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Smart Cap For Visually Impaired People Using Machine Learning

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Abstract— The people who are having complete blindness or low vision face many types of hurdles in performing every day routine works. Blindness can occur due to many reasons including disease, injury or other conditions that limit vision. Our aim is to develop a navigation aid for the blind and the visually impaired people. We design and implement a smart cap which helps the blind and the visually impaired people to navigate freely by experiencing their surroundings. The scene around the person will be captured by using a NoIR camera and the objects in the scene will be detected. The headset will give a voice output describing the detected objects. The architecture of the system consists of Raspberry Pi 3 processor, NoIR camera, headset and a power source. The processor collects the frames of the surroundings and convert it to voice output. The device uses TensorFlow API, opensource machine learning library developed by the Google Brain Team for the object detection and classification. TensorFlow helps in creating machine learning models capable of identifying and classifying multiple objects in a single image. Thus, details corresponding to various objects present within a single frame are obtained using TensorFlow API. A Text to Speech Synthesiser (TTS) software called eSpeak is used for converting the details of the detected object (in text format) to speech output. So the video captured by using the NoIR camera is finally converted to speech signals and thus narration of the scene describing various objects is done. Objects which come under different classes like mobiles, vase, person, vehicles, couch etc are detected.

Keywords: ***Raspberry Pi 3 processor, TensorFlow API, TTS, eSpeak, NoIR camera***

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I. INTRODUCTION

ision perception. Mobility and self-reliability for the visually impaired and blind people has always been a problem, they are not familiar with and usually require someone to help them navigate. They often bump into the obstacles present in their way thus hindering their free movement. According to WHO (World Health Organization), it is estimated that approximately 1.3 billion people live with some form of vision impairment. With regards to distance vision, 188.5 million people have mild vision impairment, 217 million have moderate to severe vision impairment, and 36 million people are blind. The conventional methods adopted like cane helps in avoiding the obstacles in their way but they do not help them identify and locate the objects.

Hence, assistance is required for the blind that helps him/her in locating objects in an environment. This project aims to help the blind in object detection and to provide an audio information about the object detected. The system helps the blind to navigate independently using real time object detection and identification. The proposed system consists of a Raspberry Pi-3 processor which is loaded with a pre-trained Convolutional Neural Network model (CNN) developed using TensorFlow. The processor is connected to a NoIR camera. The processor is coded in python. The NoIR camera captures the image in real time and will be provided to the Raspberry Pi-3 processor for processing it. The python code uses the COCO model to detect and classify the objects. It will draw boundary boxes around the detected and will also show the category index of the object. The category index of the detected objects will be stored in a text file. The category index consist of the class name and class id of the detected object.

The contents of the text file is converted to voice using the Text to Speech Synthesiser (TTS) software eSpeak. This system is portable and the user can easily carry it. Machine learning is termed as the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence.

Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or

infeasible to develop a conventional algorithm for effectively performing the task. It is closely related to computational statistics, which focuses on making predictions using computer.

II. RELATED WORKS

[1] Visually impaired people face lot of difficulties in their daily life. Most of the times they depend on others for help. Several technologies for assistance of visually impaired people have been developed. Among the various technologies being utilized to assist the blind, Computer Vision based solutions are emerging as one of the most promising options due to their affordability and accessibility. The main objective of the proposed system is to create a wearable visual aid for visually impaired people in which speech commands are accepted from the user. Its functionality addresses identification of objects and sign boards.

This will help the visually impaired people to manage day-to-day activities and to navigate through their surroundings. Raspberry Pi is used to implement artificial vision using python language on the Open CV platform. [2] Science and technology always try to make human life easier. The people who are having complete blindness or low vision faces many difficulties during their navigation. In this paper, we design and implement a smart cap which helps the blind and the visually impaired people to navigate freely by experiencing their surroundings. The scene around the person will be captured by using a NoIR camera and the objects in the scene will be detected. The earphones will give a voice output describing the detected objects.

The architecture of the system includes the processor Raspberry Pi 3, NoIR camera, earphones and a power source. The processor collects the frames of the surroundings and convert it to voice output. The device uses TensorFlow API, open-source machine learning library developed by the Google Brain Team for the object detection and classification. TensorFlow helps in creating machine learning models capable of identifying and classifying multiple objects in a single image Thus, details corresponding to various objects present within a single frame are obtained using TensorFlow API. A Text to Speech Synthesizer (TTS) software called eSpeak is used for converting the details of the detected object (in text format) to speech output. So the video captured by using the NoIR camera is finally converted to speech signals and thus narration of the scene describing various objects is done. Objects which come under 90 different classes like cell phone, vase, person, couch etc. are detected. [3] Human vision plays a vital role in awareness about surrounding environment. The term visual impairment covers wide range and variety of vision, from blindness and lack of usable sight; to low vision, which cannot be corrected to normal vision with standard eyeglasses or contact lenses. Visually impaired tools can assist them to enrich their lifestyle. To provide assistance to visually impaired people, this paper presents multi-sensor based system for object detection in indoor environment. Object detection is performed on a captured image using statistical parameters, which is further validated using support vector machine algorithm. To increase the accuracy of the object detection, multi-sensor concept is employed by interfacing ultrasonic sensor. Moreover, small object near feet is detected using infrared sensor.

Experimental results show efficacy of the proposed method. [4] This paper presents an effective method of providing dayto-day mobility aid to visually impaired people. An android application named X-EYE using LOOXCIE wearable camera is designed for blind people to navigate safely. Existing navigation aid systems use various hardware components such as sensors that are expensive and cause health hazards. The proposed system presents an economical solution using a wearable camera and a smart phone to provide safe navigation facility to the visually impaired user. X-EYE provides the features of obstacle detection, person recognition, location tracking and sharing, SMS reader, and language translation. Audio messages are specifically generated to provide better usability to the blind/visually impaired user.

The proposed system is robust to egocentric video limitations i.e. partial appearance of objects, sudden background change, jitter effects, and illumination conditions. Performance of the proposed method is evaluated on ten real-time egocentric videos. Experimental results indicate the effectiveness of our method in terms of providing safe mobility service to the visually impaired people.

[5] The simplest and the most affordable navigations tools available to them are trained dogs and the white canes. Although these tools are very popular, they cannot provide the blind with all information and features for safe mobility, which are available to normal people. The solution to this is to make any obstacles on the road easy to identify so that even the smallest unevenness on the path like a protrusion or a depression can be identified. In this paper, we present a cost effective and robust solution by the means of wearable and

III. BACKGROUND OF STUDY

portable assistive devices for visually-impaired people. We have used two main components, namely ultrasonic sensor Arduino Nano microcontroller. They are used in unison gyroscope which forms a critical element of the system along with other modules to create a prototype of an obstacle detection system.

The advantages and disadvantages of such a system as well as the functionalities which could be improved with the

addition of newer modules are all described here. [6] The objective of this paper is to guide unsighted people with smart device using an Android Phone. This device is an innovative and cause effective guide system for Visually Impaired People (VIP). Blind people major problem is to navigate the outdoor region. Voice is the main of scope, allows you to control your phone using your voice. This system based on Android technology and designed for trying to solve the impossible situation that afflicts the blind people.

The application helps the user to open any app as well as to call any contact through voice commands. Users can command a mobile device to do something via speech. These commands are then immediately interpreted by the Speech Recognition Engine(SRE) that converts speech into text for direct actions. This method also helps, when the VIP feels alone in a missing environment by allowing him to make a voice call to a known person. Apart from this, the system is added with a Selendroid app interface which enables the VIP to fetch the latest information from various web servers.

The latest information retrieved by the Selendroid architecture includes live weather report, transport related information and news update. [7] Eyes are organs of our visual system. In this paper, we are presenting a unique intelligent electronic eye that provides road guidance to blind people while they are walking. Surrounding visual data is collected by image and obstacle sensors mounted on a helmet which the user has to put in. The data is sent to a processor which works in a line similar to our brain function.

The processor analyses the data and provides necessary voice information to the user which helps them in movement. The electric power for this unit is availed through solar photo voltaic module, piezoelectric source and also from electricity generated from body temperature. The device will help in great extent to the visually impaired people who are unfortunate see this beautiful world. [8] This paper bring the decision about the problem facing by the visual impaired person. Here, we designed the device to system for the visually impaired person to handle problem in the environment.

They face difficulties in independent accessing public transport since they cannot read the route number and unsure about the physical location of the bus, identifying the person and they can also find difficulty in crossing the road. We focus on presenting the main advantages and limitations of each technique in effort to inform the scientific community about the progress in the area of system and also offer users a review about the capabilities of each system. [9] The need for developing a low-cost assistive system for the visually impaired and blind people has increased with steady increase in their population worldwide. The stick system presented in the paper uses artificial intelligence along with various sensors in real time to help the visually disabled people to navigate their environment independently. Image recognition, collision detection and obstacle detection are the three tasks performed by the system. The image recognition task was performed using a smartphone application powered by artificial intelligence. The tasks of collision detection and obstacle detection utilized ultrasonic sensors to alert the user of the obstacles appearing in his route. The stick system also managed to demonstrate the important characteristics of affordability, high efficiency, mobility and ease. [10] In this paper, a solar energy driven wearable autonomous smart cap for pedestrian safety has been proposed. A flexible solar panel capable of providing 10.2V and 120mA has been used as means of powering up wearable smart cap. There has been immense increase in the number of accidents noticed in the past few years due to the massive use of mobile phones on the roads.

The flexible solar panel has been used as the means to power the cap. The flexible solar panel employed in the proposed system has very less weight and is extremely flexible which make it feasible to be installed on the cap. The idea of using a flexible solar panel has the grounds for eliminating the dependency of the proposed smart cap on primary batteries which gets fueled up with time. The propounded system is an efficient system which has the ability to detect the obstacle in the path of a mobile user and alert the pedestrian in a userfriendly manner in order to avoid the accident.

The propounded system has been tested with the various volunteers and the response has been very much positive. The proposed system has been reviewed as accurate and userfriendly.

[11] This paper presents the modelling , implementation and testing of an experimental microcontroller (MCU) based smart assistive system which can be used by the visually impaired or blind people. This device includes haptic and audio feedback options from which the user can select. A Smart Phone can be used to control the device using predefined voice commands and Bluetooth connectivity. The device is portable and the purpose of its usage is to warn the user when objects are present on the walking path so collision can be avoided. Distance measurements, between the user and possible

IV. METHODOLOGY

obstacles, are performed using ultrasonic echolocation and the data provided by the ultrasonic sensor is processed by a microcontroller, which also handles the feedback part. The hardware design, software architecture and mechanical

design of the enclosure as well as the breadboard prototyping are covered in this material.

Experimental results performed in different functionality scenarios demonstrate that the proposed system can be successfully used to full fill its purpose [12] This paper reviews the proposal for a design of a wearable that describes the basis of a glove intended to help visually impaired people in their day-a-day activities.

It uses wearable technology, such as sensors and actuators, that alert the user in case of an encounter with an obstacle in two directions (according to the position of the hand), and the proximity to a desired destination.

In the first section, the introduction behind this proposal is explained, taking into account the only first poll from the region in question. The second section presents the background taking into account similar endeavours. The third section presents mechanical, electrical and control requirements.

The fourth section details the solution design of the wearable, introducing the sensors and electronic devices that conform it. The fifth section will display the functionality and the tests, including control design to take into consideration for this proposal.

[13] This paper presents a developed device to solve the problem of moving and navigating of visually impaired and blind people. This device, called Ultrasonic Assistive Headset, is light, simple and low-cost option compared with other assistive devices.

Ultrasonic Assistive Headset will guide for them among obstacles by employing ultrasonic distance sensors, microcontroller, voice storage circuit and solar panels to be battery-free. In proposed method, ultrasonic waves arrive to the ultrasonic sensors on the spherical membrane of the headset after sending this waves from ultrasonic distance sensors reflection from obstacles.

A microcontroller determines the location of the obstacles according to the sensor ID and the information of distance. The system produces a voice data defining the location, and then it speaks to blind person where the obstacles are. Ultrasonic Assistive Headset can be used easily by them both indoor and outdoor, so they can avoid obstacles quickly and accurately.

[14]Navigation assistance for visually impaired (NA VI) refers to systems that are able to assist or guide people with vision loss, ranging from partially sighted to totally blind, by means of sound commands. Many researchers are working to assist visually impaired people in different ways like voice based assistance, ultrasonic based assistance, camera based assistance and in some advance way researchers are trying to give transplantation of real eyes with robotic eyes which can capable enough to plot the real image over patient retina using some biomedical technologies. In other way creating a fusion of sensing technology and voice based guidance system some of the products were developed which could give better result than individual technology.

There are some limitation in system like obstacle detection which could not see the object but detection the object and camera based system can't work properly in different light level so the proposed system is a fusion of colour sensing sensor and the obstacle sensor along with the voice based assistance system. The main idea of the proposed system to make person aware of path he is walking and also the obstacle in the path.

[15] The visually-impaired people have the difficulty on perceive the largeness of a space and objects existed in a space by means of visual information. Particularly auditory trained visually-impaired people can recognize 3-D spatial information with environmental sounds.

However, systematic learning method of auditory training for acquired visuallyimpaired is not established sufficiently because the selfexperience of the visually-impaired people is the main reason of ability acquisition in the actual environment because they do not have enough information about moving in the real environment.

In this paper, the authors aim at demonstrating moving situations and moving needs of the visually-impaired, for example, which acoustical factors can be used in some living situation, what kind of environmental situation they think it difficult to perceive silent objects and what kind of aid they need.

Results indicated following facts: Totally visuallyimpaired people tend to get more spatial information from auditory than not-totally visually impaired people.

Regarding available auditory cues, items of rotating head in order to listen carefully to environmental sound, and hitting floors stronger by a white cane or foot for voluming up reflected or reverberated sounds were much selected by the totally visually-impaired participants who can perceive obstacles with auditory information.

Result of question about conventional devices indicated that most totally visually-impaired participants selected electrical sounding device informing obstacle distance, while most not-totally visually-impaired participants selected vibrating device informing the distance of walls or doors and tactually-stimulated device informing obstacle distance. The image recognition task was performed using a smartphone application powered by artificial intelligence. The tasks of collision detection and obstacle detection utilized ultrasonic sensors to alert the user of the obstacles appearing in his route. The stick system also managed to demonstrate the important characteristics of affordability,

high efficiency, mobility and ease. [10] In this paper, a solar energy driven wearable autonomous smart cap for pedestrian safety has been proposed. A flexible solar panel capable of providing 10.2V and 120mA has been used as means of powering up wearable smart cap. There has been immense increase in the number of accidents noticed in the past few years due to the massive use of mobile phones on the roads.

V. RESULTS AND DISCUSSIONS

Author	Year	Technique	Advantage/Scope
[1]Deepthi Jain B, Shwetha M Thakur, K V Suresh.	2018	Identifies objects and sign boards.	Distance of the obstacles are measured.
[2]Nishajith A, Nivedha J, Shilpa S Nair.	2018	Object detection and audio information.	Indoor Navigation.
[3] Charmi T. Patel, Vaidehi J. Mistry, Laxmi S. Desai, Yogesh Meghrajani.	2018	Object Detection using Infrared Sensor.	Better identification in various lighting conditions.
[4] Rabia Afzal Minhas, Ali Javed.	2018	Ego Centric Video is used for object detection.	ELM is used as a multiclass classifier to recognize 11 different people.
[5]Farooq Shaikh, Mohammed Abbas Meghani, Vishal Kuvar.	2018	Object Detection using Gyroscope Sensor.	Obstacle feedback is given through buzzers and vibrators.
[6]Kasthuri R, Nivetha B, Shabana S.	2017	Controlling through voice commands .	Provides latest weather report and news update.
[7] M Maiti, P Mallick, M Bagchi, A Nayek.	2017	Object detection with 360 degree visual information .	Power source for entire hardware is accumulated from three different sources.
[8]M Preetha, K Elavarsi, K Ramya Devi.	2017	Bus number plate detection.	Will help the blind person to identify the known and the unknown person.
[9]Sandesh Chincholi, Samir Patel.	2017	Image recognition, collision detection and obstacle detection.	Detects the presence of potholes and humps.
[10] Payal Kalra, Divesh Mittal, Prince.	2017	The process of extracting energy from the environment and convert it into usable energy (energy harvesting).	As the distance between the obstacle and user increases the vibrations increases.
[11] D. Munteanu R. Ionel .	2016	Serial Port Protocol Bluetooth module HC-05 which was designed for transparent wireless communication.	The PCB and the enclosure will be redesigned in order to minimize the size of the final product.
[12] J Alvarado, M D P Charez, R A Rodriguez.	2016	Ultrasonic sensor to detect obstacles and a vibrating motor as feedback.	Solar charging.
[13]Seyma Aymaz, Tugrul Cavdar.	2016	Piezoelectric element converts electrical energy to ultrasonic energy and vice-versa.	Voice recording samples are saved as voice commands.
[14]Chaitali Kishore Lakde.	2015	Obstacle detection using RGB sensor.	To detect multiple level of obstacle and the ground object.
[15]Takahiro Miura, Yuka Ebihara, Masatsugu Sakajiri, and Tohru Ifukube.	2013	Spatial information with auditory and tactile senses.	Visually-impaired people can recognize 3-D spatial information with environmental sounds.

IV. BLOCK DIAGRAM

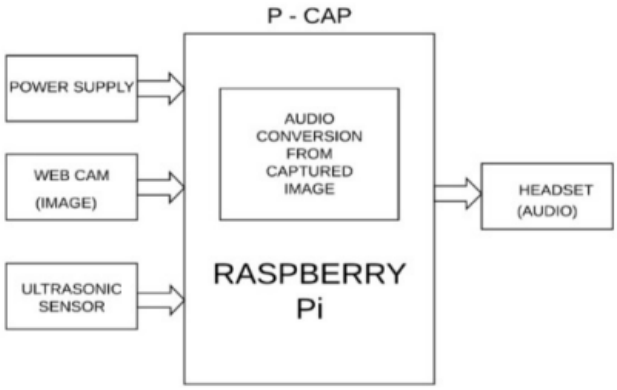
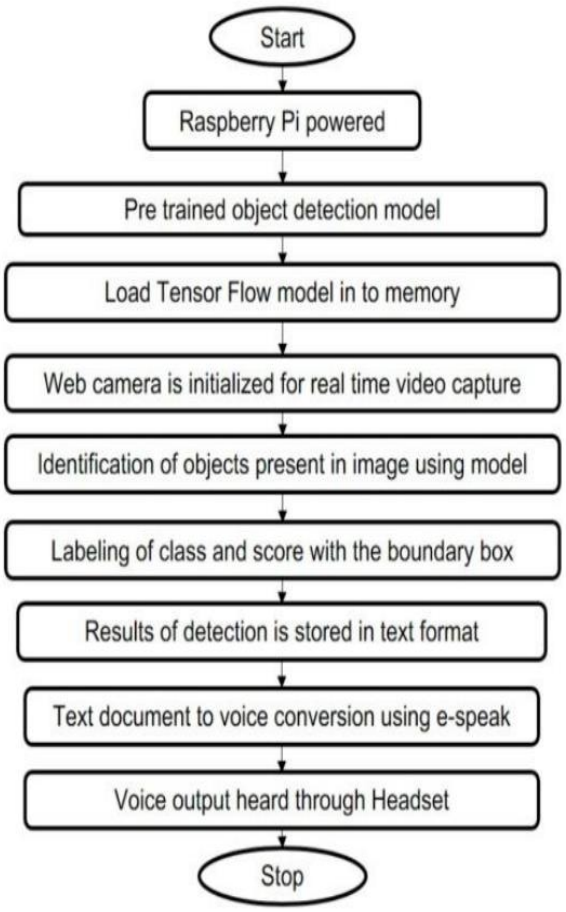


Fig1 :Proposed Block Diagram

Fig1 :Proposed Block Diagram Smart Cap is based on TensorFlow and text to speech synthesizer software. With a single object detection model, it is possible to classify multiple classes present within an image and also it can specify the position and distance of the image using ultrasonic sensor. The project is able to detect various classes of objects. The working of the system starts by suitably powering the raspberry pi processor. Thus, the web camera interfaced through one of the USB ports of pi is initialized. Real time video is captured using the NoIR camera which in turn is converted to a set of frames using python command. Here, we are using a simplest and fastest pre-trained object detection model 'API-open cv' offered by TensorFlow to detect various objects present within our image. Identification of various objects present in the image is done using detection graphs and weights. By using the text to speech converter software 'e-Speak', the text documents are converted to voice output. The headphone connected to audio jack of raspberry pi provides voice description corresponding to the objects present in the image. Fig2 : Flowchart



VI. CONCLUSION

The system has a simple architecture that transforms the visual information captured using a camera to voice information using Raspberry Pi. Unlike other systems available in the market, the subject needs only to wear the cap and does not require any particular skills to operate it. The proposed system is cheap and configurable. The person who uses it does not require any particular skill to operate it. Any blind or visually impaired person can use it simply since they have to only power up the device. The system helps in clear path indication and environment recognition. The device is a real-time system that monitors the environment and provides audio information about the environment making his/her navigation more safe and secure.

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