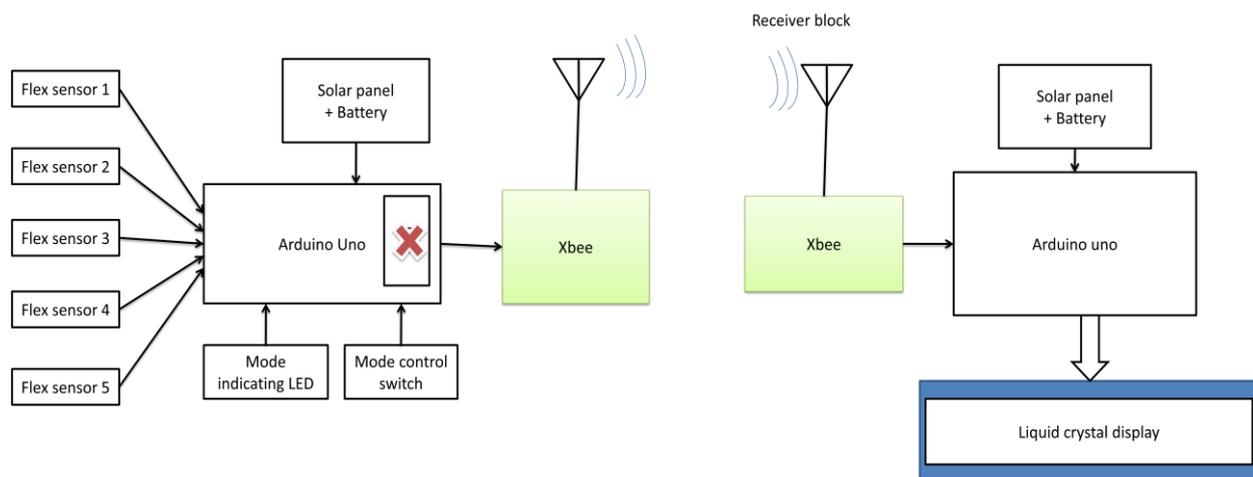


Figure-6. Transmission using XBee technology.

4. CONCLUSIONS

This paper presents a translational device for the mute and hearing impaired people using Sensing Glove Integrated with WiFi/ XBee technology. The proposed sign language interpreter provides an enhanced and comfortable way of communication for the hearing and speech impaired people. The aim of the paper is to provide a complete dialog without knowing sign language. The hand gestures of the deaf-dumb person are detected by the data glove and it supplies an analog signal to the controller for further processing. The output message is viewed on the LCD display or through the mobile application. The future enhancement is to recognize all the natural gestures of the human rather than using a particular and limited number gestures.

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