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Trinetra: An Assistive Eye for the Visually Impaired

*Rashmi N[1], Vaidyanathan K[2] , Raghavendra DS[3], T. Pavan Kumar Reddy[4], V. R. Pranay5
Department of Electronics and Communication Engineering,
BMS Institute of Technolog and Management Bangalore, India

Abstract:- Millions of people worldwide have visual impairments, and integrating them into society is a crucial ongoing goal. To support their quality of life, various guidance systems have been developed, often for specific purposes. However, these solutions can significantly enhance the mobility and safety of visually impaired individuals. To address this, a vision-based platform using Python and OpenCV library functionalities has been developed to recognize real-world objects indoors and outdoors. YOLO is a novel approach to object detection that has been used in the software. The image is transformed into a scan image for further interpretation of its contents. Efforts continue to support visually impaired individuals and enable their full participation in society. The detected image is scanned and fed into Tesseract OCR for conversion to text. Additionally, facial emotion recognition is applied to determine a person's mood. Finally, a Text-to-Speech (TTS) engine is utilized to convert the detected text and objects into audible speech.

Keywords:- *YOLO, Open-CV, Tesseract OCR, TTS, facial-based emotion recognition.*

I. INTRODUCTION

The visually impaired population is a significant segment of society, with estimates ranging in the tens of millions worldwide. Ensuring their integration into society is an important and ongoing objective, with considerable efforts being made to provide them with appropriate healthcare. To assist visually impaired individuals in leading normal lives, various guidance system techniques have been developed. Although these systems are frequently designed for specific tasks, they can significantly contribute to the mobility and safety of visually impaired individuals. The development of state-of-the-art guidance systems for visually impaired individuals is closely related to advances in image processing and computer vision, as well as the speed performance of devices and unit processors. Regardless of the technology involved, these applications must operate in real-time with quick actions and decisions, as the speed of the system may be critical for taking action.

Choosing the best solution is a trade-off between the performance of the software component and the hardware capabilities, with optimal parameter tuning being necessary.

During the indoor movement of visually impaired individuals, the assisted system's primary objective is to automatically detect and recognize objects or obstacles and provide an acoustic alert. The vision module proposed in this system is an integrated part of the platform designed to guide visually impaired individuals, but it can also be used independently of the integrated platform. The vision-based guidance system proposed has been designed, developed, and validated through experiments and iterative optimization. The module is compliant with the principle of developing a high-performance device that is cost-effective and practical for usage. The module uses disruptive technology and allows for updating and inclusion of new functions. The vision-based guidance system proposed for visually impaired individuals is an innovative solution to a pressing problem. The system's ability to recognize objects and obstacles in real time is critical for the safety and mobility of visually impaired individuals. The vision module uses advanced image processing and computer vision techniques to identify objects and obstacles and provide an acoustic alert to the user. The module can be used in a variety of settings, including public buildings, indoor spaces, and transportation hubs, to provide visually impaired individuals with the information they need to navigate safely and independently.

The vision-based guidance system proposed is not only highly effective, but it is also cost-effective and practical for usage. The module's design allows for the integration of new functions and updates, making it a highly versatile solution to the challenges faced by visually impaired individuals. The module is easy to use and can be integrated with other systems to provide a comprehensive solution for visually impaired individuals.

II. LITERATURE SURVEY

A. "Assistive Technology for the Visually Impaired Using Computer Vision" [2018]

India has a large population of blind individuals, with over 12 million people affected by this disability. Despite the availability of Braille, less than 10% of the blind population in India is able to learn and read Braille due to the steep learning curve, high cost, and limited availability of resources. This poses a major challenge for blind schools in the country, as it results in high levels of unemployment among the visually impaired. In order to address this issue, a wearable device has been proposed that makes use of computer vision to read out any form of text around the user in different lighting conditions and alignments.

The device is based on a Raspberry Pi with a compatible camera that captures the content around the visually impaired or blind person. The system employs a combination of image processing, machine learning, and speech synthesis techniques to read out the captured content in the regional language of the user. Additionally, a sensor is incorporated into the device to notify the user of the distance to the nearest object at eye level, as well as enumerate the objects in the device's sight.The proposed solution is a cost-effective and accessible alternative to Braille literacy for the visually impaired in India. The combination of both optical

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character recognition and object recognition algorithms has been found to be 84% accurate, making it a reliable tool for individuals with visual impairments. The development of such innovative solutions is essential to empower and provide equal opportunities to individuals with disabilities, allowing them to live a more independent and fulfilling life.The system is based on the combination of image processing, machine learning and speech synthesis techniques. The proposed work with the combination of both the optical character recognition and the object recognition algorithms was found to be 84%.

B. "Smart Specs: Voice Assisted Text Reading system for Visually Impaired Persons Using TTS Method" [2017]

The proposed system in [2] aims to help visually impaired individuals live their daily lives with the help of emerging technologies. The system includes smart spectacles that use an inbuilt camera to capture images of printed text, which are then analyzed using Tesseract-Optical Character recognition (OCR) to detect the text. The detected text is then converted into speech using eSpeak, an open-source speech synthesizer, and is output through headphones using text-to-speech (TTS) technology. The system's target platform is the Raspberry Pi, which provides an interface between the camera, sensors, and image processing results, while also performing peripheral manipulation functions. The system's primary objective is to provide an assistive device to the visually impaired, allowing them to access printed text through speech synthesis. This type of technology is becoming increasingly prevalent, with similar systems being developed for use in a wide range of applications. The proposed system has the potential to be an effective tool for visually impaired individuals, helping them navigate the world more independently.

C. "Assisted Movement of Visually Impaired in Outdoor Environments" [2009]

The article by V. Tiponuţ et al. [3] highlights the advancements made in developing electronic travel aids (ETAs) as a substitute for traditional navigation tools used by the visually impaired. The study discusses how ETA devices, based on sensor technology and signal processing, can enhance the mobility of blind users in unknown or dynamically changing environments. The paper presents theoretical and practical findings in the field of ETAs, including new concepts such as integrated environments for assisted movement, acoustical virtual reality, and bio-inspired solutions. The study concludes by summarizing the main outcomes and suggesting further developments in this area. Overall, the research shows that ETA devices have the potential to significantly improve the quality of life for the visually impaired by providing greater independence and mobility.

D. "A CNN Based Correlation Algorithm to Assist Visually Impaired Persons", [2011]

The paragraph discusses a paper by L. Ţepelea et al. [4], which proposes a CNN-based correlation algorithm to assist visually impaired individuals. The paper emphasizes the importance of incorporating a visual processing unit in systems designed for individuals with visual impairments, given the wealth of information that can be extracted from images. The proposed algorithm utilizes cellular CNNs to enhance the features of assisting systems and provide visually impaired individuals with more information about their surroundings. The majority of operations involved in the algorithm can be performed through parallel processing, resulting in reduced computing time, even as the size of the template images increases. Overall, the paper underscores the potential of CNN-based algorithms to improve the functionality of systems aimed at assisting visually impaired individuals.

III. PROPOSED SYSTEM

The proposed work aims to facilitate the movement and a smart reader device for blind and visually impaired. The plan defines a vision-based platform for the identification of real-life indoor and outdoor objects to guide visually impaired people and also to read out anything written texts. Using Python and OpenCV library functions, the software is developed and eventually ported to a Rasberry Pi.

The main objectives of the proposed system are:

- To study and understand the existing vision module systems.
- Working of different frameworks for the image acquisition system.
- To study how to Classify objects using YOLO.
- Finding Objects positon in the given Input frame or finding Characters written in the frame.
- Programming both the objects detected and position of the objects to a speech output using
- text-to-speech convert.
- Analyzing the written text and converting it into speech format.
- Aims to propose a method for Facial Emotion
- Recognition detection that is able to pass regions of interest to a classifier.
- Sign recognized is been said in voice format so that
- blind person has no difficulties in understanding the sign.

IV. SYSTEM REQUIREMNT

A. Hardware Requirement

- A desktop/laptop with a processor of i3 core minimum with Ram 4 Gb and 80Gb hard disk storage,
- An external web camera with high defenition of 720p.
- Raspberry pi with a minimum configuration set of 3b.
- Ethernet cable to establish the network connection.
- Power supply cable connected to a power bank of minimum 5000 mAh
- minimum 5000 mAh.

B. Software Requirement and their libraries

- Opencv : The OpenCV (Open Source Computer Vision Library) is a software library that is open-source and designed for computer vision and machine learning purposes. It includes a range of tools that enable the development of real-time applications for computer vision, and is commonly utilized in the areas of image and video processing, as well as object detection and

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recognition.

- Pyttsx3 : Pyttsx3 is a tool that lets programmers create programs that can speak out loud. It does this by using the built-in text-to-speech functionality of the computer's operating system, so it can work on any platform
- Tkinter : Tkinter is a Python library that offers pre- built widgets, including buttons, labels, and text boxes, to develop user interfaces for Python applications. It utilizes the Tk toolkit to provide a simple and user-friendly way to create graphical user interfaces in Python.
- Yolo :(You Look Only Once) is a deep learning algorithm used for object detection in images and videos. It applies a single neural network to the full image, predicting the class and bounding box coordinates of objects in one pass, resulting in fast and accurate object detection.
- Teserract: Tesseract is a free, open-source software for Optical Character Recognition (OCR) that was first developed by Hewlett-Packard Laboratories and later released as an open-source project by Google. This tool is capable of extracting text from images using advanced machine learning algorithms. It can recognize various fonts and text sizes, and even detect text in multiple languages.

V. METHODOLOGY

The given statement describes a system designed to assist visually disabled individuals. The system comprises a voice-assisted text-reading device, which utilizes four different modules to function effectively. These modules are a camera module, which captures the text, an image processing module, which processes the captured image, an optical character recognition module, which recognizes the text in the image, and a YOLO framework, which is a type of machine learning algorithm that identifies and tracks objects in an image. The system also includes a text-to-speech module that converts the recognized text into speech to assist.the visually disabled individuals in understanding the content of the captured text.

The proposed system is a voice-assisted text-reading device designed for visually impaired individuals. It involves four primary modules: a camera module, an image processing module, an optical character recognition (OCR) module, and a text-to-speech module.

The process starts with capturing an image of the text using a 5-megapixel Raspberry pi camera. However, the captured image may not be flawless, so it undergoes image processing to eliminate noise and sharpen the contrast between light and dark regions. Text cleaning is also done to improve readability for the OCR process. The YOLO library is used to detect objects in the image, and the Tesseract OCR program is used to extract text from the image.

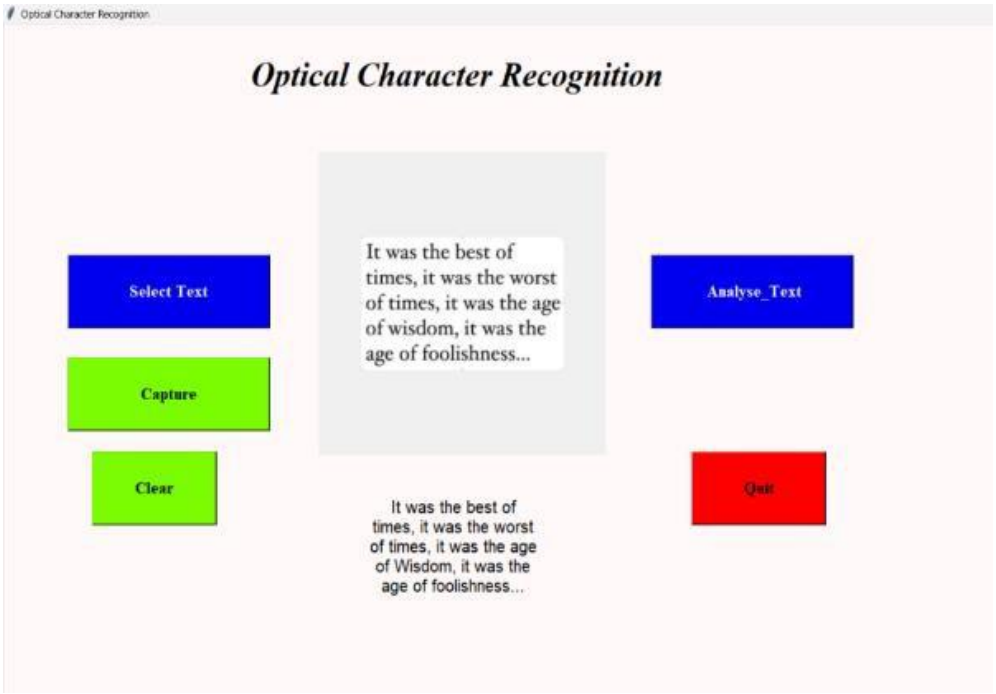

Fig. 1: Optical Character Recognition

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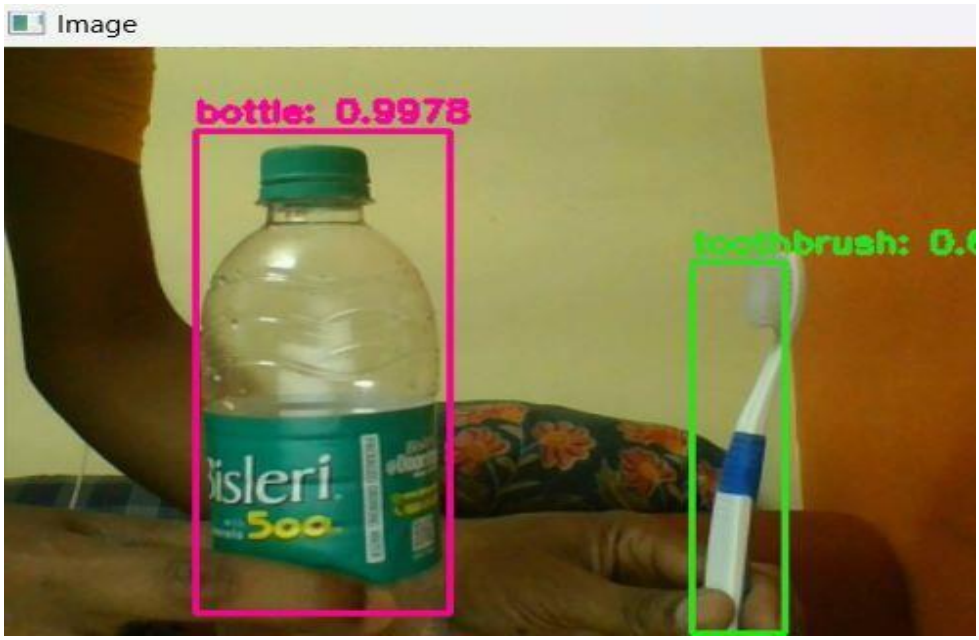

Fig. 2: Object detection by proposed system

Fig. 3: Facial Emotion recognition using proposed system

Table 1: Description of different objectives

Module name	Text Recognition	Emotion Recognition	Object Recognition
Objectives	Detecting the text input provided	Detecting the face input provided	Detecting of objects
Input	Selecting a photo or capturing an image	Capturing Video Frame	Selecting a photo capturing an image
Output	Text detection and speech output	Face detection and Emotion output	Object detection
Description	We use tesseract ocr engine which is used to extract the recognized text. The text-to-speech synthesizer is used to convert text into speech.	We use the CNN model which is used to extract the recognized emotion. We determine the emotion of the person by looking at the details of facial coordinates	All objects are identified using the JSON.YOLO is the frame used for the detection of the object

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VI. CONCLUSION

The proposed system is very much helpful for the blind people. Blind personnel can live their life in this competitive world and get employment in the office and live a normal life.

VII. FUTURE SCOPE

The proposed system can be improvised with high speed processor of Raspberry Pi 4a or 5 version and additional feature such as Bluetooth connection can be established for hearing aid for the blind person to avoid social stigma .Also the smart phone enabled control for all these objectives make the efficiency of the scope of the product expand widely.

Facial emotion detection is performed by analyzing the facial coordinates of the captured face. Finally, the extracted text is converted to speech using a speech synthesizer such as e-speak TTS engine or Google speech synthesizer.

VIII. RESULTS

The obtained results are depicted in the table of results shown below in Figure 1.The proposed system using Tesseract-OCR , the system is able to read and recognize text in images And the text is displayed and converted into speech. By implementing YOLO the proposed system is able to detect bottle at mid left and brush at mid right as shown in the figure 2. The results are verified and found to be accurate as shown in figure1 to 3 the system not only detects the facial emotions , but also detects objects and reads the text form the objects.

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