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Vijayank-A Smart Spectacle for Differently Abled People

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Abstract

In the world full of growing technologies and innovative ideas there are some disabled people like a deaf, dumb and blind who are facing different problems in their daily lives.Blind people have difficulty to avoid obstacles. Deaf and Dumb people are fighting for finding an innovative way that can make communication easier for them.In this paper, we are introducing a new system-proto VIJAYANK(Spectacle device) to assist differently-abled people. The VIJAYANK spectacle device will make use of the Wearable Technology which consist of an ultrasonic sensor, IR sensor, flex sensor, camera(To record gestures) and buzzer/speaker, Texas Instrumentation Circuitry, APR9600 audio recorder(For DEAF) and concepts of computer vision and machine learning to detect the obstacle(FOR BLIND)and to record the gestures (FOR DUMB). Deaf people able to communicate by using the speech recognition module and LCD. All these are included in one device so that this device is useful in the communication of the people suffering from any of the possible combinations of Blindness, Deafness, and Dumbness. In this paper, we will be proposing a new idea that could sever all the problems faced by the handicapped and also fulfil the voids to greater heights.

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1. Introduction

Technology has incredibly brought together a world full of creativity and ideas. With the advancement of technology, human life has become easy and very much efficient. As a result, now we can get any piece of information from the corners of the globe in just a fraction of minutes or even seconds via the internet *or* we can reach out to our friends and relatives even if they are more than a thousand miles away through smartphones and telecoms. Technology can be termed as something which reduces human efforts and gives back a better-expected output/result [1]. But even in this developing world of technology, some people are struggling to live their daily lives fully because of their incapability to do so. These people are physically challenged, who endure a feeling of disqualification from society and this is also a matter of utmost importance which should never be overlooked.

According to world health organization reports, around 1 billion people or 15% of the world's population, suffer from a disability. Among them, approximately 285 million are visually impaired, 300 million are having hearing problems and 1 million are dumb and many more suffering from one or more of the above mentioned physical disabilities[2]. But any creative ideas to help these people with disabilities are only taken on marginal grounds Although there have been some advancements on both social and technological grounds for the disabled there still exist larger voids to be accomplished.

In this paper, we will be proposing a new idea that could sever all the problems faced by the handicapped and also fulfil the voids to greater heights.

Communication is one the most elementary aspect of human life for understanding and exchanging information

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is considerably difficult for the people with disabilities especially who are deaf, dumb and blind. The main objective is to create an instrument that could help people suffering from one or more disabilities. And that's where our concept comes in.

The main aim of this paper is to pass over the break-in communication and bring forward some technology that can help out the people who are suffering from Blindness or Deafness or Dumbness or any combination of these three. Here we have put forward the proposal for a new instrument called the VIJAYANK which can help in solving the above-mentioned problem.

Our project makes use of Wearable Glass; this smart gadget is built on human interaction with the world through the Android operating system. Wearable computer with the optical head-mounted display (abbreviated as OHMD) has been developing by Google [6]. It is like a compact computer inside a pair of Glasses. Glass is equipped with a camera, speaker, display system, microphone and a touchpad as mentioned in [7], to this we are planning to add Sensors [8] for 270° Degree Obstacle Detection [9],[10], which would help the blind for navigation and ease of movements and also Smart System which would constantly store the accumulated data gathered by its momentary operation and then evaluates this information before taking any further action

Henceforth, the paper is standardized into the following sections; section 2 comprises the Related work, section 3 comprise the Propose System and section 4 gives the information on result and output and finally, we close our paper with the conclusion in section 5.

2. Related Work

In the past, many techniques have been used for helping differently-abled people. However, they were many limited.

PAPER REFERENCE	ADVANTAGES	DRAWBACK
Google Glass Used as Assistive Technology Its Utilization for Blind and Visually Impaired People [7]	This proposed system uses google glass for helping visually impaired people. The author's data shows that the tested application is focused on two main functionalities: the first one is navigation and the second deals with the recognition of 30 different objects, which are mainly addressed as obstacles for visually impaired people.	This device can't detect the speed and direction of the movement of obstacles. This device needs to improve the recognition process of the obstacles in larger participants sample with a focus on obstacles like pylons (99%) and trees/bushes (95%) and their various forms.
SMART NAVIGATION SYSTEM FOR VISUALLY CHALLENGED PEOPLE Sep.-2016 [12]	This proposed system uses US sensor-based spectacles, belt, and shoes to detect obstacles from head level to ground level and also to detect pits in-ground as well as downwards steps, these three devices are lightweight wearable devices, which makes the system easy to carry. The proposed system is a low cost, which is a significant factor because 90 percent of the visually impaired in the world lead their life in low income.	The walking speed of the new users of the system will be less awkwardness and hassle in handling and wearing these belts and shoes.
Hand Gesture Detection and Conversion to Speech and Text [13]	The strategy proposed in this paper makes utilization of a web cam through which hand gestures gave by the user are captured and identified accordingly. In this solution hand gesture to speech and text conversion has been used using human-computer-interaction to facilitate the reduction of hardware components	It focuses only on the American alphabets that means it can convert gestures of English alphabets only not even Hindi words This system requires a computer or webcam so it may not be portable and useful in the outside world.
Design and Implementation of Text To Speech Conversion for Visually Impaired People. [14]	This technology that lets computer speak to you. The TTS system gets the text as the input Text-to-speech synthesizer converts inputted text into synthesized speech and reads out to the user which can then be saved as a mp3.file. Text to speech synthesizer will be of great help to people with visual impairment and make making through a large volume of text easier.	Text to speech technology is not more accessible to a wider range because only American English can be converted by this.
Communication Assistant for Deaf, Dumb and Blind September 2019 [15]	This paper effectively produces a portable device to expel the hindrance of communication between deaf-dumb & blind. It has Braille terminal, Braille (material) display for blind and camera which will record the gestures and convert to text and speech.	This device can't communicate over a long distance. This device is always needed to carry in hand which may bother disable people.

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Many techniques required gloves, belts, and shoes with sensors which not only made the application more complex but also expensive. Additionally, there were some systems for detections which required the object to be of particular skin color. This spectacle device overcomes all of the above disadvantages i.e. this device can detect obstacle with their speed, It focuses not only on the American alphabets but also all the local languages of India

3. Proposed Method

In this proposed method we use an embedded system which consists of Pyroelectric IR sensor (Dual-Element Pyro detector), HC-SR04 ultrasonic sensors, APR9600 audio recording, speaker, capacitive touchpad controller, playbackflash memory, microcontroller, lithium battery, inertial sensors, Ambient world shooting/camera & proximity sensor, display chip (native resolution =640X360), a prism with Half-silvered mirror, mini-projector(LED array). Three ultrasonic sensors are placed on the device (left, center and right of the device) and two Pyroelectric IR sensors are placed at the front and back of the device which will detect the obstacle with its motion direction and speed.

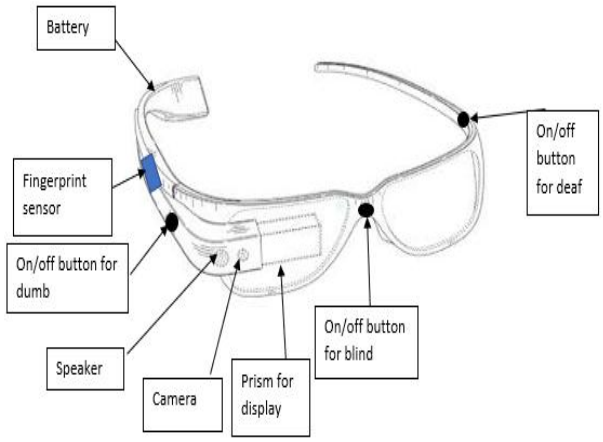

Figure 1: Outline/sketch of spectacle

The US and Pyroelectric sensors placed at the front left and right of spectacles discover the obstacles from ground level to go level and field of view of about 270 degrees. These sensors collect information regarding the obstacles and right-left sensors detect the motion and speed of obstacles and send it to the microcontroller, the microcontroller processes the information and invokes the relevant speech supported the information, that was kept in non-volatile storage(flash memory). Similarly, Pyroelectric sensors at the rear of the device detect the obstacles and its speech and motion of direction, so that if any object is moving against the direction of the users, the alert alarm won't be invoked

The equation for the distance calculation between the device and the object is:-

Distance = (Speed of sound(in cm/s) * time of pulse width)/2

Below figure shows the proposed systems of the device:-

Figure 2: Proposed model of the device

Algorithm 1: Algorithm for speech to text conversion:-

Input: Speech/voice of the person trying to communicate with a deaf person;

Output: Text form of speech is displayed on the glasses**;**

Description:

1. Switch on the recorder using the on/off button for the deaf.
2.Record speech (range of about 1m).
3. Remove noise.
4.Calculate MFCCs. *(Definition - 1)*
5. Match with the speech database that involves the Viterbi search algorithm(The algorithm has found universal application in decoding the convolutional codes).
6. If speech doesn't match then again it will record with an alert that "record speech again" else speech gets convert into Text and gets stored in display chip.

Algorithm 2: Algorithm for gestures to text & speech conversions:-

This proposal has been developed using a properly designed and user-friendly interface i.e, OpenCV which mainly aimed at real-time computer vision.

Input: gestures of hands(of dump person);

Output: Speech (converted from gestures) ;

Description:

1.Switch on the camera for recording
2.Record gestures of hand(of dumb person).
3. Recorded gestures are uploaded to the cloud. The image of the hand is regenerate into a binary image(monochromatic image). OpenCV library is employed for this conversion.
4. Find contour of the image which determines the edge of the object (using find contour() in OpenCV) *(Definition - 2)*

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5. Calculate Convexity Defects to find out the number of fingers which later is used to identify the letter. *(Definition – 3)*
6. Identify the letters based on the angles. Based on Table - 1.
7.Convert text to speech (using algorithm – 3)

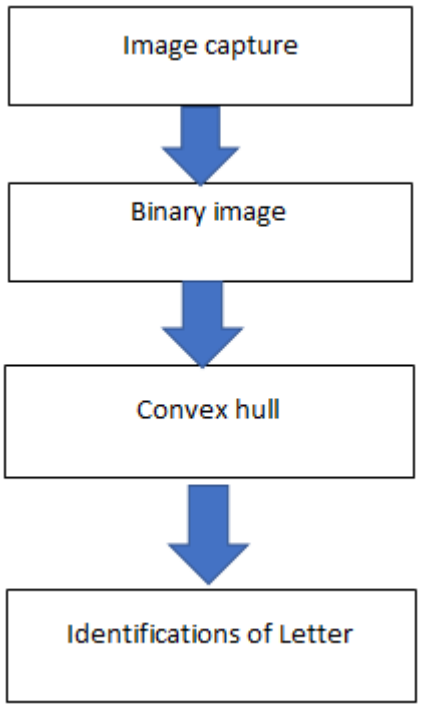

Figure 3: Flow chart of gestures to text conversion

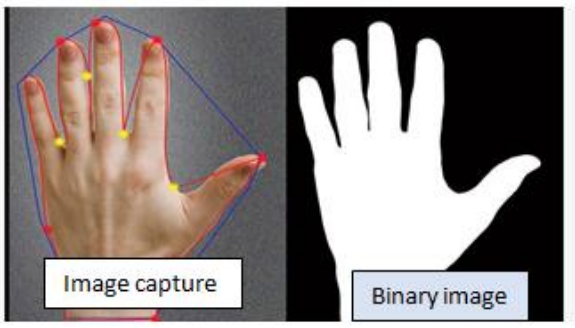

Figure 4: Image to binary conversion

Algorithm 3: Algorithm for text to speech conversions:-
Input: Text file;
Output: Converted audio file is played;
Description:
1. create a directory of letters and words identified.
2. Create a .txt file containing the alphabet or words.
3. Write a shell script that works into the directory to seek out the most recent changed file.
4. After finding the file, the corresponding audio file is played using the script.

Definitions & Formulas

Definition – 1:
Mel Frequency Cepstral Constant (MFCC) is a feature wide utilized in automatic speech and speaker recognition. The steps of Mel frequency Cepstral Coefficients calculation are–framing, windowing, Discrete Fourier Transform (DFT), Mel frequency filtering, logarithmic function and Discrete Cosine Transform (DCT).

Definition – 2:
OpenCV has to find a contour() function that helps in extracting the contours from the image. The function will return the set of coordinates of contours which will help in drawing the complete shape. Finding the define conjointly helps in deciding the assorted contour properties that area unit necessary for the identification of letters.

Definition – 3:
Convexity could be a house or hole in Associate in a Nursing object which suggests a district that doesn't belong to the item however situated within its periphery-**convex** hull. The formula for calculating Convexity Defects

We register a triangle offer the edges an opportunity to be a, b and c.This triangle is formed by the start stage of the form, the consummation purpose of the form and the most remote purpose of the shape. (a, b, c separately). "a" is computed as follows

a = math.sqrt((end[0] - start[0])**2 + (end[1] - start[1])**2)
b = math.sqrt((far[0] - start[0])**2 + (far[1] - start[1])**2)
c = math.sqrt((end[0] - far[0])**2 + (end[1] – far[1])**2)

Now, using the Cosine rule ,
cos(A) = (b2 + c2 − a2)/ 2bc
cos(B) = (a2 + c2 − b2)/ 2ac
cos(C) = (a2 + b2 − c2)/ 2ab
Angle A is calculated.

Table 1: Alphabet and its identification angle

ALPHABET	IDENTIFICATION ANGLE
A	In the case of alphabet A solely there's a very little distinction betweenthe space of a circle and also the area of the contour.
B	compute the contour area as it has the largest area among other alphabets.

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C	40-60 DEGREE
D	LESS THAN 20 DEGREE
F AND W	BOTH HAVE two convexity defects then we compare the angle.

It may also determine the Hindi alphabets most of the native languages of the Asian nation.

4. Result

There are three programs for blind, deaf and dumb each.

Visually Impaired: The people who cannot see can simply communicate with the outside world and detect the obstacles. Using this device, a person can get an alert sound through the speaker.

Hearing Impaired: Deaf people can make use of this system to communicate. The device will convert speech of person into a text message which is further displayed through mini projector and prism.

Speech Impaired: The people who cannot speak can simply communicate with the outside world with the help of sign language. Using the hand gestures, the device can convert it to speech which will be returned through the speaker.

This device issimply aguidance device and it doesn't do anything on its own however just guides visually handicapped person a way to traverse.This device is secured as this device containsa fingerprint sensor in it. This device could be a great toolin banishing the barrier of disabilities in the communication of the people suffering from any of the possible combinations of Blindness, Deafness, and Dumbness.

The test results for the three kinds of people are as follows

Blind: As per the tests on blind people the error percentage versus the distance is shown in the below graph. The graph explains that the error decreases as the distance between the person and the obstacle increases. If the obstacle is just near to the person the approximate distance calculated will be not much accurate then the obstacle in the range of 1meter. In comparison to the historically accessible devices, this device is much efficient because the proportion is way lesser than the error proportion in the ancient device. After all, this device has an ultrasonic sensor and IR sensor which are more stronger.

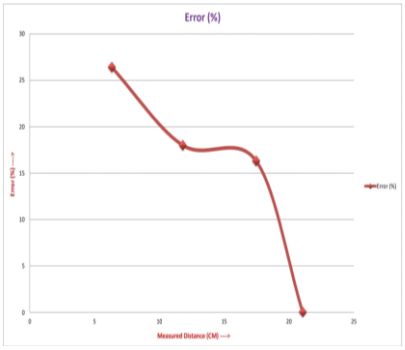
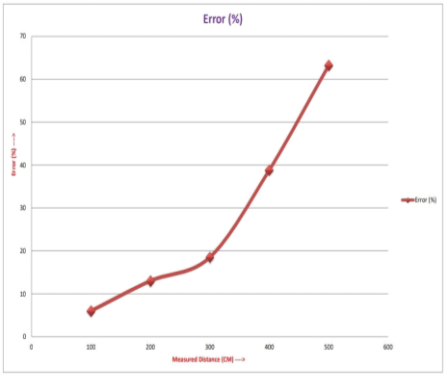


Figure 5:Error percentage vs measured distance(FOR BLIND)

Deaf-As per the tests on deaf people the error percentage versus the distance is shown in the below graph. The graph explains that the error percentage is less when the distance is less and the error percentage increases as the distance increase because if the distance increases the unwanted sound also gets captured in the device which may lead to error.



when compared to the traditional devices the success rate for this device is more as shown in the below graph

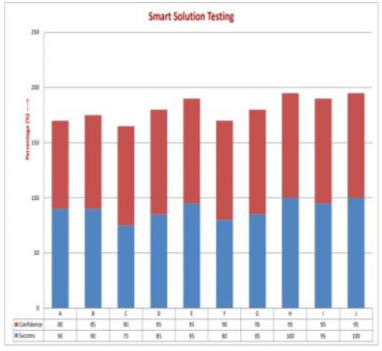


Figure 6: Success & Confidence percentage (FOR DEAF) in analyzing and understanding speech

Dumb-As per the tests on dumb people the error percentage versus the distance is shown in the below graph. The graph explains that the error is more at the minimum distance and the maximum distance between

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hands and the person and the error is less at the medium distance between the person and the hands i.e., if the hand is too much closure(10cm) or too much far(90cm) from the device then the error percentage will be more because it can not capture the gestures properly whereas if the hands are in the range of 25 to 30 cm it will record the gestures properly and we will get the output as needed. In this case, there is no existing device to compare the error percentage.

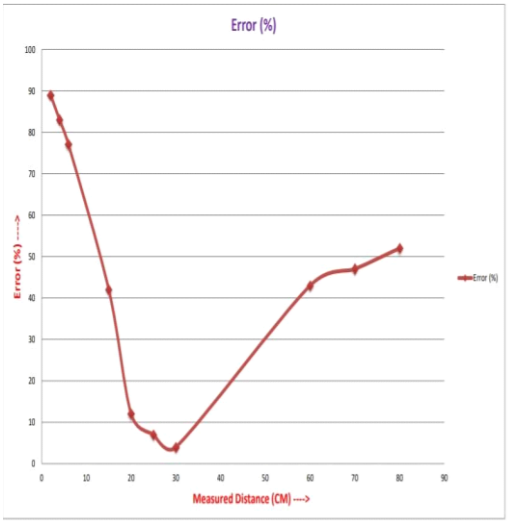

Figure 7: Error percentage vs measured distance(FOR DUMB)

5. Conclusion

Deaf, dumb and blind people have difficulties in interacting with the world, so they need assistance of somebody. This model enables them to have an increasingly normal life and be progressively self-sufficient. The "Spectacle device (Vijayank) for Blind, Deaf and Dumb people" is practically a feasible and stylish device and can be conveniently carried by any disabled person.

The person can communicate and transfer the message as per his ability and desire. This device supports all the regional languages so that it is helpful for all the illiterates and the rural people. Visually impaired can walk easily as obstacles on their ways are discover by this device. Also, the proposed system is low cost, which is a significant factor because 90 percent of the physically disable in the world lead their life in low income [16]. On the whole, the solution aims to provide aid to those in need thus ensuring social relevance. In future, we plan to make this device helps in capturing the route inside the house so that the blind person can stay alone at home and move inside the home from one room to another without any support. Also we will try to make conversion process of gestures to speech, faster. We look forward to facilitate rich interactive features which would enable the user to interact and take portability to the next level.

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