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An AI-Based Visual Aid with Integrated Reading Assistant for the Completely Blind

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ABSTRACT: Blindness prevents a person from gaining knowledge of the surrounding environment and makes unassisted navigation, object recognition, obstacle avoidance, and reading tasks a major challenge. In this work, we propose a novel visual aid system for the completely blind. Because of its low cost, compact size, and ease-of-integration, Raspberry Pi 3 Model B+ has been used to demonstrate the functionality of the proposed prototype. The design incorporates a camera and sensors for obstacle avoidance and advanced image processing algorithms for object detection. The distance between the user and the obstacle is measured by the camera as well as ultrasonic sensors. The system includes an integrated reading assistant, in the form of the image-to-text converter, followed by an auditory feedback. The entire setup is lightweight and portable and can be mounted onto a regular pair of eyeglasses, without any additional cost and complexity. Experiments are carriedout with 60 completely blind individuals to evaluate the performance of the proposed device with respect to the traditional whitecane. The evaluations are performed in controlled environments that mimic real-world scenarios encountered by a blind person. Results show that the proposed device, as compared with the white cane, enables greater accessibility, comfort, and ease of navigation for the visually impaired.

KEYWORDS: Blind people, completely blind, electronic navigation aid, Raspberry Pi, visual aid, visually impaired people, wearable system,YOLOalgorithm,voice output.

I. INTRODUCTION

1.1 Introduction

One of the major daily problems encountered by visually impaired people is unsafe mobility. They fail to detect and avoid obstacles in their path, thus causing them emotional suffering, undercutting their independence, and exposes them to injuries. A recent World Health Organization (WHO) statisticshow that there are approximately 253 million individuals around the world who are visually impaired. There are 217 million individuals with vision impairment, while 36 million people are blind. The visual impairment is turned into a matter of great concern as the number of visually impaired people tends to increase by 2 million per decade. The number of blind people is estimated to double by 2020. People with vision impairment and vision ailments need help to perform day-to-day tasks, such as walking and exploring unfamiliar environments.Millions of people live in this world with incapacities of understanding the environment due to visual impairment. Although they can develop alternative approaches to deal with daily routines, they suffer from certain navigation difficulties as well as social awkwardness.This paper aims at exploring the possibility of using the hearing sense to understand visual objects. The sense of sight and hearing sense share a striking similarity: both visual object and audio sound can be spatially localizedThe methodology of this work includes Object Extraction, Feature Extraction, and Object Comparison.

1.2 Image processsor:

An image processor does the functions of image acquisition, storage, preprocessing, segmentation, representation, recognition and interpretation and finally displays or records the resulting image. The following block diagram gives the fundamental sequence involved in an image processing system.

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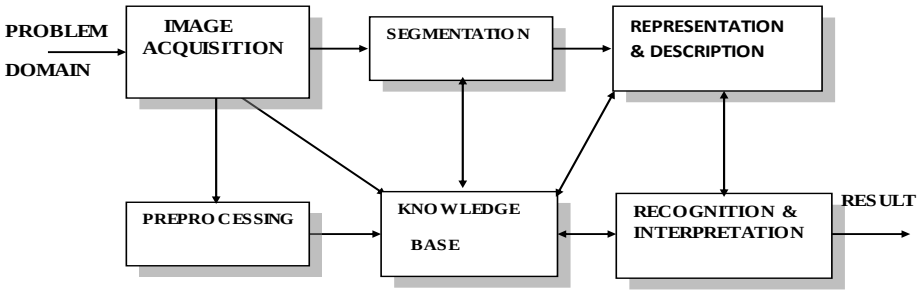

FIG 1.2 BLOCK DIAGRAM OF FUNDAMENTAL SEQUENCE INVOLVED IN AN IMAGE PROCESSING SYSTEM

As detailed in the diagram, the first step in the process is image acquisition by an imaging sensor in conjunction with a digitizer to digitize the image. The next step is the preprocessing step where the image is improved being fed as an input to the other processes. Preprocessing typically deals with enhancing, removing noise, isolating regions, etc. Segmentation partitions an image into its constituent parts or objects. The output of segmentation is usually raw pixel data, which consists of either the boundary of the region or the pixels in the region themselves. Representation is the process of transforming the raw pixel data into a form useful for subsequent processing by the computer.

1.3 Image Preprocessing:

In preprocessing section, the input image may be in different size, contains noise and it may be in different color combination. These parameters need to be modified according to the requirement of the process. Image noise is most apparent in image regions with low signal level such as shadow regions or under exposed images. There are so many types of noise like salt and pepper noise, film grains etc., All these noise are removed by using filtering algorithms. Among the several filters, wiener filter is used. In preprocessing module image acquired will be processed for correct output. Pre-processing was done by using some algorithm. For all images the pre-processing should be done so that the result can be obtained in the better way

1.4 Feature Extraction:

Statistics is the study of the collection, organization, analysis, and interpretation of data. It deals with all aspects of this, including the planning of data collection in terms of the design of surveys and experiments. This is the meaning of statistics. Statistical feature of image contains • Mean • Variance • Skewness • Standard deviationTexture Analysis Using the Gray-Level Co-Occurrence Matrix (GLCM). A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix.

1.5 Classification:

In order to classify a set of data into different classes or categories, the relationship between the data and the classes into which they are classified must be well understood. To achieve this by computer, the computer must be trained Training is key to the success of classification techniques were originally developed Features are attributes of the data elements based on which the elements are assigned to various classes. 1).The image classifier performs the role of a discriminant - discriminates one class against others. 2).Discriminant value highest for one class, lower for other classes (multiclass) 3).Discriminant value positive for one class, negative for another class (two class).

OBJECTIVE

This project involved Artificial intelligence to detect and analyze objects and send details via speaker.In the proposed work,we solve the existing system problem by using dark net YOLO techniques that are used to reduce the recognition time of multi objects in less time with best time compexities.This system hopes to allow the visually impaired users to simply press a button,speak the desired destination and be guided there with the use of audio instruction.

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PROBLEM STATEMENT

Blind people come across a number of challenges in everyday life from reading a book to walk on the street.Many tools are available to meet the challenges faced by them,but they are not sufficient.The most essentials thing a human can have vision and it plays a very essential role in the life of a person either a person can see or not. A visually challenged people need an assistant to carry on work on daily basis.Without vision it can be challenging for a visually impaired person to navigate through a room or a hallway without bumping into obstacles. Even with a aid,such as walking stick, it can be sometimes inconvenient,uncomfortable, and perhaps inaccurate in avoiding obstacles.We have discussed the challenges faced by blind people and tried to provide a satisfactory solution to them for working everyday life.

II. LITERATURE SURVEY

2.1TITLE: Visual and Infrared Sensor Data-Based Obstacle Detection for the Visually Impaired Using the Google Project Tango Tablet Development Kit and the Unity Engine
AUTHOR: RabiaJafri, Rodrigo Louzada Campos
YEAR: 2019
DESCRIPTION: A novel visual and infrared sensor data-based system to assist visually impaired users in detecting obstacles in their path while independently navigating indoors is presented. The system has been developed for the recently introduced Google Project Tango Tablet Development Kit equipped with a powerful graphics processor and several sensors which allow it to track its motion and orientation in 3D space in real-time. It exploits the inbuilt functionalities of the Unity engine in the Tango SDK to create a 3D reconstruction of the surrounding environment, then associates a Unity collider component with the user and utilizes it to determine his interaction with the reconstructed mesh in order to detect obstacles. The user is provided with audio feedback consisting of obstacle warnings.

2.2TITLE: Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis
AUTHOR: Rupert R A Bourne, Seth R Flaxman
YEAR:2020
DESCRIPTION: Global and regional prevalence estimates for blindness and vision impairment are important for the development of public health policies. We aimed to provide global estimates, trends, and projections of global blindness and vision impairment. Methods We did a systematic review and meta-analysis of population-based datasets relevant to global vision impairment and blindness that were published between 1980 and 2015.

2.3TITLE: An Electromagnetic Sensor Prototype to Assist Visually Impaired and Blind People in Autonomous Walking
AUTHOR: E. Cardillo, V. Di Mattia, G. Manfredi
YEAR:2019
DESCRIPTION: The feasibility of an electromagnetic sensor to assist the autonomous walking of visually impaired and blind users is demonstrated in this paper. It is known that people affected by visual diseases usually walk assisted by some supports, among which the white cane is the most common. Our idea consists in applying a microwave radar on the traditional white cane making aware the user about the presence of an obstacle in a wider and safer range. Compared to the already existing Electronic Travel Aids devices, the proposed system exhibits better performance, noise tolerance and reduced dimensions. In the following, the latest developments of this research activity are presented, with special concern for the miniaturization of circuit board and antennas

2.4TITLE: Outdoor difficulties experienced by a group of visually impaired Iranian people
AUTHOR: Abbas Riazi a, FatemehRiazi
YEAR:2019
DESCRIPTION: A qualitative approach using semi-structured individual interviews was used to elicit common outdoor difficulties in individuals with visual impairment. Methods: Interviews were recorded and then transcribed verbatim into text for thematic analysis. Twenty legally-blind individuals aged 34.25 ± 2.41 years with different etiologies were included in this study. Results: All participants had experienced some sort of difficulty in outdoor environments.

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2.5TITLE: Interface for Human Machine Interaction for assistant devices: A Review
AUTHOR: Saifuddin Mahmud
YEAR:2020
DESCRIPTION: Interface for the Human Machine Interaction has become a prominent area of research due to the rapid growth of automation and robotics in the recent few decades. Although an abundance of frameworks have been emerged to make the interaction between human and machine easy and robust, a substantial portion of these is not flourished in their scope. Through this review, we have tried to reveal different types of interfacing technique between human and machine to exhibit the evolution of the related technologies in developing assistant devices. This review explores the contemporary groundbreaking technologies developed for this purpose and their advantages and limitations. An outline is drawn for forthcoming development in the field of human machine interaction, human computer interaction and human robot interaction by using this review .

III. METHODOLOGY

Project entitled as blind assistance device using AI,mainly consist of two divisions in which one is "facial expression recognition" and other one is "text to speech conversion".We are combining two of these and deploying to raspberry pi device along with a pi camera.We are arranging two switches for each operation respectively.For both the operation image will be scanned through the camera.once the input is being scanned,for the face expression program switch one need to be pressed and it will perform facial expression operation similarly switch 2 will perform the text recognition to speech converion.The output is then relayed to the user through headphone or speaker or audio device.

IV. EXISTING SYSTEM

In this existing system blind people using ultrasonic sensor. Ultrasonic sensor fixed in blind people stick, if any object detect by ultrasonic in front of blind people, buzzer will be on. And a Sensing Module with Arduino as the microcontroller and Ultrasonic Sensor and IR Sensors at different positions so that it can properly detect the obstacles are used. OpenCV based object detection implemented. But it could not find object accurately Object recognition done with mat lab software. But it's a simulation output. A road surface smoothness detection systems capable of detecting obstructions in front of a person and generating a warning that notifies users but is unable to detect potholes on the road surface. The system developed was able to identify potholes but was only modeled in simulation.

Disadvantages:

It's a simulation software. So we could not implement in real-time
Output accuracy low

V. PROPOSED SYSTEM

In this proposed system we will find objects in real time using AI, OPENCV, YOLO (You only live once).After acquisition of image it has to be pre-processed and compressed. Various daily use objects' images are used to train the model. It is trained by performing feature extraction on the image to obtain the required pattern in the image. Followed by feature fusion and dimension reduction to compress the image for reliable and real time performance. Then this YOLO dataset is used to train the classifier. Comparing the performance of various classifiers we select the optimum one, and thus the object recognition model is achieved. Now any test image may be given to this model which will be classified into one of the classes the model has been trained into.

Advantages:

YOLO is extremely fast

Accuracy high and low cost

Implement to any processor with its dependencies

VI. IMPLEMENTATION

The Raspberry Pi Foundation has developed a variety of low-cost single-board computers in the UK to promote computerscience education in schools and developing countries. The original model was significantly more popular than expected and wassold for applications such as robotics outside the intended market. Peripherals (keyboard, mouse,

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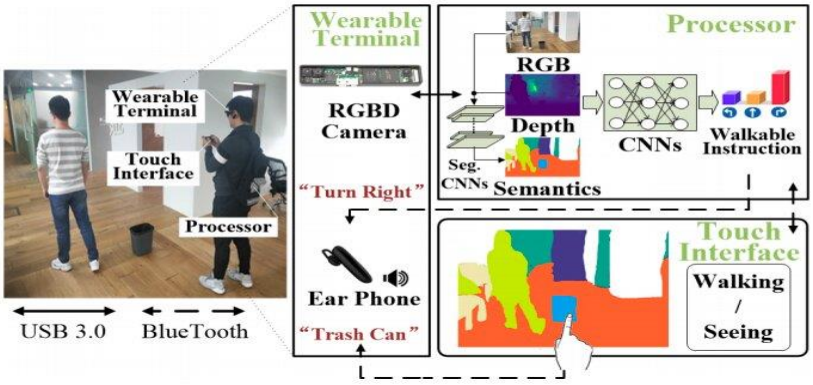
etc.) and housing are not included.On the other hand, some accessories are included in many official and unauthorized bundles. With a webcam you can do just that.You can connect one of these little insect-eyed cameras to your computer and send your own or home photos to the world. Webcamsare similar to digital cameras in that they work in the same way. However, unlike digital cameras, it is designed to create small digitalphotos that you can easily publish on your website or share on the Internet. Everything looks very simple, but how does a webcamreally work? The piezoelectric buzzer makes a sound by reversing the piezoelectric phenomenon. The essential principle is to createpressure fluctuations or strains by applying a voltage to the piezoelectric material.



6.1 PROCESSOR:

The processor is a chip or a logical circuit that responds and processes the basic instructions to drive a particular computer. The main functions of the processor are fetching, decoding, executing, and write back the operations of an instruction.

6.1.1 WEB CAM:

A webcam is a video camera that feeds or streams its image in real time to or through a computer to computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and email as an attachment. When sent to a remote location, the video stream may be saved, viewed or of sent there.

6.1.2 OPEN CV:

Open Source Computer Vision Library' initiated by some enthusiast coders in '1999' to incorporate Image Processing into a wide variety of coding languages. It has C++, C, and Python interfaces running on Windows, Linux, Android and Mac. Officially launched in 1999 the Open CV project was initially an IntelResearch initiative to advance CPU-intensive applications, part of a series of projects including real-time ray tracing and 3D display walls. The main contributors to the project included a number of optimization experts in Intel Russia, as well as Intel's Performance Library Team.

6.1.3 YOLO:

You Only Look Once (YOLO) is a network that uses Deep Learning (DL) algorithms for object detection. YOLO performs object detection by classifying certain objects within the image and determining where they are located on it.

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For example, if you input an image of a herd of sheep into a YOLO network, it will generate an output of a vector of bounding boxes for each individual sheep and classify it as such.

6.1.4 The YOLO Algorithm:

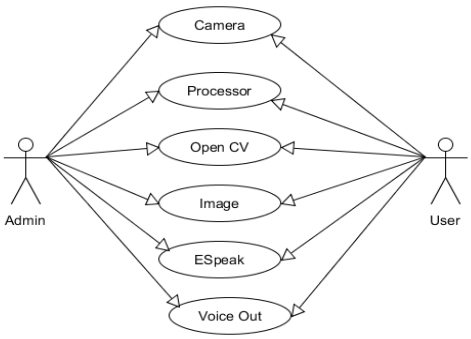
Once you insert input an image into a YOLO algorithm, it splits the images into an SxS grid that it uses to predict whether the specific bounding box contains the object (or parts of it) and then uses this information to predict a class for the object.Before we can go into details and explain how the algorithm functions, we need to understand how the algorithm builds and specifies each bounding box. The YOLO algorithm uses four components and additional value to predict an output.

The center of abounding box (b_x b_y),Width (b_w),Height (b_h) and **The Class of the object (c)**

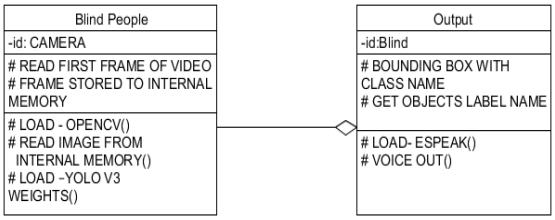
The final predicted value is confidence (p_c).

VII. SYSTEM DESIGN

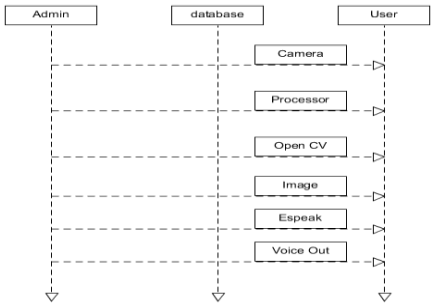
USECASE Diagram:



CLASS Diagram:



SEQUENCE Diagram:



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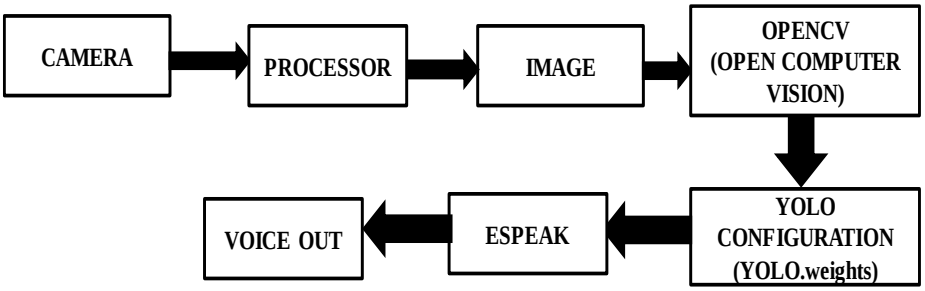
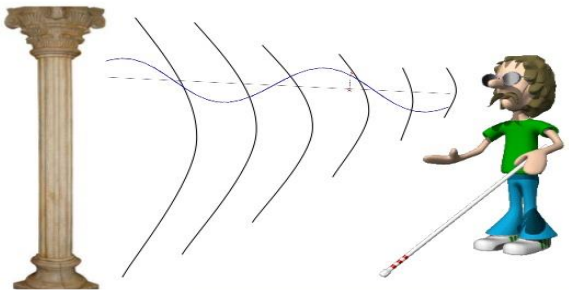
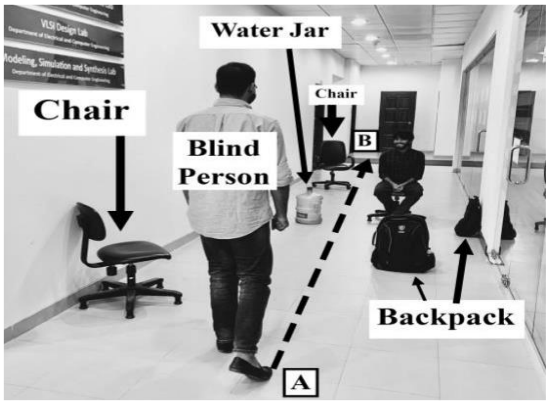
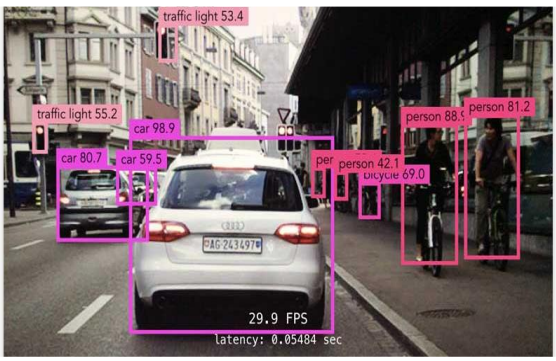
MODEL LAYOUT





VIII. RESULTS





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IX. CONCLUSION

The project started with the motivation and the idea to solve the problems of visually impaired people. Many methods were found to implement object detection and the usage of Open CV Library and YOLO was the best choice. We present a visual substitution system for blind people based on object recognition in frames. This system uses Yolo configuration, weights and features matching for object identification. We devote the experimental part to test the application in order to detect some objects in some frames withdifferent conditions. This project presents a novel navigation device for the visually impaired groups to help them reach the destination safely and efficiently.

X. FUTURE ENHANCEMENT

Future it can be used for other Indian languages and there is a heavy demand for OCR system which recognize like palm leaves. It has a wide scope in Future in terms of ArtificialIntelligence and controlling everything by just a word.This system can also be used for making arobot which wouldactasaroadguiding robot with an inbuilt stick in it which will convert the image fromtexttospeech and accordinglynotifytheobstacles around the person.Developing devices that extract text from videos instead of static images.It will be concentrated on developing a highly efficient and fast effective text to speech conversion mechanism by the Machine Learning

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