Developing an IoT Support Cane for Improved Safety and Mobility of Visually Impaired or Elderly Individuals

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CHAPTER 1
INTRODUCTION

Background of the Study

The motivation behind this capstone project stems from the need to improve the safety and mobility of the visually impaired, partially sighted or elderly people in the community, also to contribute and enhance to their daily life. The Philippines is a country of 7,107 islands and has a total population of 100,981,437, as per the August 1, 2015 Census. However, statistical data on persons with disability are based on the 2010 Census which indicates that about 16 per thousand of the country's population have disabilities representing 1.57 percent of the population. The population of persons who are blind or visually impaired in the Philippines is approximately 500,000 and the majority of them are poor and uneducated.

Data from the Department of Education (2014, 2015) show an increasing trend in SPED enrolment in public elementary schools: from 37,000 SPED students in the 2014-2015 to 42,000 SPED students in 2015-2016. In public high schools, the trend is significantly the same at 2,000 SPED enrolments in both school years.

The data of the Resources for the Blind Inc. (RBI) estimated that about 40,000 blind and visually impaired are of school age. According to the World Health Organization, around 40 million people in the world are blind, while another 250 million have some form of visual impairment. Also, the number of people with vision impairments is projected to rise significantly in the coming times due to growing populations and the adding prevalence of habitual conditions similar to diabetes. The development of assistive technologies for individuals with visual impairments, partially sighted, has been a growing area of interest in recent times. Blindness and partial sight are significant challenges that impact the quality of life, mobility, and independence of affected individualities. Traditional aids such as canes, guide dogs, and audio cues provide some level of support but are often limited in their functionality, especially in complex or dynamic environments.

The emergence of the Internet of Things (IoT) and advancements in detector and communication technologies offer new openings to address these challenges. The concept of a smart base IoT stick for blind people is a promising solution to improve mobility and independence for individuals with visual impairments. This device incorporates a range of detectors, similar as ultrasonic detectors, infrared detectors, and cameras, to collect environmental data and give real- time feedback to the user. The collected data is also reused and communicated to the user through audio or tactile cues, allowing them to navigate their terrain more safely and confidently.

The development of such a device is critical, especially in light of the increasing prevalence of visual impairments globally. Given the pressing need for effective and affordable assistive technologies for visually impaired individuals, the proposed smart base IoT stick has the potential to make a significant impact. By enforcing this technology, individuals with visual impairments can enjoy lesser mobility, independence, and quality of life. The ideal of this study is to design, apply, and estimate the effectiveness of a smart base IoT stick for visually impaired persons or partially sighted people.

Statement of the Problem

Currently, our society lacks a smart cane that enables visually impaired and elderly individuals to independently and securely navigate their surroundings. The following issues occurred as a result of the absence of an IoT-enabled smart cane:

Limited upper body coverage: The standard canes currently available provide coverage primarily for the lower body, leaving visually impaired and elderly individuals with inadequate assistance for navigating obstacles and hazards in the upper body region.

Dependence on others: Visually impaired and elderly individuals heavily rely on assistance from others to perform daily activities or travel. This dependency hinders their mobility and reduces their sense of independence. Developing methods or technologies that promote self-reliance and reduce dependence on others is a sub-problem that needs to be addressed.

Safety concerns: Due to the limited coverage of standard canes, there is a heightened risk for accidents and injuries, especially in the upper body region. Finding a solution that addresses these safety concerns is crucial.

Objectives of the Study

The study aims to:

1. To design a smart cane with IoT-enabled features that provides comprehensive coverage for both the lower and upper body regions of visually impaired and elderly individuals, enabling them to navigate obstacles and hazards independently and securely.

2. To develop innovative methods or technologies that promote self-reliance and reduce the dependence on others for visually impaired and elderly individuals in performing daily activities or traveling.

3. To test the safety features of the smart cane, ensuring that it effectively detects and alerts users to potential hazards or obstacles, thereby reducing the risk of accidents and injuries.

4. To evaluate the effectiveness and usability of the IoT-enabled smart cane in improving the mobility and independence of visually impaired and elderly individuals through user testing and feedback.

Significance of the Study

The proposed Smart Base IoT Support Cane aims to fill this gap by providing a low-cost wearable solution that can improve mobility and independence for visually impaired and elderly people. The stick uses a combination of sensors and wireless communication technology to give users real-time environmental feedback such as obstacles and elevation changes. By implementing this technology, visually impaired people or partially sighted people can navigate the world more confidently and safely, reduce the risk of accidents and improve their overall quality of life.

For visually impaired and elderly individuals, the proposed IoT-enabled smart cane offers significant advantages. It promotes independence by enabling them to navigate their surroundings without relying heavily on others. Additionally, the smart cane enhances safety through its obstacle detection and hazard alert features, minimizing the risk of accidents. With improved mobility, users can confidently move around, overcoming obstacles and hazards more effectively. The smart cane contributes to their well-being, fostering a sense of control, confidence, and freedom that positively impacts their mental and emotional health.

For relatives, It provides a sense of reassurance, knowing that their visually impaired or elderly loved ones have an additional layer of support and safety while navigating their surroundings. This alleviates concerns about potential accidents or hazards. Moreover, the smart cane reduces the burden on relatives who often assist and support visually impaired or elderly individuals, allowing them to have more personal time and focus on their own responsibilities without constantly being relied upon for assistance. This, in turn, improves family dynamics as activities can be enjoyed together without the constant need for support, fostering a more balanced and fulfilling family life. Ultimately, the smart cane's ability to enhance independence, safety, and mobility translates into an improved quality of life for the users, bringing joy and contentment to their relatives.

Scope and Limitation

The Scope of this study is to develop a specialized smart cane specifically designed for visually impaired and elderly individuals in the Philippines. Its primary objective is to enhance their independence, mobility, and safety through the integration of IoT-enabled features. The proposed system will include essential functionalities such as a panic button for emergency situations, obstacle detection for both the lower and upper body, Text-to-Speech capability, and a stick finder. The study will involve comprehensive tasks, including identifying the necessary requirements, developing the system, and evaluating its usability, user satisfaction, and overall effectiveness in meeting the unique needs of visually impaired and elderly individuals.

.It is important to acknowledge certain limitations. Firstly, the effectiveness of the smart cane may be limited to sunny weather conditions, as detecting obstacles accurately during rainy weather can be challenging. Additionally, the system's performance and applicability may vary when used in different geographical locations with unique environmental and infrastructural characteristics.

Comparison in Existing Project/Studies

Comparison of Related Studies

TITLE(S) AND AUTHOR(S)	FEATURES				
	OBSTACLE DETECTOR	TEXT TO SPEECH	GPS	SOS MESSAGING	STICK FINDER
(Bhowmick et al., 2012) Smart Cane Assisted Mobility for the Visually Impaire	✓	✗	✗	✗	✗
(Bhavishya et al., 2018) IoT based route assistance for visually challenged	✓	✗	✗	✗	✗
(Pathak et al., 2020) An IoT based Voice Controlled Blind Stick to Guide Blind People	✓	✓	✗	✗	✗
(Senining et al., 2023) IoT-based support Cane for Visually Impaired or Elderly People to enhance their safety & mobility	✓	✓	✓	✓	✓

System Architecture

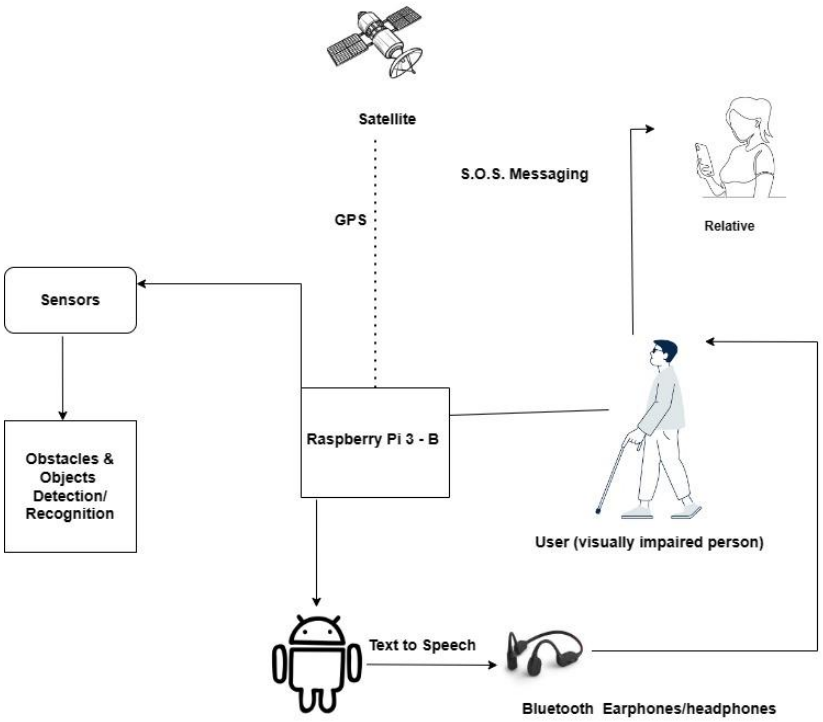

Figure 1: System Architecture of the proposed project

The smart stick system architecture for individuals with visual impairments integrates multiple components to enhance mobility and safety. At its core, the Raspberry Pi Model 3 serves as the main processing unit. Connected to the Raspberry Pi is a GPS module that receives satellite signals to determine the stick user's location. A sensor connected to the Raspberry Pi detects obstacles, providing vital hazard information. The Raspberry Pi utilizes a text-to-speech system, which conveys information about incoming obstacles, their location (above or in front), and the presence of elevated surfaces. The text-to-speech output is transmitted to wireless earphones, providing better hearing for the user. A panic button triggers the transmission of the user's current location through a GSM module to notify relatives or emergency contacts. Additionally, a dedicated button produces a distinct sound to aid visually impaired individuals in locating the smart stick easily, ensuring it is not misplaced or lost.