PROJECT PROPOSAL

Title: Development of a Mobile Application For Image Processing to Improve Environmental Recognition and Navigation for Blind People.

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2024

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Introduction

Problem

The emergence of technology has caused dramatic changes in how we connect with our surroundings. However, not every person benefits equally from these developments. Visually Impaired persons, for example, frequently suffer major difficulty when navigating and engaging with their surroundings - a issue which technology has the potential to improve.

The World Health Organization's data give context for this topic, estimating that around 285 million individuals worldwide suffer from visual impairment. This considerable segment of the worldwide population frequently relies on the aid of others to do daily chores, emphasizing the importance of creating technology that will enable them to engage more fully in routine economic and social activities. (World Health Organization, 2023) (iapb, 2024)

Solution

The integration of speech recognition and image processing technology is greatly increasing the level of freedom for people with visual disabilities, especially in difficult situations like marketplaces.

Researchers and developers are developing assistive technology, such as laser-ranging module sensors and mobile apps, to improve the safety and independence of those with disabilities. Laser ranging sensors, or LIDAR (which stands for Light Detection and Ranging) sensors that are measure the time it takes for laser pulses to bounce back from surrounding objects. This information generates a 3D map of the environment, which may be evaluated to identify barriers, traverse them, and deliver useful information to the user.

Mobile applications that link with LIDAR sensors and deliver real-time feedback through a user-friendly interface make this technology more accessible to visually impaired users. Obstacle detection can be communicated through spoken alarms, haptic feedback, and audio descriptions to assist users comprehend their surroundings.

Image processing in this context entails interpreting LIDAR sensor data and extracting pertinent environmental information. This includes spotting barriers and assessing the surroundings to improve navigation efficiency. Image processing methods improve sensor accuracy and reliability by filtering out noise and undesired data.

Simplifying Market Purchase for the Visually Impaired Through Technology like Object Identification and Indoor Navigation

The development of assistive technology has increased the independence of those who are blind or visually impaired. However, because of their design and congested aisles, markets continue to be difficult to navigate. A potential remedy for this is the combination of image processing with speech recognition technologies, including YOLOv5 Models from TensorFlow.

YOLOv5 from TensorFlow offers open-source object identification techniques that enable the extraction of data from pictures, such as pricing, which may then be voice-activated by the user. YOLOv5 also uses deep neural networks to classify objects quickly and reliably, helping people with visual impairments recognize a variety of items when they are shopping.

By combining these technologies with speech recognition, the market becomes more accessible to consumers who are visually impaired, who can now independently read labels, choose products, and get price details. This sense of independence increases the visually impaired person's self-esteem and social engagement.

But absolutely, the navigation detecting technology is not exclusive to market contexts. It may be extremely beneficial for indoor navigation in a variety of environments, assisting visually impaired people in detecting ordinary things such as chairs and tables. This improves their capacity to move around securely and freely in their homes or public places.

Following the project's development, will begin testing. It is done at the first level Project Method which is category 1 as mentioned by UWL without really engaging visually impaired persons (may mimic this by blindfolding or using another method).

In essence, the combination of speech recognition and image processing technology has the potential to alter the shopping experience for the visually impaired, giving them a new degree of freedom and participation in daily activities.

Aim and Objectives

Aim

To improve the autonomy and safety of visually impaired people, we developed a navigation detection system that uses image processing to recognize typical interior items like tables and chairs and delivers real-time auditory feedback to aid with obstacle avoidance.

Achievable chunks:

1. **Research Phase:** Conduct a thorough evaluation of existing image processing technologies and their use in assistive devices for the visually impaired.
2. **Technology Selection:** Select image recognition methods that may be tailored for item detection in indoor settings.
3. **Prototype Development:** Create a primitive version of the navigation detection system that can recognize a limited number of objects.
4. **User Feedback:** To evaluate the prototype and obtain suggestions for improvements.
5. **System Refinement:** Improve the system based on user feedback, with an emphasis on accuracy and usability.
6. **Audio Feedback Integration:** Create and integrate a text-to-speech system that gives users clear and straightforward audio cues.
7. **Final Testing:** After the project's development, will begin testing. It is done without really engaging visually impaired persons (I may mimic this by blindfolding or using another method). Conduct thorough testing in a range of interior conditions to confirm dependability and efficacy.

Objectives

Develop an Image Recognition Function:

- **Specific:** Creating an function that utilizes the camera to detect and categorize photographs.
- **Measurable:** The software should use machine learning to evaluate photos and extract useful information.
- **Achievable:** Create an app capable of correctly processing and categorizing photos.
- **Relevant:** This will help vision challenged individuals understand their surroundings.
- **Time-bound:** The app development should be completed within 1 months.

Implement Audio Feedback:

- **Specific:** Integrate TTS technology to deliver audio descriptions of the environment and objects.
- **Measurable:** Users should get clear aural input about their surroundings.
- **Achievable:** Use powerful TTS systems to translate written descriptions into spoken words.
- **Relevant:** Audio feedback can assist visually impaired individuals in navigating more successfully.
- **Timeline:** Complete integration within 1 months.

Text Recognition for Detecting Objects and Prices:

- **Specific:** Create text recognition algorithms to recognize objects and prices in markets.
- **Measurable:** Algorithms should perform well in congested and poorly light conditions.
- **Achievable:** Test and improve algorithms to assure dependability.
- **Relevant:** This will improve shopping accessibility for the visually impaired.
- **Time-bound:** Aim to complete within 1 month.

Smartphone Application Development:

- **Specific:** Develop a smartphone application with picture recognition and natural language processing capabilities by including all the other included objectives into it.
- **Measurable:** The app must be completely functioning and easy to use for visually impaired people.
- **Achievable:** Use current technologies to design a user-friendly app interface.
- **Relevant:** The software will help users with their everyday routines and increase their independence.
- **Time-Bound:** Plan to launch the app within 2 month.

Development of Indoor Navigation Assistance for Visually Impaired Persons:

- **Specific:** Create a navigation detection component within the existing app that uses image processing to identify typical interior items such as tables and chairs.
- **Measurable:** The function will properly detect items and provide aural feedback to notify the user of their presence and placement in relation to the user's present position.
- **Achievable:** Use powerful picture recognition algorithms and spatial mapping technologies to identify the location and distance between items in the environment.
- **Relevant:** This capability would greatly benefit visually impaired users by giving them with real-time, audio information about their surroundings, allowing them to navigate interior settings more securely and freely.
- **Timeline:** Aim to have a prototype of this feature available for first testing within 1 month.

Definition of Terms

- **Assistive Technology:** Tools and systems designed to help people with impairments do activities that would otherwise be difficult or impossible.

- **Speech detection:** this refers to a system's capacity to identify spoken words and turn them into text or actions.

- **Image Processing:** this picture processing is the process of conducting operations on a picture to extract relevant information. **example**(detecting a soda bottle in a market and responding through app with voice function that this is a soda bottle.).

- **Navigation Detection:** Technology that assists users in determining their position in a physical place and directing them to their goal.

Relevant Theories

Activity Theory: is a paradigm for analyzing the complex connections between people and technology. It highlights the importance of assistive technology as mediators in the activities of visually impaired people, helping their interaction with their surroundings. (Austin, 2024)

Affordance Theory: proposes that the environment provides a variety of affordances, or chances for action that an individual may quickly perceive. In the field of assistive technology, this idea guides the design of intuitive and accessible user interfaces and interactions for visually impaired users. (Alexy, 2017)

The Social Model of Disability: holds that disability is caused not by an individual's inability, but by society restrictions that impede full involvement. Assistive technology is viewed as a method of eliminating these obstacles and allowing visually impaired people to fully participate in society. (Austin, 2024)

The Person-Environment-Occupation (PEO) Model: emphasizes the dynamic interaction between individuals, their jobs (activities), and the surroundings in which they live and work. Assistive technologies are created with the goal of maximizing this interaction and improving the capacity of visually impaired people to complete daily chores. (Susanna, 2024)

Literature Reference

The existing literature gives vital information on the present status of assistive technology. Studies have emphasized the importance of technology such as screen readers and magnifiers in improving access to education and information. There is also an emphasis on the creation of wearable gadgets and the application of machine learning to improve navigation and object identification for visually impaired individuals. (Nestor, 2022)

However, the research suggests that there is still potential for development in terms of developing more intuitive, user-friendly interfaces and making these technologies available to everybody, regardless of economic background. The research argues for a more integrated strategy that takes into account the different requirements of visually impaired people and aims to develop comprehensive solutions that promote their independence and inclusion into society. (Lavanya, 2021)

Literature Gap

One of the most significant gaps is the scarcity of full solutions that fit smoothly into everyday activities of visually impaired persons. Many assistive gadgets are created as stand-alone devices or software, which might result in a collapsed user experience. There is also a lack of study into the long-term implementation and usage trends of these technologies. Furthermore, the research frequently ignores the price and maintenance of assistive technologies, which are critical criteria for widespread adoption. (Nestor, 2022)

Another notable gap is the lack of attention given to the social ramifications of using assistive technology. While there is much debate on the functional features of technology, less focus is paid to how these tools effect the social integration and mental health of visually impaired people. Furthermore, there is a demand for more focused on users research that includes visually impaired people in the development and testing stages to verify that solutions fulfill their real requirements. (Library Hi Tech News, 2020) (Susanna, 2024)

Methodology

The technique provided for the system developed to aid visually impaired persons with market navigation offers an iterative and adaptable development strategy, which is closely related to the **Agile methodology**.

Agile projects divide the development process into short, manageable increments called sprints, with each iteration encompassing planning, design, programming, and testing. This enables continual assessment and the inclusion of user feedback, which is critical for developing a user-centered product. The process indicated includes user testing and feedback, implying an iterative approach in which the system is fine-tuned depending on actual use. (atlassian, 2024)

The usage of image processing and object identification technologies such as YOLOv5 models from TensorFlow, as well as a TTS engine for voice output, suggests a project based on quick development and frequent testing. This is compatible with Agile techniques, which require frequent delivery of functioning software and allow for modifications at any stage of the development process.

Furthermore, the project's emphasis on enhancing the shopping experience for visually impaired people through real-time identification of objects and pricing indicates a user-centric design approach. Agile methodology prioritizes customer communication above contract negotiation, therefore the project team would collaborate extensively with visually impaired consumers to better understand their wants and preferences, further supporting the Agile approach.

Conclusion

To summarize, this topic has witnessed substantial progress and shows great potential for improving the quality of life in this population. A critical review of the literature finds that, while there have been substantial advances in smartphone-based supportive services and other technologies, integration, cost, and long-term user acceptance remain issues. These innovations have the potential to empower users, maximize functioning, and encourage inclusion; nevertheless, the gap among the availability of such technology and the real requirements of the visually impaired remains. (Khan, 2021) (Mahadeo, 2024)

The Justification for this project aims comes from the necessity to fill these gaps. The project aims to construct a comprehensive system that incorporates image processing and speech detection for environmental recognition and navigation, resulting in a more smooth and intuitive experience for users. The goals are defined with the idea of creating a solution that is not only technologically advanced, but also accessible, user-friendly, and attentive to the various demands of the visually impaired community.

Finally, this research emphasizes the necessity of a user-centered strategy that prioritizes visually impaired persons' real-world needs and experiences, with the goal of delivering solutions that are not only effective, but also egalitarian and empowering.

Project Plan

Work Breakdown Chart

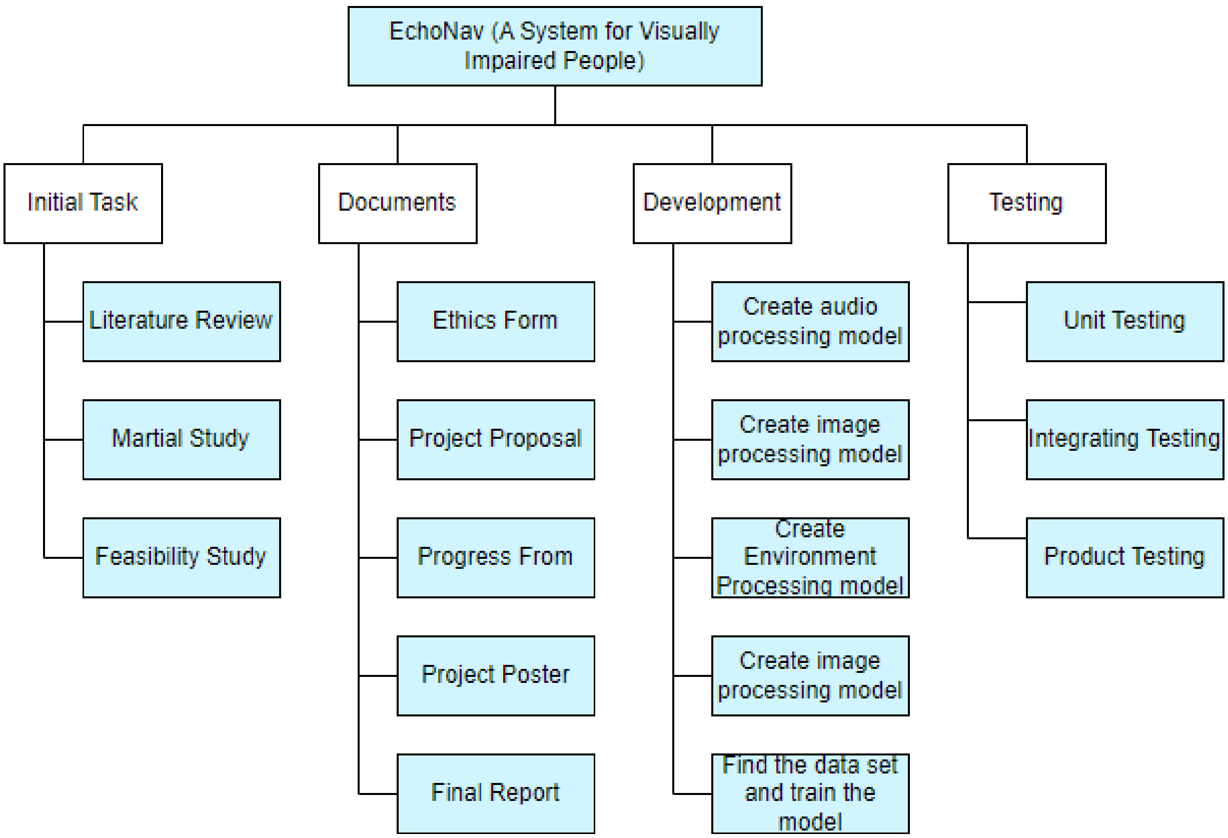


Figure 1 Work Breakdown Structure for the system EchoNav

Technologies Used

TensorFlow: TensorFlow Lite is an ML model format made by converting TensorFlow models into a smaller implementation model. You can use pre-trained models with TensorFlow Lite, tweak existing models, or develop your TensorFlow models and then convert the same to TensorFlow Lite format. TensorFlow Lite models can perform almost any task that regular TensorFlow models can: Object detection, NLP, pattern identification, and other operations on input data such as images, video, audio, or text.

YOLOv5 From TensorFlow: will be utilized for image processing tasks including filtering and object detection. Also will be used for real-time item identification, calculating the chance of product presence in the picture grid. TensoreFlow offers pre-trained YOLOv8 models for my project through there website.

The TTS Engine: converts recognized text into voice, allowing visually challenged users to hear product names and pricing.

Front-End and Back-End Development: The project will use Flutter, a flexible UI framework created by Google, for both front-end and back-end development. Flutter's ability to give a consistent experience across many platforms makes it an excellent choice for developing a unified system that is responsive.

Libraries and Tools: The project will make use of Flutter libraries that are simple but powerful, reducing development time and improving functionality. These libraries offer a variety of pre-built components and utilities, which can considerably decrease development time and effort.

Materials

Physical resources: Cameras, PCs, mobile devices, and particular software for image processing, such YOLOv5 Models From TensorFlow.

Locations: include particular markets where the system will be tested, as well as an internal environment such as a bedroom with a variety of goods.

Objects/Resources: This might include items at a shop that the system recognizes and describes to the user, as well as products in a bedroom.

System design

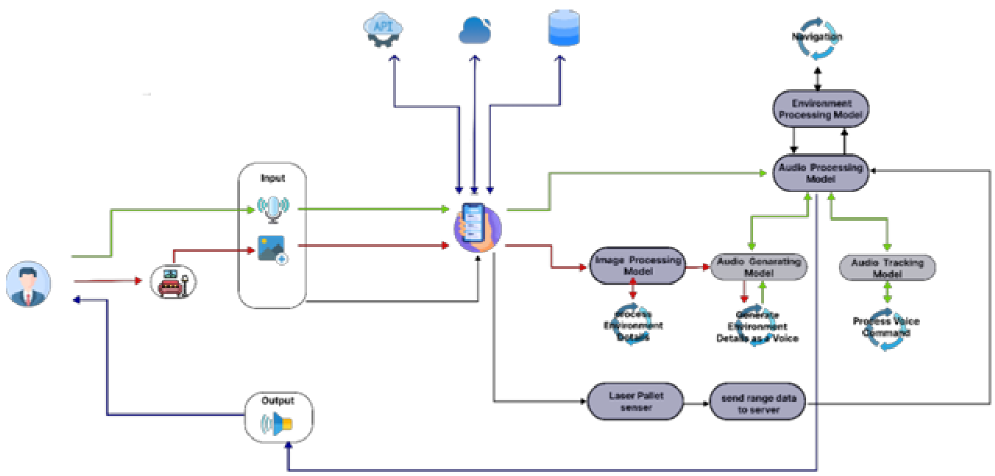
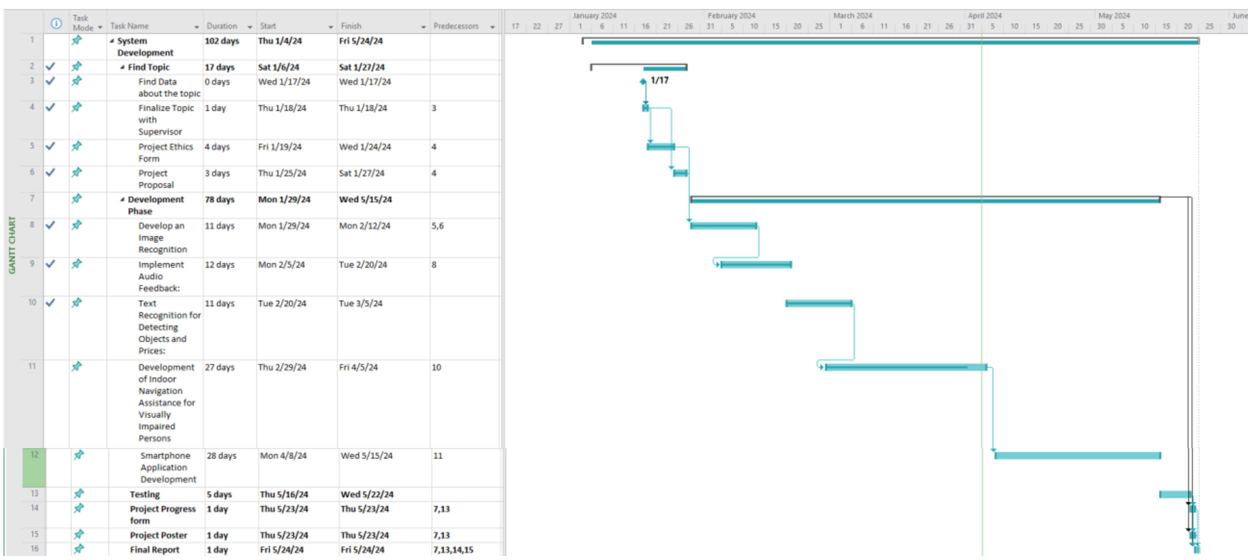


Figure 2 System Design

Gantt Chart



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**System Development**	**102 days**	**Thu 1/4/24**	**Fri 5/24/24**	
2		**Find Topic**	**17 days**	**Sat 1/6/24**	**Sat 1/27/24**	
3		Find Data about the topic	0 days	Wed 1/17/24	Wed 1/17/24	
4		Finalize Topic with Supervisor	1 day	Thu 1/18/24	Thu 1/18/24	3
5		Project Ethics Form	4 days	Fri 1/19/24	Wed 1/24/24	4
6		Project Proposal	3 days	Thu 1/25/24	Sat 1/27/24	4
7		**Development Phase**	**78 days**	**Mon 1/29/24**	**Wed 5/15/24**	
8		Develop an Image Recognition	11 days	Mon 1/29/24	Mon 2/12/24	5,6
9		Implement Audio Feedback:	12 days	Mon 2/5/24	Tue 2/20/24	8
10		Text Recognition for Detecting Objects and Prices:	11 days	Tue 2/20/24	Tue 3/5/24	
11		Development of Indoor Navigation Assistance for Visually Impaired Persons	27 days	Thu 2/29/24	Fri 4/5/24	10
12		Smartphone Application Development	28 days	Mon 4/8/24	Wed 5/15/24	11
13		**Testing**	**5 days**	**Thu 5/16/24**	**Wed 5/22/24**	
14		**Project Progress form**	**1 day**	**Thu 5/23/24**	**Thu 5/23/24**	7,13
15		**Project Poster**	**1 day**	**Thu 5/23/24**	**Thu 5/23/24**	7,13
16		**Final Report**	**1 day**	**Fri 5/24/24**	**Fri 5/24/24**	7,13,14,15

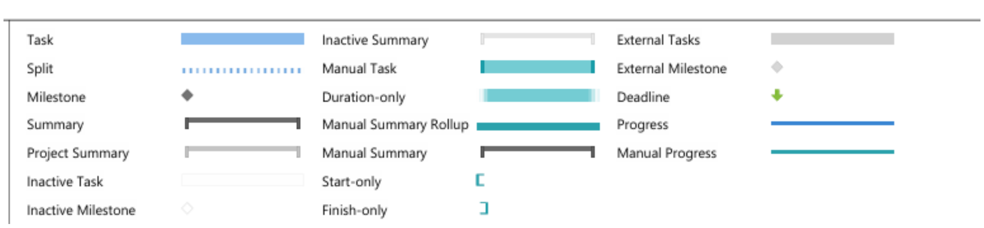


Figure 3 Gantt Chart an timeline for the project

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