# A Multi-Purpose Guide Dog for Visually Impaired

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**Abstract—**The World Health Organization estimates that 285 billion people around the globe are sight impaired. Due to a lack of technology, the subject of integration of individuals with disabilities in fashionable culture remains current, despite the huge technical advance in digital management systems in the previous 10 years. For the visually impaired, this proposal suggests a voice-activated intelligent navigation system. The framework is used for real-time control and image processing. Further, speech recognition and commanding have been integrated. Using the guide dog's ability to avoid obstacles, recognize and follow traffic signs, and communicate with humans via speech, a system is created. After that, the system uses speech synthesis to compose a voiceover that describes the identified visual scene. In addition to carefully guiding the visually impaired person to their destination, the guide dog robot may entertain them by vocalizing diverse visual information. The system's components include scene captioning, object identification, and voice synthesis. Experiments performed with our guide dog validate the efficacy of this approach.

***Index Terms*—Multi-Purpose Assistance, Guide Dog, Visually Impaired, Blind Assistance, Virtual Dog, Supportive Dog**

## I. INTRODUCTION

The World Health Organization estimates that at least 2.2 billion people worldwide are either completely blind or have a visual impairment that affects their ability to see close objects or far away [1]. One of the most important forms of assistive technology for the visually impaired is the guide dog, which, in comparison to other options like white canes and electronic mobility aids with built-in sensors, allows the user more freedom of movement. The most complete Guide Dog breeding, training, as well as mobility services are provided by Guide Dogs Australia, the foremost supplier of orientation and mobility for those with limited vision or no vision at all. It takes a lot of time, money, and specific knowledge to train guide dogs to become good mobility aids. Anyone, regardless of their visual impairment, can benefit from this form of mobility assistance provided by a certified Guide Dog. Nevertheless, not everyone can get a guide dog, and there are a lot of variables that might affect whether or not they are a good fit, including user expectations, travel habits, living conditions, and attitude for dogs [2]. Depending on aspects like the dog's health, mental and physical talents, and other personal circumstances, the effectiveness of Guide Dogs may vary across different climates and situations, regardless of the training they get.

A lot of work has gone into creating walk-guide and guide- dog systems in the past few years [3][4]. When a human is sight handicapped, they take the role of a guide dog. A method allowing visually impaired people to use a multi-purpose guide dog is what we're proposing in this project. The inability to travel alone is a reality for many people due to severe vision problems. So, to aid their mobility, individuals need to employ a variety of instruments and procedures. A trained professional in orientation and mobility may assist the blind and visually impaired by teaching them to navigate safely and autonomously using their residual senses. One further option is to use guide dogs, which are specifically trained to assist the visually impaired in their daily activities by detecting and avoiding impediments and then signaling to their owners when it's time to change their path. Despite the widespread agreement that sight is fundamental, millions of individuals worldwide are either blind or severely visually impaired and need on the assistance of others at all times [5]. A great many aspects of human existence have been profoundly impacted by technological advancements, such as the facilitation of communication for the visually impaired and the rapid and global dissemination of information, which have improved people's quality of life in many ways and alleviated pain and suffering in others. People who are visually impaired are still a part of our society, and modern technology has a major effect on their daily life. Help for the visually impaired was previously available, but it was pricey and had limited features. In order to help the visually impaired travel safely and independently, several electronic travel aides (ETAs) have been developed in recent decades. Everyone else fails to comprehend the difficulties encountered by visually impaired and blind persons on a daily basis [6]. These assistive devices all work by scanning the surroundings using various technologies and then displaying the resulting data to other senses, most notably hearing and touch. We hope that this article can serve as a means of providing them with some technological assistance by outlining an electronic tool that could help them with some of their issues. When an electronic device senses an obstruction, it relays that information to the visually impaired, allowing them to move freely. The environment limits the mobility of the visually handicapped. People with visual impairments have a difficult time navigating urban areas safely and confidently on their own. An electronic assistance for the visually handicapped is proposed in this study together with a theoretical model as well as a system idea [7].

Ultimately, we want our initiative to achieve People who are visually handicapped or blind sometimes face the daunting task of navigating potentially hazardous roads on their own [8]. The world is home to millions of people who are blind or visually impaired and who are always in need of assistance. There have been attempts to enhance the walk stick by including a remote sensor; for a long time, the standard walking stick was a well-known feature of blind people's navigation. There are a lot of electrical devices made for those who are visually impaired. A smart stick and guiding dogs are integral to the majority of the gadgets. Therefore, we suggest an ETA, or Electronic Travel Aid, to aid the navigation of people who are visually impaired.

Modern technology innovations provide intelligent robots equipped with sophisticated artificial intelligence capabilities can help the visually impaired and the blind by increasing their mobility and providing constant vital support. The goal of the joint effort between Guide Dogs Australia and the UTS Robotics Institute is to create a smart robot guide that can reliably assist the visually impaired with mobility and navigation, much like a real Guide Dog. However, the researchers acknowledge that no artificial device can replace a human Guide Dog when it comes to personality, social support, experience, and physical appearance [9]. Building a robot guide with essential capabilities that enable it to understand and respond appropriately in different settings associated with respective crucial situations. As a result, we will go over some basic functional mobility aid features and talk about frequently used sensor-assisted portable electronic mobility aids in this post. In addition, we examine the gaps in functionality and compare state-of-the-art robotics technology with current robotic mobility aids based on these important aspects [10].

## II. RELATED STUDY

Recent developments in robotics have had a significant effect on the visual route guiding business, and several researchers have proposed various blind assistive systems [11]. But it's not easy for mobile guiding robots to navigate the unpredictable ambient environment. In the robotics industry, the Internet of Things is viewed as a more adaptable and efficient means of communication for robot control. To help the visually impaired go to their LPDs, this study proposes a smart and multipurpose speech recognition guiding robot powered by a Real-Time Operating System. With the help of the Google Voice Recognition API, this robotic dog can understand what the user is saying and respond accordingly. To avoid obstacles in its route, this robotic dog responds to light detection signals. In order to intelligently avoid operating environment corners, it also employs the Corner Crossing Algorithm. This robot has a "Watchdog" mode that acts as a watchdog and alerts the operator to any unusual movement. It also has a fire sensor. During the day, the robot may charge itself using solar cells by navigating to areas with natural sunshine, according to an included self-charging capability[11].

As a personal helper, the suggested robot would help the vision handicapped avoid obstacles, recognize known or unfamiliar individuals they are engaging with, and navigate [12]. The subject's actual location can be precisely determined by the robot's built-in GPS system. This robot's ability to recognize the individuals the subject engages with is its most innovative feature. Accurate image processing combining viola jones and SURF algorithms has enabled the achievement of the challenging goal of real-time facial detection and identification. The system now features an obstacle avoidance architecture embedded with several sensors to direct it in the right direction. As a result, the robot is an amalgam of the most cost-effective and safest features [12].

When indoors, people with visual impairments typically struggle to find their way about [13] and their degree of acquaintance with the area determines the nature of the difficulties and the remedies. To better comprehend the cooperative character of human-robot interaction in navigation, a user requirements assessment was developed in a joint effort. In the user research, people with visual impairments were interviewed to talk about their experiences with familiar, somewhat familiar, as well as unknown places and how they navigated them. After that, we spoke about their present approaches to way-finding in certain areas and how they may envision a robot assisting with navigation. We provide four case studies that demonstrate user demands, such oral guidance and orientation for learning and navigating a new environment, and typical techniques, like the employment of white canes and other devices, as well as extra illumination and other forms of human support [13].

Being able to take care of one's basic needs is a prerequisite for living independently [14]. Nevertheless, the existing solutions fail to fulfill several critical duties for those who are blind or visually impaired. Our study's overarching objective is to aid BVI residents in achieving more independence by developing technological solutions to such issues. This paper introduces a proof-of-concept socially assistance robotic cane that can 1) guide users to a socially preferred seat in unfamiliar public spaces and assist with navigation, and 2) find and retrieve the desired item from a grocery store shelf. With the help of sighted blindfolded testers, we conducted an initial pilot study to assess our system. The results were promising, indicating that our system has the ability to offer users navigation guidance that is both effective and purposeful, maximizing their privacy, intimacy, and convenience while also boosting their confidence in navigating independently. We also conducted research that demonstrated the system's ability to find things that beginner users want and to give them excellent fine-grain manipulation advice while still making the process enjoyable for them [14].

To help the blind and visually impaired travel independently, it is essential to make pedestrian settings easier to navigate [15]. The goal of this research was to develop an assisted guiding robot that uses deep reinforcement learning and ultra wide-bandwidth beacons to find its way along predetermined routes. When estimating the robot's position and navigational objective, a SLAM framework is usually employed. However, in specific dynamic settings, SLAM frameworks might be susceptible. The suggested navigation system is able to successfully sidestep obstacles since it is a learning technique built on cutting-edge DRL. For settings with moving people, the suggested method works well with UWB beacons. In addition, we developed an audio-interfaced handle that facilitates natural feedback between the guiding robot and BVI users. An audio interface was added to the UWB beacons so they could gather data about their surroundings. Points of interest and turn-by-turn information are provided to BVI users through the on-handle and on- beacon vocal commentary. Participants in this study were asked to navigate through various scenarios using BVIs. In a virtual ward, a path was planned to symbolize regular tasks. Dynamic barriers may influence SLAM-based state estimate in real-world scenarios, and occlusions from walkers or other obstacles may impede the visual-based path. Systems using current SLAM techniques have struggled to traverse areas with moving pedestrians, while the suggested system was able to do so with ease [15].

## III. METHODOLOGY

As a basis for the suggested system, we have covered a handful of tools that can assist the visually handicapped. We have created a pair of smart glasses that can do several things. The visually challenged have benefited greatly from recent advances in image processing methods. Many gadgets rely on computer vision in conjunction with other sensors. A simple optical sensor device as well as a microprocessor is included into our multipurpose smart glass. In order for the micro- controller to handle the data, the optical sensor takes readings from the environment. In order to give the user the information they want, the micro-controller processes and handles the raw data. It is impossible for those with impairments to pinpoint certain items. We have developed smart glass that can identify and categorize various items. It can identify labels and names and then play them back for the user. It can read the text as well as then play back the audio version for the user. Additionally, it has the capability to transform text into Braille and save it in memory for future use, such as printing Braille output for individuals who are visually impaired. In order to help the visually handicapped avoid obstacles, we created a functional model of a shoe that incorporates sensors. As a result, the user is protected from potential harm or accidents. The parts that make it up are as follows:

**(i) Arduino UNO:** One board that uses the ATmega328 micro-controller is the Arduino Uno. An analogue input, thirteen digital inputs (six of which may be used as pulse width modulation outputs), a sixteen megahertz crystal oscillator, a power connector, an ICSP header, a USB port, and a reset button are all part of it. It comes with all the necessary components for supporting the micro-controller; all you need is a USB cable, an AC-to-DC adapter, or a battery to begin. The following figure Fig.1 describes the Arduino UNO microcontroller.

**Fig.1 Arduino UNO**

**(ii) Dimension Drawing:** It may be used as a drill guide or a reference for the dimensions of an Arduino hole. This drawing is printed out on a normal 8.5×11 page at a size of 1:1, allowing you to place it on your mounting platform and utilize a pre-drill punch on the paper without any further steps. If you would like to ensure accurate printing, you may find a 1-inch scale marking adjacent to the title block. The measurements are there for your reference, and you may also use it to direct your drilling. This drawing is printed out on a normal 8.5×11 page at a size of 1:1, allowing you to place it on your mounting platform and utilize a pre-drill punch on the paper without any further steps. The following figure Fig.2 showsthe dimension drawing.

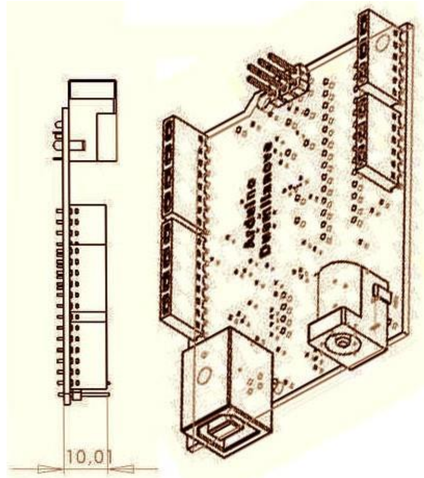


**Fig.2 Dimension Drawing**

**(iii) Wet Sensor:** A wet sensor may be easily inserted into liquids like blood or water and read by a handheld meter. The sensor measures electrical resistance after applying a modest charge to the electrodes. The following figure Fig.3 shows the wet sensor.

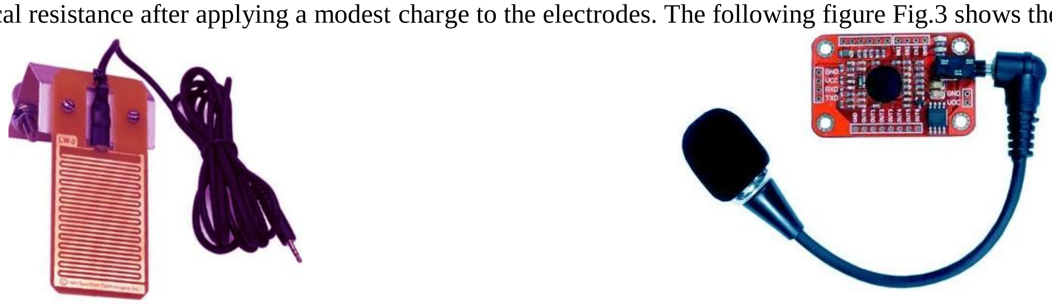

**Fig.3 Wet Sensor**

**(iv) Ultrasonic Sensor:** Similar to sonar, which measures distance by deciphering the echoes of ultrasonic sound waves, ultrasonic sensors do the same thing. With a margin of error of under 3 centimeters, this ultrasonic module precisely measures distances from 0 to 300 centimeters. It is a useful sensor for mapping and distance measuring because to its small size, increased range, and ease of use. The module's two-pin interface makes it easy to trigger and measure with micro- controllers. When the burst echo returns to the sensor after a certain amount of time, the sensor sends out an ultrasonic pulse in response. It is easy to determine the distance to the target by measuring the width of the echo pulse, which includes blinders for non-contact measurements from 0 to 1 cm. The following figure Fig.4 shows the ultrasonic sensor.

**Fig.4 Ultrasonic Sensor**

**(v) APR Voice Module:** Module allows for the recording and playback of high-quality audio for up to eleven minutes at a sampling rate of eight kilohertz and a resolution of sixteen bits. Depending on your needs, you may split the entire period using the on-board jumpers into 1, 2, 3, or 8 messages. These messages can be activated by on-board switches or external events connected to the chip. One form of voice recorder that may capture hours of talks is the digital voice recorder, but there are other varieties as well. The use of digital voice recording has numerous advantages, such as serving as a reminder, providing security in times of need, and facilitating processes like recording conversations using either a pen voice recorder or a wristwatch voice recorder, allowing users tocapture hours of talk. The following figure Fig.5 shows the APR voice module.

**(vi) Buzzer:** The term "buzzer" originates from the rasping sound produced by electro-mechanical buzzers that were powered by stepped-down AC voltage from the line at 50 or 60 cycles. These devices now serve as signaling devices. 33 The usage of a ring or beep is another typical method of signaling the pressing of a button. A speaker, tiny audio transformer, and a relay comprise the innovative buzzer circuit. By pressing the switch, the relay can be activated between the primary contact of the transformer and the closed relay contact. The typically closed contact immediately opens when the relay runs, cutting power to the device. The contacts then shut, and the process starts all over again, but this time at a pace that is so rapid that the pulses of current creates variations in the main and secondary of the transformer. The following figure Fig.6 shows the buzzer.


**Fig.5 Buzzer**

**(vii) LCD Display:** In the same way that LEDs are utilized, liquid crystal cell displays were also employed. Displaying numeric and alphabetical characters using dot matrix as well as segment displays are examples of these uses. One of the many components that display crystal-like optical characteristics while still in a liquid state is the liquid crystal material. On the interior faces of the glass sheets are placed transparent electrodes, and on top of that are layers of liquid crystal. The term "liquid crystal display" (LCD) refers to an electrical device that uses liquid crystals to show images. These pixels can be either color or monochrome and are arranged on a thin, flat screen that is illuminated by a back- light or reflector. It operates on extremely low voltages, making it ideal for use in electrical devices that rely on batteries. A material that combines the best features of liquids and crystals is used in LCDs. Instead of a melting point, these substances exhibit a temperature range where the molecules are nearly as mobile as they are in a liquid, but they are organized in a crystal-like structure. There are two glass panels that make up an LCD, and the liquid crystal

components are placed in the middle. Transparent electrodes placed on the inside of the glass plates provide a boundary between the crystal and the electrodes, allowing the liquid crystal molecules to remain to a certain orientation angle. Turbulence is created when a possibility is placed across the cell, which causes charge carriers in the liquid to break the molecular alignment. In its inactivated state, the liquid appears clear. Light is distributed in all directions by the molecular turbulence when the liquid is triggered, giving the impression that the cell is brilliant. The following figure Fig.7 shows the LCD display.

**Fig.6 LCD Display**

**(viii) IR Sensor:** An infrared (IR) sensor is a type of electrical gadget that uses light emission to detect objects in its immediate environment. Infrared (IR) sensors can detect motion and also monitor an object's temperature. All items typically emit heat radiation in the infrared band. Even though we can't see these rays, an infrared sensor can pick them up. Both the emitter and the detector are infrared light-emitting diodes (LEDs). The photo-diode only reacts to infrared light that has the same wavelength as the IR LED. As infrared light hits the photo-diode, its resistances and output voltages will shift in relation to the amount of light that reaches them. An infrared source, a transmission channel, an optical component, infrared sensors or receivers, and signal processing are the five main components of a standard infrared detection system and sources of infrared light that are defined by their wavelength, such as infrared lasers and LEDs. Vacuum, atmosphere, and optical fibers are the three most common mediums for infrared transmission. To concentrate the infrared light or restrict its spectrum response, optical components are employed. When it comes to amateur robot, infrared sensors are by far the most common. The following figure Fig.7 illustrates the block diagram ofthe proposed system.

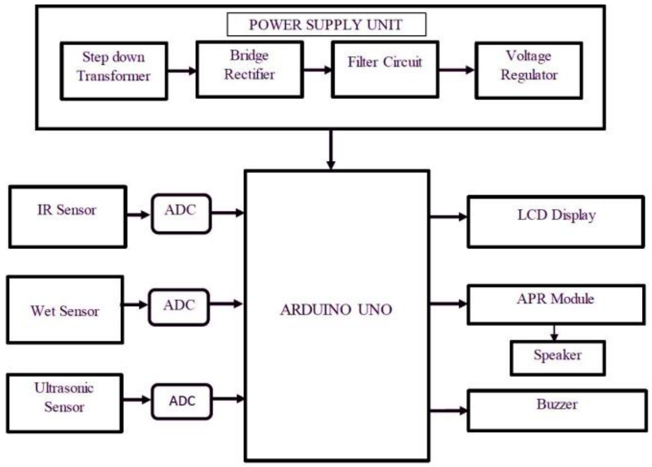


**Fig.7 Block Diagram**

## IV. RESULTS AND DISCUSSIONS

In this paper, an ultrasonic sensor picks up on any impediment in the path of the user, while an infrared sensor finds any holes or pits in the ground and sounds an alarm through a buzzer. The purpose of a water level sensor is to detect the depth of water and sound an alarm using a buzzer. The LCD screen also shows pertinent notifications. The user is informed of the related result by voice output, which enhances the assistant's modularity. The APR voice module and speaker are utilized to read it out in a regional language. Our proposed smart electronic guide dog for the visually impaired gets around these problems. A voice-activated technology has been created to aid the sight blind. In order to identify obstacles, an ultrasonic sensor is used. To find the holes in the trail, an infrared sensor is employed. It is possible to detect and indicate the water level with the help of a water level sensor. Along with the guiding dog, we are employing an APR speech module to obtain awareness through voice commands and control the system. To aid the independence of the visually impaired, this technology can detect water, digs, doors, and obstructions. Two scenarios one involving family members and the other involving outsiders are considered when Matlab is processed using Image Processing.

The following figure, Fig-8 represents the overall hardware implementation completed in this work, in which it consists of Arduino UNO microcontroller, Ultrasonic Sensor, Transformer Unit, Buzzer, LCD Display and so on.

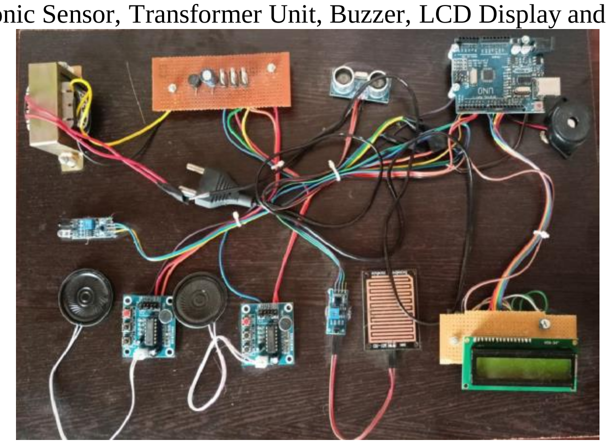

**Fig-8 Proposed Hardware Design**

## V. CONCLUSION AND FUTURE SCOPE

As a result, persons who are visually impaired may go where they want to go securely, without assistance. The technology recognizes impediments on the route to the target. When the system detects an obstruction or the user becomes lost, additional pathways are successfully produced. Building and designing a lightweight, inexpensive, and easily transportable gadget to assist the visually handicapped in navigating unfamiliar environments is the overarching goal of the suggested system. We made sure that the proposed method is easy to use and would be beneficial to people of all ages. With this system design, we prioritize sensor fusion for interior navigation, use ultrasonic sensors to identify obstacles, and keep infrastructure to a minimum. The major goal of this technology is to create a device that is both affordable and easy to use for individuals who are visually impaired. Improvements to the system's efficiency and user burden reduction with the incorporation of a camera to provide precise guiding for the visually impaired will be the primary focus of future development. Photos taken using webcams and NI-smart cameras may be used for object recognition and to scan an area for potential obstacles for a blind person. The object's form and substance can also be detected. Since a blind person has no means of correcting the matching %, it must be almost perfect all the time in order to be dependable and trustworthy. Determining targets at great distances is possible using the concepts of mono pulse radar. An alternative goal may be to develop a novel approach to blind people optimal and safe neural network-based path detection.

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