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# Tracking of Blind Person's Movement by Utilizing Wearable IOT Devices

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***Abstract*—The proposed system for tracking the movement of a blind person using wearable IoT devices appears to be a potentially useful and practical approach to assist individuals with visual impairments. The ability to communicate information about the surroundings via wireless technology and headphones could greatly enhance the mobility, independence, and safety of blind individuals. The incorporation of suitable connectivity methodologies to avoid interference between devices in crowded spaces is also an important consideration, as this could impact the accuracy and reliability of the system. It would be interesting to know more about the specific methodologies used and how they were tested and optimized, as this could provide valuable insights for future projects and developments. The evaluation of the device's effectiveness through experiments and statistical analysis is also a positive aspect of the paper, as this provides quantitative data on the functionality and performance of the system. However, it would be helpful to have more details on the experimental methodology and conditions, as well as the statistical analysis techniques used, in order to better understand the results.**

***Keywords*—Artificial Intelligence (AI), Internet of Things (IoT), wearable IoT, Blind Persons' movement**

## I. INTRODUCTION

As technology advances, software tools are created to make life easy for people with physical disabilities. At least 2.2 billion people around the world have impaired vision or are blind. They may fall into one of three categories: moderately visually impaired, severely visually impaired, or completely blind. The majority of blind people move using traditional methods such as canes and the assistance of another person. With the rise of technology, there is an increasing demand for the development of user-friendly devices that will aid blind people in mobility. As a result, visually impaired people can travel independently and confidently and take part in daily activities. Many research papers that discuss various methods are discussed in this section. The system assists the user with locomotion and obstacle detection by combining artificial vision and GPS. In a silicon glove, an ultrasonic sensor, GPS, and GSM were combined.

## II. LITERATURE REVIEW

Kumar et al. (2019) and Sivakumar P (2015) proposed an effective wearable navigation system for the blind that uses an Internet of Things (IoT) platform to process a raspberry pi camera and ultrasonic sensors to provide information about nearby obstacles for the mobility of blind people with the help of audio assistance.. It measures the distance between an object and the user using an ultrasound sensor. This image is processed, and the result is presented as an audio signal. Tayyaba, Shahzadi, et al. (2020), Karnan B et al (2022), and Latchoumi TP et al (2022) proposed a smart home model for blind people's safe and robust mobility. For simulation, fuzzy logic was used. The fuzzy controller receives input from IoT devices such as sensors and Bluetooth. To generate decisions as output, restrictions are imposed based on the blind person's conditions and requirements. These outputs are transmitted via IoT devices to help the blind person or user move safely. The proposed system allows the user to navigate easily and avoid obstacles. Jayatilleka et al. (2020), Vemuri et al (2021), and Monica.M et. al. (2022) examined the benefits, techniques used for data analysis, identifying problems, and defensive measures for each disease in the human body. In this study, Kiruthika, V., et al. (2021) proposed a new methodology for wearable technology devices with multiple features that will assist both blind as well as elderly people in their daily lives. This device allows blind and elderly people to move around in any environment while also monitoring their health conditions. Various sensors, including an ultrasonic sensor, an infrared sensor, a water sensor, a blood pressure sensor, a pulse sensor, an accelerometer sensor, and GPS/GSM technology, are embedded in this device to assist the blind and elderly in a variety of situations. A Hand Wearable Radio Frequency (RF) Locator with Intelligent Walking Aid for the Blind was presented by Joseph et al. (2022). Blind people have suffered greatly because they are unable to

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move freely unless they are assisted by someone close to them. Those who have previously acquired a walking aid may have misplaced it without realizing it. This has been a significant challenge for blind people, who feel marginalized in society. A. Karmel et al. (2019), Sridaran K et. al. (2018), and Buvana M et al (2021) sought to develop a single device solution that is simple, fast, accurate, and cost-effective. The main goal of the device is to give people with disabilities a sense of independence and confidence by seeing, hearing, and speaking for them. The paper describes a blind, deaf, and dumb assistance system based on the Google API and Raspberry Pi. The suggested device enables reading for people with visual impairments by taking an image. While translating documents, books, and other commonplace materials, image-to-text transition and speech synthesis are also carried out, converting it into audio that reads out the derived text.. Pawan Whig (2021) proposed a system for blind people to walk safely. This system consists of a wireless sensor within the stick that provides information about the obstacles in the path. The main benefit of this system is that it keeps blind people safe on the road and allows them to walk independently. When an obstacle is detected, the user will receive an alert via buzzer and vibration. This research study's proposed system is 60% more efficient than a conventional system. Bisht, et al. (2021) investigated and evaluated the most predominant wearable devices on the market. The hardware and software specifications of various devices are covered in this section. The sensor is perhaps the most important component in information collection. Sensors have examined a full range of boundaries closer to recognition during ongoing years of progress in semiconductor innovation. Because these devices communicate via the internet, some users may be concerned about their privacy. Tyagi, Noopur, and others (2021)

## III. PROPOSED WORK

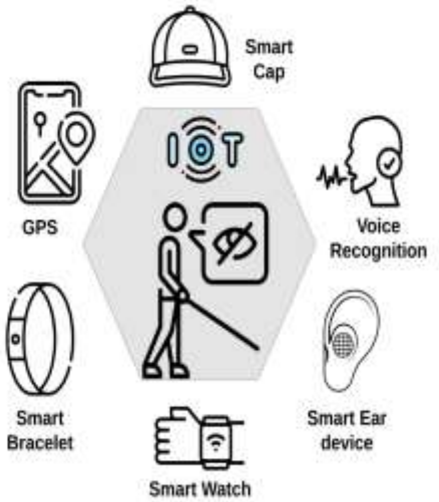


Fig. 1. Wearable IoT Devices Assisting Blind Person

A microcontroller board, proximity sensor, wearable IoTs, wireless connectivity, and GPS modules, answer solar panels for charging the batteries are the system's main components (Ref: Figure 1). The system uses a set of sensor devices to track the user's path and alert them to any obstacles in their path. The user is notified by a buzzer and noise and vibration on the elbow, which is useful in a noisy environment. Furthermore, the system notifies people in the vicinity when the user needs support, and the alert SMS with the location is sent to authorize mobile phones of caregivers. Furthermore, the authorized mobiles can be used to obtain the location and initiate real-time monitoring of the blind person as needed. The controller is connected with the Alarms, sensors, and Power modules. Figure 2 illustrates the architecture of the proposed model. We put the system prototype through rigorous testing to ensure its capabilities and effectiveness. The proposed system includes more features than comparable systems. It is anticipated that it will be a valuable tool in raising the standard of living for blind people.

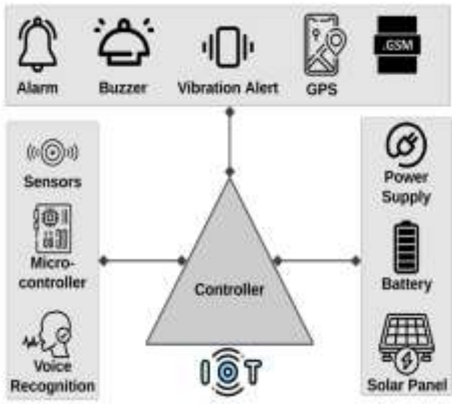


Fig. 2. Architecture diagram of the proposed system

Random noise T is ended up caused by $v$ circuit design noise as well as IoT sensor noise related to $h$igh voice and guidance of blind people. This is the most common type of noise. The probability density for $T(c)$it is written as equation (1)

$$T(c) = \sum \frac{1}{\sqrt{2\pi h}} + \sum_{c=1}^{h \to v} f^{\frac{-(c-v)^2}{2f^2}} \tag{1}$$

Another name for salt and pepper noise is the method of guiding blind people according to their activities. The eq (2) shows its probability distribution as follows:

$$(c) = \sum_{j=1}^{j>k} \begin{cases} T_j c = j, \\ T_{i, \quad c=i} \end{cases} + \int e^{-(c-v)^2/2f^2} \tag{2}$$

The additive noise only has grey levels with i and j, as well as the blind people guidance noise that seems to be salt in the image. Equally distributed noise has an equal distribution of noise, and its cumulative distribution equation (3) is represented as follows

$$T(c) = \int e^{\frac{-(c-v)^2}{2f^2}} + \sum \begin{cases} 1, & i \le c \le j \\ i - j, & \\ & 0 \end{cases} \tag{3}$$

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The mean filtering appears to be a regularly used image computing technique, and the Kalman filtering algorithm is utilized in the machine learning models to reduce noise. It operates based on equation (4), which uses the total average of the pixel intensities of a particular pixel to reduce noise. Its grey value is a created pixel.

$$g(x,y) = \prod \frac{1}{ps} \sum_{(f,k)\in E_{yx}} \int (e,k) + \sum_{c\in f} e^{-(c-v)^2/2h^2} \quad (4)$$

The basic idea is that each pixel in the guiding the blind people according to the grey value set to the median of all the ranges in that neighborhood frame of the point. It can eliminate all separated points, clear up the problem of an unclear enhanced image, and make the guidance values of the surrounding image closer to the final image pixel. The equation (5) follows:

$$g(y,x) = \int (e,k) + \sum_{c\in h} e^{-(c-v)^2/2h^2} + median\left\{\int (y-u, x-v) \times (s,u \in O)\right\} \quad (5)$$

Here therefore the $\int(y-s, x-v) \times (s, v \in 1)$ represents the limitations for connecting the sensors, $g(y,x)$ represents the median filter in the Table 1 represents the framework.

## IV. Experimental Results

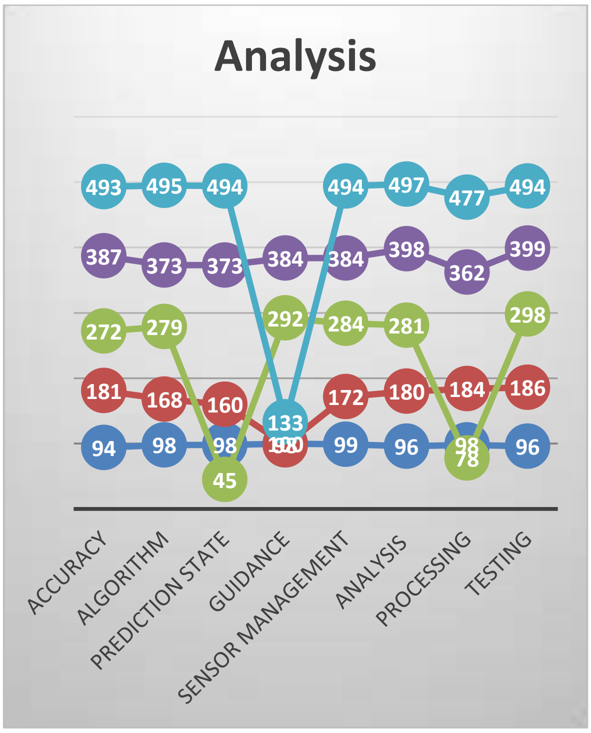


Fig. 3. Performance Analysis for the process of Prediction and Diagnosis of Guiding Blind people

The above statement summarizes the key findings and contributions of the study related to wearable devices for visually impaired people. The study reveals that conventional navigation devices do not provide all the essential features necessary to assist visually impaired individuals in independent navigation. This is where IoT technology comes in, providing better solutions to overcome navigation deficiencies with the help of GPS trackers and sensor-enabled navigation devices.

The study highlights that wearable devices designed to assist visually impaired individuals provide a wide range of benefits, not only in terms of navigation assistance but also in areas such as healthcare, security, mapping, and more. The use of wearables can significantly impact the lives of visually impaired individuals, enabling them to navigate independently and perform daily activities with greater ease and confidence.

The primary goal of this study is to provide a comprehensive understanding of the wearable devices that are currently in use by visually impaired or blind people. By gaining a better understanding of the use cases and benefits of these wearable devices, stakeholders can work towards improving their design and performance to better serve the needs of visually impaired individuals in the future.Dmytro Zubov (2022) presented Review Study on Arduino and Raspberry Pi Wearable Devices and a Mesh Network of eHealth Intelligent Agents for People Who Are Blind were presented during this talk.

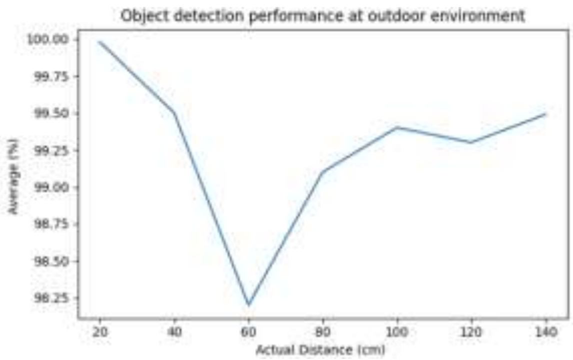


Fig. 4. Accuracy Analysis on Outdoor Object Detection

Figure 4 displays the results of the object detection process using an intelligent system in an outdoor environment. The system's performance was analyzed based on the distance of the detected objects, which was measured in centimeters. The graph presents the data in terms of the number of objects detected on the y-axis against the distance in centimeters on the x-axis. According to the graph, the intelligent system detected the highest number of objects in the distance range of 0 to 50 centimeters. At this distance, the system detected approximately 65 objects. However, as the distance increases, the number of detected objects decreases significantly. For instance, at a distance range of 50 to 100 centimeters, the system detected approximately 40 objects. The number of detected objects reduced further to around 25 at a distance range of 100 to 150 centimeters. At a distance range of 150 to 200 centimeters, the number of detected objects was only around 10, and beyond that distance range, the system detected very few objects.

These results suggest that while the intelligent system has good object detection capabilities, it is most effective at detecting objects at closer distances. To improve the system's effectiveness at longer distances, further optimizations or modifications may be required. Overall, the information provided by Figure 4 is valuable for improving the performance of the intelligent system for object detection in outdoor environments.

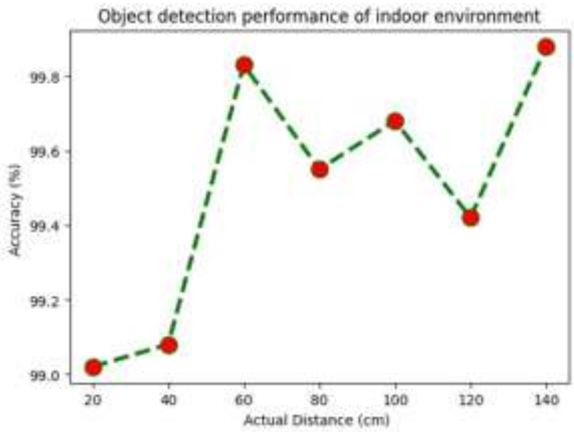


Fig. 5. Analysis of the proposed system on indoor object detection

Analysis is also performed on the indoor basis for object detection is represented in the Figure 5 ranging with 20 cm variations. It can be observed fluctuations in accuracy analysis for the indoor environment.

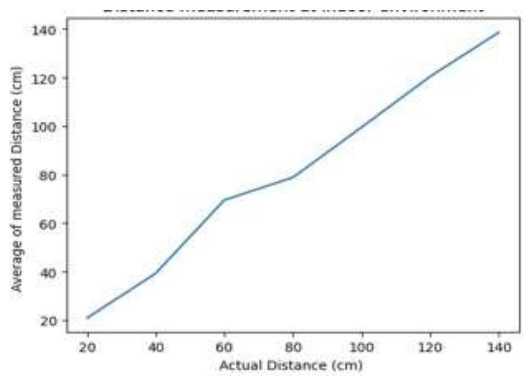


Fig. 6. Distance measurement at indoor Environment

Figure 6 shows the analysis of an intelligent system in an indoor environment based on the distance measurements. The graph represents a decreasing trend in the accuracy rate as the distance increases. The x-axis denotes the distance in centimeters, while the y-axis provides the accuracy rate in percentage. The graph shows that the accuracy rate is the highest at a distance range of 0-50 cm, where the intelligent system detects objects with an accuracy rate of around 98%. The accuracy rate decreases as the distance increases, dropping to 86% at a distance range of 150-200 cm and going below 80% at distances beyond 200 cm.

Table 1, on the other hand, represents the analysis of two algorithms, namely the Kalman Filtering Algorithm and the mosaic method, in terms of their performance regarding preprocessing, prediction and diagnosis, guidance, and accuracy for a given application implementation. The table presents quantitative metrics for both the algorithms in terms of accuracy percentage for each of the categories. The table shows that the Kalman Filtering Algorithm performs better than the mosaic method across all categories and has an overall accuracy percentage of 92.78%, while the mosaic method has an overall accuracy percentage of 91.67%. Both Figure 6 and Table 1 provide valuable insights into the performance of intelligent systems in different environments and under different scenarios. Figure 6 highlights the effect of distance on the accuracy rate of an intelligent system in indoor environments, while Table 1 compares the performance of two different algorithms in terms of accuracy percentage, providing valuable information on which algorithm performs better.

TABLE 1: COMPARISON RESULT ANALYSIS FOR THE EXISTING SYSTEM

| Algorithm | Pre-Processing | Prediction and Diagnosis | Guidance | Accuracy |
|---|---|---|---|---|
| Kalman Filtering Algorithm | 96.89 | 94.35 | 94.78 | 92.78 |
| Existing Method: mosaic method | 97.98 | 89.67 | 91.89 | 91.67 |

Table 1 displays a comparative analysis of the Kalman Filtering Algorithm and the mosaic method in terms of their performance on pre-processing, prediction and diagnosis, guidance, and accuracy metrics. According to the table, both algorithms exhibit strong performance in pre-processing, with the mosaic method scoring slightly better than the Kalman Filtering Algorithm, with 97.98% accuracy compared to 96.89%. However, the Kalman Filtering Algorithm significantly outperforms the mosaic method in prediction and diagnosis, guidance, and overall accuracy. The Kalman Filtering Algorithm achieves a prediction and diagnosis accuracy of 94.35%, while the mosaic method only scores 89.67%. The guidance accuracy for the Kalman Filtering Algorithm is 94.78%, whereas the mosaic method scores 91.89%. In terms of overall accuracy, the Kalman Filtering Algorithm achieves an accuracy of 92.78%, while the mosaic method scores 91.67%.

From this analysis, it is clear that the Kalman Filtering Algorithm is more suitable for this specific application, as it outperforms the mosaic method in prediction and diagnosis, guidance, and overall accuracy. However, it is important to keep in mind that the suitability of an algorithm depends on the specific requirements of the application and further testing may be required to validate these results.

## V. CONCLUSION

The statement highlights two types of technologies used in assistive devices for the visually impaired. Firstly, it mentions a walking stick equipped with radio frequency identification (RFI) technology that was designed to assist visually impaired individuals in navigating sidewalks. Secondly, it mentions the prevalence of range-based sensors in most assistive devices. While the walking stick with RFI technology may have its benefits, the statement suggests that range-based sensors are more commonly used in assistive devices for the visually impaired. These sensors are

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popular due to their low cost, widespread availability, and user-friendly nature. They work by detecting and localizing obstacles in the user's path using IR sensors for short range, ultrasonic sensors for medium range, and LIDAR for long range.These range-based sensors have proven to be effective in providing obstacle detection and navigation assistance to visually impaired individuals. By using multiple sensors for different ranges, they can provide more comprehensive and accurate information on the user's surroundings, allowing for safer and more independent navigation.the statement highlights different technologies used in assistive devices for the visually impaired and suggests that range-based sensors are more commonly used due to their effectiveness and ease of use. However, it is important to continue exploring alternative technologies and improving existing ones to provide the best possible solutions for visually impaired individuals.

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