Audio Navigation System for Visually Impaired People

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Abstract – This paper proposes a unique smart phone capability in the sense that it comes with an inbuilt camera for visually impaired people to overcome the difficulties whilst navigation. Detection of the obstacle and measurement of distance is done using depth cameras. Post to reception of information from the environment, the visually impaired person is guided via a headphone. Information from the internet can be collected using the GSM/GPRS module. The headphone button is used by the system for voice input from the user. Emergency tasks such as sending SMS and time location are sent to the subject's guardian while the subject is in danger. This concept allows visually impaired people to walk both indoors and outdoors independently. Experimental results obtained show that the navigation system eases the user's travelling experience in complex indoor and outdoor environments. Hence, it serves as a blind-friendly device for helping the visually impaired people to travel hassle-free and safely. The goal is to provide an effective means of navigation for the visually-impaired.

Index Terms – Audio Navigation, Visually Impaired.

1. INTRODUCTION

The number of visually impaired people is on the raise over the last few years. According to the report of the world health organization (WHO), about 253 million people live with vision impairment. Among them, 36 million people are visually impaired and 217 million have moderate to severe vision impairment. The major portion of visually impaired people is aged 50 or older and live in the developing countries. Every day these visually impaired people face problems in understanding and interacting with the surroundings, particularly those that are unfamiliar. It is hard for a visually impaired person to go out alone and there are not many available products that can assist them. However, research has been going on for decades for developing an effective device for visually impaired people. In this paper, a device with new features that can aid in multiple tasks while maintaining low development cost. The device can easily guide the visually impaired people and is able to give proper directions.

2. RELATED WORKS

Various methodologies regarding the welfare of vision-impaired people using the concept of AI and ML have been proposed. Here are some of them in brief.

One of the approaches is proposed by Bing Li [1] pioneering effort of indoor robotic navigation,NavChair used sonar sensor to detect objects. A vector field histogram (VFH) algorithm and later Minimal VFH were proposed to provide effective sonar-based obstacle detection and avoidance. VFH used sonar readings to update a local map with detected obstacle in the form of uncertainty grids, which was used to calculate a polar histogram to represent the geometric information of the obstacles.Finally,NavChair found a direction with minimum VFH cost and followed it to bypass obstacles. The RGB-D indoor navigation system. Intelligent assistive navigation is an emerging research focus for the robotics community to improve the mobility of blind and visually impaired people. For indoor navigation on mobile devices, numerous studies have been carried out

Jinqiang Bai,et.al [2] proposed a system that includes a depth camera for acquiring the depth information of the surroundings, an ultrasonic rangefinder consisting of an ultrasonic sensor , a MCU (Microprogrammed Control Unit) for measuring the obstacle distance, an embedded CPU (Central Processing Unit) board acting as main processing module, which does such operations as depth image processing, data fusion, AR rendering, guiding sound synthesis, etc., pair of AR glasses to display the visual enhancement information and an earphone to play the guiding sound.

Feng Lan, Shanghai Jiao Tong University, Shanghai, China [4] proposed a smart glass prototype system based on Intel Edison. The Intel Edison is a tiny computer offered by Intel as a development system for wearable devices. The board's main SoC is a 22 nm Intel Atom "Tangier" (Z34XX) that includes two Atom Silvermont cores running at 500 MHz and one Intel Quark core at 100 MHz (for executing RTOS Viper OS). The SoC has 1 GB RAM integrated on package. There is also 4 GB eMMC flash on board, Wi-Fi, Bluetooth 4 and USB controllers [3]. Edison is powerful in computing but small in shape that makes it perfect to build a wearable device. Public signs in cities can act as guides for people. Following the public signs, people can find public infrastructure, such as public toilets, bus stations, subway stations, hotels and so on. So finding and recognizing the public signs outsides would help someone who is visually impaired or visually impaired gain increased independence and freedom. Therefore, they have implemented an application of public signs recognition in this developed smart glass system. This application can automatically detect, analyse and recognize all kinds of public signs around the visually impaired and visually impaired and give corresponding voice hints through wireless bone conduction headphones. With the help of this smart glass system, the visually impaired may find bus stations, subway stations, restaurants, hotels and so on. The visually impaired may even go for a trip alone.

John Brabyn et.al [3] proposed a project to solve instrumentation problems encountered by visually impaired employees or potential employees who are not suited to (nor do they require) complex microcomputer or synthetic speech circuitry for practical solutions. A common problem encountered by custom cabinetmakers, as well as individual homemakers, is finding the structural members within walls ("studs") onto which heavy shelves and wall hangings can be mounted. There have been many devices for finding "studs," but these are traditionally visual instruments. They have successfully modified a commercial stud finder to present auditory feedback to the visually impaired cabinetmaker and handyman". The Zircon "Stud Sensor" (also marketed by Radio Shack as the "Archer Stud finder") is a relative capacitance meter that senses hidden structures by their capacitance effect; it presents these relative indications to a sighted user via a column of LEDs. By reverse engineering, a "relative capacitance" analog signal was found which could be used to drive a voltage-controlled oscillator. Thus, with their modified instrument the visually impaired user hears a distinct rise in pitch when the capacitance increases - which happens when a stud is found. Four prototypes are being made for field trials, and several visually impaired individuals who have tested the unit have found it effective and easy to use.

Andrew J. Rentschler et.al [6] proposed a system to test the walker when run on a two-drum test machine. The walker was then run through the functionality test and visually inspected for cracks or damage. This approach helps the visually impaired navigate hassle free through streets.

Elaiyaraja [14] et.al proposed a system in which the prototype consists of an optical glass with head-mounted camera that captures images and offloads the computation to the database. The database is built using Microsoft Azure API and consists of details of all known persons to the visually impaired. Based on the computations, the database performs facial recognition and identification. If it is a face that already exists in the database, then the person's name and face features will be returned. If it is an unknown face, then it returns that the person is unknown to the visually impaired. With the help of identification information obtained from the unknown person, he/she can be added to the database. The Text to Speech API converts the input text into human-sounding custom speech and returned as an audio file.

3. PROPOSED FRAMEWORK

3.1. Overview

The Audio navigation system proposed can be implemented in the smart phone itself. It is more battery efficient and portable. A dedicated voice assistant directs the visually impaired with help of google maps. Notifications will be given through headphones via voice commands so that it cannot confuse the user. It will guide the person during walk so one can make sure he is stable while stepping. This requires the internet connection; however, most of the processing is done offline. This system also allows the user to do basic mobile functionalities such as calling and messaging through voice commands. Fig 1 represents the overview of the flow in the system.

3.2. Proposed System

Obstacles in the visually impaired's pathway are captured using the phone's camera system shown in Fig 2. The data is then processed and used in guiding the visually impaired via an obstacle free path. This is implemented with the help of TensorFlow. Initial process of this audio navigation system is to find the obstacles before the user. It is required to guide the user how to avoid them without encountering. A depth-sensing camera with IR sensor in a mobile can provide us the data how far an object is away from the camera. Input data is processed through tensor flow and open-cv. Detected objects with its accuracy of detection will be the outcome of this module.

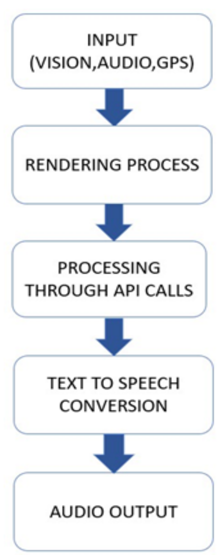

Fig 1. System Overview Diagram

Audio navigation is required to notify the person "How to move" and "What is before them". First objective of this module is filter what to be notified and what must be neglected.

The input to this module will be from the text output of camera vision. The detected objects distanced detected by depth cam, which is shown in Fig 2, and the object itself will be formed, as a sentence through a program .It will be played as audio to the user. The text to audio conversion is done by gTTS API service. In terms of storage, data is stored internally.

Objective of this module is to get users audio input and direct them to the places where they like to move. Audio input is processed as text by gTTS module. User’s location is obtained from the device as input. The input is given to “DIRECTIONS API” to find the directions for their given place from the user’s location.The reply from the API is used by the user to guide them all the way. Nearby API locates the nearby location to their location.

A visually impaired person downloads the developed application in his/her smartphone and performs the initial setup with the guardians help. The person then connects the headphones to the smartphone. This application helps to navigate to the desired destination with the help of our assistant providing audible directions. In addition to this, the assistant also provides recommendations for nearby eateries, shops, hospitals etc. In order to use these features the person has to long press the headphone button.

3.3. Applications

To allow the visually impaired navigate through cities independently .To know the nearby locations and directions to the places. Basic mobile functionalities such as call, message and checking battery status. It detects the object against them to notify them through voice commands .It notifies the object and how far it is from the person. It can locate nearby hospitals with no constraints and other locations within 1 Km radius. It can be used globally with some constraints. This system will be trained for an induvial user which gives them more accessibility.

Fig 2. Mobile Camera System

4. EXPERIMENTAL RESULT

The camera analyzes and recognize objects. It then conveys this information to the visually impaired via the headphone. As an example consider the above two images. Fig 3 shows how the camera recognize the human faces along with the certainty that the object is a human. Similarly, Fig 4 shows how camera recognize the bottle. Fig 5 shows the voice assistant interface which will converted as background process. The interface consist of three parts: Results, Respsonse, Get,gps and input.In input field the user’s voice is taken as input.Get gps gives the user location. Input can be either given as text or voice. Audible reply is given by the assistant and also the response field will carry the reply. The app logo within an app drawer is shown in Fig 6.

Most of the audio comments are given by google assistant’s default voice with the pitch rate and speed of 20%.It can be adjust in accordance with google account maintenance.

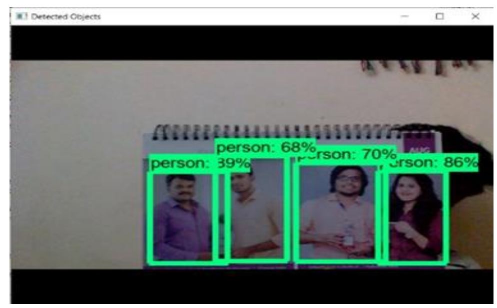

Fig 3.TensorFlow Vision Detecting Persons

Fig 4. TensorFlow Vision Detecting Bottle

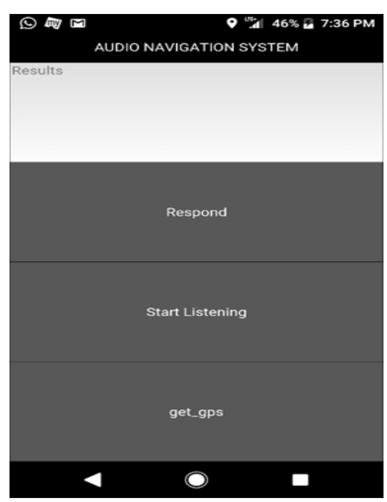

Fig 5. Interface of the Application

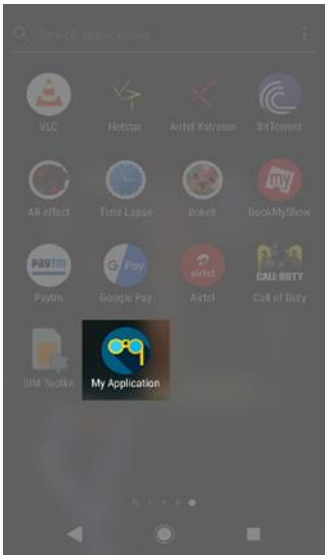

Fig 6. Application Icon in the App-Drawer

5. CONCLUSION

A majority of the proposed system involve the use of the 3d glass or an obstacle detection system to assist the visually impaired for navigation. The systems are often complex to operate and expensive to implement. This paper describes an approach similar to ones discussed but differs in terms of simplicity and cost. The system proposed requires basic smartphone, dedicated service with internet connectivity and a headset to help the visually impaired navigate effectively.Obstacle detection and audible guidance using voice assistant gives an easier way of access.

The system developed is portable in the sense that it requires a smartphone with internet connectivity. Thus, a cost effective and simplistic solution is made possible. Requires internet connection at all times to ensure proper functionality. Problems of usage in places with limited network connectivity. Sometimes, radiation from mobile device imposes health hazards for the life.

6. FUTURE ENHANCEMENT

Rather than providing a single instance update on directions, the assistant can be programed to provide on the walk instructions. This is similar to a person walking beside the visually impaired person and providing direction. This approach will be implemented with machine learning. The image processing is done using TensorFlow .The ultimate goal is to guide the visually impaired through cities effectively and hands-free.

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