

IOT-Based Smart Shoes for Blind People

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Abstract

Visually impaired people experience significant difficulties while moving independently, particularly in unfamiliar environments and public places where obstacles may not be easily detected using conventional walking aids. This paper presents an IoT-based smart shoe designed to assist blind and visually impaired users through obstacle detection, navigation assistance, location tracking, and energy harvesting. The proposed system integrates an ultrasonic sensor, Arduino Nano, buzzer, vibration motor, GPS module, battery, and piezoelectric discs. The ultrasonic sensor detects nearby obstacles and the Arduino Nano processes the sensed information to generate vibration and buzzer alerts. A GPS-based tracking unit provides the user's location and can trigger an SMS to a parent or guardian when the user activates the control switch. In addition, piezoelectric discs embedded in the shoe sole convert mechanical pressure generated during walking into electrical energy, which is stored in a rechargeable battery. The developed prototype provides a compact, low-cost, and user-friendly assistive solution that can improve independent mobility and safety for visually impaired people.

Keywords— IoT, smart shoes, visually impaired, ultrasonic sensor, Arduino Nano, GPS, piezoelectric energy harvesting, obstacle detection, assistive technology.

INTRODUCTION

Blind and visually impaired people face several challenges in moving independently, especially while travelling through unfamiliar environments. Conventional aids such as walking sticks and trained assistance animals provide valuable support, but they may not detect every obstacle or provide location information. The project report identifies the need for a compact electronic assistive device capable of sensing obstacles and providing immediate feedback to the user. The proposed smart shoe embeds sensing and control hardware directly into footwear, thereby reducing the need for the user to carry an additional electronic device.

The proposed system uses IoT-enabled sensing and an embedded controller to improve mobility. An ultrasonic sensor is employed to identify obstacles in the user's path, while a buzzer and vibration motor provide warning signals. The system is intended to operate in both indoor and outdoor environments and provide a simple interface for the user. The project report further describes GPS tracking as an additional safety feature for locating the visually impaired person.

Another important feature of the proposed system is energy harvesting from human walking. Piezoelectric discs are installed in the shoe sole to convert mechanical pressure generated during walking into electrical energy. The generated energy is subsequently stored in a battery and can support low-power wearable electronics. The report describes piezoelectric energy harvesting as an environmentally friendly method for utilizing mechanical energy that would otherwise be wasted.

Thus, the proposed smart shoe combines obstacle detection, user feedback, location tracking, and energy harvesting in a single wearable platform. The resulting system aims to provide a low-cost and user-friendly assistive device that can improve the independence and safety of visually impaired users.

LITERATURE SURVEY

Ariba Khanam, Anuradha Dubey, and Bhabya Mishra proposed a smart assistive shoe for visually impaired people using ultrasonic sensors and an Arduino controller. The system detects nearby obstacles and provides audio and vibration feedback to the user, thereby improving mobility and reducing dependence on conventional walking aids [1]. Shlesha Khursade *et al.* developed a smart shoe system that combines obstacle detection, buzzer alerts, vibration feedback, and smartphone-based navigation. Their work also considered predefined obstacle detection ranges and navigation algorithms for assisting visually impaired users [2].

Saylee Begampure *et al.* proposed smart navigational shoes integrating GPS, Bluetooth, a smartphone application, and vibration-based directional guidance. The system uses location information to provide navigation instructions through the wearable device [3]. Based on these studies, the proposed work combines obstacle detection and navigation with additional GPS tracking and piezoelectric energy harvesting. Piezoelectric discs are embedded in the shoe sole to convert mechanical pressure during walking into electrical energy, which can be stored in a battery. Thus, the proposed system integrates obstacle detection, user alerts, location tracking, and energy harvesting into a single wearable assistive platform.

PROBLEM STATEMENT

Visually impaired people face difficulties in independently identifying obstacles and navigating safely in unfamiliar environments. Conventional walking aids may not provide sufficient information about obstacles, direction, or the user's location. Therefore, there is a need for a compact and affordable wearable system that can detect nearby obstacles, provide immediate feedback, track the user's location, and support safer independent movement.

OBJECTIVES

The main objectives of the proposed system are:

1. To develop an IoT-based smart shoe capable of detecting obstacles and providing vibration and buzzer alerts to assist visually impaired users during walking.
2. To integrate GPS-based location tracking and piezoelectric energy harvesting to improve user safety and provide supplementary power for the wearable system.

PROPOSED SYSTEM

The proposed smart shoe consists of an Arduino Nano as the primary controller, an ultrasonic sensor for obstacle detection, a buzzer and vibration motor for user feedback, a GPS module for location tracking, a rechargeable battery for energy storage, and piezoelectric discs for harvesting energy from walking. The hardware components are embedded into or attached to the shoe so that the user can operate the system without carrying a separate bulky device. The system architecture includes separate functional units for obstacle detection, feedback generation, GPS tracking, and power generation.

During operation, the ultrasonic sensor emits ultrasonic waves and measures the reflected signal to determine the presence of an obstacle. The Arduino Nano receives the sensor information and activates the appropriate warning mechanism. The buzzer provides an audible alert, while the vibration motor provides tactile feedback. The report describes vibration feedback as being associated with left, right, or front obstacle conditions. This arrangement allows the user to respond to obstacles without relying exclusively on auditory information.

The GPS tracking subsystem uses a NEO-6M GPS module connected to the Arduino. When the user activates the control button, the system is designed to trigger an SMS to a predefined parent or guardian number through the

associated communication arrangement. The GPS module receives satellite signals and provides location information for tracking the user's position.

The energy-harvesting subsystem consists of piezoelectric discs installed in the shoe soles. During walking, mechanical pressure is applied to the discs, producing an electrical output through the piezoelectric effect. The discs are connected in series, and the generated energy is stored in a battery. This provides a supplementary energy source for the low-power wearable electronics.

BLOCK DIAGRAM

The Fig 1 represents an Arduino Nano-based smart shoe system designed to detect obstacles and water and alert the user through a vibrating motor and buzzer. The ultrasonic sensor detects nearby objects, while the water sensor identifies water presence; the Arduino Nano processes these signals and activates the appropriate alerts to guide the user safely.

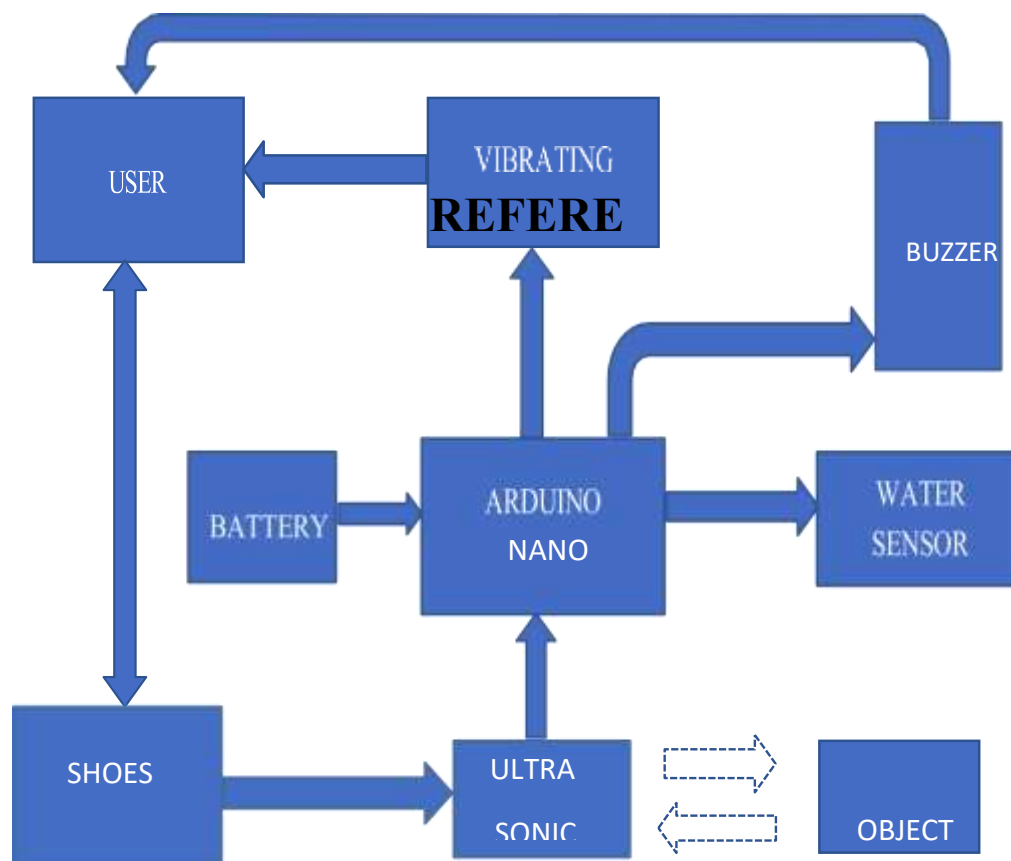


Fig 1 Block Diagram

CIRCUIT DIAGRAM

The Fig 2 shows the Arduino Nano as the main control unit, with its digital and analog pins used for interfacing with the sensors and alert devices. It provides the required connections between the power supply, sensors, buzzer, and vibrating motor, enabling the system to process sensor inputs and generate appropriate alerts.

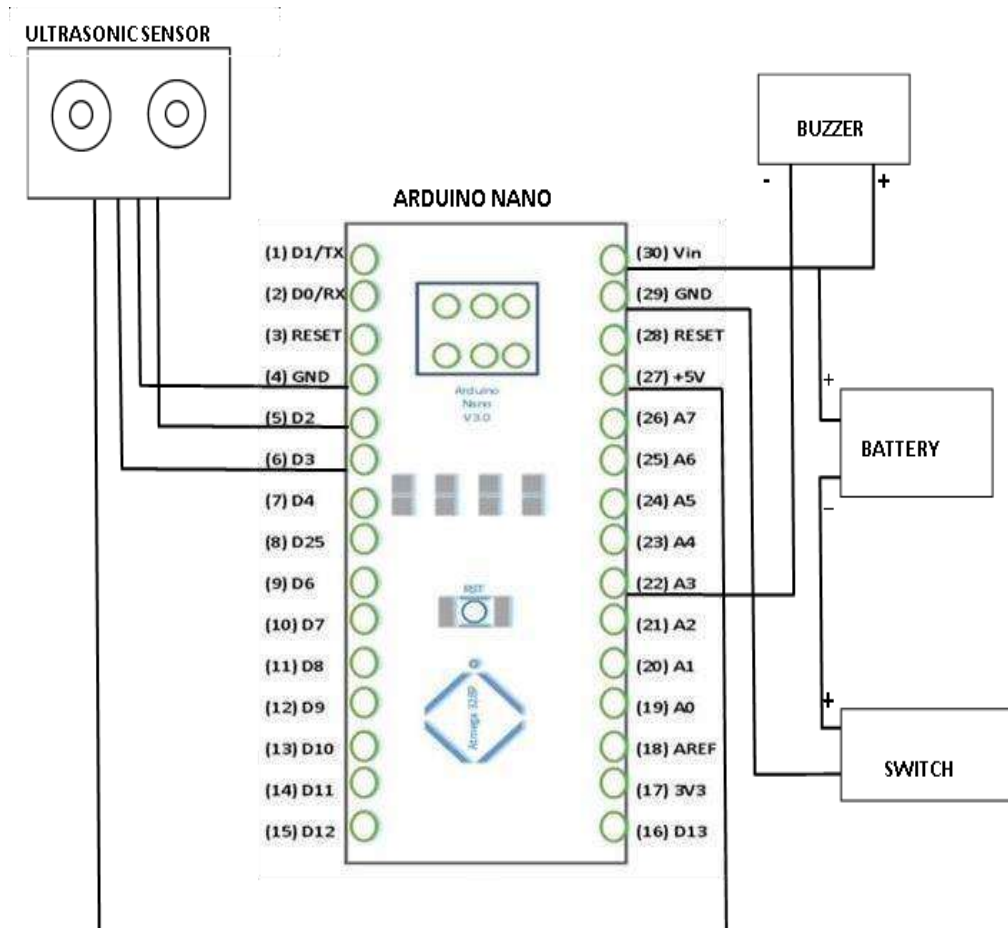


Fig 2 Circuit Diagram

METHODOLOGY

The working methodology begins when the user wears the smart shoe and switches on the system. The ultrasonic sensor continuously monitors the surrounding area. When an obstacle enters the sensing range, the sensor output is processed by the Arduino Nano. Depending on the detected condition, the controller activates the buzzer and vibration motor to warn the user. The report states that the system is designed to detect obstacles and provide vibration feedback for directional assistance.

The GPS subsystem operates independently as a safety and tracking function. The NEO-6M module communicates with the Arduino through serial communication. When the user presses the designated button, the location information is used to trigger an SMS to the stored parent or guardian number. The system therefore provides an additional means of monitoring the user's location.

The energy-harvesting stage operates simultaneously during walking. Mechanical pressure on the piezoelectric discs produces an electrical voltage. The generated output is conditioned and stored in the rechargeable battery. The stored energy can subsequently support the low-power electronic components of the wearable system.

RESULTS AND DISCUSSION

The Fig 3 demonstrates developed prototype of the integration of obstacle detection, feedback, GPS tracking, and energy harvesting within footwear. According to the project report, the smart shoe successfully detects obstacles and alerts the visually impaired user, supporting safer movement without requiring a large handheld device. The ultrasonic sensor is identified as an important element for improving mobility by detecting obstacles in the user's surroundings.

The obstacle detection subsystem provides immediate feedback through buzzer and vibration mechanisms. The GPS subsystem provides location-tracking capability and can communicate the user's location following activation of the control button. The piezoelectric subsystem demonstrates the feasibility of harvesting energy from human walking and storing the generated electrical energy in a battery.

The prototype therefore combines several functions that are normally provided by separate devices. Its major advantages include compactness, ease of use, obstacle detection, navigation assistance, GPS tracking, user-controlled vibration patterns, and the ability to generate supplementary electrical energy while walking.



Fig 3 hardware setup

CONCLUSION

An IoT-based smart shoe for blind and visually impaired people has been presented as a compact assistive system for improving independent mobility. The proposed prototype integrates an ultrasonic sensor, Arduino Nano, buzzer, vibration motor, GPS module, battery, and piezoelectric discs. The ultrasonic sensor detects obstacles and the controller provides warning signals through audible and tactile feedback. GPS functionality provides an additional safety mechanism by enabling location tracking and guardian notification, while piezoelectric discs utilize mechanical pressure from walking to generate supplementary electrical energy.

The developed system demonstrates the feasibility of integrating sensing, navigation, communication, and energy harvesting into wearable footwear. Its compact and user-friendly design can reduce dependence on conventional mobility aids and support safer movement. Future integration of camera-based object recognition and intelligent path planning can further improve the reliability and functionality of the system.

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