International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Smart Blind Wand Using Ultrasonic and Infrared Sensors to Improve Mobility of the Visually Impaired

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Submitted: 26/01/2024 **Revised**: 04/03/2024 **Accepted**: 12/03/2024

Abstract: The eye is a part of the human body's organs, which is included in the five senses and has a crucial function in vision. Each person undoubtedly has different eyesight; therefore, this organ operates based on the principles related to light and darkness. With the sense of sight, humans can carry out all their activities. We know that some individuals must have limited physical conditions of the eyes, and some are even blind from birth. This research introduces an innovative solution for the visually impaired by designing and implementing a mobility aid in the form of a blind cane. This tool uses ultrasonic sensors as a substitute for the sense of sight, enabling the detection of obstacles or objects in front of the user. Additionally, infrared sensors are employed to detect the presence of holes. The Arduino microcontroller serves as the central hub for managing data from both types of sensors. The cane utilizes five HCSR-04 ultrasonic sensors with a transmitter range capable of detecting objects or obstacles within a warning distance. The response to this detection is conveyed to the user through a vibrating motor, providing alerts via vibrations and buzzer sounds located at the bottom of the cane. Consequently, this mobility aid for the visually impaired can significantly enhance effectiveness, increase independence, and offer practical solutions for daily activities.

Keywords: *Arduino UNO, Blind, HCSR-04 Ultrasonic, Infrared*

1. Introduction

The competitiveness of a technology-focused company depends on its capacity to recognize opportunities arising from technological advances and transform them into innovations [1]. In numerous nations, the shift towards a novel economy subsequent to the revolution in information technology, commonly denoted as 'digitalization' or Industry 4.0, is accompanied by the emergence of innovative configurations and mechanisms [2]. In particular, start-up universities derived from or based on technology, as well as startups that rely on existing technologies to commercialize them in the market [3], and even technology-based companies, are increasingly recognizing the importance of identifying innovative applications for new or existing technologies [4]. As the future success of these entities relies on identifying and synchronizing opportunities stemming from technological advancements, the drive toward technology-driven innovation takes on an important role [5].

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Nevertheless, the lack of concentration and consideration in both literature and practice has resulted in the underdevelopment and elusive nature of the technology push process [6]. The analysis of selected technologies to ascertain suitable applications is a crucial step in the "technology push" [7]. To execute this step with a solid foundation, it is necessary to gather information about the technology in question [8]. Understanding the attributes of the technology, particularly its distinctive advantages, plays a pivotal role in identifying opportunities [6]. Moreover, a comprehensive comprehension of the technology equips one with the necessary knowledge about its capabilities and limitations, enabling the identification of the most appropriate technology for the subsequent application in engineering design. Furthermore, a description of the technology can furnish details on costs, performance characteristics, and other significant factors that may impact the engineering design process [7]. The realm of deep learning, which embodies a stimulating and influential facet of artificial intelligence that is concurrently stimulating and high-impact, holds immense significance in the contemporary era [9].

The sense of sight presents itself as one of the most important senses for humans. Our visual system is so intricate and powerful because it allows us to perceive, identify, and understand objects around us [10]. We perceive ourselves as a unified entity joined by many bodily sensations that spontaneously merge into a cohesive and unbroken sense of the body itself. The perception of one's own body, particularly the sensation of having a body, relies on the assimilation of information from diverse sensory sources [11], [12], [13]. Sensory input from vision, touch, and proprioception play an important role in the multisensory integration process, which supports body self-perception [11], [12], [13], [14], [15], [16]. In addition, other senses also contribute to self-body perception, including visceral interoception [17], [18], skin-based interoception [15], [19], [20], [21], vestibular input [22], [23], and auditory feedback [24], [25]. However, vision is often considered to have a major role in the integration of these body-related signals due to its increased spatial dependence and acuity under favorable visual conditions, thus providing intricate information on body position, movement, and posture.

According to the World Health Organization, there are 2.2 billion people who are visually impaired or blind, with 40 million of them completely blind [26]. In contemporary society, the provision of information technology and assistance for autonomous navigation to individuals who are blind or visually impaired (BVI) poses significant difficulties that require attention. Many organizations and governments have proposed new infrastructure to meet the needs of the BVI population. Environmental awareness is one of the main challenges faced by BVI individuals in their daily lives. Various options, such as walking sticks, guide dogs, and smartphone apps, have been provided for this purpose, but each has limitations. For example, canes are ineffective for long distances and crowded areas, while trained dog cats are very expensive and require a high level of attention. In addition, they are not suitable for preventing BVI individuals from dangerous situations. Many solutions based on Global Positioning Systems (GPS) have recently been introduced. However, due to their limited accuracy and precision, as well as their inability to function indoors, these solutions are not suitable for BVI residents. In addition, GPS cannot provide information about nearby objects. Several other solutions based on computer vision approaches have been proposed to address autonomous assisted navigation for BVI individuals.

It is imperative to consider the diverse challenges and needs faced by people with disabilities and find ways to improve their quality of life through research. Blindness is one such disability that needs attention. The World Health Organization (WHO) categorizes distance vision impairment into four classifications: mild visual impairment, moderate visual impairment, severe visual impairment, and blindness [27]. Especially for individuals who fall into the last two categories, blind or severely visually impaired, additional efforts and attention are required for them to navigate the world as they rely on conventional techniques such as white canes and navigation and mobility aids. Technological advancements have provided new aids that enable visually impaired individuals to move around independently.

In their previous work [28], the research study found that the integration of the infrared (IR) spectrum in the face recognition system improved the precision and AUC value of the receiver operating characteristic (ROC) curve for individuals with highly pigmented skin. The performance of highly pigmented faces increased from 97.5% to 99.0% when the IR spectrum was included. The inclusion of IR improves the performance of the face recognition system; however, the use of a limited dataset in this investigation hinders the ability to extrapolate the performance improvement to the full dataset incorporating IR images.

Subsequently, in a follow-up study [29], this paper proposes a new approach that combines several models to detect aircraft in orbit using data from the thermal infrared sensor (TIS) of the SDGSAT-1 satellite, which has a spatial resolution ranging from 1×1 to 2×2 pixels. The approach was validated using a three-band thermal infrared aircraft dataset (TIFAD) with a spatial resolution of 30 m, generated from thermal infrared images acquired from SDGSAT-1. This paper presents the contrail detection findings using an improved probabilistic Hough transform algorithm (Hough-Lines). The proposed approach achieves 90.01% pixel accuracy for contrail detection, surpassing previous methods used for cloud detection. In the research conducted by [30], the research study compared the utilization of low and high-resolution infrared sensors to estimate crowd density in urban areas, aiming to improve the efficiency of transportation and public services in low-density scenarios. Both technologies proved valuable in estimating crowd density, but high-resolution cameras demonstrated greater accuracy, albeit at a higher cost for integration into infrastructure. Low-cost, low-resolution infrared cameras can produce reasonable results; however, for increased accuracy, high-resolution cameras are required. Achieving a balance between cost and performance may be important to encourage the installation of more Internet of Things (IoT) systems using infrared technology. This paper presents three image processing techniques and their results, including sample data, analysis flowcharts, and results obtained. The relationship between the number of people and the average temperature was analyzed using infrared images processed with a threshold algorithm. The results show that low-resolution infrared cameras can be used for human object recognition, although additional techniques will be used for future analysis. The research study investigated the difference between low-resolution and high-resolution infrared cameras in detecting the number of people during nighttime in a dimly lit environment. The investigation was conducted at Nottingham tram stops. Equation (4) was used to estimate the number of people based on the number of pixels in the infrared image. Pixel counting has proven to be a valuable technique for predicting the number of people, and the calibration of pixels to the number of people is expressed by an equation.

High-resolution infrared images after interpolation and edge detection produce superior results for human object recognition compared to low-resolution images. The accuracy of the algorithm increases as the number of people at the tram stop increases.

Furthermore, in a different study [31], this paper introduces a compact integrated infrared CO_2 gas sensor that can be used to monitor tidal end CO_2 levels. The size of the sensor has been significantly reduced by about 80% compared to sensors available in the market, measuring only 10 mm x 10 mm x 6.5 mm. It exhibits low power consumption and fast response speed. The sensor is capable of accurately monitoring end-of-tidal CO_2 concentrations, with a reading accuracy of less than 50 ppm. In addition, it exhibits excellent stability over long periods, with a minimal drift of only 5.4 ppm/day. Consequently, the proposed sensor surpasses conventional commercial sensors in terms of power consumption, response time, and size. The integration technique employed during the sensor fabrication process shows promising prospects for widespread use in portable gas analysis instruments. The system is capable of recording a range of two to five motion-related events, depending on the velocity filter applied, with the number of events decreasing as the filter becomes tighter. In addition, the system has demonstrated the ability to distinguish between objects and humans by utilizing the features provided by the PIR, MW, and TC sensors. Validation tests were conducted to assess the range and accuracy of the PIR and MW sensors, which revealed the effective range of these sensors. The system was subjected to various scenarios involving pedestrian flow and unmanned quad-copter movement to simulate a robotic platform at different heights, thus elucidating the system's response in the presence of mechanical systems or humans. To validate the system, high-resolution video cameras were positioned at fixed points, enabling visual verification and measurement validation [32].

The rapid advancement of technology in today's world is accelerating knowledge and scientific progress. With current technological developments, it can be utilized and further developed to assist humans in their tasks, thereby increasing efficiency and convenience. Therefore, it is imperative for all individuals, especially students, to be able to keep pace with the rapid evolution of technology.

The purpose of this research is to design a device to detect holes in blind canes by utilizing infrared sensors. Visually impaired individuals rely heavily on canes for their daily mobility, making them an essential tool. However, these individuals often face the risk of falling due to potholes or obstacles on the streets that are conventionally difficult to detect. To improve the safety and independence of visually impaired users, we have designed and implemented a cane pothole detection system based on infrared sensor technology. This method uses infrared sensors to identify surface changes around the cane and then provides real-time alerts through a feedback mechanism. Tests were conducted to evaluate the performance of the device in detecting holes accurately and immediately. The results of this research are anticipated to make a major contribution towards improving safety and quality of life for visually impaired cane users.

2. Methodology

At the investigation stage, the utilization of infrared sensors on blind canes for hole detection requires a series of sequential steps, which include requirements analysis, system design, prototype tool design, software design, and finally, the implementation of mechanical components.

2.1 Requirements Analysis

2.2.1 Hardware

In the manufacture of canes for the visually impaired, various hardware equipment is required to ensure the functionality and effectiveness of the tool.

1. Arduino Uno
   Serves as the central processing unit for input and output data, thus providing a cognitive mechanism for individuals with visual impairment
2. Ultrasonic sensor
   Plays an important role as a detector of obstacles or entities near the user, thus sending important information to avoid obstacles.
3. Infrared Sensor
   Is used to identify uneven surfaces or potholes, allowing users to improve their perception of road conditions.
4. Breadboard
   Serves as a platform for interconnecting circuits with VCC and ground, thus ensuring stability in component assembly.
5. Buzzer
   Serves as an auditory output that informs the user of ambient conditions.
6. Motor DC Vibrator
   Is used as a vibrating motor on the stick, thus offering haptic feedback to the user to add to the sensory experience.
7. Jumper Cable
   Acts as a link between the module and the Arduino Uno, thus ensuring a seamless and efficient data flow.
8. Battery
   Serves as the main power source to power the Arduino microcontroller and other components.
9. Last, a used creche stick
   Is a fundamental component in the construction of a blind cane, as it provides the physical basis for the integration of the entire system. Through the

incorporation of this diverse hardware, it is hoped that the blind cane can provide effective assistance to users in their daily mobility.

2.2 System Design

2.2.2 System Block Diagram

The System Block Diagram serves as a visual representation that offers an explanation of how a comprehensive system works. In this context, a block diagram is used to illustrate the operational procedure of a blind cane equipped with an infrared sensor. The main constituents of this block diagram include DC battery power as the main energy source, and Arduino Uno as the data processing center.

DC battery power assumes the role of a driving force that supplies voltage or power to the entire Arduino circuit and other components. Its main purpose is to provide the energy required for the efficient functioning of the system. After the reception of power, the Arduino Uno is responsible for processing the inputs and outputs of the various sensors, namely the ultrasonic sensor and the infrared sensor.

The ultrasonic sensor is tasked with detecting the presence of obstacles or objects around the user, while the infrared sensor is focused on identifying uneven or hollow ground surfaces. The information obtained from these two sensors is then processed by the Arduino to generate an appropriate response. This process provides users with vital information regarding road conditions and the presence of obstacles, thus allowing them to navigate with enhanced safety and efficacy.

As such, this system block diagram presents a clear depiction of the power flow from the energy source to the data processing by the Arduino, effectively illustrating the essence of the operational mechanism of this innovative blind cane. Shown below is a depiction of the block diagram referenced in Figure 1.

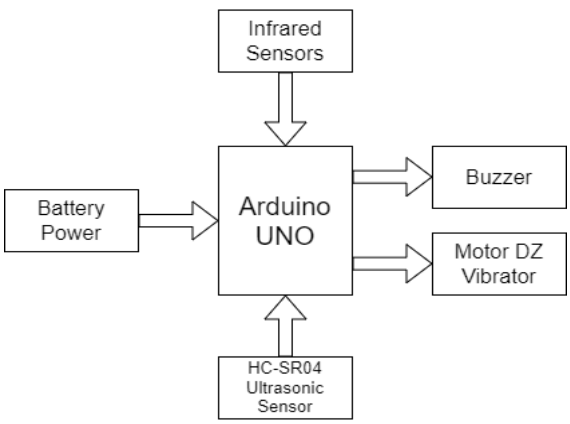


Fig 1: Block Diagram

2.3 Tool Prototype Design

The design of complete circuit components on a blind cane starts with the initial step of sketching and designing the layout of the cane. At this stage, each critical element is methodically identified and designed to ensure seamless integration and optimal functionality. Particularly, attention is directed towards the main handle of the cane, which is designed with comfort and ease of use in mind for the blind user.

In addition, a dedicated space is designed to securely mount and access the Arduino Uno components on the stick. The vibrator and buzzer motors, as critical elements in providing haptic and auditory feedback, are carefully positioned to maximize the efficacy of notifications to the user.

The rod, serving as the main physical component, is considered during the design process to ensure durability and comfort during use. The ultrasonic sensor, consisting of four parts, is arranged in a specific manner to cover the optimal viewing angle for detecting obstacles around the user. In addition, the ultrasonic sensors and infrared sensors are strategically placed on the stick to ensure precision in detecting objects and ground conditions.

With this methodology, the design of circuit components in a blind cane takes into account not only technical functions but also ergonomic aspects and the immediate needs of the user. This process culminates in a well-integrated cane that empowers blind users to navigate their daily activities with great safety and independence. Figure 2 below is a picture of the prototype tool.

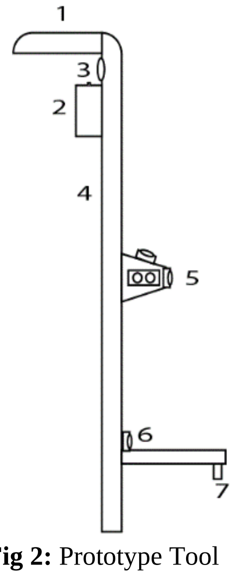


Fig 2: Prototype Tool

Description:

1. The main handle of the stick
2. arduino uno component holder
3. Vibrator motor and buzzer
4. Stick rod
5. Ultrasonic sensor 4 pieces
6. Ultrasonic sensor
7. Infrared sensor

2.4 Software Design

When involved in software design to detect holes in blind canes through the use of infrared sensors, the use of flow charts can prove to be an invaluable visual tool for understanding the logic and workflow of the program. Presented here is a brief depiction of some of the stages involved in software design that can be effectively conveyed through the medium of flowcharts.

- Initialization:
  The initial step involves the initiation of the system, which includes variable assignment and initial setup of sensors and other related hardware.
- Reading Sensor Data:
  The program will proceed to read the data coming from the infrared sensors, to detect fluctuations in the ground surface. This particular process requires the action of reading analog or digital values from the sensor.
- Infrared Sensor Data Analysis:
  The data received from the infrared sensor will be processed, where it will undergo an evaluation aimed at discerning if there are any significant changes that signal the presence of holes or obstacles on the ground surface.
- Reading Ultrasonic Sensor Data:
  This particular stage involves the act of retrieving data from the ultrasonic sensor, which is responsible for detecting objects or obstacles located around the user.
- Analyze Ultrasonic Sensor Data:
  The program will proceed to analyze the data coming from the ultrasonic sensors, with the aim of ascertaining distances and identifying the presence of objects that require the user's attention.
- Provide Feedback:
  Based on the results obtained from the analysis, the system will provide feedback to the user through the use of a buzzer, thus signaling the presence of an obstacle, as well as through the utilization of a DC motor vibrator, thus providing haptic feedback.
- Power Optimization:
  This stage entails the implementation of strategies designed to optimize the utilization of battery power, thus allowing the device to operate both efficiently and durably.
- Continuous Looping and Monitoring:
  After providing feedback, the program will return to a stage that involves reading sensor data, thus perpetuating this process on an ongoing basis to facilitate real-time monitoring of the surrounding environment.

  This particular flowchart serves to reflect the logical progression of the software, thus providing a clear understanding of how the individual components interact in the context of hole detection and notification dissemination to users who rely on blind sticks equipped with infrared sensors.

  Figure 3 below is a system flowchart.

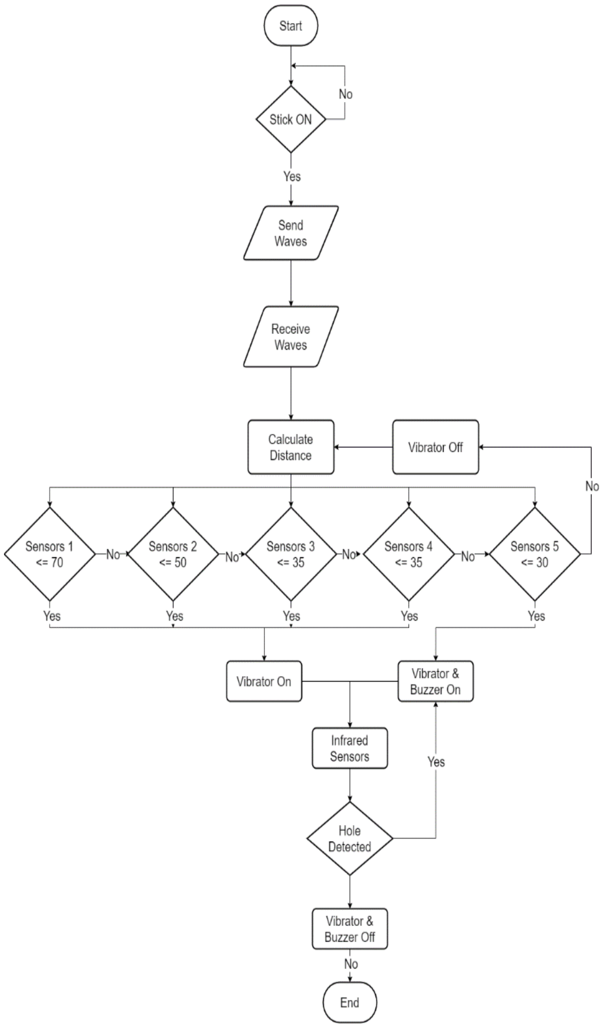


Fig 3: Flow chart System

2.5 Mechanical Implementation

The mechanical implementation discussed in the article deals with the creation of a hole detection mechanism on a blind cane using infrared sensors. This implementation involves various stages, including the physical design of the cane, the integration of electronic components, and the appropriate configuration of the motor and bell. The following are the key aspects to consider in the mechanical implementation for the development of this tool:

1. Physical Design of the Wand:
   The initial phase of mechanical implementation focuses on the physical design of the stick. This entails selecting materials that are lightweight and durable, ensuring optimal comfort for the user. The shape and size of the cane were also taken into account to accommodate the user's mobility and facilitate seamless integration with other components.
2. Component Installation:
   Strategic placement of electronic components, such as the Arduino Uno, infrared sensor, ultrasonic sensor, buzzer, and vibrating DC motor, is critical. The

installation process should prioritize ergonomic and safe positioning to prevent interference with user comfort.

3. Infrared and Ultrasonic Sensor Preparation:
Careful positioning of the infrared sensors is necessary to effectively detect changes in the ground surface. Likewise, the ultrasonic sensor must be placed at an optimal angle to detect objects in the user's environment. Ensuring proper coordination between these two types of sensors is critical to the success of the system.
4. DC Vibrator Motor:
Installing a DC vibrator motor on the wand requires consideration of the contact area and its sensitivity to motion. This configuration allows for timely and convenient haptic feedback when holes or obstacles are detected.
5. Buzzer:
The buzzer is strategically positioned to ensure that the notification sound is heard by the user. Adjustments are made to the volume level and frequency of the sound to meet specific notification requirements.
6. Jumper Cables:
Jumper cables are used to connect electronic components to the Arduino Uno. It is essential that the cable arrangement is neat and secure to prevent potential interference or connection failure.

By carefully implementing these mechanical aspects, a hole detection device integrated into a blind cane using an infrared sensor can be developed. This design ensures an ergonomic, functional and safe tool that blind individuals can rely on to enhance their daily activities. The tools used in the mechanical implementation are Arduino UNO, Infrared Sensor, Ultrasonic Sensor, vibrator motor, buzzer. The mechanical description of the circuit is shown in Figure 4 below.

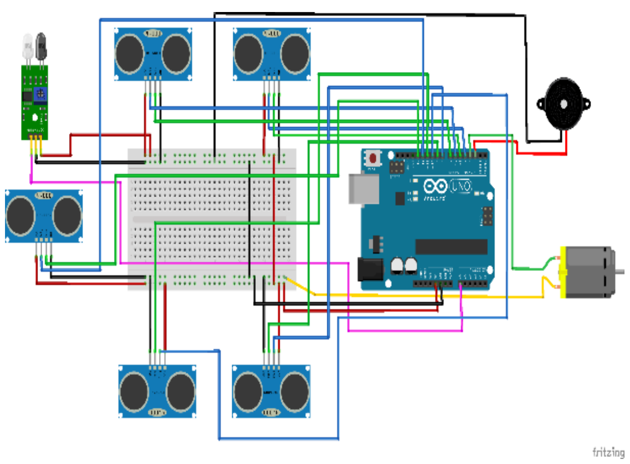


Fig 2: Suite

The mechanical implementation of a hole detection device on a blind cane using infrared sensors is an important step in creating a functional and efficient tool. This development combines various mechanical and electronic components to build a system that increases the independence of blind users. The blind stick integrates Arduino UNO as the central processing unit, an Infrared Sensor and Ultrasonic Sensor for hole and object detection, a vibrator motor for haptic feedback, and a buzzer for audio notification.

From a mechanical point of view, the blind stick is carefully designed to prioritize user comfort and stability during daily use. The main handle located at the top of the stick is ergonomically made for easy gripping. Infrared sensors are strategically mounted on the front of the stick to detect changes in ground level, while four ultrasonic sensors are positioned on the sides to ensure comprehensive object detection coverage around the user.

In addition, haptic feedback is provided to the user through vibrations generated by the vibrator motor, which is positioned near the lower end of the stick, upon detection of a hole or obstacle. To ensure clear auditory notification, the buzzer is located at the top or center of the stick. The arrangement of the jumper cables is carefully executed, guaranteeing reliable connectivity between electronic components such as the Arduino Uno, sensors, and motors.

The main objective of this mechanical implementation is to equip visually impaired individuals with a tool that enhances their mobility and safety. By integrating these components into a blind cane, it is anticipated that this instrument will serve as an effective and reliable solution in assisting users in avoiding potential hazards and providing informative and convenient feedback.

3. Results and Discussion

The development of a hole detection device on a blind cane using an infrared sensor includes a crucial stage involving meticulous assembly and comprehensive testing of the entire circuit. During the assembly process, each component, including the Arduino Uno, Infrared Sensor, Ultrasonic Sensor, vibrator motor, and buzzer, was carefully put together to ensure proper connectivity and physical stability of the device. Deliberate mechanical adjustments are applied to prioritize user safety and comfort during routine use.

After assembly, the next, equally important, step entails careful testing of each sensor individually or as a cohesive unit. The testing process is conducted with great care to validate the functionality of each component, ensuring that the infrared sensor can accurately detect changes in the ground surface, the ultrasonic sensor can identify objects in the user's vicinity, the vibrator motor provides haptic feedback, and the buzzer provides audible notifications according to the desired design.

The testing phase also includes simulating various conditions that visually impaired individuals may encounter

in their daily lives. The aim is to guarantee the reliability of the device in various situations and environments. The results of these tests are used to make any necessary adjustments or improvements to the hardware or software in case of technical discrepancies or problems.
Through careful assembly and thorough sensor testing, it is anticipated that this blind cane hole detection device will offer a reliable and effective solution for users. This process is an important step in ensuring the reliability of the device in enhancing the independence and safety of blind individuals in their daily mobility. In Figure 4.1 below is a series of tools that were successfully used for testing

Fig 5: Device Circuit

The table No.1 below, presents the detection distance results of the ultrasonic sensors obtained during this study. The data documented in the table includes the various positions of the ultrasonic sensors and the distance range that each sensor can measure. The information presented in the table provides a complete picture of the performance of the ultrasonic sensors in detecting objects or obstacles around the research environment.

Table No.1 Ultrasonik Sensor

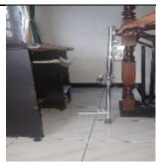
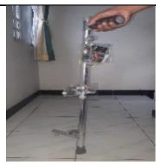
No	Ultrasonik Sensor	Detection distance
1.	Sensor 1	1-70 cm
2.	Sensor 2	1-50 cm
3.	Sensor 3	1-35 cm
4.	Sensor 4	1-35 cm
5.	Sensor 5	1-30 cm

During the stick test, the detection range of the ultrasonic sensor varies depending on its position. To measure the distance between the wand and surrounding objects, ultrasonic sensors were used. Each ultrasonic sensor is strategically placed to ensure optimal coverage. By utilizing multiple sensor positions, the information gathered covers a wide viewing angle, thus providing a comprehensive understanding of the wand's environment.

Testing is conducted via a live walk-through, where the test stick is moved through the test chamber. Throughout the journey, ultrasonic sensors continuously measure the distance between the stick and surrounding objects. The data obtained from each sensor is then integrated to create a three-dimensional representation of the environment. This approach facilitates a holistic evaluation of the cane's ability to detect and avoid objects, while also providing important insights for the development of navigation systems or assistance tools for cane users. By utilizing ultrasonic sensor technology and this direct run testing method, it is anticipated that this research will improve the performance and reliability of canes as mobility aids.

The testing of the stick involved varying the detection range at each position of the implemented ultrasonic sensor. The testing process was conducted through a walk-through method, where the wand was moved directly to ascertain the sensor's response to the surrounding environment. The results of these tests are documented in detail in Table 3.2, which provides an overview of the stick's performance in detecting objects or obstacles at various ultrasonic sensor positions. The information listed in the table provides important insights into the effectiveness and sensitivity of each ultrasonic sensor in supporting the overall functionality of the cane as a mobility aid.

Table No.2 Trial Tool

No	Sensor	Detection distance	Stick Testing Picture	Description
1	Ultrasonik 1	1-70 cm		Vibrator ON
2	Ultrasonik 2	1-50 cm		Vibrator ON
3	Ultrasonik 3	1-35 cm		

				Vibrator ON
4	Ultrasonik 4	1-35 cm		Vibrator ON
5	Ultrasonik 5	1-30 cm		Vibrator dan buzzer ON

In the ongoing evaluation process, the main focus lies on the ability of the infrared sensor to overcome the challenges associated with descending stairs. The evaluation method involves placing the cane in a designated position as the stairs are lowered. The infrared sensor, which is affixed to the stick, functions by emitting an infrared beam and detecting its reflection from the surrounding surfaces. The position and angle of these sensors are strategically designed to offer optimal information during the descent of the stairs.

The purpose of this test was to measure the effectiveness of the infrared sensor in detecting variations in the height and surface characteristics of the stairs. Throughout the descent, the sensor continuously measures the distance between the stick and the ladder. The data collected from the infrared sensor provides valuable feedback on changes in the height of the ladder, allowing the stick to adjust its movement accordingly. The results of this test are expected to provide a comprehensive understanding of the extent to which infrared sensors can improve the safety and comfort of cane users when navigating stair obstacles. As a result, the advancement of infrared sensor technology in canes could be a significant step towards improving users' independence and mobility.

The infrared sensor test was continued by placing the stick in a certain position while descending the stairs, and the results of this test are documented in detail in Table 4.3. The testing process was conducted to evaluate the response of the infrared sensor to changes in the elevation and surface structure of the stairs. Involving the use of the stair descent method as a test scenario, the infrared sensor on the stick emits infrared light to detect the presence of a hole in front of the stick. The test results listed in the table provide significant information regarding the performance of the infrared sensor in alerting the user through the vibration of the cane and the sound of the buzzer, strengthening the understanding of the effectiveness of this mobility aid in overcoming obstacles when interacting with the stair environment.

Table No.3 Infrared Sensor Test

Infrared Sensor	Hole Detected		Vibrator and Buzzer ON

The entire functionality of the cane has undergone a series of trials involving the use of the cane for walking. In this testing process, various aspects regarding the performance and reliability of the cane are thoroughly examined. The use of a walking stick as a mobility aid requires comprehensive testing that takes into account the various conditions and situations that the user may encounter, including walking on diverse surfaces, maneuvering around obstacles, and interacting with the surrounding environment.

The importance of testing canes for walking lies in the holistic evaluation of the capabilities of the sensors and navigation system. This test verifies that the cane not only meets safety and comfort standards but also provides effective assistance to visually impaired individuals during their daily walking activities. The data obtained from this test yields a comprehensive picture of the cane's performance in various usage scenarios, ensuring that this mobility aid is reliable and relevant in meeting the needs of users in diverse environmental circumstances.

The positive results obtained from these tests demonstrate the potential of the cane to greatly benefit visually impaired individuals in enhancing their independence and mobility. Therefore, the development of this walking stick can be seen as an important step towards providing innovative solutions for the visually impaired community.

4. Conclusions

Based on the research and analysis conducted on the blind cane, it can be concluded that this particular cane set is designed using Arduino Uno as the core component of the entire device. The cane is equipped with 5 HCSR-04 ultrasonic sensors, which serve to detect obstacles or objects in the vicinity. The operational principle of these ultrasonic sensors involves emitting waves and then receiving them to measure the distance of the detected object. The user is warned through vibrations when encountering obstacles.

Next, an infrared sensor is used to detect holes in front of the stick. The user is alerted through vibrations on the stick and an audible buzzer sound. The entire system is integrated to provide users with comprehensive information about their surroundings. By utilizing ultrasonic and infrared sensor technology, the cane is able to offer more elaborate and informative responses, thus improving safety and convenience for visually impaired users.

The successful use of Arduino Uno as the control center demonstrates the flexibility and efficiency of the system.
By using ultrasonic and infrared sensors, the stick can not only detect surrounding objects, but also detect differences in surface contours such as holes.

The results of this research form the basis for further development to improve the performance and functionality of the cane so that it can make a positive contribution to the daily life of its users.

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