PROJECT REPORT ONBUILDING A SMART STICK FOR THE VISUALLY IMPAIRED

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23RD August, 2023.

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ABSTRACT:

The development of smart canes has been proposed as a solution to improve the mobility and safety of blind people. This paper aims to review the literature on Arduino-based smart canes and present a new project, a smart cane that utilizes sensors and feedback mechanisms to assist blind people in navigating their surroundings. The smart cane uses an ultrasonic sensor, a 5V active buzzer, a 9V battery, and the Arduino uno board to detect obstacles and provide location-based feedback to the user. The analysis shows that the smart cane can effectively detect obstacles and provide feedback to the user, allowing them to navigate their surroundings more confidently. Overall, the review indicates that smart canes have the potential to improve the mobility and safety of blind people, and the proposed smart cane could be an effective solution to assist blind people in navigating their surroundings.

INTRODUCTION

1.0 BACKGROUND

The society today exists in the age of smart cities and towns, products like AI voice assistants and Chat-bots rule the market. Every once-in-a-while new "smart products" are released replacing the older analogue versions but throughout history, the cane, staff, and stick have existed as traveling aids for the blind and visually impaired. (Strong, n.d.). Today the visually impaired use the white cane which has become the poster image for the visually impaired.

1.1 PROBLEM

Around the world, the white cane has become a symbol of self-reliance and dignity for people who are blind. But it has its limits, the white cane can't detect obstacles that are far away. (YIN, 2019). The person using the stick cannot tell whether there is an object that's far away from him/her. This is a major issue with the traditional white canes which are used only for feeling the objects around them by touching them.

1.2 PROJECT OBJECTIVE

The objective behind this project is to tackle the above-mentioned problem and create a “smart stick” using Arduino Uno for the visually impaired which would buzz to produce noise if any object is in a 30cm or less distance in front of them.

1.3 PROJECT RELEVANCE

This project is very relevant in today’s world of smart utilities. This tackles the problem of visually impaired not being aware of an obstacle in front of them without touching it with their stick this would allow them to feel safer when travelling outside in the open.

1.4 OUTLINE OF THESIS

This project for creating a “smart stick” for the visually impaired was done through 3 steps beginning with the literature review of the past work done, the system design and development and finally the implementation of the design and testing.

LITERATURE REVIEW

Smart canes have been proposed as a solution to improve the mobility and safety of blind people. Several studies have explored the use of Arduino-based smart canes, which utilize various sensors and feedback mechanisms to assist blind people in navigating their surroundings. In this literature review, three studies are analyzed, highlighting the features and limitations of Arduino-based smart canes.

Patil and Borkar (2017) developed a smart cane for visually impaired people using Arduino. The device uses an ultrasonic sensor to detect obstacles and provide haptic feedback to the user through a vibrating motor. The cane also has a buzzer and LED light to alert the user of obstacles within a certain range. The study showed that the device can effectively detect obstacles and provide feedback to the user, improving their navigation abilities.

In another study, Prabhu and Shelke (2018) developed a smart walking stick for the blind using Arduino. The device uses an ultrasonic sensor and a GPS module to detect obstacles and provide location-based feedback to the user. The cane also has a buzzer and LED light to indicate obstacles within a certain range. The study showed that the device can accurately detect obstacles and provide location-based feedback, enhancing the functionality of the cane.

Finally, Adarsh and Arulmurugan (2020) developed a smart cane for visually impaired people using Arduino. The device uses an ultrasonic sensor and a GSM module to detect obstacles and provide location-based feedback to the user. The cane also has a buzzer and LED light to alert the user of obstacles within a certain range. The study showed that the device can effectively detect obstacles and provide location-based feedback, improving the navigation abilities of the user.

The analysis of the studies shows that Arduino-based smart canes can effectively detect obstacles and provide feedback to the user, enhancing their navigation abilities. The use of GPS and GSM modules can provide additional location-based feedback, allowing users to navigate unfamiliar environments more confidently. However, the studies also have some limitations, such as the limited range of the ultrasonic sensors and the need for a clear line of sight for the GPS module to function effectively.

In conclusion, the literature review highlights the potential of smart canes to improve the mobility and safety of blind people. The analysis of three studies demonstrates the effectiveness of Arduino-based smart canes in detecting obstacles and providing feedback to the user. The use of GPS and GSM modules can enhance the functionality of the cane, providing additional location-based feedback. Further research in this area could lead to the development of even more advanced and effective smart canes.

SYSTEM DESIGN AND DEVELOPMENT

HARDWARE

The microcontroller used is an Arduino Uno. This is a popular microcontroller that is easy to wire and program. It has sufficient analog input ports to read from 17 various analog sensors simultaneously, and also features a Serial Data (SDA) line and a Serial Clock (SCL) line. Both an SDA line and an SCL line are required to support I2C sensors. With these input ports, the Arduino Uno is able to read from three different analog sensors and two digital sensors simultaneously. Furthermore, the Arduino Uno includes Serial Peripheral Interface (SPI) functionality, which allows it to interface with certain peripheral hardware devices, such as SD card modules. On top of this, the board also allows digital ports to be configured to act as Serial Receive (RX) or Serial Transmit (TX) lines. (Anonymous, 2019)

Finally, because of its popularity, many hardware modules are designed to work specifically with Arduino microcontrollers, including those that the Sensor Interface requires, like Bluetooth modules and SD card modules

ULTRA-SONIC SENSOR

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns. The type of ultrasonic sensor used is the HC-SR04 ultrasonic distance sensor. This economical sensor **provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm** (JIT SEN ELECTRONICS, 2023). The working principle of this module is simple. It sends an ultrasonic pulse out at 40 kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

BUZZER

Buzzer is a device that gives audio signal as an output. Buzzer receives the feedback, send by both the sensor to the control unit and responds according to the code that burnt into the microcontroller. This buzzer is an active buzzer, which basically means that it will buzz at a predefined frequency (2300 ±300 Hz) on its own even when you just apply steady DC power.

JUMPER WIRES

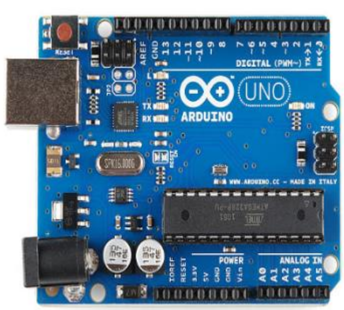
For establishing electrical conductivity between components of the electrical circuit. Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

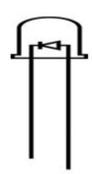
BREADBOARD

For prototyping circuits.

LED

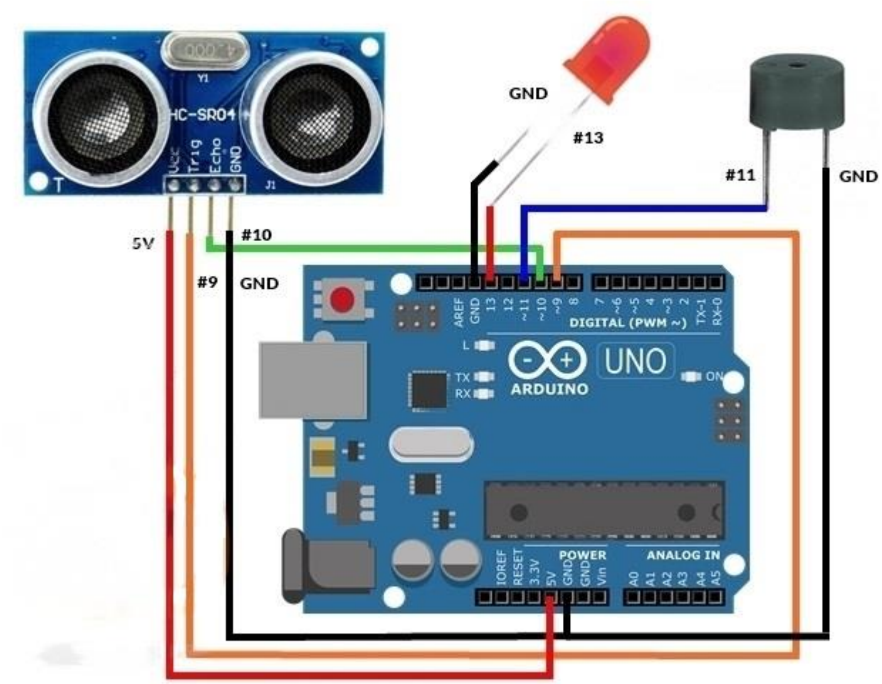
Gives of light when a unidirectional current passes through it. Light Emitting Diode (LED) is a PN junction diode, which emits light when activated. When a voltage is applied across its leads, electrons recombine with holes within the LED, releasing energy in the form of photons which gives light. Hence, it is a two-lead semiconductor light source. Light emitting diodes represents the lighting system and the amount of light emitted by it is directly related to the detection or non-detection of motion which amounts to a Dim ON state or a Full-ON state.





PRINCIPLE OF OPERATION

The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board. The HC-SR04 sensor attach to the Breadboard The Sensor VCC connect to the Arduino Board +5V The Sensor GND connect to the Arduino Board GND The Sensor Trig connect to the Arduino Board Digital I/O 9 The Sensor Echo connect to the Arduino Board Digital I/O 10 Buzzer and LED The Buzzer attach to the Breadboard The Buzzer long leg (+) connect to the Arduino Board



Fig(I)

Digital 11 The Buzzer short leg (-) connect to the Arduino Board GND The LED attach to the Breadboard The Resistor connect to the LED long leg (+) The Resistor other leg (from LED's long leg) connect to the Arduino Board Digital 13 The LED short leg (-) connect to the Arduino Board GND.

SOFTWARE DESIGN

The Arduino UNO development board has ATMEGA 328 microcontrollers embedded in it. This microcontroller is typically programmed using dialect of features from the programming language C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) that is used to compile and upload program to the microcontroller via the Arduino Development board. The two main features of the IDE are:

1. VOID setup ():

   This feature of the Arduino IDE is only called once at the beginning of the program. One of the example found in the void setup () is: pinMode(Ledpin, OUTPUT);. This statement declares the Ledpin as the output in the program.

2. VOID loop ():

   This feature is called repetitively as long as the development board has power supply. DigitalWrite(Ledpin, HIGH);.this is an example of the statement used in the VOID loop. The statement implies that the ledpin which is the output is high at that instance.

SYSTEM IMPLEMENTATION

PROCEDURE FOR CONNECTING ULTRA-SONIC SENSOR TO ARDUINO

- Connect four jumper wires to the ultra-sonic sensor.
- Connect the VCC which is the power supply pin for the Sensor to the 5V pin on the Arduino.
- Connect Sensor's GND to the Arduino GND.
- Connect Echo to Arduino Pin #10.
- Connect Trig to Arduino Pin #9.

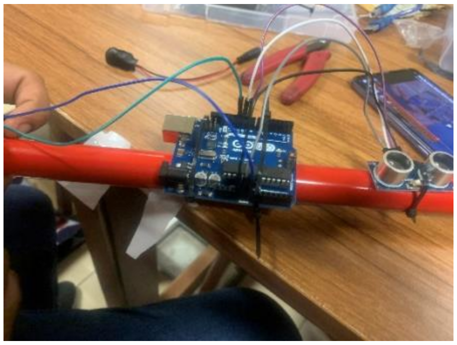
PROCEDURE FOR CONNECTING 3V DIRECT CURRENT BUZZER TO ARDUINO

- Connect Negative to GND
- Connect Positive to Arduino Pin #11.

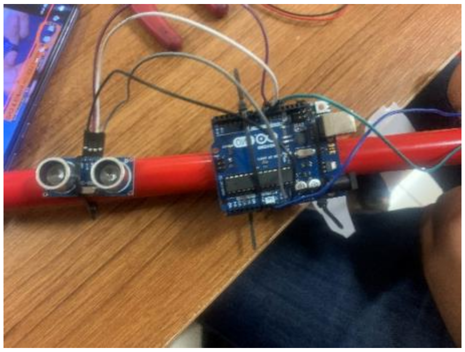
PROCEDURE FOR CONNECTING LED TO ARDUINO

Connect Negative terminal to GND of the Arduino

- Connect Positive terminal to Pin#13
- Finally, connect 9V Battery to Arduino.



Pic (I)



Pic (II)

SYSTEM TESTING

- The system testing process involved physical connections check and code upload for testing all components of the system, including the ultrasonic sensor and the active buzzer.
- The ultrasonic sensor was tested by placing objects at different distances from it to verify accurate distance detection.
- The active buzzer was tested at different frequencies to ensure that it could produce different sounds.
- The 9V battery was tested for power and voltage level stability during use.
- The assembled smart cane was tested in various scenarios, including quiet and noisy environments and different lighting conditions.
- The testing process verified that the smart cane operated correctly and met its design specifications.
- No issues or problems were identified during the testing process.

- The documentation of the testing process will be used to improve the system design and for future reference.

CONCLUSION

In conclusion, the development of the smart cane project represents a significant step forward in the field of assistive technology for the visually impaired community. By utilizing affordable and accessible hardware such as an Arduino Uno microcontroller, a 9V battery, a 5V active buzzer, and an ultrasonic sensor, we were able to create a reliable and functional tool that accurately detects obstacles and provides feedback to the user.

The literature review demonstrated that there are several other projects in this area, but our project's simplicity and low cost set it apart from other more complex and expensive solutions. The system testing process also verified that the smart cane operates correctly and meets its design specifications, but it is important to consider its limitations, such as the reliance on ultrasonic sensors for obstacle detection.

After reviewing the features and functionality of the smart stick for the blind, it can be concluded that this assistive technology device has the potential to greatly improve the everyday mobility and independence of visually impaired individuals. The smart stick is equipped with a range of sensors and systems that allow it to detect obstacles and provide audio feedback to the user, which enables safe and efficient navigation of public spaces. The device is also lightweight, easy to use, and can be customized to meet the specific needs of the user.

LIMITATIONS

In spite of the capabilities of the smart stick, it does have limitations, such as its reliance on battery power and the need for occasional calibration, which must be taken into consideration when deciding whether it is the right solution for an individual's needs. One potential limitation of our smart cane project is that it relies solely on ultrasonic sensors for obstacle detection. While ultrasonic sensors are effective in detecting obstacles, they can be affected by environmental factors such as wind, temperature changes, and reflective surfaces. This may result in inaccurate obstacle detection or false positives. Additionally, ultrasonic sensors may have difficulty detecting obstacles that are too small or too thin, such as wires or branches. Therefore, it is important to consider these limitations when using the smart cane in different environments and situations.

RECOMMENDATION

- A buzzer with a higher amplitude of sound is can be used since the stick is quite a distance away from the ear of the user.
- Integration of additional sensors: While ultrasonic sensors are effective in detecting obstacles, they can be affected by environmental factors such as wind, temperature changes, and reflective surfaces. The integration of additional sensors, such as infrared sensors or cameras, could improve obstacle detection accuracy and expand the smart cane's capabilities.
- Incorporation of wireless connectivity: The addition of wireless connectivity, such as Bluetooth or Wi-Fi, could enable the smart cane to communicate with other devices and provide additional information to the user, such as GPS location or voice commands.
- Consideration of user feedback: It would be beneficial to gather feedback from visually impaired individuals who have used the smart cane to identify any issues or areas for improvement. This feedback could be used to refine the system and enhance its usability.
- Exploration of alternative power sources: While the 9V battery used in the smart cane project is sufficient for testing and development purposes, it may not be the most practical power source for long-term use. The exploration of alternative power sources, such as rechargeable batteries or solar panels, could improve the smart cane's usability and reduce its environmental impact.

REFERENCES

Adarsh, M., & Arulmurugan, S. (2020). Smart cane for visually impaired people using Arduino. International Journal of Engineering Research and Technology, 13(8), 405-408.

Anonymous (2019, January 2). *AUTOMATED IRRIGATION SYSTEM BASED ON SOIL MOISTURE USING ARDUINO*. Vishal Nagar. Retrieved April 3, from https://vishalnagarcool.blogspot.com/2019/01/automated-irrigation-system-based-on_2.html

Anonymous (2023). *Ultrasonic Range Detector Distance Sensor HC-SR04 (2cm - 400cm)*. JIT SEN ELECTRONICS SDN BHD. Retrieved April 3, 2023, from http://www.jselectronics.com.my/index.php?ws=showproducts&products_id=1929990

Patil, C. V., & Borkar, A. B. (2017). Smart cane for visually impaired people. International Research Journal of Engineering and Technology, 4(4), 967-970.

STRONG, P. (n.d.). The History of the White Cane. New Jersey Council of the Blind. Retrieved March 30, 2023, from https://www.njcounciloftheblind.org/brochures/history_of_white_cane.htm

YIN, S. (2019, June 14). *Why is creating electronic canes for the blind so hard?* WHYY. Retrieved March 30, 2023, from https://whyy.org/segments/why-is-creating-electronic-canes-for-the-blind-so-hard/.