Smart Stick for the Blind

A Comparative Study of 3D Mapping from Ultrasonic Sensors and Camera Input using Machine Learning Tools

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I BACKGROUND

The proposed research work will be carried out by the undersigned researcher independently, funded under 'Alpona Banerjee Memorial Endowment Funding Scheme' in collaboration with TCGTBI and IIC 5.0 IIEST Shibpur.

II INTRODUCTION

The purpose of this research proposal is to address the challenges faced by visually impaired individuals in navigating their surroundings independently. We aim to develop a smart stick prototype that utilizes 3D mapping techniques based on ultrasonic sensors, and compare its performance with camera input using machine learning tools. The proposed smart stick aims to enhance the mobility and safety of blind individuals by providing accurate and real-time information about their environment.

III PROBLEM STATEMENT

Visually impaired individuals face numerous challenges in safely navigating their surroundings due to their limited perception of obstacles and environmental features. Traditional white canes used by blind individuals provide basic obstacle detection capabilities but lack the ability to capture and analyze the spatial information necessary for comprehensive environment understanding. Existing solutions that incorporate camera-based approaches often struggle in challenging lighting conditions, making them unreliable in various real-world scenarios.

IV METHODS

A. Smart Stick Prototype Development

We will design and develop a smart stick prototype equipped with ultrasonic sensors and a camera module. The ultrasonic sensors will provide distance measurements to nearby objects, enabling the creation of a 3D map of the environment. The camera module will capture visual information to be used as a reference for comparison and evaluation purposes.

B. Data Collection and Annotation

A diverse set of environments will be selected to collect data for training and evaluation purposes. We will collect data using the smart stick prototype while navigating indoor and outdoor environments, focusing on scenarios encountered in daily life by visually impaired individuals. The data will be annotated to provide ground truth information about the presence and location of obstacles, allowing for supervised learning approaches.

C. Machine Learning Model Development

We will leverage machine learning techniques to develop a model capable of analyzing the data collected from both the ultrasonic sensors and the camera. We will explore various deep learning architectures such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to extract features from the camera input and ultrasonic sensor data. The model will be trained to predict obstacle locations and distances, aiming for high accuracy and real-time performance.

D. Performance Evaluation

The performance of the smart stick prototype will be evaluated by comparing the results obtained from 3D mapping using ultrasonic sensors with those obtained from the camera input. Evaluation metrics such as accuracy, precision, recall, and F1 score will be used to assess the performance of the machine learning model. Additionally, real-world user feedback and subjective assessments will be collected to gauge the usability and effectiveness of the smart stick in improving navigation for visually impaired individuals.

V APPLICATIONS

The proposed smart stick has various potential applications, including but not limited to:

i Enhanced mobility for visually impaired individuals in indoor and outdoor environments.
ii Improved safety and autonomy during navigation in crowded or unfamiliar areas.
iii Assistive technology for blind individuals in educational and vocational settings.
iv Potential integration with other smart devices and navigation systems for seamless accessibility.

VI EXPECTED RESULTS

We anticipate that the smart stick prototype utilizing 3D mapping from ultrasonic sensors, combined with machine learning tools, will provide accurate and real-time information about the environment, allowing visually impaired individuals to navigate more independently and safely. By comparing the results obtained from ultrasonic sensors with those obtained from the camera input, we expect to evaluate the advantages and limitations of each approach and identify the most effective and reliable method for obstacle detection and spatial mapping in different scenarios.

VII REFERENCES

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