ThirdEye - Connecting the dots of the unseen world

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***Abstract*—Blind and visually impaired people have encountered a lot of challenges when perform- ing most of the natural activities performed by non-disabled people. In particular, many dangerous situations occur in environments that are unfamiliar to them. This IoT project aims to enhance the mobility and independence of visually impaired individuals by devel- oping a wearable device that can be attached to their spectacles. The proposed system uses IoT technologies to create a comprehensive environment perception and navigation aid, assisting blind individuals in recognizing and interacting with their surroundings more effectively. The device leverages Arduino technology and is seamlessly connected to a mobile phone. Its primary functionality is to detect objects in the user's vicinity and provide real-time audio cues to assist with navigation and obstacle avoidance. The system utilizes ultrasonic or infrared sensors to continuously scan the surroundings, measuring distances to nearby objects. The Arduino microcontroller processes this data and communicates wirelessly with a mobile phone application. The project emphasizes user-friendly design and accessibility, ensuring that visually impaired individuals can easily configure and use the device. Through this innovative IoT solution, visually impaired individuals gain increased awareness of their surroundings, improving their ability to navigate in- dependently and with confidence. This project demonstrates the potential of IoT and Arduino technology to address real-world challenges and enhance the quality of life for individuals with visual impairments.**

I. Introduction

Visually impaired individuals face a multitude of challenges that can significantly impede their daily lives, jeopardizing their independence and overall well-being. The absence of visual cues severely impedes their ability to detect and navigate obstacles, ranging from uneven surfaces to unexpected barriers, increasing the risk of accidents and injuries. Simultaneously, the limited access to real-time environmental information exacerbates their struggles, hindering their ability to perceive surroundings, recognize objects, and identify potential hazards, perpetuating a constant state of vulnerability. The challenge extends indoors, where visually impaired individuals encounter difficulties in various indoor activities. Navigating unfamiliar indoor spaces becomes particularly problematic due to obstacles, changes in elevation, and dynamic environments that may lack tactile or auditory cues. The inherent reliance on others for assistance not only diminishes their autonomy but also contributes to feelings of isolation and dependency. Such a device would help visually impaired individuals detect and avoid obstacles effectively, empowering them to navigate both indoor and outdoor environments with confidence and independence.

II. Literature Survey

Many works have been done on making life better for the visually impaired.In their collaborative work in 2023, Shivang Sunil Singh, Mayank Agrawal, and M Eliazer introduce a cutting-edge approach to collision detection and prevention for the visually impaired, leveraging computer vision and machine learning. Their methodology involves the detection and localization of obstacles, with the obtained information relayed to the visually impaired individual through a voice interface.[1]

Kohli and Agarwal (2022) ingeniously combine the YOLOv5image detection model with two powerful Python text-to-speech conversion libraries,pyttsx3 and gTTS, to create an assistive system tailored for the visually impaired.

Trained on a custom dataset of 15 essential objects and the extensive MS COCO 2017 Dataset, the YOLOv5 model boasts superior accuracy in object detection. The authors' meticulous comparison of pyttsx3 and gTTS underscores the critical role of text-to-speech conversion,with the choice of library influencing the overall user experience.[4]

Vinnarasu A. and Deepa V. Jose (2021) address the paramount role of speech as a potent means of human communication, serving as a conduit for the expression of thoughts and emotions in diverse languages. Recognizing the inher- ent variations in speech, the authors shed light on the challenges arising from linguisticnuances, pacing differences, and regional dialects within a language, all of which con- tribute to potential misunderstandings.[[19]

Mohamed Hammad (2022) introduces a pioneering End-to-End Data Authentication Deep Learning Model designed to fortify IoT configurations. At the heart of this innovation lies the utilization of edge servers—hardware entities strategically positioned at the network's periphery, in close physical proximity to end-users and on-site applications.Hammad leverages the principles of edge computing, positioning com- putational services at or near the physical locations of users or data sources. This strategic placement not only ensures swifter and more reliable services, enriching user experiences, but also empowers companies to bolster support for latency-sensitive applications, dis- cern trends, and elevate the quality of products and services. Hammad's work thus not only contributes to the evolving landscape of IoT security but also embraces the trans- formative potential of edge computing in fortifying data integrity and user interactions. His model, backed by robust edge servers, provides a resilient framework for end-to-end data authentication, ensuring a secure and efficient environment for IoT configurations.[12]

In pursuit of empowering visually impaired individuals to learn and achieve their goals, a groundbreaking assistive technology has emerged. The devised solution ingeniously combines a smartphone with a laser pointer to create a virtual white cane, revolutionizing the traditional aid for the visually impaired. The working mechanism is orchestrated through the smartphone's camera capturing the reflection of the laser pointer's beam, and employing active triangulation to calculate the distance to objects in the user's path. The genius of the system lies in its feedback mechanism—a personalized vibration generated by the smartphone, where the magnitude correlates with the calculated distance. This tactile feedback serves as an invaluable guide, enabling users to navigate their surroundings with heightened awareness and avoid collisions with obstacles.[4]

Rahul Kevadia in 2020, the focused on the transformative potential of wearable technology, a category encompassing smart devices designed to be worn as accessories. Notably, these devices, including activity trackers and smartwatches, exemplify the broader concept of the Internet of Things (IoT), leveraging electronic devices to monitor daily activities.[20]

Savera Sarwar and Danish Channa in 2022, made a audio aid system for the visually impaired takes center stage. This innovative solution operates on the versatile Raspberry Pi platform, integrating cutting-edge technologies to enhance accessibility. Object detection is powered by the YOLO (You Only Look Once) algorithm, trained on the COCO (Common Objects in Context) dataset.[12]

P Devika, S P Jeswanth, and Billu Nagamani in 2022, addressed the challenges faced by the visually im- paired. This innovative system centers around TensorFlow, a powerful deep learning framework, to enable object detection and recognition.[13]

Dr. M Y Babu, Akash Jatavath, and G Yashwanth Kumar Reddy in 2023, introduced a innovative object detection system tailored for the visually impaired , anchored by the YOLO (You Only Look Once) algorithm. Trained on the COCO dataset, the system ensures a comprehensive recognition of diverse objects in real-time.[7]

Ganesh Khekare and Kalpeshkumar Solanki in 2022, intro cutting-edge real-time object detection system with integrated speech recognition unfolds, leveraging the prowess of TensorFlow Lite. The system commences with an RGB camera module capturing live visual data, seamlessly interfaced with an Android app.[17]

Raihan Bin Islam, Samiha Akhter, and Faria Iqbal in 2023, aimed at empowering indi- viduals with visual impairments through the application of deep learning. Operating People In Public Transportation 10 on the versatile Raspberry Pi embedded system, this comprehensive system sets a new standard by commencing with a sophisticated Video Capturing Module that utilizes the Raspberry Pi camera to capture real-time video, forming the bedrock of a revolutionary user experience.[5]

Salvador Martinez Cruz, Luis Morales-Heranandenz, Gerardo I, Juan P, and Karla A's groundbreaking work introduces an advanced Outdoor Navigation Assistance System tailored to empower visually impaired individuals in navigating public transportation seam- lessly. Central to this system is the strategic utilization of Bluetooth Low Energy (BLE) technology for location and communication, facilitated through a dedicated mobile ap- plication named SUBE. BLE beacons strategically placed on buses and their stops are tracked in real time by the SUBE app [15].

Seiji Sasaki and Chinthaka Premachandra (2021) presented a pioneering approach to head posture estimation through deep learning, utilizing 3-D pointcloud data acquired from a RealSense D435 depth sensor. The method involves capturing characteristic facial areas and extracting head data from the generated point cloud.PyTorch is employed as the deep learning library, optimized with GPU processing for accelerated computations[16].

Usman Masud, Tareq Saeed, Hunida M, Fezan UL, and Ghulam Abbas in 2022,introduced a transformative smart assistive system , focusing on obstruction avoidance for visually impaired individuals. This system integrates a Rasp- berry Pi 4B, a camera, an ultrasonic sensor, and an Arduino, all mounted on an individ- ual's walking stick. The technology captures images of the surroundings, preprocessing them with Viola-Jones and TensorFlow object detection methodologies.[9]

Yunjia Lei, Son Lam, Abdesselam Bouzerdoum, Hoang ThanhLe, and Khoa Luu (2022) contributed to the realm of assistive technologies with a focus onPedestrian Lane Detection designed specifically for the visually impaired. This technologyserves the crucial purpose of providing essential information about walkable regions, aiding blind individuals in staying on pedestrian lines, and enhancing obstacle detection for a safer navigation experience.[10]

Takahiro Nozaki and Hermano Igo Krebs in 2022, marked a significant advancement in the realm of robotic object manipulation.

In 2021, Shishun Tian, Minghuo Zheng, Wenbin Zou, Xia Li, and Lu Zhang embarked a revolutionary journey to advance blind navigation systems, with a particular focus on dynamic crosswalk scene understanding for the visually impaired.[14]2023 Charis Ntakolia, Serafeim Moustakidis, and Athanasios Siouras contributed to the field of smart assistive systems with a focus on autonomous path planning and obstacle avoidance. Emphasizing dynamic adaptability, their system is designed to dynamically extract spatiotemporal information, identify objects, and adjust routes in real-time, ensuring flexibility in response to the user's environment.[2]

In 2023, P. Yao, X. Sui, Y. Liu, and Z. Zhao introduced a comprehensive approach to vision-based environment perception and autonomous obstacle avoidance for unmanned underwater vehicles.[6]In 2023, Ahmed Ben Atitallah, Yahia Said, Mohamed Amin Ben Atitallah, Mohammed Albekairi, Khaled Kaaniche, Turki M. Alanazi, Sahbi Boubaker, and Mohamed Atri presented a novel approach to assistive navigation for blind and visu- ally impaired individuals through the embedded implementation of an obstacle detection system.[3]

III. Existing System

Existing systems for visually impaired people include wearable devices , smartphone apps etc, Out door navigation systems , computer vision systems , Mobility canes etc . As of January 2022, various assistive technologies have been developed to aid visually impaired individuals in object detection and navigation. Traditional tools such as guide dogs and mobility canes remain crucial, while smartphone apps like BlindSquare and Microsoft's Seeing AI utilize GPS and artificial intelligence to provide location-based information and object recognition. Wearable devices like OrCam MyEye offer real-time audio feedback by incorporating cameras and sensors. Ultrasonic sensors aid obstacle detection, and indoor navigation systems use Bluetooth beacons for guidance within buildings. Computer vision projects and smart glasses from companies like OrCam and Aira leverage cameras and connectivity to assist users in understanding their surroundings. Additionally, urban planning includes tactile paving and wayfinding systems to enhance navigation in public spaces. Continuous advancements in this field emphasize the importance of considering individual preferences and staying updated on the latest technologies. .one of the major disadvantages are the lack of audio cues , accuracy , complexity .

IV. PROPOSED SYSTEM

ThirdEye is a groundbreaking IoT project meticulously engineered to significantly improve the daily lives of visually impaired individuals. The process will commences with the capture of visual data from the user's surroundings via a camera integrated into smart glasses. This video stream is then swiftly transmitted through a WiFi module to a central server, where state-of-the-art image processing techniques, coupled with TensorFlow, analyze and identify objects within the environment. The identified Regions of Interest (ROI)will guide the user through their surroundings, and in the presence of sudden obstacles, an ultrasonic sensor triggers audible alerts for timely warnings. The system will continually update navigation directions based on real-time object detection, with the server transmitting these updates to the user's mobile application. Users will receive clear and intuitive audio cues through the mobile application, enhancing their situational awareness and facilitating smooth navigation. Furthermore, the system will identify reading materials through the camera, sending captured text to the server. Upon receiving a read command, the server will convert the text to speech, providing users with accessible information through the mobile application. In essence, the SmartVision Assistive System is a holistic solution, seamlessly integrating environmental perception, dynamic navigation assistance, and text-to-speech capabilities to empower visually impaired individuals, fostering independence and accessibility in their daily lives.

V. ADVANTAGES

The proposed IoT project for enhancing the mobility and independence of visually impaired individuals through a wearable device offers several advantages:

1. Increased Independence: The wearable device will empower visually impaired individuals to navigate and interact with their surroundings more independently. This will contributes to their overall sense of autonomy and reduces dependency on others for assistance.

2. Real-time Environment Perception: By utilizing ultrasonic or infrared sensors, the system will continuously scans the environment, providing real-time data on the distances to nearby objects. This will enable users to have a dynamic and up-to-date understanding of their surroundings, helping them make informed decisions during navigation.

3. Obstacle Avoidance: The primary functionality of the device is to detect objects in the user's vicinity and provide audio cues in real-time. This will help users navigate safely by alerting them to obstacles and potential hazards, allowing them to make adjustments to their path accordingly.

4. Integration with Mobile Phones: The seamless connection between the wearable device and a mobile phone will enhance the user experience. Users will receive audio cues directly on their mobile phones, which are devices commonly used by many individuals. This integration will also allow for

easy configuration and customization through a user-friendly mobile application.

5. Arduino Technology: Leveraging Arduino technology will ensure a cost-effective and customizable solution. Arduino microcontrollers are known for their versatility and ease of use, making the device accessible to a broader user base.

6. User-friendly Design: The project emphasizes user-friendly design and accessibility, acknowledging the specific needs of visually impaired individuals. The goal is to ensure that users can easily configure and use the device, making it a practical and intuitive solution for the target audience.

7.Enhanced Awareness of Surroundings: The IoT solution will enhance the awareness of visually impaired individuals regarding their environment. This will increase awareness and can lead to greater confidence in navigating various spaces and scenarios, contributing to an improved quality of life.

8. Demonstration of IoT and Arduino Potential: The project will showcase the practical application of IoT and Arduino technologies to address real-world challenges. This demonstration will highlight the potential of these technologies to create innovative solutions that directly impact the lives of individuals with visual impairments.

In summary, the advantages of this IoT project will include improved independence, real-time environment perception, obstacle avoidance, mobile phone integration, cost-effectiveness through Arduino technology, user-friendly design, enhanced awareness, and a demonstration of the potential of IoT and Arduino in addressing societal challenges.

VI. FUTURE SCOPE

Given the tools specified for the project, the camera module of Arduino and TensorFlow will be utilized for object detection, leveraging the camera's visual input and TensorFlow's machine learning capabilities. Navigation will be facilitated through the use of Region of Interest (ROI) algorithms and ultrasonic sensors, combining spatial awareness and distance measurement to guide the user effectively. The text-to-speech functionality will be implemented using PyTTSx3, providing a natural and audible output based on the processed information. We will get the audio output through a mobile application ,Upon installation and login, our mobile application seamlessly operates in the background, delivering audio outputs to the user's mobile phone, enhancing accessibility and providing a continuous, unobtrusive experience.The integration of these hardware and software components will create a application that can recognize objects, navigate environments, and convert text to speech, enhancing the overall user experience.

VII. CONCLUSION

The Third Eye project stands as a groundbreaking and transformative initiative with the power to significantly improve the lives of millions in the visually impaired community globally. Our commitment to leveraging technical expertise underscores the creation of a practical and innovative solution, fostering independence and accessibility. This endeavor not only showcases the potential for positive impact but also exemplifies the intersection of technology and social responsibility. By addressing the unique challenges faced by the visually impaired, the Third Eye project embodies a commitment to inclusivity and represents a substantial step forward in enhancing the quality of life for a diverse and often underserved population. This innovative solution exemplifies the meaningful intersection of technology, compassion, and empowerment, marking a significant contribution to the ongoing dialogue on accessibility and inclusiveness in today's rapidly evolving technological landscape.

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