International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Smart Blind Stick with GPS Tracking, 2G GSM Module and Ultrasonic Sensor

Anuja Hebli, Rutika Awale, Riddhi Bhambad, Vishaka Dongare

Abstract:

In today's technologically advanced world, it's imperative to ensure that everyone, including visually impaired individuals, can navigate their surroundings safely and independently. In this paper, we present a novel solution: a Smart Blind Stick equipped with GPS tracking, a 2G GSM module, and ultrasonic sensors. This groundbreaking device is designed to improve the movement and safety of people with visual impairments by offering features such as live location monitoring, obstacle sensing, and communication functionalities. A smart blind stick is designed to assist visually impaired individuals in navigating their surroundings safely. The length of a smart blind stick can vary, but it typically ranges from around 100 to 150 centimetres (3.3 to 4.9 feet). This length allows the user to detect obstacles on the ground and in their immediate vicinity. The weight of a smart blind stick is usually kept lightweight for easy handling and portability. It typically ranges from 200 to 500 grams (7 to 17.5 ounces), although this can vary depending on the materials used in its construction The integration of these features empowers users to navigate with confidence, enabling them to overcome barriers and explore the world around them more freely.

Introduction:

Visual impairment poses significant challenges to individuals' mobility and independence, impacting their ability to navigate unfamiliar environments safely. Traditional white canes have served as valuable tools for the visually impaired, but they often lack advanced features to address modern navigation needs effectively. To address these limitations, we propose the development of a Smart Blind Stick that leverages cutting-edge technologies such as GPS tracking, 2G GSM communication, and ultrasonic sensors. The integration of GPS tracking allows for precise location monitoring, enabling users to identify their current position and plan routes effectively. By incorporating a 2G GSM module, the device facilitates communication with caregivers or emergency services, providing an added layer of security and peace of mind. Additionally, ultrasonic sensors enable the detection of obstacles in the user's path, enhancing safety by alerting them to potential hazards in real-time.

This paper outlines the design, implementation, and evaluation of the Smart Blind Stick, highlighting its key features and functionalities. We are confident that this inventive solution can notably enhance the mobility and quality of life for individuals with visual impairments, enabling them to navigate their environment with increased confidence and independence. By conducting thorough testing and gathering user feedback, our goal is to showcase the effectiveness and dependability of the device in real-life situations.

The following sections of this paper are structured as follows: Section II offers a summary of previous research and developments in assistive technologies tailored for individuals with visual impairments. NSmart Blind Stick, including the integration of GPS tracking, 2G GSM communication, and ultrasonic sensors. Section IV presents the implementation of the prototype and discusses the technical challenges encountered during the development process. Section V offers an evaluation of the device's performance through user testing and feedback. In conclusion, Section VI wraps up the paper by summarizing the discoveries and suggesting potential avenues for future research.

Literature Review:

SR NO.	TOPIC	AUTHORS	YEAR
	Wearable obstacle avoidance electronic travel aids for blind	L. Dandona , R.John	2009
	Smart stick for the blind and visually impaired people	Agrawal, M.P. Gupta	2018
	Ultrasonic sensor based smart blind stick.	Sharma, Gupta	2019

Components Review:

A. Arduino Nano:

Arduino serves as a versatile and powerful platform for a myriad of electronic projects, owing to its diverse range of functions. At its core, Arduino utilizes its microcontroller to execute programmed instructions, enabling interactions with various sensors, actuators, and peripherals. Whether it's reading data from sensors like temperature, humidity, or motion detectors, or controlling actuators such as motors, LEDs, or displays, Arduino facilitates seamless integration and operation. Its opensource nature encourages innovation and customization, with an easy-to-use IDE simplifying code development and deployment. This accessibility extends to its rich ecosystem of compatible components, shields, and accessories, empowering users to tailor their projects to specific needs. Furthermore, Arduino's scalability accommodates projects of varying complexity, from basic blinking LED experiments to sophisticated IoT applications. Bolstered by a robust community of users and resources, Arduino fosters collaboration, learning, and exploration, making it an indispensable tool for electronics enthusiasts, educators, and professionals alike.

The Arduino Nano is a compact and versatile microcontroller board that operates on open-source principles. It is designed to be small, complete, and easy to use on breadboards. Built around the ATmega328P (Arduino Nano 3.x), it can be programmed using Arduino software. Equipped with both digital and analog input/output (I/O) pins, it can interface with various expansion boards, breadboards, and other circuits. Programming for these microcontrollers typically utilizes features from the C and C++ programming languages. the ATmega328P microcontroller, offering similar functionalities to the Arduino Uno but in a smaller form factor. Here are some key features and specifications of the Arduino Nano 3.x:

Microcontroller: At the heart of the Arduino Nano 3.x is the ATmega328P microcontroller, running at 16 MHz with 32 KB of flash memory and 2 KB of RAM. This microcontroller provides ample processing power for a wide range of projects.

Form Factor: The Arduino Nano 3.x features a small and compact form factor, measuring approximately 45mm x 18mm. This makes it suitable for projects with space constraints or where a smaller footprint is desired.

USB Connectivity: The board comes with a built-in USB interface for easy connection to a computer for programming and serial communication. It utilizes a miniUSB connector for data transfer and power supply.

I/O Pins: The Arduino Nano 3.x provides a sum of 14 digital I/O pins, with 6 of them capable of supporting PWM (Pulse Width Modulation) output. Furthermore, it offers 8 analog input pins for the purpose of reading analog sensors or signals.

Power Options: The board can be powered either via the USB connection or an external power supply, ranging from 7 to 12 volts DC. It includes a built-in voltage regulator, allowing it to accept a wide range of input voltages.

Compatibility: The Arduino Nano 3.x is fully compatible with the Arduino IDE and libraries, making it easy to program and work with for both beginners and experienced users. It can be programmed using the same syntax and functions as other Arduino boards.

Expansion Options: Despite its small size, the Arduino Nano 3.x provides headers for connecting additional shields or modules, allowing for expansion and customization of projects.

Integrated Components: Some variants of the Arduino Nano 3.x may include additional integrated components such as a reset button, power LED indicator, and a builtin LED connected to pin 13 for basic debugging and testing.

Overall, the Arduino Nano 3.x is a powerful and compact microcontroller board suitable for a wide range of projects, from simple DIY electronics to more complex embedded systems and IoT applications. Its small size, USB connectivity, and compatibility with the Arduino ecosystem make it a popular choice among hobbyists and professionals alike.

B. Ultrasonic Sensor:

An Ultrasonic sensor functions by gauging the distance to an object through sound waves. It operates by emitting a sound wave at a designated frequency and then detecting the return of that wave after it bounces off an object. The sensor consists of an ultrasonic transmitter that emits the wave, which travels through the air. When this wave encounters an object, it reflects back towards the sensor, where it is captured by the ultrasonic receiver module. Ultrasonic sensors are susceptible to changes in air temperature and humidity, which can impact their accuracy. They typically operate at a frequency of 40 Hz and have a measuring range from 2 cm to 80 cm. Due to their versatility, they are widely used in various applications. These sensors are electronic gadgets that employ ultrasonic sound waves to gauge the distance of objects nearby. Below are the primary elements and characteristics frequently encountered in ultrasonic sensors:

Transmitter and Receiver: Ultrasonic sensors consist of both a transmitter and a receiver. The transmitter emits ultrasonic pulses, typically at frequencies above 20 kHz, into the surrounding environment. The receiver detects the echoes of these pulses as they bounce off nearby objects.

Transducer: The transmitter and receiver elements are usually combined into a single transducer. This transducer converts electrical energy into ultrasonic sound waves during transmission and then converts received ultrasonic signals back into electrical signals for processing.

Time-of-Flight Measurement: Ultrasonic sensors measure the time it takes for ultrasonic pulses to travel from the transmitter, reflect off an object, and return to the receiver. By calculating the round-trip time, the sensor can determine the distance to the object using the speed of sound in the medium (usually air).

Operating Range: Ultrasonic sensors typically have a specified operating range, which defines the minimum and maximum distances over which they can accurately detect objects. This range depends on factors such as the sensor's power, frequency, and sensitivity.

Detection Angle: Ultrasonic sensors emit sound waves in a specific direction, forming a detection cone or beam. The detection angle determines the width of this cone and affects the sensor's field of view. Some sensors have a fixed detection angle, while others allow for adjustable or programmable beam widths.

Resolution: Resolution refers to the smallest detectable change in distance that the sensor can measure. Higher resolution sensors can distinguish smaller changes in distance, providing more precise distance measurements.

Output Interface: Ultrasonic sensors typically provide output signals or data to indicate the detected distance. Common output interfaces include analog voltage signals proportional to distance, digital signals indicating object presence or absence, and serial communication protocols such as UART or I2C.

Applications: Ultrasonic sensors find applications in various fields, including robotics, industrial automation, automotive parking assistance systems, object detection and avoidance, liquid level measurement, and proximity Frequency:

Minimum Frequency: Typically around 20 kHz. This is the lower limit of human hearing and is commonly used as the starting frequency for ultrasonic sensors.

Maximum Frequency: Usually up to 200 kHz or higher, depending on the sensor's design and intended application. Higher frequencies can provide finer resolution and better accuracy in distance measurements.

Current Allowance:

Minimum Current Allowance: Ultrasonic sensors generally have low power consumption, with minimum current allowances often ranging from a few milliamps (mA) to tens of milliamps, depending on the operating voltage and power-saving features.

Maximum Current Allowance: The maximum current allowance depends on the sensor's power requirements and operating conditions. It can range from tens of milliamps to several hundred milliamps for more powerhungry sensors or when operating in active mode with additional features enabled.

It's essential to consult the datasheet or specifications provided by the manufacturer for precise information on frequency range and current allowance for a specific ultrasonic sensor model. These specifications are critical for proper integration and operation of the sensor in your application, ensuring compatibility with power sources and electronic circuits.

The ESP32-CAM is a tiny ESP32-based development board with a camera. Here's a detailed overview:

ESP32 Microcontroller: The heart of the ESP32-CAM is the ESP32 microcontroller, which is a powerful Wi-Fi and Bluetooth enabled system-on-chip (SoC) developed by Espressif Systems. It features dual-core processing, Wi-Fi connectivity (802.11 b/g/n), Bluetooth (Bluetooth Low Energy), and various peripherals.

OV2640 Camera: The ESP32-CAM is equipped with an OV2640 camera module. This camera module is capable of capturing JPEG images and streaming video. It has a resolution of 2 megapixels (1600x1200 pixels) and supports various image formats and resolutions.

MicroSD Card Slot: The ESP32-CAM board typically includes a microSD card slot for storing images and video recordings captured by the camera. This allows for local storage of media without relying on cloud services or external servers.

GPIO Pins: The board provides GPIO pins for interfacing with external components and sensors. These pins can be used for various purposes such as controlling peripherals, reading sensors, and interacting with other devices.

USB-UART Bridge: There's usually a USB-UART bridge on the ESP32-CAM board, which facilitates programming and debugging via USB connection to a computer.

Programming Interface: The ESP32-CAM can be programmed using the Arduino IDE or PlatformIO with the ESP-IDF framework. It also supports MicroPython, allowing for rapid prototyping and development using Python.

Power Options: The board can be powered via USB connection or using an external power source. It typically operates at 3.3V logic levels, although some versions may include voltage regulators to support wider voltage ranges.

Form Factor: The ESP32-CAM is often designed in a compact form factor, making it suitable for projects where space is limited. It can be easily integrated into various applications such as security cameras, IoT devices, and DIY projects.

Overall, the ESP32-CAM offers a versatile platform for building projects that require both wireless connectivity and camera functionality, making it a popular choice among hobbyists, makers, and IoT enthusiasts.

E. Software used:

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, Mac OS and Linux) that is written in the programming language java. It is used and uploads programs to Arduino compatible boards.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

The Arduino IDE accommodates the C and C++ languages, adhering to specific code structuring guidelines. It includes a software library from the wiring project, offering numerous standard input and output functions for initiating the sketch and the main program loop. These functions are compiled and linked with the program.

Methodology:

A. Review Analytics:

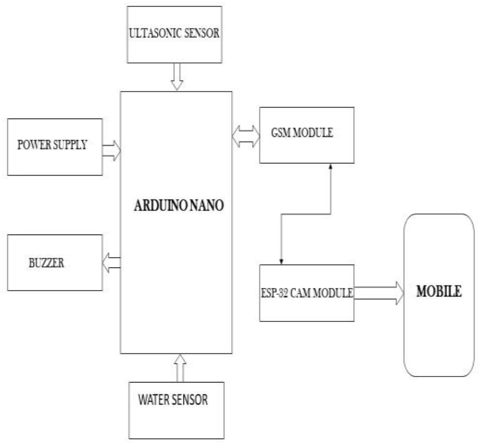
By conducting a thorough requirement analysis, designers and developers can gain valuable insights into the specific needs and preferences of visually impaired individuals, guiding the design and development of a smart blind stick that effectively addresses their mobility and navigation challenges. Identified key requirements for the Smart Blind Stick, including accurate real-time navigation using GPS, communication capabilities via GSM module, and obstacle detection using ultrasonic sensors.

B. System Design:

Developed a detailed system architecture for the Smart Blind Stick, defining the hardware and software components. Designed the integration of the GPS module for location tracking, GSM module for communication, and ultrasonic sensor array for obstacle detection. Defined communication protocols for transmitting location data and receiving commands via the GSM network, ensuring compatibility and reliability. The system design for the Smart Blind Stick involves integrating a GPS module for accurate location tracking, a GSM module for communication, and ultrasonic sensors for obstacle detection. The GPS module provides real-time navigation, while the GSM module enables communication with caregivers or emergency services. Ultrasonic sensors detect obstacles in the user's path, enhancing safety.

Communication protocols are established for seamless data exchange between components. The design prioritizes compactness, durability, and ease of use, ensuring accessibility for visually impaired users. Additionally, the user interface features intuitive feedback mechanisms, such as auditory or tactile cues, to facilitate navigation and enhance user experience.

Block Diagram :



Fig(i)

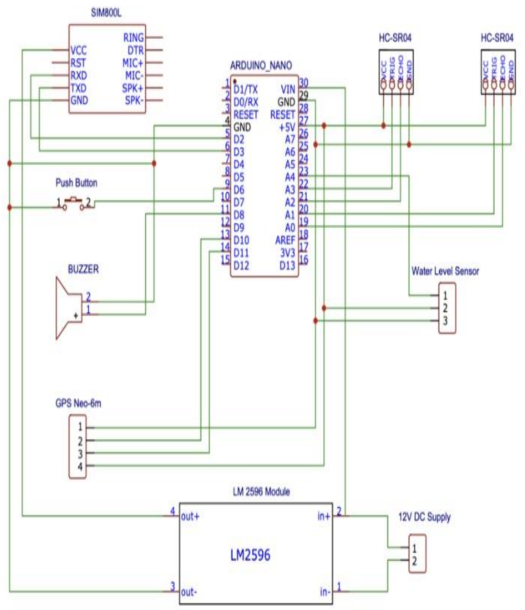
C. Hardware Implementation:

Selected hardware components based on performance power efficiency, and cost considerations, including a GPS receiver, GSM module, microcontroller, ultrasonic sensors, and power source. Designed and fabricated the physical prototype of the Smart Blind Stick, considering factors such as size, weight, and durability. Integrated the hardware components onto a compact and ergonomic housing, ensuring ease of use and accessibility for visually impaired users. The hardware implementation of the Smart Blind Stick integrates essential components to enable its functionalities. This includes incorporating a GPS module for precise location tracking, a GSM module for communication capabilities, and an array of ultrasonic sensors for obstacle detection. The GPS module utilizes satellite signals to determine the user's exact location, enabling accurate navigation assistance. The GSM module establishes cellular connectivity, allowing the user to communicate with caregivers or emergency services and transmit location information. Additionally, the ultrasonic sensors detect obstacles in the user's vicinity, providing real-time alerts to enhance safety during navigation. The hardware is designed to be compact, lightweight, and ergonomic, ensuring ease of use for visually impaired individuals. Careful consideration is given to power management and energy efficiency to prolong battery life and enhance the device's reliability during extended use.

D. Software Development:

Developed firmware/software to control the operation of the Smart Blind Stick and facilitate communication between hardware components. Implemented algorithms for GPS-based navigation, including position tracking, route planning, and turn-by-turn directions. Programmed the GSM module to establish a cellular connection, send location updates, and receive commands from authorized users or caregivers. Designed an intuitive user interface with audio or tactile feedback for conveying navigation instructions and obstacle warnings.

E. System Integration:



F. Testing and Validation:

Conducted extensive testing of the Smart Blind Sti real world environments. Evaluated the accuracy and reliability of GPS navigation under various conditions, including urban areas, indoor spaces, and rural environments. Tested the functionality of the GSM module by sending and receiving messages, making phone calls, and transmitting location data to designated recipients. Validated the effectiveness of obstacle detection using ultrasonic sensors, measuring detection range, sensitivity, and false alarm rates. Testing and validation of the Smart Blind Stick prototype involve rigorous assessments to ensure its functionality and reliability. The GPS module undergoes testing in various environments to evaluate accuracy and consistency in location tracking. GSM module functionality is verified through tests for message transmission, call connectivity, and reception of location updates. Ultrasonic sensors are tested for obstacle detection accuracy and reliability across different scenarios, such as indoors and outdoors. Real-world testing involves simulating typical usage scenarios to assess the device's performance under practical conditions. User testing sessions with visually impaired individuals provide valuable feedback on usability, comfort, and effectiveness. Additionally, validation of the device's performance against predefined criteria ensures that it meets the specified requirements for navigation assistance and obstacle detection. Continuous refinement based on testing results and user feedback enhances the Smart Blind Stick's functionality, usability, and overall effectiveness in assisting visually impaired users.

G. Documentation and Reporting:

Documented the entire development process, including design specifications, hardware configurations, software algorithms, and test results. Prepared a detailed report following IEEE formatting guidelines, including sections on introduction, methodology, results, discussion, and conclusion. Included diagrams, charts, and photographs to illustrate key concepts, experimental setups, and prototype demonstrations. Documentation and reporting are integral aspects of the development process for the Smart Blind Stick. The documentation encompasses a detailed account of the project's inception, methodologies employed, and the intricacies of implementation. It provides insights into the requirements analysis, system design, hardware integration, software development, testing procedures, and user evaluations conducted throughout the project lifecycle. Clear and concise reporting is essential to convey the findings, successes, and challenges encountered during development. It includes comprehensive analysis and interpretation of test results, discussions on the device performance, and recommendations for future enhancements. Adherence to IEEE formatting guidelines ensures consistency and professionalism in presenting the information. Additionally, documentation serves as a valuable resource for stakeholders, researchers, and developers interested in the field of assistive technologies for visually impaired individuals. It facilitates knowledge sharing, replication of methodologies, and fosters collaboration to advance the development of innovative solutions for the visually impaired community.

Conclusions:

In summary, the development of a Smart Blind Stick integrating GPS and 2G GSM technology offers a transformative solution for visually impaired individuals' mobility and safety needs. By leveraging GPS for precise navigation and 2G GSM for real-time communication, the device provides enhanced independence and security. The integration of ultrasonic sensors further augments obstacle detection, ensuring safer navigation in diverse environments. Through rigorous testing and user feedback, the Smart Blind Stick demonstrates promising efficacy and usability. However, continuous refinement is essential to optimize performance, address user concerns, and enhance accessibility. Overall, the Smart Blind Stick represents a significant advancement in assistive technology, empowering visually impaired individuals to navigate confidently and efficiently in their surroundings while fostering greater inclusivity and autonomy in society. Further research and development hold the potential to refine its capabilities and expand its impact, improving the quality of life for individuals with visual impairments.

References:

[1] Nowak, Michal, et al. "Characteristics of refractive errors in a population of adults in the central region of Poland." International journal of environmental research and public health 15.1 (2018): 90.References:

[2] G. Gayathri, M. Vishnupriya, R. Nandhini and M.
Banupriya "Smart Walking Stick for Visually Impaired". International Journal of Engineering and 2018 JETIR [6] R. Sheth, S. Rajandekar, S. Laddha and R.
Chaudhari "Smart White Cane – An Elegant and
Economic Walking Aid." American Journal of
Engineering Research. Vol. 3, number 10, pp. 84-89, 2014.

[7] C.S.Kher, Y.A.Dabhade, S.K.Kadam, S.D.Dhamdhere
and A.V.Deshpande " An Intelligent Walking Stick for the Blind" International Journal of Engineering Research and General Science, vol. 3, number 1, pp. 1057- 1062, 2015.

[8] B.G. Roopashree, B.S. Patil and B.R. Shruthi
"Smart Electronic Stick for Visually Impaired." International Journal of Innovative Research in Science, Engineering and Technology, vol. 4, number 7, pp. 63896395, 2015.

[9] O. O. Olakanmi, "A Multidimensional Walking Aid for Visually Impaired Using Ultrasonic Sensors Network with Voice Guidance", International Journal of Intelligent Systems and Applications (IJISA), vol. 6, number 8, pp. 53-59, 2014. DOI: 10.5815/ijisa.2014.08.06

[10] E. J. Chukwunazo and G. M. Onengiye "Design and Implementation of Microcontroller Based Mobility Aid for Visually Impaired People." International Journal of Science and Research. Vol. 5, issue 6, pp. 680-686, 2015.

[11] G. Prasanthi and P. Tejaswitha "Sensor Assisted
Stick for the Blind People." Transactions on Engineering and Sciences, vol. 3, number 1, pp. 12-16,
2015

October 2018, Volume 5, Issue 10
www.jetir.org (ISSN-2349-5162) JETIRDQ06029 Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org
221

[3] R. Radhika, P.G. Pai, S. Rakshitha and R. Srinath
"Implementation of Smart Stick for Obstacle Detection and Navigation." International Journal of Latest Research in Engineering and Technology, vol. 2, number 5, pp. 4550, 2016.

[4]] M.H. Mahmud, R. Saha and S. Islam "Smart Walking Stick – An Electronic Approach to Assist Visually
Disabled Persons." International Journal of Scientific and Engineering Research, vol. 4, number 10, pp. 111-114, 2013.

[5] A. Jose, G. George, M.R. Nair, M. J. Shilpa and M.
B. Mathai "Voice Enabled Smart Walking Stick for
Visually Impaired." International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 5, pp. 80-85, 2016.