Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 9, S. 37-41, 1, 2025

Araştırma Makalesi

IJANSER
https://as-proceeding.com/index.php/ijanser
ISSN:2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 9, pp. 37-41, 1, 2025

Research Article

IoT-Based Material Comparative Cane Recommendation for Visually Impaired Individuals

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(Received: 15 January 2025, Accepted: 21 January 2025)

(2nd International Conference on Modern and Advanced Research ICMAR 2025, January 15-16, 2025)

ATIF/REFERENCE: Gündüz, K. A. (2025). IoT-Based Material Comparative Cane Recommendation for Visually Impaired Individuals. *International Journal of Advanced Natural Sciences and Engineering Researches*, 9(1), 37-41.

Abstract – Although traditional canes enable the visually impaired to perceive their environment tactilely, they cannot measure distance. Therefore, the ability of visually impaired people to detect obstacles and hazards in advance and change direction appropriately is a critical factor that increases their independence. The IoT-based distance measuring cane offers a technological solution that aims to enable visually impaired individuals to move more safely and independently outdoors. These canes have a high technological value thanks to advanced sensing technologies and implemented software solutions. The sensors' capacity to detect environmental obstacles increases the accuracy and reliability of the system, while software algorithms ensure accurate analysis of obstacles. In addition, this technology works in conjunction with data processing and feedback systems to provide instant audible and vibrating alerts to users, enabling the visually impaired to explore their surroundings faster and more safely. The proposal is an important innovation in the field of technological solutions for the visually impaired and contributes to their greater participation in social life. In this study, a system that detects environmental obstacles and gaps and provides distance information to visually impaired individuals through audible and vibrating alerts is proposed and a price and feature comparison is made with similar products in the market. Thus, potential hazards can be recognized early and users can be guided in a safer way.

Keywords – Cane, Disability, IoT, Distance, Warning.

I. INTRODUCTION

There are approximately 1 million 200 thousand visually impaired individuals in our country, these individuals cannot correctly perceive the environmental obstacles they encounter in their daily lives and as a result, they may encounter some accidents. According to research, 65% of visually impaired individuals encounter obstacles and have accidents when they are out alone. This situation reveals the importance of technological tools that will provide them with information about their surroundings. The distance measuring cane project aims to help visually impaired people perceive their surroundings in a safer way and recognize potential dangers earlier.

Although traditional canes enable the visually impaired to recognize obstacles in their surroundings by touch, these canes can only detect obstacles at close range and do not provide information about distance. Research shows that 70% of visually impaired people often have accidents because they do not know the distance of the obstacles around them. The distance measuring cane, which was developed to overcome these shortcomings, aims to provide safe navigation by informing the user about obstacles and gaps in the

environment with audible or vibrating warnings. By using technologies such as ultrasonic sensors, the distance of obstacles can be detected up to 4-5 meters and the user receives instant feedback when approaching obstacles. Due to this feature, with the opportunities provided by IoT technologies, its use is increasing day by day in smart city, smart home, smart traffic, smart agriculture and biomedical systems as well as smart farm and animal husbandry fields, which are the subject of this thesis.

IoT has many definitions as there are many research studies on it and it is still a developing technology. In Casagras' final report (Coordination and Support Action Global RFID-related Activities and Standardization) [1]. It was emphasized that it is a global infrastructure that establishes communication between objects with physical equipment and virtual objects, generating data and sharing the data generated. It is stated that it allows objects to collaborate and work in any environment where there is internet [2].

The distance measuring cane allows visually impaired people to perceive environmental obstacles more safely and effectively, which is one of the biggest challenges they face in their daily lives. Traditional white canes allow the visually impaired to recognize obstacles in their environment by touch. However, such canes can only detect obstacles at close range and do not inform the user about hazards in the environment [3]. A distance-measuring cane, on the other hand, informs the user of the distance of obstacles around them, allowing them to explore a wider area more safely.

II. MATERIALS AND METHOD

The designed cane measures the distance of obstacles in the environment and informs the user how far away these obstacles are with audible or vibrating signals. In this way, visually impaired individuals can early recognize obstacles not only in front of them but also at greater distances around them. For example, as an obstacle gets closer, the speed of the signal increases, alerting the user that danger is approaching. This allows users to react quickly and avoid potential accidents [4].

This innovative feature of the cane allows visually impaired people to explore their surroundings more comfortably [5]. While traditional canes only allow the visually impaired to feel obstacles tactilely, the distance measuring cane also makes it possible to recognize hazards in the environment earlier. This is especially useful in dangerous situations such as vehicles in traffic, crowded streets or narrow passages. By receiving a signal before approaching obstacles, the user has the opportunity to change direction more safely [6].

This study uses a modern technology integrated into a cane to help visually impaired people better perceive their surroundings.

The distance measuring cane project aims to provide a solution by using technology to enable visually impaired individuals to perceive the obstacles they encounter in daily life in a safer way [7]. Various analytical and experimental solution methods will be used to achieve this goal. Since the project requires an integrated system where hardware and software work together, both theoretical analysis and experimental tests play an important role in this process [8].

First, the right environmental sensing technology needs to be selected for the success of the project. In this context, the distance of obstacles in the environment will be measured using sensor technologies and this data will be processed through software [9]. In the first phase, the effects of environmental factors (e.g. distance, type of obstacle, environmental noise) will be evaluated using analytical methods. This analysis will help to select the most suitable sensor types and improve distance measurement accuracy. Mathematical modeling and simulation methods will be used to predict the sensing ability of the sensors and the overall performance of the system [10].

The second phase is the prototype design and development phase. In this stage, the first prototype will be created by integrating the identified sensors and other hardware components. Experimental methods will come into play here and the designed system will be evaluated how it performs in real life through tests with visually impaired individuals [11]. The prototype will be tested to answer questions such as how accurately it can detect obstacles at certain distances and how timely and effective the warnings are. In the feedback collection and analysis phase, user feedback will be collected to identify possible deficiencies in the system and to make improvements. The third phase is the software development and

integration phase. In this phase, algorithms and software solutions will be developed to accurately process the data from the sensors. The software will be tested and optimized to integrate functionalities such as data processing algorithms, audio feedback mechanisms and vibratory alerts [12].

Finally, in the system integration and final testing phase, all components will be brought together to evaluate the overall performance of the system. Extensive testing will be carried out to determine the reliability and accuracy of the system, after which any errors or glitches will be fixed. This experimental process aims to create a user-friendly design and enable the cane to be used effectively in everyday life.

The combination of these analytical and experimental solution methods will allow the development of the distance measuring cane as an accurate, reliable and user-friendly product.

Hardware Components [13]

The prototype was constructed using the following components:

Metal canes (standard white cane base structure)

Piezzo buzzers for audio feedback

Lithium polymer batteries for power supply

TP4056 charging modules for battery management

PIR motion sensors (HC-SR505 mini) for obstacle detection

Raspberry Pi Pico microcontrollers for system control

3D printed enclosures for hardware protection

Table 1. Cost Analysis for IoT-Based Smart Cane Prototype (As of January 2025) [14] - Component Cost Breakdown (Per Unit)

Component	Specifications	Unit Price (USD)	Quantity	Total (USD)
Metal Cane	Standard white cane base	$15.00	1	$15.00
Piezo Buzzer	Active buzzer 5V	$1.50	1	$1.50
Lithium Polymer Battery	3.7V 2000mAh	$8.00	1	$8.00
Charging Module	TP4056	$2.00	1	$2.00
PIR Motion Sensor	HC-SR505 mini	$3.50	1	$3.50
Raspberry Pi Pico	RP2040	$6.00	1	$6.00
3D Printed Enclosure	Custom design	$5.00	1	$5.00
Ultrasonic Sensor	HC-SR04	$2.50	1	$2.50
Wires and Connectors	Various	$3.00	1 set	$3.00
PCB Board	Custom design	$4.00	1	$4.00
Miscellaneous Components	Resistors, capacitors, etc.	$5.00	1 set	$5.00
Total Per Unit				**$55.5**

* If the developer card used changes, the price will change accordingly. In addition, the amount required to design the cane appropriately is approximately 45 US dollars [15].

III. RESULTS

Produced at low cost, the motion sensor cane aims to reach a wide range of users. Thanks to its affordable price, the visually impaired can access this innovative product more easily [16].

Table 2. Price-to-Feature Ratio Comparison [17]

Product	Price (USD)	Detection Range	Battery Life	Smart Features
WeWalk	599	1.6m	5 days	High
UltraCane	795	4m	3 days	Medium
iCane	299	2m	2 days	Low
Smart Guide	249	1.5m	2 days	Low
EasyWalk	149	1m	1 day	Minimal
Our Prototype	99	4-5m	2-3 days	Medium

This gives them the opportunity to move independently and improve their quality of life. Moreover, affordability supports the mainstreaming of such technologies in society and promotes greater adoption of solutions that facilitate the daily lives of people with disabilities [18].

IV. DISCUSSION

The motion sensor cane is an innovative technology designed for the visually impaired. Its ultrasonic sensors detect obstacles in the environment and alert the user through vibration or sound. This device facilitates safe movement and reduces the risk of bumping into obstacles. User-friendly with its lightweight and ergonomic design, the cane is an important tool in increasing the independence of the visually impaired [19].

Furthermore, thanks to this technology, visually impaired people not only perceive their surroundings, but also have the chance to move more independently in public life [20]. Being able to move safely outdoors, they are encouraged to participate in community events, build social relationships and take a more active role in everyday life. This helps visually impaired people to participate more in society and increase their independence.

Key Competitive Advantages of Our Prototype [21]

- Cost-Effectiveness: Significantly lower price point compared to market alternatives
- Detection Range: Comparable or better than premium options (4-5m)
- Maintainability: Easy to repair and upgrade
- Open Source Potential: Possibility for community development and improvements

In conclusion, the distance measuring cane project offers an innovation that enhances the safety of visually impaired individuals, while at the same time strengthening their social independence through the possibilities offered by technology [22]. Such technologies have great potential to solve existing disability-related problems and play an important role in promoting social awareness and empathy.

V. CONCLUSION

The designed prototype will not only increase the safety of visually impaired people, but also improve their quality of life, enabling them to participate more independently in social life [23]. The distance measuring cane will enable visually impaired people to explore their surroundings more freely and will not only increase social awareness and empathy, but also encourage more active participation of disabled people in society [24].

The proposed prototype will help visually impaired individuals to realize the obstacles they face in daily life faster, help them avoid dangers, and enable them to lead a safe and independent life.

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