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CNN-Based Object Recognitions and Tracking System to Assist Visually Impaired People

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ABSTRACT: All the senses that humans possess, vision is one of the most important and plays a vital role in helping us comprehend our surroundings. It is challenging for those with visual impairments to move around outside in the absence of supervision. Thus, this essay is an endeavor to create a human object detecting system with less vision. To accomplish this, a few things are needed parts like an audio player, an application, and a camera gadget. Our team has created and executed an Android app that will utilize the camera on the phone to identify the items surrounding the person with vision impairment. Additionally, the application will notify the user of the object's direction as well as their distance from it. The application will notify the person who is blind about the object's name, direction, and distance utilizing an audio gadget like the phone's speaker or headphones. This arrangement will enlighten and support those who are blind or visually impaired about the different things surrounding them and assist them in navigating and moving about on their own. Therefore, our objective is to present a visual substitution technique that will benefit the visually people's daily lives by providing them with information about the different things surrounding.

KEYWORDS: Convolutional Neural Network, Robotics, Object Recognition, Computer Vision, YOLO

I.INTRODUCTION

Scholars estimate that the number of visually impaired people worldwide will increase from 38.5 million in 2020 to more than 115 million by 2050 [1]. So increased societal and governmental attention will be needed in the future. Specifically, the visually impaired need assistive tools when they walk outdoors. White canes and guide dogs are currently the most well-known assistive tools for the visually impaired [2]. Although white canes are cheap and easy to use, they cannot provide important visual information, such as obstacle location, type, and proximity. Visual information is indispensable for environmental perception and movement safety during outdoor navigation [3]. Guide dogs can assist the visually impaired to avoid obstacles; however, their life span is about 8 to 12 years [4], and the cost of breeding and training a guide dog is very high. Many researchers have developed various assistive devices for the visually impaired [5,6,7]. To safely guide the visually impaired while walking, the assistive tools should have the ability to recognize the surrounding environment quickly and accurately.

A wearable device for visually impaired people was developed by [5] in which the device used different types of sounds to inform users whether there were obstacles in front of them or not. It also used different frequencies and decibels to indicate the location of the obstacles. In the paper [6], the authors combined wearable glasses and augmented reality technology and then integrated the traversable direction visual enhancement function to help partially sighted people to walk safely. In addition, they developed three-voice prompts to guide severely or profoundly visually impaired people in a safe direction. A wearable navigation device [7] with an RGB-D camera, a gyroscope, and a smartphone were proposed to guide the user in bypassing obstacles when the visually impaired travel through indoor and outdoor environments.

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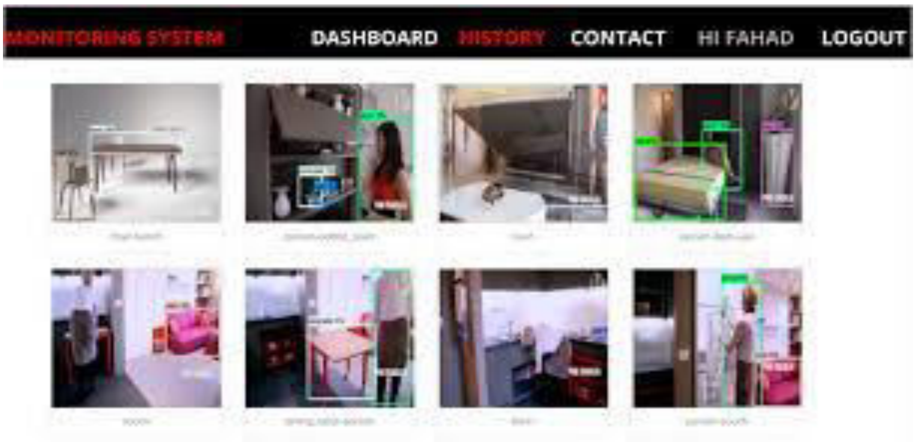

Fig 1: CNN-Based Object Recognition and Tracking

When visually impaired people walk outdoors, obstacle avoidance, safe intersection transition, and accurate route navigation are of great importance. Many assistive frameworks have been developed to achieve these goals, which rely on smartphones, sensors, or computer vision. The authors of the paper [8] reviewed several related articles and analyzed the advantages and disadvantages of the different techniques. In the paper [9], the authors used the images captured by RGBD camera to train a semantic segmentation network and a classifier such that the visually impaired can recognize the road environment and walk toward their correct direction. However, there is no guidance if it is a dead-end in front of the user. Yang et al. [10] used smart glasses and a laptop with a real-time semantic segmentation network to lead the user. The system proposed by [11], composed of a pair of smart glasses and a portable processor, can recognize guide bricks and crosswalks for visually impaired users in outdoor environments. Paper [12] provided a segmentation network to recognize crossroads and used an image processing method of color space to identify traffic lights and help the visually impaired use the crosswalk safely. The study of paper [13] used a smartphone to help the visually impaired avoid aerial obstacles. For the visually impaired, a set of glasses with integrated infrared (IR) transceiver sensors and a white cane with accelerometer and gyroscope sensors [14] are used to avoid obstacles and detect whether the user falls. In the paper [15], the authors proposed a sensor-based wearable device for the walking assistance of visually impaired people. An algorithm based on image depth information and fuzzy logic was proposed in [16] to detect multiple objects in real-time, and it achieved high accuracy on obstacle avoidance.

II.LITERATURE SURVEY

Several researchers have given a variety of methods, ranging from background subtraction to CNN. Among the techniques used for human tracking have been given in this area. For pedestrians, human tracking consists of three fundamental processes tracking: tracking, human detection based on frame sequence and tracking analysis for a specific objective. Three essential components make up pedestrian tracking. It can be compared to object tracking 1) Identification of the pedestrian in the frame of the video, 2) The detection's tracking, and 3) Track analysis for the designated objective. The segmentation, classification, background subtraction, and object feature point detection techniques of earlier studies have all been covered in this literature review. For attributes that described the object are what allow tracking to be flawless. Most significant, hence object detection is essential. You can do this by applying either deterministic or probabilistic both appearance-based models and motion models. To accomplish the Improved accuracy versions of the model have been showcased with time.

The feature points in the were updated and trained within the tracking procedure. The object's only tracking difficulty is that it needs a lot of features that aren't always available feasible. CNN has been utilized recently to classify and recognize images to significantly increase performance. Millions of photos representing various classes are used to train CNN. CNN are the instructional strategies that take advantage of spatial information of a photograph and automatically identify the intricate details. CNN encroaches on the diversity of an input. The characteristics in this algorithm were acquired through an online procedure. Instead, two images are used to analyze the spatial and temporal aspects of only one picture. Tong and colleagues introduced the method in which the cascade is the final layer of the

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CNN module that has been per-trained. utilizing the web SVM to acquire discriminative appearance models. The Bayesian network is used to carry out the tracking. saliency map specified with target. Pte-trained CNN model was utilized by Wang et al for online following. Following parameter tuning, the CNN is utilized to modify the object's appearance in the scene and the likelihood map are made to, as opposed to labeling

III.METHODS

The main goal of this system is object detection. Both object location and object classification are included. Object classification is the process of object discovery into many previously specified classifications. In different Put another way, object classification gives an image a label. The name of the object seen in that picture is written on that label. For example, when a computer is given a picture of a cat, it will attempt to categorize it and assign the outcome the name "Cat." It is simple for us to recognize the items in any picture, but for a computer, classifying objects is a laborious task. When an object is being localized, the computer creates a bounding box—a rectangular box—around it to remove it from the image. Therefore, object detection is the result of combining object localization and categorization, in which we attempt to sort and separate the many objects in the picture. We shall receive the object's name and the bounding box's coordinates in the module's output. These bounding box coordinates will be utilized in the upcoming components to ascertain the object's orientation and to determine the object's distance from the user.

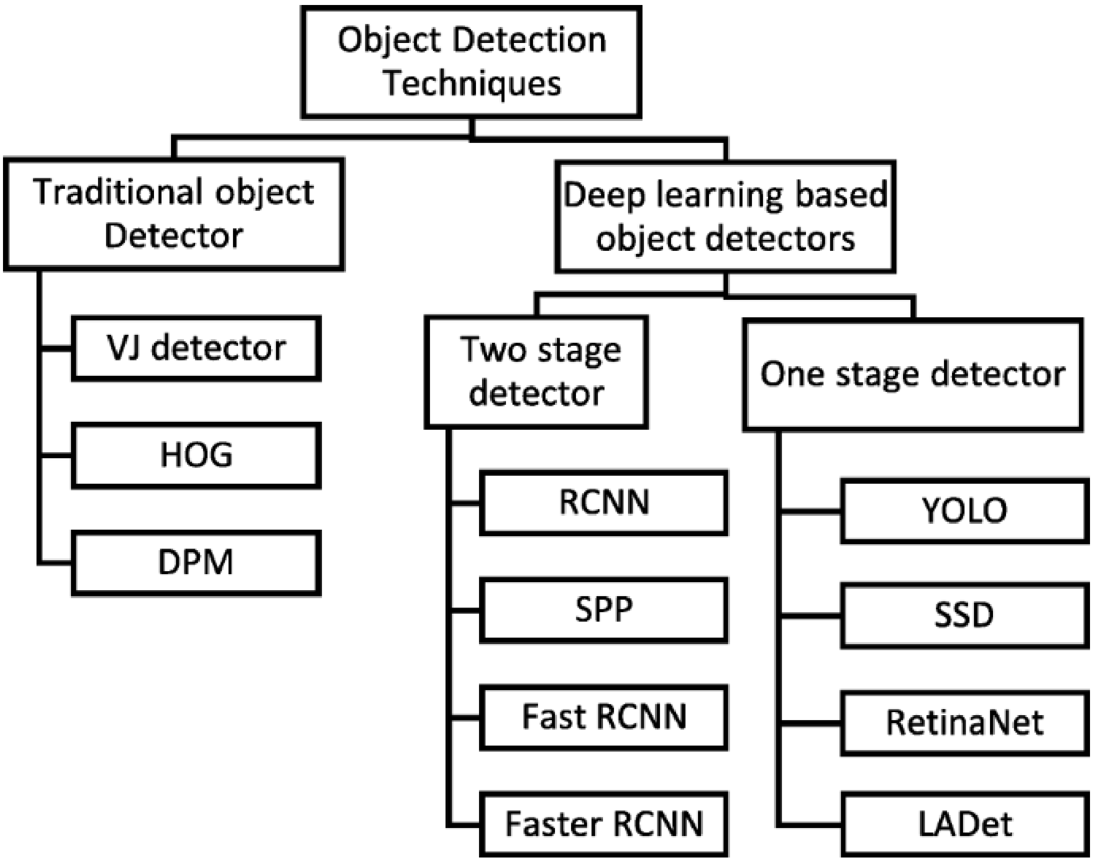

Fig 2: Tools, techniques, datasets and application areas

Tensor Flow's object detection API model, which can categorize 80 items by default, will be used for object detection. Retraining the model will enable us to classify additional objects. It recognizes objects in real time; capture is not necessary and saves any picture. Every given frame will include several objects .as a result, we will be giving various objects distinct priorities. since it is impractical to advise the user who is blind about anything that is in front of him or her. The items having the ultimate product for each will be based on the top priority picture. Additionally, the accuracy measure provided by the Tensor Flow object detection model indicates the degree of confidence with which the object

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has been spotted. It is articulated in terms of proportion. The confidence level's threshold value is maintained at 70% to raise the system's accuracy. The user will only receive information regarding the items that have been found with a greater than 70% degree of confidence.

The user with vision impairment will be notified of the object's distance from them. Open CV (Open-source Computer Vision Library) will be utilized for figuring out the separation. The calculation of the distance will be done using Triangle Similarity Law. It would be more advantageous for the visually impaired user to determine the object's distance from him/her since it will provide the user with information about the kin the area surrounding him and the object's distance from him instead than merely being aware of the object's name. The calibration module must be run each time the application is launched to calibrate the device's camera before determining the distance. Calibration's primary goal is to ascertain the camera lens's focal length, which will be required for additional computation.

IV.RESULT ANALYSIS

we have mentioned that the training data were collected on sunny days during daylight hours to train the Fast CNN. However, we also have done some experiments that used the trained Fast-SCNN on rainy days or at night. The experiment results are stated below. The system still works well in cloudy weather with sufficient brightness. However, it almost fails on rainy days when there is stagnant water affecting the segmentation result of the sidewalk. Furthermore, the system is unstable to recognize the sidewalk and crosswalk without stagnant water. Moreover, it did not work well at night since the environment is too dark, or streetlights of different brightness may confuse the segmentation result. Therefore, for the sake of safety, we suggest the visually impaired uses the proposed system on daytimes and not rainy days. In order to improve the system to be also feasible on rainy days and at night, it needs to collect a lot of extra training data on rainy days and at night. We need more time and more effort to study this issue in the future.

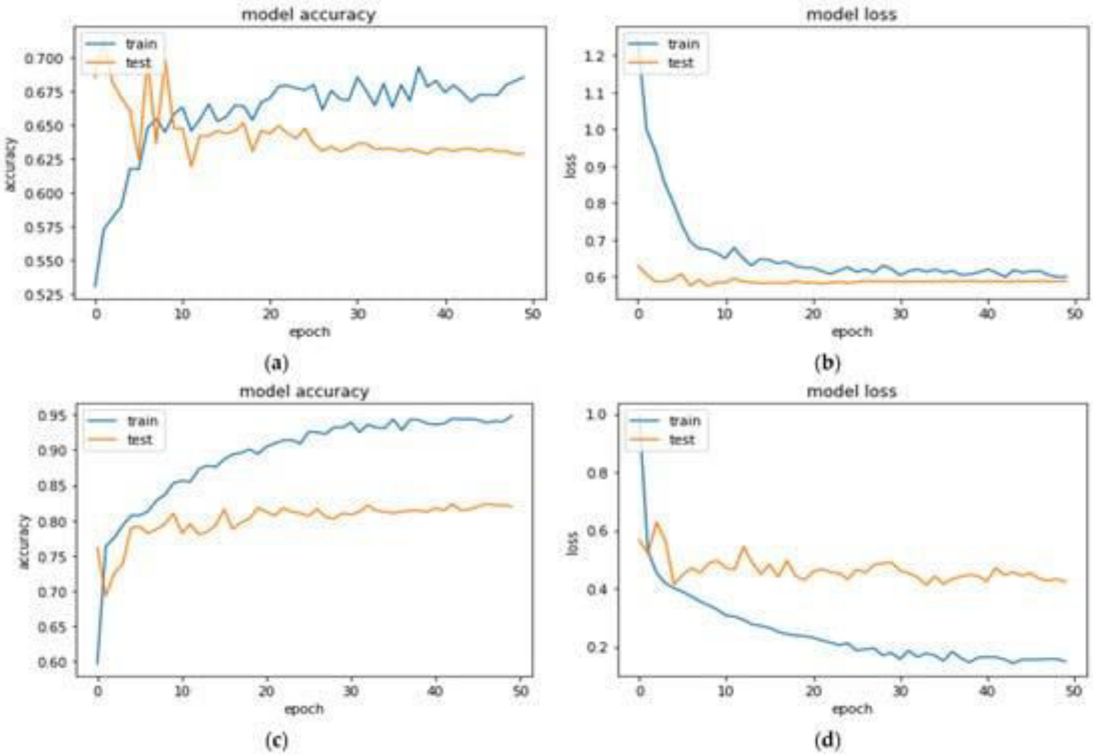

Fig 3: Result Analysis

We have to admit that we did not invite enough visually impaired persons to do the experiments since it is hard to find a large number of visually impaired people to test in a short time in Taiwan. However, we have to supplement that before we invited the natural visually impaired person to experiment one time, we would request several (about 5–6) students in my lab wear blindfolds to do many experiments in advance

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V.CONCLUSIONS

This study has proposed a wearable assistive system to help the visually impaired walk safely on the sidewalk or crosswalk without hitting obstacles. The semantic segmentation model Fast-SCNN was trained to recognize the user's surrounding environment, and the depth map created by the ZED 2 was used to measure the object's distance in front of the user. Combining the above two environmental information, we have developed a walking guide strategy for the visually impaired. Moreover, the object detection model YOLOv5s was trained to detect and identify obstacles. With the aid of the proposed assistive system, the experiment has shown that a visually impaired user can walk on the sidewalk and crosswalk safely without hitting any obstacles. However, we have to admit that if an object appears suddenly in the camera's blind spot within 0.2~1 m in front of the user, they may not have time to avoid it. In this situation, the white cane is still helpful for the visually impaired person. Therefore, we suggest that the visually impaired person still uses the white cane to maximize safety when using the assistive system. In addition, the study on visually impaired people traversing an intersection with traffic lights is still in progress. The traffic light platform "Invignal" can provide the traffic light status and timing for each intersection in northern Taiwan. This platform will be used in our consequent experiment. We will publish the study result if we have a more stable experiment result in the future. Furthermore, we will continue experimenting with more visually impaired users to verify the effectiveness of our proposed system. For the limited testers, we have completed different experiments many times, and the performance is almost consistent.

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