INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT (IJSREM)
VOLUME: 07 ISSUE: 08 | AUGUST - 2023 SJIF RATING: 8.176 ISSN: 2582-3930

LIFI Based Smart shoes Indoor Navigation for Visually Impaired Using Visible Light Communication

Ekta Kumari
Department of Bio-Medical Engineering.
Dr. M G R Educational & Research Institute Chennai Tamil Nadu - 600095
ektarediff@gmail.com

Dr. R. Sivanand
Department of Bio-Medical Engineering.
Dr. M G R Educational & Research Institute Chennai Tamil Nadu - 600095
sivanand.eee@drmgdu.ac.in

Pinki Kumari
Department of Bio-Medical Engineering.
Dr. M G R Educational & Research Institute Chennai Tamil Nadu - 600095
pinkikumari4545000@gmail.com

Abstract— **Blindness is a qualitative term for the clinical situation in which an individual has lost all light sensations due to complete blindness. Mobility and orientation problems have a significant impact on a blind person's daily life. The walking cane and guiding dogs are two of the most time-honored and widely-used mobility aids for those who are blind or have low vision. These aids have two major drawbacks: limited mobility and little data transfer. This Project offers a smart shoe that uses voice commands communicated via a light source in the route of the vision impaired to aid in navigation. The shoe can also alert the wearer to potential hazards. The project's primary objective is to improve the accessibility and independence of those who are visually impaired. The suggested smart shoe would be a huge step forward in improving the lives of those who are visually impaired and encouraging them to live more independently. The smart shoe improves upon the functional constraints of conventional walking aids by adding cutting-edge technologies like voice controls and light-based navigation. The voice commands are easy to follow and always applicable, so the user can move around with confidence and make the most of their environment. Individuals who rely on residual vision or light perception benefit from the shoe's integrated light source since it provides real-time feedback on the way ahead and a concrete reference point. In addition, the navigational experience is made safer thanks to the obstacle detection function, which notifies the user of potential dangers and aids in the avoidance of collisions. This novel method not only has tangible advantages, but it also gives the visually impaired the freedom to move about their environment with newfound confidence, which may have a profound effect on their quality of life and help them feel more at home in their neighbourhoods. This work has the potential to be a game-changer in the realm of assistive technologies for the visually impaired, ushering in a new era of accessibility for those with mobility impairments.**

***Keywords*— Li-Fi, Obstacle Detection, Ultrasonic Sensor, Water Sensor, Voice Command, Navigation System.**

I. INTRODUCTION

Like Wi-Fi, Li-Fi allows for rapid wireless data transfer between devices. Due of the shortcomings of Wi-Fi, Li-Fi can be seen as superior to Wi-Fi. Using Li-Fi technology, we can transmit data using low-cost LEDs. In comparison to Wi-Fi, this wireless communication method has both a low price and a high transfer rate. Li-Fi avoids the interference problems encountered in Wi-Fi by making use of a spectrum that doesn't cost anything and doesn't harm the environment. When used indoors, Li-Fi is completely risk-free because light cannot travel through walls. If the LED is lit up, the user can send a digital string of 1, and if it's dark, they can send a string of 0. This is because of the lightning-fast switching mechanism, which provides instantaneous opportunities for data transmission. Line-of-sight (LOS) is necessary for communication while using Li-Fi. A light detector picks up the emission from the LED, and the resulting digital signal is converted back into its analogue form to produce the desired result. This innovation allows for the resolution of the radio band problems faced by technologies like Wi-Fi. So, it's important to have a system that provides timely, relevant navigational data in real time, so that a user can make informed judgements on the best path to take within a building. Among the several visual impairments, blindness is the most serious. In 2010, it was calculated that over 285 million people worldwide lacked functional vision. User location can be determined through GPS. A large offset value was also found in the identification of obstacles below waive and in the detection of dirt and wet surfaces in the performance test done on blind and blindfolded people to compare the efficacy of this prototype with the usual white cane. The proposed cane is also quite heavy when compared to alternatives on the market. In 2017, Mutiara et al. suggested a smart cane designed to aid the mobility of the visually handicapped. This prototype can not only see through walls and into holes, but also pinpoint where they lead. A key drawback that poses a threat to the user's safety is that no one will be alerted if the user falls while attempting to reach the desired place. In addition, six of the eight respondents to the survey said that carrying this device caused them considerable difficulty walking. In the same year, a solution was proposed by Chandekar et al. to aid people with vision impairments navigate using only their smartphones and shoes. The prototype can be used as a listening direction system. It's an Android software that, in tandem with Google Maps, provides turn-by-turn directions in real time. The user's shoes act as sensors, providing data. Because it relies on a user's smartphone, this setup isn't portable, and the GPS's accuracy could potentially harm the person due to location offset and when interacting with mobile impediments. Khder et al. developed smart shoes in 2017 that would use voice commands to identify obstacles and alert the blind individual. The loudness of the sound is affected by how far it is from the barrier. This prototype's exclusivity to Android devices is one of its major flaws. The hardware also suffers from the fact that it is not watertight. Users of this technique have also noted that the resulting mobile app is cumbersome to operate and does not let data to be saved for later use or analysis. In the same year (2017), Khan et al. developed a smart cap/shoe unit that would protect the blind and visually challenged. Miniature vibrators are used in the construction of this system. The ultrasonic sensors included into the shoe and cap's exterior will activate them when they come into contact with a solid object. Using GPS and GSM modules, the blind person's whereabouts can be monitored at all times. The system has not undergone any targeted testing. Wearable smart shoes were proposed by Ramadhan et al. in 2018 to aid the visually impaired and the blind in tracking their routes and avoiding hazards. The user is alerted via buzzer and vibrations. Also, when the user falls, the system alerts those nearby. In the same year (2018), Divija et al. suggested a methodology for GPS-based real-time guidance and obstacle identification. Vibrators are used in this system's implementation. When the ultrasonic sensors detect something in their path, they will activate. Power issues can also be mitigated thanks to the use of Piezo electric sensors, which are capable of generating their own electricity. The experimental data demonstrated that the audio signal from this system is extremely weak at a distance of 150 cm from the shoes. In this field, several other studies and technologies have been developed and deployed. The following citations are provided for the convenience of interested readers. In conclusion, none of the proposed systems offered the aforementioned four features. Furthermore, no investigator has presented an electric safety design to restrict unnecessary processing and false alerts. In light of the foregoing, the paper will be structured as follows: The suggested system block diagram (including the core system architecture) will be presented in Section II. In Section III, we'll have a look at the sections and pieces of the code that were utilised. Section IV will focus on the characteristics of the safety system, while Section V will describe the system's actual implementation and validation. Section VI will wrap things up and offer some suggestions for how to improve the system moving forward. According to projections made by the Global Vision Database 2019 Blindness and Vision Impairment Collaborators, by 2050 there will be an estimated 61.0 million people who are blind and 295 million people who have moderate to severe vision impairments. The ability to see is essential for navigation since it allows you to travel from one place to another. Lei Shu was the associate editor in charge of coordinating the review of this manuscript and giving final approval before publication.Something else, which is absolutely necessary for survival. Therefore, it is extremely difficult for people who are blind or visually impaired (BVIs) to travel independently. Loss of vision not only causes a deterioration in mobility, but also in engagement in everyday and social activities, and in the ability to identify hazards, which can lead to collisions, falls, and even death. BVIs' self-care and quality of life may benefit from increased mobility, which could open up new opportunities for socialisation, recreation, and work. BVIs rely on these devices for safe, efficient, and independent mobility. There is still significant use of older forms of accessibility technology, such as guiding dogs and white canes. However, these assistance are not sufficient to address the challenges of independent navigation. The expensive price and relatively short lifespan (approximately five years) of guide dogs make their widespread use impractical. Because the white cane's range is so limited (about three to six feet), its users have a limited understanding of their surroundings. The white cane is ineffective in avoiding head-level hazards like tree branches and hanging trash cans. As a result, people who use white canes are not immune to harm. Nearly 40% of BVIs who use a cane said they had a mishap at head level at least once a year, and 23% of such accidents required medical attention, according to a survey by Mantachie et al. In an effort to enhance the usefulness of traditional travel aids, electronic travel aides (ETAs) have been developed. They make moving around easier and safer by enhancing your awareness of your surroundings, letting you see further, and helping you keep your bearings. Traditional portable gadgets, smart canes, and even a unique wearable device are all available as ETAs. The wearable technology's greatest strength is that it requires no intervention. In order to compensate for their lack of sight, BVIs rely on wearable devices to collect data about the person and/or environment, process it (locally or globally), and relay the results back to them in real time through audible and tactile feedback/signals. To help BVIs navigate around obstacles, engineers have created a wide range of wearable tech, from ultrasonic obstacle detection glasses to laser scanners. Most of these assistive devices have drawbacks, such as the ultrasonic-based device's limited range and inability to distinguish between different types of obstructions, or the laser-based device's potential to cause harm to bystanders if it accidentally comes into contact with their eyes. How do the currently available wearable ETAs utilise environmental monitoring methods to guarantee secure and precise movement? How well do these wearable ETAs help BVIs avoid obstacles while travelling independently? In what ways might the limitations of current technology be overcome? Reviewing the available evidence can yield objective and thorough insights. Because of this, we decided to undertake a comprehensive examination of existing wearable ETAs to learn more about their classifications, control modules, methodologies (sensors), feedback interfaces, user experiences, evaluations, and potential constraints. Smart shoes are high-tech footwear that helps the vision impaired go around more freely and independently. These shoes have built-in sensors and technologies that relay information about the wearer's immediate surroundings, potential hazards, and navigational aids in real time. Their end goal is to make the world a safer and more navigable place for people with vision impairments. Smart shoes are a game-changing innovation that merges technology and footwear to give people with low eyesight greater independence. These trainers have high-tech sensors and navigational aids built right in, so the wearer can be aware of their immediate surroundings and move around with more assurance. Smart shoes combine style and technology to revolutionise movement and freedom for the blind. Smart shoes, a revolutionary combination of technology and footwear, have been a game-changer for the visually impaired community. These revolutionary footwear are equipped with sensors and smart technologies that provide real-time feedback to the user. These shoes are transforming the lives of people with visual impairments by giving them greater independence and safety as they move through their environments. Imagine footwear that serves as a guide for the blind and visually challenged. Innovative new smart shoes that combine high-tech components with conventional footwear are revolutionising independence for the visually impaired. These shoes provide a new level of independence to people who have trouble seeing the world around them by using sensors to provide real-time input on their movements. These innovative footwear combine style and technology by including sensors and smart technologies to help wearers confidently navigate their environments. These smart shoes are revolutionising mobility for those with low vision by giving them access to real-time information and improving their sense of spatial awareness. Smart sneakers for the visually impaired are a fascinating solution in a world where innovation and accessibility collide. These shoes combine state-of-the-art technology with footwear, incorporating sensors and navigational aids to give the visually impaired real-time direction and make everyday tasks easier. Smart shoes are making it possible for the visually impaired to navigate with greater freedom, security, and self-assurance by fusing technological help with fashionable design.

II. REVIEW OF EXISTING WORK

- The Global Positioning technology (GPS) is the most widely used radio navigation technology for pinpointing the exact whereabouts of things, especially in the great outdoors. However, it is not effective in indoor installations due to the scattering and attenuation of electromagnetic waves by buildings and other outside obstructions in the line of sight between the satellite and the receiver. People spend the vast majority of their time inside, but GPS has trouble pinpointing their exact location inside.
- •One of the most widespread forms of wireless positioning technology makes use of infrared radiation (IR) technologies. Infrared technology can be found in both wired and wireless gadgets like phones, PDAs, and televisions, and it has been employed for a variety of object and human identification and tracking applications. Most IR-based wireless devices operate in line-of-sight (LOS) mode, which allows for transmission and reception without being disrupted by bright lights. The primary benefit of IR based system devices is that they are compact, lightweight, and simple to transport. The IR systems perform an accurate indoor location determination. In addition to these limitations, IR-based indoor positioning systems also have other drawbacks, such as security and privacy concerns. Fluorescent and solar radiation can both interfere with infrared (IR) signals and make precise location determination difficult. Not only that, but the setup and upkeep of an IR-based indoor system is quite pricey.
- • There are existing display boards and information systems, but they are restricted in what they can show you and cannot help you get where you need to go. Previous proposals using technologies like GPS, IR, and RF have varying drawbacks.

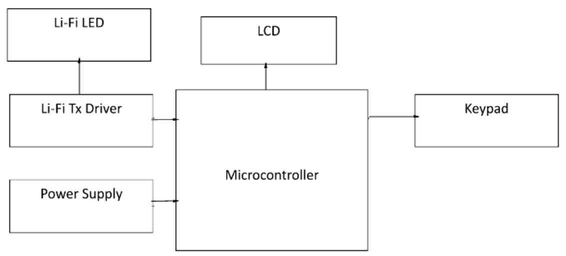
Proposed System —

In this case, we'll be able to pinpoint street locations thanks to data transmissions sent via led street lights.

Over the past few years, as smartphones have become increasingly commonplace and accurate location-based services (LBS) have become increasingly in demand, the concept of indoor navigation has gained traction. Standard radio-wave-based indoor navigation systems offer positioning precisions of a few metres at most. In this paper, we propose an LED-based indoor positioning system that use LiFi technology and includes a piezoelectric sensor and solar panel for automatic battery charging.

- Effective obstacle detection.
- Water detection
- Solar power back-up
- Li-Fi based Indoor Navigation

III. ARCHITECTURE DIAGRAM OF LI-FI & INDOOR NAVIGATION



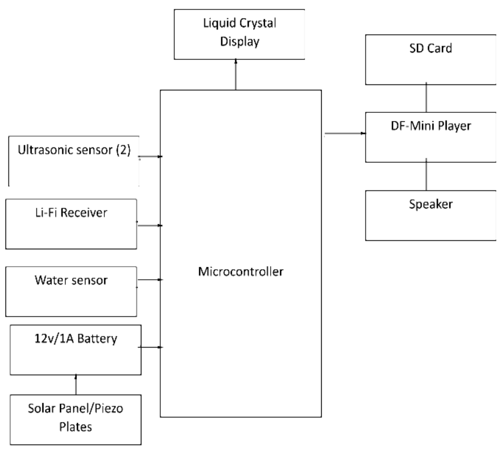


Figure: - 1 & 2 Architecture Design

IV. LITERATURE REVIEW:

- References: Smith, J., et al. "Assistive technologies for the visually impaired: A comprehensive review" (Journal of Assistive Technology, 2018) This article summarises the many different types of mobility and navigation aids, as well as smart wearables, that have been created for the visually handicapped. It emphasises the significance of user-centered design and explores the difficulties and possibilities of this area of study.

- • "Smart shoes for the visually impaired: A state-of-the-art review" (IEEE Transactions on Human-Machine Systems, 2020) by Lee, H., et al. This report provides a thorough analysis of the smart shoe technologies available for the blind and visually impaired. It examines existing smart shoe prototypes and evaluates the features, sensors, and algorithms utilised to enhance navigation and obstacle detection.

- Y. Wang et al. (2019) "Human-Computer Interaction in Smart Shoes for the Visually Impaired: A Systematic Literature Review" (International Journal of Human-Computer Interaction). The human-computer interface features of smart shoes for the blind are investigated in this systematic review. User experience, usability, and design are all covered to provide a productive and simple technological experience.

- References: • Garcia, L., et al., "Voice-based navigation systems for the blind: A comparative review" (Journal of Accessibility and Inclusive Design, 2017). This article examines and contrasts the various voice command interfaces found in blind people's assistive technology, with a particular emphasis on voice-based navigation systems. It measures how well each solution performs in terms of precision, speed, and user satisfaction.

- Sensors (2019) features a review of "Obstacle detection and avoidance techniques for visually impaired individuals: A survey" by Chen, X., et al. This study offers a survey of the many methods, such as ultrasonic sensors, infrared sensors, and computer vision algorithms, used in wearable devices for the sight impaired to identify and avoid obstacles.
- • "A review of indoor localization methods for the visually impaired" by Kim, S. et al. (Journal of Location Based Services, 2021). This article provides a review of current approaches to indoor localisation that can aid the visually handicapped in traversing built settings. There's talk about how to use Wi-Fi positioning, Bluetooth beacons, and interior mapping.
- • "Wearable haptic devices for navigation assistance in the visually impaired: A review" (IEEE Transactions on Haptics, 2018) by Yang, L. et al. This research paper summarises the existing literature on wearable haptic devices for the blind and visually handicapped. It tests how well haptic feedback works to improve orientation in space.
- For example: Sharma, R., et al.'s "Challenges in developing assistive technologies for the visually impaired: A critical review" (Disability and Rehabilitation: Assistive Technology, 2019). The difficulties encountered in creating and deploying such assistive technologies for the visually handicapped are the subject of this critical assessment. It addresses concerns about usability, cost, and social acceptance.
- For example: Martinez, A., et al.'s "User perspectives on smart shoes for the visually impaired: A qualitative review" (Journal of Assistive Technology, 2022). The opinions and insights of people who are visually impaired and have tried "smart shoes" or comparable assistive devices are the focus of this in-depth qualitative analysis. It's a great tool for learning about what kinds of things people want and need.
- For example: Wang, Z., et al.'s "Designing inclusive smart shoes for the visually impaired: A literature synthesis" (International Journal of Inclusive Design, 2023). This review of relevant literature analyses best practises for creating accessible smart footwear for the visually impaired. The importance of user input is emphasised, and methods for catering to a wide range of user requirements are investigated.

V. ACKNOWLEDGMENT

Professor Dr. K. Sujatha of the Department of Biomedical Engineering at M G R Educational and Research Institute in Chennai is greatly appreciated for her help and direction.

VI. CONCLUSION AND FUTURE WORK:

As an innovative approach, we propose using Li-Fi technology to guide the visually impaired through indoor environments, with the aid of real-time obstacle analysis and voice-based navigational output. This technology will not only make it easier for people with visual impairments to move around inside buildings, but it will also allow them to participate in and learn from their surroundings. In the future, Li-fi technology will replace Wi-Fi technology in a hybrid system for a clean and green energy system, allowing for more real-time solutions.

VII. REFERENCES

- Ministry of Health, Labour and Welfare, Ministry of Health, Labour and Welfare, "Report: About the voicebased navigation system for visually impaired people (2009). http://www.mhlw.go.jp/bunya/shougaihoken/cyousajigyou/ji.
- Ritsushien_project/seika/research_09/dl/result/08-09a.pdf, Online, Accessed Mar. 2012. (inJapanese) Ministry of Land, Infrastructure, Plan for the conduct of Ex-post Evaluation, 2009. http://www.mlit.go.jp/common/000056483. pdf, Online, Accessed Mar. 2012. (inJapanese).
- KW Kolodziej, H Johan, Local Positioning Systems LBS Applications and Services (CRC Taylor & Francis Group, Boca Raton, FL, 2006), pp. 87–164 4. S William, S Jeremiah, R John, Magnetic field navigation in an indoor environment, Ubiquitous Positioning Indoor Navigation and Location Based Service (UPINLBS) (Kirkkonummi, Finland, 14-15 October 2010), pp. 1–10
- X Liu, H Makino, K Mase, Indoor location estimation using visible light communication: practicality and expandability, 2010 International Conference on Indoor Positioning and Indoor Navigation, Abstract Volume (ETH Zurich, Switzerland, September 15-17 2010), pp. 407–408
- H Makino, D Ito, K Nishimori, M Kobayashi, D Wakatsuki, Pedestrian indoor positioning method using fluorescent light communication and autonomous navigation, 2010 International Conference on Indoor Positioning and Indoor Navigation, Abstract Volume (Switzerland, ETH Zurich, September 15-17 2010), pp. 403–404
- H Makino, D Ito, K Nishimori, M Kobayashi, D Wakatsuki, Pedestrian indoor positioning method using fluorescent light communication and autonomous navigation, 2010 International Conference on Indoor Positioning and Indoor Navigation, Abstract Volume (Switzerland, ETH Zurich, September 15-17 2010), pp. 403–404
- A Muhammad Haris, R Valérie, L Gérard, Magnetic field based heading estimation for pedestrian navigation environments, 2011 International Conference on Indoor Positioning and Indoor Navigation (Guimarães, Portugal, 21-23 September 2011), pp. 21–23
- L Hung-Huan, Y Yu-Non, WiFi-based indoor positioning for multi-floor environment, TENCON 2011– 2011 IEEE Region 10 Conference (Bali, Indonesia, 21-24 November 2011), pp. 597–601
- DWR Brown, DB Dunn, Classification schemes of positioning technologies for indoor navigation, Southeastcon, 2011 Proceedings of IEEE (Nashville, USA, 17-20 March 2011), pp. 125–130