Portable Camera Based Identification System For Visually Impaired People

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***Abstract*— The global expansion of visual impairment is a very sensitive subject. Living in constant uncertainty has always had a negative impact on many aspects of their lives. The digital revolution is accelerating in the fast-paced culture, and it has had a good impact on blind people's life as well. The report describes a reform work to create a support system for those who are blind or visually impaired. People with visual impairments, from the partially unsighted to the completely blind, can use the image recognition and text navigation system to support and direct them via auditory commands. The tool includes the sequential operations of indoor obstacle detection and recognition. The presence of an object is identified using an ultrasonic sensor. Here, a single chip known as a Raspberry Pi is being integrated with both the text navigation device and the identification system. The Raspberry Pi operates with great accuracy and speed. An object is photographed by the navigation system's camera module, processed using the single shot detection (SSD) algorithm, and then converted to text by an optical character recognition (OCR) engine before being communicated over the speaker using the text-to-speech (TTS) converter tool. The object recognition and the text navigation system are specially designed for blind individuals to operate the tool conveniently in a solitary manner.**

Keywords*— *Visual impairments, text navigator, obstacle detection, Ultrasonic sensor, Raspberry Pi, Single Shot Detection (SSD) algorithm, Text-to-Speech (TTS) converter.

I. Introduction

One of the main disabilities that blind individuals encounter globally is visual impairment. The circumstance results in the loss of the irreplaceable sensitivity of perception. Visually impaired people struggle in both their daily and social lives. Blind person finds it difficult to recognize what is in front of them without touching it with their hands. We've discussed a cutting-edge method for designing a set of assistive technology for the blind. A portable, user-friendly tool has been created that can identify blockages using an ultrasonic sensor and a Raspberry Pi. If the barrier is proximate, Raspberry Pi sends a signal to activate a buzzer and issues a voice command via the headphones. The initiative attempts to inform blind persons of the presence of a barrier in front of them, as well as what impediment it is and how far away it is. For instance, people can erroneously assume that the cell phone is in front of them instead of a large-sized television. So, it is crucial that you understand what the item is. The full specifics of its position are brought to the individual's attention, For example, a cell phone is in front of them at a distance of 30 inches along with a buzzer sound. The use of sound instructions allows the gadget to serve as both a text navigator and an identification system for those who are blind or partially sighted and are experiencing vision loss. Individuals who are blind or visually impaired can benefit from object recognition and the Textual Navigation system, which transforms text into speech. They may apply the tool without the intervention of others.

II. Literature Survey

[1] By locating the path, identifying obstacles in front of them, and avoiding them as a result, The paper makes it easier for a blind person to walk. The YOLO object detection technique, which makes use of the COCO dataset, is used put into practice.

[2] Based on a paper called the Smart E-cane, we discovered that employing different canes could be helpful to identify a high-raised surface in front of a person. The depth of an object is clearly depicted. A self-sufficient way of life is emphasized. The things that are at a sudden depth, obstacles higher than waist level, or staircases, are also included, focusing on the significant risk they pose. The camera detection approach is applied.

[3] A blind-friendly interface is created to distribute User Interface Artefacts (UIAs), such as labels, buttons, layouts, and panels across various devices. The user experience is enhanced by the framework's customization of UI elements into streamlined, blind-friendly user interfaces for smartphones and wearables.

[4] The third eye or "additional vision" provided by Arduino Bases allows blind persons to navigate obstacles while on foot. The ultrasonic sensor and the Arduino, which was programmed for sensor and buzzer vibration to help with collision avoidance, perform the object-detecting work.

[5] The paper named Raspberry Pi Based Reader for Blind People is an automatic document reader for those with visual impairments. It makes use of computer programming and image-sensing tools to identify printed characters using optical character recognition technology. A method to extract text from penned documents, transform it to machine-encoded text, produce text files, and then use Digital Image

Analysis to process them such that the content is output as audio has been suggested.

[6] A picture or video (many frames) that have been collected and analyzed using a camera connected to a Raspberry Pi will be the input. Thus, the object is discovered, and the blind individual receives audio information via earphones.

[7] The essay serves as a survey of many computer science, voice recognition, and image recognition approaches to assist the blind. The idea is implemented by creating an Android application that can assist the user using voice commands, acknowledge and analyze the surrounding environment, and provide an appropriate answer. It provides a productive alternative for persons with visual impairments to use their smartphones to engage with their surroundings.

[8] The aim was to give visually impaired people a wearable device with a virtual assistant system so they could perform some of the more fundamental chores on their own without assistance. The system was designed to give blind individuals voice-over assistants to help them with things like reading, interpreting their environment, finding an object, identifying emotion in someone's face, etc.

[9] A "smart cane" has been created. It supports the person and directs them toward successful task completion. With the aid of many sensors installed in it, it recognizes all obstructions in its way. The microcontroller may access the information and transmit it as vibrations that can alert the user to roadblocks. It is an environmentally friendly device that can be very helpful to the blind.

[10] The reference paper, Book Reader, described an assisted reading system based on the use of a camera for persons who are blind people to read text on printed materials, labeling, and physical copies of papers. The work translates text from an image to a voice after text extraction. They may be created on a Raspberry Pi with a battery backup, and the intelligent reader will be very helpful for persons who are blind as well as for average people.

[11] The purpose of the study was to offer a thorough set of recommendations for establishing navigation apps for people with disabilities. To assist consumers in navigating a retail mall, the rules were integrated into a prototype interface. The prototype proved that the suggested design principles are easily implementable and offered a blueprint for the upcoming creation of navigation apps for individuals with various types of disabilities.

[12] The Dark Light seeks to open up the blind to the outside world. The has an ultrasonic sensor attached to an Arduino and it delivers audio data to users using headphones to communicate the measured distance of a barrier in front of them. It can be tracked, and Google Assistant will direct blind persons to their precise location when moving. Up to around 2 meters is the maximum distance the device can measure.

[13] The Smart Stick has a camera and raspberry pi attached to it that aid in the identification of objects that provide obstacles for blind people. These objects can be easily detected and communicated to blind people using earbuds that are firmly connected to them. For the intention of preventing the puddles, a further sensor is added to the auditory warnings and positioned at the bottom of the stick. Using the Dark Flow and YOLO algorithm will enable the purpose.

[14] A moisture sensor, two ultrasonic sensors, and a Pi camera module are included in the proposed system. When an object is detected nearby, the system determines its nature and gives input in the form of speech, such as a warning, through an earphone. The overall system's objective is to provide blind people with a cost-effective, reliable method of collision avoidance and wayfinding that gives them the perception of artificial vision by informing them of the static and moving objects in their environment, enabling them to move around on their own. The deep learning technique utilized is the methodology that is thought to be the best for predicting the results of object detection. The device activates whenever an object is close by and notifies the user through an audio message whether the thing is nearby or far away.

[15] The study proposes a technology that will assist blind individuals in navigating and transmitting messages to family members. A working model that consists of a walking stick with an integrated controller and an electronic switch (e-SOS). According to programming, the camera is used to take pictures of traffic lights and then sends signals to the blind individual to help him navigate safely. Webcam records are sent to the Raspberry-pi Controller upon photo click. The person will receive some necessary details about light levels through the headset through the photo processing software.

[16] A face- and text-recognition architecture based on Raspberry Pi that is primarily intended for blind navigation has been put up. The model's primary goal is to assist blind people by directing them to utilize the system design. It can identify faces, barriers, signs, and humans like known and unidentified people utilizing face and text recognition features. To assist and direct the blind individual, it outputs the scanned and recognized visuals as audio. It was created specifically for blind navigation.

[17] The technology is affordable, lightweight, straightforward, and wearable with ease. The pi-camera has been used to take the picture, and a controller is provided to move the camera in the desired direction. The module is built inside the stick. The system is then modified to better meet the needs of the user using the insightful information gleaned from the feedback.

[18] The experiment does a comparison of object detection using YOLO (You Only Look Once) and mobilenet SSD (Single Shot Detection). The model analyses object detection models based on their operational performance in different scenarios. Following a number of tests, it was shown that SSD delivers a greater speed but lacks a little bit in accuracy. It comes to the conclusion that judgments must be rendered in accordance with the requirements.

[19] The study presents a goal to draw attention to flexible design and apps, as well as uses for smartphones as assistive technology for people who are blind or visually impaired, including educational ones. Additionally, it covers user benefits and difficulties as well as usability testing is done by app makers. People with visual impairments can carry out daily tasks, autonomous working, transportation, social inclusion and engagement, education, etc. thanks to a variety of built-in accessibility features and third-party accessible applications.

[20] The study called Smart Blind Stick has made an effort to suggest the design and creation of a practical stick that can assist the blind. We typically achieve the goal by

integrating sensors into the cane in predetermined locations that provide information about the environment to the user via audible feedback.

III. Existing System

The outcomes of many literature reviews led to the following conclusions. Many real-time image processing applications, such as face identification, home monitoring systems, CCTV (Closed-Circuit Television) cameras, etc., use portable, low-power microcontrollers like the Raspberry Pi.

Object recognition and sound wave production are carried out via ultrasonic sensors. Radar systems operate similarly to how an ultrasonic sensor does. Acoustic waves can be produced by an ultrasonic sensor by converting electrical energy, and vice versa. It has been found that the sensor allows for the detection of surrounding objects. With several circuit boards, like the Arduino, Raspberry Pi, and others, they can be connected.

It can be assumed that we can use a variety of OCR (Optical Character Recognition) techniques to convert an image to text. For instance, Google Lens and other widely used applications utilize the standard. Many algorithms are available to us that enable text-to-speech conversion. We may actually learn that different Natural Language Processing Algorithms have been employed for the goal by looking through various research publications.

Based on earlier initiatives, it is evident that the optimum method for locating objects is to use ultrasonic sensors. Alarms can be used to locate a specific object. That, however, falls short of what a blind person needs. Distance and awareness of what is in front of them are needed.

There were several drawbacks in the prior models, such as the inability to identify the name of the obstacle in front of a blind person, which resulted in a lot of misconceptions on the part of the user. But recently proposed certain models tried resolving the issue of image recognition but failed in terms of the algorithm used CNN or YOLO has been the preferred algorithm each of which has its own limitations while other better algorithms can be employed which provide better precision and speed.

Details on the user's proximity from the device are also missing from the existing models which can be a huge limitation.

IV. Proposed System

A. Description

Only the detection of a hindrance cannot tell them what is blocking their path. For their next actions, they must know what the object is. For instance, they might mistake a tiny obstruction like a cat for a larger obstruction like a cow, or the opposite. Therefore, it is crucial to identify any obstacles and their location. Therefore, it can be a cause for concern. We have attempted to create a machine that addresses the problem by using it as a starting point or a limitation in the already suggested systems. The model aims at solving by using the single shot algorithm. We have also made efforts to use the SSD algorithm for image recognition other than the previously employed CNN (Conventional Neural Network) and YOLO algorithm which has been proven to be the best for the purpose. However, if the visual impairment is an issue, you also need to concentrate on providing verbal information that explains the provided context. To improve the user application, a text-to-speech conversion feature is necessary. A model that can recognize and speak aloud about the object and its location, is being presented.

V. Methodology

A. Description

The described technique gives an indication of how someone can effectively use technology to get around their impairments. The proposed system is intended to work on finding familiar products without having to use their touching and smelling abilities, along with gap-distancing them. The model works by capturing things on a live camera and periodically updating the person with audio text. The facility, when combined with available devices such as a walking cane, a head wearable device, or a watch, could actually increase usage of the discussed subject.

B. Flow Diagram

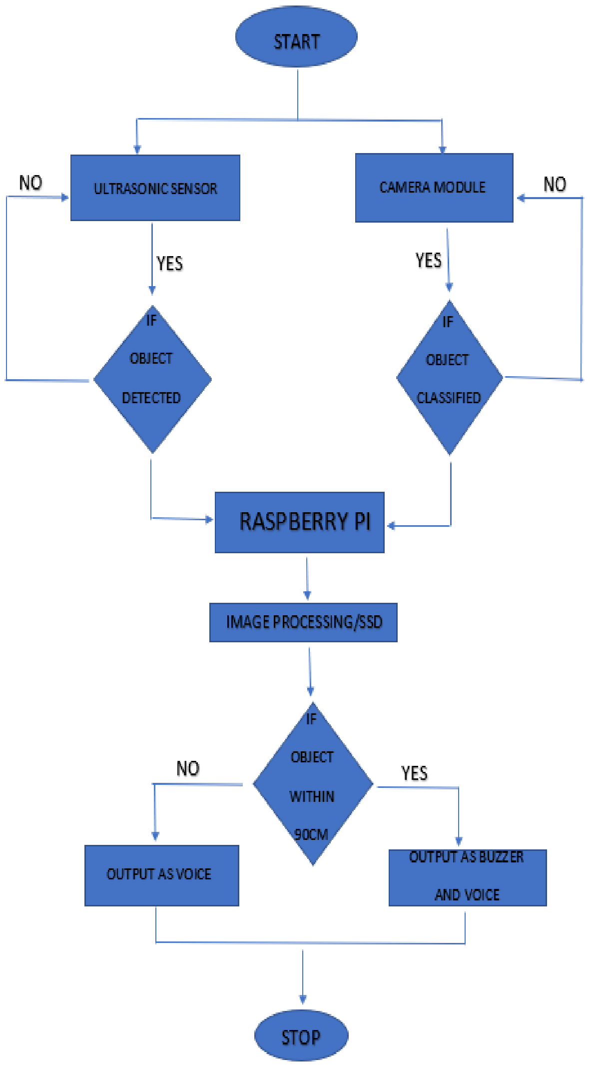

Fig 1. Flow Diagram

C. System Architecture

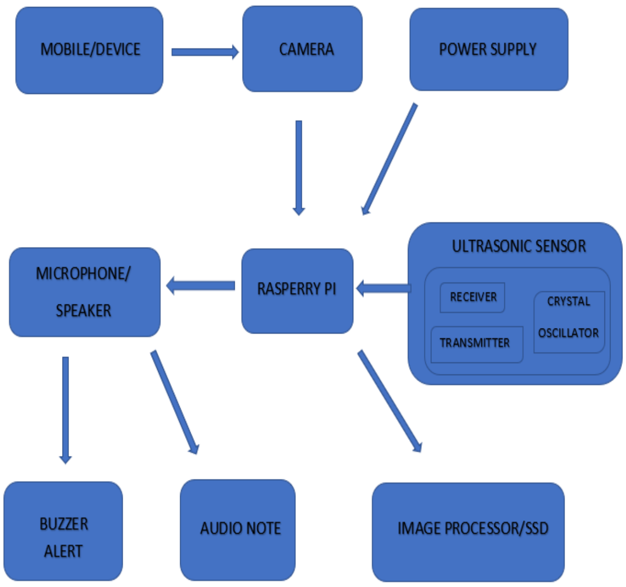

Fig 2. System Architecture

D. Modules

➢ *Object Detection Using Ultrasonic Sensor*

The existence of an object is detected by a proximity sensor, which is a non-contact sensor when the object enters the sensor's field of view. One such proximity sensor tool is the ultrasonic sensor which is utilized for detecting an object. When the sent signal encounters an obstruction, the sensor sends out a signal that is reflected back. The bouncing signal will be read by the sensor, which will then compare it to the initial signal sent out. The sensor will assume it has come across an impediment if there is a disparity between those signals. The crystal oscillator keeps track of the count as the ultrasonic sensor transmits and receives trigger and echo for a certain amount of time using its transmitter and receiver modules. The procedure begins as soon as the power supply is turned on; its output is then used to determine the distance at a later time. Here, the ultrasonic distance measuring module is used to determine how far apart the person and the object are.

➢ *Object Capturization Using Camera*

The placement of a camera allows for the detection of things in the path on the camera's display. When an object is identified, it starts functioning by giving input to the raspberry pi port in addition to the input of the ultrasonic sensor's detection. In case, a straightforward web camera that can record both still images and video has been deployed. A faster detection rate may be achieved with more sophisticated camera solutions.

➢ *Connections in Raspberry pi Port*

Out of the microcontrollers available, Raspberry pi is the most suited tool for machine learning algorithms. Users of the Raspberry Pi may easily manage another operating system thanks to the remote access capability. Although Python is likely the most adaptable and user-friendly programming language, the Raspberry Pi may also be programmed in a variety of other languages, such as Java and C++. The image recognition and text navigational technologies are both housed on a single device known as the Raspberry Pi. The Raspberry Pi operates with great precision and a speed of 900MHz. The image is sent to the raspberry pi port by the camera module that captures it. The distance calculated using the ultrasonic sensor detection is saved into the Raspberry Pi. There is also a headphone jack for listening to the output. At that stage, the majority of the image processing and distance calculation is completed.

➢ *Image Processing using SSD Algorithm*

The intake for image processing is an image, a collection of visuals, or a video, such as a portrait or a video frame. The image is processed by numerical computations using any sort of signal processing. A picture or a set of metrics or features relating to the picture may be the outcome of image analysis. The camera's acquired image, which the Raspberry Pi accepts as input, is then taken for additional processing. The SSD algorithm is utilized in the situation because of its capacity for greater accuracy and quicker speed. The image at a moment is classified as a grid and conclusions are made accordingly. The COCO (Common Objects in Context) dataset is taken into account here.

A model with a high level of precision and recall will benefit from a solid dataset. A massive dataset for object detection, image segmentation, and captioning released by Microsoft called MS COCO is utilized. Engineers in machine learning and computer vision frequently use the COCO dataset for a range of computer vision studies. Real-time object detection techniques are frequently compared using COCO as a benchmark. Advanced neural network libraries automatically interpret the COCO dataset's format COCO was developed by gathering natural pictures, and images that show everyday life and include background information. In a typical scene, numerous items may be present; each should be identified as a distinct entity and properly segmented. The classification and segmentation of the items in the photos are provided by the COCO dataset. Dataset annotations can be used to train machine learning models to identify, categorize, and describe items. Certain pre-trained items are included in the classes of the COCO dataset for object detection and tracking. However, the data only makes use of 80 of Coco's total 91 classes. A total of 328K photos make up the collection. Approximately 25 GB makes up the dataset.

➢ *Distance Calculation*

A measurement of how far away the thing is from the blind person is made. It is accomplished by employing the HC SR04 ultrasonic sensor. The sensor is equipped with four pins. The ground is linked to pin 6, Trigger to pin 16, Echo to pin 18, and VCC to pin 1. Pin 1 is used for VCC. The ultrasonic sensor generates a specific amount of ultrasound in Hertz. It bounces back after getting into contact with an object in a path. The interval between wave emission and reception is used as a benchmark.

It can be applied to objects up to 400 cm. The calculated time is stored in the raspberry pi port. Using the following formula, the distance is computed.

Distance= (Time Elapsed*34300)/2

where, Time Elapsed =Stop Time–Start Time

34300-Speed of Sound

➢ *Presenting the Output as Voice Note*

In order to provide the results in an auditory output that is suitable for individuals who are visually andicapped, the text reader system is being utilized. It makes use of the pyttsx3 package in python. Python's pyttsx3 library serves to convert text to speech. The obstacle's identity and also its approximate distance is acquired using the voice synthesis process. The speaker or the headphone has to be connected to the raspberry pi (As easy as plugging in a headphone port on a phone or laptop). This section reads the discovered output for usage. Additionally, a buzzer is also connected to the Raspberry Pi. The buzzer sound also alerts the blind individual if the object is detected within 90 inches of the camera.

E. *Algorithm Used*

SSD is intended for real-time object detection. It has been demonstrated to be the best algorithm for processing images, outperforming conventional techniques. The SSD model detects objects in a single pass, which significantly reduces the amount of time required. Training and testing datasets with given class labels and ground truth bounding boxes are required. The Pascal VOC (Visual Object Classes) and COCO datasets are a good and decent starting point.

The image is divided into grids by SSD. Each grid cell in the image is assigned the task of identifying items in its respective region. To detect an object, all that is necessary is to predict its type and location within that zone. The location is disregarded and treated as the background class if no item exists no item present there. To naturally handle objects of varied sizes, the Single Shot Detector network integrates predictions from many feature maps with different resolutions.

SSD advantages include:

- With SSD, all computation is contained in a single network, eliminating proposal development and any following pixel or feature resampling stages.
- Systems that need a detecting component can incorporate it easily and with little training.
- In addition to being substantially faster and offering a single framework for both training and inference, SSD is more accurate than approaches that include an additional object proposal phase.

Fig 3. Object detection using SSD

VI. Result and Discussions

A. *Experimental Setup*

The components are connected and setup as in the given diagram

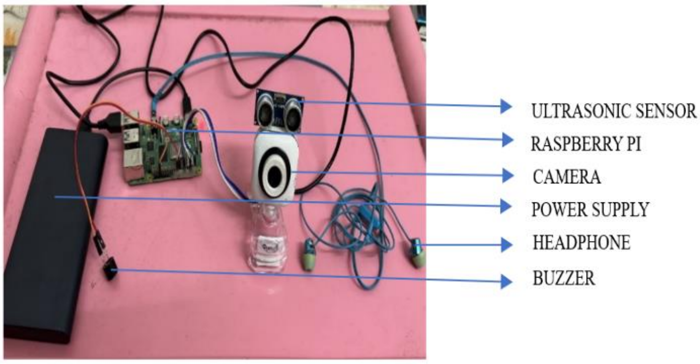

Fig 4. Connections of the Model

B. *Observations*

After successful execution of the model, we would be able to find the name of the object classified and also along with at what distance it is. The snapshots of the moving video appear as images one after another on the screen.

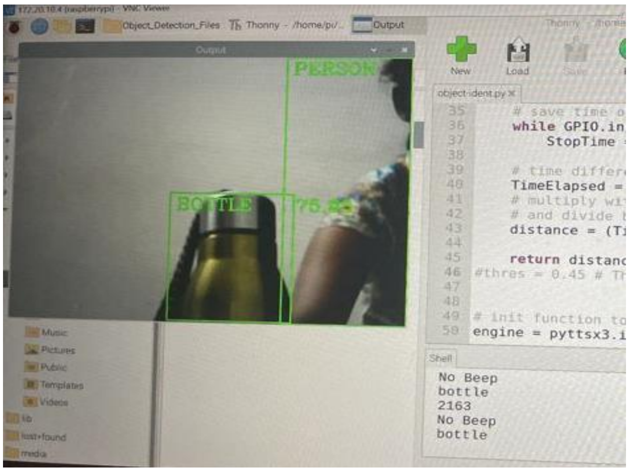

Fig 5. The output of Image Recognition

The output appears as a text for reference.

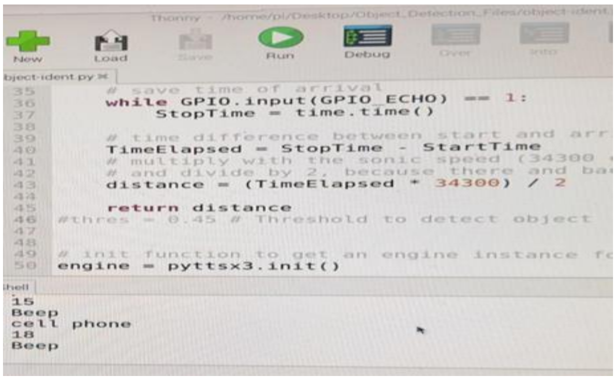

Fig 6. Written output appearing on the Screen

The output is also played in an audio format for visually impaired people which is the major purpose of the model.

C. Why use SSD?

The single-shot detector is frequently the preferable option, which is why SSD is used. We primarily desire faster predictions on an image for recognizing larger objects, when precision is not an especially significant concern, which is the fundamental justification for employing the single-shot detector.

The COCO, ILSVRC, and PASCAL VOC datasets are just a few examples of the many datasets that may be used to train and test the Single-shot detector. They can effectively detect larger objects, such as persons, bananas, cell phones, etc.

With reference to the paper cited [18], certain findings can be drawn regarding why SSD is the optimum method for image analysis in the situation of the blind. Following a comparative investigation of related image recognition systems, the paper makes several recommendations. Jaccard Index, also known as the Intersection over Union (IoU), is frequently used as a scoring metric to assess the speed and accuracy of detections. It can be estimated by dividing the area of the union between the expected detection and the ground truth by the area of the union among the predicted value and its corresponding ground truth value.

When there is a tendency to square measure to run it on a video and the truth trade-off is hence really small, SSD might be a better option. When exactness is taken into account instead of wanting to move quickly, YOLO is a superior choice. Each of the compared models has distinct qualities of its own and is effective in the applications it is used in. So, when real-time identification is chosen to take as a prime concern where the input is in form of a succession of large-sized images or videos for the visually impaired people speed plays a crucial influence than the precision changes.

Conclusion

Technology has touched the lives of people in different ways. It has not found an excuse in the case of visually impaired people also. Every defect has to be fixed with a healing treatment. One such way to mend the lives of blind people is by helping them out with an assistive system on their day-to-day living basis to improve their quality of life. By employing this model, the person would gain knowledge of the name of the thing in front of them. The items in his local vicinity, such as his home, are familiar, and so is the distance separating him from that object. The sound of the alarm also causes one to get more cautious as they get closer to a barrier or hindrance. This strategy helps people carry out daily tasks at their convenience. The idea suggests a low-cost solution to the problems with blind people's independent mobility and navigation. In the mere future, this technology may be used in conjunction with other strategies for mending vision impairments such as safety purposes related to healthcare like alerting family members or friends in an emergency, and also in some cases of future educational objectives. Future introduction of other image detection algorithms and libraries still hold a lot of promise for us.

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