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Vision Assist: An Android-based Object Detection and Text Recognition Application for the Visually Impaired

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Abstract: Sight is one of the most important human senses among all the human senses present, and assumes a fundamental work in understanding the surrounding environment. Visually impaired people find it difficult to move outside without supervision. Therefore, this document is an attempt to develop an object detection system for humans with reduced vision. It takes a few to do that segments such as a camera, an application, and an audio device. We have designed and implemented an Android application that will use the phone's camera to detect the objects around the visually impaired user. Additionally, the application will also inform the user about the direction of the object and the distance of the user from the object. The application will inform the visually impaired user about the object name, direction, and distance of the object using an audio device such as headphones or the phone's speaker. This system will help the visually impaired people by informing them about the various objects around them and help them in their orientation around independently. So, our goal is to present a visual substitution system which will help the vision disabled people in their daily lives by informing them about the various objects around them using an object detection system.

I. INTRODUCTION

They live with millions of people in this world difficulty understanding the environment due to vision disabilities. Navigation around is one of the biggest problems faced by visually impaired people. It's hard for travel independently because they cannot analyze the location of objects and people who surround them. In to be able to move outside, visually impaired people they need someone to lead them. The white can is one of the most common aids for the visually impaired people. While this is useful for navigation, it isn't notify users of various obstacles until they are very close to them. So because of the shortcomings of these conventional solution, a lot of research is being done to develop it better and advanced aids to help the visually impaired. Android application will be developed in this system to detect objects, for which it uses the phone's camera detect objects in front of the user. The application will detect objects using the Tensorflow object detection API and provide the user with an audio message about the name and location of the object. Location includes direction and distance of the object relative to user. The audio message will be provided visually disabled user with the help of an audio device such as headphones or phone speaker. The purpose of this paper is to highlight how object detection, a technique based on computer vision, can help the visually impaired people to support independent travel by presenting an overview of application for object detection for visually impaired people.

II. PROBLEM STATEMENT

The inability to see the surrounding makes it difficult to move around or do anything on one's own. A lot of objects have the same texture or shape which makes it even harder for a visually impaired person to sense what objects are around or they holding. Visually impaired people suffer in many ways. Nearly one-third of people with vision loss suffer from clinical depression, a rate that is twice as high as the general population of the same age.

III. PROPOSED SYSTEM

Object Object detection is the main goal of this system. It consists of object classification and object localization. Object detection is the process of categorizing an object into different classes that were defined earlier. In others words, object classification assigns a label to the entire image. This label is the name of the object present in this image. For the computer gets a picture of a cat and tries classify it and output as "Cat". It's easy for us to identify objects present in any image but for a computer, object classification is a tedious task. When locating objects, the computer tries to isolate object from the image by drawing a rectangular box around it which is also called Bounding Box.

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So object detection is a combination of object classification and localization of objects in which we strive classify and isolate multiple objects present in an image. The output of this module will give us a name object and bounding box coordinates. These bounding box coordinates will be used next modules for determining the direction of the object and to calculate the distance of the object from the user. The visually impaired user will be informed about the distance of the object from him/her. We will be using OpenCV (Open source Computer Vision Library) for calculating the distance. The distance will be calculated using the Triangle similarity law. It would be more beneficial for the visually impaired user to know the distance of the object from him/her as it will give the user an idea about the relative space around him and how far the object is from him rather than knowing just the object name.

The camera of the device has to be calibrated first in order to determine the distance, thus the calibration module has to be executed whenever the application is launched for the first time. The main objective of calibration is to determine the focal length of the camera lens, which will be needed for further calculation. Determining the direction of the object The direction of the object will be informed to the visually impaired user in the following way: “to the left”, “to the right”, “at the center”. The direction will help the user to determine the exact location of the object, enabling him/her to navigate around in a better way.

In order to determine the direction, we will divide the image in 3 parts along the length of the screen. The ratio of these lengths is 3:4:3. The portion of the image in which the center of the object lies will determine the direction of the object. For instance, if the center of the object lies in the first portion of the screen, its direction will be LEFT. The coordinates of the center can be calculated using the coordinates of the bounding box. Only the x coordinates of the bounding box are required to determine the x coordinate of the center.

IV. LITERATURE SURVEY

1. Android Based Object Detection System for Visually Impaired. Authored by Badave, Ajinkya, Rathin Jagtap, Rizina Kaovasia, Shivani Rahatwad, and Saroja Kulkarni IEEE – 2020. Technique used Tensorflow’s object detection API model (SSD MobileNet). Accuracy is 87%. Requires large dataset for training.

2. Android Application for Object Recognition using Neural Networks for the Visually Impaired. Authored by Dosi, Sanika, Shivani Sambare, Shashank Singh, Netra Lokhande, and Bhushan Garware IEEE – 2018. Techique used MobileNet. The application's reliance on a pre- trained dataset restricts its ability to identify unknown or untrained objects.

3. Object Recognition Development for Android Mobile Devices with Text- to-Speech Function Created for Visually Impaired People. Authored by Burta, Andrei, Roland Szabo, and Aurel Gontean IEEE – 2020. Technique used Content-Based Image Retrieval System. Scalability, Dependency on Feature Extraction.

4. Object Recognition App for Visually Impaired. Authored by Jakhete, Sumitra A., Pranit Bagmar, Avanti Dorle, Atharva Rajurkar, and Piyush Pimplikar IEEE – 2019. Technique used Object Detection API provided by Tensorflow (uses SSD mobilenet v1), MULTIBOX and YOLO. Dataset is limited to only 80 classes.

5. Object Detection and Narrator for Visually Impaired People. Authored by Nasreen, Jawaid, Warsi Arif, Asad Ali Shaikh, Yahya Muhammad, and Monaisha Abdullah IEEE – 2019. Technique used VGG16, YOLOv3. Accuracy is less. Dataset is limited to only 8 classes.

V. SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS
OS – Windows
Processor – Intel Multi-Core Processor (i3 or i5 or i7)
Hard Disk – 10GB
RAM – 12GB

SOFTWARE REQUIREMENT
IDEs Used – Jupyter Notebook, PyCharm.
Tools – Anaconda Navigator, Android Studio
Programming Languages – Python, Java

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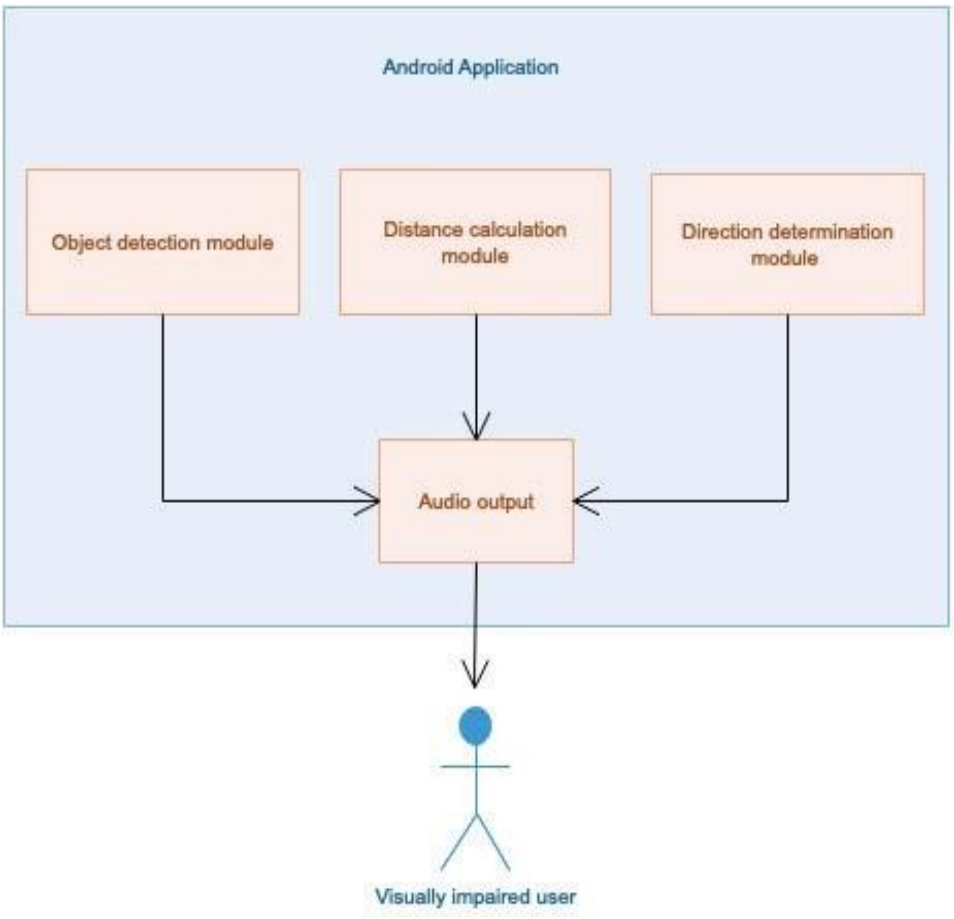
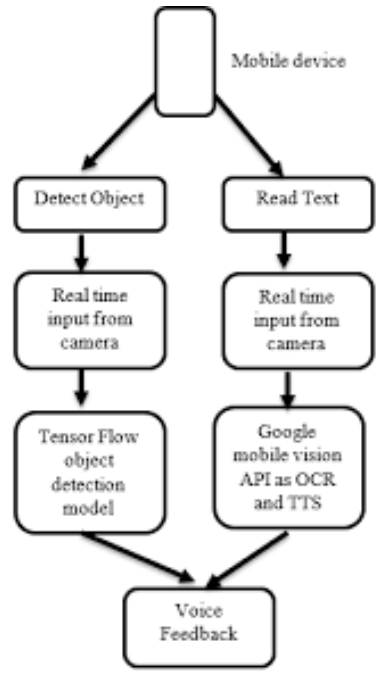
VI. SYSTEM ARCHITECTURE



VII. METHODOLOGY



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The methodology behind an Android-based object detection system for the visually impaired involves a multi-step approach aimed at developing a robust and user-friendly solution. Initially, the system undergoes extensive research and analysis to identify the most suitable object detection algorithms and techniques, considering factors such as accuracy, speed, and computational efficiency. Once the appropriate algorithms are selected, the development process begins with the creation of a dataset comprising diverse images of objects commonly encountered in daily life. This dataset is used to train and fine-tune the object detection model, leveraging techniques like transfer learning to adapt pre-trained models to the specific requirements of the application. Simultaneously, the user interface is designed with accessibility in mind, focusing on intuitive interaction and effective communication of detected objects to the visually impaired user.

This involves collaboration with individuals from the target user group to gather feedback and iterate on the design to ensure usability and inclusivity. The system architecture is then implemented on the Android platform, leveraging the capabilities of mobile devices such as cameras, processors, and sensors. Optimization techniques are employed to ensure real-time performance and minimal resource usage, enabling seamless operation even on low-end devices. Throughout the development process, rigorous testing and validation procedures are conducted to evaluate the accuracy and reliability of the object detection model, as well as the effectiveness of the user interface in conveying information to the user.

This includes both simulated testing scenarios and real-world trials to assess performance in diverse environments and conditions. Finally, the Android-based object detection system undergoes iterative refinement based on user feedback and performance evaluations, with updates and enhancements continuously rolled out to improve functionality, usability, and overall user experience. By following this methodology, developers can create a highly effective and empowering solution for the visually impaired, facilitating greater independence and accessibility in their daily lives.

VIII. CONCLUSION

In the last few years, many solutions have been conceived to assist the visually impaired people in navigating around and recognizing objects in their surrounding environment. But, most of these systems are not feasible to use in the day- to-day life of the visually impaired people due to the high cost of infrastructure that is needed to implement these systems.

Our goal is to devise a system that can help the visually impaired to recognize the objects around them while indoors and navigate around independently while outdoors. In order to use our system, the visually impaired user does not need to learn any specific skill. Moreover, the cost of the proposed system is minimum as only a smartphone is needed to implement it. Hardware, such as sensors, is not used in our object detection system, unlike other proposed systems, thus reducing the overall cost of the system.

A prototype application has been developed which currently has all the functionalities mentioned in this paper except the distance calculation functionality. Along with the distance calculation functionality, we will be re-training the Tensorflow's object detection model in order to detect more objects.

IX. FUTURE ENHANCEMENT

The system can be equipped with text to speech feature that can recognize the text in front of the visually impaired user and provide an audio output for the same. This will enable the user to understand the written text around him. The refined version of such a system can enable a visually impaired user to read a regular book without having to purchase an audiobook; it can also help the user to identify various medicines independently. Thus, a Text to Speech feature in our system can improve the usability of it exponentially.

The model can be retrained to identify various foods and dishes. Food detection can be useful to the visually impaired user when he/she is having a buffet.

The system can be trained to recognize people who are frequently encountered by the user such as family members and friends using facial recognition algorithms.

Currency denomination recognition can also be an additional feature that can be worked upon, as it will help the visually impaired person to recognize the denomination of the money which he will be handling. Although the currency notes are equipped with physical features that help the visually impaired people to identify the denomination, a currency recognition feature can make it easier for visually impaired users to handle money as the physical features of the notes may not be as clear due to "soiling" that was caused during the circulation.

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