1. What can you address in this project?-1min(page2)

We decided to focus on an engineering project because we find the practical application of technology more engaging, and it brings us a greater sense of achievement. Our goal is to develop a system that detects nearby obstacles, measures their distance, and alerts visually impaired users to avoid them, thereby enhancing their independence and safety in navigation.

This project addresses a critical gap in assistive technologies for the visually impaired. Current research in this area is limited, resulting in systems that fail to significantly improve upon the functionality of the traditional white cane. While the cane remains a reliable tool for detecting nearby obstacles, it falls short in providing detailed information about the environment.

1. What are the expected results of the project?-2min(page3)

Our project aims to overcome these limitations by developing a comprehensive system that not only detects obstacles and estimates distances but also provides rich contextual information about the environment. This may include:

1. Detailed descriptions of objects in the user's front, including their class and dimensions.
2. Notifications about traffic signals and other important visual cues.
3. Providing information about the object’s size and type, which the cane cannot convey. This allows users to make informed decisions about whether to step over, walk around, or otherwise navigate past these obstacles.
4. Maintaining high recognition accuracy in low-quality and low-light environments, ensuring the system remains effective in various conditions such as nighttime or poorly lit indoor spaces.
5. Achieving real-time processing on small, low-power computing platforms, making the system portable and practical for everyday use without compromising on performance.

So, this system will involve object detection and classification, distance measurement and TTS.

3. Ideas to solve the problems -2min(page4)

Our object detection and classification approach will be based on the YOLO (You Only Look Once) algorithm, with YOLO v4 as our starting point. However, to meet the requirements of real-time processing and portability, we might considering significantly optimize the model by exploring model compression techniques to reduce size of the model or considering replacing the CSPDarknet53 backbone with a lighter architecture like MobileNet. We will also investigate efficient YOLO variants such as YOLOv8-nano, which we plan to fine-tune for our specific use case.

For distance estimation, we will explore both monocular and Dual Camera approaches:

1. Monocular Depth Estimation: We will investigate the MonoDepth algorithm, which uses a single camera to estimate depth. This method could be beneficial for creating a more compact and cost-effective system.

2. Dual Camera: For potentially more accurate results, we will implement a dual camera system using the Semi-Global Matching (SGM) algorithm. This approach uses two cameras to calculate depth based on the disparity between the two images.

We will compare the performance and accuracy of both methods to determine the most suitable approach for our system.

4. Collecting datasets -1.5min(page5)

first, We will use the open source BDD100K dataset for training our YOLO model. This dataset is particularly suitable for our task as it contains labeled images from various cities, covering a wide range of lighting conditions and weather scenarios, including rain, fog, and nighttime scenes. These characteristics make it an ideal choice for our objective, especially in tackling the challenges of low-light detection.

secondly, We will supplement dataset by gathering additional data focused on low-lying obstacles such as short posts, steps, and speed bumps, as well as temporary obstacles commonly.

moreover, This custom dataset will also include images captured in various lighting conditions, particularly in low-light environments.

To enhance our model's robustness and generalization capabilities, we will employ a range of data augmentation techniques. These include geometric transformations, color adjustments, noise injection, Mixup and Mosaic.

5. Conducting literature survey–2min(page6)

We conducted an extensive literature survey to understand the current state-of-the-art in computer vision techniques to assistive technologies for the visually impaired. Our research highlighted several key areas and challenges:

We reviewed the YOLO (You Only Look Once) algorithm, as outlined by Redmon et al. (2016), and its advancements, including YOLO v4 by Bochkovskiy et al. (2020). These studies form the foundation of our object detection approach.

For distance estimation, we explored both monocular and stereo vision approaches. We examined the MonoDepth technique proposed by Godard et al. (2017) for single-camera depth estimation. For stereo vision, we studied the Semi-Global Matching (SGM) algorithm by Hirschmüller (2008), which offers robust performance in various environments.

For potential implementation on small computing devices, we looked into "MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications" by Howard et al. (2017), which provides insights into creating efficient models for mobile and embedded vision applications.

These references and insights have provided a comprehensive foundation for identifying the technical challenges and potential optimizations in our project, guiding our decision-making process for both object detection and distance estimation techniques.

6. Conclusion–1min

In summary, our project aims to develop an assistive vision system for the visually impaired, capable of detecting objects, estimating distances, and providing timely notifications to users.

This project not only allows us to apply and extend our knowledge in computer vision but also has the potential to make a meaningful impact on people's lives. Through careful consideration of challenges such as low-light conditions and the need for edge computing implementations, we are positioning our project to address real-world needs and contribute to the field of assistive technologies.