FinJect: A Locating App for Visually Impaired Users

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ABSTRACT

Visually impaired people face several challenges in their day-to-day life. One vital challenge is locating their belongings. There was an idea to ease their life using advancement in Artificial Intelligence (AI) and Bluetooth Low Energy (BLE) tags. In this research paper, an Internet of Things (IoT)-based Android App - FinJect is proposed for visually impaired users to assist them in locating their belongings. These cost-effective BLE tags are used for tagging their belongings. An object detection facility is also provided as it isn't feasible to attach BLE tags on every object. Object detection assists the user to detect the objects using a mobile camera within user proximity. In image detection, AI plays a vital role in training the data set and providing the user with more precise and accurate results.

1. Introduction

Blindness is one of the most, if not the most, misunderstood type of disability. Globally, an estimated 253 million people live with vision impairment, out of which 36 million are blind, and 217 million have moderate to severe vision impairment. With regards to near vision, 826 million people live with a near vision impairment. The burden of visual impairment in India is estimated at 62 million; of these, 54 million people have low vision, and 8 million are blind.

Blind people do lead a normal life with their own style of doing things. But, they definitely face troubles due to inaccessible infrastructure and social challenges. Let us have an empathetic look at some of the daily life problems faced by the blind people.

> Navigating Around the Places.

> Finding Reading Materials

> Finding their belongings

> Getting information about things etc.

While many tools have been introduced to help address these problems using computer vision and other sensors (talking OCR, GPS, radar canes, etc.), still many of their problems are unsolved.One of the major problem they face is finding their day-to-day life belongings.We have solutions for outdoor navigation(radar canes etc) but for navigating to indoor things, there is a lack of technology. One may easily forget where he/she put belongings indoors. The person without visual impairment can easily find anything with naked eyes, but those with visual impairment have to walk around everywhere to find those things.

Few studies have been conducted with persons with visual impairments concerning mobile application or "app" usage. The current study explores the use of mobile apps with this population globally. Descriptive statistics and bivariate tests were used to examine associations between demographic characteristics and mobile app use. Results show that persons with visual impairments frequently use apps specifically designed for them to accomplish daily activities. Furthermore, this population is satisfied with mobile apps and would like to see improvements and new apps. Hence the need arises for self locating application, which will provide the user to overcome some of their challenges. The self-locating aspects plays a vital role in easing the life of visually impaired user. It can help them tag and locate their belongings without depending on other human beings.The self-locating aspect can broaden the possibility of living a normal life to some extent for the visually impaired users.

2. Related Work

Before getting our hands on the actual application development, we first compared various parameters. We started off by comparing various technologies in the market, their cost, effectiveness and reliability. Alongside this, we also took into consideration what the market already had and what more can be added.

For this, we compared between different applications available on the App Store and Play Store. We interviewed some visually impaired students and retrieved the required data from them regarding the top priority things they need in their day to day life. About 285 million people are visually impaired worldwide: 39 million are blind and 246 million have low vision (severe or moderate visual impairment). Hence, we had to consider a cost-effective project in order to meet the requirements of the user. Finally weighing all the pros and cons we decided to go ahead with Object tagging and Object detection. The major role of the app is to help visually impaired users to locate their objects with the help of BLE tags. We have reduced the cost drastically by using BLE in place of Bluetooth beacons and it is the most convenient way to locate things. BLE Mini is a Bluetooth module that can be used on embedded systems. It supports Bluetooth 4.0 Low Energy (BLE) technology.

The features of BLE Tag are:

- On-board programmable components
- Bluetooth 4.0

- 512Kb EEPROM, 1 LED, Push Button
- 0.1mA power consumption
- Accessories included - Coin Cell Battery holder & 3 connectors
- Powering options - 3.7V Li-ion

The proposed app would accept voice commands from the user. On entering the object name, the object from the database would be called and the tag attached to that respective object would start buzzing. This would help the user to locate his items easily in the room. The Application also has a facility for the user to insert or delete items from the database as per his preferences.

For Object detection we had to find a way to deal with real time object detection. We had to find the right algorithm as well as the right environment. We found that Fully Convolutional Neural Network (FCNN) and Convolutional Neural Network (CNN) are some algorithms which will help us achieve the required results for detecting objects precisely.

Finally weighing all the pros and cons we decided to go ahead with Object tagging using Internet of Things (IoT) devices and Object detection using Artificial Intelligence (AI). The object detection will provide the user with adjustments in the environment and deal with the task easily and empower the users to be self-dependent.

3. Methodology

This is a descriptive study, including students from Pune university with visual impairment in Pune, India, 2019.Under the guidance of Prof. Bhole, 5 students were selected by convenience sampling. For data collection , a Questionnaire was used in face to face interviews. The Questionnaire measures daily usable major things, how they find things in their relative places, how frequently they use their mobile phone, ease of use etc.

A detailed study for required resources for the development of the app was made through peer review and literature review, where we compared all the technologies and apps available in the market for visually impaired people. Detailed study of each parameter was noted down. After getting acquainted with the difficulties, the idea of an app was proposed.

The first version of the app which uses BLE (Bluetooth Low Energy) devices to locate objects, was developed under HCI using Android studio. To make the app more efficient, Artificial Intelligence algorithms were chosen to detect objects. Object detection came into picture with a motive to further aid the visually impaired users .

Object detection is done with the help of OpenCV library just to make the application work in the real time mode, which benefits us in our case. OpenCV is a library of programming functions mainly aimed at real time computer vision.

You Only Look Once (YOLO) is a computer vision technique which is used as a pre-trained neural network in our project. The motive of using a pre-trained network was to minimize the hardware usage of the smartphone. Since it was of utmost importance to make it as feasible as possible, where the user won't have to spend handsomely on a high end processor smartphone.

4. Design of the FinJect App

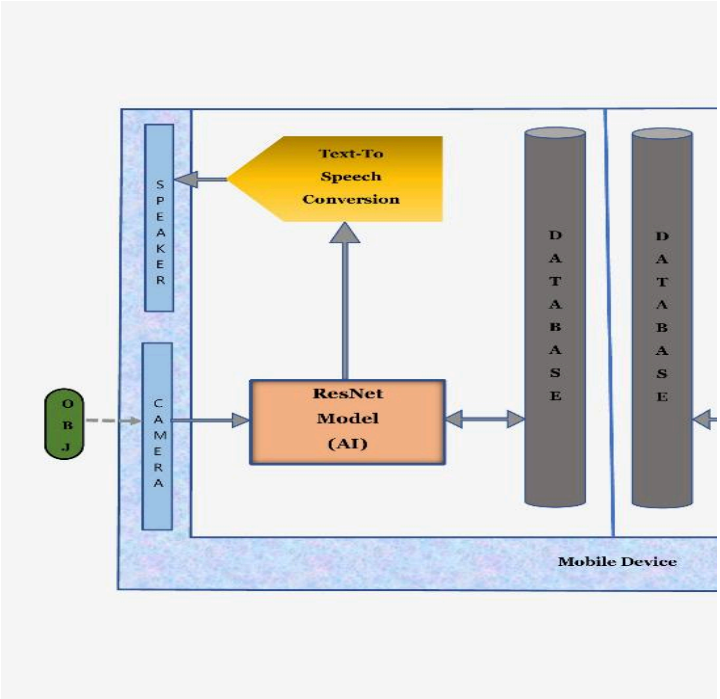
4.1 Object Tagging

The technology available today has helped blind users accomplish tasks they weren't able to before, approaching levels of independence and autonomy closer to their sighted counterparts. This application is designed principally for visually impaired users. We have kept it very straightforward and accessible taking into account countenance of a visually impaired user. The view of the application screens is landscape (Horizontal) so that it's convenient and cavernous to use. The home screen is split into two integral parts. The upper part has an Image Recognition Button covering half of the screen and the lower part has an Object tagging button covering the lower part of the screen. One may find Object tagging convinient to look for his/her essential things.While some may find the Image detection option supportive to look for the daily essentials.

Fig. 1. Main screen of our application.

The main screen of the app is divided into two halves. When the user starts the app, it automatically starts searching for the BLE tags. Upon searching the tags, each tag is added to the list which is displayed at the bottom half. When the user clicks on the item in the list, he/she can rename it. The list of tags is sorted depending upon the number of times the tag is used to find an object. The top half of the screen is merely a button which is used to find the tags using voice command. Once the user clicks the button, which occupies the top half a google voice recognition dialog pops up, where the user is supposed to say the name of the tag which he/she had previously named. if the tag is available to connect then the app connects to the tag and once the connection is done the tag starts buzzing.

Fig. 2 Block diagram: Function of mobile app



4.2 Object Detection

In the field of Artificial Intelligence, oftentimes we require an algorithm which will work on a given object/image and help us detect what it is. On a similar note we will be dealing with various algorithms which help us in real time detection as our project desires. Object detection is a technique which deals with computer vision and image processing. It works on an image as well as on a video. It extracts different features from an image or a video and groups them with the help of labels which is pre-trained for a set of objects into bounded boxes for detecting the object.

This technology has many innovative techniques. RetinaNet, Fast R-CNN (Region based Convolutional Neural Network) and YOLO (You Only Look Once) are some of the techniques.

We used YOLO technique in our project, since it uses a single stage detector i.e. it detects all the bounded boxes in a single pass through the image or the neural network unlike RetinaNet and Fast R-CNN which uses dual-stage detectors. Though it seems that dual-stage detection performs better than single stage detection in terms of accuracy, single stage detection is faster which is of utmost importance considering the real time system where the user would not appreciate a high response time from the system.

```
# import the necessary packages
import numpy as np
import argparse
import time
import cv2
import os
# construct the argument parse and parse the arguments
ap = argparse.ArgumentParser()
ap.add_argument("-i", "--image", required=True,
  help="path to input image")
ap.add_argument("-y", "--yolo", required=True,
  help="base path to YOLO directory")
ap.add_argument("-c", "--confidence", type=float, default=0.5,
  help="minimum probability to filter weak detections")
ap.add_argument("-t", "--threshold", type=float, default=0.3,
  help="threshold when applying non-maxima suppression")
args = vars(ap.parse_args())
```

Fig.3. It is a sample of how bounded boxes + confidence helps in creating a class probability map.

YOLO algorithm design:

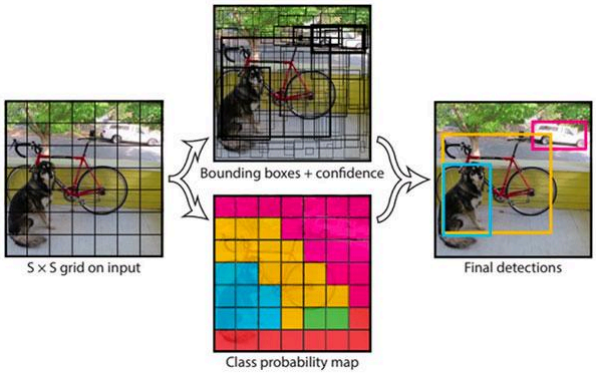


Fig.4. shows how YOLO detects all the bounded boxes in an image.

This diagram helps us understand how YOLO detects the bounded boxes in an image using the concept of class probability map which is calculated with the help of pre-trained datasets with labels for each image.

Coming to the working of the application, the algorithm used is called You Only Look Once (YOLO), which is an optimized image detection algorithm. It helps in image prediction multiple times for various regions in the image. The pre-trained YOLO is fed to the application, checks in its database and tries to map the image with the name set following the particular image. Then, it displays the probability of a particular image following with its name according to the dataset using bounded boxes as it predicts multiple regions in an image. The mechanism of translating the text into voice helps the user to understand what object is in front or around. In this way, the user is able to know about his surroundings. Since we are focusing indoors or in a closed room environment, it is quite easy for the visually impaired users to find belongings on a regular basis.

5. Conclusion

Reviewing the problems and difficulties faced by visually impaired users while locating their belongings and understanding the need of assisting required for them to complete these tasks, we came up with this app FinJect. Studying these areas takes a functionalist approach to adapt services and the environment around these visually impaired users. The Invention has a unique combination of two cost-effective technologies. These technologies complement each other in terms of range and efficiency. Object tagging with the help of IOT devices cannot be attached to every household object, so the devices are attached to only those things which come in as top priorities of the user. While the rest of the objects can be perceived through the smartphone's camera using Object Detection algorithm YOLO. The uniqueness of the invention is the way the technologies complement each other and help in aiding the visually impaired users on a daily basis. FinJect provides a high degree of mobility and therefore new possibilities for everyday usage.

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