EASYWALK - SMART CANE FOR VISUALLY IMPAIRED

A PROJECT REPORT

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We **ARCHANA G (211420104022), ANUDHARSHNI M P (211420104020) & BRINDHA C S (211420104044)** hereby declare that this project report titled "**EASYWALK – SMART CANE FOR VISUALLY IMPAIRED**", under the guidance of "**Dr .K. SANGEETHA M.E., Ph.D.,** " the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

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ABSTRACT

In the contemporary world, the prevalence of visual impairment has reached alarming proportions. According to the World Health Organization (WHO), the global estimate stands at a staggering 2.2 billion individuals afflicted with vision impairment, and regrettably, the availability of constant assistance remains an elusive prospect. Simple activities such as crossing a street or moving around unfamiliar places can be daunting. In order to assist those who are blind or visually impaired in their daily lives without the assistance of others, the smart stick has been offered as a solution. The Smart Stick is a cutting-edge assistive device designed to enhance the mobility and safety of visually impaired individuals. Equipped with advanced sensors, the Smart Stick employs a multifaceted approach to alert users of potential obstacles, holes, and water bodies in their path. When the user clicks the emergency button it sends an SOS alert message to emergency registered contact with live location tracking. This initiative transcends the realm of technology; it embodies a lifeline to independence and security.

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LIST OF ABBREVIATIONS

IoT	-	Internet of Things
DL	-	Deep Learning
NLP	-	Natural Language Processing
OCR	-	Optical Character Recognition
DC	-	Direct Current
LDR	-	Light Dependent Resistor
IR	-	Infrared
ANN	-	Artificial Neural Network
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communications
SDLC	-	Software Development Life Cycle
IDE	-	Integrated Development Environment
MQTT	-	Message Queuing Telemetry Transport
AI	-	Artificial Intelligence
LiDAR	-	Light Detection and Ranging
WHO	-	World Health Organization

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CHAPTER 1

CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

- Traditional white canes, while valuable tools for the visually impaired, exhibit inherent inefficiencies that compromise effective navigation.
- The current smart cane design faces challenges due to the integration of multiple sensors, leading to increased complexity, power consumption, and limitations in obstacle detection.
- They cannot warn users of impending dangers or provide insights into changes in terrain, making navigation more challenging and potentially risky.
- It lacks features to distinguish obstacles, detect water bodies, and accommodates blind and handicapped individuals. The absence of an emergency button and rain sensor also compromises safety.

1.2 IoT AND MOBILE APPLICATION IN HEALTHCARE

The integration of the Internet of Things (IoT) into healthcare has revolutionized the way patient care is delivered and managed. IoT technology, with its extensive network of interconnected devices and sensors, has brought about transformative changes in healthcare, spanning prevention, diagnosis, treatment, and post-treatment care.

At its core, IoT in healthcare revolves around seamless data collection and exchange. Wearable fitness trackers and medical devices continuously gather real-time health information, including vital signs, medication adherence, activity levels, sleep patterns, and more. This constant flow of data empowers both patients and healthcare providers with unprecedented insights into individual health, enabling early detection of issues, timely interventions, and personalized care plans.

A significant advantage of IoT in healthcare is its facilitation of remote monitoring and telehealth services. Patients can be monitored from their homes, reducing the need for frequent in-person visits. Telehealth appointments, powered by IoT, enable virtual consultations with healthcare professionals, ensuring medical expertise is easily accessible.

Telemedicine applications have emerged as pioneers in this digital transformation, facilitating remote consultations between patients and healthcare providers. Through video calls, chat functionalities, and secure file sharing, these apps break down geographical barriers, enabling individuals to seek medical advice without the constraints of physical proximity. This not only ensures more accessible healthcare but also plays a crucial role in managing emergencies, where timely communication can be a matter of life and death.

Health and wellness applications have found a place in the daily lives of users, providing tools for fitness tracking, nutrition planning, and integration with wearable devices. These apps empower individuals to take charge of their well-being, promoting healthier lifestyles through personalized insights and recommendations. The seamless integration with wearables not only enhances the accuracy of health data but also fosters a continuous and real-time monitoring approach, allowing for early detection of potential health issues.

Emergency response applications leverage mobile technology to enhance the efficiency of emergency services. Through location-based services and SOS features, these apps ensure swift responses to critical situations, potentially saving lives. The integration of such applications with wearables adds an extra layer of security, providing automatic alerts in case of emergencies. The healthcare industry has witnessed enormous transformation due to technological advancement and interference. In the past few years, we can clearly see the role mobile app development has played in the transformation of the healthcare sector. The Covid-19 pandemic is not over yet and the healthcare mobile apps have paved their way towards tremendous growth during such a crisis, changing the perception of the health industry amongst people globally.

In conclusion, IoT and mobile applications have become integral to modern healthcare, offering advantages spanning preventive care, diagnostics, treatment, and patient empowerment. As technology continues to advance, the potential for further innovation in healthcare applications remains vast. By prioritizing security, user-friendly interfaces, and interoperability with existing healthcare systems, these applications are poised to continue shaping the future of healthcare, making it more accessible, efficient, and patient-centric.

1.3 OVERVIEW OF EXISTING SYSTEM

Traditional canes, often known as white canes, are indispensable tools that have long been utilized by individuals with visual impairments for navigation. However, their inherent inefficiencies are becoming increasingly apparent as technology advances. These canes, available in three primary types: the long cane, which aids in obstacle detection; the support cane, providing additional stability; and the identification cane, serving as a visible signal to others of the user's visual impairment, rely solely on tactile feedback, which can be limited in conveying information about the environment. Users must sweep these canes in front of them while walking, and any obstacles encountered are detected through tactile feedback, often in the form of vibrations or resistance.

While traditional canes have played a crucial role in enhancing the physical safety of individuals with visual impairments, they lack the ability to provide comprehensive information about the environment, making them less efficient compared to modern technological solutions, such as smart blind sticks, that offer real-time environmental data and connectivity options for a more inclusive and advanced navigation experience.

Blind sticks that incorporate cameras relying on visual information have demonstrated significant advancements in aiding individuals with visual impairments in navigation. However, their effectiveness may encounter limitations in low-light conditions or complete darkness, presenting challenges for users navigating environments with inadequate lighting. In such scenarios, the reliance on visual information becomes less reliable, potentially impacting the overall utility of the smart cane in providing real-time assistance.

- Conventional white canes lack the ability to detect chest or head-height obstacles, potentially endangering users in areas with low-hanging obstacles. It provides comprehensive obstacle detection and ensure safer navigation for individuals with visual impairments.
- Traditional canes lack reach and sensitivity to detect smaller indoor obstacles like chair legs or cords. Maneuvering in cluttered spaces and identifying overhead hazards is challenging. They provide little assistance in detecting changes in elevation like stairs.
- The range of detection for traditional canes is confined to the cane's physical reach, limiting users' ability to anticipate obstacles beyond their immediate vicinity.
- Real-time image processing, a key component of smart canes with cameras, can be computationally intensive, leading to potential delays in providing feedback to users. This may affect the responsiveness of the smart cane and

impact the user's experience.

- Conventional white canes demand significant physical effort and continuous manual operation, which can be fatiguing and less suitable for individuals with varying physical abilities.

- Blind sticks with cameras relying on visual information may face challenges in low-light conditions or complete darkness, impacting their effectiveness for users navigating environments with inadequate lighting.

- Traditional canes do not provide detailed information about hole or pit, making it challenging for users to navigate such features independently and safely.

1.4 OVERVIEW OF PROPOSED SYSTEM

The innovative Smart Stick represents a significant leap forward in assisting individuals with visual impairments by addressing the limitations of traditional white canes. It harnesses cutting-edge technology to provide real-time environmental feedback, advanced obstacle detection, and enhanced navigation support.

Equipped with an array of sensors, including ultrasonic and Raindrop sensors, the Smart Stick continuously scans the surroundings, identifying obstacles, drop-offs, and objects in the user's path. The Smart Stick incorporates a suite of sensors that extends its utility far beyond the capabilities of conventional canes.

These sensors facilitate obstacle detection and water detection capabilities, empower users to navigate their surroundings with greater confidence. It uses advanced wireless communication technologies, prominently featuring precise location tracking and seamless connectivity to a companion mobile application on the user’s smartphone.

The Smart Stick ensures accurate geolocation data and real-time guidance. Additionally, it incorporates a fluorescent covering for increased efficiency, enabling safe navigation even in low-light or dark conditions, altogether making it a transformative and indispensable tool for visually impaired individuals.

- **Enhanced Safety**: Smart blind sticks utilize advanced sensors to detect obstacles and hazards in real-time, providing users with immediate feedback for safer navigation.

- **Portability:** These sticks are lightweight and designed for easy portability, allowing users to carry them conveniently. This portability enables users to take their sticks wherever they go, promoting independence and confidence in navigating various environments.

- **Affordability:** Smart blind sticks aim to be cost-effective, ensuring accessibility for a broad user base.

- **Improved Independence**: Users gain greater independence in mobility and daily activities with the assistance of smart blind sticks.

- **Location Sharing:** These sticks offer location-sharing capabilities during emergencies, ensuring timely assistance from caregivers or emergency services.

- **Real-Time Feedback**: Users receive real-time information about their surroundings, enabling informed decision-making and reducing accidents.

- **Integration with Mobile Devices**: Smart blind sticks seamlessly connect to mobile devices, enhancing their functionality and connectivity.

- **Enhanced User Experience:** Incorporating tactile feedback, such as vibrations or texture changes, provides immediate and intuitive alerts to users. Audible alerts further enhance awareness by providing auditory cues about nearby obstacles or hazards.

CHAPTER 2

CHAPTER 2

LITERATURE REVIEW

1. **Title:** Design of Smart Cane with integrated camera module for visually impaired people

   Author: Lavanya Narayani. T et al.

   Year:2021

   It presents a smart cane designed to assist visually impaired people in unfamiliar environments. The cane uses two ultrasonic sensors to measure distance between stationary and hanging objects, providing alert signals when obstacles fall within a 2 meters threshold. The design also includes a camera module ESP-32 to capture moving objects' images and obstacle detection. The module receives an enable signal from the PIR sensor, saving processor time. It also provides information about the situation around the blind person and their relatives in case of an emergency. The paper also provides the implementation cost and power requirement for the smart cane.

2. **Title:** An Efficient Smart Cane Based Navigation System for Visually Impaired People

   Author: Akhlaqur Rahman et al.

   Year:2019

   It proposes a smart system for blind people to avoid obstacles or holes in their path. The system calculates the distance between the device and terrain, determining if the path is flat or has obstacles. The user is informed through vibration while holding the cane. The prototype uses a laser light, camera, and personal computer for computation. A tentative design for the cane that stays vertical is also provided.

3. **Title:** An Ultrasonic Sensor-based blind stick analysis with instant accident alert for Blind People
   Author: Chandu Ramisetti et al.
   Year:2022

   The project aims to create a smart stick for blind people who cannot move without a stick. The stick can sense obstacles, make buzzer sounds, and beep with different intensities to alert them. Ultrasonic sensors can be used to detect various obstacles, such as pits, walls, drainages, vehicles, and people. If the stick is forgotten, the user can communicate with it via a mobile app, which responds with voice output. If the stick is involved in an accident, a vibrating sensor with a specific intensity can be connected, sending messages to relatives via GPS and GSM connected to the Arduino board.

4. **Title:** Assistive Stick for Visually Impaired People
   Author: Danish Asad Khan et al.
   Year:2022

   It proposes a smart solution using deep learning (DL), natural language processing (NLP), and IoT technologies to assist them without human intervention. A smart stick is developed using a Raspberry Pi, an ultrasonic sensor, and a camera. The stick can detect obstacles within 1.5 meters and generate audio warning messages. It can also capture images from its surroundings and read text from them. The text is detected using the EAST text detector and recognized using an OCR Engine tesseract. The text is converted into audio, allowing the person to hear about their surroundings. All calculations and processing are done on the Raspberry Pi, and the generated audio can be heard using an earphone or headphone. The proposed solution is successfully implemented and demonstrated, finding it to be efficient and cost-effective.

5. **Title:** Smart Stick for the Blind and Visually Impaired People
   Author: Mukesh Prasad Agrawal et al.
   Year:2018

   Blindness is a significant issue that affects individuals' lives, causing them to miss the visual beauty of the world. They face numerous difficulties in daily tasks, such as transport, and often require human assistance to navigate. However, when no assistance is provided, blind people's dependencies can deteriorate their confidence. Traditionally, they used cane sticks to guide themselves, which caused accidents and danger. In a technologically driven era, a solution called the "Smart Stick" has been developed to help these differently abled people. The device uses sensors to detect obstacles in the path, identifying them with various sensors. A microcontroller retrieves data and transmits it as vibrations, notifying the user about obstacles on the way. This efficient device is expected to be a significant benefit for blind people. The "Smart Stick" is a technologically driven solution that aims to help these differently abled individuals navigate their environment safely and effectively.

6. **Title:** Smart blind stick
   Author: Prashik Chavan et al.
   Year:2022

   It proposes a smart blind stick that can assist blind people in walking safely and understanding their environment. The stick consists of a stick with components and sensors mounted over it, working in two cases: detecting obstacles with an ultrasonic sensor in front and rotating the sensor through an angle to detect obstacles in crowded places. The switch button allows the blind person to switch between cases, and the stick can detect all obstacles in its range. It also identifies the appropriate environments to use, allowing the blind person to walk confidently and overcome their fear while walking.

7. **Title:** Smart Blind Stick for Visually Impaired People using IoT

   Author: Rajanish Kumar Kaushal et al.

   Year:2022

   The current assistive device for the visually impaired, a stick, is insufficient for their independence. Traveling is a significant challenge for them, and traffic conditions make daily journeys more difficult. To address this, a new method employs the Internet of Things (IoT) paradigm to connect the visually handicapped with their surroundings. An ultrasonic sensor scans the environment for obstacles, while an ESP32 camera collects traffic signal images. An Artificial Neural Network (ANN) model detects traffic signals. A speaker is permanently attached to the controller, alerting the user about obstacles and traffic signals. The system confirms if the person is in the nearer area and sends a text message to the registered mobile number if they are navigating long distances. The smart blind stick is both simple to use and cost-effective due to the integration of various sensors and modules with IoT.

8. **Title:** Computer Vision and Iot Based Smart System for Visually Impaired People

   Author: Sneha Rao et al.

   Year:2021

   Visually impaired individuals often face navigation challenges, often using walking sticks. However, these sticks have limitations. A more suitable method alerts users about obstacles and guides them to their location. This paper proposes an assistance system based on a shoe that uses IoT devices, sensors, and computer vision algorithms for obstacle detection, avoidance, and navigation. The system uses smartphone-based voice assistance and haptic feedback calculated using sensors and actuators. This innovative approach offers a more suitable and efficient solution for visually impaired individuals.

9. **Title:** Smart blind helping stick using Iot and android
   Author: Srishti Agrawal et al.
   Year:2020

   It aims to develop a Smart Blind Helping Stick based on IoT technology, using an Arduino board module and an Android application. The stick detects obstacles in walking routes and assists blind individuals in making decisions to avoid accidents. The system uses ultrasonic, moisture detection sensors, Bluetooth, DC Buzzer, LDR sensor, and IR proximity sensors to detect obstacles in specific directions. The moisture sensor detects water on the surface, while the LDR sensor detects light or dark areas. The Android application connects to the Arduino via Bluetooth module, and a DC buzzer is connected for failure conditions. The aim is to help blind and visually impaired individuals navigate their surroundings more easily.

10. **Title:** IoT based Smart Stick with Automated Obstacle Detector for Blind People
    Author: Vyash Natarajan et al.
    Year:2022

    The world is increasingly embracing new technologies and inventions to enhance productivity and power. It proposes an automated model for the blind stick, utilizing the Internet of Things (IoT) concept to create a safe environment for the blind population. The model integrates sensors and an Arduino UNO processor, demonstrating the dedication of this generation to contributing to society through technology. The Arduino UNO processor processes this data in real-time, allowing for quick and accurate navigation adjustments. Additionally, the IoT connectivity enables remote monitoring and updates, ensuring the device remains up-to-date with the latest advancements and safety features. This groundbreaking approach not only enhances safety but also empowers individuals.

CHAPTER 3

CHAPTER 3

THEORETICAL BACKGROUND

3.1 IMPLEMENTATION ENVIRONMENT

The system requirements are specified to bring up the project with clear view and to have the proper flow of SDLC (Software Development Life Cycle)

HARDWARE REQUIREMENTS

- Ultrasonic sensor
- Buzzer
- Raindrop sensor
- Fluorescent tape
- Wires
- Capacitor
- Battery
- Diode
- Regulator
- GPS Neo
- Push Button
- Breadboard

SOFTWARE REQUIREMENTS

- Arduino IDE
- Embedded C
- MQTT server
- Android smart phone
- ReactJS

3.2 SYSTEM REQUIREMENT SPECIFICATION

3.2.1 ULTRASONIC SENSOR

Ultrasonic sensors have become indispensable in the realm of modern technology due to their versatility and precision. These devices are capable of emitting high-frequency sound waves and capturing their reflections, enabling them to not only measure distances accurately but also to identify objects.

The core components of an ultrasonic sensor, typically consisting of a transmitter and a receiver, work harmoniously to emit ultrasonic waves into the environment. These waves then interact with objects in their path, bouncing back towards the sensor. By meticulously measuring the time it takes for these waves to return, the sensor can swiftly and accurately calculate the distance to the object.

The applications of ultrasonic sensors are vast and diverse, spanning across fields such as robotics, industrial automation, automotive technology, and even healthcare. Their non-contact operation and remarkable distance-measuring capabilities, ranging from centimeters to several meters, make them invaluable tools in enhancing safety, efficiency, and precision across various technologies and industries.

Ultrasonic sensors represent a pivotal intersection of science and technology, contributing significantly to the advancement of various domains by offering precise distance measurements and object identification through the ingenious utilization of sound waves.

The distance calculation formula,

Distance = (Speed of Sound × Time) / 2utilized by ultrasonic sensors is a fundamental principle in their operation. This formula provides a straightforward yet highly effective method for determining the distance to objects or obstacles in their vicinity. Here's a more detailed breakdown:

1. Distance: This is the parameter the sensor aims to measure. It represents the spatial separation between the sensor itself and the object under scrutiny. In practical applications, this distance is crucial information, as it allows systems to make informed decisions about how to interact with the object or whether to avoid it.

2. Speed of Sound: The speed at which sound waves propagate through the medium in which the sensor operates. In most cases, ultrasonic sensors function in air, where the speed of sound is approximately 343 meters per second at room temperature. This value is pivotal to the accuracy of the distance calculation since the sensor relies on it to gauge the time taken for sound to travel to the object and back.

3. Time: This parameter represents the duration it takes for the ultrasonic sound wave to travel from the sensor, reach the object, and return to the sensor. The sensor precisely measures this time interval, which is essential for calculating the distance.

4. Division by 2: The division by 2 in the formula accounts for the fact that the sound wave travels to the object and then returns to the sensor. To determine the one-way distance, you need to halve the total time taken.

In practical terms, when an ultrasonic sensor emits a high-frequency sound wave, it records the time it takes for this wave to bounce off an object and return to the sensor. By applying this time measurement to the formula, the sensor calculates the distance to the object with impressive precision. This fundamental principle enables ultrasonic sensors to be widely used in various applications, such as obstacle detection and avoidance in robotics and automated systems.

In essence, ultrasonic sensors transform the physics of sound wave propagation into a powerful tool for measuring distances and detecting objects, making them essential components in numerous technological advancements across industries.

Figure 3.2.1 Ultrasonic sensor

3.2.2 MOISTURE SENSOR

A raindrop sensor, also known as a rain sensor or rain detector, plays a crucial role in various applications, particularly in the field of weather monitoring and control. These sensors are designed to detect and respond to the presence of rain or water droplets on a surface. Here's a more detailed explanation of their components and how they work:

Sensing Surface: The top surface of a raindrop sensor is equipped with conductive traces or electrodes. These traces are highly sensitive to water droplets and can quickly detect when water makes contact with them. The sensing surface is usually made from materials that promote good electrical conductivity and durability.

Control Circuitry: Within the raindrop sensor, there is specialized control circuitry responsible for processing the signals received from the sensing surface. When rain or water droplets bridge the conductive traces on the sensor's surface, it triggers a noticeable change in electrical conductivity. The control circuitry is designed to recognize this change.

Output Interface: Raindrop sensors typically come with output interfaces that facilitate communication with external devices such as microcontrollers, weather monitoring systems, or even irrigation controllers.

These output interfaces can include digital or analog pins, which provide a signal or data indicating the presence and intensity of rainfall. When rain or water droplets fall on the sensor's sensing surface, they create a conductive path between the electrodes. This path alters the electrical properties of the sensor, either by changing its resistance or capacitance, depending on the sensor's design. The control circuitry promptly detects this alteration and generates an output signal, which can be further processed to determine the level of rainfall or simply to ascertain whether it's raining.

Raindrop sensors find applications in various fields, from weather stations and automated irrigation systems to smart home automation. They enable automated responses to weather conditions, ensuring efficient use of resources and enhancing safety and comfort. Overall, raindrop sensors are essential components in creating smart, responsive systems that can adapt to changing weather conditions.

Moisture sensors find diverse applications in healthcare, facilitating wound care by monitoring exudate levels, managing incontinence through timely product changes, assessing skin hydration for dermatological conditions, regulating humidity in respiratory therapy, ensuring optimal environmental conditions in medical facilities, and monitoring hydration levels in patients and athletes. Overall, moisture sensors play a crucial role in various aspects of healthcare, from wound management and incontinence care to respiratory support and environmental monitoring. Their integration enhances patient care, promotes comfort and well-being, and contributes to more effective treatment outcomes.

In summary, the incorporation of a rain sensor in a smart cane aligns with the broader trend of leveraging technology to enhance accessibility and safety for individuals with visual impairments. By providing real-time information about weather conditions, the smart cane becomes a more versatile tool that empowers users to navigate the world with greater confidence and independence.

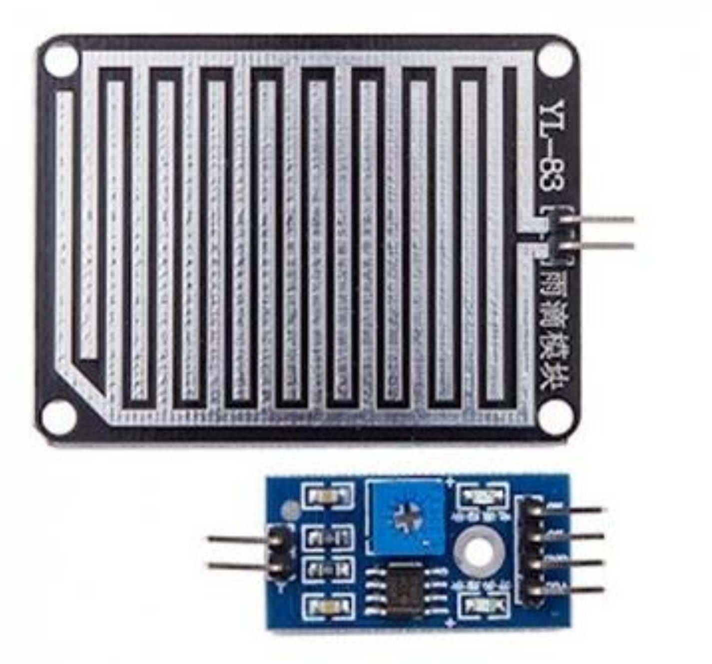

Figure. 3.2.2 Moisture sensor

3.2.3 BUZZER

A buzzer used with an Arduino, often referred to as a piezo buzzer, functions as a miniature speaker that can be directly connected to a Microcontroller like the Arduino Uno. Its primary role is to serve as an alarm system that works in conjunction with various sensors such as ultrasonic, water, and heat flame sensors. When these sensors detect obstacles or potential hazards in front of a visually impaired user, the buzzer comes into action, alerting the user by emitting a sound. You have the flexibility to specify the tone's frequency. This buzzer operates by harnessing the reverse of the piezoelectric effect to generate sound.

Figure. 3.2.3 Buzzer

CHAPTER 4

CHAPTER 4

PROPOSED METHODOLOGY

4.1 ARCHITECTURE OVERVIEW

The architecture diagram for the smart cane depicts a sophisticated integration of various components meticulously designed to enhance mobility for individuals with visual impairments. At its core, the smart cane comprises physical elements engineered for durability, comfort, and ease of use. Crafted from lightweight yet robust materials, the cane's design prioritizes both functionality and user comfort, ensuring optimal maneuverability and grip for extended periods of use. Its collapsible nature further enhances portability, catering to the diverse lifestyles of its users.

Complementing the physical elements are an array of sensors strategically embedded throughout the cane's structure. These sensors employ advanced technologies such as ultrasonic to detect obstacles in the user's path. Continuously gathering data in real-time, these sensors provide precise feedback on obstacle distance and location, enabling users to navigate safely and confidently through their environment.

The seamless integration of connectivity modules further elevates the smart cane's functionality. Cloud connectivity allows for data storage and analysis, driving continuous improvement and customization of the user experience. In addition to its core functionalities, the smart cane incorporates an emergency messaging feature triggered by a dedicated button. This crucial addition ensures users have immediate access to assistance in times of distress or emergency situations.

Furthermore, the smart cane's cloud connectivity enables centralized monitoring and management of emergency alerts. Caregivers or emergency responders can access real-time updates on the user's location and status, facilitating swift and appropriate assistance.

By incorporating an emergency messaging feature, the smart cane enhances user safety and peace of mind, ensuring that individuals facing visual impairments can confidently navigate their surroundings knowing that help is readily available at the touch of a button.

Through the cohesive integration of physical elements, sensors, connectivity modules, and user interfaces, the smart cane operates synergistically to offer unparalleled obstacle detection and enhanced functionality for individuals facing visual impairments. This unified system represents a significant advancement in assistive technology, empowering users to navigate their environments with confidence, independence, and dignity.

The smart cane combines physical elements, sensors, connectivity modules, user interfaces, and an emergency messaging feature to address visual impairments. It offers obstacle detection, enhanced functionality, and safety measures, empowering users to navigate with confidence and independence. This innovative assistive technology reaffirms inclusivity and accessibility.

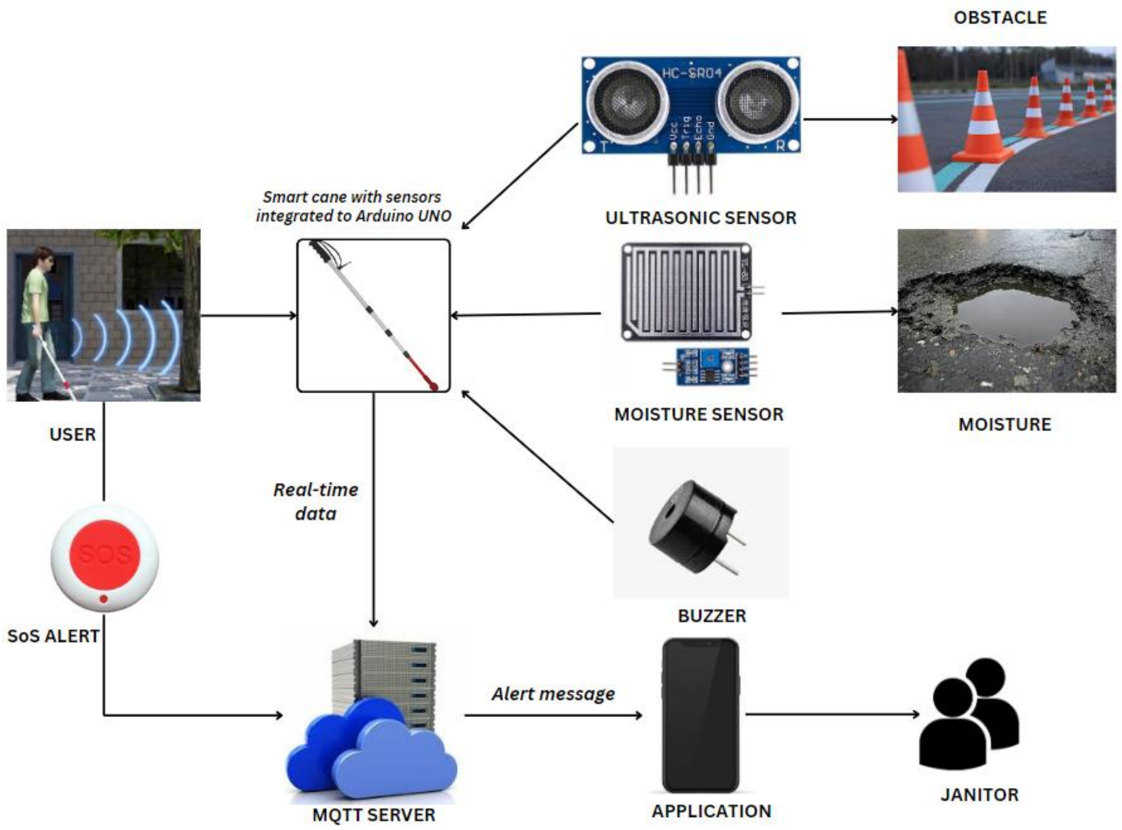

Figure. 4.1 Architecture Diagram

4.2 UML DIAGRAMS

4.2.1 Usecase diagram

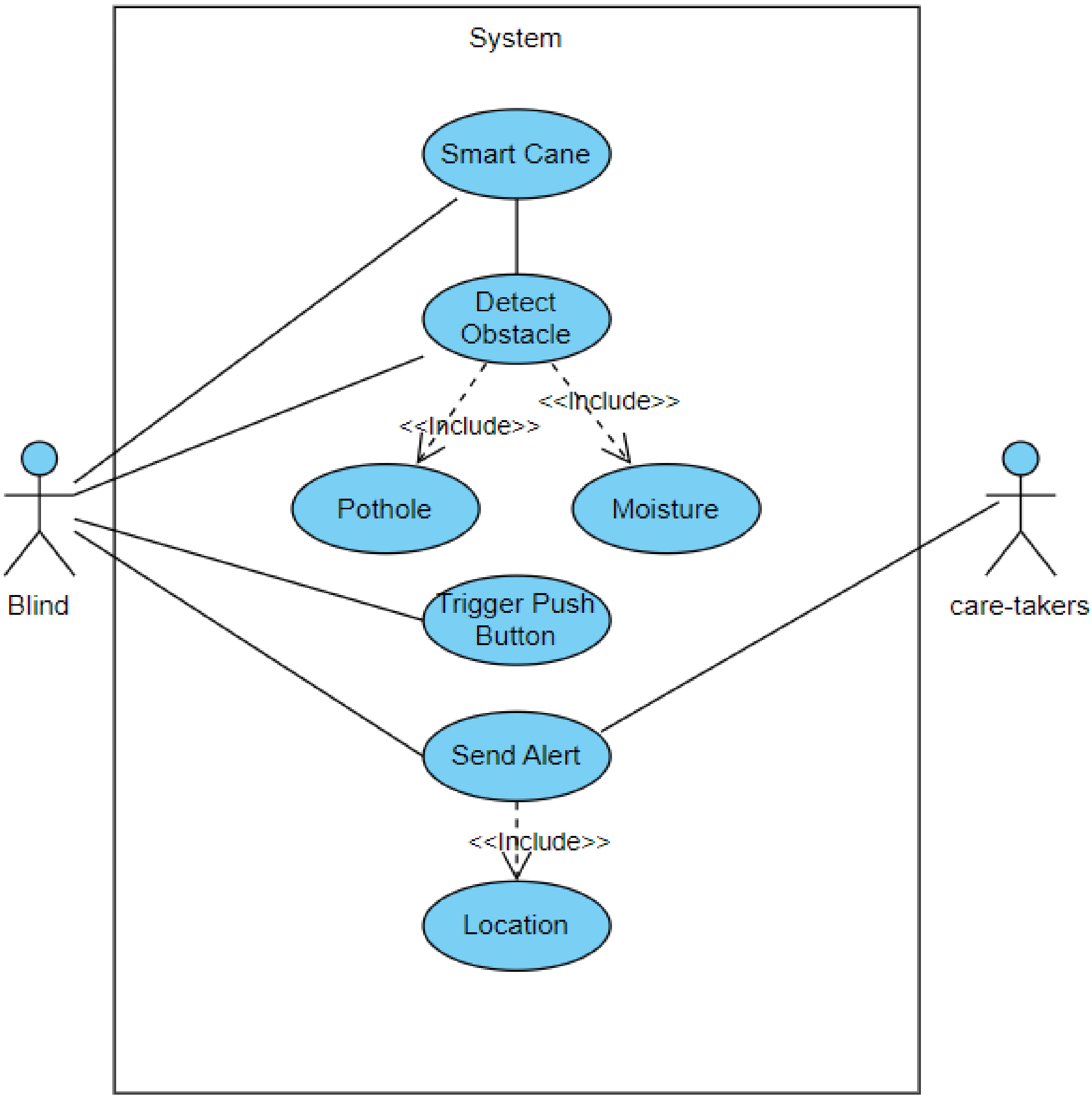

Figure.4.2.1 Usecase Diagram

This use case diagram refers to activities done by System and users and their corresponding use cases of Smart cane. It identifies the system's functionalities, such as obstacle detection and navigation assistance, as well as user actions like activating the cane.

4.2.2 Activity diagram

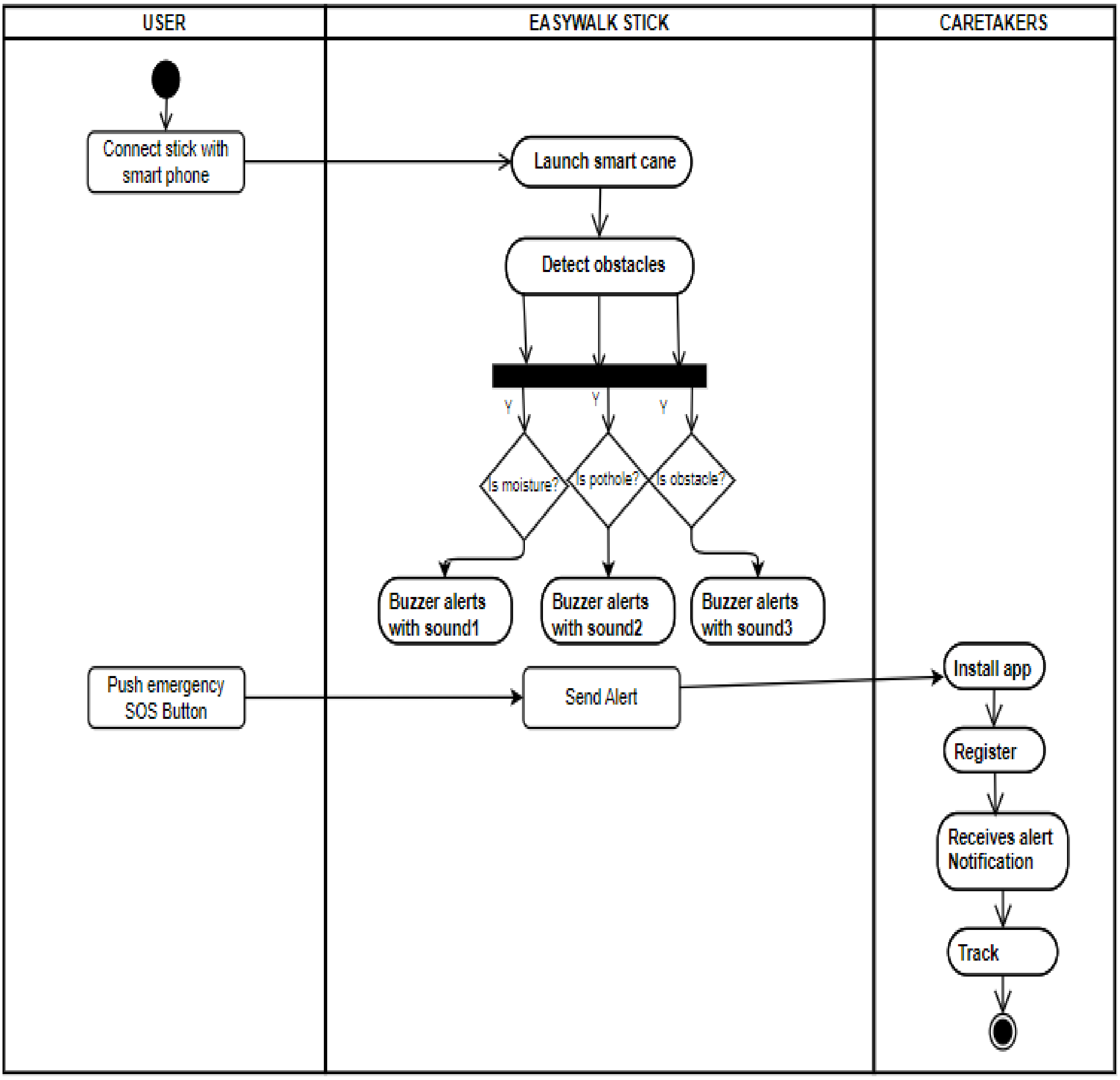

Figure.4.2.2 Activity Diagram

The activity diagram illustrates the sequential flow of actions involved in utilizing both the Smart Cane device and its application. It encompass steps such as activating the device, connecting it to the application, sending emergency alert to the care taker smart phones.

4.2.3 Sequence diagram

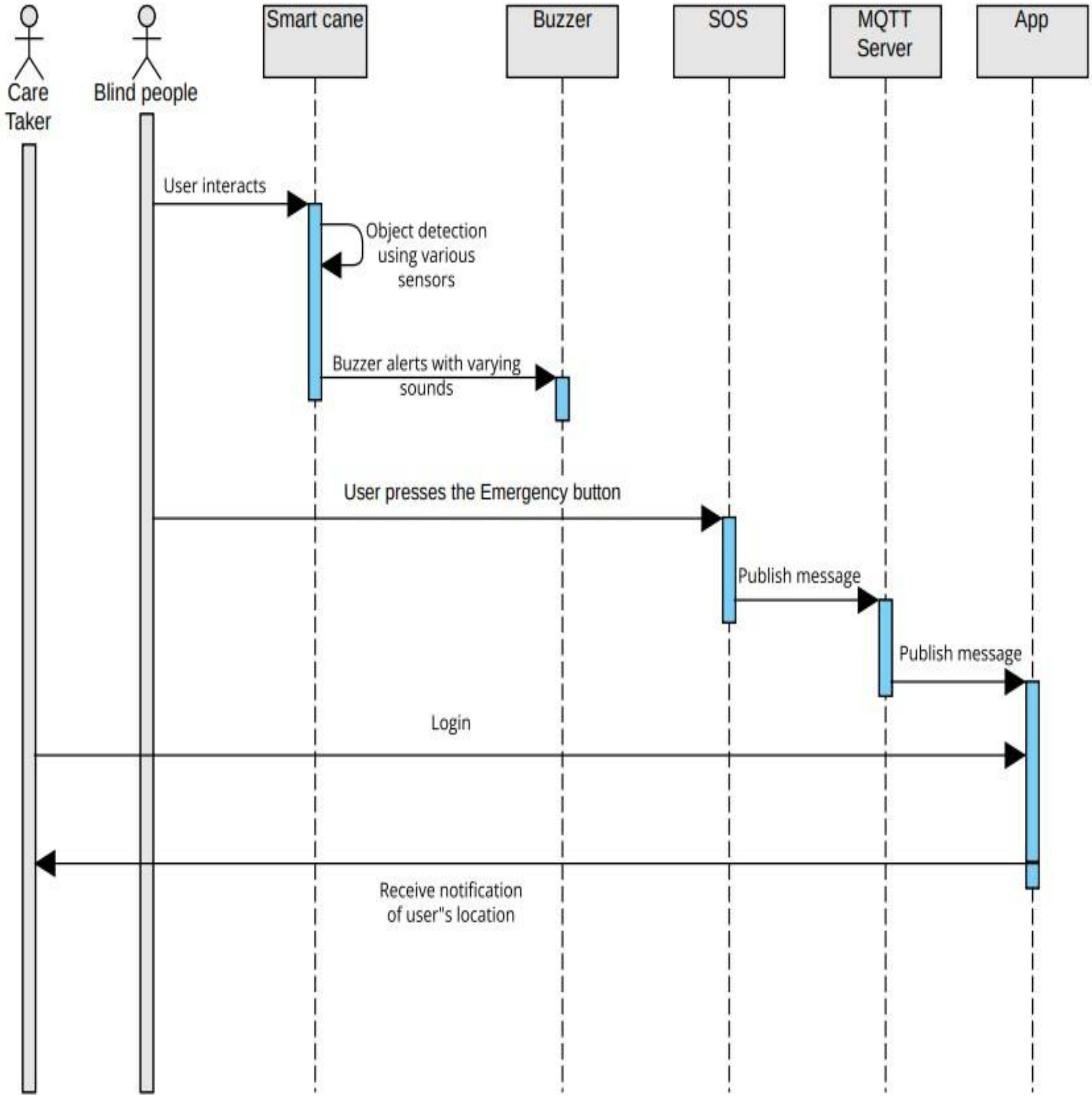

Figure.4.2.3 Sequence diagram

The sequence diagram of EasyWalk shows the sequence of activities performed by the user while using the device.

4.2.4 State chart diagram

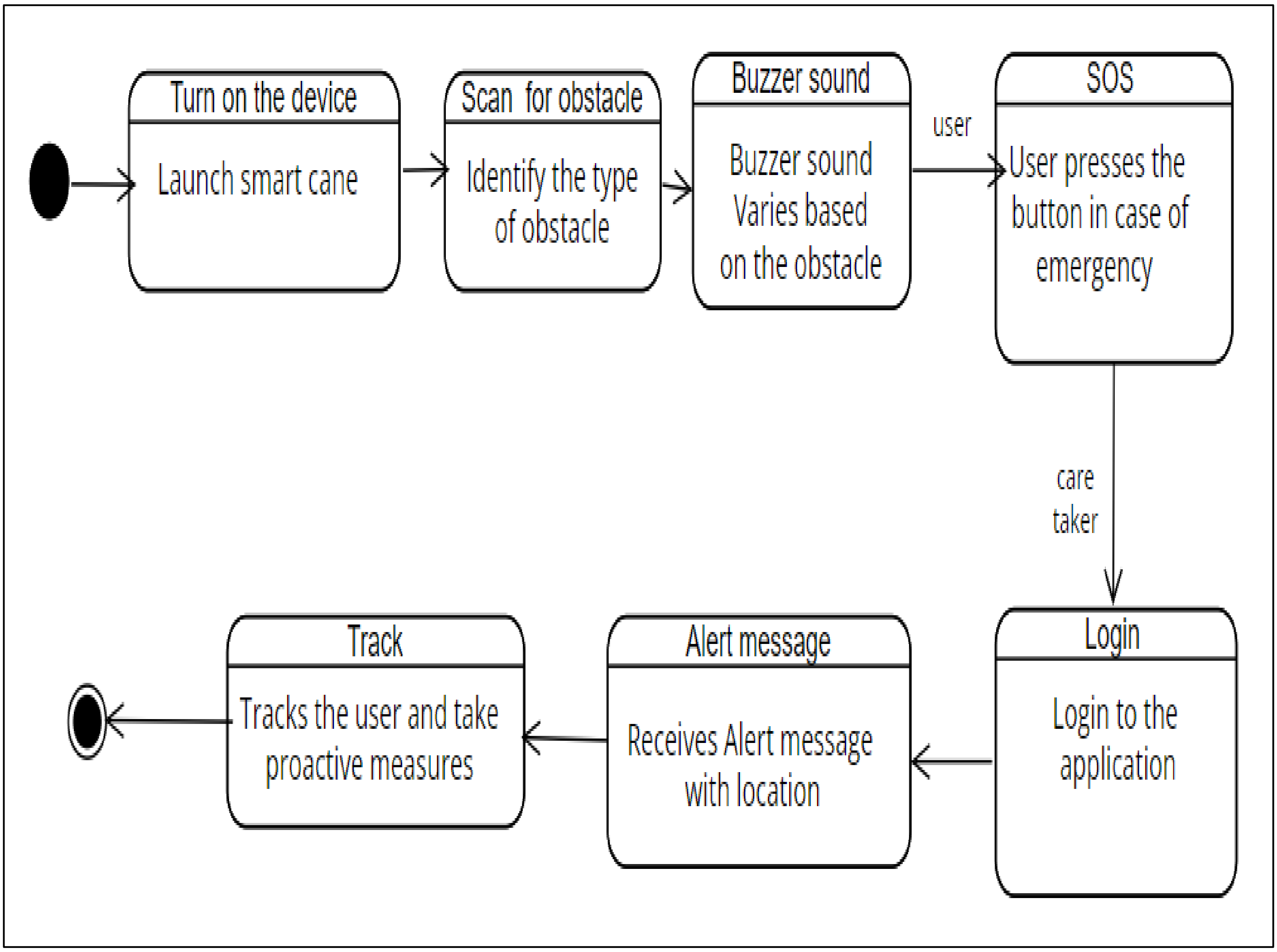

Figure.4.2.4 State chart diagram

EasyWalk Smart cane's state chart diagram depicts the entire workflow of the application. It shows the various states of the application from the installing stage and the features of device. It illustrates transitions between states, such as device pairing, detecting obstacles, sending emergency alert to care taker, installing application and tracking the visually impaired people, which offers a comprehensive overview of the application's functionality.

4.2.5 Data flow diagram

LEVEL 0

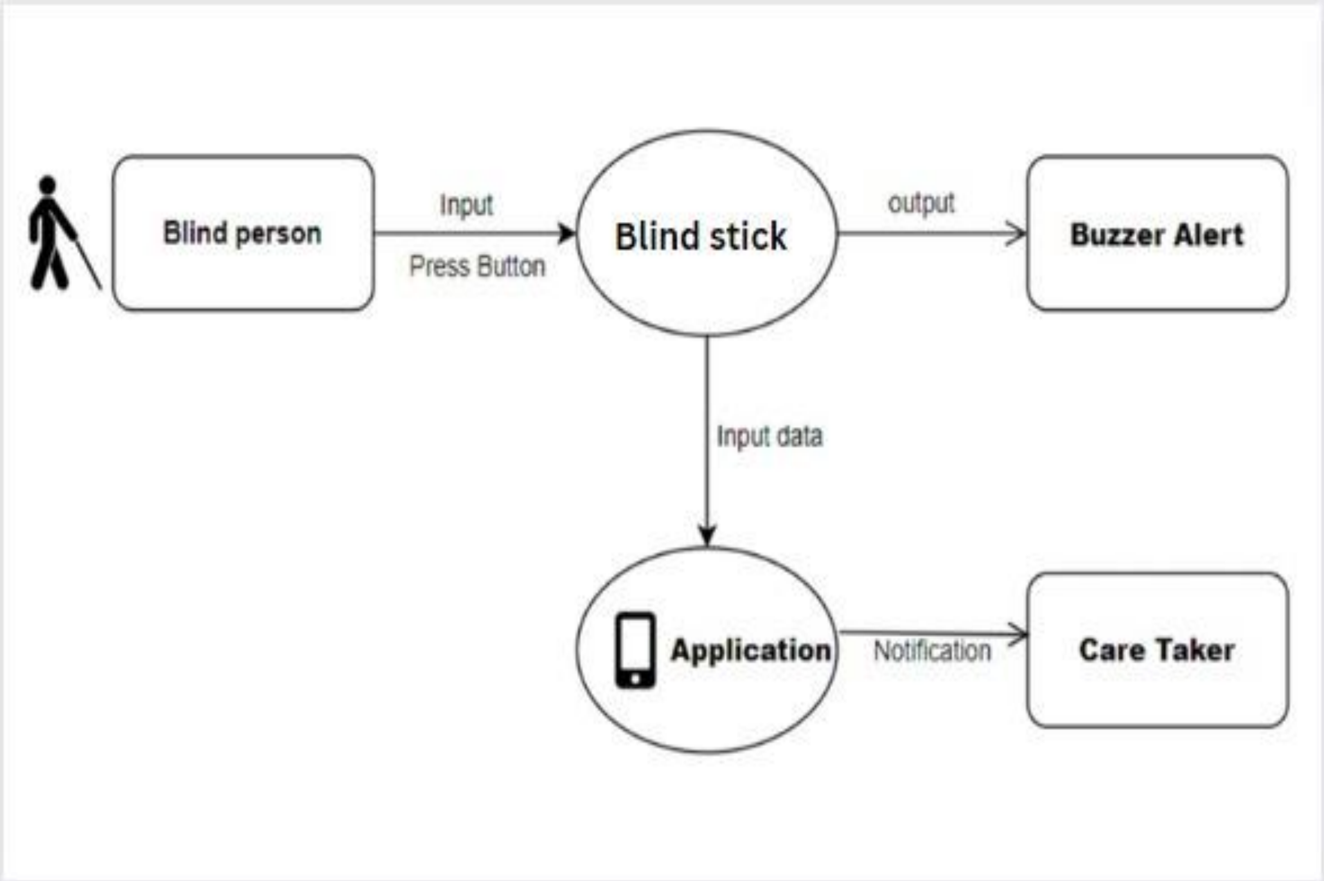

Figure 4.2.5.1 DFD Level 0

Level 0 DFD for a smart cane illustrates basic interactions. It features external entities like the user, smart cane device, mobile app, and cloud server. Processes include sensor data collection, processing, alert generation, and communication with the cloud. Additionally, the GPS navigation feature utilizes location data to guide users along predefined routes or provide real-time directions, enhancing safety and independence for visually impaired individuals.

LEVEL 1

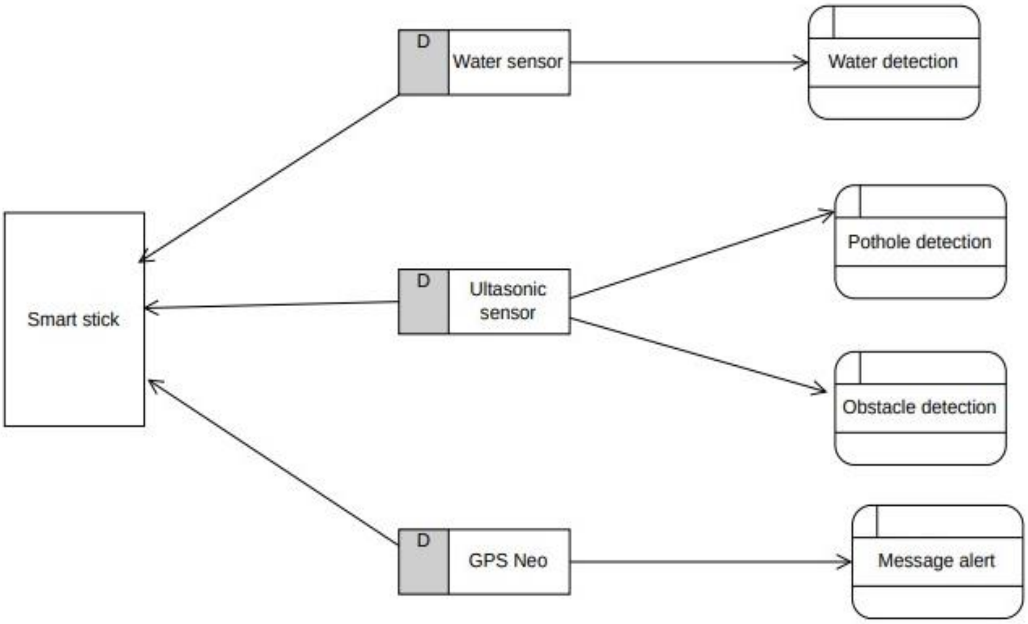

Figure 4.2.5.2 DFD Level 1

At level 1 of the Data Flow Diagram (DFD) for the smart cane system, the primary processes include obstacle detection, moisture and pothole detection and tracking.

LEVEL 2

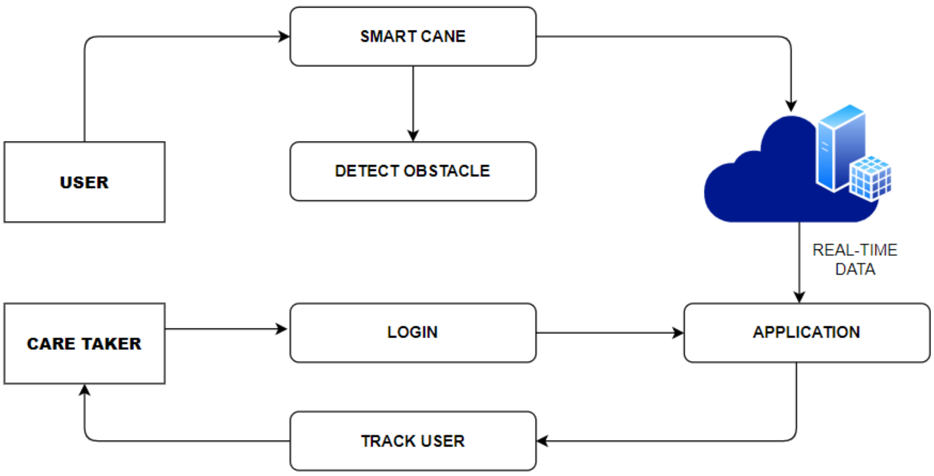

Figure 4.2.5.3 DFD Level 2

At level 2 of the Data Flow Diagram (DFD) for the smart cane, the obstacle detection system analyzes data from sensors. Real-time data is transmitted to the cloud, from where it is relayed to the mobile application, subsequently notifying the caretaker.

CHAPTER 5

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 MODULE DESCRIPTION

The modules involved in this project includes:

- Obstacle detection
- Moisture detection
- Pothole detection
- Emergency alert

5.1.1 OBSTACLE DETECTION

The ultrasonic sensor serves as the cornerstone of functionality for the Blind Stick, playing a pivotal role in enhancing the mobility and safety of individuals with visual impairments. By harnessing ultrasonic waves, this sensor adeptly identifies obstacles in close proximity to the user's path. Upon detecting an obstruction, whether it be a curb, a wall, or any other impediment, the sensor swiftly relays this critical information to the microcontroller, enabling prompt action to navigate around the obstacle and ensure the user's safety.

The obstacle detection feature of the Smart Cane with Multi-Sensor Detection System is a critical component designed to enhance the safety and mobility of visually impaired individuals. Through the utilization of ultrasonic sensors strategically positioned along the length of the cane, the system continuously scans the user's surroundings. These ultrasonic sensors emit high-frequency sound waves, which bounce off nearby objects and return to the sensors. By analyzing the time, it takes for the sound waves to return, the system can accurately determine the distance between the cane and any obstacles in its path.

Upon detecting an obstacle within a predefined range, the system immediately activates a warning signal, alerting the user to the presence of the obstacle. This warning signal comes from the buzzer. This real-time feedback allows users to promptly adjust their path, navigate around obstacles, and avoid potential collisions, thereby significantly reducing the risk of accidents or injuries. Furthermore, the obstacle detection feature is designed to be intuitive and reliable, providing users with consistent and accurate information about their surroundings. The sensors are sensitive enough to detect a wide range of obstacles, including stationary objects like walls, furniture, or poles, as well as moving objects like pedestrians or vehicles.

5.1.2 MOISTURE DETECTION

The moisture detection feature of the Smart Cane serves as a critical safeguard against potential slipping hazards, particularly in adverse weather conditions. Positioned strategically near the cane's tip, the rain sensor continually scans the ground for the presence of moisture, including rainwater, snow, or other liquids. This sensor operates by detecting changes in conductivity or reflectivity caused by moisture, allowing it to accurately identify wet surfaces. Importantly, the sensor's sensitivity can be finely tuned to distinguish between various levels of moisture, ensuring reliable detection even in light rain or damp conditions.

When moisture is detected, the system immediately activates a warning signal to alert the user. This warning signal is designed to be highly noticeable, that comes via a buzzer. By providing real-time feedback about wet surfaces, the moisture detection feature empowers users to take proactive measures to avoid potential slipping hazards. This includes navigating around puddles, adjusting their gait to maintain stability, or seeking alternative routes when necessary.

Moreover, the moisture detection feature is especially beneficial in outdoor environments where hazards may be less visible, such as poorly lit areas or uneven terrain. By alerting users to the presence of moisture, the system helps prevent accidents and injuries, thereby enhancing user safety and confidence during travel. Additionally, the integration of this feature underscores the Smart Cane's commitment to providing comprehensive assistance to visually impaired individuals, enabling them to navigate their surroundings with greater independence and peace of mind, regardless of weather conditions.

5.1.3 POTHOLE DETECTION

The pothole detection feature of the Smart Cane utilizes advanced ultrasonic sensors to enhance user safety and mobility, particularly when navigating outdoor environments. These ultrasonic sensors are strategically positioned along the length of the cane, continuously scanning the ground for surface irregularities such as potholes, cracks, or uneven terrain. By emitting high-frequency sound waves and measuring their reflections, the sensors can accurately detect changes in surface elevation and identify potential hazards.

When a pothole or uneven surface is detected within the cane's proximity, the system promptly activates a warning signal to alert the user. This warning signal is given by the buzzer. By providing real-time feedback about surface conditions, the pothole detection feature enables users to navigate with greater confidence and avoid potential tripping hazards. Furthermore, the sensitivity of the ultrasonic sensors can be adjusted to detect potholes of varying sizes and depths, ensuring comprehensive coverage of potential hazards. This versatility allows users to navigate safely in a wide range of outdoor environments, from sidewalks and pathways to parks and urban streets.

When the smart cane's microprocessor receives data showing the existence of a pothole, it triggers a carefully crafted alarm system to swiftly alert the user to the potential hazard. As an essential warning system, this alarm system makes sure that those who are blind or visually impaired are aware of any possible hazards before they come into contact with them.

5.1.4 EMERGENCY ALERT

The emergency SOS button integrated into the Smart Cane serves as a crucial lifeline for users, allowing them to swiftly request assistance in urgent situations. When activated, the SOS button initiates a sequence of actions designed to notify designated caregivers or emergency contacts of the user's predicament. Utilizing MQTT (Message Queuing Telemetry Transport) protocol, the system sends predefined messages containing vital information, including the user's location coordinates, to a centralized MQTT server. This server acts as an intermediary, facilitating communication between the cane and the caregivers' devices, such as smartphones or computers. Upon receiving the SOS message, caregivers are promptly alerted to the user's distress, enabling them to respond quickly and appropriately.

Moreover, the MQTT server architecture ensures reliable and efficient message delivery, even in challenging network conditions. Messages are transmitted using a lightweight, publish-subscribe messaging protocol, minimizing bandwidth usage and latency. This ensures that emergency alerts reach caregivers without delay, regardless of their location or network connectivity. Furthermore, the MQTT server offers scalability and flexibility, allowing for the seamless integration of additional functionalities or third-party services. For instance, caregivers may receive SOS alerts via SMS, or through our mobile application, depending on their preferences and requirements. Additionally, the server can support multiple users and devices, accommodating the needs of individuals with diverse caregiving arrangements or support networks.

CHAPTER 6

CHAPTER 6

6.1 RESULTS AND DISCUSSION

i. Place the smart cane in an open area without obstacles

As the smart cane is gently placed on the ground in an open area, its sensors immediately begin scanning the surroundings. In the absence of obstacles within its range, the smart cane's system registers a clear path and initiates a status check. The absence of obstacles prompts the smart cane to maintain a standby mode, conserving energy until further movement is detected. Despite the lack of obstacles, the cane's sensors remain active, continuously monitoring the surroundings for any sudden changes. With no obstacles to alert the user about, the smart cane remains silent, providing a seamless user experience in open areas. Users can confidently navigate open spaces with ease, relying on the smart cane's reliable detection capabilities.

ii. Place the smart cane in a narrow corridor or obstructed area

Navigating narrow corridors or obstructed areas can pose challenges, especially for individuals using a smart cane. When encountering a narrow corridor or obstruction, the smart cane's sensors detect the reduced space or obstacle ahead. Upon detection, the smart cane initiates its buzzer alert system, emitting a distinct sound pattern to alert the user.

This audible alert serves as a prompt for the user to proceed cautiously, adjust their path, or seek assistance if necessary. By providing real-time alerts in narrow corridors or obstructed areas, the smart cane empowers users to navigate safely and confidently, reducing the risk of collisions or accidents while promoting independence and mobility.

iii. Test the rain sensor in a dry environment

Placing a rain sensor in a dry environment typically yields no buzzer alert due to the absence of water to trigger the sensor. Rain sensors are designed to detect moisture, typically in the form of rain or water droplets. When exposed to moisture, these sensors complete a circuit, triggering an alert mechanism such as a buzzer. However, in a dry environment, there is no moisture present to activate the sensor. As a result, the circuit remains incomplete, and the buzzer fails to receive the signal to sound an alert. In such conditions, the rain sensor essentially remains dormant and does not fulfil its intended function.

iv. Expose the rain sensor to water or simulate rain

Exposing the rain sensor to water or simulating rain triggers the sensor to activate, producing a response in the form of a buzzer alert. When water contacts the rain sensor, it completes an electrical circuit or alters the conductivity of the sensor's surface, signalling the presence of moisture. This triggers the sensor to send a signal to the connected buzzer alert system, initiating an audible alarm. The buzzer alert serves as a warning mechanism, notifying users of the onset of rain or the presence of moisture. This timely alert allows for prompt action to be taken, such as activating drainage systems, adjusting irrigation schedules, or protecting sensitive equipment from water damage.

v. Place the smart cane on a flat, even surface

Placing the smart cane on a flat, even surface triggers a response wherein the absence of any buzzer alert indicates stability. Utilizing advanced sensor technology, the smart cane detects changes in its environment, particularly shifts in inclination or orientation. When positioned on a level surface, the cane's sensors register consistency in its surroundings, thus negating the need for any alert. This absence of a buzzer signal provides users with immediate feedback, assuring them of a secure placement. This real-time analysis enhances user confidence, as they can rely on the cane's intelligence to accurately assess their immediate surroundings.

vi. **Place the smart cane on a surface with small potholes or uneven terrain**
When placing the smart cane on a surface with small potholes or uneven terrain, its integrated sensors immediately detect the irregularities. These sensors are finely tuned to perceive changes in surface elevation and texture. As the smart cane makes contact with the uneven ground, its sophisticated system triggers a buzzer alert.The buzzer alert serves as a vital warning mechanism for the user, providing real-time feedback about the terrain's condition. Its purpose is to alert the user to the presence of potential hazards, ensuring they can navigate safely and confidently.

The emergency SOS button integrated into the smart stick has proven to be a vital safety feature, facilitating swift assistance for visually impaired individuals in distress. Upon activation, the button triggers an emergency message containing the user's location to their designated caretaker. This immediate message enables caretakers to promptly respond to the user's situation and provide assistance as needed. Simultaneously, the companion mobile application enhances the caretaker's ability to track the user's location in real-time. By logging into the app, caretakers can access a map interface displaying the user's current location, ensuring they can quickly locate and reach the user in case of an emergency or if assistance is required. By integrating with the smart stick, the mobile application enhances caretakers' ability to monitor the user's movements and ensure their safety, offering peace of mind to both the user and their support network.

6.2 SYSTEM TESTING

TEST CASE ID	TEST CASE	EXPECTED RESULT	ACTUAL RESULT	PASS/ FAIL
TC01	Place the smart cane in an open area without obstacles	Smart cane indicates no obstacles detected with no buzzer alert	No obstacles detected with no buzzer alert	Pass
TC02	Place the smart cane in a narrow corridor or obstructed area	Cane provides appropriate alerts or feedback with buzzer alert	Obstacles detected with buzzer alert	Pass
TC03	Test the rain sensor in a dry environment	No moisture detected with no buzzer alert	No moisture detected with no buzzer alert	Pass
TC04	Expose the rain sensor to water or simulate rain	Smart cane detects rain with buzzer alert	Smart cane detects rain with buzzer alert	Pass
TC05	Place the smart cane on a flat, even surface	No buzzer alerts indicating potholes	No buzzer alerts indicating potholes	Pass
TC06	Place the smart cane on a surface with small potholes	Cane provides buzzer alerts for detected potholes	Cane provides buzzer alerts for detected potholes	Pass
TC07	Before user presses the SOS button	Displays No Blind SOS Detected message	As mentioned in fig.A.3.3 it displays “No Blind SOS Detected message”	Pass
TC08	After user presses the SOS button	Displays Alert message with a location URL to track user	As mentioned in fig.A.3.4& A.3.5 it displays alert with location URL to track user	Pass

CHAPTER 7

CHAPTER 7

7.1 CONCLUSION

The Smart Blind Stick initiative represents a significant leap forward in creating a more inclusive and accessible world for individuals living with visual impairments. By transcending longstanding barriers to independence and safety, it offers a transformative solution that empowers users and enhances their quality of life. The discussion on our smart stick design underscores the necessity of enhancing safety measures for visually impaired individuals during travel, whether in familiar or unfamiliar surroundings.

The development of our proposed smart cane with obstacle detection, moisture detection, pothole detection, and emergency SOS services represents a significant contribution to the field of assistive technology for visually impaired individuals. By integrating advanced sensors and real-time communication capabilities, our smart cane offers a comprehensive solution to enhance mobility, safety, and independence. The inclusion of multiple detection features addresses key challenges faced by visually impaired individuals, such as navigating obstacles, avoiding hazards, and accessing timely assistance in emergencies.

The Smart Blind Stick not only offers functional advantages but also plays a profound role in reinstating dignity and autonomy for individuals who may have previously felt marginalized or dependent on others for support. By providing the necessary tools for confident navigation, it empowers individuals to actively engage in society, pursue their goals, and explore the world independently. This sense of empowerment cultivates agency and self-reliance, leading to enhanced overall well-being.

7.2 FUTURE ENHANCEMENT

Integrating AI algorithms into smart canes can elevate their capabilities, such as advanced obstacle recognition, intelligent route planning, and personalized assistance based on user preferences and behavior. Expanding feedback mechanisms to include tactile and visual cues can offer more comprehensive information, particularly benefiting users with additional sensory impairments. Incorporating emerging technologies like 5G and IoT devices can enhance real-time communication, data transmission, and remote monitoring, thereby improving the overall user experience.

Smart canes will likely feature more advanced sensory capabilities, leveraging technologies such as LiDAR, radar, and advanced computer vision algorithms. These enhancements will enable the cane to detect obstacles with greater accuracy and provide more detailed environmental information to the user. It may integrate with urban infrastructure, communicating with traffic lights, pedestrian crossings, and other smart city features. This integration will provide users with real-time information about their surroundings, including safe crossing times and nearby hazards.

They are likely to integrate with wearable devices and IoT technologies, allowing for seamless communication and data sharing between different assistive devices. This integration could enable features such as remote monitoring, emergency assistance, and connectivity with other smart devices in the user's environment. It may leverage data analytics and machine learning algorithms to continually improve their performance and adapt to users' changing needs. By analyzing user behavior and environmental data, these devices can optimize navigation assistance and provide personalized support over time.

APPENDICES

APPENDICES

A.1 SDG GOAL

SDG 3: Good Health and Well-being

By employing cutting-edge sensors and technologies, such as ultrasonic sensors and cameras, the smart stick acts as a proactive safety measure for visually impaired individuals, mitigating the risk of accidents and injuries caused by environmental hazards. This innovative tool not only promotes physical well-being by enhancing safety but also fosters mental health by instilling confidence and independence in navigating daily surroundings. Through its contribution to improving the health and safety of visually impaired individuals, the smart stick plays a vital role in advancing the broader goals of ensuring good health and well-being for all.

SDG 10: Reduced Inequalities

By addressing the specific needs of visually impaired individuals, it plays a crucial role in reducing disparities related to accessibility and mobility. Through its innovative features and technology, the smart stick empowers visually impaired individuals to navigate their surroundings independently, thereby breaking down barriers to social inclusion and equal opportunities. Access to mobility aids like the smart stick not only promotes equal participation in education, employment, and community life but also fosters a more equitable society where everyone, regardless of their abilities, can thrive and contribute. In championing the cause of reducing inequalities, the smart stick stands as a symbol of inclusivity and empowerment for all individuals.

A. 2 SOURCE CODE

SMART_CANE.ino

```
#include <NewPing.h>
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
#include <PubSubClient.h>
#include <WiFi.h>

// Replace these with your WiFi credentials
const char *ssid = "project";
const char *password = "project@123";

// Replace this with the address of your MQTT broker
const char *mqttBroker = "103.217.220.20";
const int mqttPort = 1883;

// Define the pins for the first ultrasonic sensor
#define TRIGGER_PIN_1 12
#define ECHO_PIN_1 14

// Define the pins for the second ultrasonic sensor
#define TRIGGER_PIN_2 27
#define ECHO_PIN_2 26

// Define the pins for the third ultrasonic sensor
#define TRIGGER_PIN_3 32
#define ECHO_PIN_3 33
```

```
// Define the pin for the moisture sensor data
#define MOISTURE_PIN 15  // Change this to the desired GPIO pin

// Define the buzzer pin
#define BUZZER_PIN 13 // Change this to an available pin

#define BUTTON_PIN 2

// Define the pins for the GPS module
#define GPS_RX_PIN 17
#define GPS_TX_PIN 16
#define GPS_BAUD_RATE 9600

// Define the maximum distance to check for obstacles
#define MAX_DISTANCE 200

// Define obstacle distances for each sensor
#define OBSTACLE_DISTANCE_1 20
#define OBSTACLE_DISTANCE_2 10
#define OBSTACLE_DISTANCE_3 12

// Define the expected range for the distance ratio
#define EXPECTED_RATIO_MIN 0.5
#define EXPECTED_RATIO_MAX 2.0

// Create instances of the NewPing class for each sensor
NewPing sonar1(TRIGGER_PIN_1, ECHO_PIN_1, MAX_DISTANCE);
NewPing sonar2(TRIGGER_PIN_2, ECHO_PIN_2, MAX_DISTANCE);
NewPing sonar3(TRIGGER_PIN_3, ECHO_PIN_3, MAX_DISTANCE);
```

```
// Create a SoftwareSerial object for the GPS module
SoftwareSerial gpsSerial(GPS_RX_PIN, GPS_TX_PIN);

// Create a TinyGPS++ object
TinyGPSPlus gps;

// Create a WiFiClient instance to connect to the MQTT server
WiFiClient espClient;
PubSubClient client(espClient);
bool buttonPressed = false;

void setup() {
  Serial.begin(115200);

  // Connect to Wi-Fi
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }
  Serial.println("Connected to WiFi");

  // Connect to MQTT broker
  client.setServer(mqttBroker, mqttPort);

  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(MOISTURE_PIN, INPUT);
   pinMode(BUTTON_PIN, INPUT_PULLUP); // Internal pull-up resistor
```

```
  attachInterrupt(digitalPinToInterrupt(BUTTON_PIN),buttonISR,
FALLING);
}

void loop() {
  // Connect to MQTT if not connected
  if (!client.connected()) {
    reconnect();
  }

  // Get distance from the first sensor
  unsigned int distance1 = sonar1.ping_cm();

  // Get distance from the second sensor
  unsigned int distance2 = sonar2.ping_cm();

  // Get distance from the third sensor
  unsigned int distance3 = sonar3.ping_cm();

  // Read moisture level
  int moistureLevel = digitalRead(MOISTURE_PIN);

  // Print the distances and moisture level to the serial monitor
  Serial.print("Distance Sensor 1: ");
  Serial.print(distance1);
  Serial.print(" cm\t");

  Serial.print("Distance Sensor 2: ");
```

```
Serial.print(distance2);
Serial.print(" cm\t");

Serial.print("Distance Sensor 3: ");
Serial.print(distance3);
Serial.print(" cm\t");

Serial.print("Moisture Level: ");
Serial.println(moistureLevel == HIGH ? "Dry" : "Wet");

// Check for obstacles based on predefined distances
if (distance1 <= OBSTACLE_DISTANCE_1) {
  Serial.println("Obstacle detected by Sensor 1!");
  // Add your actions for obstacle detection by Sensor 1
  beepBuzzer(1); // Single beep
}

if (distance2 <= OBSTACLE_DISTANCE_2) {
  Serial.println("Obstacle detected by Sensor 2!");
  // Add your actions for obstacle detection by Sensor 2
  beepBuzzer(2); // Single beep
}

if (distance3 <= OBSTACLE_DISTANCE_3) {
  Serial.println("Obstacle detected by Sensor 3!");
  // Add your actions for obstacle detection by Sensor 3
  beepBuzzer(2);
}
```

```
// Check moisture level and trigger a triple beep if moisture is detected
if (moistureLevel == LOW) {
  Serial.println("Moisture detected! Triple beeping the buzzer.");
  beepBuzzer(3); // Triple beep
}


 if (buttonPressed) {
while (gpsSerial.available() > 0) {
  if (gps.encode(gpsSerial.read())) {
    if (gps.location.isValid()) {
      Serial.print("Latitude: ");
      Serial.print(gps.location.lat(), 6);
      Serial.print(", Longitude: ");
      Serial.println(gps.location.lng(), 6);

      // Publish GPS data to MQTT
      publishGPS(gps.location.lat(), gps.location.lng());
    } else {
      Serial.println("Waiting for valid GPS data...");
    }
  }
}
}

// Maintain the MQTT connection
client.loop();

delay(500); // Adjust delay as needed
```

```
}

void beepBuzzer(int beepType) {
  // Beep the buzzer based on the specified beep type
  if (beepType == 1) {
    digitalWrite(BUZZER_PIN, HIGH);
    delay(1000); // Single beep duration
    digitalWrite(BUZZER_PIN, LOW);
  } else if (beepType == 2) {
    for (int i = 0; i < 2; i++) {
      digitalWrite(BUZZER_PIN, HIGH);
      delay(500); // Duration of each beep in the double beep
      digitalWrite(BUZZER_PIN, LOW);
      delay(500); // Interval between beeps in the double beep
    }
  } else if (beepType == 3) {
    for (int i = 0; i < 3; i++) {
      digitalWrite(BUZZER_PIN, HIGH);
      delay(200); // Duration of each beep in the triple beep
      digitalWrite(BUZZER_PIN, LOW);
      delay(200); // Interval between beeps in the triple beep
    }
  }
}

void publishGPS(float latitude, float longitude) {
  // Publish GPS data to the specified MQTT topic
  String topic = "gps_data";
  String payload = String(latitude, 6) + "," + String(longitude, 6);
```

```
  client.publish(topic.c_str(), payload.c_str());
  Serial.println("Published GPS data to MQTT");
}

void reconnect() {
  // Loop until we're reconnected to the MQTT broker
  while (!client.connected()) {
    Serial.println("Attempting MQTT connection...");
    // Attempt to connect
    if (client.connect("ESP32Client")) {
      Serial.println("Connected to MQTT broker");
    } else {
      Serial.print("Failed, rc=");
      Serial.print(client.state());
      Serial.println(" Retrying in 5 seconds...");
      // Wait 5 seconds before retrying
      delay(5000);
    }
  }
}

void buttonISR() {
  // Interrupt Service Routine (ISR) for the push button
  buttonPressed = true;
}
```

APPLICATION CODE

Login.js

```
import React, { useState, useEffect} from 'react'
import { StyleSheet, Text, View, TextInput, TouchableOpacity, Dimensions
} from 'react-native';
import NormalHealth from "./NormalHealth";
import AbnormalHealth from "./AbnormalHealth";
import LinearGradient from 'react-native-linear-gradient';
import AsyncStorage from '@react-native-async-storage/async-storage';
import MQTT from 'react-native-mqtt-new';
import { KeyboardAwareScrollView } from 'react-native-keyboard-aware-
scroll-view';
import PushNotification from 'react-native-push-notification';

export default function App(props) {
  const [flag, setflag] = useState(0);
  const [usernameentered, setusernameentered] = useState("");
  const [passwordentered, setpasswordentered] = useState("");
  const [SOS_Topic, setSOS_Topic] = useState("gps_data");
  const { width, height } = Dimensions.get("screen");
  const [lat, setlat] = useState("");
  const [lon, settlon] = useState("");

  function login() {
    if (usernameentered == "") {
      alert("Please enter Username ")
    }
    else if (passwordentered == "") {
      alert("Please enter Password ")
```

```
    }
 else if (usernameentered == "1" && passwordentered == "1") {
setflag(1)
      MQTT.createClient({
        uri: 'mqtt://103.217.220.20:1883',

        clientId: 'your_client_id'
      }).then(function (client) {
        client.on('closed', function () {
          // console.log('mqtt.event.closed');
        });
        client.on('error', function (msg) {

        });

        client.on('message', function (msg) {
          console.log('mqtt.event.message', msg);
          console.log(msg.data)
          console.log("********** substring*********")

          if (msg.data != "0") {

            if (flag == 0 || flag == 1) {
              var mqttvalue = msg.data;
              var splits = mqttvalue.split(',');
              setlat(splits[0]);
              settlon(splits[1]);
              setflag(2)
            }
```

```
}
        })

        client.on('connect', function () {
          console.log('connected');
          client.subscribe(SOS_Topic, 0);
        });

        client.connect();
      }).catch(function (err) {
        console.log(err);
      });
      // console.log (usernameentered)
      // console.log (passwordentered)
    }
    else {
      alert("Entered Username and Password is incorrect")
    }
}

const callback = (value) => {

  console.log("++++++++++++++++++++++++++++" + value)

  // setfarmstatus(0)

  setflag(1)
}
if (flag == 0) {
```

```
return (
  <KeyboardAwareScrollView

    enableAutomaticScroll
    extraScrollHeight={10}
    enableOnAndroid={true}
    extraHeight={Platform.select({ android: 200 })}
    style={{ flexGrow: 1 }}

  >

    <View style={styles.container}>

     <LinearGradient colors={['#3dcc8c','#42f5a4', '#23ad6f']} style={{
flex: 1, height: height, justifyContent: 'center', alignItems: 'center' }}>

      <Text style={styles.logo}>BLIND APP</Text>
      <View style={styles.inputView} >
        <TextInput
          style={styles.inputText}
          placeholder="Username"
          placeholderTextColor="grey"
          onChangeText={text => setusernameentered(text)} />
      </View>
      <View style={styles.inputView} >
        <TextInput
          secureTextEntry
          style={styles.inputText}
          placeholder="Password"
```

```
            placeholderTextColor="grey"
            onChangeText={text => setpasswordentered(text)} />
          </View>
          <TouchableOpacity style={styles.loginBtn}
            onPress={login}
          >
            <Text style={styles.loginText}>LOGIN</Text>
          </TouchableOpacity>

        </LinearGradient>
      </View>

    </KeyboardAwareScrollView>
  );

}
else if (flag == 1) {

  return (

    <NormalHealth
    />
  )
}

else if (flag == 2) {

  return (
```

```
    <AbnormalHealth callback={callback} lat={Number(lat)}
lon={Number(lon)} />
   )
  }
}
const styles = StyleSheet.create(
{
  container: {
    flex: 1,
  },
  logo: {
    fontWeight: "bold",
    fontSize: 25,
    color: "white",
    marginBottom: 50
  },
  inputView: {
    width: "80%",
    backgroundColor: "white",
    borderRadius: 10,
    height: 50,
    marginBottom: 20,
    justifyContent: "center",
    padding: 20
  },
  inputText: {
    height: 50,
    color: "black",
    fontSize: 18
```

```
  },
  forgot: {
    color: "white",
    fontSize: 11
  },
  loginBtn: {
    width: "80%",
    backgroundColor: "#0b99a3",
    borderRadius: 10,
    height: 50,
    alignItems: "center",
    justifyContent: "center",
    marginTop: 40,
    marginBottom: 10
  },
  loginText: {
    color: "white",
    fontWeight: 'bold',
    fontSize: 20
  },
  linearGradient: {
    flex: 1,
    alignItems: 'center',
    justifyContent: 'center',
  },
}
);
```

NormalHealth.js

```
import React from 'react';
//import all the components we are going to use
import { StyleSheet, View, Text, SafeAreaView, Image, Button, Alert,
Dimensions } from 'react-native';
const { width, height } = Dimensions.get("screen");

const App = (props) => {
  return (

    <View style={styles.container}>
      <Text style={{ textAlign: 'center', fontSize: 30, bottom: 50, fontWeight:
'bold', color: "green" }}>BLIND APP</Text>
      <Image
        source={require('./safe.jpeg')}
        style={{ width: width / 2 + 40, height: height / 3, margin: 16 }}
      />
      <Text style={{ textAlign: 'center', fontSize: 27, fontWeight: 'bold',
marginTop: 25, color: "green" }}>NO BLIND SOS DETECTED</Text>

    </View>
  );
};
const styles = StyleSheet.create({
  container: {
    flex: 1,
    alignItems: 'center',
    justifyContent: 'center',
    backgroundColor: 'white',
```

```
      flexDirection: 'column'
    },
  }
  );
  export default App;
```

AbnormalHealth.js

```
import React, {Component, useState, useEffect} from 'react';
import {
  StyleSheet,
  View,
  Text,
  Alert,
  Dimensions,
  Switch,
  TouchableOpacity,
  Image,
} from 'react-native';
import {WebView} from 'react-native-webview';
import SendIntentAndroid from 'react-native-send-intent';

const windowWidth = Dimensions.get('screen').width;
const windowHeight = Dimensions.get('screen').height;

export default function App(props) {
  const onPress = () => {
    props.callback(0);
  };
```

```
  const openGoogleMap = () => {

    var geo = props.lat + ',' + props.lon;
              SendIntentAndroid.openMapsWithRoute(geo, "d")
  };


  TouchableOpacity.defaultProps = {activeOpacity: 0.8};

  return (
    <View style={{flex: 1, backgroundColor: 'white'}}>
      <View style={{flex: 1, justifyContent: 'center', alignItems: 'center'}}>

      <TouchableOpacity style={styles.loginBtnbus}
onPress={openGoogleMap} >

        <Text
          style={
{
            textAlign: 'center',
            fontSize: 20,
            fontWeight: 'bold',
            marginTop: 20,
            color: 'red',
          }
}

          >
```

```
        BLIND SOS IS DETECTED
        </Text>

        <Text style={{fontSize:15,fontWeight:'bold'}}>Click here for track blind person</Text>

        </TouchableOpacity>

        {/* <TouchableOpacity style={styles.loginBtn2} onPress={onPress}>
          <Text style={styles.loginText}>BACK TO NORMAL</Text>
        </TouchableOpacity> */}
      </View>
    </View>
  );
}

const styles = StyleSheet.create(
{
  screenContainer: {
    flex: 1,
    justifyContent: 'center',
    padding: 16,
  },
  appButtonContainer: {
    elevation: 8,
    backgroundColor: '#05b311',
    borderRadius: 15,
    paddingVertical: 15,
    paddingHorizontal: 15,
```

```
},

appButtonText: {
  fontSize: 10,
  color: '#fff',
  fontWeight: 'bold',
  alignSelf: 'center',
  textTransform: 'uppercase',
},

loginBtn: {
  width: '80%',
  backgroundColor: 'red',
  borderRadius: 10,
  alignItems: 'center',
  justifyContent: 'center',
  padding: 10,
  margin: 10,
},

loginBtn5: {
  backgroundColor: 'red',
  borderRadius: 10,
  alignItems: 'center',
  justifyContent: 'center',
  padding: 10,
  margin: 10,
},
```

```
  loginBtn2: {
    width: '80%',
    backgroundColor: 'green',
    borderRadius: 10,
    alignItems: 'center',
    justifyContent: 'center',
    padding: 10,
    margin: 10,
  },

  loginBtnbus: {
    width: '80%',
    backgroundColor: 'lightgrey',
    borderRadius: 10,
    alignItems: 'center',
    justifyContent: 'center',
    padding: 10,
    margin: 10,
  },
  loginText: {
    color: 'white',
    fontWeight: 'bold',
    fontSize: 20,
  },
}
);
```

A.3 SCREENSHOTS

SMART CANE SETUP

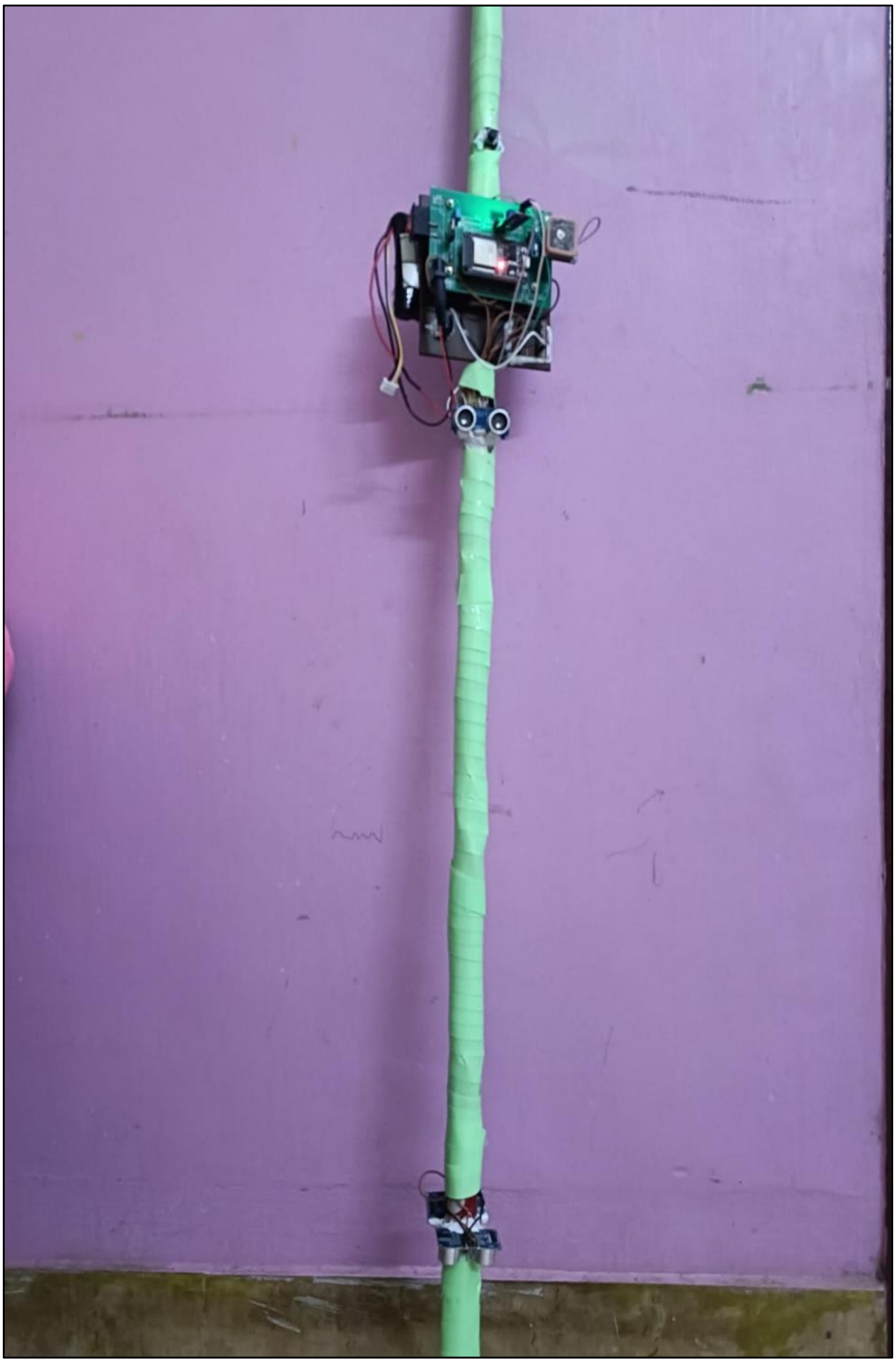

Figure.A.3.1 Smart Cane

OUTPUT IN APPLICATION

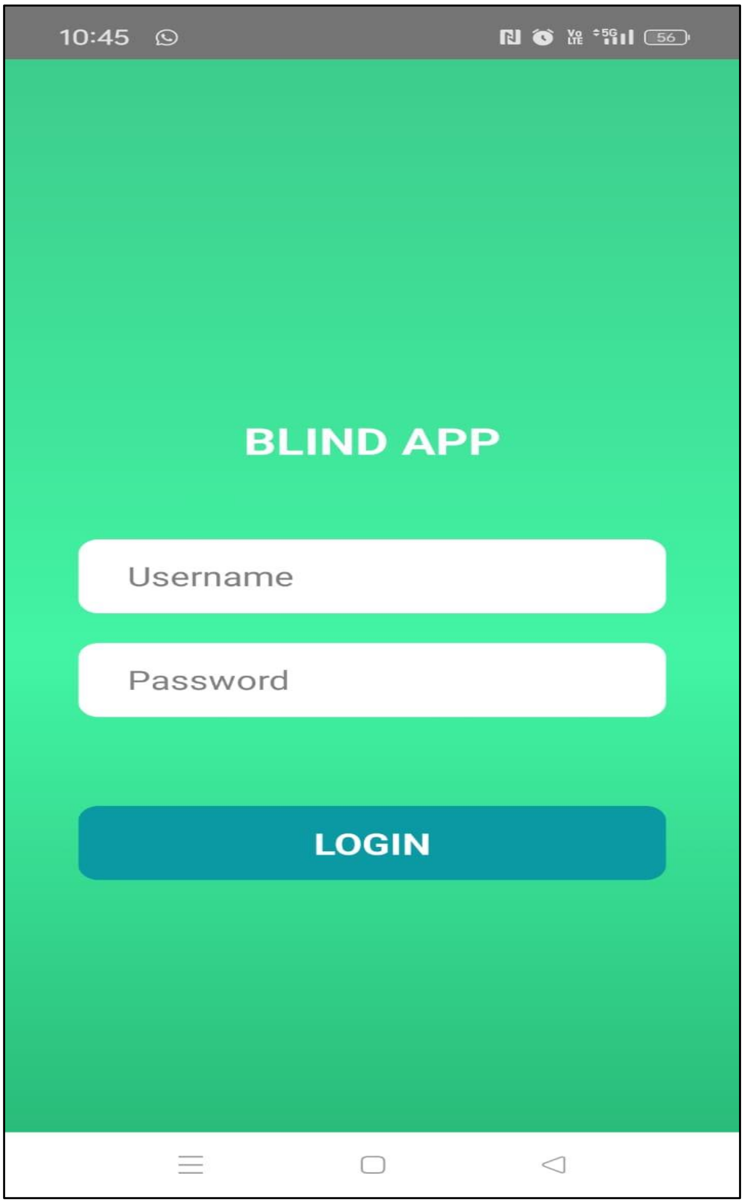

Figure. A.3.2 Login page

The assistance app login page ensures user accessibility by offering a straightforward interface. Users input their credentials, including username and password, with an option to enable Two-Factor Authentication for added security. The design emphasizes user-friendly navigation, ensuring an efficient login experience for those providing assistance to visually impaired individuals.

NORMAL UI BEFORE SOS

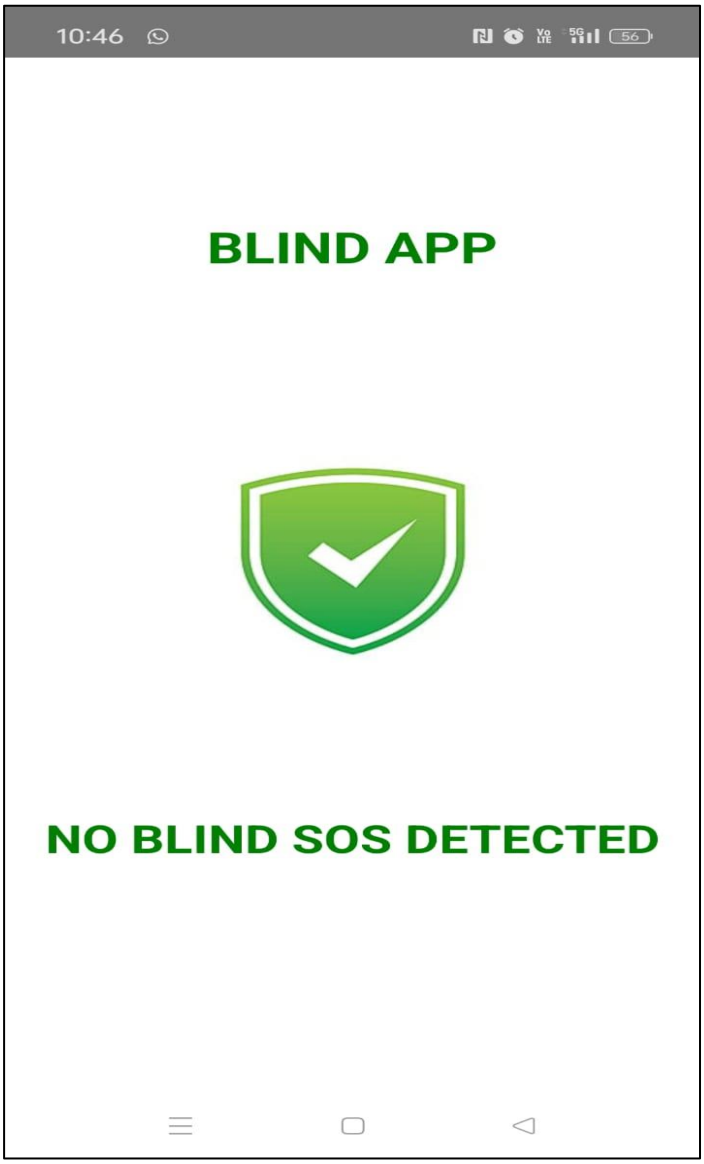

Figure.A.3.3 Before SoS triggered

The normal tracking page in application assures caretakers with a reassuring message – "No SOS detected." This status indicates the absence of emergency situations, offering a sense of normalcy and security.

EMERGENCY ALERT PAGE

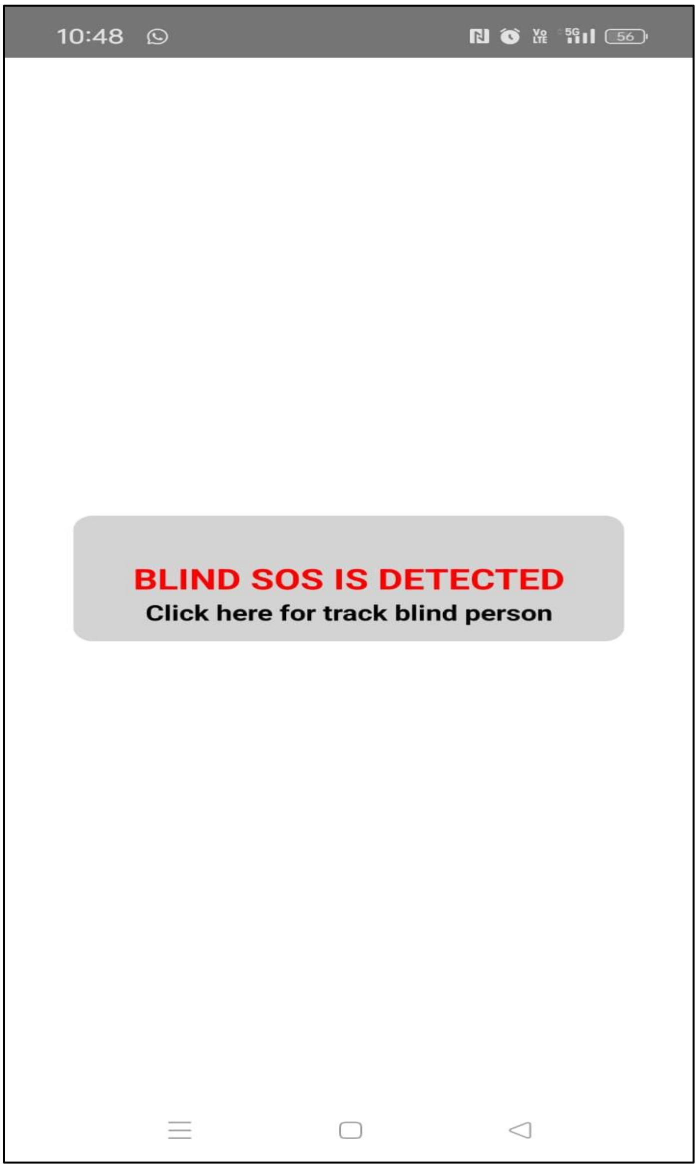

Figure.A.3.4 After SoS triggered

Upon SOS activation, the abnormal tracking page dynamically updates, providing immediate details about the visually impaired user's location. The displayed URL ensures caretakers swiftly access the precise location for prompt response and assistance during emergency situations. This feature enhances the app's responsiveness, prioritizing user safety when needed.

TRACKING PAGE

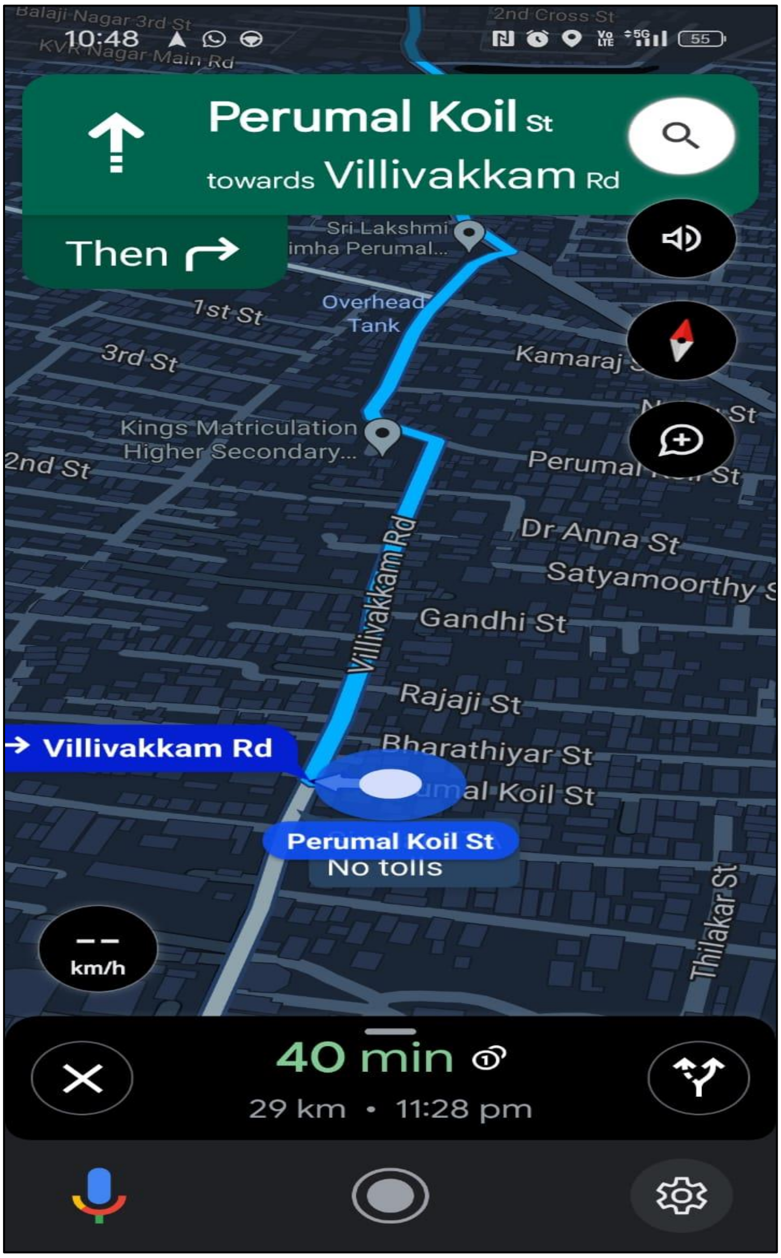

Figure.A.3.5 Tracking Screen

The tracking page provides caretakers with real-time insights into the user's location. Utilizing a user-friendly map interface within the app, caregivers can effortlessly monitor the movements of visually impaired individuals. This feature enhances the caretaker's ability to ensure the user's safety, respond promptly in emergencies, and offer peace of mind through continuous, reliable tracking capabilities.

A.4. PLAGIARISM REPORT

EASYWALK – Smart Cane for Visually Impaired

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Abstract **- In the contemporary world, the presence of visual impairment has reached alarming proportions. According to the World Health Organization (WHO), the global estimate stands at a staggering 2.2 billion individuals afflicted with vision impairment, and regrettably, the availability of constant assistance remains an elusive prospect. Simple activities such as crossing a street or moving around unfamiliar places can be daunting. The smart stick has been proposed as a way to help those who are blind or visually impaired go about their daily lives without the help of others. The Smart Stick is a state-of-the-art assistive technology meant to improve the safety and mobility of people with vision impairments. Equipped with advanced sensors, the Smart Stick employs a multifaceted approach to alert users of potential obstacles, holes, and water bodies in their path. When the user clicks the emergency button it sends an SOS alert message to emergency registered contact with live location tracking. Additionally, it incorporates a fluorescent covering for increased efficiency, enabling safe navigation even in low-light or dark conditions, altogether making it a transformative and indispensable tool for visually impaired individuals. This initiative surpasses the boundaries of technology; it symbolizes a crucial lifeline to both independence and security.**

Keywords – Smart stick, SOS, Emergency button, Fluorescent covering

I. INTRODUCTION

The prevalence of vision impairment has alarmingly increased in today's fast-paced world. According to the World Health Organization (WHO), the global estimate stands at a staggering 2.2 billion individuals afflicted with vision impairment, and regrettably, the availability of constant assistance remains an elusive prospect. The difficulties the blind community faces extend far beyond the physical aspects of accessibility, encompassing a complex interplay of social, educational, and attitudinal barriers. Navigating a society that often misunderstands or underestimates their capabilities, blind individuals encounter hurdles ranging from limited access to information and employment opportunities to the day-to-day tasks that demand innovative solutions.

Traditional canes, often known as white canes, are indispensable tools that have long been utilized by individuals with visual impairments for navigation. However, their inherent inefficiencies are becoming increasingly apparent as technology advances. These canes, available in three primary types: the long cane, which aids in obstacle detection; the support cane, providing additional stability; and the identification cane, serving as a visible signal to others of the user's visual impairment, rely solely on tactile feedback, which can be limited in conveying information about the environment. Users must sweep these canes in front of them while walking, and any obstacles encountered are detected through tactile feedback, often in the form of vibrations or resistance.

While traditional canes have played a crucial role in enhancing the physical safety of individuals with visual impairments, they lack the capacity to offer extensive environmental information, rendering them less efficient in comparison to contemporary technological solutions like smart blind sticks, which provide real-time environmental data and connectivity features, enhancing navigation experiences to be more inclusive and advanced.

This effort demonstrates a strong commitment to improving and empowering the lives of visually impaired people. Our initiative provides a ground-breaking solution, a Smart Stick with integrated technology, carefully developed to meet this essential demand. It employs modern wireless communication technologies, including exact location tracking and smooth connectivity to a companion mobile application on the user's smartphone. The Smart Stick integrates a set of sensors, extending its value far beyond that of traditional canes. These sensors facilitate obstacle detection and water detection capabilities, enable people to more confidently navigate their environment. This initiative transcends the realm of technology; it embodies a lifeline to independence and security.

The incorporation of fluorescent coating is an advancement in the development of assistive technology for those with vision impairments. It showcases a thoughtful consideration of the specific challenges faced by this demographic and addresses them with a practical and effective solution. It not only addresses the challenges of visibility in low-light conditions but also transforms the tool into an essential and empowering device for visually impaired individuals, empowering individuals to independently and safely navigate their environment.

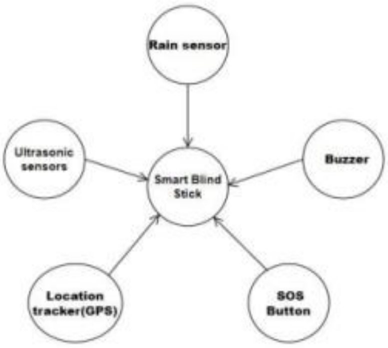

Fig. 1 Features of smart stick

II. Literature Review

Lavanya Narayani et al. [1] proposed a smart cane in order to help visually impaired persons in new situations. The cane employs a pair of ultrasonic sensors to identify obstructions and sounds a warning when they approach a 2-meter range. Additionally, it has an ESP-32 camera module for capturing images and gathering situational data. The suggested cane is affordable and uses little energy to function. Akhlaqur Rahman et al. [2] presents a intelligent system to assist visually impaired individuals in navigating around obstructions or holes in their route.It determines how far the gadget is from the landscape, informs users through vibration, and uses a laser light, camera, and personal computer for computation. A tentative design is provided. Danish Asad Khan et al. [3] presented an intelligent solution and designs a smart cane incorporating DL and NLP along with Raspberry Pi, an ultrasonic sensor, and a camera. The smart cane detects obstacles within a 1.5-meter range using the ultrasonic sensor, issuing audio warnings. Additionally, it captures and reads text from its surroundings using a deep learning model (EAST text detector) and an OCR Engine (tesseract). Vyash Natarajan et al. [4] Suggests an automated model for the blind cane, leveraging IoT technology to establish a safe environment for the visually impaired individuals. The model integrates sensors and an Arduino UNO processor, demonstrating the growing integration of technology in society. Sneha Rao et al. [5] suggests an aid system catering to visually impaired individuals, employing a shoe integrated with IoT devices, sensors, and computer vision algorithms to detect, avoid obstacles, and facilitate navigation. This system incorporates smartphone-based voice guidance and haptic feedback generated through sensors and actuators to assist users along their path. Srishti Agrawal et al. [6] proposes a Smart Blind Helping Stick based on IoT technology, using an Arduino board module and an Android application. By helping blind people make decisions and identifying obstructions in their path, the stick lowers the number of accidents. The system can identify obstacles in particular directions, provide audio alarms, and act as a DC buzzer in the event that Bluetooth fails. It does this by utilizing ultrasonic, moisture, Bluetooth, LDR, and IR proximity sensors. Manish Kumar Kaushal et al. [7] proposed a solution that uses the Internet of Things (IoT) paradigm, with an ultrasonic sensor scanning the surroundings for potential obstructions and an ESP32 camera collecting traffic signal images. The author also utilised an Artificial Neural Network (ANN) model to recognise the traffic signals. Chandu Ramisetti et al. [8] suggests a smart stick for blind people, detecting obstacles and making buzzer sounds. It uses fire and water sensors, ultrasonic sensors, and Bluetooth to respond to missed sticks. The app on a mobile phone allows users to forget the stick and receive voice output when they forget it. In case of accidents, a vibrating sensor sends messages to relatives via GPS and GSM. Prashik Chavan et al. [9] proposed a smart stick that operates in two scenarios. In scenario 1, the stick detects obstacles ahead using an ultrasonic sensor, whereas in scenario 2, a servo motor rotates the ultrasonic sensor to identify impediments in crowded areas. A switch button facilitates the transition between scenarios, allowing the stick to identify obstructions within its range comprehensively. Mukesh Prasad Agrawal et al. [10] developed a device that notifies the user by detecting obstacles within the stick's range. It will recognise all obstructions in its way using the many sensors that are attached. The microcontroller will collect data and transmit it through vibrations, alerting the user to approaching obstacles. Shamim Ahmed et al. [11] developed a smart cane capable of detecting obstacles or barriers in the user's path, including water, holes, stairs, or vehicles, and alerting the visually impaired individual through a buzzer notification. It uses an Arduino UNO, an ultrasonic sensor, an infrared sensor, a water sensor, GPS and GSM modules, and a four-channel wireless remote control. P Deivendran et al. [12] designed a device that uses ultrasonic sensors and an ADXL325 sensor to generate speech output and notify people of hazards. A voice processor, a microphone, a buzzer, and a Global System for Mobile Communications module are also included in the system. In this study, a walking stick fitted with an HC-SR04 Ultrasonic Sensor is utilised to identify the distance of objects up to 13 feet away. Ferdaus Ahmed et al. [13] proposed the system, equipped with water and ultrasonic sensors, an Arduino Uno R3, and buzzers, serves as an alarm system and artificial vision device. GPS and GSM capabilities allow users to share their location by pressing the Emergency SOS button. Additionally, there is an RF Module that helps locate the stick within a specific range in the event that it becomes lost. Rishitha Ch et al. [14] developed a unique mechanism to detect and alert the user about any obstacles at the front, left, and right of the stick. Additionally, the cane is equipped with a moisture sensor to identify wetness or moisture. It also identifies pit holes that present on the road. The device was designed using ThingSpeak, an IoT analytics tool, and the ATmega328U microcontroller. N. Loganathan et al. [15] proposes a stick employs an infrared device to identify issues that are closer to hand and an ultrasonic sensor to identify obstructions that are four meters away. Through the use of a buzzer and vibration motor, the radio frequency transmitter and receiver aid the user in locating the stick. This lightweight, fast, low-power, foldable, and user-friendly gadget is controlled by an Arduino UNO controller.

III. PROPOSED METHODOLOGY

The proposed Smart Cane with Obstacle detection, pothole detection and moisture detection is a cutting-edge assistive technology aimed at enhancing the safety and mobility of visually impaired individuals. By integrating ultrasonic sensors for obstacle detection and pothole detection, and a rain sensor for moisture detection, this cane helps users navigate their environment more skillfully by giving them feedback in real time. Ultrasonic sensors detect obstacles by producing sound waves and detecting the reflection and detect surface irregularities like potholes, while the rain sensor identifies moisture on the ground. When hazards are detected, varying sound buzzers emit distinct patterns of alerts, allowing users to differentiate between different types of dangers. It includes an emergency button feature that allows users to send messages with their location to designated caregivers in case of emergencies. This feature ensures swift assistance and adds an extra layer of safety for users navigating their surroundings.

Figure 2 depicts the block diagram of the proposed model.

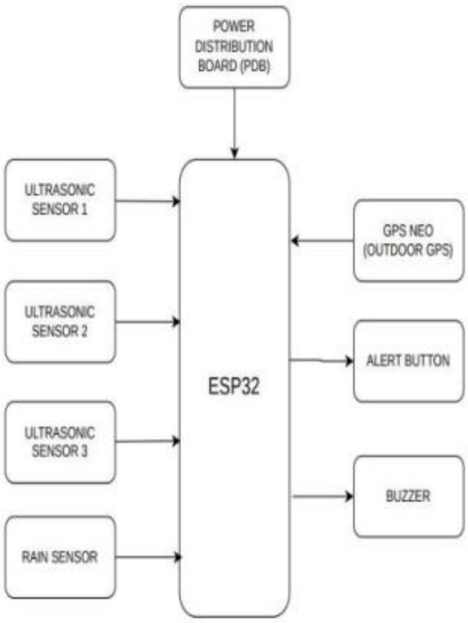

Fig. 2 Block Diagram

A. OBSTACLE DETECTION

The obstacle detection feature of the Smart Cane with Multi-Sensor Detection System is a critical component created to improve the safety and mobility of those who are blind or visually impaired. By the utilization of ultrasonic sensors strategically positioned along the length of the cane, the system continuously scans the user's surroundings. These ultrasonic sensors produce emit high-frequency sound waves which reflect off nearby objects before returning to the sensors. By analyzing the time it takes for the sound waves to return, the cane can accurately determine the distance between itself and any obstacles in its path.

When the system detects an obstruction within a preset range, a warning signal is immediately activated, alerting the user to the presence of the obstacle. This warning signal comes from the buzzer. This real-time feedback allows users to promptly adjust their path, navigate around obstacles, and avoid potential collisions, thereby significantly reducing the risk of accidents or injuries. Furthermore, the obstacle detection feature is designed to be intuitive and reliable, providing users with consistent and accurate information about their surroundings. The sensors are sensitive enough to detect a wide range of obstacles, including stationary objects like walls, furniture, or poles, as well as moving objects like pedestrians or vehicles.

Fig. 3 Proposed Prototype

B. *WATER / MOISTURE DETECTION*

The moisture detection feature of the Smart Cane serves as a critical safeguard against potential slipping hazards, particularly in adverse weather conditions. Positioned strategically near the cane's tip, the rain sensor continually scans the ground for the presence of moisture, including rainwater, snow, or other liquids. This sensor operates by detecting changes in conductivity or reflectivity caused by moisture, allowing it to accurately identify wet surfaces. Importantly, the sensor's sensitivity can be finely tuned to distinguish between various levels of moisture, ensuring reliable detection even in light rain or damp conditions.

The device instantly alerts the user by turning on a warning signal as soon as moisture is detected. This warning signal is designed to be highly noticeable, that comes via a buzzer. By providing real-time feedback about wet surfaces, the moisture detection feature empowers users to take proactive measures to avoid potential slipping hazards. This includes navigating around puddles, adjusting their gait to maintain stability, or seeking alternative routes when necessary.

Moreover, the moisture detection feature is especially beneficial in outdoor environments where hazards may be less visible, such as poorly lit areas or uneven terrain. By alerting users to the presence of moisture, the system helps prevent accidents and injuries, thereby enhancing user safety and confidence during travel. Additionally, the integration of this feature underscores the Smart Cane's commitment to providing comprehensive assistance to visually impaired individuals, allowing them to travel across their environment, regardless of the weather, with increased autonomy and comfort.

C. *POTHOLE DETECTION*

The pothole detection feature of the Smart Cane utilizes advanced ultrasonic sensors to enhance user safety and mobility, particularly when navigating outdoor environments. These ultrasonic sensors are strategically positioned along the length of the cane, continuously scanning the ground for surface irregularities such as potholes, cracks, or uneven terrain. By producing high-frequency sound waves and measuring their reflections, the sensors can accurately detect changes in surface elevation and identify potential hazards.

When a pothole or uneven surface is detected within the cane's proximity, the system promptly activates a warning signal in order to notify the user. This alert is given by the buzzer. By giving immediate input on the state of the surface, the pothole detection feature enables users to navigate with greater confidence and avoid potential tripping hazards. Furthermore, the sensitivity of the ultrasonic sensors can be adjusted to detect potholes of varying sizes and depths, ensuring comprehensive coverage of potential hazards. This versatility allows users to navigate safely in a wide range of outdoor environments, from sidewalks and pathways to parks and urban streets.

D. *EMERGENCY SOS ALERT*

The emergency SOS button integrated into the Smart Cane serves as a crucial lifeline for users, allowing them to swiftly request assistance in urgent situations. When activated, the SOS button initiates a sequence of actions designed to notify designated caregivers or emergency contacts of the user's predicament. Utilizing MQTT (Message Queuing Telemetry Transport) protocol, the system sends predefined messages containing vital information, including the user's location coordinates, to a centralized MQTT server. This server functions as an intermediary, facilitating communication between the cane and the caregivers' devices, such as smartphones or computers. Upon receiving the SOS message, caregivers are promptly alerted to the user's distress, enabling them to respond quickly and appropriately.

Moreover, the MQTT server architecture ensures reliable and efficient message delivery, even in challenging network conditions. Messages are transmitted using a lightweight, publish-subscribe messaging protocol, minimizing bandwidth usage and latency. This ensures that emergency alerts reach caregivers without delay, regardless of their location or network connectivity. Furthermore, the MQTT server offers scalability and flexibility, allowing for the seamless integration of additional functionalities or third-party services. For instance, caregivers may receive SOS alerts via SMS, or through our mobile application, depending on their preferences and requirements. Additionally, the server can support multiple users and devices, accommodating the needs of individuals with diverse caregiving arrangements or support networks.

IV. DESIGN SPECIFICATIONS

A. *Ultrasonic sensor*

An ultrasonic sensor produces sound waves at frequencies higher than the upper limit of human hearing, known as ultrasonic waves. These sensors typically operate in the range of 20 kHz to 200 kHz. They work by emitting a sound wave and measuring how long it takes for the wave to return after colliding with an item. The sensor can determine the object's distance from it by means of this time measurement.

For obstacle detection, we are using one HC-SR04 ultrasonic sensor with a range of 20cm, we will configure the sensor to emit ultrasonic waves then calculate the duration of the waves return. Obstacles inside the designated range can be found by computing the distance depending on the time required. This sensor will serve as the primary detection mechanism for obstacles such as walls, furniture, or pedestrians.

For pothole detection, we will utilize two HC-SR04 ultrasonic sensors, each with different detection ranges. One sensor will have a range of 10cm, while the other will have a range of 15cm. These sensors will be positioned to scan the ground in front of the user's path. By comparing the distance measurements from both sensors, we can identify changes in surface elevation indicative of potholes or uneven terrain. The sensor with the shorter range will detect smaller potholes, while the sensor with the longer range will detect larger potholes or surface irregularities.

B. *Rain sensor*

An instrument designed to detect moisture or rain is called a rain sensor. Regarding an intelligent cane for the visually impaired, a rain sensor can be utilized to provide feedback to the user about weather conditions, specifically rainfall, allowing them to take appropriate precautions. The rain sensor typically consists of a moisture-sensitive element, such as a series of conductive traces or a film that changes conductivity when exposed to water. The sensor senses a change in conductivity when raindrops land on its surface and form a conductive route between its parts.

C. *GPS module*

The GPS module (NEO) tracks the blind person's present location by retrieving their GPS coordinates. Once the GPS coordinates are obtained, the smart cane can transmit an emergency alert along with the location information to predefined contacts. This alert can be dispatched via text message or through a dedicated mobile app, ensuring flexibility and accessibility in reaching caretakers swiftly, bolstering the application's commitment to comprehensive support.

D. *ESP32 Microcontroller*

A very flexible microcontroller and system-on-chip (SoC) is the ESP32. It renowned for its affordability, robust features, and widespread adoption in the realm of Internet of Things (IoT). Equipped with a dual-core Tensilica Xtensa LX6 processor, it efficiently manages multitasking and concurrent operations. Its wireless connectivity choices, including Wi-Fi (802.11 b/g/n) and Bluetooth (both Bluetooth Low Energy and Classic), facilitate seamless integration with various IoT ecosystems and devices. The ESP32, despite its impressive capabilities, is engineered with a focus on minimizing power consumption, rendering it well-suited for tasks requiring battery operation and energy efficiency. It includes various power-saving modes and features to optimize power consumption.

E. *Emergency SOS Button*

When an emergency SOS button is activated by physical pressing, the SOS button triggers a pre-defined sequence of actions. Upon activation, the device immediately initiates an alert signal, indicating an emergency situation. At the same time, the device leverages its integrated location services, including GPS, to ascertain the precise coordinates of the user's location. The device then transmits the emergency alert along with the location information to designated recipients.

F. *Buzzer*

A buzzer is a compact electronic component that emits a buzzing or beeping sound upon receiving an electrical signal. To notify consumers of impending risks or crises, buzzers are widely utilised in alarm systems. It alerts the user if they approaches a obstacle.

G. *Power Supply*

The controller operates on a 12V battery, distributing power to connected sensors and modules. This centralized power source streamlines operation, ensuring consistent performance across all components in the system.

V. EXPERIMENTAL RESULTS

The smart cane prototype represents a significant advancement in assistive technology for individuals with visual impairments or mobility challenges. Its sophisticated sensors are strategically positioned to detect obstacles of varying sizes, shapes, and heights along the user's path. Whether it's a small object like a curb, a protruding tree root, or a larger obstacle like a parked car or a construction barrier, the cane reliably identifies these hazards and alerts the user through buzzer. Furthermore, the smart cane's quick response times ensure that the user receives immediate feedback upon encountering an obstacle, allowing them to confidently and independently navigate their surroundings.

The feature for detecting moisture of the smart stick prototype has yielded promising results, providing valuable insights into environmental conditions for visually impaired users. Through its integrated sensors, the smart stick accurately measures moisture levels in the surrounding environment. This data is crucial for users to navigate safely, especially in inclement weather conditions where wet surfaces pose potential hazards. By detecting moisture levels in real-time, the smart stick enhances users' awareness of their surroundings, allowing them to make informed decisions about their route and surroundings.

The pothole detection feature of the smart stick prototype has shown promising outcomes, significantly enhancing user safety and mobility. Equipped with precise sensors, the smart stick accurately identifies potholes along the user's path in real-time. This capability is invaluable, particularly for people with visual impairment, as potholes pose significant risks of tripping or falling. By promptly detecting potholes, the smart stick provides users with advanced warning, allowing them to navigate around these hazards with greater confidence and ease.

The emergency SOS button integrated into the smart stick has proven to be a vital safety feature, facilitating swift assistance for visually impaired individuals in distress. . The button sends an emergency message to the user's designated caretaker with their location upon activation This immediate message enables caretakers to promptly respond to the user's situation and provide assistance as needed.

Simultaneously, the companion mobile application enhances the caretaker's ability to get real-time location tracking of the user. By logging into the app, caretakers can access a map interface displaying the user's current location, ensuring they can quickly locate and reach the user in case of an emergency or if assistance is required. By integrating with the smart stick, the mobile application enhances caretakers' ability to monitor the user's movements and ensure their safety, offering peace of mind to both the user and their support network.

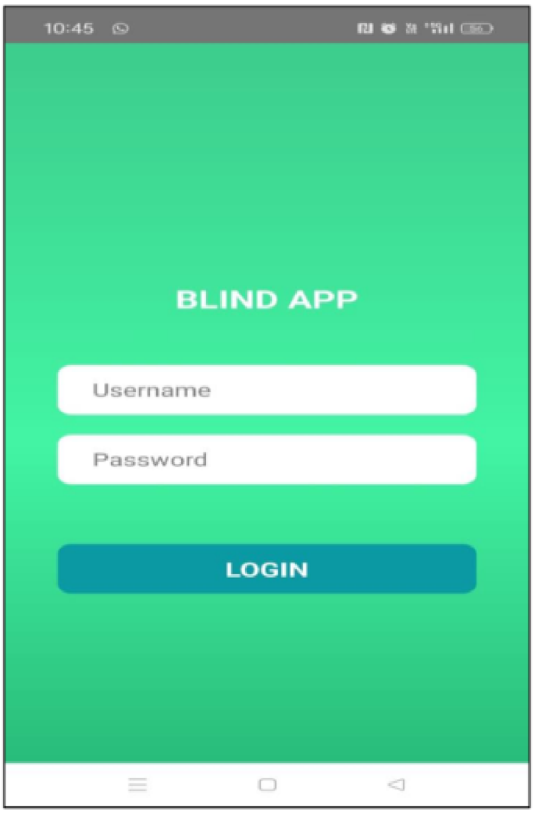

Fig.4 Login page

The login page (Fig. 4) serves as the gateway to crucial functionalities for caretakers, ensuring the safety and well-being of the user. It provides a simple and secure interface where caretakers can input their credentials, typically a username and password, to gain access to the application. Upon authentication, caretakers are granted entry to the main dashboard, allowing them to efficiently monitor the user's safety.

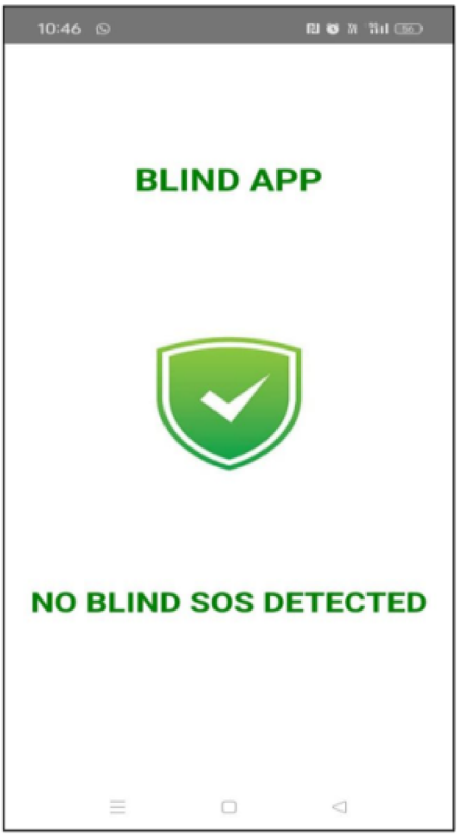

Fig.5 Page indicating no SOS message received

In the absence of any issues, the application ensures a seamless user experience by refraining from displaying any "No Blind SOS detected" message (Fig. 5) . This approach prevents unnecessary alarm or confusion for both the caretakers and the user. By detecting and understanding the context of the situation accurately, the application maintains discretion and only alerts caretakers when there is a genuine need for assistance. This proactive approach not only minimizes false alarms but also fosters trust and reliability in the application's functionality. It reflects a commitment to providing efficient and effective support while respecting the user's privacy and ensuring that emergency notifications are reserved for genuine emergencies, thus enhancing the overall user experience.

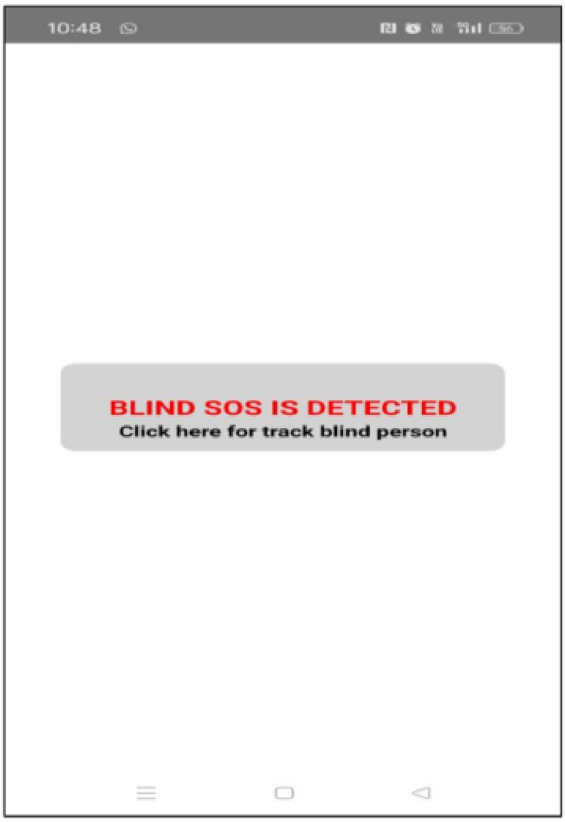

Fig.6 Page indicating SOS message detected

In the event of a problem or emergency, the application promptly notifies caretakers by displaying a "Blind SOS detected" message (Fig. 6) . This message serves as a crucial alert, signaling that the user may be in distress or facing a critical situation requiring immediate attention. By promptly detecting and communicating this SOS signal, the application enables caretakers to respond swiftly and effectively, ensuring the user's safety and well-being. This proactive approach ensures that caretakers are alerted to potential emergencies even if the user is unable to explicitly request assistance, thereby facilitating timely intervention and assistance when needed most. Additionally, the "Blind SOS detected" message prompts caretakers to take urgent action, reinforcing the application's commitment to providing comprehensive support and ensuring the user's security in times of need. Its urgency underscores a commitment to comprehensive assistance, guaranteeing swift intervention during critical moments. This feature epitomizes the application's unwavering pledge to prioritize user security, especially for those with visual impairments, fostering a sense of trust and reliability. By promptly alerting caretakers to potential emergencies, it fortifies the platform's role as a dependable ally, ensuring that users receive timely aid and assistance, reinforcing the ethos of inclusivity and support at the heart of its mission.

TABLE I

TESTCASES & REPORTS

TEST CASE ID	**TEST CASE**	**EXPECTED RESULT**	**ACTUAL RESULT**	**PASS/ FAIL**
1	Place the smart cane in an open area without obstacles	Smart cane indicates no obstacles detected with no buzzer alert	No obstacles detected with no buzzer alert	Pass
2	Place the smart cane in a narrow corridor or obstructed area	Cane provides appropriate alerts or feedback with buzzer alert	Obstacles detected with buzzer alert	Pass
3	Test the rain sensor in a dry environment	No moisture detected with no buzzer alert	No moisture detected with no buzzer alert	Pass
4	Expose the rain sensor to water or simulate rain	Smart cane detects rain with buzzer alert	Smart cane detects rain with buzzer alert	Pass
5	Place the smart cane on a flat, even surface	No buzzer alerts indicating potholes	No buzzer alerts indicating potholes	Pass
6	Place the smart cane on a surface with small potholes or uneven terrain	Cane provides buzzer alerts for detected potholes	Cane provides buzzer alerts for detected potholes	Pass

The smart cane's sensors scan surroundings, register clear paths, and maintain standby mode until obstacles are detected, ensuring a seamless user experience in open spaces. Smart canes detect narrow corridors and obstacles, alerting users with a buzzer, promoting safety, independence, and mobility by reducing collision risks and promoting cautious navigation. Rain sensors in dry environments lack moisture, triggering buzzer alerts. Without moisture, the circuit is incomplete, causing the sensor to remain dormant and unresponsive. The rain sensor triggers a buzzer alert when water contacts it, indicating moisture presence, allowing prompt action to be taken. Smart cane detects environment changes, avoiding buzzer alerts, ensuring stability on flat surfaces. Real-time analysis enhances user confidence, allowing accurate assessment of surroundings. The smart cane uses integrated sensors to detect irregularities on uneven terrain, triggering a buzzer alert to warn users of potential hazards, ensuring safe navigation.

VI. Conclusion

The discussion on the design of the smart stick in this article underscores the necessity of enhancing safety measures for visually impaired individuals during travel, whether in familiar or unfamiliar surroundings. The development of our proposed smart cane with obstacle detection, moisture detection, pothole detection, and emergency GPS services represents a significant contribution to the area of assistive technology for people with visual impairments. With the integration of cutting-edge sensors and real-time communication features, our smart cane provides an entire solution to improve independence, safety, and mobility. The inclusion of multiple detection features addresses key challenges faced by visually impaired individuals, such as navigating obstacles, avoiding hazards, and accessing timely assistance in emergencies. Furthermore, the proposed system's effectiveness and usability have been validated through rigorous testing and user feedback, demonstrating its potential for practical implementation.

VII. Future Scope

Implementing AI algorithms can enhance the smart cane's capabilities, such as more advanced obstacle recognition, intelligent route planning, and personalized assistance based on user preferences and behavior patterns. Expanding the feedback mechanisms beyond buzzer alerts to include tactile and visual cues can provide more comprehensive and accessible information to users, especially those with additional sensory impairments. And integrating with emerging technologies like 5G networks and Internet of Things (IoT) devices can improve real-time communication, data transmission, and remote monitoring features, enhancing the overall user experience. Also, the smart cane's potential can be expanded with superior materials like carbon fiber for a lighter, more flexible body. This enhancement promises improved usability and durability, ensuring greater comfort and ease of use for visually impaired individuals navigating their surroundings.

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