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IoT Based Real-time Communication for People with Sensory Impairment

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Abstract:- The biggest challenge faced by deaf, blind, or dumb people is communication. Some people face difficulties in communicating with others due to their inability of hearing or sighting. Some of them are deaf or blind by born whereas a few of them lose their hearing or visual ability by accidents. Recently, there have been studies and researches on how to make their life easier by different approaches such as mobile applications, devices based on hand gloves for the deaf-dumb, the internet, etc. This project aims to develop a method for communication for people with sensory impairment with the help of IoT. The main purpose of the project is to help them communicate more easily with both the ordinary people as well as sensory impaired. The proposed system would make better use of technology-based on Raspberry Pi with some advanced features of converting. In this project, there are two major conversion units. One of them is converting audio into text, which favors the deaf people. The other one is an image to audio conversion, where the image is converted into text via image processing and the text is converted into audio, this proportion of the system is useful for the blind people. There are few additional features for blind people such as a voice calculator, voice assistant, and object detector to help them with moving around and their basic needs. The output for deaf people will be shown on the LCD and the blind people will be able to hear through the speakers. It is expected that communicating for sensory impaired will be easier by using the system. The prototype can be accessed easily by the deaf and for the blind people. There is a voice assistant by which they can access all the functions mentioned above. It can be used to help the sensory impaired in their education. An observation of the outcomes of the project was done by providing different types of components for a better result. All the components worked properly to make the system more efficient. The main goal of the project is to reduce difficulties in their communication, among themselves and with ordinary people and this project can be made more useful in the future by making the design simpler.

Keywords:- *Communication; Conversion; Education; Features; IoT; Sensory Impairment.*

I. INTRODUCTION

Communication is a process of exchanging or sharing ideas, feelings, thoughts, or information. Communication between deaf, dumb, and a blind person have always been a challenging task [1]. There are about 466 million people around the world with disabling hearing loss and 34 million among them are children [2]. According to the World Health Organization, about 285 million people in the world are blind, 300 million are deaf and 1 million are dumb [3]. Many devices and systems are available to help deaf, dumb, and blind people improve communication, adapt to their environment, and function in society more effectively [4]. For people with disabilities, the IoT can be transformational because it can enhance safety, mobility, and independence which can often lead to enhanced privacy and many IoT devices and services have been designed to enhance the lives of people with disabilities and reduce their dependence on others [5]. The IoT based real-time communication is a good and easy way to develop an advanced method of communication for people with sensory impairment so that they can communicate with ordinary people as well as the sensory impaired. This project will help the sensory impaired students with their education and it can also be used by the individuals in communication purposes. The raspberry-pi is used as a microcontroller. The python programming language is used for the conversion in the raspberry pi. A normal person or a disabled person who can speak may talk through the device and the inputted words will be displayed

on the LCD, this part of the project is for the ones who are deafened. There is a conversion unit that converts text to audio which helps the people who are unable to speak, with this conversion a communication can be established between a person who cannot speak and a blind person. There is a camera which captures an image and converts it to text, here the text to audio also takes place to convert the text into audio for the blind people. In this project, we have added some additional features for the blind people such as a voice calculator, voice assistant, and object detector to help them with moving around and their basic needs. There is a text to speech conversion to help mute people communicate with blind people, this project represents the establishment of a provisional analysis of IoT based real-time communication system. A micro-controller was used for the hardware implementation of this project. This will be both low at cost and environmentally friendly at the same time for the user.

II. RELATED WORK

Students from Singhad Institute of Technology accomplished a paper based on IoT real-time communication for deaf people, in 2017. They have proposed a system to develop and advance method of communication for deaf people with the help of IoT, raspberry pi, GSM module, and mobile application. The working principle of the system is that an audio or voice signal is given as an input through the raspberry pi device which is converted into text by using cloud search API and python programming language. The converted text is then transmitted to the mobile application through the cloud, Wi-Fi, or Bluetooth. The system also converts the texts typed by a deaf person into audio and this process was achieved by the python programming language. It can be used for both short- and long-range communication [6].

Various research papers are representing numerous ways of communication process for sensory impaired. In 2019, a journal was published to help blind people. The proposed system is designed for blind people to hear the context of the text image without reading them. Basically, there are two main systems used for the conversion, the first one is optical character recognition (OCR) and the second is text to speech synthesizer (TTS). The system is designed with the help of raspberry-pi and a camera is necessary because it will capture the image as the input which is later transmitted to the TTS unit and the output of the TTS is received by the user. It can covert both capital and small letters form an input text and convert it to an audio signal [7].

In 2019, students from Qatar University have conducted research and they have designed a digital computerized mobile smart system as an efficient way to communicate between Arabian deaf–dumb impaired and normal Arabian people. There are two stages, first one involves a device or hardware such as gloves flex sensor equipped with a three-axis accelerometer that is controlled by a microcontroller for generating digital outputs of the hand gestures or signs. In the second step, the outputs of the hand gestures are converted into written texts and voices with high accuracy. It also allows the deaf to translate words of ordinary people into sign language using the speech library in c#. There are other studies which suggest a different type of process such as gesture image processing, tracking hand motion and detecting its gravity center, Neural Network for gesture recognition. The gloves sensor technique has a higher efficiency, fast response, mobile, and it converts the outputs into complete texts instead of letters or alphabets [8].

III. FEATURES OF RASBERRY PI

The world has changed radically with the advent of engineers' ideas, theories, and innovations. Raspberry pi is one of these inventions. All over the world, the work of electronics was becoming an Adriano board. But the chip of raspberry pi has changed all. With this raspberry pi, it is now possible to do the work of electronics very easily. Raspberry pi is a very innovative and powerful mini-computer. The idea of raspberry pi first came in 2006. It was created by Eben Upton. The Raspberry pi foundation was formed in 2009 in the UK. They wanted to give people the knowledge and tools so they can make computer software and hardware. In 2011, raspberry pi's prototype was revealed by BBC. After some modification, it got a new design and look. Then it was finally released on 19 February 2012. The first look of raspberry pi in 2006 was not the same as the pi that would launch in 2012. It had two models, model A, and model B. In 2014, the latest version of Model B+ was launched in the market. Raspberry pi has its own operating system known as Raspbian but other operating systems can also run in it. The main programming languages that are used in raspberry pi are python and scratch. Basically, raspberry pi's job is not to remove the computer or laptop but to work in a supplement with them. It is also used as a microcontroller [9].

Fig. 1. Raspberry Pi [10]

Fig. 1. shows a raspberry pi, microcontroller-based tiny single-board computer. The official language programming language for raspberry pi is python. It is capable of everything that a desktop computer can execute. In this project, raspberry pi is used as a microcontroller and it handles all the conversion units and other features.

A. Specifications

- SoC: Broadcom BCM2837
- CPU: 4× ARM Cortex-A53, 1.2GHz
- GPU: Broadcom Video Core IV
- RAM: 1GB LPDDR2 (900 MHz)
- Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless
- Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
- Storage: Micro SD
- GPIO: 40-pin, Header, Populated
- Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI) [11].

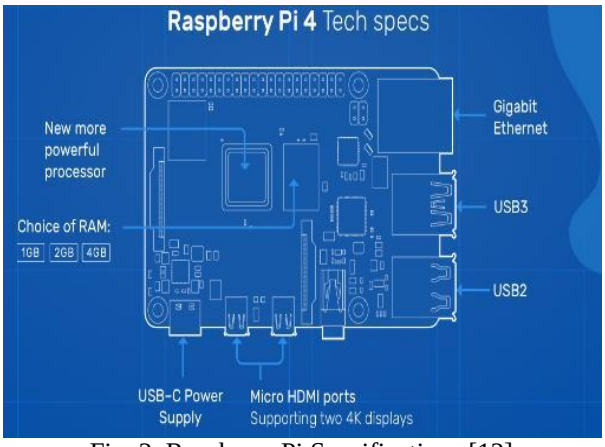


Fig. 2. Raspberry Pi Specifications [12]

Fig. 2. shows the USB ports, Powering port, micro HDMI ports and Gigabit Ethernet. Specifications of the raspberry pi 4 are shown.

IV. METHODOLOGY

The overall methodological approach of the respective project was a mixture of quantitative and qualitative approaches. Firstly, people's view and understanding of the research idea was evaluated. Moreover, people were interviewed, and their opinions were gathered for the progression of the project work. Additionally, experiments are conducted under controlled variables and environments and the desired output of the experiments represents the zenith success of the project work.

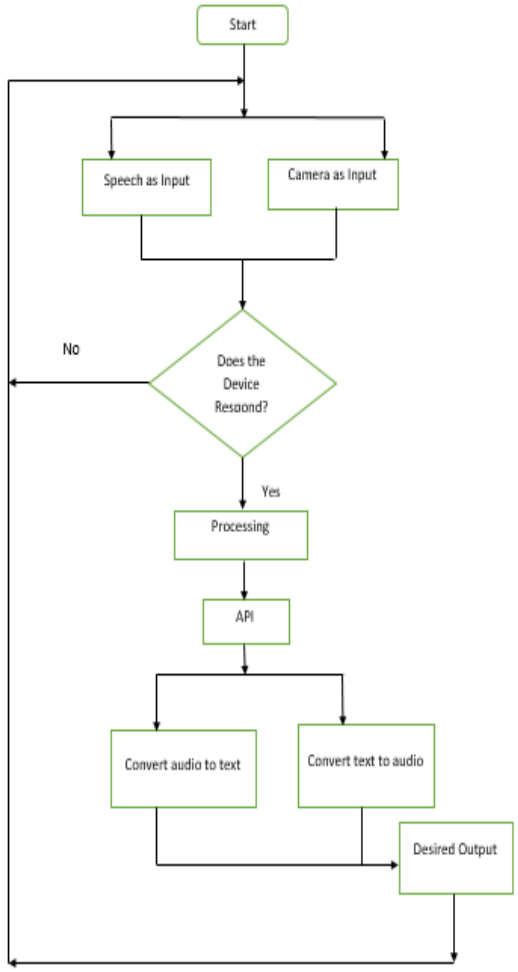


Fig. 3. Flowchart of the Prototype

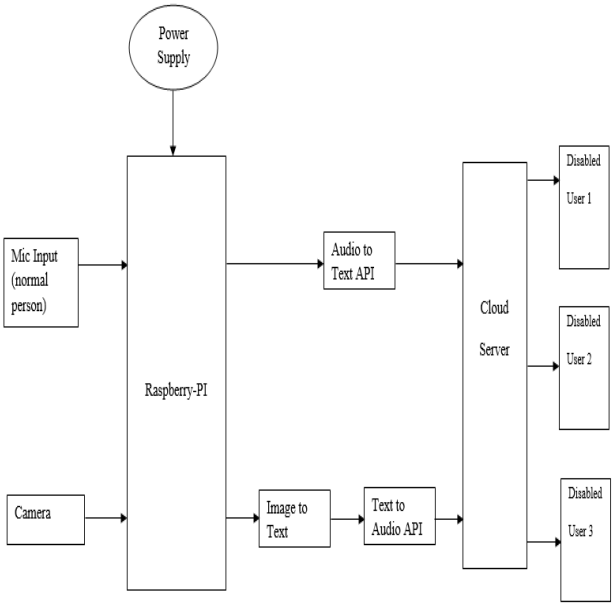
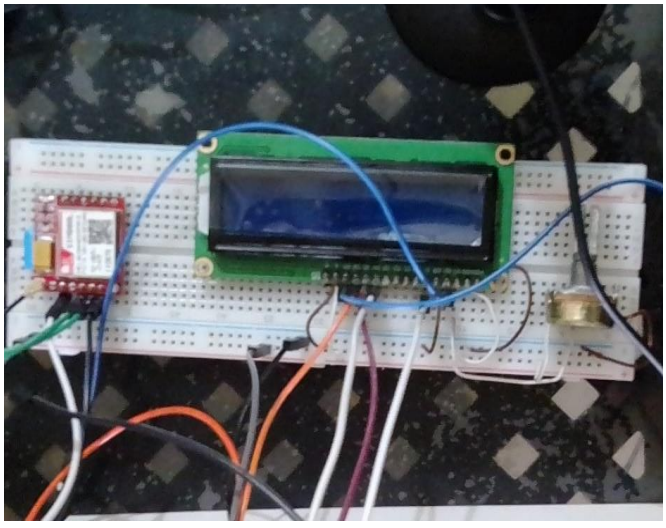


Fig. 4. System Block Diagram

Fig. 3., illustrates the system flowchart of the proposed system. As shown in the above figure, there are two inputs, audio, and camera. Considering speech as input for deaf people, input goes to Raspberry Pi. If the device does not respond, it will go back to the initial point. If the device responds, the input will pass through the Raspberry-pi to API. API now converts the input audio to speech. If it happens, the user will get the desired output. If not, it will recheck and go back to the starting point. Now considering the camera as input for blind people, input goes to the Raspberry-pi. If the device does not respond, it will go back to the start point. If the device responds, the input will pass through the Raspberry-pi to API. The API now converts the input text from an image to speech. If it happens, the user will get the desired output. If not, it will recheck and go back to the starting point.

On the other side in the Fig. 4., it can be seen that a microcontroller is used to accomplish the work. Raspberry-pi is used as a microcontroller which is connected with a power supply. The main operation of Raspberry-pi in this project is to receive the input and pass it through API. The API converts audio to text and text to audio. This operation is done by python code used in Raspberry Pi. A microphone and a camera are connected to the raspberry-pi as the source inputs. When it is considered for the microphone, input audio comes to the Raspberry-pi and the audio is passed through audio to text API which converts audio into text. Finally, the output will be shown on the screen of a device which is handled by users. So, it completes the full operation for a deaf person. For a blind person, a camera is used as input. The camera captures the text that is transmitted to the Raspberry-pi. The captured image will be converted to text through the image to text API. The input text will pass through the text to voice API which converts the text into audio. A blind person will get the audio on his device.

V. DESIGN PROTOTYPE



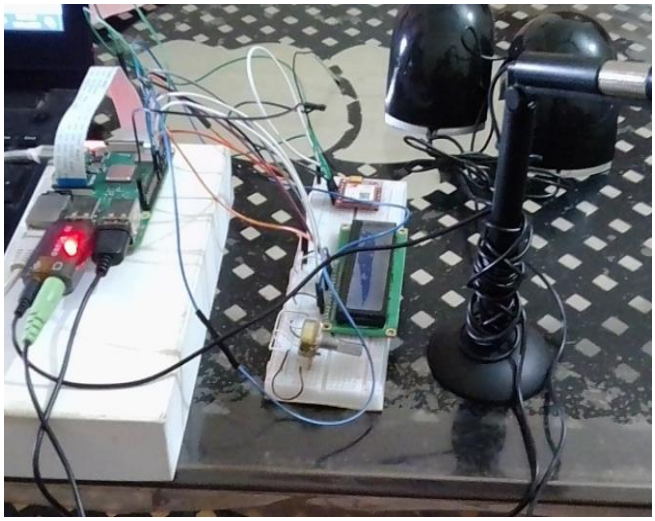
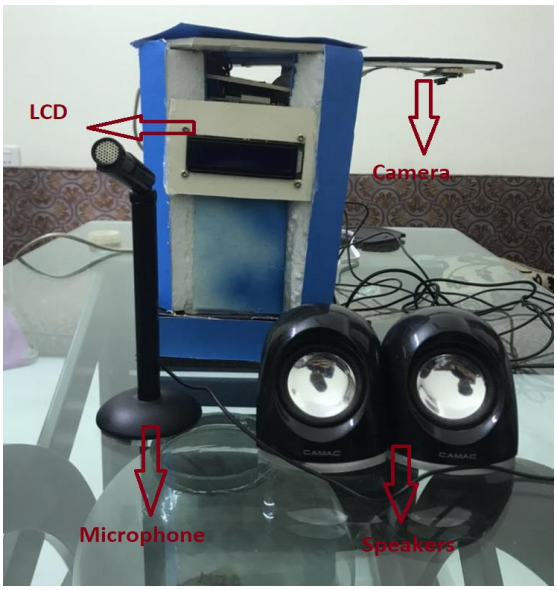


Fig. 5. Preliminary Circuit of the System



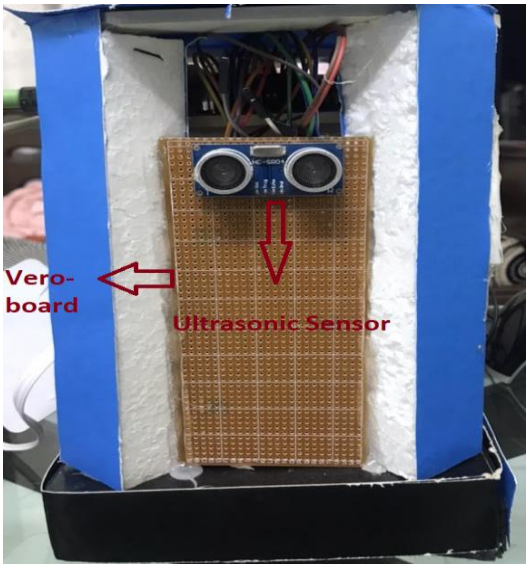


Fig. 6. Design Prototype

The given figure shows the prototype of the whole project. In this project, the microcontroller, and circuit which is used to accomplish the project. Raspberry Pi is the microcontroller. A raspberry pi camera is connected to raspberry pi and it captures the image and then it sends the image to the conversion units. Microphone and speakers are also connected to the raspberry pi, the microphone is used as an input for the receiving audio and the speakers are used as an output to listen to the converted audio from an image. The LCD is connected to the raspberry pi which shows the text outputs only. Finally, some connecting wires, variable resistors, and power supply are connected to complete the execution properly.

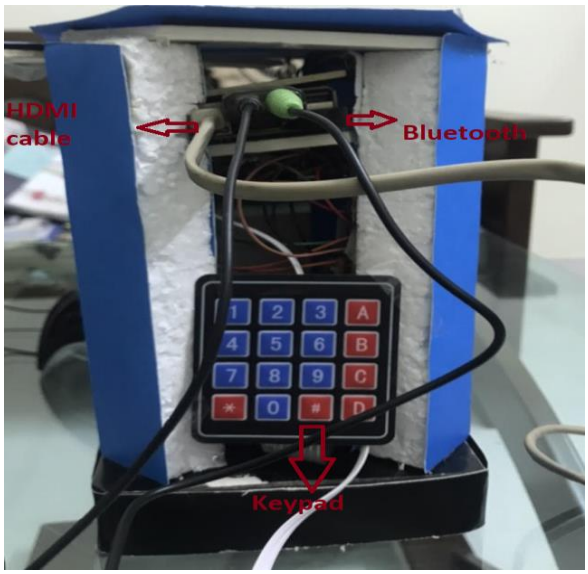


Fig. 7. Complete Structure of the Project

This is the prototype structure of the fabricated device. This prototype satisfies all the described operations.

VI. RESULT

Fig. 8. GUI of the Project

Fig. 8 represents a set of options for different conversions that are used to help the sensory impaired.

A. Voice to Text Conversion

Fig. 9. Voice to Text Conversion

Fig. 9 shows the result of speech to text conversion. If the first option is selected the device responses and waits for the user to transmit an input. That input voice is converted into text.

B. Image to Audio Conversion:

Fig. 10. Image to Text Conversion

Fig. 10. illustrates the conversion from image to audio. Here, the raspberry pi camera is being used to capture the image of words, and this captured image is processed to alter into text. The output of image to text is shown in the above figure. However, the output of this function is audio but there is no way to visualize audio and that is why it has been demonstrated with text.

C. Object Detection

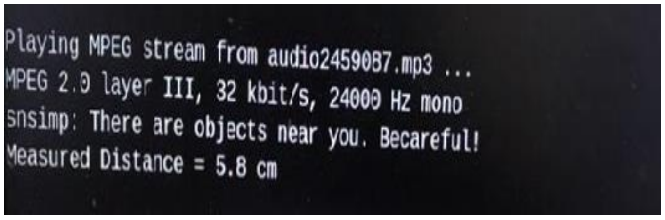


Fig. 11. Text to Speech Conversion

Fig. 11. represents the ultra-sonic sensor measuring the distance of an object. It detects the nearby object and notifies the user through the audio output. The distance output is shown through the command window.

D. Voice Calculator

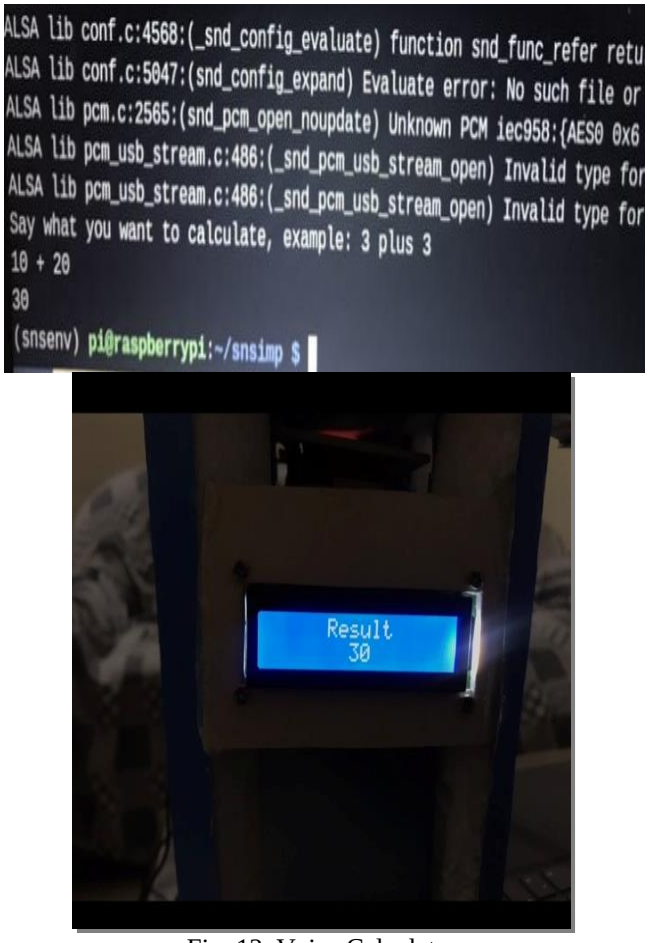


Fig. 12. Voice Calculator

Fig. 12 shows the command window of the voice calculator along with the output. The user has given two numerical values to add and the result is displayed on the LCD. The output is also transmitted through audio.

VII. CONCLUSION

In this project, a few things related to disabled people were discussed about their impairment, and the solutions for their life betterment were discussed. This project represents the establishment of a provisional analysis of IoT based real-time communication system. A microcontroller was used for the hardware implementation of this project. It is now expected that among disability those who use this IoT-based system will be benefitted. However, it is not possible to provide something that will match up to a normal person's ability. The system focused on mainly helping deaf and blind people. It can make their life easier in terms of communication. It has also object detectors which may help the blind person in traveling independently without any interruptions. Every minimum required equipment was provided to complete the project with good effort. The major priority was to complete the project with good service at an affordable price.

VIII. ACKNOWLEDGEMENT

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