

Vision For Blind and Deaf: A Glove-Based Approach

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Abstract—The major problem that we see around us is the difficulty faced by blind or deaf people to recognize the object that is in front of them. If a person is only blind and can hear properly, then somebody can tell him what is in front of him, if a person can see but cannot hear, then someone can talk to the deaf person using sign language, but if the person is both blind and deaf then the person needs assistance of someone. Visually disabled people are dependent on the assistance of somebody to cross the road or to go around anywhere. This paper presents the implementation of a tool which helps both blind and deaf to identify any object nearby. The main aim of the project was to design a system or a device that operates automatically and can work as a human eye for the blind person and also helps the deaf person to know about the detected object using some sensing technology. There are mainly two goals basically the first one is “Object Detection” and another one is “Speech Recognition”.

Keywords— Image recognition, Voice detection, You only look once (YOLO).

1. INTRODUCTION

Millions of people live in this world with incapacities of understanding the environment due to visual impairment. Although they can develop alternative approaches to deal

with daily routines, they suffer from certain navigation difficulties as well as social awkwardness [1]. For example, it is very difficult for them to find a particular room in an unfamiliar environment. When a person is blind there are number of ways to make him know about the detection of object in front of him as by using the hearing sense to understand visual object. If the person is not blind but a deaf then he or she can see well but cannot converse, as they cannot hear what the person on the other side is saying. One can learn the sign language to understand the speech and otherwise can use machine to hear. There are recent advances with the help of which it is possible to give technological support to people with visual impairment during their movement [2]. This purpose of tool presented in this paper is twofold: Firstly, it will help the blind people in detection of any object; secondly it also acts as a speech recognition system that will help the hearing-impaired people to understand what is being told to them. Our project works for both blind as well as deaf people as we are using our project for object detection, speech processing into text and there is used of one language that is generally taught to the blind people

and deaf people that is braille language. Braille language is represented in the form of raised dots and people read and write it with the sense of touch. It has twenty-six distinct combinations for all the alphabets. It has combinations for punctuation marks also. People read it by their hands in the direction from left to right in each line. It needs the involvement of both the hands and all the fingers, but particularly index finger does the reading. An average person can read about 125 words in one minute, but the person who has fast reading skills is able to read 200 words in a minute [6].

The prominent part about it is that with the aid of this sensing language mainly deaf people and blinds can also read variety of reading materials be it, recreational, educational reading, financial statements and restaurant menus. With braille, blind people can also continue their hobbies and can enhance their inner talent by doing cultural enrichment with materials like music scores, hymnals, playing cards, and board games. Various solutions and methods were invented over the years to help blind people to read. However, most of them were enhanced versions of print letters. These braille codes will represent the actual output of our project. In our project, we have used a glove in which we will use 5 fingers + the top of hand to represent these 6 dots. We have fixed 6 motors at these 6 points so the bit wherever is 1 will make the motor vibrate and wherever bit is 0 the motor will not show any action.

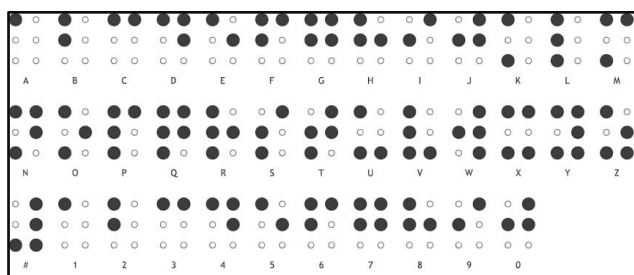


Figure 1: Braille codes

We have used Arduino in our project which will convert each character of the string into the signal and then signal is passed and to the motor and the motor will vibrate. The motors are connected into the ports of the Arduino. There is proper mechanism for the Arduino connection that is explained in the later section. We have used resistors for the purpose of power maintenance and the resistor color code that we have used is brown red brown and golden. The overall resistance that we are using is 100ohm with 5 percent of tolerance. The code that we have designed to

run this circuit is Python code that is of approx. hundred lines. Mainly the work is of libraries that need to be pre-installed in the laptop in the Anaconda distribution. Anaconda is the software that we are using and the code will be run on the “SPYDER” that is like a Python IDLE.

The central part of our project which is doing all the processing of the string into characters and then characters into certain codes is Arduino. The in-built architecture of Arduino has 14(0-13) digital pins where we have connected the 6 motors by leaving the gap of one port in between and there are 6 (A0-A5) Analog pins also. Other than this there is a GND(ground) button. There is one button known as Power LED indicator (11) which you can see on the circuit board, at the place where “UNO” button is there, next to it is LED one. After connecting Arduino with a power source, if green light comes there means the circuit is on and if not that means there is an issue to recheck. The heart of Arduino, the micro controller is at the number (13). It is responsible for the overall functionality of the chip. The voltage regulator (14) is basically used to control the flow of voltage. The voltage amount given to the Arduino board is controlled by voltage regulator to be over. It is used to limit the power. Do not try to do something with Arduino which is more than 20 volts. The number (10) represents RESET button. So, in case if Arduino is not working properly you can reset the chip configuration from here. The board needs to get connected with a power supply. The Arduino UNO will be on by connecting it through the USB. In the picture above the USB connection is labeled (1) and the barrel jack is labeled (2).

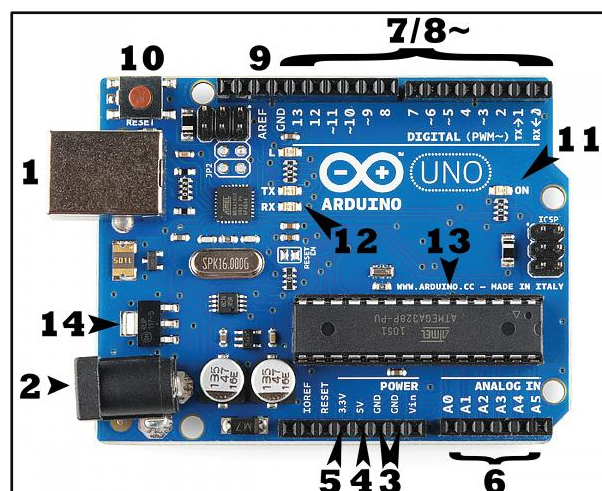


Figure 2: Arduino Circuit

The rest of the paper is divided as follows: Section 2 gives overview of the related work done by different researchers. Section 3 is about methods and techniques used for object detection and speech recognition. Section 4 gives result about the experiments done and section 5 is about conclusion and future work.

2. RELATED WORK

Many researchers have worked on facilitating the visually impaired and deaf people by implementing various tools and methods. Tool called EonTex Conductive Stretchable sensor was developed by [3] which is e-textile technology in which a sensor is in the form of a fabric. The sensor reads the analog signals for sensor reading process. Microcontrollers were used to read the analog signals along with sign language translator. Nanayakkara et al. [4] had implemented a system for visually impaired people. They have implemented a system in which detector is kept in the shoe of the user or tip of the walking cane. The system acted as a vibrator as a signaling element. Ultracane [5], a patented work was developed as a mobility aid. It is a smart stick for blind people which navigate them while walking. In traditional stick they tell you about obstacle which are near to your stick but they don't warn you about the obstacle which are at some height like in front of head or chest, so this stick was made considering all the cases where obstacles can be. It covers a wide range of area to look for obstacle. It has two buttons one let you know about the direction of object and other vibrates and the frequency of vibration let the user know the proximity of object. In [6] the researchers had presented an experimental system that does image-to-sound mapping while preserving the visual information. The system consisted of pipelined special purpose computers connected to a standard television camera. The input image resolution was 64X64 pixels with 16 gray-tones per picture. In [7], the authors have developed a smart system that served hearing and speech impaired persons. They have implemented a low cost wired interactive glove, which was interfaced with a computer running MATLAB or Octave. The glove mapped the hand gestures with the help of bend sensors. The authors in [8] have presented a result from different studies on screen reader used for visually impaired people. Y. Kawai and F. Tomita [9] have outlined the visual support system which provided the 3D visual information using 3D virtual sounds. Three-dimensional information included distance map, object detection, object tracking. The proposed system was expected to be useful in situation with less infrastructures. In [10] the authors have presented a prototype of a device that helped in

navigational information to the persons with visual impairment. They have used a portable glove, a computer and a camera. They have showed that the prototype performed well with minimized obstacle while identifying object by blind person

3. METHODS AND TECHNIQUES

For object detection, we have majorly used the backend libraries of machine learning. The major ones are Tensorflow, Keras, OpenCV and NumPy. We have written python code for the object detection and speech to text conversion. The hardware circuit is the prominent part of our project which has the connection of Arduino that will provide us the result that is objects detected or the speech in the form of text and then at last in the form of braille codes. The 6 dots of braille for each character is proposed with the 6 vibration motors that are attached on the glove and by wearing the glove one can feel the vibration of the motors and can find out the text. To run the code, we have used the utility called Anaconda distribution in which SPYDER IDLE is there for the code execution. The image captured will be detected for the objects present in it and then the output in the string form goes to braille and then the character by character Arduino will process the output in motors.

In our framework, the in-built camera of laptop is used for the video capturing and in-built microphone is used to record the voice of a person and then provide the text for it. There are two main functionalities involved, which are:

Object detection

Object detection is the process of finding real-world objects such as faces, building, furniture, things in images or videos. This algorithm typically uses pre classified features and learning algorithms to recognize the category of real-world object. It is commonly used in applications such as image classification, security purpose, surveillance, and automated vehicle parking systems.

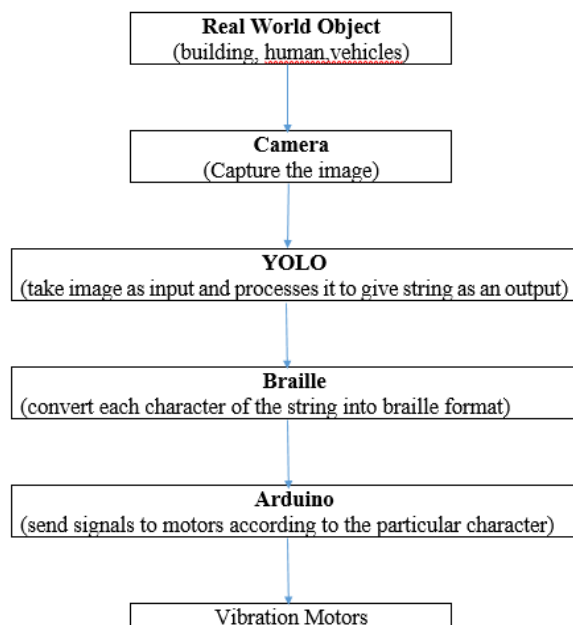


Figure 3: Flow chart

In this project object will be detected by following a step wise approach

STEP 1: IMAGE CAPTURIZARTION

This part involves the capturing of the video with a camera. In our case we are using the camera of the laptop and to on the camera we have set certain procedures which will take some input from user side and then on the Web camera and start capturing the video. This part constitutes the capturing of the image with the aid of web camera and then save that image at a particular location that is specified in the code. To save that image we need to press a particular key from the keyboard which will be input and its output will be that the image is saved. Every time when a new image is captured it will replace the old captured picture with the new one, that will the image will be overwritten. The name of the file we have specified in our project is “saved_img” and we have used the default location to save it inside the laptop and the default location is “C:/Users/hp/saved_img”.

STEP 2: BACKGROUND LIBRARIES RUN

After the image gets saved in the laptop, then the background processing will start in which the tensor flow library will do image tracking. It will track down all the objects present in the given image. The other assisting libraries here are Keras and OpenCV. This part includes the object provided as input to the machine and then the

output will be the detection of various objects which are present there in the picture. It will use the OpenCV library which means that there are trained models in the Machine learning which will help to recognize a particular object in the world.



Figure 4: Captured image (Single object detection)

```

Press Q for speech recognition
Image saved!
Using TensorFlow backend.
WARNING:tensorflow:From C:\Users\hp\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:4070: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From C:\Users\hp\Anaconda3\lib\site-packages\imageai\Detection\keras_retinanet\backend\tensorflow_backend.py:22: The name tf.image.resize_images is deprecated. Please use tf.image.resize instead.

tracking <tf.Variable 'Variable_0' shape=(9, 4) dtype=float32> anchors
tracking <tf.Variable 'Variable_1:0' shape=(9, 4) dtype=float32> anchors
tracking <tf.Variable 'Variable_2:0' shape=(9, 4) dtype=float32> anchors
tracking <tf.Variable 'Variable_3:0' shape=(9, 4) dtype=float32> anchors
tracking <tf.Variable 'Variable_4:0' shape=(9, 4) dtype=float32> anchors
WARNING:tensorflow:From C:\Users\hp\Anaconda3\lib\site-packages\imageai\Detection\keras_retinanet\backend\tensorflow_backend.py:46: add_dispatch_support.<locals>.wrappe (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
    
```

Figure 5: Image tracking

STEP 3: OBJECTS DETECTED

After the image gets tracked the object detection module will provide us the output in two parameters. One is the name of the object and second is percentage probability which means the accuracy to say that the given object is called tree or anything in the world. For instance, the upper image shows a cell phone so the output will be

```
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From C:\Users\hp\Anaconda3\lib\site-packages\keras\tensorflow_backend.py:422: The name tf.global_variables is deprecated. Use tf.compat.v1.global_variables instead.

detection: [{'name': 'cell phone', 'percentage_probability': 54.8, 'box_points': [266, 29, 535, 444]}]

cell phone : 54.82525825500488
Traceback (most recent call last):
  File "<ipython-input-1-a32f7d8d2c29>", line 155, in <module>
```

Figure 6: single object detected

STEP 4: BRAILLE CONVERSION

This string output will now be separated into characters using the braille and then as in braille there are different codes for different characters so the Arduino will process each character according to braille purpose. Just for demonstration purpose we earlier used the LEDs for the substitution of motors to see the output as for character “c” the code is “100100” so where the bit is 1 the motor will vibrate and where the bit is 0 the motor won’t. Similarly, for the bit on, light glows else not. Motors configured according to Arduino ports as:

Table-1: Port configuration

MOTORS	PORT NUMBERS
Vibration Motor 1	Port Number 12
Vibration Motor 2	Port Number 10
Vibration Motor 3	Port Number 8
Vibration Motor 4	Port Number 6
Vibration Motor 5	Port Number 4
Vibration Motor 6	Port Number 2

The output in braille codes for the text “cell phone” is shown in the given picture. Vertically the first line shows the code for c:100100 and then second vertical is for e:100010 and last one for l:111000. Similarly, the codes for other alphabets will also be shown in this manner only.

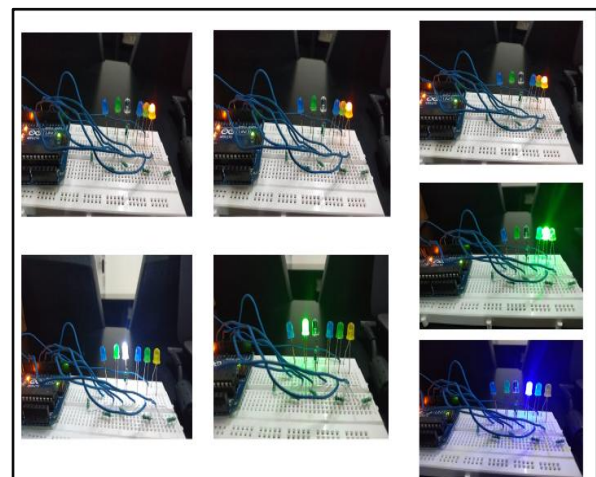


Figure 7: Braille output for “cel”

Speech Recognition

Have you ever thought about adding speech recognition to your Python project? It is really easy to implement. The high success of speech-enabled products like Amazon Alexa has proven that some degree of speech support will be a prominent aspect of household technology for the upcoming future. To embed speech recognition into your Python application offers a level of interactivity and accessibility that few technologies can match. The accessibility improvements alone are worth considering. Speech recognition assist the elderly and the physically and visually impaired to interact with the people and converse without GUI need. Whatever the person in front of you will say, the deaf person can understand it by the braille codes. First the speech will be converted to text and then text to braille output. The requirement is about converting the speech into text. We have designed it by using the Google API and we will also require internet to process the same. We are using the in-built microphone of the laptop to fetch the speech. The major library which is assisting this module is speech recognition and at the time of voice recording Pyaudio will be used and after the system has listened and the voice is recorded then the Google API will process it using the “recognize_google()” function in which the recorded audio will be passed as a parameter. Then the output will be displayed on the console in the text format.

STEP 1: SPEECH TO TEXT

Figure 8 say something will allow the user to speak, for that purpose we are using the in-built microphone of

laptop and then processing will do the background processing of “speech recognition” library which converts speech to text and then the output will be displayed.

```

.... print("Press W for image recognition")
.... print("Press Q for speech recognition")
Press W for image recognition
Press Q for speech recognition
Say something
Processing.....
I think you said:
hello hello
Press W for image recognition
Press Q for speech recognition
Say something
Processing.....
Press W for image recognition
Press Q for speech recognition
Say something
Processing.....
I think you said:
this is me
Press W for image recognition
Press Q for speech recognition

```

Figure 8: Speech to text conversion

STEP 2: TEXT TO BRAILLE

In this similarly as in object detection whatever the text is there it will be processed into braille codes per character and then the Arduino will convert the codes into signals and the signals will be shown in the form of vibration using motors. The configuration of motors according to hand fingers are as follows:

Table-2 : Design notations

PART OF HAND	MOTOR (BRAILLE DOT NO.)
LITTLE FINGER	DOT NO. 6
RING FINGER	DOT NO. 5
MIDDLE FINGER	DOT NO. 4
INDEX FINGER	DOT NO. 3
THUMB	DOT NO. 2
TOP OF THE HAND	DOT NO. 1

4. RESULTS AND DISCUSSIONS

Final Implementation

To implement this project, we need to run a software code that will operate the hardware circuit. The utility that we use to run the code is “SPYDER” which is like the Python IDLE platform. We will write the code in the spyder and it will start connecting to the Kernel.

Basically we our code we have mostly used the in-built functions, libraries and packages that will imported one by one and implement the code. The main motive of this project is object detection and to make the person understand about that object we have taken the help of Braille language and to represent 6 dots of braille we have used 6 motors.

We have taken a glove in which we have fitted 5 motors at 5 fingers and the motor no. 6 is at the top of the hand. The motors are attached to the circuit using the wires. Wherever the bit is 1 the motor will vibrate and wherever the bit is 0 there is no vibration. By feeling that vibration, the person will understand the string of the object detected.

STEP 1: Kernel will get connected and code starts to run and provides option to choose the module.

STEP 2: Web Camera start reading the image and also save the image at default set location.

STEP 2.1: “W” is pressed and Web Camera is On

STEP 2.2: “S” is pressed and Image is Saved

STEP 3: Libraries start importing and will work at the backend

STEP 4: Object present in the image gets detected and represented in string format

STEP 5: Braille code will convert the string into characters and process the character into braille codes

As the output which is coming here is tv. So for t the braille code is ‘011110’ and v is ‘111001’. Where the bit is 1 the motor will vibrate and where the bit is 0 the motor will not vibrate.

STEP 6: Arduino will send signals to vibration motors to represent the 6-bit braille codes.

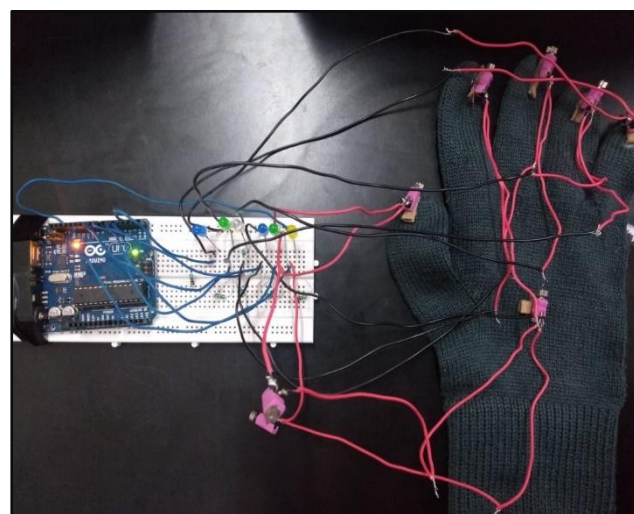


Figure 9: Final circuit

5. CONCLUSION AND FUTURE WORK

This paper provides a new approach that can help people to deal with both the possibilities be it blindness and deafness. The project part that has designed is a kind of prototype that needs to be refurbished into the product as I have explained in the final working system. Then it will work as a real time device or gadget which provides vision to the blinds and hearing sense to the deaf.

The main features of this project is the libraries that are running at background and the Arduino which is the main part to process the output in the braille format.

We are planning to deploy our whole model in Cloud and then can process it then and there and for camera be will be using a small camera with microphone just like we have in smart watches and bands so as to take images of surrounding and record audio. so these thing will remove the need of the laptop but we still have to somehow give input string to our Arduino so that it can vibrate the motors accordingly for that we can either use a small Arduino kit and can attach in the glove or can use microprocessor and fit it into the smartwatch or band and will connect it with motors on glove. So, what we are left with is a simple hand glove with a smartwatch or band attached with glove itself on wrist side and that will be connected to cloud. Moreover, to improve the quality and efficiency of our model we will store audio and images in database for better user experience. so even if the device is broken or lost or malfunctioned then that stored data will help the user to get all his details back from database and we will also let our model train itself with all the data it is getting for better results, by considering in mind that it does not undergo overfitting.

First whenever we will give that device to an user first we will input some details on that device like: name of the person, type of disability, like if a person is blind then he needs camera only or if a person is deaf then he just needs voice module only then our system will activate only those modules which are needed by user, then our camera will capture images of surrounding and voice modulator will record audio and will send that to cloud which will process those inputs and will send converted signals to smartwatch/band which then will vibrate the motors accordingly. And as the motors and Arduino need less power to operate so our system's battery will also be able to last long in single charge similar to that of smartwatches.

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