Smart Eye for Visually Impaired-An aid to help the blind people

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***Abstract*—This paper presents an idea of developing a smart system which can assist the visually impaired people in their daily activities. Actually, there are many challenges faced by visually impaired people. In most cases, they require constant support in almost all scenarios especially in their day to day activities. Some of the major challenges include difficulty in moving from one place to another without the assistance of someone. Other challenges include difficulty in recognizing people, detecting obstacles, etc. In order to count avert this situation, we propose a "smart eye system" in this work. The device is a voice enabled system that would direct the visually challenged person in their day to day works. The device combines the various available technologies and integrates them into a single multipurpose device that can be used by the visually impaired. The paper discusses about the design of such a system and the challenges involved in designing the device.**

Keywords*—*face recognition, obstacle detection, route navigation, sensors, voice commands, visually impaired

I. Introduction

The number of visually impaired is so large that it has a huge impact on the economy of the country. In fact in this busy world, common man doesn't have time to even look at these differently able ones. Thus, the visually impaired people constantly require the support of someone in their daily works, especially while on roads. Most often these people are considered a burden by others while some just ignore their presence and leave them to care for themselves all alone. This creates a feel of loneliness in them. This concept of being dependant on someone creates a feeling of demotivation and loss of self –confidence in some cases as well.

Some of the major challenges include difficulty in moving from one place to another without the assistance of someone. Other challenges include difficulty in recognizing people, detecting obstacles on their way and so on. Some devices available in the market help them to overcome a few of these challenges. There is always a huge number of researches involved with the sole aim of building devices to help these visually challenged people. Thus, there arises a need for building a system or device which could aid the visually impaired in all their activities. As mentioned above, the visually impaired need to be extra careful while on roads and a Global Positioning System (GPS) enabled with obstacles detection would come handy in such situations.

It also becomes difficult for the blind to recognize a person. Usually, blind identify people based on their voice. This is always not effective as it might be difficult for the blind to recognize the voice of the person who had not been in touch for a long time. Thus, a device to help identify known people becomes necessary. This issue can be resolved by using face detection algorithms. Face recognition is one of the most relevant applications of image analysis. The true challenge here is to build a system that could integrate all these and work as an eye for the visually impaired. Hence, the objective of this work is to aid the visually impaired in their day to day activities like moving from one place to another and identification of persons.

II. Related Works

Visually challenged persons face hurdles in walking and navigation. Various walking sticks and canes are available in the market for the navigation purpose. It all started with simple walking cane which then evolved to become smart walking stick with obstacle detection using Infra Red (IR) or Ultra Violet (UV) sensors. This section explains about the existing approaches that are required to help the blind people to identify locations and help them to live an independent life.

Sangami et al describes a walking cane which detects obstacles on the way using IR sensors and issues a buzzer sound as warning. The white cane can only be used to detect obstacles up to knee-level within a limited range of 2-3 feet. The major drawback is that the buzzer sound can be unheard of in the traffic sounds on the roads [1]. In addition to that Chaitrali et al proposed a navigation device uses voice output for .issuing warnings when obstacles are detected. Here, obstacles are detected with a help of IR sensors and Radio Frequency Identification (RFID) technology. This device is connected to an android phone through Bluetooth. An android application is designed which gives voice navigation

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based on RFID tags read and also updates person's location information on the server. Moreover, one more application is designed for family members to access the blind person's location through the server whenever needed [2].

Dambhare and Sakhare proposed a device which has GPS (Global positioning system) for route navigation which is interfaced with the microcontroller and issues the warnings through voice commands. The device also acts as an artificial vision system to some extent [3]. In [4] and [5], this system is also designed as a vision substitute device for the visually impaired. It captures the video in front of the person and converts it into frame for enhanced visual sight. The processing is done with help of Matlab.

Smart guiding glasses have been proposed to guide the visually impaired people. Augmented Reality (AR) has been used to guide people with weak vision and auditory cues have been used to guide totally blind people in [8]. Zhou et al. developed a robust smart application using powerful mobile smart phone and smart sensors, to accurately detect objects up to ten feet away, and give interactive audible information about the objects in proximity [9]. A prototype of a shrewd glass to describe the live scenario whenever needed has been proposed to help the visually impaired in [10]. Maiti et al have proposed a electronic eye to give walking instructions for blind and poor visioned people, using image and obstacle sensors embedded in helmet [11].

The various issues in the existing system are no continuous Internet connectivity, sometimes Android and smart phone usage is not preferred by people. Many people also feel uncomfortable using the stick as it trends to disturb others around them. Almost all the devices available solve only one aspect of the issues faced by the blind whereas the proposed smart eye aims to resolve multiple issues. Wearable devices in the form of watches and belts are also in the developing stages.

The above research works carried out in this domain, very clearly shows that there is a wide scope for the useful contributions in route navigation, person identification etc., for guiding visually impaired persons.

III. WORKING OF SMART EYE

Any device aimed at assisting the visually challenged should be handy and easy to use. There is also a need for voice to text as well as text to voice convertors [6]-[7]. This should also be independent of touch screens as they are commonly used in android systems. Therefore, building a system with above constrains is a real time challenge.

The aim here is therefore to build a system that is compatible in all aspects as well as provides scope for extension in future. The various technologies used to ensure these factors include image processing and embedded technology. The system includes voice enabled route navigation (GPS based) system with obstacle detection, image processing to identify persons with no need of Internet connectivity and it is not based on android features.

A. Methodology

The smart eye consists of Raspberry Pi as the microcontroller with camera, sensors headphones and other sub components connected to it. The design of the system is described as given in Fig. 1. The various components like camera, Global Positioning System (GPS) module, Infra Red (IR) sensor and Light Dependent Resistor (LDR) kit need to be interfaced with the Raspberry Pi for the effective functioning of the device. All the components are connected via General Purpose Input Output (GPIO) pins. It also has a slot in which 16GB Secured Digital (SD) card is inserted to store data.

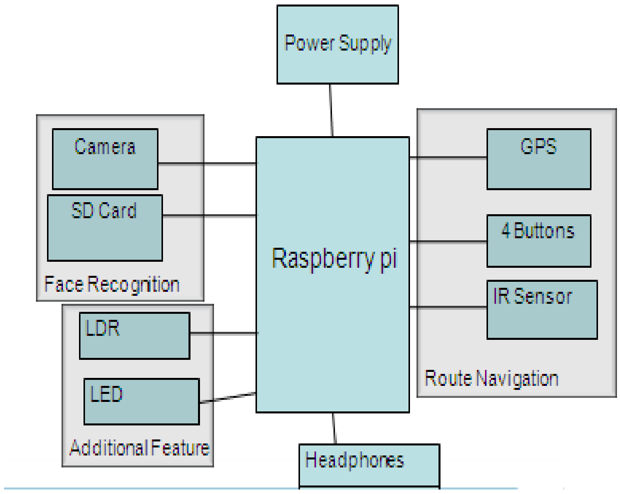

Fig. 1. Design of smart eye device.

B. Raspberry Pi with GPS Module

It is necessary to interface the Global Positioning System (GPS) module and Raspberry Pi to ensure proper tracing of the location. The Raspberry Pi uses the values of latitude and longitude obtained from the GPS module antenna. The GPS module is interfaced with the microcontroller and then a separate power connection is given to GPS module. The GPS module is interfaced using GPIO pins.

C. Raspberry Pi with Camera

The camera is used to take pictures (20 different images) of the person before the webcam. These are stored in the Raspberry Pi's SD card and then used for recognition. The fswebcam package is installed to interface the camera with Pi. The captured images are processed using Open Source Computer Vision (OpenCV) which is a library of programming functions mainly aimed at real-time computer vision.

D. Raspberry Pi with LDR

The light dependent resistor or also known as the LDR sensor is used to detect if it is dark or light. In the light, this sensor will have a resistance of only a few hundred Ohms, while in the dark it can have a resistance of several Mega Ohms. The capacitor in our circuit acts like a battery charging up whilst receiving power and then discharging when no longer receiving power. The connection is established using GPIO pins.

The major problem here is that the python codes use digital values but the resistance is measured continuously. We will be measuring the time it takes for the capacitor to charge and send the pin high. This is an easy but inaccurate way of telling whether it is light or dark. The pin number used to establish connection should be manually specified here. The Raspberry Pi receives information from the LDR kit and gives the warning when it becomes dark.

E. Raspberry Pi with IR Sensor Module

Here, a Passive Infrared (PIR) motion sensor is used. This motion sensor consists of a Fresnel lens, an infrared detector, and supporting detection circuitry. The lens on the sensor focuses any infrared radiation present around it toward the infrared detector. Our bodies generate infrared heat, and as a result, this heat is picked up by the motion sensor. The sensor outputs a 5V signal for a period of one minute as soon as it detects the presence of an object. It offers a tentative range of detection of about 6-7 meters and is highly sensitive. When the PIR motion sensor detects an object, it outputs a 5V signal to the Raspberry Pi through its GPIO and the Raspberry Pi is coded to output a voice message saying obstacles detected. The device consists of a camera and a hand held device as shown in Fig. 2.

Fig. 2. Implementation of system.

F. Working of Smart Eye

The test bed of the proposed smart eye is shown in Fig. 3.

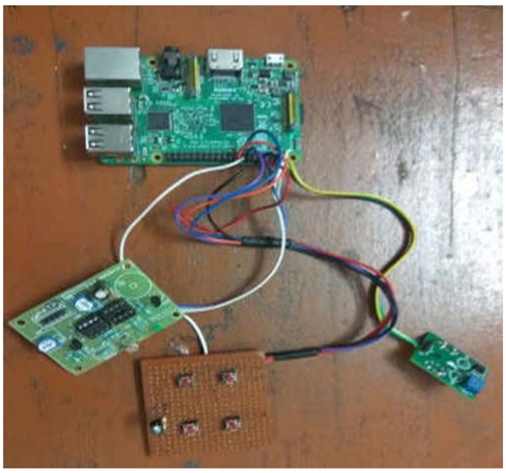

Fig. 3. Test bed.

The entire system can be divided into two simple subsystems namely route navigation and the other one is the face detection and recognition. The navigation module also includes the obstacle detection system. The device guides the person to the pre-stored destination whose path is stored. The user can choose the destination with the help of buttons. The system is provided with 4 buttons using which the user can select his/her desired location and then the navigation route for these locations are given as voice command using headphones. Fig. 4 shows the destination buttons.

1) Route navigation: The GPS captures the current location of user and then checks if the destination is valid or not. If the destination is a valid one, then the path to reach that destination is actually given in form of voice commands. The GPS continuously keeps track of the latitude and longitude values while guiding the user. The voice commands are very simple and easily understandable. The headphones are used to give all the commands, like the desired navigation route and alert the user if there is any obstacle in the way.

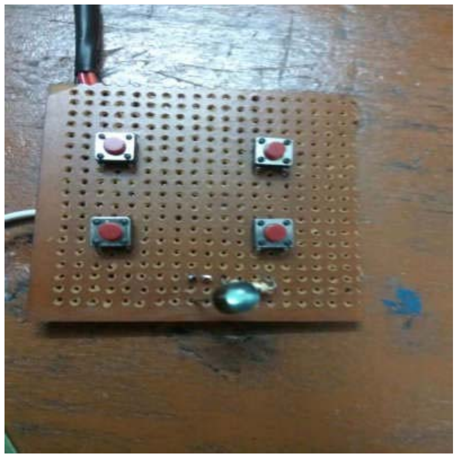

Fig. 4. Destination buttons.

2) Face detection and recognition: The face detection and recognition module uses the camera to capture the images of the face of the person in front of the user and store them in the SD card, the storage card within the microcontroller. The camera is fixed on the shirt collar of the user. The web camera has three lights that automatically switch on in the dark. It also has 16 special effects and 10 backgrounds frames. For efficiency purpose, the camera captures 20 images of the face and these are stored along with the person name. This is manually done before the device can be put into practical use. If the same person comes in front of the user again then the camera captures the image and compares it with the previously stored images and if a match if found, the corresponding name of the person is read out. No voice output is made in case no match is found. The image capture and processing is done with the help of OpenCV software.

3) Additional Feature: To increase the capability of the system, the device also has LRD circuit connected to a Light Emitting Diode (LED). When the light falling on the LDR goes below a certain threshold value, then the LED starts to glow. A warning regarding the same is also given as voice command. This can be used by other people to identify the visually impaired during low light, that is during night time. This is mainly for the safety reasons. This is the significance

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of our proposed work in comparison with other existing works.

IV. Experimental Results

In order to activate the components connected to Raspberry Pi, sudo python blindapp.py command is issued. Once the GPS is enabled, it prints the latitude and longitude present in the default text file. Here, the default location file is set as Home.txt.

When the user chooses a destination using the buttons as shown in Fig. 4, a voice confirmation for the same is given to ensure that the user has chosen the desired destination only. For image training, the device is trained to store images of the person using the command sudo python train.py filename.

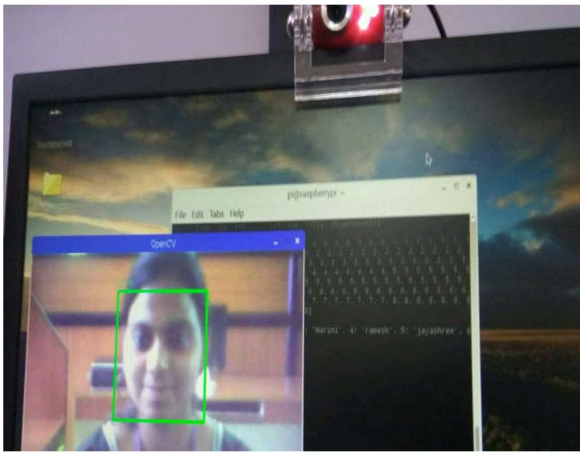

Fig. 5. Image captured for training the device.

The captured images of 20 samples for the person are saved in a folder for future comparison. The image comparison and recognition is done using the following command: python face_detect.py.

Fig. 6. shows the screenshot of the image correctly recognized.

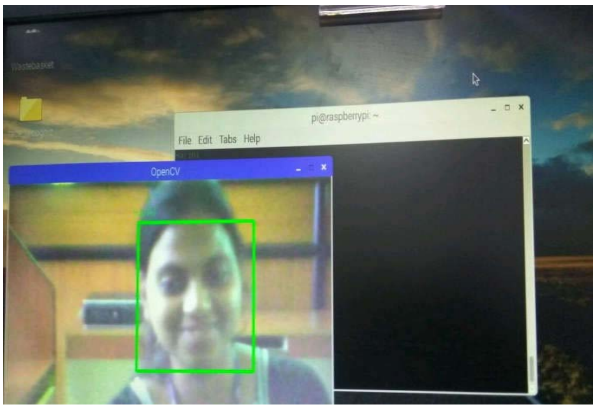

Fig. 6. Image recognition.

The proposed system has been tested for its features like route navigation and person identification successfully. In addition, the system also helps in recognizing the visual disability of a person.

V. Conclusion

The proposed system integrates the working of the various modules and thus provides a multipurpose device for the visually impaired. The device is designed in such a way that it is handy and portable. The device continuously monitors the current location of the user with the help of the GPS. The device also issues warning when obstacles are detected on the way. It also helps to identify people based on the previously stored images. It can also be kept in pockets, thus relieves the user from the need to hold on the device for a long time as in case of sticks. The clarity of output is high since the output is given as voice commands through headphones. Since all the data are fed to the system before its use, it doesn't require Internet connectivity for its working. This is particularly helpful if Internet connectivity is not available all throughout the city. In addition, the device doesn't use any Android or other touch screen related technology thus it is very simple and easy to use.

The device as of now is customized for a few locations only. However, there is scope for extending it to more locations as well as integrate it with Google Maps for better performance of GPS. The obstacle detection module can be enhanced to the extent of identifying the obstacle and naming it along with warning. The camera can be placed in spectacles for better positioning of images. The camera can be made to take pictures at different angles as well. Another enhancement could be to let identify or recognize faces by processing video instead of images.

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