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Tutoring and Communication Prototype Device For Blind, Deaf and Mute

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***Abstract* - In this project a hand gesture recognition system is used to recognize the Indian sign language and convert it into the audio and visual outputs. The Raspberry Pi is used to implement the project using python programming with the Image processing techniques. A camera is connected to the Raspberry Pi for the recognition of Hand gestures. The Hand signs are then converted into the audio by the Raspberry Pi and played through the speaker. A LCD screen is provided for Speech to text conversion which displays the words spoken by the blind communicator to the deaf. The proposed idea can recognise the hand gestures effectively and this may help millions of differently able people to communicate with others. The device also helps to ease the difficulties faced by the differently able tutors to teach classes. This device can also be used for training purposes and to improve the interaction between the tutor and the tutored.**

Index Terms - Hand Gesture recognition, Indian Sign Language, Audio, Visual feed, Raspberry Pi, Contour Algorithm , LCD screen, Tutoring, Communication, Differently able, Python Programming, Camera .

I. INTRODUCTION

In this world about 5% of the population are deaf or mute and roughly 39 million blind. There are various modes of communication for these differently able like Braille code , Sign languages , etc. in which the Indian Sign Language (ISL)[4] is used by 2.7 million in Bangladesh , India , Pakistan and so on. Till now very little work has been done to develop a device that translates the ISL to corresponding text and voice. But almost every mode of communication is based around the majority of the population and these minority of the differently able are left out. Our device reduces this gap and smoothens the communication even among the differently able and the normal people.

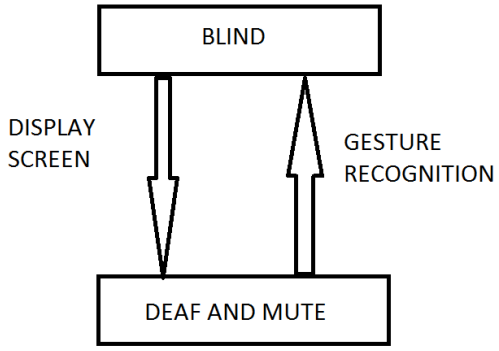

Figure 1: Deaf and mute communication with a blind

The major problem arises when a blind tries to communicate with a mute/deaf person this can be

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Vol-22-Issue-2-April-June-2019

overcome by this project. So far devices for improving their understanding of the environment have been invented as well as methods like the Braille, Sign language, which was introduced as an option for studying engraved text and easy communication.

In fact, according to the survey, Only less than 10% of the world population can communicate and teach with the existing systems for communication. For situations like this, a solution is found with the algorithm to help the impaired people.

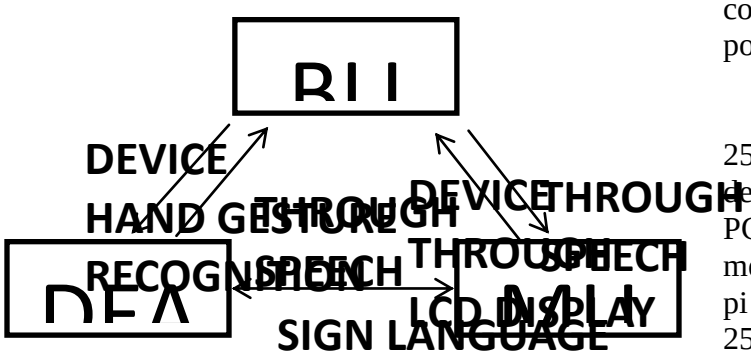

Figure 2: Communication among blind, deaf and mute

This device will be custom hardware for the differently able people to teach others like them in the same way as the normal teachers do. So, an algorithm has been developed and used on a custom hardware implementation in order for the differently able people to teach in the same way as normal teachers do. This is done by capturing the image which is to be read using a raspberry pi camera module. Raspberry pi is a credit card sized single board computer.

The text to speech engine converts text to speech output [2]. A microphone is used for speech input. The developed system is regarded as a step-forward towards the advancements in Electronic Teaching Aids, smart lenses and should contribute to the betterment of the life of individuals with vision, speech and hearing loss.

II. DEVICE COMPONENTS

A. RASPBERRY PI

It is a single computer board with credit card size, that can be used as similar to what normal PC does. There are two models in which includes Model A and Model B. The main difference between the A and B model is presence of Ethernet Port, where model A consumes less power compared to model B due to absence of Ethernet port.

The raspberry pi model aboard is designed with 256MB of SD CARD RAM and model B is designed with 51MB. Raspberry pi is a small size PC compare with other PCs. The normal PCs RAM memory is available in gigabytes. But in raspberry pi board, the RAM memory is available more than 256MB or 512MB.

Figure 3: Raspberry pi 3 b+

The central processing unit is known as brain of this raspberry pi responsible for transferring the instructions through mathematical and logical operations. This graphics processing unit consists of specialized chip that is responsible for speeding up the operation on image calculations. It is mainly designed with the Broadcom video core IV. The Ethernet port acts as main gateway for communication and additional devices.

ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

The general purpose input & output pins are used in the raspberry pi to associate with the other electronic boards. These pins can accept input & output commands based on programming raspberry pi. The raspberry pi affords digital GPIO pins. These pins are used to connect other electronic components. For example, you can connect it to the temperature sensor to transmit digital data.

The power source cable is a small switch, which is placed on side of the shield. The main purpose of the power source connector is to enable an external power source.

B. IMAGE PROCESSING

The Indian Sign Language is captured through the camera and is stored in the Raspberry Pi. To this image the program assigns a word or sentence for later use. When shown in front camera the program compares the current sign to the saved copy and if the both are same the word or sentence assigned to it is given as audio output and visual text.

Figure 4: Captured image and HSV converted image

In a similar manner, Cam shift method and Hue, Saturation, Intensity (HSV) colour model are used for hand tracking and segmentation. For gesture recognition, Genetic Algorithm is used [4] .

The use of depth map and colour image is done together to extract more accurate hand contour. The representation of the detected hand contour based on Bezier curve as metadata to provide an interoperable interface between a detection module and a recognition module.

C. SPEECH TO TEXT

The speech to text conversion[2] is done by the program which uses similar technique done by Google API [8]. The Google Application Programming Interfaces (APIs) are developed by Google which allows communication with Google services and their integration to other services. The Google API is used in mobile phones and computers for voice commands recognition. In this project the speech is first recognized by the raspberry pi and compared with the standard format of the words. The matched words are displayed on the screen. Thus speech is converted to text and is displayed on the display device[7].

This is done by recording the word or sentence for 10 seconds and is stored in the Raspberry Pi. Then the Pi shows the said words or sentence in the monitor or LCD screen[3]. The Hand gesture is recognized by the angles made between the fingers and the contour and the defect points. Different regions are well captured and the processing time will be concerned in the overall performance during the processing phase. The signs are stored before hand and when it is shown in front of the camera it is compared to already stored standard format photo and when it matches the word or sentence assigned to it, they are displayed as text on the screen, which can be read by the deaf or mute person.

D. DISPLAY

The Display options of the Raspberry Pi board are of the types such as HDMI and or USB port LCD screens. Many LCD and HD TV monitors can be attached using an HDMI to HDMI cable or HDMI to VGA cable. The different versions of HDMI are 1.3 and 1.4 and 1.4 is recommended. The O/Ps of the Raspberry Pi audio and video is through Speakers and LCD or TV Monitors, but does not support I/p.

ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

III. PROBLEM STATEMENT

The main problem is the algorithm section, which automatically captures images and recognizes all kinds of single handed gestures and are turned into speech, under certain circumstances.

The problem that is described above encounters the following difficulties:

1) Limitations with hardware (Ram, camera resolution, processing speed).
2) Noise in the captured pictures (light exposure , reflections , shadows, blurring and so on).
3) Not giving proper hand gesture by the user as per the ISL (Indian Sign Language) standards.
4) Double hand sign is not recognizable and real time system.

IV. PRIOR WORK

In the beginning of 20th century many research have been conducted and data have been collected in order to develop a successful device that would ease the communication among the blind, deaf and mute. In June 2005 a research paper was submitted by A.Dabrowski, P.Kardys and T.Marciniak on the title
"Bluetooth technology applications dedicated to supporting blind and hearing as well as speech handicapped people" at 47th International Symposium ELMAR , Zadar, Croatia. Which developed a hand held device[5].

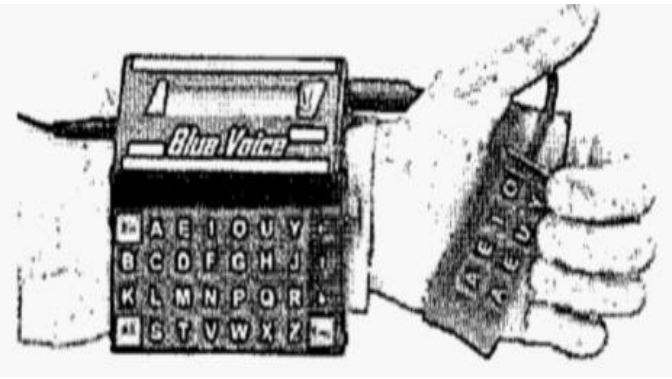

Figure 4: A.Dabrowski and Kardys prototype of blind communication device[5]

Then followed by various methods of gesture recognition was developed in terms of smart spectacles, gloves using flex sensor and so on. Then comes the Camera based gesture recognition systems using raspberry pi. The difficulties arose when the accuracy of the hand gesture recognition through the Camera was not accurate. Later the Cam shift method, contour algorithm using convex hull and so on were developed to increase the accuracy of gesture recognition through the camera.

Even the use of flex sensors[2] on a hand glove and the use of smart glasses[1] was done. In that model the shape of the hand which used the BSL and ISL. The outputs were produced in text format in a LCD screen and the Audio was shown using an APR9600 module. The Hand Gesture or the Hand Signs were converted to an electrical signal using the sensor. Those electrical signals were processed and they produced appropriate audio and textual output. The previously designed devices were not able to accurately trace the Hand Gestures. This was submitted by Vikram Sharma M, Vinay Kumar N, Shruti C Masaguppi and Suma MN on the title “Virtual talk for deaf, mute, blind and normal humans” at the Texas Instruments India Educators' Conference in 2013[3].

V. METHODLOGY

The methodology mentioned here can be done in two ways . The video capture technique by which the hand gestures are directly recognized by contour algorithm then immediately giving audio output in real time. The next method is to capture the gesture as the images for every second and they are compared with previously recorded images of the gestures , if the match occurs then the output is displayed or heard through the device.

ISSN: 0971-1260
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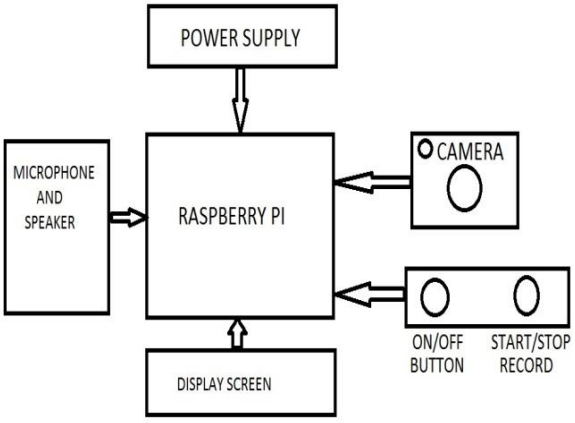

Figure 5: Circuit connection block diagram

In the first method the video is captured by the camera . The video of gesture which is in RGB (red, green, blue) graphics format is then converted to HSV (hue, saturation, value) [4] . The video which has the wide distribution of 1000s of pixels at an instant , where the each pixel may have different color of varied contrast and brightness . By the conversion of RGB to HSV of video , the noises formed due to the color difference between hand and surrounding environment that is captured are reduced . The average HSV value of pixels in the video is calculated and is applied to the video . Now the regions of different contrast and brightness is reduced and common contrast , brightness and color value is applied to the video and is maintained within a threshold value . As the result of conversion, the video that is captured becomes grey colored . The video is then blurred , to reduce the noises caused due to shadow regions on the palm . The contour algorithm is then applied to the resultant video , which then identifies and calculates the contour regions and defects in the hand that is recognized . Finally the calculated value represents output of the gesture , as it recognizes the gesture and gives audio and visual output .

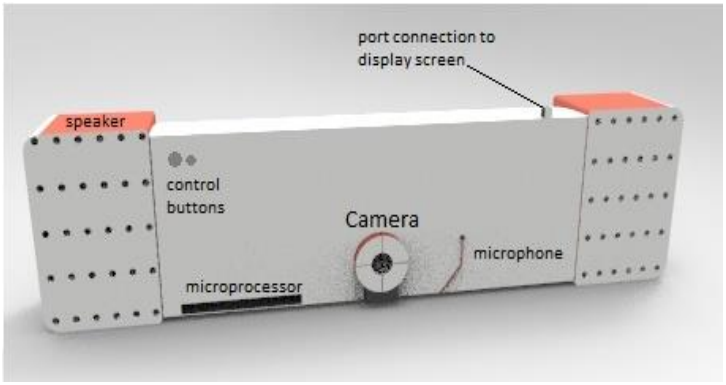

Figure 6: Prototype of the tutoring And communication device

VI. FUTURE SCOPE

In the future when the memory of the raspberry pi is improved this can be done in real time conditions with hand tracking system in the device being connected to the cloud memory along with face recognition of the users.

There will be a rapid decrease in the time lag between the Sign recognition and the conversion of the speech to text and sign to text or speech[6]. And the different sign languages used in different countries will also be implemented.

VII. CONCLUSION

The teachers and professors who are differently able will be able to teach with ease without any issues regarding the communication between the students and the teachers.

There will be a proliferation in the field of teaching and the number of students who will enroll themselves in school without the fear of any discrimination. This will improve the moral or both the teachers and the students.

ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

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