Industry Oriented Mini Project Report

on

NAVIGATING INSOLE

Submitted in partial fulfillment of the requirements
for the award of degree of

BACHELOR OF TECHNOLOGY

in

Information Technology

by

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(NAAC 'A' Grade & NBA Accredited- ECE, EEE, CSE & IT)

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CERTIFICATE

This is to certify that the Project report on **“ NAVIGATING INSOLE ”** is a bonafide work carried out by **V.Tanusree (20WH1A1221), E.Sushmitha (20WH1A1237)** and **N.Saivarshini(20WH1A1241)** in the partial fulfillment for the award of B.Tech degree in **Information Technology , BVRIT HYDERABAD College of Engineering for Women, Bachupally, Hyderabad** affiliated to Jawaharlal Nehru Technological University, Hyderabad, under my guidance and supervision. The results embodied in the project work have not been submitted to any other university or institute for the award of any degree or diploma.

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DECLARATION

We hereby declare that the work presented in this project entitled **"NAVIGATING INSOLE"** submitted towards completion of in IV year I sem of B.Tech IT at "BVRIT HYDERABAD College of Engineering for Women", Hyderabad is an authentic record of our original work carried out under the esteemed guidance of **Ms. Ch. Sai Lalitha Bala, Assistant Professor**, Department of Information Technology.

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This project report is dedicated to my beloved Family members and supervisor for their limitless support and encouragement and to you as a reader

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ABSTRACT

Visually impaired individuals encounter numerous challenges in navigating their environment independently and safely. Navigating Insole is an innovative solution to address the challenges and enhance the mobility and autonomy of the visually impaired. A shoe-based navigation system helps the visually impaired, where an individual can be assisted to travel around freely in the surrounding. As the navigation system is fitted in the individual's shoes, it helps the person to move freely. With the help of these shoes directional guidance is provided to the wearer. The shoes are built using "Internet of Things" technology embedded with various sensors and microcontrollers. These innovative shoes incorporate a system of vibrations strategically positioned through the sole. This intuitive use of vibrations empowers the visually impaired by supplementing their spatial awareness and granting them a more comprehensive understanding of the world around them. These shoes promote confidence among visually impaired person. As a result, a complete adaptive equipment is being advanced to improve the standard and comfort of life of the visually impaired.

Keywords: Shoe-based navigation system, Internet of Things (IoT) technology, Vibrations, Sensors, Microcontroller

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Chapter 1

Introduction

The Navigating Insole is an innovative project designed to significantly enhance the daily lives of visually impaired individuals. By integrating advanced technology into specially designed shoes, this initiative aims to boost the mobility and independence of users. The insoles employ vibrations and intelligent guidance systems to provide real-time feedback, making navigation more instinctive and secure. The primary emphasis is on addressing the unique challenges faced by the visually impaired, offering them a reliable and accessible means to confidently navigate their surroundings. Through the integration of sensory feedback and cutting-edge technology, the Navigating Insole stands as a symbol of inclusivity, dismantling barriers and cultivating a more connected and supportive environment.

1.1 Motivation

The inspiration behind the Navigating Insole project stems from a deep-seated commitment to improving the quality of life for visually impaired individuals. Recognizing the challenges they face in daily mobility, our motivation is rooted in the desire to empower and uplift this community. The project is driven by the belief that technology can be a transformative force in creating a more inclusive society. By developing smart shoes that go beyond functional assistance, we aspire to instill a newfound sense of independence and confidence in our users. Witnessing the positive impact that enhanced mobility can have on an individual's well-being fuels our dedication to this endeavor. The project aims not only to provide a practical solution for navigation but also to contribute to a broader societal shift towards embracing diversity and accessibility. Ultimately, the Navigating Insole project is motivated by the aspiration to make a meaningful and positive difference in the lives of those who are visually impaired.The ultimate goal remains steadfast: to make a lasting and positive impact in the lives of those who are visually impaired.

1.2 Objective

The primary objective of the Navigating Insole project is to develop an advanced assistive technology that significantly enhances the daily mobility and independence of visually impaired individuals. By integrating cutting-edge technology into specially designed shoes, the project aims to create a reliable and accessible navigation system. The focus is on providing real-time feedback through vibrations and smart guidance systems, fostering a more intuitive and secure walking experience. Beyond functional assistance, the objective extends to instilling a heightened sense of independence and confidence in users. The project aspires to break down barriers faced by the visually impaired, contributing to a more inclusive society. Through the fusion of tactile feedback and technology, the Navigating Insole seeks to revolutionize the standard of living for visually impaired individuals. The objective is also aligned with broader societal goals, promoting diversity, accessibility, and a supportive community. Ultimately, the project aims to make a positive impact by improving the overall well-being and comfort of those who are visually impaired.

Figure 1.1: GPS integration

1.3 Problem Definition

The IoT-based navigation system is envisioned as a wearable technology seamlessly integrated into everyday clothing, offering a discreet and intuitive solution for individuals to navigate their surroundings. Utilizing vibrations for directional guidance, the system responds to left or right movements, enhancing mobility and independence. The core innovation lies in the unobtrusive nature of the wearable, eliminating the limitations posed by existing navigation methods reliant on visual cues and obstacle detection. The system's discrete design aims to blend seamlessly into users' attire, ensuring a non-disruptive and inclusive navigation experience.By providing tactile feedback for navigation, the IoT-based solution caters to the visually impaired community, addressing their unique challenges. The emphasis is on creating a user-friendly, hands-free navigation system that adapts to diverse environments, empowering individuals to reach fixed destinations with confidence and ease. The IoT connectivity ensures real-time updates and personalized navigation, contributing to a more inclusive and accessible technological landscape.

Chapter 2

Literature Survey

2.1 Research Papers

2.1.1 IoT-Based Navigation Assistance for Visually Impaired People

[1] The integration of ultrasonic sensors and an Arduino UNO board has given rise to an innovative IoT-based smart shoe system designed specifically for individuals with visual impairments. Emphasizing the transformative capabilities of the Internet of Things (IoT), this technology facilitates communication among physical entities, offering a rapidly evolving and empowering solution. Notably, in India, where over 40 million people are blind, including 1.6 million children, independent travel poses a significant challenge. The reliance on others for various aspects of daily life, particularly when crossing streets, underscores the need for enhanced mobility solutions. The smart shoe, incorporating multiple sensors, a micro-controller, and buzzers, operates as an IoT-enabled device. When the wearer encounters an obstacle, the shoe proactively alerts them through buzzing, fostering independent travel. Complementing this technology, smart glasses, also IoT-enabled with integrated sensors, extend the scope of object detection over a wider region, enhancing overall efficiency. The collaboration between the smart shoe and smart glasses exemplifies a synergistic approach to prevent users from colliding with obstacles, thereby fostering a safer and more autonomous mobility experience for individuals with visual impairments.

2.1.2 Smart Blind Stick

[2] This paper introduces a Smart Stick as an innovative aid for blind individuals, aiming to enhance their independence and safety while walking. The Smart Stick is equipped with various components and sensors, including an ultrasonic sensor and a servo motor. It operates in two cases: Case 1 involves detecting obstacles in front using the ultrasonic sensor, while Case 2 utilizes the servo motor to rotate the ultrasonic sensor, particularly useful in crowded places. In both cases, obstacle detection triggers a buzzer sound to alert the blind person. The switch button facilitates a seamless transition between the two cases. The Smart Stick is designed to detect obstacles within its range, providing a reliable and comprehensive solution for blind individuals. The paper emphasizes the potential of this technology to instill confidence in blind individuals, allowing them to navigate their surroundings with greater assurance and independence.

2.1.3 IoT based Smart Shoes for Blind people

[3] This paper discusses the significant challenges faced by blind individuals in India, who constitute the third-largest blind population globally. The visually impaired encounter difficulties in navigating their surroundings, leading to potential accidents and challenges in finding their way back home. To address these issues, the proposed study introduces a novel solution called "IoT-based Smart Shoes for blind people." This innovative system aims to enhance the mobility and safety of blind individuals during travel. By leveraging Internet of Things (IoT) technology, the smart shoes offer a promising solution to help the visually impaired navigate their surroundings more effectively and find their way home when faced with route-related challenges. The implementation of such a system has the potential to significantly improve the lives of blind individuals by providing them with increased independence and safety in their daily travels.

2.1.4 Internet of Things - Enabled Smart Shoes for Blind People

[4] This paper outlines a paper focused on developing a system to enhance the independence, simplicity, and safety of blind individuals in their daily activities, especially in navigation. The proposed solution is a Smart Shoe equipped with various sensors connected to an Arduino, enabling functions such as obstacle detection, pothole detection, slippery surface detection, health tracking, and heat sensing. The system also incorporates GPS-GSM navigation and location tracking, along with an emergency-SOS facility for comprehensive assistance. Power for the Smart Shoe is sourced from both batteries and piezoelectric plates, which

generate power during walking. In the event of obstacles, the system sends data to the microcontroller, which processes and transmits it to an Android application via Bluetooth. The application then alerts the blind user through voice instructions, aiding in accident prevention. The overall aim is to provide a holistic solution for outdoor travel, emphasizing safety and ease of mobility for individuals with visual impairments.

2.1.5 Low-Cost Smart Shoe for Visually Impaired

[5] This paper addresses the challenges faced by visually impaired individuals during independent travel by introducing an electronically aided smart shoe. The primary objective is to enhance the safety of visually impaired individuals by providing a more efficient alternative to the traditional blind stick. The smart shoe utilizes sensor technology to detect obstacles within a specified range and promptly sends alert messages through audio signals or vibrations to the user, enabling them to identify and navigate around potential hazards. This real-time feedback mechanism aims to reduce the risk of accidents, injuries, and collisions, offering a technologically advanced solution to improve the transportation experience for the visually impaired

2.1.6 SMART SHOES FOR BLIND USING INTERNET OF THINGS: A REVIEW

[6] This paper introduces a thought regarding managing the issues looked by blind people through smart shoes. Due to the blind people face many challenges especially when moving in public places. 285 million people are estimated to be visually impaired worldwide out of which 39 million people are blind and 246 have low vision [1]. Smart shoes will help a blind person to mover on independently with help of ultrasonic sensor to detect obstacles. In this paper presents various smart shoes for blind technology using Internet Of Things.

2.1.7 Smart Shoe

[7] This paper discusses the development of a prototype called the ”Smart Shoe” designed to address the issue of improper gait patterns, particularly during activities like running, jumping, and climbing steps. The motivation for this development arises from the strain placed on the plantar areas and heels of the foot, which can worsen over time due to the impact of the foot on the ground. Traditional gait analysis systems are often bulky and expensive, leading to the proposal of a more accessible solution.

2.1.8 Design and Implementation of Smart Shoes for Blind and Visually Impaired People for More Secure Movements

[8] This paper addresses the numerous challenges faced by blind and visually impaired individuals in their daily mobility and navigation, leading to accidents and the risk of getting lost. The proposed solution involves the design, implementation, and validation of smart shoes intended to enhance the safety of blind and visually impaired people during their movements. The system is specifically developed to detect obstacles, wet floors, and instances of patients' falls. In the event of any of these incidents, the user is notified acoustically through voice alarms. Additionally, a compatible phone application has been designed to inform the patient's parents about any issues and share the user's location. The design phase incorporates safety measures, particularly in electrical safety, to minimize errors and false alarms while increasing overall accuracy. The system underwent testing with five subjects, revealing low faulty errors, high accuracy, and detection percentages, with an impressive accuracy rate reaching approximately 96%. The results suggest that the proposed smart shoes could significantly contribute to ensuring safer mobility and well-being for blind and visually impaired individuals.

2.1.9 Smart shoes: walking towards a better future

[9]This paper introduces a cutting-edge solution, namely "Smart Shoes," dedicated to addressing the intricate mobility challenges faced by individuals with visual impairments. The comprehensive exploration conducted within the study sheds light on the multifaceted limitations experienced by the visually challenged, whether navigating outdoor environments or indoor spaces, underscoring their reliance on external assistance for daily tasks. The Smart Shoes proposed in this research leverage state-of-the-art Internet of Things (IoT) technology, incorporating a sophisticated ensemble of sensors, microcontrollers, a buzzer, speaker, and vibration motor. The primary focus revolves around delivering real-time alerts to the wearer, offering crucial information about encountered obstacles and even identifying wet surfaces or water bodies. Additionally, the system is designed to communicate with caretakers through a Telegram bot, ensuring swift notification in case of a fall. The overarching objective of this technological innovation is to significantly enhance the security, safety, and independence of individuals with visual impairments. By providing a holistic and adaptive equipment solution, the Smart Shoes aim to improve the overall quality of life for this community, empowering them to navigate their surroundings with confidence and ease.

2.1.10 Blind guide - A virtual eye for guiding indoor and outdoor movement

[10] In this paper, a design of a wearable equipment that helps with the perception of the environment for blind and visually impaired people in indoor and outdoor mobility and navigation is presented. Our prototype can detect and identify traffic situations such as street crossings, traffic lamps, cars, cyclists, other people and low and high obstacles. The detection takes place in real time based on input data of sensors and optical cameras, the mobility of the user is aided with audio signals.

2.1.11 Smart Shoes For Visually People

This paper discusses the significance of eyesight in our lives and acknowledges it as a valuable gift. It emphasizes the challenges faced by individuals who have difficulty visualizing the world, impacting their ability to move freely in society. The main focus is on the development of wearable technology for the visually impaired, specifically an Internet of Things (IoT)-based smart shoe device. This device incorporates ultrasonic sensors and an ESP32 microcontroller to aid individuals with visual impairments. The text briefly introduces the core concept of the Internet of Things as a technology that enables communication between physical objects, highlighting its rapid expansion and development in various industries.

2.1.12 Design of microcontroller-based Virtual Eye for the Blind

This paper tells about the goal of empowering blind individuals to live more independently by leveraging advanced technologies. The main components of this innovative system include ultrasonic sensors and a camera strategically integrated into various elements such as shoes, a cane, and a cap. The ultrasonic sensors serve the crucial role of detecting obstacles in the person's path, promoting safe navigation. To enhance the system's capabilities, a camera is employed to differentiate between static elements like walls and dynamic features such as doors. By combining these technologies, the project aims to furnish blind individuals with real-time information about their surroundings, enabling them to comprehend and navigate through both stationary and moving obstacles. This endeavor not only showcases the potential of technology in improving the lives of visually impaired individuals but also underscores the significance of user-centric design and the seamless integration of sensory feedback for an effective and empowering solution.

Chapter 3

System Design

3.1 Proposed System

The proposed system of the Navigating Insole combines various technologies to create an effective and user-friendly navigation solution for visually impaired individuals. Anchored by the microcontroller, this innovative footwear seamlessly incorporates a GPS module to ascertain precise user coordinates, facilitating accurate real-time navigation guidance. The GPS module continuously receives signals from satellites, determining the user's geographical coordinates. The sensors track the user's movement and orientation, providing real-time data to the microcontroller.The strategic placement of vibration motors within the insole translates this data into tactile feedback, enabling users to discern directional cues. This holistic approach, combining GPS technology and vibration motors, culminates in a groundbreaking solution that empowers visually impaired individuals with enhanced mobility, independence, and confidence in navigating their surroundings.

3.2 Hardware Components

1.GPS Module: A Global Positioning System (GPS) module is a device that enables precise location tracking and navigation by receiving signals from a network of satellites in orbit around the Earth. The GPS system consists of a constellation of satellites that continuously broadcast signals containing information about their location and the current time. GPS modules, often integrated into various electronic devices such as smartphones, navigation systems, and IoT devices, receive these signals and use the information to calculate the user's position in terms of latitude, longitude, and altitude. The GPS module typically includes a receiver that processes the signals from multiple satellites, a processor to perform calculations, and an antenna to capture the signals. The module requires a clear line of sight to multiple satellites to ensure accurate positioning. Modern GPS modules can provide high-precision location data, often with accuracy within a few meters. GPS technology has become ubiquitous in various applications, ranging from navigation and mapping to tracking and geotagging. It plays a crucial role in enhancing the functionality of devices and services that rely on accurate location information. In the Navigating Insole system, the GPS module serves as a cornerstone for providing precise real-time navigation guidance to visually impaired individuals. Integrated into the insole, the GPS module communicates with a network of satellites, capturing signals that contain vital information about their orbits and current time. Through meticulous data processing, the module calculates the user's three-dimensional position, including latitude, longitude, and altitude. Utilizing the microcontroller as the central processing unit, the system translates the integrated data into specific vibration patterns through strategically placed motors within the insole, offering intuitive directional guidance. The integration of GPS technology into the Navigating Insole not only enhances the accuracy of guidance but also contributes to increased independence, mobility, and confidence for visually impaired individuals as they navigate their surroundings.

Figure 3.1: GPS module

2.Vibration motors: Vibration motors are electromechanical devices integral to numerous applications, known for their ability to generate controlled vibrations or oscillations. Widely employed for haptic feedback in consumer electronics like smartphones and gaming controllers, these motors enhance user experiences by simulating tactile sensations. Vibration motors can be controlled for amplitude, frequency, and duration of vibrations. Integration with microcontrollers allows programmable control, making them suitable for diverse applications where compact design, low power consumption, and customizable vibration patterns are essential, contributing significantly to the enhancement of user interfaces and the functionality of various electronic devices. In the context of the Navigating Insole for visually impaired individuals, vibration motors are a critical component designed to provide tactile feedback and guide users based on directional cues.

These motors are strategically embedded within the insole and play a central role in communicating navigation instructions to the wearer. The vibration motors used in this application are typically compact and lightweight, ensuring they seamlessly integrate into the structure of the insole without causing discomfort to the user. In the context of the Navigating Insole for visually impaired individuals, vibration motors are a critical component designed to provide tactile feedback and guide users based on directional cues. These motors are strategically embedded within the insole and play a central role in communicating navigation instructions to the wearer. The vibration motors used in this application are typically compact and lightweight, ensuring they seamlessly integrate into the structure of the insole without causing discomfort to the user. The vibrations produced by these motors serve as a non-intrusive means of conveying information about the user's navigation path. For instance, a vibration on the left side of the insole may indicate that the user should turn left, while a vibration on the right side signals a right turn. The intensity and duration of vibrations can be modulated to communicate additional details, such as the proximity of a destination or the presence of obstacles.

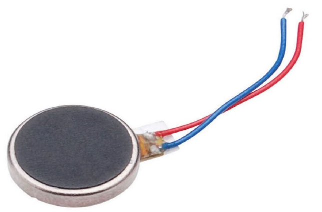

Figure 3.2: Vibration motor

3.Ultrasonic sensor: Ultrasonic sensors are devices that use ultrasonic waves for distance measurement, object detection, and navigation. Ultrasonic sensors emit short pulses of high-frequency sound waves (ultrasonic waves) and then measure the time it takes for these waves to bounce back after hitting an object. Ultrasonic sensors can be easily interfaced with microcontrollers such as Arduino or Raspberry Pi. Ultrasonic sensors are versatile and find extensive use in various industries due to their reliability, simplicity, and non-contact nature. They play a crucial role in enhancing automation, safety, and efficiency across a wide range of applications. In the Navigating Insole for visually impaired individuals, ultrasonic sensors can be employed as part of the obstacle detection system. These sensors enhance the safety features of the insole by detecting obstacles or objects in the user's path, providing alerts, and contributing to rerouting guidance to avoid potential collisions. Ultrasonic sensors are strategically placed on the sides or front of the insole to continuously emit ultrasonic waves. These waves travel outward and bounce back when they encounter an obstacle. The distance data from the ultrasonic sensors is integrated into the overall navigation system, which may also include information from GPS. When an obstacle is detected within a predefined range that may pose a collision risk, the system generates alerts. These alerts can be communicated to the user through variations in vibration patterns or other sensory feedback mechanisms. By integrating ultrasonic sensors into the Navigating Insole, the system becomes more adaptive and responsive to the user's environment. The combination of ultrasonic sensors with other technologies contributes to a comprehensive solution that not only guides visually impaired individuals towards their destination but also ensures a safer and obstacle-aware navigation experience.

Figure 3.3: Ultrasonic sensor

4.Arduino board: The core component of the Arduino ecosystem is the Arduino board, a small, programmable microcontroller board that serves as the brain of the projects. The board is equipped with input and output pins, allowing users to connect various sensors, actuators, and other components to interact with the physical world. Arduino boards are programmed using the Arduino IDE (Integrated Development Environment), which simplifies the coding process with a user-friendly interface. In Navigating Insole the Arduino board interacts with the GPS module. The GPS module continuously receives signals from satellites to determine the user's precise geographical coordinates. The Arduino processes this data, providing real-time information about the user's location. This step is crucial for accurate navigation guidance. The Arduino board interfaces with sensors that track the user's movement and orientation. These sensors feed real-time data to the microcontroller, allowing it to understand how the user is navigating their surroundings. This information is vital for providing accurate and context-aware guidance. The Arduino board then takes this processed information and controls the strategic placement of vibration motors with the insole. The Arduino board in this system acts as the central control unit, coordinating the communication between the GPS module, sensors, and vibration motors. Its role is to process data, make decisions based on that data, and provide output in the form of tactile feedback, ultimately creating a holistic and groundbreaking solution for enhanced mobility and independence for visually impaired individuals. The Arduino board then takes this processed information and controls the strategic placement of vibration motors within the insole.

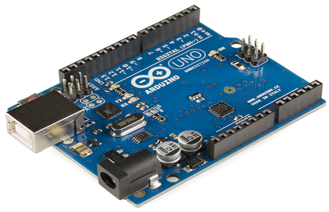

Figure 3.4: Arduino board

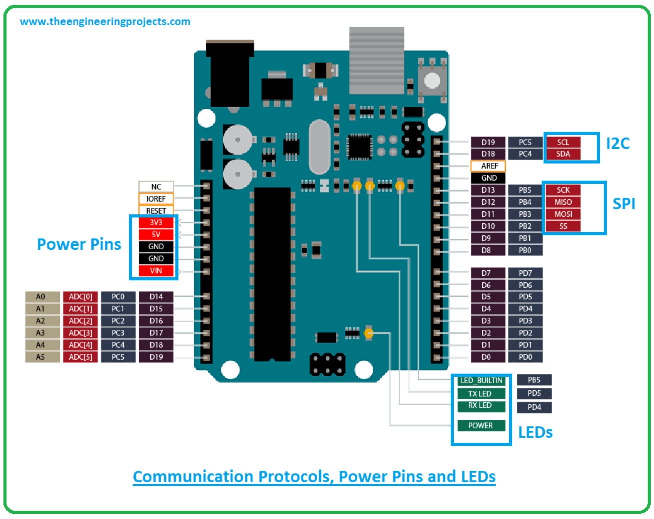

Figure 3.5: Arduino pinout

1. **Vin:**
This is the input voltage pin of the Arduino board used to provide input supply from an external power source.
2. **5V:**
This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.
3. **3.3V:**
This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board.

4. **GND:**
This pin of the board is used to ground the Arduino board.

5. **Reset:**
This pin of the board is used to reset the microcontroller. It is used to Resets the microcontroller.

6. **Analog Pins:**
The pins A0 to A5 are used as an analog input and it is in the range of 0-5V.

7. **Digital Pins:**
The pins 0 to 13 are used as a digital input or output for the Arduino board.

8. **Serial Pins:**
These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data resp.

9. **External Interrupt Pins:**
This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.

10. **PWM Pins:**
This pins of the board is used to convert the digital signal into an analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pin.

11. **SPI Pins:**
This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library.

SPI pins include:

SS: Pin number 10 is used as a Slave Select

MOSI: Pin number 11 is used as a Master Out Slave In

MISO: Pin number 12 is used as a Master In Slave Out

SCK: Pin number 13 is used as a Serial Clock

LED Pin: The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

12. **AREF Pin:**
This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

3.3 Software Component

1.Arduino IDE: Arduino IDE (Integrated Development Environment): The Arduino IDE is essential for programming the Arduino board. It provides a user-friendly interface for writing, uploading, and managing the code that runs on the microcontroller. It is used to develop the firmware that controls the interaction between the GPS module, sensors, and vibration motors. In the context of the Navigating Insole, we can utilize the Arduino IDE to craft the firmware, the set of instructions that govern the behavior of the microcontroller. This firmware is crucial in orchestrating the seamless interaction between the GPS module, movement and orientation sensors, and vibration motors. The IDE's functionality extends beyond code development, encompassing features for debugging, monitoring, and configuring the Arduino board. Ultimately, the Arduino IDE plays a central role in the creation of a cohesive software foundation that enables the integration of various hardware components, facilitating the realization of an effective and user-friendly navigation solution for visually impaired individuals.

3.4 Libraries

1.TinyGPS++: The TinyGPS++ library is designed to simplify the parsing of NMEA GPS data and provide a convenient interface for extracting relevant information. In the context of the Navigating Insole, the TinyGPS++ library could be used to interface with the GPS module and extract precise location data.TinyGPS++ offers a user-friendly interface that significantly simplifies the extraction of pertinent information. By incorporating TinyGPS++, the development process is expedited, and the code becomes more readable and manageable. The library's intuitive functions allow developers to effortlessly access data such as latitude, longitude, altitude, and more, enabling seamless integration of accurate location information into the broader navigation algorithm. Overall, the TinyGPS++ library acts as a powerful facilitator, enhancing the efficiency of the Navigating Insole by offering a robust solution for parsing and utilizing GPS data.

2.SoftwareSerial: In the Navigating Insole, the SoftwareSerial library is a key component facilitating communication between the Arduino microcontroller and the GPS module. Given that the primary hardware serial ports on the Arduino may be occupied by other peripherals or communication protocols, SoftwareSerial allows the creation of an additional software-based serial communication channel.

This proves crucial when integrating a GPS module, which typically communicates using serial protocols. The library enables developers to define a virtual serial port with specified receive (RX) and transmit (TX) pins, providing flexibility in choosing digital pins for communication. By initializing and configuring SoftwareSerial in the Arduino sketch, the microcontroller gains the ability to receive and transmit data to and from the GPS module. This ensures a seamless flow of NMEA GPS data from the module to the microcontroller, facilitating its subsequent processing using libraries like TinyGPS++. Through this implementation, SoftwareSerial significantly enhances the versatility of the Navigating Insole project, allowing for effective communication with the GPS module while preserving the integrity of other hardware communication channels.

Chapter 4

Methodology

4.1 Architecture

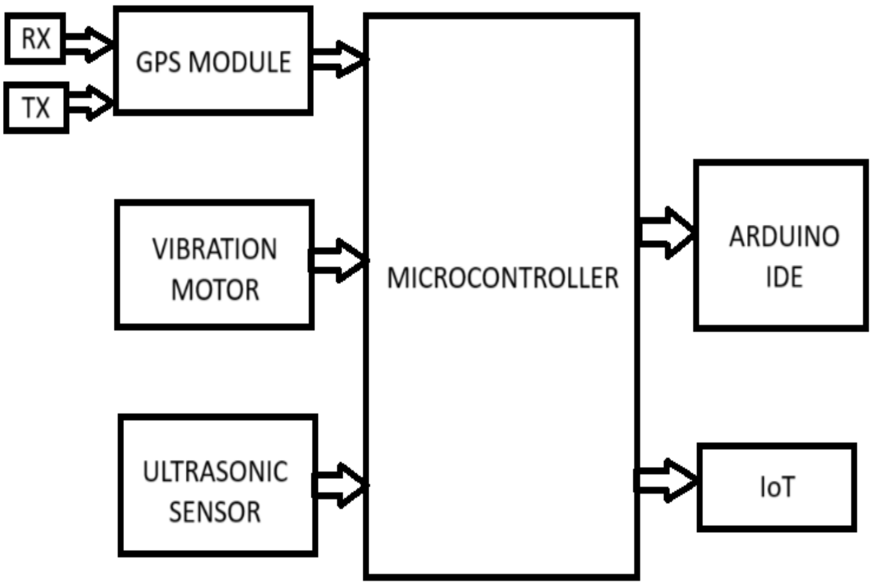

Figure 4.1: Architecture

The architecture of the Navigating Insole reflects a holistic approach, combining hardware and software components to create an effective and user-friendly solution for enhancing mobility, independence, and confidence for visually impaired individuals in navigating their surroundings.

4.2 Modules

1.GPS module The GPS module is a critical component that provides precise geographical coordinates based on signals received from satellites. It continuously communicates with multiple satellites to determine the user's location, including latitude, longitude, and altitude. Enhancing the functionality and effectiveness of the device. Provides accurate real-time navigation guidance by taking longitude and latitude of the user's destination. The GPS module is connected to the Arduino microcontroller, serving as a source of real-time location data. The module's communication protocol, often based on the NMEA (National Marine Electronics Association) standard, is parsed and processed by the Arduino firmware, leveraging libraries such as TinyGPS++ to extract relevant information. The GPS module forms the foundational component for the Navigating Insole, offering accurate location data that serves as the basis for navigation guidance. It enables the system to understand the user's position within their environment and plan routes accordingly.

2.Object Detection: The object detection module is responsible for identifying obstacles or hazards in the user's path. This module typically employs sensors, such as ultrasonic or infrared sensors, to detect the presence and proximity of objects. The object detection sensors are connected to the Arduino microcontroller. When an obstacle is detected, the sensors relay this information to the microcontroller, triggering appropriate responses in the navigation algorithm. The object detection module enhances user safety by identifying potential obstacles in the environment. When an obstacle is detected, the navigation algorithm can adapt, providing the user with additional cues or altering the recommended path to avoid collisions.

3.Navigation through Vibration: The navigation through vibration module translates processed data into tactile feedback through strategically placed vibration motors within the insole. The intensity, pattern, and duration of vibrations convey directional cues to guide the user. The vibration motors are controlled by the Arduino microcontroller, which processes inputs from the GPS module, object detection sensors, and potentially other sources. The navigation algorithm determines the appropriate vibration patterns based on the user's location, desired direction, and potential obstacles. This module is crucial for providing real-time feedback to the user, enabling them to navigate their surroundings confidently. The tactile cues through vibrations serve as an intuitive and non-intrusive means of communication, allowing users to understand their environment without relying on visual or auditory cues.

Chapter 5

Implemention

5.1 Power Supply

The power supply in the navigating insole project is pivotal for reliable module operation, notably the GPS module. Specific connections include grounding to ensure a shared reference, drawing 5V from the Arduino for stability, and establishing communication links between the GPS module and Arduino pins. A stable power source is crucial for precise navigation, preventing data loss, and facilitating seamless module synchronization, ensuring accurate wayfinding. This meticulous power supply design contributes to overall system reliability and effective integration, minimizing the risk of malfunctions.

5.2 Global Positioning System

The GPS module is a key component for precise wayfinding. It receives signals from satellites to determine the user's exact location, enhancing navigation accuracy. Connected to the Arduino, the module's Rx and Tx pins facilitate communication, while a stable 5V power supply ensures consistent operation. The GPS module plays a crucial role in preventing data loss during communication and synchronizing with other modules. Its reliability and ability to process satellite signals contribute significantly to the overall effectiveness of the navigation system.

5.3 Vibration Motors

Vibration motors contribute to tactile feedback, offering users a tangible sense of direction. Situated within the insole, these motors generate vibrations based on sensor input, aiding in user guidance. Managed by the Arduino, they play a pivotal part in conveying directional cues, enhancing the overall effectiveness of the insole's navigation system. Activation and modulation of vibrations provide users with an intuitive wayfinding experience, making these motors integral to the project's success.

5.4 Ultrasonic Sensor

Ultrasonic sensors in the navigating insole project play a crucial role in object detection, enhancing user safety. These sensors emit ultrasonic waves and measure their reflection to identify obstacles in the user's path. Integrated into the insole, they provide real-time data on the surroundings. Connected to the Arduino, ultrasonic sensors contribute to the project's objective of obstacle detection by triggering alerts when obstacles are detected. Their ability to sense distances ensures users navigate safely, making them essential for creating a comprehensive and reliable navigation system.

Chapter 6

Results and Discussions

6.1 Code

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>

// RX, TX
SoftwareSerial SerialGPS(4, 3);

TinyGPSPlus gps;

// Connect to any digital pin for left vibration motor
const int leftVibrationPin = 2;
// Connect to any digital pin for right vibration motor
const int rightVibrationPin = 8;
// Connect to the trig pin of the ultrasonic sensor
const int trigPin = 6;
// Connect to the echo pin of the ultrasonic sensor
const int echoPin = 7;

// Initialize with default values
double targetLat = 0.0;
double targetLng = 0.0;

void setup() {
  Serial.begin(9600);
  SerialGPS.begin(9600);
```

```
  pinMode(leftVibrationPin, OUTPUT);
  pinMode(rightVibrationPin, OUTPUT);

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  // Prompt the user to enter target coordinates
  Serial.println("Enter target latitude:");
  while (!Serial.available()) {
    // Wait for user input
  }
  targetLat = Serial.parseFloat();

  Serial.println("Enter target longitude:");
  while (!Serial.available()) {
    // Wait for user input
  }
  targetLng = Serial.parseFloat();

  // Display entered coordinates
  Serial.print("Target Coordinates: ");
  Serial.print("Latitude: ");
  Serial.print(targetLat, 6);
  Serial.print(", Longitude: ");
  Serial.println(targetLng, 6);
}
// Function to measure distance using the ultrasonic sensor
double getDistance() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  return pulseIn(echoPin, HIGH) * 0.034 / 2;
}


void loop() {
  while (SerialGPS.available() > 0) {
    if (gps.encode(SerialGPS.read())) {
      // Check if GPS fix is valid
```

```
      if (gps.location.isValid()) {
        // Get current latitude and longitude
        double latitude = gps.location.lat();
        double longitude = gps.location.lng();

        // Calculate the difference in coordinates
        double latDiff = targetLat - latitude;
        double lngDiff = targetLng - longitude;

        // Measure the distance using the ultrasonic sensor
        double distance = getDistance();

        // Adjust the vibration motors based on the differences
        // and obstacle detection
        if (lngDiff > 0.001 && distance > 10) {
          // Move right, activate right vibration motor
          digitalWrite(leftVibrationPin, LOW);
          digitalWrite(rightVibrationPin, HIGH);
          Serial.println("Move right");
        } else if (lngDiff < -0.001 && distance > 10) {
          // Move left, activate left vibration motor
          digitalWrite(leftVibrationPin, HIGH);
          digitalWrite(rightVibrationPin, LOW);
          Serial.println("Move left");
        } else if (distance <= 10) {  1
          // Obstacle detected, vibrate both motors
          digitalWrite(leftVibrationPin, HIGH);
          digitalWrite(rightVibrationPin, HIGH);
          Serial.println("Obstacle detected");
        } else {
          // No movement,stop both vibration motors
          digitalWrite(leftVibrationPin, LOW);
          digitalWrite(rightVibrationPin, LOW);
          Serial.println("NO movement");
        }
      }
    }
  }
}
```

6.2 Experimental Results

Figure 6.1: Navigating insole

Figure 6.2: Navigating insole with vibration motors

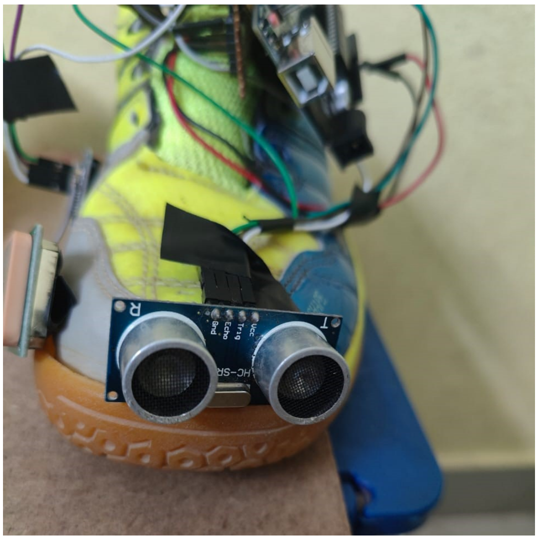

Figure 6.3: Ultrasonic sensor

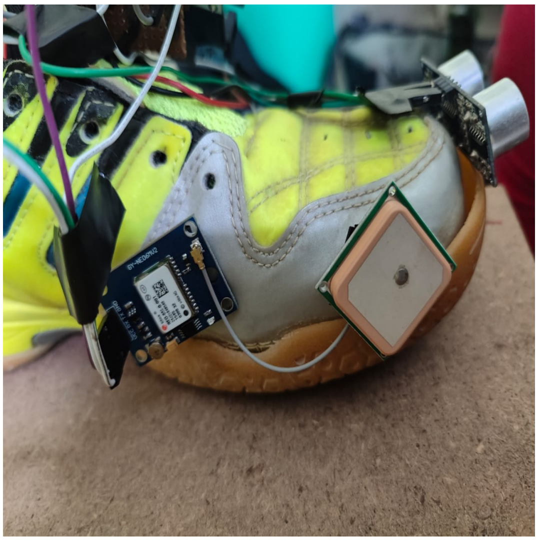

Figure 6.4: gps module

Figure 6.5: Right shoe

Figure 6.6: Left shoe

Figure 6.7: User wearing Navigating insole

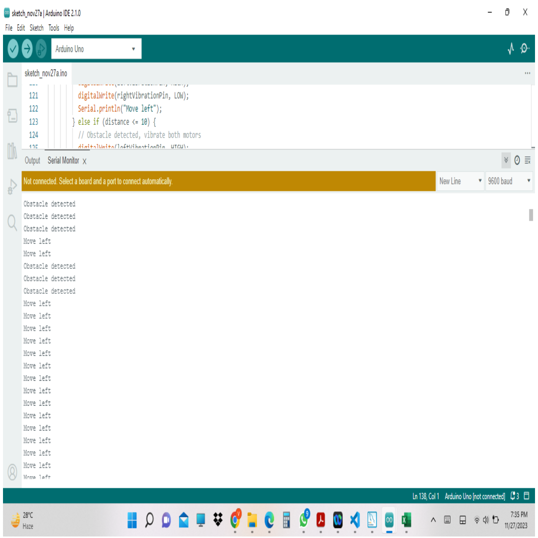

Figure 6.8: Direction indication and obstacle detection

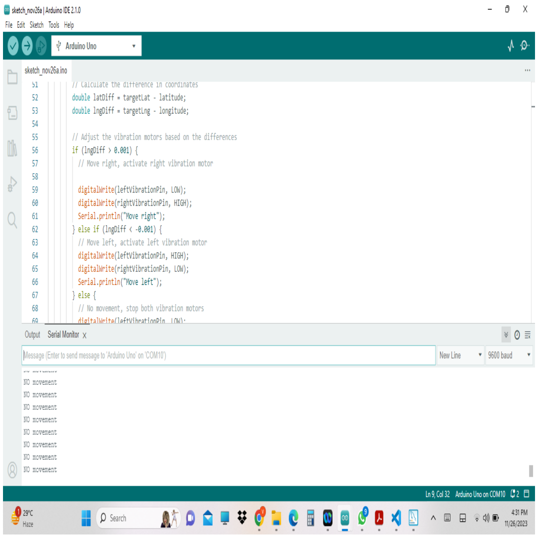

Figure 6.9: No Movement if source and destination are equal

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Chapter 7

Conclusions and future works

7.1 Conclusion

In conclusion, the proposed IoT-based navigation system represents a breakthrough in addressing the limitations of existing solutions by offering a discreet and intuitive method for individuals to navigate towards a fixed destination. By integrating smart technology seamlessly into everyday clothing, particularly in the form of smart shoes, the system taps into sensors and GPS technology to track the user's movements and orientation. The fusion of data from these sensors enables the system to accurately calculate the user's position, allowing for real-time directional guidance through vibrations corresponding to left or right movements. This wearable navigation system not only enhances mobility and independence but also eliminates the reliance on visual cues or obstacle detection, making it particularly beneficial for individuals with visual impairments or those who find traditional navigation methods disruptive. The unobtrusive nature of the technology, woven into everyday attire, ensures that users can navigate their surroundings with confidence while maintaining a sense of normalcy.As the system prioritizes user experience and convenience, continual refinement based on user feedback and advancements in sensor and GPS technologies will be crucial. Ultimately, this IoT-based navigation solution holds the promise of significantly improving the daily lives of individuals by providing a seamless, non-intrusive, and effective means of reaching their destinations.

7.2 Future Works

Integration with Google Maps API: Incorporating the Google Maps API or other mapping services to enhance the navigation capabilities. This would allow users to input destination addresses directly, receive turn-by-turn directions, and potentially receive real-time updates on the route.

Water and Rain Protection: Integrating water-resistant or waterproof materials into the design of the insole to protect it from rain or water exposure. This could involve using waterproof coatings, sealants, or even designing the insole with water-resistant components.

More Accurate Sensors: Research and implement more advanced and accurate sensors for better environmental perception. This could include high accurate gp modules for navigation, more precise ultrasonic sensors, or even incorporating additional sensor types such as lidar or infrared sensors for improved obstacle detection.

Adjustability to Any Shoe: Designing the navigating insole to be adjustable and adaptable to various shoe sizes and styles. This would involve creating a modular or customizable design that can be easily fitted into different types of footwear, making it more accessible to a broader range of users.

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