B.M.S. COLLEGE OF ENGINEERING
Bengaluru-560019.

Autonomous College, affiliated to
Visvesvaraya Technological University, Belgaum

Project Work -2 Report on
“ASSISTIVE WEARABLE FOR THE VISUALLY IMPAIRED”

Submitted in partial fulfilment of the requirement for completion of
PROJECT WORK –2 [22EC6PWPJ2]

Submitted by

Nandan P Kashyap	**USN: 1BM21EC082**
Rachana Krishna Kulkarni	**USN: 1BM21EC119**
Samuel John Raj.P	**USN: 1BM21EC141**
Vedansh Narayan Sharma	**USN: 1BM21EC196**

Under the guidance

Dr. K.N.Rajanikanth

Associate Professor
BMS College of Engineering

Bengaluru

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BMS College of Engineering
Bull Temple Road, Basavanagudi, Bengaluru-560019

BMS COLLEGE OF ENGINEERING

Autonomous college, affiliated to VTU

Bull Temple Road, Bengaluru – 560 019

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certified that the Project work -2 entitled " **Assistive Wearable for the Visually Impaired "** is a bonafide work carried out by **Nandan P Kashyap (1BM21EC082), Rachana Krishna Kulkarni (1BM21EC119), Samuel John Raj.P (1BM21EC141) and Vedansh Narayan Sharma (1BM21EC196)** submitted in partial fulfilment of the requirement for completion of PROJECT WORK - 2 [22EC6PWPJ2] of Bachelor of Engineering in Electronics and Communication during the academic year 2023-24. The Project Work - 2 report has been approved as it satisfies the academic requirements.

Guide
(Dr. K.N.Rajanikanth)
Associate Professor
Department of ECE
BMS College of Engineering

Head of Department
(Dr. Siddappaji)
Professor and Head
Department of ECE
BMS College of Engineering

(Dr. Muralidhara S)
Principal
BMS College of Engineering

External Viva

Name of the Examiners | Signature with Date

1.

2.

DECLARATION

We, **Nandan P Kashyap (1BM21EC082), Rachana Krishna Kulkarni (1BM21EC119), Samuel John Raj.P (1BM21EC141) and Vedansh Narayan Sharma (1BM21EC196) ,** hereby declare that the Project Work -2 entitled **Assistive Wearable for the Visually Impaired** is a bonafide work and has been carried out by us under the guidance of **Dr. K.N.Rajanikanth ,** Associate Professor, Department of Electronics and Communication Engineering, BMS College of Engineering, Bengaluru submitted in partial fulfilment of the requirement for completion of PROJECT WORK - 2 [22EC6PWPJ2] of Bachelor of Engineering in Electronics and Communication during the academic year 2023-24. The Project Work -2 report has been approved as it satisfies the academic requirements in Electronics and Communication engineering, Visvesvaraya Technological University, Belagavi, during the academic year 2023-24.

We further declare that, to the best of our knowledge and belief, this Project Work -2 has not been submitted either in part or in full to any other university.

Place: Bengaluru

Date: 11/07/2024

Nandan P Kashyap	1BM21EC082
Rachana Krishna Kulkarni	1BM21EC119
Samuel John Raj.P	1BM21EC141
Vedansh Narayan Sharma	1BM21EC196

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1. Nandan P Kashyap 1BM21EC082
2. Rachana Krishna Kulkarni 1BM21EC119
3. Samuel John Raj.P 1BM21EC141
4. Vedansh Narayan Sharma 1BM21EC196

ABSTRACT

Visually impaired individuals encounter significant challenges in daily tasks, particularly in navigation and collision avoidance. Existing solutions like white canes and caregiver assistance are limited, addressing only one aspect of these challenges at a time. To provide comprehensive support, we propose an integrated wearable system that enhances the independence and safety of visually impaired individuals. This system combines object classification, emergency communication, and collision prevention into a single, efficient solution.

The core of our system is a Raspberry Pi module running TensorFlow Lite for real-time image classification. A live feed from a camera module captures the surroundings, which the Raspberry Pi processes to identify objects. The identified objects are then communicated to the user via speech synthesis. Additionally, an emergency SOS button is included to alert caregivers in distress situations through a WhatsApp chatbot. For collision prevention, an obstacle detection sensor continuously scans for obstacles, providing haptic feedback to the user upon detection.By integrating these functionalities, our wearable system offers a cost-effective and holistic approach to assist visually impaired individuals, significantly improving their ability to navigate and interact with their environment safely and independently.

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Abbreviations	Full Form
AUV	Autonomous Underwater Vehicles
IEEE	Institute of Electrical and Electronics Engineers

Chapter 1:

Introduction

In this project, our objective is to develop an innovative assistive system specifically designed for individuals with visual impairments. This system integrates advanced technologies to offer real-time assistance and enhance safety. Central to our design is the use of Tensor Flow on a Raspberry Pi platform, which facilitates sophisticated object detection capabilities. By recognizing objects in the user's surroundings, the system provides essential information about the environment, enhancing situational awareness. The detected objects are communicated to the user through audible speech, seamlessly converting visual data into verbal cues.

To address emergency situations, the system is equipped with an SOS button. This feature allows users to quickly alert caregivers by sending a pre-configured message via WhatsApp, ensuring timely assistance when needed. Additionally, to further improve user safety, the system incorporates collision prevention functionality. This is achieved through obstacle detection sensors that continuously monitor the user's path. Upon detecting an obstacle, the system provides haptic feedback through subtle vibrations, enabling users to navigate with greater confidence and avoid potential hazards.

By combining these features, our assistive system aims to significantly enhance the independence and safety of visually impaired individuals, allowing them to interact more effectively with their surroundings and respond promptly in emergencies.

Chapter 2:

Literature survey

The authors proposed a solution to address the challenges faced by visually impaired individuals through the development of a wearable device incorporating object detection, text recognition, and text-to-speech conversion functionalities. This comprehensive system aims to provide real-time feedback to users, enabling them to navigate their surroundings and access textual information independently. By utilizing technologies such as Raspberry Pi, camera modules, and gTTS (Google Text-to-Speech), the device offers cost-effective and practical solutions compared to traditional sensor-based aids. The study emphasizes the importance of integrating multiple features into a single device to enhance user independence and safety. Results from the study demonstrate the effectiveness of the system in identifying obstacles and reading textual content aloud, thereby empowering visually impaired individuals to perform daily tasks with greater ease and efficiency. The proposed solution lays the foundation for future enhancements, including navigation assistance and object detection in low-light conditions, to further improve the quality of life for visually impaired individuals. [1]

The paper explores development of utilization of a combination of the CNN neural network FAST-SCNN and depth maps from the ZED 2, the front-facing environment image for visually impaired individuals is divided into seven equal sections. Each section's walkability confidence is calculated, and a voice prompt guides the user towards the safest direction. This system helps navigate sidewalks, avoid obstacles, and safely traverse crosswalks. Additionally, the YOLOv5s network identifies obstacles directly ahead. Testing around an MRT station in Taiwan with visually impaired individuals showed increased feelings of safety while walking outdoors. The experiment confirmed the system's effectiveness in guiding safe navigation of sidewalks and crosswalk. [2]

The paper discusses the implementation CNN-based semantic segmentation techniques within the realm of computer vision. These methods estimate semantic labels from RGB or RGBD images, aiding in understanding room layouts, object identification, and even low-lying obstacle detection. By amalgamating semantic segmentation with appearance and structural information, there's potential to enhance the accuracy of classifying navigable paths. However, there's a dearth of efficient methods for conveying this rich information to me. Consequently, I'm intrigued by the notion of designing touch interfaces to facilitate efficient object location. [3]

The paper explores development of assistive technologies tailored to empower visually impaired individuals in navigating their surroundings and fostering independence. A plethora of research endeavors have resulted in innovative solutions, each harnessing distinct sensor technologies and communication frameworks to address the multifaceted challenges faced by the visually impaired community.One pioneering initiative introduces a sophisticated system integrated into a white cane. Employing a combination of sensors for obstacle detection, localization modules, and tags for indoor positioning, this system operates seamlessly to enhance mobility without necessitating external assistance. Similarly, a navigation gadget leverages sensors and readers, complemented by the robust connectivity of a mobile platform to provide real-time location awareness and obstacle detection through voice output. [4]

The paper discusses the implementation of wearable navigation and assistive systems aid visually impaired individuals by providing real-time guidance and environmental feedback, enhancing mobility, independence, and accessibility in daily activities. The technological framework of wearable navigation and assistive systems integrates sensors like GPS, LiDAR, and ultrasonic, alongside wireless communication and embedded computing platforms. These systems provide real-time navigation cues and environmental feedback, enhancing mobility and accessibility for visually impaired individuals through wearable devices. Design considerations for wearable navigation and assistive systems for the visually impaired involve optimizing ergonomics, size, and interface for accessibility. Emphasis is placed on user centered design, ensuring ease of use and comfort. [5]

The paper discusses the implementation of a wireless indoor positioning system heralds a new era of independent mobility, utilizing local and global positioning servers alongside smartphone technology to provide precise location data. Moreover, an algorithmic approach, integrating technologies, promises enhanced location tracking and obstacle avoidance, paving the way for a virtual tracking device tailored to outdoor exploration. A comprehensive system and an enhanced white cane underscore the importance of user-centric design, incorporating features such as voice recognition, water detection sensors, and vibration alerts to ensure comprehensive assistance and heightened safety. The evolution of assistive technologies further encompasses wearable systems, exemplified by a versatile device integrating components such as pedometers, GPS, tags, and sensors. By amalgamating these components, users can seamlessly navigate their surroundings, with real-time feedback and remote monitoring capabilities enhancing safety and peace of mind. [6]

The paper presents a notable surge in the development of assistive technologies tailored to empower visually impaired individuals in navigating their surroundings and fostering independence. A plethora of research endeavors have resulted in innovative solutions, each harnessing distinct sensor technologies and communication frameworks to address the multifaceted challenges faced by the visually impaired community. One pioneering initiative introduces a sophisticated system integrated into a white cane. Employing a combination of sensors for obstacle detection, localization modules, and tags for indoor positioning, this system operates seamlessly to enhance mobility without necessitating external assistance. Similarly, a navigation gadget leverages sensors and readers, complemented by the robust connectivity of a mobile platform to provide real-time location awareness and obstacle detection through voice output. [7]

Chapter 3:

Problem Analysis & Solution

3.1 Problem Definition

Visually impaired individuals encounter significant challenges in performing everyday tasks, particularly in navigation and collision avoidance. Traditional solutions, such as white canes or reliance on caregivers, often fall short, as they typically address only one issue at a time and lack efficiency. There is a crucial need for an integrated wearable system that offers comprehensive assistance to tackle these challenges effectively. Such a system should encompass a range of features to enhance the independence and safety of visually impaired individuals. By incorporating functionalities for navigation, object detection, emergency communication, and collision prevention, the system can provide a multifaceted approach to aid in daily activities. This holistic solution aims to empower visually impaired individuals, allowing them to navigate their environments with greater confidence and reduced reliance on external help. The development of such an assistive wearable system represents a significant step forward in improving the quality of life for those with visual impairments.

3.2 Proposed Solution

The proposed solution is a comprehensive assistive wearable system designed to aid visually impaired individuals by integrating multiple functionalities into a single, cohesive unit. The system primarily focuses on object classification and emergency communication to enhance the user's independence and safety.

Object Classification and Speech Synthesis:

The object classification component of the assistive wearable system leverages advanced computer vision and machine learning technologies to provide real-time environmental awareness for visually impaired individuals. A camera module attached to the wearable system continuously captures a live video feed of the surroundings, which is connected to a Raspberry Pi acting as the central processing unit. The captured images are first processed using OpenCV, an open-source computer vision library. Key preprocessing steps include resizing to adjust image dimensions, normalization to scale pixel values, color space conversion, and noise reduction to ensure clear and accurate input for the detection model. The preprocessed images are then fed into a TensorFlow Lite model for object detection. TensorFlow Lite is chosen for its efficiency and suitability for embedded systems like the Raspberry Pi. The object detection process involves using a pre-trained model like MobileNet SSD (Single Shot MultiBox Detector) to balance speed and accuracy. The model processes the image, identifying objects and generating bounding boxes with class labels and confidence scores. TensorFlow Lite optimizes the model for real-time performance with minimal latency. This process is underpinned by key concepts like Convolutional Neural Networks (CNNs) for pattern recognition, feature extraction, bounding box regression for object location, and Non-Maximum Suppression (NMS) to filter redundant bounding boxes. By implementing these principles and leveraging TensorFlow Lite and OpenCV, the assistive wearable system effectively classifies objects in real-time, providing essential information through audible feedback, enhancing the user's situational awareness, and promoting greater independence and confidence in navigating their surroundings.

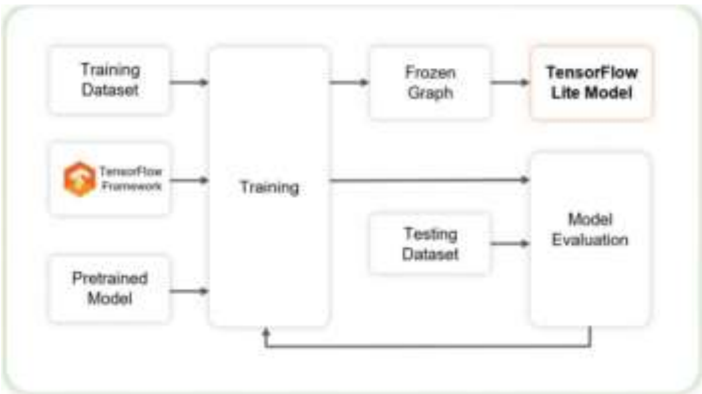

Figure 1. Block diagram of Object-Classification

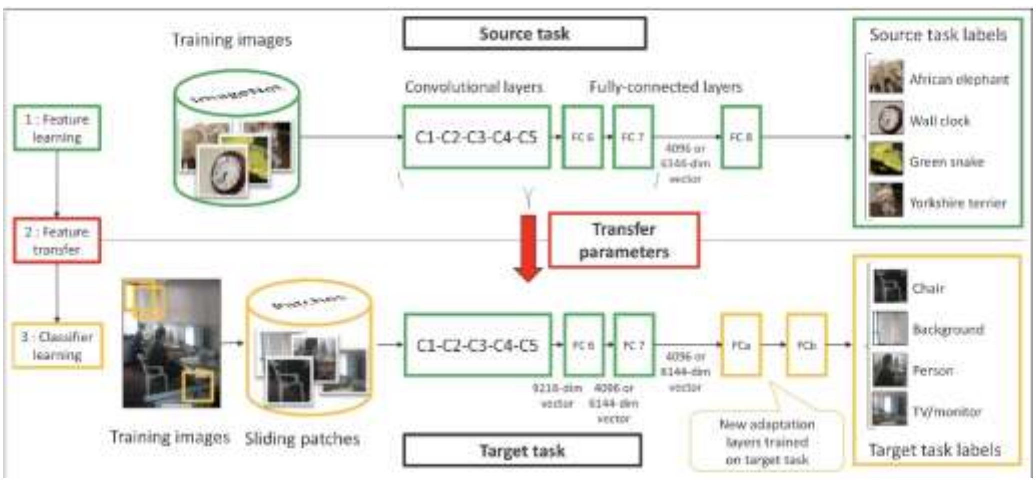

Figure 2. Pictorial diagram of Object Classification

Emergency SOS Button: In emergency situations, a physical switch connected to a GPIO pin of the Raspberry Pi acts as the emergency SOS button. When pressed, this button triggers the Raspberry Pi to send an alert message to a designated caregiver. This is achieved through the integration of Twilio, a cloud communications platform. The Raspberry Pi communicates with Twilio's API to send a pre-configured text message, notifying the caregiver of the user's distress and providing the necessary details for timely assistance.

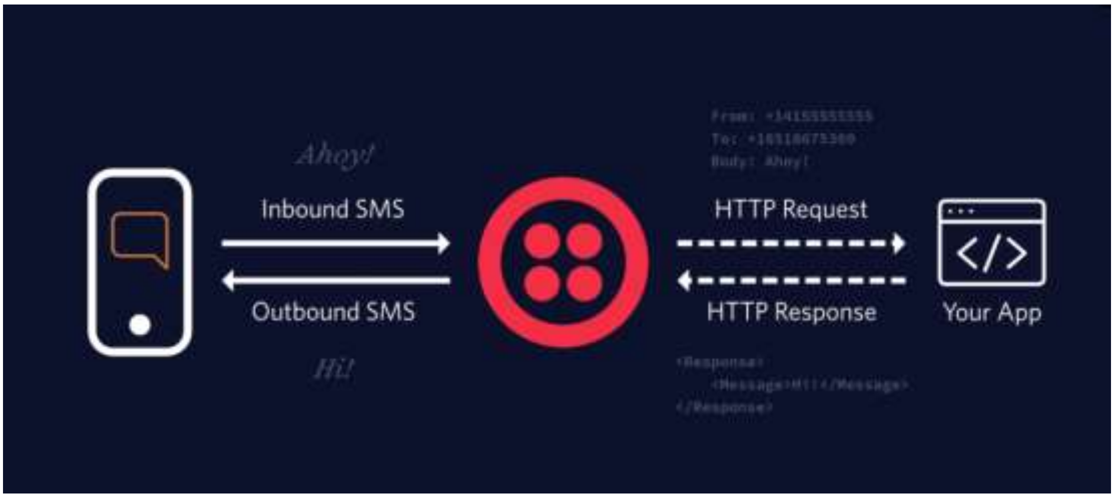

Figure 3. Block diagram of Emergency SoS

Figure 4. Pictorial diagram of Emergency SoS

By combining these features, the assistive wearable system offers a practical and efficient solution to the challenges faced by visually impaired individuals. The use of TensorFlow Lite for object classification ensures that the system can recognize and communicate important environmental information quickly and accurately. The emergency SOS functionality, facilitated by Twilio, provides a reliable means for users to seek help when needed. This integrated approach significantly enhances the safety and autonomy of visually impaired users, enabling them to navigate their environment with greater confidence and reduced reliance on external support.

Chapter 4:

Methodology & Implementation

4.1 Block Diagram

4.1.1 Pictorial Representation

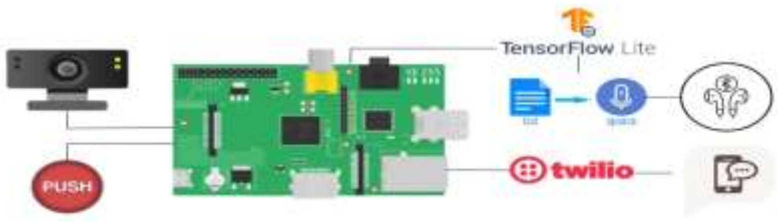

Figure 5. Pictorial diagram of Assistive tool for visually impaired

4.1.2 Flow Chart

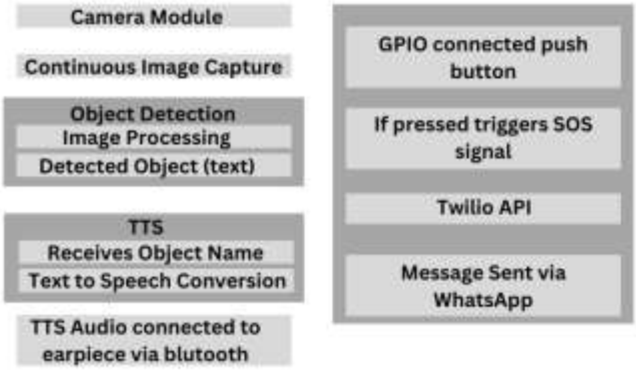

Figure 6. Block diagram of Assistive tool for visually impaired

Chapter 5:

Results & Discussion

The proposed assistive wearable system for visually impaired individuals represents a significant advancement in enhancing their daily lives through innovative technology. By integrating object detection and emergency SOS functionalities into a single device, the system addresses critical challenges faced by blind individuals, thereby improving their independence, safety, and overall quality of life.

The system's ability to classify and communicate objects in real-time using TensorFlow Lite and OpenCV provides invaluable assistance to visually impaired users. By analyzing the live video feed captured by the camera module, the system identifies and verbally communicates objects in the user's surroundings. This capability enhances situational awareness, enabling users to navigate unfamiliar environments with greater confidence and efficiency. For example, it can identify obstacles, doorways, or specific objects like chairs or stairs, allowing users to plan their movements and interact more effectively with their surroundings.

In emergency situations, the integrated SOS button linked to Twilio allows users to swiftly alert caregivers or emergency services. By pressing the button, the Raspberry Pi sends a predefined text message via Twilio, notifying designated contacts of the user's distress and providing crucial location information. This feature ensures timely assistance, potentially reducing response times in critical situations, such as accidents or medical emergencies.

The combined functionalities of object detection and emergency SOS significantly enhance the safety, independence, and overall well-being of visually impaired individuals. The ability to navigate independently and receive immediate assistance in emergencies empowers users to lead more autonomous lives. This independence fosters confidence and reduces reliance on external support, promoting a sense of dignity and control over daily activities.

Utilizing Raspberry Pi as the central processing unit offers a cost-effective solution compared to traditional assistive technologies. Raspberry Pi's affordability and versatility make it accessible for widespread adoption, potentially lowering barriers to access for visually impaired individuals worldwide. Moreover, the integration of multiple functionalities into a single device enhances cost-effectiveness by consolidating various assistive features into one portable and efficient system.

In conclusion, the proposed assistive wearable system represents a transformative tool for visually impaired individuals, leveraging object detection and emergency SOS capabilities to enhance safety, independence, and overall quality of life. By harnessing the power of Raspberry Pi, the system not only offers advanced functionalities but also ensures affordability and scalability, making it a practical and impactful solution for the blind community globally.

Chapter 6:

Future Trends and Conclusion

6.1 Conclusion

In conclusion, the proposed assistive wearable system exemplifies a pivotal advancement in technology aimed at empowering visually impaired individuals. By integrating robust object detection capabilities using TensorFlow Lite and OpenCV, coupled with an efficient emergency SOS feature via Twilio, the system significantly enhances user safety, independence, and overall quality of life. The ability to identify and communicate surrounding objects in real-time equips users with crucial environmental awareness, facilitating confident navigation and interaction with their surroundings. Meanwhile, the emergency SOS functionality ensures prompt assistance during critical situations, fostering a sense of security and autonomy. Moreover, leveraging the cost-effective Raspberry Pi platform underscores the system's accessibility and scalability, potentially transforming the landscape of assistive technologies for the visually impaired. This collective approach not only addresses current challenges comprehensively but also sets a promising precedent for future innovations in enhancing accessibility and inclusivity for individuals with visual impairments.

6.2 Future Trends

1. **Deep Learning for Enhanced Object Recognition:** Research is focusing on using deep learning techniques like convolutional neural networks (CNNs) to improve object recognition accuracy in real-world environments, allowing for more reliable and detailed scene understanding.

2. **Mobile and Edge Computing Solutions:** There is a shift towards using mobile devices and edge computing platforms (like Raspberry Pi) for processing and analysis, enabling faster and more responsive assistive technologies without heavy reliance on cloud services.

3. **Tactile and Auditory Interfaces:** Innovations in tactile displays and auditory interfaces are enhancing the way visually impaired individuals interact with digital information, providing intuitive feedback through touch and sound.

4. **Navigation and Spatial Awareness Systems:** Research is exploring advanced navigation systems that integrate GPS, inertial sensors, and computer vision to provide precise indoor and outdoor navigation aids, improving mobility and independence.

5. **User-Centric Design and Accessibility Standards:** There is a growing emphasis on designing assistive tools with direct input from visually impaired users, ensuring that devices are intuitive, easy to use, and meet accessibility standards for inclusivity in daily activities.

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APPENDIX A:

Plagiarism Report

https://searchenginereports.net/plagiarism-checker

APPENDIX B:

APPENDIX C:

Research Publications