Smart Navigation Assistance System for Blind People

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Abstract - *Real time object detection is a diverse and complex area of computer vision. If there is a single object to be detected in an image, it is known as Image Localization and if there are multiple objects in an image, then it is Object Detection. This detects the semantic objects of a class in digital images and videos. The applications of real time object detection include tracking objects, video surveillance, pedestrian detection, people counting, self- driving cars, face detection, ball tracking in sports and many more. Convolution Neural Networks is a representative tool of Deep learning to detect objects using OpenCV (Opensource Computer Vision), which is a library of programming functions mainly aimed at real time computer vision. This project proposes an integrated guidance system involving computer vision and natural language processing. A system equipped with vision, language and intelligence capabilities is attached to the blind person in order to capture surrounding images and is then connected to a central server programmed with a faster region convolutional neural network algorithm and an image detection algorithm to recognize images and multiple obstacles. The server sends the results back to the smart phone which are then converted into speech for blind person's guidance. The existing system helps the visually impaired people, but they are not effective enough and are also expensive. We aim to provide more effective and cost-efficient system which will not only make their lives easy and simple, but also enhance mobility in unfamiliar terrain.*

Key Words: **OpenCV, Artificial Intelligence, YOLO V3, Convoluted neural network**

1.INTRODUCTION

Vision impairment is one of the major health problems in the world. Vision impairment or vision loss reduces seeing or perceiving ability, which cannot be cured through wearing glasses. Nearly about 37 million people across the globe are blind whereas over 15 million are from India. People with visual disabilities are often dependent mainly on humans, trained dogs, or special electronic devices as support systems for making their decisions. Navigation becomes more difficult around places or places that are not familiar. Surviving devices, the objects that are at a sudden depth or obstacles above waist level or stairs create considerable risks. Thus, we were motivated to develop a smart system to overcome these limitations.

2. LITERATURE REVIEW

A few recent works on real-time object detection were recently reported. The report's contents are weighed in terms of their benefits and drawbacks. Blind people's movements are traditionally led by a walking stick and guide dogs, which require a long time to become used to. There are a few smart systems on the market that use electronic sensors put on the cane, but these systems have several drawbacks. Smart jackets and walking sticks have been investigated as technology advances, including sensors embedded in the walking sticks. The model is a simple jacket that must be worn by the blind person. Any obstruction notification is supplied via sensor-specific voice messages. The messages are tailored to the recipient. [4]
Researchers and authors have also worked on a prototype, smart rehabilitative shoes and spectacles that has been designed and developed to facilitate safe navigation and mobility of blind individuals. The system has been designed for individuals with visual loss requiring enhancement and substitution aids. Three pairs of ultrasonic transducers (transmitter and receiver) are positioned on the medial, central, and lateral portions of the toe cap of each shoe. A microcontroller-based belt pack device powered by a 12 V, 2500 mAh NiMH battery controls the transmitted signal of each of the three transducers and relays the reflected signal through an activation signal to the associated tactile output. Detecting obstructions at head level is done with Ray-Ban (Luxottica Group S.p.A., Milan, Italy) spectacles. They are equipped with a pair of ultrasonic transducers positioned in the center of the bridge, as well as a buzzer mounted on one of the temples.
The University of Michigan is working on the creation of a sophisticated computerized Electronic Travel Aid (ETA) for blind and visually impaired people. A belt containing a small computer, ultrasonic and other sensors, and support electronics will make up the device. The signals from the sensors will be processed by a proprietary algorithm before being communicated to the user via headphones. The NavBelt device will allow a blind person to walk across unfamiliar, obstacle-filled situations quickly and securely.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

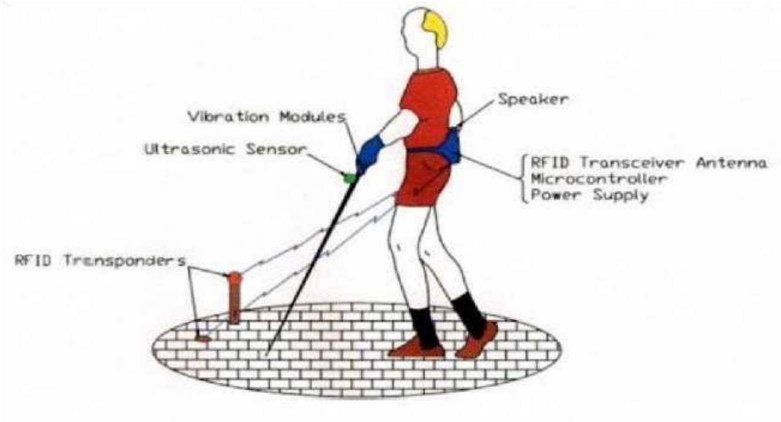

Fig -1: Ultrasonic sensor-based guidance system for blind people

The three R's, or reconstruction, recognition, and rearrangement, can be used to summarize computer vision (CV) activities. Reconstruction entails calculating the three-dimensional (3D) scenario that produced a certain visual representation. Objects in the image are labelled as a consequence of recognition. [2]

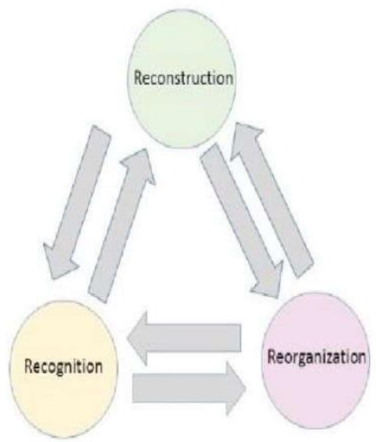

Fig -2: The 3R's of Computer vision

An android Smartphone is connected to a Linux server, and image identification is performed using a deep learning algorithm. When the system is in operation, the smart phone sends images of the scene in front of the user to a server over a 4G or Wi-Fi network. Following that, the server runs the recognition process and sends the final findings to the smart phone. Through audio notifications, the system would notify the user of the location of obstacles and how to avoid them. The disadvantage of this system is continuous need of internet and cost of hosting an advanced and high computing server. [2]
There is another research that focus mainly on creating an artificially intelligent, fully automated assistive technology that allows visually impaired people to sense items in their environment and provide obstacle-aware navigation by providing real- time auditory outputs. Sensors and computer vision algorithms are combined to give a practical travel aid for visually impaired persons that allows them to view various things, detect impediments, and prevent collisions. The entire framework is self-contained and built for low-cost processors, allowing visually impaired people to use it without the need for internet access. The detected output is also designed for faster frame processing and more information extraction i.e., item counting a shorter time period. In comparison to previously developed methods, which were primarily focused on obstacle identification and location tracking with the use of simple sensors and did not incorporate deep learning, the proposed methodology can make a substantial contribution to assisting visually impaired persons. [1]

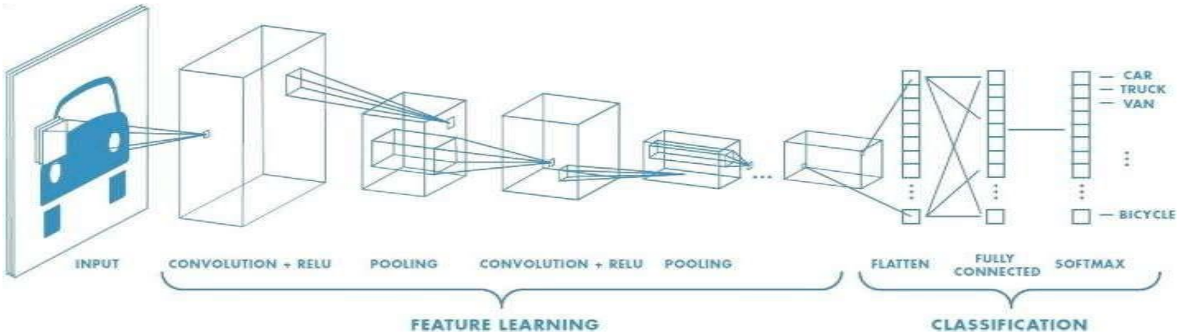

Fig -3: Feature learning process of convoluted neural network

A novel approach to object detection called YOLO. Classifiers have been repurposed to do detection in previous work on object detection. Instead, think of object detection as a regression issue with geographically separated bounding boxes and class probabilities. In a single assessment, a single neural network predicts bounding boxes and class probabilities directly from entire images. Because the entire detection pipeline is a single network, it can be optimized directly on detection performance from beginning to end. Our unified architecture is lightning quick. The YOLO model's base model processes images at 45 frames per second in real time. Fast YOLO, a smaller variant of the network, processes 155 frames per second while maintaining twice the mAP of other real-time detectors. A network with 24 convolutional layers and two fully connected layers makes up the architecture. The features space from preceding layers is reduced by alternating 1 X 1 convolutional layers. It uses half resolution (224 X 224 input picture) to train the convolutional layers on the ImageNet classification task, then doubles the resolution for detection. [7] The provided image was segmented into grids of S X S in the YOLO-based object detection [34], with S denoting the number of grid cells in each axis.

Each grid unit was responsible for detecting any targets that entered the grid. Then, for the B number of bounding boxes, each of the grid units projected a matching confidence score. The highest probability represents a greater confidence score of the associated object, while the confidence score represents similarity with the sought object. [1] Darknet-53 which is made up of 53 convolutional layers serves as a feature extractor for YOLO-v3. It has the fastest measured floating-point operation speed, implying that the network performs better when GPU resources are used. The framework was linked to a live video feed, and image frames were collected as a result. The captured frames were pre-processed and fed into the trained model, and if any object that had been previously trained with the model was spotted, a bounding box was created around it and a label was generated for it. Following the detection of all objects, the text label was transformed into voice, or an audio label recording was played, and the following frame was processed.

3. EXISTING SYSTEM

The existing systems that are currently available for the visually impaired comes at their own cost. Most of the systems are not integrated to wearable products. There are other systems which consists of expensive camera and sensors which are not affordable by everyone.

A blind stick is an advanced stick that allows visually challenged people to navigate with ease using advanced technologies, integrated with ultrasonic sensor along with light, water and many more sensors. If the obstacle is not that close, the circuit does nothing. If the obstacle is close to the microcontroller, then it sends a signal to sound. The blind stick would not be capable of telling what object is in the front. It is something which is not a wearable, and it must be carried by hand.

4. PROPOSED SYSTEM

Our system is designed in a way to provide better efficiency and accuracy which can be embedded to a wearable device. It provides a real time three-dimensional object detection if any obstacle is detected within the specified distance. The output of the object detected is supported by a text to voice google API, where notifications are sent through voice messages. To develop a scientific application or model that can be embedded to a daily wearable and provide accurate real-time three- dimensional object detection that is supported by notifications through voice messages if any obstacle is detected within the distance.

5. LITERATURE REVIEW

Table 1: Summary of Literature Survey.

SlNo	No Title of the paper, Journal Name and Year	Methodology	Advantages	Disadvantages
1.	Efficient Multi-Object Detection and Smart Navigation Using Artificial Intelligence for Visually Impaired People, Entropy, 2020	Darknet, YOLO v3, OpenCV, COCO	Higher accuracy in object detection and can get better with use	Expensive for now. Integration problem.
2.	PARTHA: A Visually Impaired Assistance System,2020 3rd International Conference on Communication System, Computing and IT Applications (CSCITA)	Image Processing, Arduino,Indoor Navigation, Speech Commands, indoor localization, Ultrasonic sensors, Tiny Yolo V2	Low light detection, security and real time location sharing.	limited scope and functionality,cost inefficiency, systems not being portable
3.	Integrating Computer Vision and Natural language, Kyambogo University, 2019	I-R sensor and ultrasonic sensor working on Sonic path finder. Google pixel 3XL. Microsoft Kinetic Sensor.	I-R sensor and ultrasonic sensor working on Sonic path finder. Google pixel 3XL. Microsoft Kinetic Sensor.	Expensive camera and sensors.
4.	Design and Implementation of mobility aid for blind people - 2019	Ultrasonic sensor and Arduino Uno.	Better lowlevel object detection and low cost.	Objects in elevated area is not detected
5.	Design and Implementation of Smart Navigation System for Visually Impaired, International Journal of Engineering Trends and Technology	Arduino Nano R3, Raspberry Pi V3 , RF module, GPS, GSM module, Proteus 8.6, Arduino Software 1.8.2 andPython 2.7	Practical, cost efficient, Voice Recognition, SMS alert.	limited scope and functionality, Small Box Detection due to inappropriate localization
6.	Blind Assist System, International Journal of Advanced Research in Computer and Communication Engineering, 2017	I-R Sensors, ATmega32 8-bit microcontroller.	Low cost, audio and vibration feedback.	Bluetooth Connectivity and lessaccurate
7.	You Only Look Once: Unified, Real-Time Object Detection, University of Washington	Fast YOLO, YOLO R-CNN	Combining R-CNN with YOLO	Small Box Detection due to inappropriate localization
8.	Design and Development of a Prototype Rehabilitative Shoes and Spectacles for the Blind, 2012 5th International Conference on Biomedical Engineering and Informatics	Ultrasonic transducers, A 12 V, 2500 mAh NiMH battery-operated, microcontrollerbased belt pack unit	Low-level obstacles detection (up to 90 cm)	Objects in elevatedarea not detected
9.	Wearable Assistive Devices for the Blind,Issues and Characterization, LNEE 75, Springer, pp 331-349, 2010.	Survey made on assistive devices that can be used to guide visually impaired.	Use of vests, belts, actuators, servo motors and sensors.	Sensory overload, Long learning/training time, Acoustical feedback, Tactile feedback

6. METHODOLOGY

Considering all the other literature, we have come up with our methodology where we aim to provide a scientific application or model that can be embedded to a daily wearable. A real-world object is live fed with the help of a webcam where it provides accurate real-time three-dimensional object detection. The processed output is then further given as output in the form of text, where this processed text is converted into speech API that is supported by notifications through voice messages, if any obstacle is detected within specific distance. The messages are made specific so that the user can track the position and distance of obstacle properly and avoid any inconvenience while doing their daily activities. This speech is given as an audio output to the user.

7. CONCLUSION

This project proposes a system to assist blind people in their navigation. With the proposed design and architecture, the blind and the visually impaired will be able to independently travel in unfamiliar environments. Deep learning-based object detection, in assistance with various distance sensors, is used to make the user 222222aware of obstacles, to provide safe navigation where all information is provided to the user in the form of audio. The proposed system is more useful and efficient than the conventional ones and can provide information about the surrounding information. It is practical, cost efficient and extremely useful. To sum up, the system provides numerous additional features which the competing systems do not provide fully and can be an alternative or a very good enhancement to the conventional ones.

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