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Perception of RFID Based Assistive and Localization for Visually Impaired People

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Abstract: *The Arduino IDE functions as a software tool utilized for programming Arduino boards and are accessible as an open-source application on the internet. Google has also expanded Android's capabilities to other platforms, such as Android TV, Android Auto, and Android Wear, each featuring its own specialized user interface. This adaptability makes Android compatible with various devices like notebooks, game consoles, digital cameras, and other electronics. The widespread adoption of mobile phone technology has significantly broadened Android's user base and the potential of mobile devices. From serving as basic communication tools, mobile phones have evolved into multifunctional devices, including cameras, music players, and tablet PCs, and web browsers. As emerging technologies continue to appear, there is a growing demand for innovative software and operating systems. These technologies have practical applications in different areas, such as aiding visually impaired individuals, supporting deaf and mute individuals, and providing indoor map navigation and localization services.*

1. INTRODUCTION

Blind mobility remains a significant challenge for scientists globally, as they strive to develop effective assistive devices for the visually impaired. The issue has gained prominence due to the increasing number of visually impaired and partially sighted individuals. The World Health Organization's data indicates that the prevalence of blindness varies between industrialized and developing countries, with approximately 0.4% and 1% of the population affected. To address the problems faced by the visually impaired, this paper proposes a system enabling blind individuals to move independently and make emergency calls to a predefined number. Additionally, the system aids in locating lost individuals. The system's architecture is depicted in Fig1. During the experimental phase, the system demonstrated promising performance on various surfaces, achieving a 5% error rate. The primary focus of this project is on visually impaired individuals, often overlooked by large companies due to their relatively small numbers. By addressing the needs of this group, the project serves as a visual indicator to draw attention to their requirements. The system combines RFID tags and Braille for those who cannot hear, providing them with a means to navigate and determine their location independently. With an established RFID infrastructure, blind individuals can explore and engage in activities without external assistance, and it can also benefit advances in robotics by providing precise location information.

2. LITERATURE SURVEY

Title: "MERCURY: A Hardware-Free System for Indoor Localization and Navigation "The growing demand for location-aware applications on mobile devices necessitates real-time indoor positioning. One effective approach is to combine various positional information sources like inertial and ranging measurements with maps, creating a network localization and navigation (NLN) paradigm. However, existing infrastructure-free systems fail to effectively fuse different data types. This paper introduces the Mercury system, implementing NLN's key concepts, spatiotemporal cooperation, and environmental knowledge. By employing a real-time belief propagation algorithm, Mercury successfully combines map data with acceleration, angular velocity, and range measurements from smartphones. Experimental evaluations demonstrate that Mercury achieves reliable location accuracy, with spatial cooperation significantly reducing user location uncertainty and improving robustness to imperfect initial positions compared to other systems. Title: "CANS: A Congestion-Adaptive and Small Stretch Emergency Navigation Algorithm Using Wireless Sensor Networks" Wireless sensor networks (WSNs) find essential applications in emergency evacuation navigation, ensuring safe and swift exits during hazardous situations. Existing solutions prioritize finding the safest path for individuals but overlook potential congestions and detours caused by a large number of people rushing to exits.

In this paper, we present CANS, a novel Congestion-Adaptive and small stretch emergency Navigation algorithm for WSNs. CANS adopts the level set method to monitor hazardous area boundaries and exit evolution, allowing nearby individuals to experience mild congestion with slight detours, while distant individuals avoid unnecessary deviations. Additionally, CANS incorporates a local and simple status updating scheme to adapt to emergency dynamics. Remarkably, CANS operates entirely through cyber-physical interactions between people and sensor nodes without relying on location information or a specific communication model. It offers scalability, efficiency, and effectiveness as validated through experiments and simulations. In their 2016 article titled "Evaluation of Two Wi-Fi Positioning Systems Based on Autonomous Crowdsourcing of Handheld Devices for Indoor Navigation," Y. Zhuang, Z. Syed, Y. Li, and N. El-Sheimy discuss the limitations of current Wifi positioning systems (WPS) that rely on databases of Wi-Fi access point locations and propagation parameters. Building such databases can be time-consuming and labor-intensive. To address these issues, the authors propose two autonomous crowdsourcing systems that operate on smartphones. These systems utilize their designed algorithms along with an inertial navigation solution from a Trusted Portable Navigator (TPN) to autonomously and adaptively build and update the database based on the dynamic indoor environment. The paper also presents two improved Wi-Fi positioning schemes, namely fingerprinting and trilateration, corresponding to the two database building systems.

These schemes are evaluated and compared through field tests. The primary contribution of the paper lies in the introduction of two crowdsourcing-based WPSs that overcome the limitations of existing crowdsourcing-based systems that require a floor plan or GPS, are suitable only for specific indoor environments, or implement a simple MEMS-based sensors' solution. The results from different test scenarios show that both proposed systems achieve promising performance, with average positioning errors for both schemes being less than 5.75 meters. In the paper titled "RGB-D Camera Based Wearable Navigation System for the Visually Impaired" by Y. H. Lee and G. Medioni (2016), a novel wearable indoor navigation system for the visually impaired is introduced. The system aims to guide visually impaired users from one location to another without relying on a pre-existing map or GPS data. To achieve this, the system utilizes accurate real-time ego motion estimation, mapping, and path planning in the presence of obstacles. The ego motion estimation is performed in real-time using sparse visual features, dense point clouds, and the ground plane, which helps reduce drift from the head-mounted RGB-D camera. Furthermore, a 2D probabilistic occupancy grid map is generated to efficiently analyze travers ability, forming the basis for dynamic path planning and obstacle avoidance. The system can store and reload maps during travel, allowing the coverage area of navigation to continually expand. It calculates the shortest path between the starting and destination locations and generates a safe and efficient way point based on the travers ability analysis result and the shortest path. The way point is constantly updated as the user moves.

3. EXISTING SYSTEM

Over the last few decades, numerous indoor navigation systems have emerged, specifically designed for mobile devices. These systems incorporated a range of technologies like wireless sensor network fingerprints, geomagnetic fingerprints, inertial measurement units, and even utilized the camera on Google Glass devices. However, in recent times, significant progress has been made in computer vision software, such as visual odometer, and hardware like graphics processing units (GPUs). These advancements have opened up exciting new opportunities for real-time indoor simultaneous localization and mapping (SLAM) based on vision-based techniques. With the power of computer vision and high-performance hardware at their disposal, these developments hold the potential to enable highly accurate and real-time indoor navigation.
This groundbreaking wearable technology is the first of its kind for blind individuals, effectively addressing the shortcomings of existing devices. While there are numerous instruments and smart devices available for visually impaired individuals to aid navigation, many of them suffer from portability issues and require extensive training to operate. This innovation stands out for its affordability, making it accessible to a wide range of users. What sets this device apart is its unique design: it can be comfortably worn like a piece of clothing, boasting simplicity and a remarkably low cost. Such an all-encompassing solution has not been seen in the market before. With the potential for improvements in the prototype and widespread adoption, this innovation can greatly benefit the blind community. Built upon an Arduino board, this special wearable device is equipped with five ultrasonic sensors. These sensors are distributed across different parts of the body: two on each shoulder, two on

each knee, and one on the hand. The five ultrasonic sensors together provide a five-dimensional view of the surrounding environment, enabling blind individuals to navigate effortlessly. When the ultrasonic sensors detect obstacles in their vicinity, the device alerts the user through vibrations and sound beeps. Notably, the intensity of the vibration and the rate of beeping increase as the distance to the obstacle decreases. This feature makes the device fully automated, allowing blind individuals to confidently and independently travel anywhere without the fear of colliding with objects. Overall, this wearable technology shows great promise in revolutionizing the lives of visually impaired individuals, offering a practical, affordable, and user-friendly solution for their navigation needs**.**

Existing System - Block Diagram:

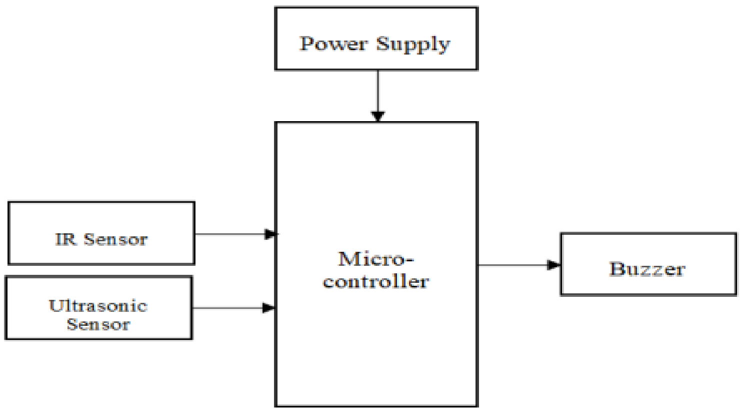

FIGURE 1. Block Diagram of Existing System

Existing System - Circuit Diagram:

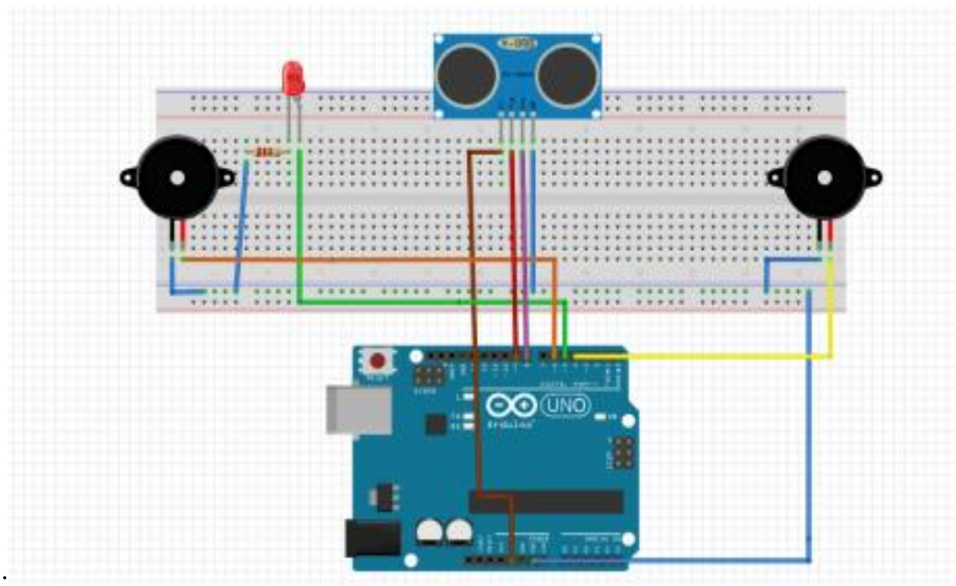

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FIGURE 2. Circuit Diagram of Existing System

Instructions for assembling the circuit:

Start by cutting the breadboard into dimensions of 5 X 3 cm and then solder the female headers for the Arduino onto the board. Proceed to solder the buzzer next. Attach the vibrating motor using a glue gun and solder wires to establish a connection. Connect the LED to the circuit. Proceed to connect the switch. Next, connect header pins for the ultrasonic sensors and the battery input. Follow the circuit diagram and solder all the components accordingly. Finally, connect both the Arduino and ultrasonic sensor to the board. Disadvantages of the existing system: The current system lacks indoor positioning accessibility.

4. PROPOSED SYSTEM

Our team introduced an innovative mobile solution for blind navigation and wayfinding, achieving superior results compared to previous attempts. The core of our system involves an RFID indoor map capable of parsing geometric data and extracting. This feature significantly improves the overall user experience. To address the limitations of voice recognition software, which often experiences malfunctions in noisy environments or misunderstands user commands, we developed the Smart Cane. This robust Human-Machine Interface (HMI) reduces reliance on voice commands, thus mitigating the related issues. In conclusion, our real-time holistic mobile solution presents a substantial advancement in blind navigation and wayfinding, showcasing significant success in comparison to previous endeavors.

Transmitter (Blind People Stick): In our system, we utilize an ultrasonic range finder, which offers three different techniques to obtain data: Serial, Analog, and Pulse Width Modulation (PWM). The distance is determined based on the analog value obtained from the sensor. However, the accuracy of this method is unsatisfactory, leading to significant deviations from the actual distance measurement. To address this issue, we employ the pulse width modulation technique. In this approach, the sensor generates 58 pulses per centimeter and 147 pulses per inch, resulting in a more accurate distance measurement. To implement our project, we chose the Arduino NANO board, which incorporates the AT mega 328p microcontroller. This microcontroller effectively operates the sensors and performs filtering operations on the acquired distance data from the sonars. The filtered distance information is then transmitted to an Android application through a Bluetooth module. Additionally, we have connected three vibrating motors to the board as part of our setup.

Block Diagram:

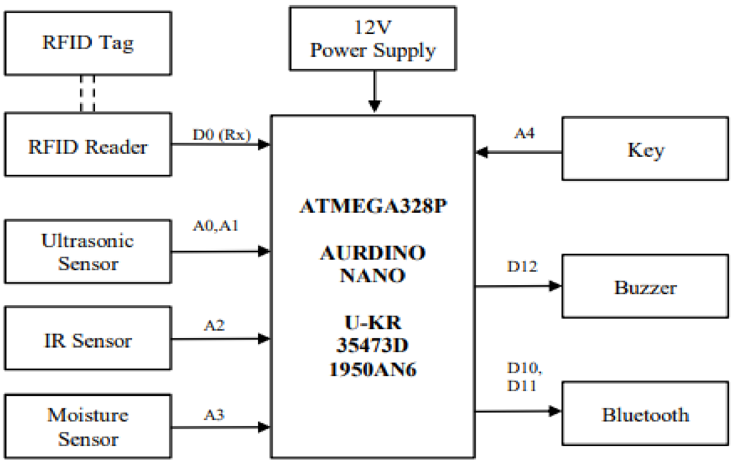

FIGURE 3. Block Diagram of Transmitter

Receiver (Android Phone): The Radio Frequency Identification (RFID) system consists of a tag (transponder) that holds a unique ID. An RFID reader is utilized to capture this unique ID from the tag. The reader emits electromagnetic waves containing a signal to identify objects. The RFID tag, upon receiving the radio frequency signal, then transmits the identification information of the object it is attached to back to the reader.

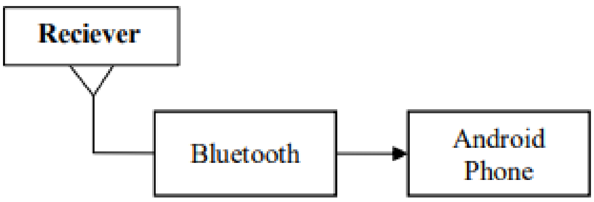

FIGURE 4. Block Diagram of Receiver

A. Particle filtering method:

In the past, several techniques have been utilized for tag detection. One such approach is the Particle Filter (PF) method, which is used for accurately tracking indoor RFID tags. By combining RFID data from the RFID system with image data from the webcam, this system can precisely identify the position of a vehicle.

B. K-nearest neighbor algorithm:

For localization, the K-Nearest Neighbor (KNN) algorithm is employed to estimate the closest visible position of the target tag to the reader. To achieve accurate location sensing of objects, a novel localization algorithm is utilized, which detects changes in tag readability to infer the presence of neighboring tags.

C. Trilateration positioning method

The Trilateration Positioning Method is employed to determine the position of a tag or reader by utilizing range information. This system introduces a new algorithmic approach for passive RFID localization in indoor environments, incorporating elliptical trilateration and fuzzy logic.

D. Real-time location system (RTLS) algorithm:

The Real-Time Location System (RTLS) is used to automatically identify and track object locations in real-time, typically within a building or enclosed area. RTLS is more efficient than other methods as it requires fewer iterations, provides security bonding, and ensures data packet delivery.

E. Bluetooth module"

This system incorporates a Bluetooth module HC-05 to transmit data about the location of detected objects to the Android application. The choice of the Bluetooth module is based on its affordability, ease of interfacing with the microcontroller, and compatibility with Android phones, making it ideal for communication between the hardware module and the Android application.

F. Voice command:

The "APK for Blind" application was specifically designed to cater to blind individuals who may not be familiar with the Android interface. To ensure ease of use, the application enables them to control it entirely through voice commands in the English language. The implementation allows blind users to give voice commands without the necessity of physically touching the phone. Instead, they can simply press the headset button, providing a convenient and accessible way to interact with the application hands-free.

Circuit diagram:

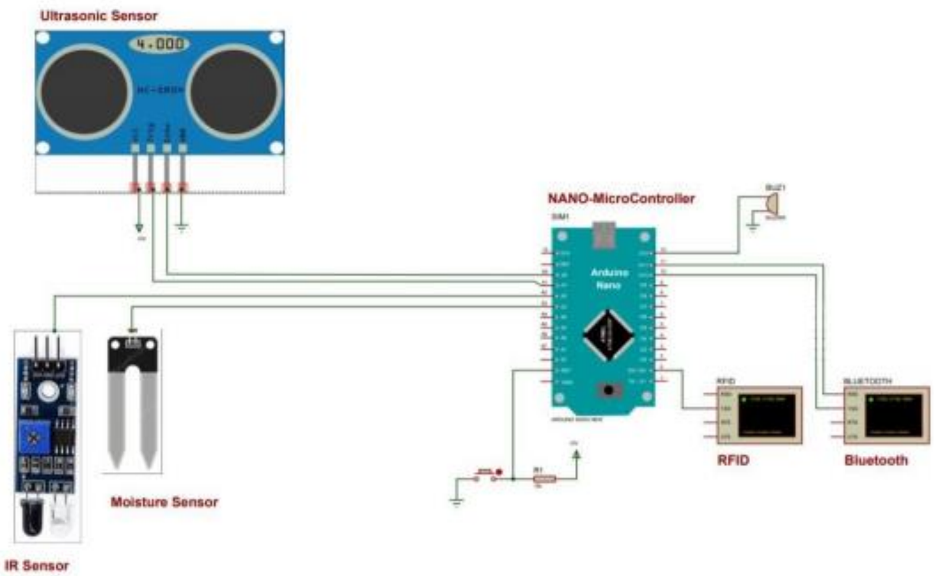

FIGURE 5. Circuit Diagram of Proposed System

***Working of Proposed System*:**

The HC-05 module is a convenient Bluetooth SPP (Serial Port Protocol) device created for effortlessly establishing a wireless serial connection. It works with Bluetooth V2.0+EDR (Enhanced Data Rate) and offers a speedy 3Mbps modulation. The module includes a comprehensive 2.4GHz radio transceiver and baseband, and it operates using CSR Blue core 04-External single chip Bluetooth technology with CMOS technology and AFH (Adaptive Frequency Hopping Feature). Its compact dimensions, measuring 12.7mm x 27mm, contribute to simplifying the design and development procedures. RFID tags are mounted along the path within the indoor environment, and the blind person carries a white cane or hand glove equipped with an RFID reader. When the blind person enters a room or area, the RFID reader reads the tag's ID, and a voice feedback is generated from the smartphone. The blind person wears earphones to receive the audio instructions. The RFID tag information is stored in a database, and the hardware components are connected to the application via Bluetooth. The navigation system involves various location tracking algorithms to guide the visually impaired person effectively. On the user side, an RFID reader module with an integrated microcontroller and an RF transceiver transmit the tag's information. On the server side, a Smartphone receives the tag's information for wireless communication with the user. Along the path, RFID passive tag networks are installed for path identification. The tag IDs are stored in the database. The RFID reader reads the tags and wirelessly transmits the data to the smartphone. The smartphone then searches for the received tag ID in the database and responds to the user through voice commands. The visually impaired person follows the audio instructions to navigate and move forward safely**.**

Hardware Components
Arduino NANO Microcontroller. RFID, IR Sensor, Ultrasonic Sensor, Moisture Sensor, Bluetooth, power Supply, Transformer.
Power Supplies**:** It is typically associated with providing electrical energy, occasionally mechanical energy, and rarely other types of energy. For digital electronics experimentation, a small +5V power supply can be quite handy. Inexpensive wall transformers with adjustable output voltage can be easily obtained from electronics stores and supermarkets. However, these transformers often suffer from poor voltage regulation, making them less suitable for digital circuit experiments unless improved regulation is achieved. To address this issue, the following circuit serves as a solution:

Transformer: When the primary circuit's current changes, it generates a varying magnetic field, which induces a changing voltage in the secondary circuit. This enables energy transfer between the two circuits. The voltage induced in the secondary circuit (VS) is ideally proportional to the primary circuit's voltage (VP) based on the ratio of their respective wire windings. By appropriately selecting the number of turns in the windings, transformers can step up or step down alternating voltage. Stepping up occurs when the number of turns in the secondary coil (NS) is greater than in the primary coil (NP), while stepping down happens when NS is less than NP. This is preventing significant energy losses due to wire resistance. To overcome these losses, transformers convert electrical power into a high-voltage, low-current form for efficient long-distance transmission. Once the power reaches its destination, it is transformed back to its original form for effective distribution. This has enabled power generation to be situated far from the points of demand, shaping the electricity supply industry worldwide. Transformers come in various sizes and designs for specific applications, ranging from small coupling transformers in microphones to massive giga volt-ampere-rated units used in national power grids. Despite their diversity, all transformers operate on the same fundamental principles. Half-wave rectifier: The half-wave rectifier permits only one half (positive or negative) of the AC wave to pass through, blocking the other half. This results in a lower mean voltage since only a portion of the input waveform reaches the output. In single-phase supply, it requires one diode, and in three-phase supply, it needs three diodes. However, the output from half-wave rectifiers contains significant ripple and requires extensive filtering to eliminate AC frequency harmonics. Full-wave rectifier: A full-wave rectifier converts the entire input waveform into a constant polarity (either positive or negative) at its output. It effectively converts both polarities of the input waveform into pulsating direct current, resulting in a higher average output voltage. This type requires two diodes and a center-tapped transformer. The 78xx and 79xx series are two types of voltage regulators. The 78xx series provides fixed regulated positive voltages ranging from 5V to 24V, while the 79xx series provides fixed regulated negative voltages. Arduino Nano shares similar functionality with the Arduino Duemilanove but comes in a different package. It is equipped with the ATmega328P microcontroller, the same as Arduino UNO. The primary difference lies in their package types, where Arduino UNO uses PDIP with 30 pins, and Arduino Nano uses TQFP with 32 pins. Additionally, the Nano offers two extra ADC ports, providing a total of 8 ADC ports. Unlike other Arduino boards, the Nano lacks a DC power jack and instead uses a mini-USB port for programming and serial monitoring. It automatically selects the strongest power source based on potential difference, and the power source selection jumper is not applicable**.**

5. SOFTWARE REQUIREMENTS

The Arduino IDE is a software tool used for programming Arduino boards, available as an open-source application on the internet. Google has also extended Android's functionality to other platforms like Android TV, Android Auto, and Android Wear, each with its own specialized user interface. Android is versatile and can be found in various devices such as notebooks, game consoles, digital cameras, and other electronics. The widespread adoption of mobile phone technology has significantly expanded Android's user base and the capabilities of mobile devices. From basic communication tools, mobile phones have evolved into cameras, music players, tablet PCs, web browsers, and more. As new technologies emerge, the demand for innovative software and operating systems continues to grow. These technologies have various practical applications, including assisting visually impaired individuals, supporting deaf and mute individuals, and providing indoor map navigation and localization services.

6. CONCLUSION

The outcome of our efforts is a flexible architecture that enables blind individuals to navigate and track their movements autonomously. We conducted extensive testing with various scenarios to ensure its functionality and effectiveness. The blind assistive device, along with the Eye mate for Blind Android application, proves to be highly beneficial for blind individuals as it allows them to move independently without relying on others. Moreover, the system incorporates a voice call feature that enables the user to request emergency assistance when needed. Additionally, the implementation of the Blind Tracker application facilitates real-time tracking of the blind person's location, making it a practical and valuable tool for ensuring their safety and well-being.

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