"SAHARA"- Means of Communication Between Visual, Hearing and Speech Impaired Individuals

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Abstract : Human life has become increasingly pleasant and simpler due to the advances in science and innovation. According to World Health Organization (WHO), around the world, 285 million individuals are visually impaired, 300 million are deaf mute and another 1 million are dumb. This prototype is designed to provide these kinds of disabled individuals a means of communication. This device takes the flex sensors input of a deaf-mute through usage of a sensor glove that acknowledges the hand gestures, textual content input of the blind using a Braille keypad and a Web Application is designed to take inputs from a normal person. The textual content output will be displayed on LCD screen, the speech output is produced the usage of a speaker and the Braille output using four solenoid motors organized in a form with a view to resemble braille character, hence enabling all the three above mentioned disabled individuals to have an efficient interaction among themselves as well as normal people.

***Keywords* – Deaf, dumb, blind, braille, BeagleBone Black, MSP-430, communication, flex sensors.**

I. INTRODUCTION

Bio Interaction is very difficult for the visionless, deaf or voiceless people which is major requirement of life. There are certain ways of interaction among such individuals through the means of Braille for the visionless and Sign Language for deaf and mute.

Blind can speak normally while the deaf-mute communicate by means of Braille language. The only means of communication accessible to the vocally enabled person is by using "Sign Language" [1]. This is the primary way of communication among dumb and deaf. Deaf people cannot communicate effectively if they are far from each other. For an instance, consider a case where a normal individual would like to interact with a deaf individual who is far away, then they cannot share their views with each other.

If two deaf / dumb people are close to one another, interaction is possible through sign language, but this method might not be efficient as it requires vast knowledge of sign language by both individuals. Most of normal people and blind people can't recognize sign language. If a person has all three disabilities, such as when a blind person is deaf-mute, there is no way he/she can communicate. Blind people only know the Braille script and the braille system can't be understood by deaf and dumb people. Thus, they face difficulties while communicating [2].

This issue prompted us to implement the deaf, dumb and blind communicator. The long-term objective is to allow communication between people with visual impairment (i.e. blind people), hearing impairment and voice impairment (i.e., dumb and deaf), on the one hand and people with visual impairment, hearing impairment and speech impairment on the other [3]. There is currently no means of communication between people in a country such as India who, sadly, are in large numbers.

Table 1: Combinations of One or more impairments possible with this prototype

Sl. No.	Communication Case	Sending message by A	Reply to be sent by B
1	Normal individual X to Blind individual Y.	X will send text message.	Y will send message by means of Braille keypad.
2	Normal individual X to Dumb individual Y.	X will send text message.	Sign message by Y to X converted to audio/text message only.
3	Normal individual X to "Blind and Dumb" individual Y.	X will send text message.	Y will send Braille message which will be converted into text/audio message.

4	Normal individual X to "Deaf - Mute" individual Y.	X will send Text message which is converted to text/only text message.	Sign message by Y to X converted to audio/text message only.
5	Blind individual X to Blind individual Y.	X will send message by means of Braille keypad.	Y will send message by means of Braille keypad.
6	Blind individual X to Dumb individual Y.	X will send message by means of Braille keypad.	Sign message by Y to X converted to audio.
7	Blind individual X to "Deaf -Mute" individual Y.	X will send message by means of Braille keypad.	Sign message by Y to X converted to audio.
8	Dumb individual X to Blind individual Y.	Sign message by X to Y converted to audio.	Y will send message by means of Braille keypad.
9	Dumb individual X to Dumb individual Y.	Sign message by X to Y converted to audio.	Sign message by Y to X converted to audio.
10	Dumb individual X to "Deaf-Mute" individual Y.	Sign message by X to Y converted to audio/text message only.	Sign message by Y to X converted to audio.
11	"Deaf-Mute" individual X to Blind individual Y.	Sign message by X to Y converted to audio message only.	Y will send message by means of Braille keypad which is converted to text.
12	"Deaf-Mute" individual X to "Deaf-Mute" individual Y.	Sign message by X to Y converted to text message only.	Sign message by Y to X converted to text message only.
13	"Deaf -Mute" individual X to Dumb individual Y.	Sign message by X to Y converted to audio/text message only.	Sign message by Y to X converted to text message only.
14	"Blind and Dumb" individual X to Blind individual Y.	X will send message by means of Braille keypad which is converted to audio.	Y will send message by means of Braille keypad which is converted to audio
15	"Blind and Dumb" individual X to Dumb individual Y.	X will send message by means of Braille keypad which is converted to text/audio.	Sign message by Y to X converted to audio/Braille output.
16	"Blind and Dumb" individual X to "Deaf and Dumb" individual Y.	X will send message by means of Braille keypad which is converted to text.	Sign message by Y to X converted to audio/Braille output.
17	"Blind and Dumb" individual X to normal individual Y.	X will send message by means of Braille keypad which is converted to text.	Y will send Text message which is converted to audio message.
18	"Deaf-Mute" individual X to normal individual Y.	Sign message by X to Y converted to audio/text message only.	Y will send Text message which is converted to text/only text message.

19	"Blind and Deaf and Dumb" individual X to Blind individual Y.	X will send message by means of Braille keypad which is converted to audio.	Y will send message by means of Braille keypad.
20	"Blind and Deaf and Dumb" individual X to "Deaf and Dumb" individual Y.	X will send message by means of Braille keypad which is converted to text.	Sign message by Y to X converted to Braille output only.
21	"Blind and Deaf and Dumb" individual X to Dumb individual Y.	X will send message by means of Braille keypad which is converted to text/audio.	Sign message by Y to X converted to Braille output only.
22	"Blind and Deaf and Dumb" individual X to Normal individual Y.	X will send message by means of Braille keypad which is converted to text/audio.	Y will send Text message which is converted to Braille output.
23	"Blind and Deaf and Dumb" individual X to "Blind and Dumb" individual Y.	X will send message by means of Braille keypad which is converted to audio	Y will send message by means of Braille keypad.
24	"Blind and Deaf and Dumb" individual X to "Blind and Deaf and Dumb" individual Y.	X will send message by means of Braille keypad which is converted to Braille output.	Y will send message by means of Braille keypad which is converted to Braille output.

This project focuses on cases mentioned above and try to frame a better which would allow individuals with different impairments to interact effectively with straight people or individuals of their own kind in the living world.

II. Literature Survey

Anbarasi Rajamohan *et al.* [1] have proposed a framework in which a means of communication is provided to the deaf-mute using a sensor glove. The glove is affixed with five flex sensors which are made up of resistive carbon elements. The flex sensor is basically a voltage divider network.

Depending on the bend curvature, a corresponding resistance is produced by the flex sensor. The sensor glove is also equipped with accelerometer and tactile sensors which help in increasing the sensitivity of the prototype.

All the three mentioned sensors in the sensor glove are connected to an Arduino. Arduino processes the data received from the sensors and co-relates with the stored data, the corresponding letter which matches with the data is then given out at the output. The intermediate training module results can be seen on the LCD screen and the final gesture recognition output can be heard on the speaker connected to Arduino.

T.Yamunarani *et al.* [2] have designed a translator which helps other understand what the dumb and deaf want to convey as the general majority of the people do not understand sign language. The proposed system consists of a processed image which is fed to the Arduino as input, following which the Arduino displays the corresponding pre-saved message in a LCD display and the message can also be heard on a speaker. The image of the hand gesture is processed using image processing techniques in MATLAB.

The images are acquired using webcam which are further used for testing and training. Further, a Weiner filter is used to remove the noise from the original image and is then converted to grayscale.

Then the image is explored and analyzed properly using feature extraction technique, which is done using histogram of oriented gradients (HOG). The extracted features are then classified by comparing each testing case to the pre-saved training class. The obtained output is the fed to the Arduino which is interfaced with the PC and hence the output is obtained.

Moataz Soliman *et al.* [3] have explored the integration of Cloud computing and Web services with IOT (Internet of Things) for the concept of Smart Home. Smart home drastically reduces physical need to control or monitor home appliances/security apparatus. The main focus of this approach is, the smart utilization of Arduino in creating an intelligent prototype by embedding it with sensors and actuators.

The authors also speak about the benefits and uses of ZigBee technology and emphasis on smart networking using ZigBee. Next is how cloud services can also be incorporated in smart services and how JSON data format can be used to increase the efficiency of cloud services.

Further, a case study is done on measuring different parameters such as light and humidity, controlling various devices such as air-conditioners, ovens, washing machine etc as well as controlling the security apparatus of the house using RFID technology.

Nikolaos Bourbakis *et al.* [4] have proposed a prototype Tyflos-Koufos in order to reduce the communication gap between deaf and blind. This paper discusses in particular the necessity for the conversion of various modalities into a common medium which is understandable and shared by visual and hearing impaired. The Tyflos device assists the blind where as Koufos assists the deaf individuals.

The blind individual wears a spectacle embedded with camera which takes images and inputs them to Tyflos device. Tyflos then performs Object characterization and also extracts all possible features and hence provides NL text and vibration patterns as output. These NL texts are converted into speech and is provided as output to blind through earphones.

The koufos device with deaf individual accepts all nearby sounds and converts them to NL text and vibration patterns. These vibration patterns help deaf in realizing the sense of volume, pitch and tone hence they can feel what others are saying.

Zenon Chaczko *et al.* [5] have illustrated the practicality and suitability of using popular tools which are available as open source such as the Node-Red and the Raspberry Pi in the Internet of Things.

This paper shows fairly easy realistic workflows involving the hardware and software of Raspberry Pi, and a programming environment of Node-RED, which students may perform for the purpose of stimulating learning, understanding the Internet of Things and gaining basic computer engineering abilities.

The aim of Node-RED programming is to make programming as simple as possible by cabling graphical blocks known as nodes. This paper also demonstrated the creation of IoT application using Node Red to frame a program that sends an automatic email using RPI Linux box.

Piyush Patil *et al.* [6] developed a means of communication for deaf individuals using IoT which involved the usage of Raspberry Pi embedded with advanced feature of real time speech to text conversion.

In this developed prototype, the workflow is as follows – Normal person speaks into Raspberry Pi which detects sound using speech recognition module. This speech is then converted to text and is sent to the application present in deaf individual's mobile. This prototype has multiple possibilities of communication between Raspberry pi and Mobile application such as Bluetooth, Wi-Fi or a Cloud server, but makes use of any one of the available modes based on the situation.

III. METHODOLOGY

This project has been put forth to solve the disabilities and their combination that a person may suffer from, namely blindness, deafness and dumbness.

In addition, this prototype as shown in Fig-1, takes distance as one of the main hurdles of efficient communication and provides a suitable technique to reduce this among people with speech, hearing and visual impairments.

Below are the functions of the module for transmitting the input given by one disabled individual to other:

- In this project, module used is a kind of wearable technology which can be worn like a glove [4]. Firstly, this module's output and input are made to suit the user's requirement [5].
- For example, in the case of a blind individual, input is taken by means of Braille keypad and output is provided by the means of audio or Braille. So, the module is programmed to take input and send output according to the user's requirements.
- The message from the user to be sent can be taken into the prototype as an entry. Inputs are in the form of text, Braille language and hand gestures. The prototype consists of a glove affixed with flex sensors for accepting input along with a software which converts braille language into text.
- If the sender's message is in the form that the recipient acknowledges and recognizes, the response will be direct, that is message is delivered to the individual at the receiving end. Input is transformed to a voice signal irrespective of its first form for long distance communication and then it is transmitted to the receiver via cloud [6].

3.1 TRANSMITTER

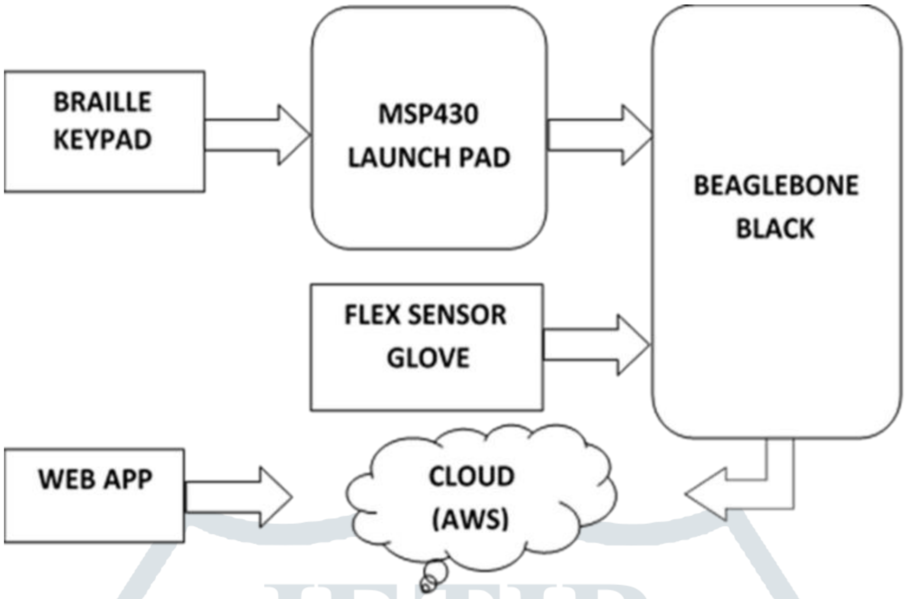

Figure 1: Transmitter Section Block Diagram

- The deaf mute uses sensor glove to give input.
- The blind uses braille keypad to give input
- Flex Sensor glove is directly connected to the BeagleBone Black, whereas Braille keypad input is first processed by MSP-430, which assigns a corresponding character to each key press and passes it on to BeagleBone Black [7].
- BeagleBone Black transmits this message to the cloud using Internet.
- A normal person can give text input via web app, which is directly connected to the cloud [8].

3.2 FLOW OF DATA TRANSMITTED THROUGH WEB APPLICATION:

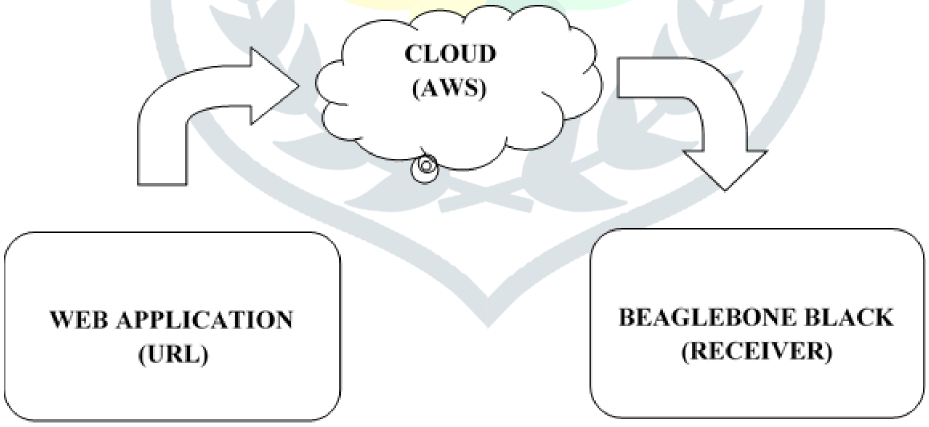

Figure 2: Flow of data transmitted through Web Application

As shown in the above figure 2, the flow of the data transmitted through the web application is described in brief:

- The message input given by a normal individual through the URL web app is sent to the Amazon Web Services (AWS) cloud and the input is stored there.
- The BeagleBone Black at the receiver end is burnt with a Python code which is used to communicate with the AWS and the retrieve the message stored in it. The BeagleBone Black uses http client package to request the message from the cloud.
- The data is then conveyed to the receiver in various forms suiting his/her state.

3.3 RECEIVER SECTION

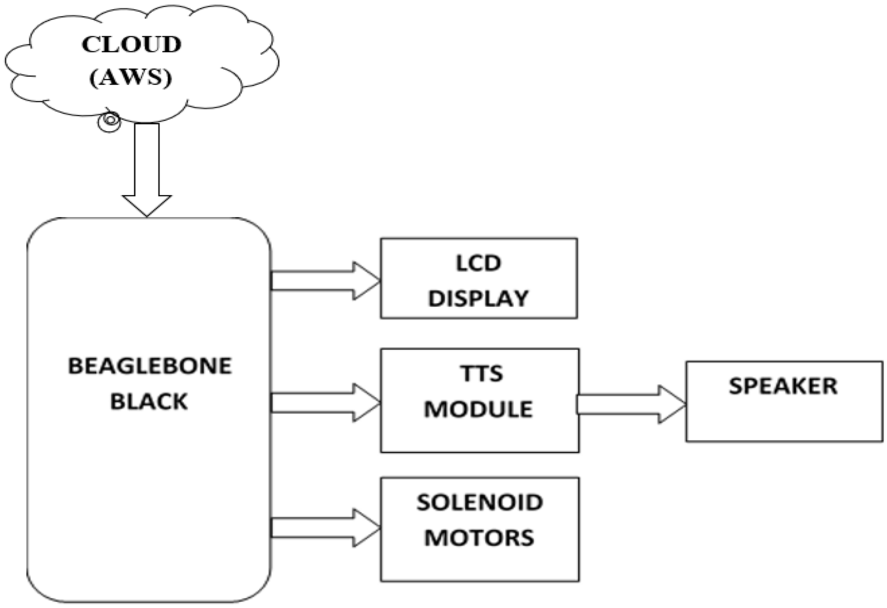

Figure 3: Receiver Section Block Diagram

- BeagleBone Black receives message from cloud processes the text message and coverts it to desired output [7].
- LCD display is used to show text messages to deaf, dumb and normal person.
- The text message is converted into speech message using TTS conversion as required for blind and normal individuals.
- This text message is also processed into braille output using vibrating motors (solenoid motors) as required for blind.

IV. RESULTS

The Experimentation has been done by setting up all the required components. The detailed pictures of each of the input and output along with brief explanation of what is happening in the images is conveyed below.

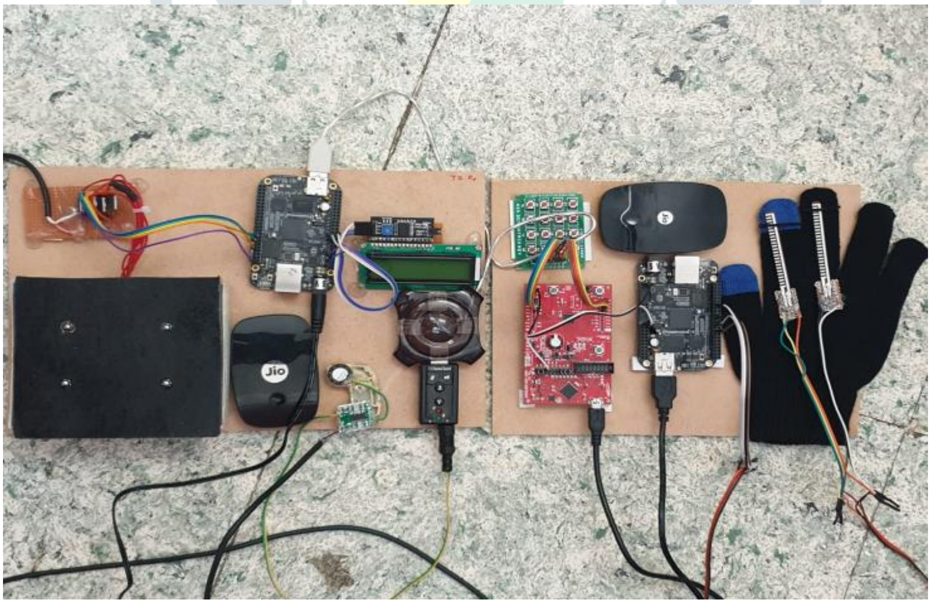

Figure 4: The prototype of SAHARA

The figure 4 depicts a clear visual of the complete experimental setup of SAHARA. It includes both transmitter and receiver sections with all necessary internet connectivity. Transmitter Section consists of a Jio dongle for internet connectivity, a Flex Sensor Glove, a Braille Keypad, a MSP 430 Launch Pad and a BeagleBone Black. The web app is also a part of transmitter. Receiver section consists of a Jio dongle for internet connectivity, a BeagleBone Black, a LCD Display, a Speaker with a TTS module Intermediate and a 2x2 Solenoid Motor Array with IRLZ44N MOSFET Driver.

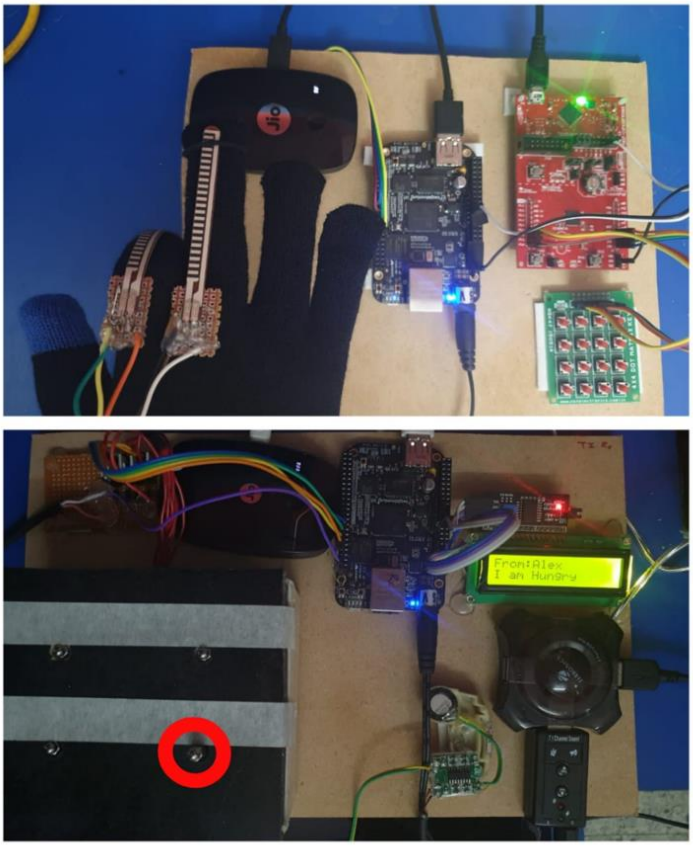

Figure 5: Corresponding outputs for input through Sensor Glove

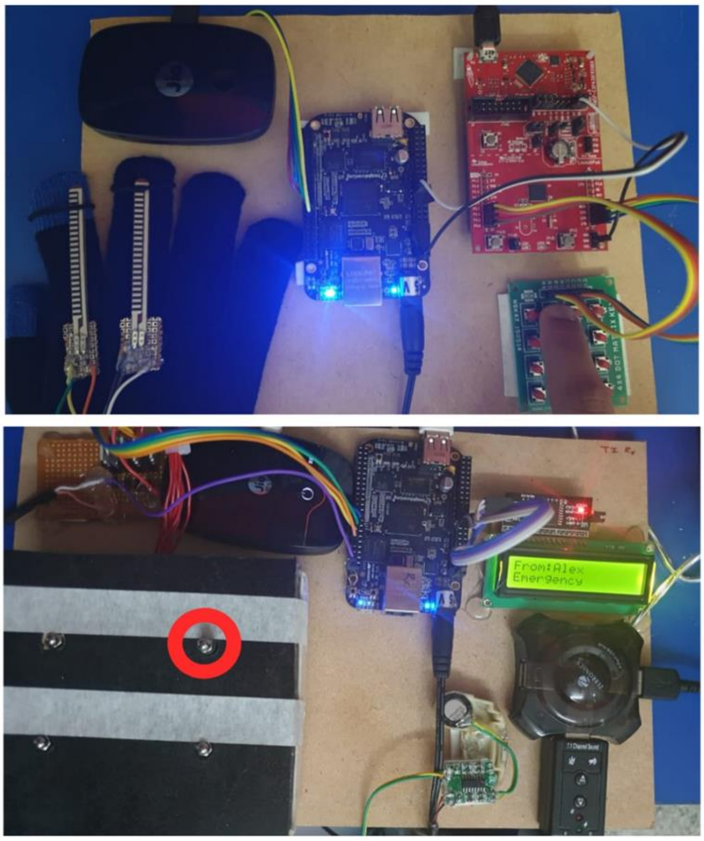

Figure 6: Corresponding outputs for input through Braille Keypad

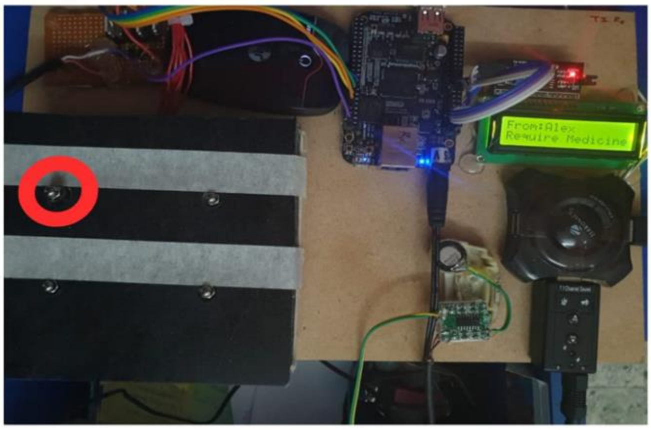

Figure 7: Corresponding outputs for input through Web App

The figure 5 describes that when an input is given through Flex Sensor, it is mapped to its assigned character by Transmitter BeagleBone Black and sent to cloud. The Receiver BeagleBone Black retrieves the character from the cloud and then finds the Phrase allocated to that character which is "I am Hungry" in this case and the same is displayed, heard and felt through LCD, Speaker and Solenoid Motor Array respectively along with the information regarding the name of person (Alex) from whom the message has been sent.

The figure 6 describes that when an input is given through Braille Keypad by pressing one of 16 keys, the key presses is mapped to its assigned character by the MSP 430 Launch Pad. That character is then transmitted serially to the BeagleBone Black at the Transmitter end which sends the same to the cloud. The Receiver BeagleBone Black retrieves the character from the cloud and then finds the Phrase allocated to that character which is "Emergency" in this case and the same is displayed, heard and felt through LCD, Speaker and Solenoid Motor Array respectively along with the information regarding the name of person (Alex) from whom the message has been sent.

The figure 7 shows how the input is taken through web application and its corresponding outputs. As shown, the user interface of the web app provides a field to enter his/her name and has 16 phrases listed below it where a user can choose any one that he/she wants to send. The web application is designed using Node Red. In the backend, the selected phrase is mapped to the assigned character and is sent to the cloud directly. The Receiver BeagleBone Black retrieves the character from the cloud and then finds the Phrase allocated to that character which is "Require Medicine" in this case and the same is displayed, heard and felt through LCD, Speaker and Solenoid Motor Array respectively along with the information regarding the name of person (Alex) from whom the message has been sent.

V. Conclusion

The proposed module "SAHARA" acts as a tool which eliminates the barrier of disability in communicating with individuals who have any combination of vision, hearing and speech impairments among them and also normal individuals. This prototype uses the new and evolving wearable technology that allows the handicapped person to easily carry the system anywhere and everywhere, rendering our research portable. When correctly assembled in small size and in large quantities, this product can be produced at a very low price with good usability, as per the specification and functionality of this system. Using this device, an individual can interact and convey his/her thoughts according to his/her will and capability. It also supports the communication in real time, making it more efficient.

VI. Future Scope

Several potential developments can be correlated with this proposed work some of which are listed below as:

- sensor glove which is connected through wires to the BeagleBone Black microcontroller, can be made wireless by affixing a Bluetooth module on the flex sensors affixed on the glove, thus eliminating the usage of wires.
- The BeagleBone Black also supports Wi-Fi, Ethernet and Bluetooth, hence incorporating these capabilities into the app so that the app can link to any Bluetooth or Wi-Fi supporting modules.
- Sensing the motions and actions can be more accurate by using components such as accelerometers, thus making the information delivery much efficient.
- Since this is a form of wearable technology, new advancements or developments may be integrated to make the module much lighter and robust.
- The number of possible inputs can be increased by using more flex sensors and also more combinations of output can be realized by increasing the number of solenoid motors in the array.
- If the existing prototype is fused with technologies like Machine learning, Deep learning and Artificial Intelligence, it's efficiency can further be increased.

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