MERGING LANES: WHERE E-LEARNING DIVERSITY MEETS FUTURE TRENDS

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SMART BLIND STICK: DESIGNING AN INTELLIGENT AND ASSISTIVE DEVICE FOR VISUALLY IMPAIRED WITH OBSTACLE DETECTION AND NAVIGATION ASSISTANCE

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ABSTRACT

The Smart Blind Stick is an innovative assistive device designed using Internet of Things (IoT) technology to improve the quality of life for visually impaired individuals. Navigating unfamiliar environments poses a significant challenge for the blind, as traditional white canes are unable to detect certain obstacles such as overhead barriers, water puddles, or changes in lighting. This smart stick addresses these limitations by incorporating advanced sensors and connectivity features aimed at enhancing safety, mobility, and independence. The device features ultrasonic sensors for obstacle detection, a water sensor for wet surface awareness, a light sensor for low-light conditions, and a GPS module for real-time location tracking. These components work together to provide the user with immediate feedback through vibrations or alerts. The system is built on a microcontroller platform such as Arduino or Node MCU and uses IoT connectivity for live monitoring and emergency support via mobile applications. Developed using the Agile methodology, the Smart Blind Stick meets key functional requirements such as obstacle avoidance, environmental sensing, and location sharing. It enables visually impaired users to navigate more confidently in various environments. In conclusion, this device demonstrates how the integration of IoT and embedded systems can provide a practical and scalable solution to enhance the independence and safety of people with vision impairments.

Keywords: Internet of Thing (IoT) technology, switch, notification, mobile application, vision impairment

Introduction

Devices connected to the Internet of Things (IoT) outnumber people in the modern world. Because of the wireless network and low-cost CPUs, billions of physical devices are linked to the internet globally to share and gather data. Devices may now communicate real-time data without human intervention thanks to the addition of digital intelligence levels, thereby merging the digital and physical worlds. Analyst Garter estimates that IoT device usage increased by 31% between 2016 and 2017 and is

predicted to grow exponentially. 20.4 billion IoT devices are predicted to be in operation by 2020 (Constance, 2017). IoT is currently being used in many other industries, including transportation, home automation, agricultural, and many more. IoT can therefore be utilized to address a wide range of problems and yield several advantages for humanity. IoT can assist both us and those who are less fortunate, such as those who are disabled or have health problems, if it is implemented properly.

The majority of blind people have been using blind walking sticks, a unique conventional technology, for decades. In order to identify steps, drop-offs, curbs, and obstructions, blind people will sweep the blind walking stick to the left and right as they walk. By allowing blind persons to adjust to different methods like obstacle detection, echolocation, and beach line, it expands their sensing ability to better comprehend their surroundings. However, when blind individuals sweep, the blind walking sticks may inadvertently tap their ankles and slide between their feet, causing severe injuries. As a result, blind people are endangering their lives when they travel.

The Smart Blind Stick will be created using mobile applications and Internet of Things sensors. To increase the mobility of blind people in their daily lives, this invention necessitates the integration of several components. To function as a whole, each component must relate to the others via a variety of APIs. In addition, this invention will employ a Raspberry Pi 3 model B as a microcontroller to connect all of the sensors. The Smart Blind Stick's primary brain is the Raspberry Pi, and Python scripts will be used to program logical schematics into the Raspberry Pi's operating system. Connecting every sensor to the Raspberry Pi is the primary purpose of the script.

Literature Review

The smart blind stick is an electronic gadget that makes use of technology to help blind individuals overcome the challenges associated with using a blind walking stick. It has been enhanced and gets over the blind walking stick's drawbacks. The purpose of this invention is to identify navigation systems and obstructions. Ultrasonic sensors, an Arduino, a buzzer, and a remote control were used in the design of this innovation (Manikanta, Phani, and Pravin, 2018). Using ultrasonic waves, ultrasonic sensors have been utilized to identify potential obstructions (Manikanta, Phani, and Pravin, 2018). When the sensor detects obstacles, it transmits the information to the micro controller, which interprets it and determines whether the obstacles are sufficiently close.

- **Raspberry Pi**

In the center of the blind stick is a Raspberry Pi. Prior to the Raspberry Pi starting up, the Raspbian software will be installed (Raspbian, n.d.). The Raspberry Pi will be powered by the power bank.

However, the Raspbian operating system on the laptop will be loaded and accessed via an Ethernet cable.

- **Ultrasonic sensor**

One of the elements utilized in the invention is the ultrasonic sensor. The ultrasonic sensor will be positioned above the water sensor and at the bottom of the blind stick. The Raspberry Pi and the ultrasonic sensor will be connected via jumper cables. This sensor uses ultrasonic sound waves to determine the distance to an object and detect impediments. Voltage common collector (VCC), signal output pin (Trig), signal input pin (Echo), and ground (GND) are the four pins of the ultrasonic sensor (Pi, n.d.). The Raspberry Pi's 5-volt pin, which will power the sensor, will be linked to the VCC pin.

- **Water Sensor**

The lowest point of the blind stick is where this sensor is located. The presence of water has been detected using this sensor. "," "–," and "S" are the three pins on this sensor (Caballero, 2016). The Raspberry Pi's 5-volt pin, which will power the sensor, will be linked to the "+" pin. The Raspberry Pi's GND pin will be linked to the "-" pin, and its GPIO pin will be connected to the "S" pin.

- **Global positioning system (GPS) Module**

The GPS tracking device is positioned behind the blind stick. Therefore, once the blind person leaves the house, the guardian can follow their location at any time using this GPS tracking. The GPS module has four pins: GND, VCC, Transmitter (TxD), and Receiver (RxD) (GPS Module, 2018). The Raspberry Pi's 3-volt pin, which powers the GPS module, will be attached to VCC pins. For serial communication, GND will be linked to the Raspberry Pi's GND pin, and TxD and RxD will be connected to the GPIO pin.

Methodology

The analytical model, which includes use case diagrams and encompass design specifications like sequence diagrams and user interfaces for this invention, is the methodology employed. The sequence diagram for the smart blind stick's mobile application is displayed in Figure 1.

The processes and features that have been incorporated into each of the application's activities are depicted in the sequence diagram for the users' part in the mobile application in the above picture. The blind individual is user two, while user one is referred to as a guardian. Initially, the guardian must log in to the Smart Blind Stick application in order to open and authorize it. They must register if they don't already have an account. Before leaving the area, the blind person will turn

on the blind stick and press the switch. The GPS would begin to store and update the location in the database every 30 seconds after the blind individual hit the switch.

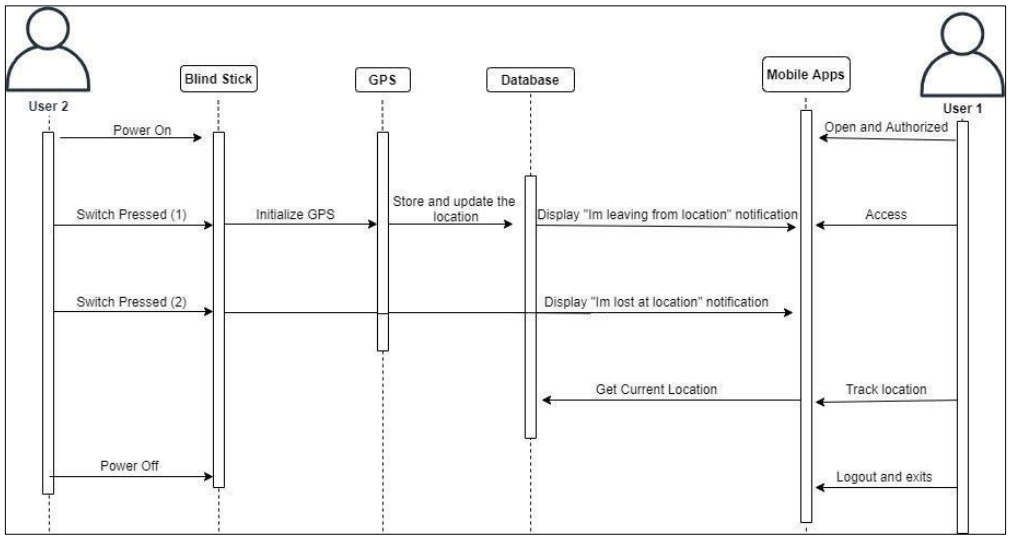

Figure 1. Sequence diagram for Mobile Application

Conclusion

In conclusion, developing an Internet of Things (IoT) project requires significant time, effort, and careful planning. To successfully implement the technology in the Smart Blind Stick, a systematic and well-structured development process must be followed. A large and complex task needs to be divided into several smaller components so that each part can be developed, tested, and integrated more efficiently into the overall system. This structured approach helps ensure that the final product functions effectively and meets the intended objectives. Throughout the development of this project, various technical and personal skills have been acquired. In addition to gaining knowledge about IoT technologies, sensors, and system integration, important soft skills such as self-discipline, problem-solving, and time management have also been developed. These skills are essential for maintaining consistency in product development and for continuous self-improvement in future technological projects.

Furthermore, this paper explains the design stage of the Smart Blind Stick in detail. It describes the process of planning the system architecture, selecting suitable hardware components, and designing the interaction between sensors, microcontrollers, and communication modules. The design stage is a critical phase because it determines how the system will operate and ensures that the device can effectively assist visually impaired users in detecting obstacles and navigating safely. Overall, the

project demonstrates how IoT technology can be applied to develop practical assistive devices that improve the safety and mobility of individuals with visual impairments.

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