International Journal of Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: 10.31695/IJASRE.2022.8.8.6

Volume 8, Issue 8
August - 2022

Development of Navigation System for Blind People based on Light Detection and Ranging Technology (LiDAR)

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ABSTRACT

The use of blind-aided navigating systems has become very essential in the 4th industrial revolution. The essence of this is to improve navigating autonomy for the blind. Although, navigation challenges are not of serious concern to people with eye defects. However, this is a major concern for blind people due to the time-consuming navigation process. These limitations necessitate the use of walking sticks, dogs, or people to navigate their path. This project provides a blind navigation system based on Light Detection and Ranging Based Navigation System for Blind People (LiDAR). The components of this fabricated device involve a charging system, a LiDAR sensor, a microcontroller, a calling stick, two buzzers, a switch vibration motor with an RF transmitter, and a receiver to give object detection and real-time assistance to the blind. The mode of its operation is by detecting obstacles along the route of a blind person and giving a notification via the buzzer and the vibration motor. Also, during emergencies, the buzzer rings and informs the visually impaired person using the device. On the other hand, the microcontroller and other modules in the device have a continuous ongoing relationship which is beneficial to the user. Another appreciable benefit of this device is the ability to recharge the battery component, the device is of low-cost, quick, simple-to-use, and novel solution for the blind.

Key Words: *Buzzer, LiDAR sensor, Light Detection, Microcontroller, Navigation, Vibration.*

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1. INTRODUCTION

1.1 Background

Statistics reveal that about 80% of all the information collected from our surrounding environment and interpreted by human intellect comes from visual engagement [1]. The eyes play a big role in safety even when other sensory organs fail to play this role. The majority of people value more their eyes than any other sensory organ. A Tellwut survey conducted with more than 2000 participants about the importance of sight shows that 61% of the participants agreed that, of the five senses, the sight was the one they could not live without [2]. The largest effect on daily living, according to more than 70% of respondents, would be losing one's vision. [3].

While, sight is considered to be the main organ that helps us in getting information through different forms. Some people within our community are unable to get information through sight because they can't visualize things rather than touching, smelling, tasting, and hearing from a friend, neighbor, or relative. Also, it is not 100% safe because much information collected is other people's thoughts and knowledge. So, the image that is built in the brain, is due to the knowledge of other people. This disability, makes the visually impaired and blind people live a dependent life especially when they want to interact with the environment [4]. This dependence is a challenge in the society we live in today and it has made people give up on them and let them. To some, they would even abandon the minority at home which increases the number of beggars within society. Like other human beings, visually impaired people wish to conduct different activities daily in any environment safe and secure without depending on other people. They wish to collect information from the real world, navigate in different places, be familiar with the environment and judge it by their own decision and be comfortable within that environment.

The challenges that visually impaired and blind people are facing have been recognized by society, and scientists and technologists have taken action to make sure that the people with sight disabilities are taken care of and supported to reach their desires through the use of the Internet of Things (IoT). So, many tools have been developed to assist them to engage in society.

These include the white cane which is used for navigation and the braille system which is a system of raised dots used for recognizing words.

1.1.1 Blindness

Vision loss is the definition of blindness [5]. It could also refer to a loss of eyesight that cannot be improved with the use of glasses or contact lenses. If you are partially blind, your vision is severely limited; if you are entirely blind, you are unable to see anything, including light. (Most people mean complete blindness when they use the word "blindness").

The loss of eyesight, which may be partial or total, is referred to as "visual loss." This loss of vision may happen overnight or gradually over time. [6].

Causes of blindness are as follows: CVI (Cortical visual impairment), Retinitis pigmentosa, Macular degeneration, and Prematurity retinopathy. As described below.

I. **Cortical Visual Impairment (CVI)**

The primary cause of childhood blindness in the modern era is cortical/cerebral visual impairment (CVI). Unlike ocular forms of visual impairment, CVI is a brain-based disorder that frequently coexists with another visual impairment. [7].

People with this diagnosis have difficulty understanding what their healthy eyes see since the problem is in the brain. For example, a youngster with CVI may perceive the world as a swirling mass of color [8].

II. **Retinitis pigmentosa**

According to the US National Library of Medicine, retinitis pigmentosa is a hereditary condition that affects up to one in every 4,000 persons in the United States and Europe [9]. Due to the slow disintegration of retinal cells, people with this eye disorder frequently have problems seeing at night and lose peripheral vision. Early detection is the most common, and it can lead to total blindness later in life.

III. **Macular degeneration**

Another main cause of vision loss is macular degeneration, which affects an estimated 10 million people residing in the US. Although this condition has many different manifestations, dry macular degeneration is the most common. Adults who suffer from this kind of visual impairment experience deterioration in their central vision. Because of the way both disorders impact one's eyesight, a hereditary disorder called Stairgate Syndrome in youngsters appears extremely similar to macular degeneration [10].

IV. **Prematurity retinopathy**

Prematurity retinopathy is an eye disease that affects babies who are born early. It all starts when blood vessels in the eye leak or bleed, causing scarring and retinal detachment. Prematurity retinopathy can appear at birth, although it is difficult to detect without a thorough eye examination [11]. Despite the amount of visual loss that is frequently associated with this disorder, people who have this diagnosis are more than capable of reaching their objectives.

1.2 Problem Statement

Despite the presence of different tools that help visually impaired and blind people in getting close to the real world, still, navigation of blind people is a challenge since some of the things cannot be detected by using the white canes like traffic signs, warnings, and traffic lights, things behind them and things above them. This might lead to unintentional accidents especially when a blind person navigates in a new environment. The difficulty of perception and familiarity of the blind with their respective environment remains a major challenge. This often affects their physiological response and participation. When a blind person has a psychological issue, the white cane's alarm sound is insufficient to warn them about an obstruction. Even though the blind person has been alerted by the white cane's alarm, this could cause him or her to strike an object and sustain an injury.

1.3 Rationale of the study

Navigation is unavoidable, especially for people who want to perform tasks. This project is conducted purposely to help blind people to carry out their tasks in any environment, to help them feel comfortable with other people in the new environment and even interact with it. So, the project ensures self-reliant and safe navigation of blind people.

Many technologies are exclusively designed for interior navigation and lack obstacle detection and location determination capabilities in outside settings. Researchers have spent years developing an interactive and sensitive white cane to assist and inform those who are blind or visually impaired [12]. It is true obstacles are avoided, but information about detected obstacles and the environment is not provide

DOI: 10.31695/IJASRE.2022.8.8.6

2. LITERATURE SURVEY

2.1 Introduction

The traditional white cane has long been an effective primary device for the visually impaired to remain mobile and self-sufficient. However, there are several limits to this mobility aid, such as the inability to notify the user of head-level obstacles, drop-offs, or obstructions more than a meter away [13].

One way to better address the problem of visual impairment was to find easier ways to navigate their environment which could replace the traditional walking sticks using blind sticks with better navigation properties, improved through the fitting with innovative features such as sensors. One such tool is the "Smart Blind Walking Stick" which consists of an Ultrasonic sensor, buzzer, and microcontroller with a unique idea of a wireless **rf** remote in case the person forgets his or her stick behind can easily find it. The limitation of this study is using of one Ultrasonic sensor to measure the distance of the obstacles, thus means measuring only one side, and the remote just make the buzzer generate sound so that the sightless person can follow the sound while he or not aware of the environment towards the stick [14]. A similar study was conducted; the problem addressed by a walking stick is that the user must be near the obstacle to feel its location. They proposed the "Intelligent Walking Stick for Elderly and blind people" that allows blind and elderly persons to roam around in strange environments while keeping track of their medical conditions. The limitation of this study is that no smart camera aid in object recognition as well as scanning entire instances for the presence of a large number of things in the blind's path when determining long-range to avoid colliding with other people when waggling [15].

On the other hand, Sightless people cannot carry out their usual activities, such as going for a stroll, calling on friends or family, or performing any other accustomed actions. The proposed solution is "Design and Implement Smart Blind Stick" that can assist the person in walking safely without worry of colliding with another person or solid objects. The limitation of the study is that used three (3) Ultrasonic sensors for three different angles thus right, left, and front but still the problem about the upward object will hit them without any alert [16].

In addition, the problem addressed is walking along the street with a visual impairment makes it harder to distinguish things in front of them, which is dangerous. The proposed solution is "An IoT-based Voice Controlled Blind Stick to Guide Blind People" that warns and informs the blind person about the dangers; this will make it easier for a blind person to walk safely and comfortably. The limitation of the study is that the range of the Ultrasonic sensors is short and cannot compute the upward distance of objects [17, 18].

Perhaps, introduce a paper on an IOT-based voice control to guide blind people in their paper they introduce the use of a smart stick infrared sensor to detect the staircases and a pair of ultrasonic sensors to detect an obstacle in front of the user within four meters. In addition, at the bottom of the stick, another ultrasonic sensor is placed to prevent puddles. A search warning is prompted upon the identification of an obstacle. The system configuration comprises the Arduino UNO, buzzer, and two pairs of ultrasonic sensors. The stick cannot alert the user with more than one alarm sound at a distance of 50cm [19].

Then came about Using Infrared (IR) sensors, a smart blind stick can provide an early cautioning of an obstruction. The stick instructs persons who are blind to use vibrating signals once they have identified the barriers. However, the smart stick primarily concentrates on identifying obstacles; it cannot assist the blind in an emergency. Additionally, the IR sensors are insufficient because they can only identify the closest obstruction at a close range. Additionally, a smart stick with laser sensors to detect curbs and impediments had been developed. The presence of obstacles was signaled by a microphone that made a loud "BEEP" sound. The idea behind a laser cane is really straightforward and logical. The stick cannot get psychological or cognitive assistance; it can only detect obstructions. There is only a beep sound that triggers any obstacle and there is no help to guide it [20].

The study addressed the issue of blind persons being unable to afford the high costs of assistive technology. They offered a smart, practical 3D working stick for blind persons, and their research advocated the usage of low-cost smart walking devices that include an IR sensor, an ARM controller, and a GSM module. For location-based sharing, a GSM is used. The walking stick also has a camera that takes in images, converts them to text, and then outputs sound through the earphones. After seeing someone in the blind school being taught how to use the blind stick, the proposal was offered. This smart stick is unable to detect a wide range of items [21].

The paper addressed the problem of blind people traveling to the desired location and finding the desired object that is already there in front of them at the desired place. They introduced the virtual eye for the blind using IoT for the blind people for them to come up to the real world. The study comprises three units an ultrasonic sensor and flex sensor, a GSM module, and the image-to-

DOI: 10.31695/IJASRE.2022.8.8.6

text and text-to-sound module, whereby the study has the limitation of high energy consumption in running the microcontroller [22].

2.2 Research Gap

This study identified an ostensible evidence gap in the project concerning LiDAR-based navigation Systems for blind people. The previous studies have addressed aspects of the limitation of energy consumption in running the microcontroller, the limitations of the Ultrasonic sensor which is used by the majority in their work unable to detect a wide range of items and is not good for detecting fast moving objects have a limited detected range [22]. The main objective of the LiDAR-based system is to overcome this limitation.

2.3 Proposed System

The depending life of blind people is a challenge in the society we live in today. Many tools have been developed to assist them to engage in society just like other people.

This project provides a blind navigation system based on Light Detection and Ranging Based Navigation System for Blind People (LiDAR) Device comprises a charging system, a LiDAR sensor, a microcontroller and a calling stick. Two buzzers, switch vibration motor with RF transmitter and receiver to give real-time assistance to the blind.

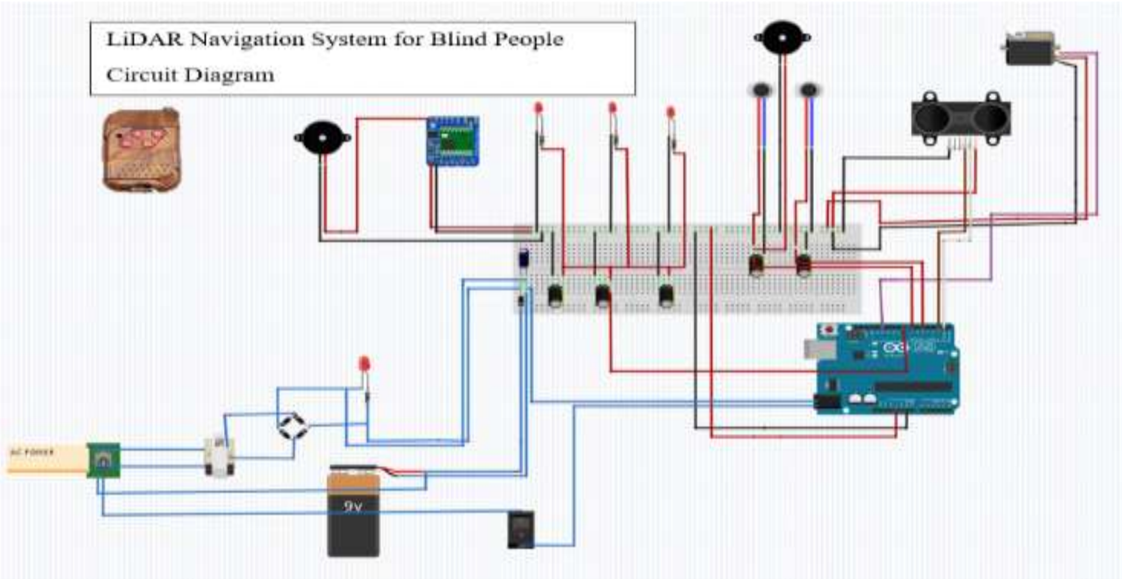

Figure 1: The system Circuit

2.4 System Description

The way this system works is that the user of the stick has to turn on the system to be able to use it. This system starts with the LiDAR sensor to sensitize the environment, if there is something nearby, he or she is heading, the LiDAR sensor will capture the object and send a message to the buzzer and the buzzer will immediately notify the user using the sound that he or she is approaching something in front of him. If the user does not hear the sound, the vibration motor will vibrate to inform the user that is very near to the object, where the vibration motor is locked up where the user puts the palm of his hand to hold the stick and it is easy to feel the vibration. This system has LEDs that light up to indicate the presence of a person or something to enable people and operators of fire engines from night accidents due to darkness. There is a remote that he or she will use to call the stick and the set sound will detect where the stick is making a sound. The stick remains with the charge for 32 hours and is rechargeable.

DOI: 10.31695/IJASRE.2022.8.8.6

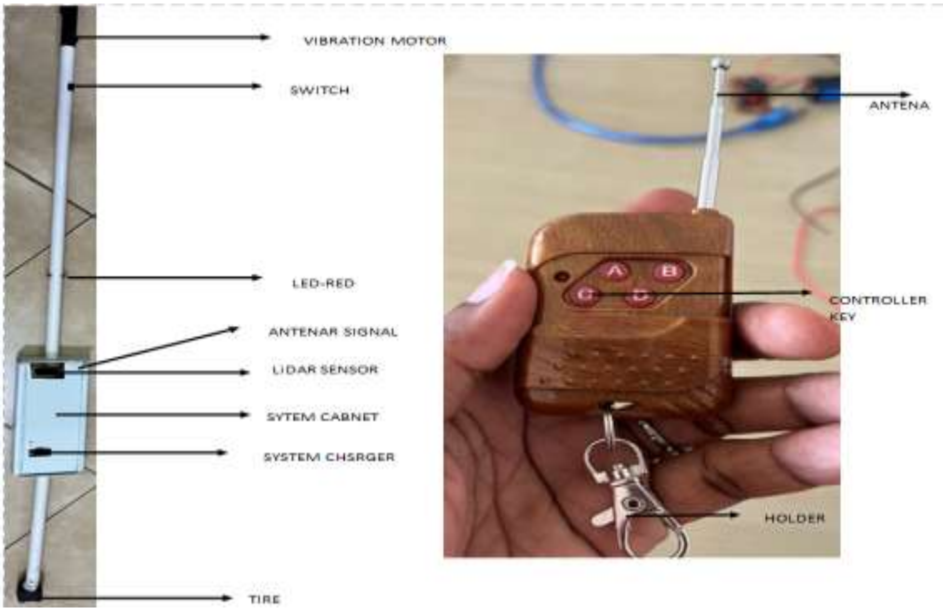

Figure 2: System Prototype

2.5 System Testing

The testing of the system was done in different ways. First, the unit testing was performed to ensure all subsystems are working as required, and then integration testing followed. After there, the whole system was tested to check its performance, accuracy, and efficiency of the system.

Black box testing was also done to ensure the good performance of the system. Below are the pictures showing different system testing which was performed.

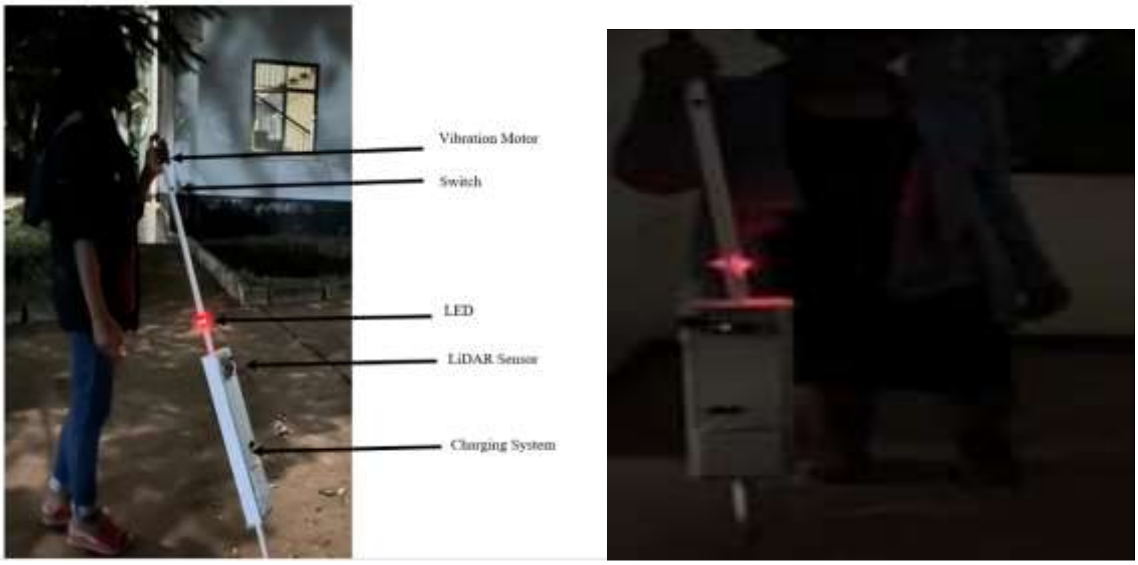

Figure 3: Testing the Light Detection and Ranging-Based Navigation System for Blind People

LiDAR sensor was able to detect fast-moving obstacles on the road such as car compared to other sensors such as ultrasonic sensor.

3 RESULTS AND DISCUSSION

3.1 Results

Navigation was conducted several times by closed eyes people using LiDAR Navigation System for Blind people and people were able to avoid the obstacles along the way. When the object is 120 centimeters far, the system was vibrating as a sign of alerting a person that there is an object in front. When the object was 60 centimeters away, the system was making an alerting sound from

DOI: 10.31695/IJASRE.2022.8.8.6

the buzzer to alert the user that he is very near to the object. The system was able to detect the objects which were parallel to the user, objects on the ground, and overhead objects as shown in the picture below. When we compare other studies where the comparing it to other studies that have used other sensors like the Ultrasonic sensor which has lacked some features such as seeing things pass very fast. And uses a Laser beam that illuminates pulses to measure the signal of an object and Ultrasonic uses a sound wave.

3.1.1Device Performance Analysis

Angular rate is a performance specification that describes the frequency of LiDAR beam motion on the stick. For 2D LiDAR the time taken for one complete sweep in the FOVH (Field of view horizontal) is called the line scan time (T_{Line}). This parameter is a product of horizontal resolution (H_{res}) and response time (T_{resp}) as shown in Equation (5). Furthermore, the angular rate for the horizontal axis (AH) is computed by taking the reciprocal of line scan time (T_{Line}) as shown in Equation (6). The unit for horizontal axis rate (A_H) is measured in Hertz. Unlike the computation of the horizontal axis rate, the vertical axis (A_V) rate requires the derivation of extra parameters before it can be computed. The total number of scan points (N) is one such parameter. It is a product of horizontal resolution (H_{res}) and vertical resolution (V_{res}) as shown in Equation (7). Later, the time taken for a complete frame (T_{frame}) is computed as shown in Equation (8). Lastly, the vertical axis rate (A_V) is computed by taking the reciprocal of a frame time (T_{frame}). The angular rates can be also expressed in terms of degrees per second as shown in Equation (10).

$$FOV_H = \theta_2 - \theta_1 \quad (1)$$

where θ_1 is the minimum azimuth angle, θ_2 maximum azimuth angle.

$$FOV_V = \varphi_2 - \varphi_1 \quad (2)$$

where φ_1 is the minimum elevation angle and φ_2 maximum angle measured clockwise direction with respect to *y* axis.

$$H_{res} = FOV_H / d\theta \quad (3)$$

where $d\theta$ is the azimuthal angular resolution in degrees

$$V_{res} = FOV_V / d\varphi \quad (4)$$

where $d\varphi$ is the elevation angle resolution in degrees

$$T_{Line} = H_{res} \times T_{resp} \quad (5)$$

where H_{res} is the angular resolution in steps and T_{resp} is the response time of LiDAR to collect data from a point.

$$A_H = 1/T_{Line} \quad (6)$$

where T_{Line} is the time taken for 2D sweep

$$N = H_{res} \times V_{res} \quad (7)$$

where H_{res} and V_{res} are the angular resolution in steps for horizontal and vertical planes respectively.

$$T_{frame} = N \times T_{resp} \quad (8)$$

where N is the total number of scan points measured from the scene and T_{resp} is the response time of LiDAR to collect data from a point.

$$A_V = 1/T_{frame} \quad (9)$$

where T_{frame} is the time required for 1 complete area scan

$$D = A \times FOV \quad (10)$$

where A is the axis rate in Herts and FOV is the Field of view in degrees.

The LiDAR sensor: When the LiDAR sensor was placed in front of any obstacle, it turns the buzzer and vibration on the three different ways as illustrated in Fig below

At 65 cm >= distance 45 the vibration with low intensity was triggered.

DOI: 10.31695/IJASRE.2022.8.8.6

At 45 cm <= distance of 20 cm the second vibration with high intensity was triggered.
At a distance of < 20cm the buzzer and two vibrations, were all triggered.

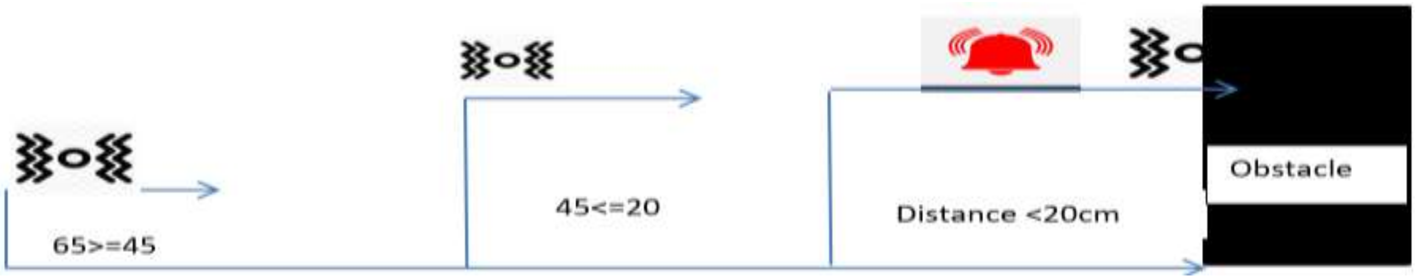

Figure 4:LiDAR System placed in front of an obstacle

Table 1:The table shows the performance analysis Result of the LiDAR-based navigation system.

Module No.	Module Name	Observation	Expected Result	Actual result
1	Obstacle detection	If the obstacle is within 20 cm	Obstacle detected with 2 vibrations and 1 buzzer	Pass
2	Obstacle detection	If the obstacle is beyond 20 cm and 45 cm	Obstacle detected with 2 vibration	Pass
3	Obstacle detection	If the obstacle is beyond 45cm and 65 cm	Obstacle detected with 1 vibration	Pass
4	Obstacle detected	If the obstacle is >= 66 cm	Obstacle not detected	Fail

3.2 Discussion

The LiDAR Navigation System for Blind People presented is not of compatible size because of lacking materials and expertise in mechanical design. Also, the circuit has seemed to be largely due to the lack of a PCB printing machine. The presented system is just a prototype. It can be reduced in size in a way that it can be folded after use when the mechanical and material engineers will be engaged in developing the system.

4. CONCLUSION AND FUTURE WORK

4.1 Future Work

We recommend the following to be the future work of this project.

i. Recognition of objects using machine learning so that blind people can collect information about any surroundings on their own.

ii. Reducing the size of the system so that it should be portable and lightweight.

iii. Embedding the GPS to help them identify their locations.

4.2 Conclusion

During data collection from different communities of blind people, it seemed that they need a navigation system that will help them in doing their activities for their advancement. The LiDAR Navigation System for Blind People, is the system that solves the existing challenge that the blind people in our society are facing. Detection of the objects using this system will help blind people to navigate in different surroundings confidently without quarreling with other road users.

DOI: 10.31695/IJASRE.2022.8.8.6

ACKNOWLEDGMENT

This study was supported by the Program of a Master's degree in Embedded and Mobile Systems at the Nelson Mandela African Institution of Science and Technology (NM-AIST) in Arusha, Tanzania, which is part of the Centre of Excellence for ICT in East Africa (CENIT@EA). We also wish to sincerely thank our supervisors, Drs. Mussa and Sinde, for their sage advice, constant support, and tolerance. They have motivated me throughout my academic career and daily life with their extensive knowledge and depth of experience.

REFERENCES

[1] A. Munier, T. Gunning, D. Kenny, and M. J. B. j. o. o. O'Keefe, "Causes of blindness in the adult population of the Republic of Ireland," vol. 82, no. 6, pp. 630-633, 1998.

[2] ALex, "Reasons Why Your Eyes Are Important " in *www.ultralase.com/blog/reasons-why-your-eyes-are-important/* vol. 2022, ed. Ultralase: Ultralase, 2019.

[3] W. H. Organization, "World report on vision," 2019.

[4] J. D. Steinmetz, R. R. A. Bourne, P. S. Briant, S. R. Flaxman, H. R. B. Taylor, and J. B. Jonas, "Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study," *The Lancet Global Health,* vol. 9, no. 2, pp. e144-e160, 2021/02/01/ 2021.

[5] A. Kumar and P. J. I. j. o. o. Vashist, "Indian community eye care in 2020: Achievements and challenges," vol. 68, no. 2, p. 291, 2020.

[6] G. Cioffi and J. J. G.-C. M. t. e. P. Liebmann, PA: Elsevier, "Diseases of the visual system," 2020.

[7] S. T. Demarest *et al.*, "CDKL5 deficiency disorder: Relationship between genotype, epilepsy, cortical visual impairment, and development," vol. 60, no. 8, pp. 1733-1742, 2019.

[8] S. S. Philip, A. Guzzetta, O. Chorna, G. Gole, and R. N. Boyd, "Relationship between brain structure and Cerebral Visual Impairment in children with Cerebral Palsy: A systematic review," *Research in Developmental Disabilities,* vol. 99, p. 103580, 2020/04/01/ 2020.

[9] F. Newton and R. J. G. Megaw, "Mechanisms of photoreceptor death in retinitis pigmentosa," vol. 11, no. 10, p. 1120, 2020.

[10] F. G. Holz *et al.*, "RANIBIZUMAB TREATMENT IN TREATMENT-NAIVE NEOVASCULAR AGE-RELATED MACULAR DEGENERATION: Results From LUMINOUS, a Global Real-World Study," (in eng), *Retina (Philadelphia, Pa.),* vol. 40, no. 9, pp. 1673-1685, 2020.

[11] S. J. Kim, A. D. Port, R. Swan, J. P. Campbell, R. P. Chan, and M. F. J. S. o. o. Chiang, "Retinopathy of prematurity: a review of risk factors and their clinical significance," vol. 63, no. 5, pp. 618-637, 2018.

[12] S. Desai, R. Shah, P. Waghela, and B. Madan, "Smart Stick for Blind People Using Ultrasonic Waves," in *2nd International Conference on Advances in Science & Technology (ICAST)*, 2019.

[13] F. Sorgini, R. Caliò, M. C. Carrozza, C. M. J. D. Oddo, and R. A. Technology, "Haptic-assistive technologies for audition and vision sensory disabilities," vol. 13, no. 4, pp. 394-421, 2018.

[14] V. V. Nahar, J. L. Nikam, P. K. J. I. J. o. M. T. i. E. Deore, and Research, "Smart blind walking stick," vol. 2349, pp. 645-652, 2016.

[15] S. Singh, "Intelligent Walking Stick for Elderly and Blind," *International Journal of Engineering Research & Technology* vol. 9, no. 03, March-2020, 2020.

[16] I. A. Satam, M. N. Al-Hamadani, and A. H. Ahmed, "Design and Implement Smart Blind Stick," *Journal of Advanced Research in Dynamical and Control Systems,* vol. 11, no. 8, pp. 42-47, 2019.

[17] M. Adil, T. Rafa, J. Ferdoush, A. Mahmud, and A. Pathak, "An IoT based Voice Controlled Blind Stick to Guide Blind People," 2020.

[18] S. Gangwar, "Smart stick for Blind," *New Delhi, Sept,* vol. 26, 2011.

[19] A. Pathak, M. Adil, T. S. Rafa, J. Ferdoush, and A. Mahmud, "An IoT based Voice Controlled Blind Stick to Guide Blind People," 2020.

[20] A. A. Nada, M. A. Fakhr, and A. F. Seddik, "Assistive infrared sensor based smart stick for blind people," in *2015 science and information conference (SAI)*, 2015, pp. 1149-1154: IEEE.

DOI: 10.31695/IJASRE.2022.8.8.6

[21] N. D. Kumar and A. S. Mala, "Practical Implementation of 3D Smart Walking Stick for Blind People," *AIJR Proceedings*, pp. 391-398, 2021.

[22] K. P. D. Niveditha K, Nivedha P,Pooja B,Lakshmikantha G C, "Virtual Eye for Blind using IOT," *International Journal of Engineering Research & Technology (IJERT)*, vol. 8, no. 11, 2020.

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DOI: 10.31695/IJASRE.2022.8.8.6