Project Report

EMBEDDED SYSTEMS THEORY

Subject code**: CS-16101**

Title: Obstacle detection system to assist the visually impaired individual

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Abstract:

This report presents the design and development of microcontroller-based assistive devices for visually impaired individuals utilizing NodeMCU ESP8266 microcontroller and an LCD display. Assistive devices play a crucial role in enhancing the independence and quality of life for individuals with visual impairments. Among these technologies, those utilizing ultrasonic sensors have gained prominence due to their effectiveness in providing real-time environmental feedback. This report explores the design, functionality, and benefits of an assistant device tailored for blind individuals, leveraging ultrasonic sensor technology.

Broad Area:

Ultrasonic sensors find applications in various fields for distance measurement due to their accuracy, reliability, and versatility. Some broad areas where ultrasonic sensors are commonly used for distance measurement include:

Industrial Automation: Monitor conveyor belts, aid in object detection, and guide robotic arms, enhancing manufacturing efficiency.

Smart Parking Systems: Detects vehicle presence and proximity, optimizing parking space utilization and reducing congestion.

Automotive Safety: Enable obstacle detection, enhancing driver awareness and reducing collision risks.

Medical Devices: Facilitate non-invasive distance measurement in ultrasound imaging and surgical instruments, ensuring precision in diagnosis and treatment.

Security and Surveillance: Provide perimeter protection, intruder detection, and surveillance, offering early warnings of security breaches.

Environmental Monitoring: Measure distance, water levels, and fluid flow, aiding in flood monitoring, irrigation management, and water quality assessment.

Navigation and Localization: Provide accurate distance measurements and obstacle detection, aiding in path planning, localization, and mapping for autonomous systems.

Problem Statement:

Design and implement a system for object detectors using NodeMCU ESP8266 and ultrasonic sensor technology which is suitable for various applications including robotics, automation, and security systems.

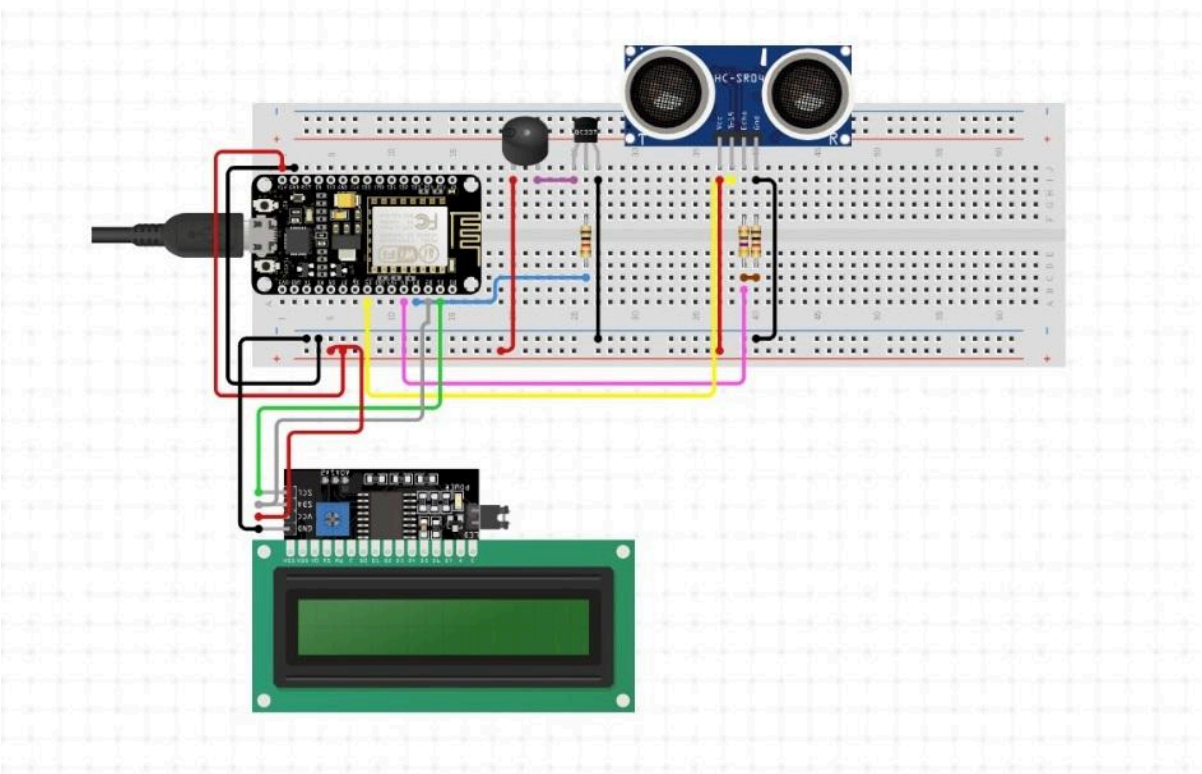
The system should accurately detect the presence of objects within a specified range and provide real-time monitoring. The measured distance is shown using an LCD display and buzzer indicates the threshold distance between device and object.

Objective:

The objective of this report is to analyze and evaluate the design, implementation, and effectiveness of an obstacle detection system aimed at assisting visually impaired individuals. Specifically, the report focuses on the utilization of NodeMCU (ESP8266) microcontroller and ultrasonic sensors to develop a robust and reliable system for detecting obstacles in the user's surroundings.

- **System Design Analysis:** Examine the architecture and components of the obstacle detection system, including the NodeMCU microcontroller, ultrasonic sensors, and feedback mechanism.
- **Technical Implementation Evaluation:** Assess the technical implementation of the system, including hardware integration, sensor calibration, data processing algorithms, and communication protocols.
- **Functionality and Performance Testing:** Evaluate the functionality and performance of the obstacle detection system in detecting obstacles, providing real-time feedback, and ensuring user safety and confidence in navigation.

Circuit Diagram:



Hardware Components:

- NodeMCU ESP8266 microcontroller
- Ultrasonic Sensor
- LCD Display Module
- Buzzer
- Jumper cables
- USB Cable Type A/B
- Breadboard

Software Components:

- Arduino IDE
- NodeMCU Firmware
- LCD Display Library

Code:

```
const int trigPin = D3;
const int echoPin = D0;
const int buzzer = D8;
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

long duration;
int distance;
int safetyDistance;

// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
	pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
	pinMode(echoPin, INPUT);   // Sets the echoPin as an Input
	pinMode(buzzer, OUTPUT);   // Sets the buzzer as an Output
	lcd.begin();
	lcd.backlight();

	Serial.begin(9600);       // Starts the serial communication

	lcd.backlight(); // Turn on the backlight
}

void loop() {
	// Sets trigPin HIGH
	digitalWrite(trigPin, HIGH);
	delayMicroseconds(100);
	digitalWrite(trigPin, LOW);

	duration = pulseIn(echoPin, HIGH);
	// Calculating distance
	distance = (duration / 2) / 29.1;

	Serial.print(distance);
	Serial.println("CM");
	delay(300);
```

```
        // Prints the distance on the Serial Monitor
        Serial.print("Distance: ");
        safetyDistance = distance;

        // Display distance on LCD
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Distance(cm):");

        lcd.setCursor(0, 1);
        lcd.print(distance);
        // lcd.print(" CM");

        // Sound buzzer if distance is less than or equal to 5
        if (safetyDistance <= 10) {
                digitalWrite(buzzer, HIGH);
                delay(100);
        } else {
               digitalWrite(buzzer, LOW);
        }
}
```

Outcomes:

- Effective object detection and avoidance systems
- Audio alert mechanism
- Cost effectiveness
- User-friendly operation
- Enhanced users safety

Performance Measures:

- **Accuracy:** Verify detected obstacle distances against actual distances to ensure reliable obstacle detection.
- **Precision:** Evaluate the system's consistency in detecting obstacles within a specified range, providing precise feedback.
- **Response Time:** Measure the time taken for the system to detect obstacles and alert users, ensuring timely reactions.
- **Detection Range:** Assess the system's capability to detect obstacles at varying distances, providing ample time for user responses.

Comparison:

Traditional Mobility Aids vs Ultrasonic Sensor Assistance for Visually Impaired Persons

- **Precision and Effectiveness:** Ultrasonic sensor assistance provides more precise and effective guidance compared to traditional mobility aids such as canes or guide dogs. It offers real-time feedback about obstacles and surroundings, enhancing navigation capabilities.
- **Energy Consumption:** Ultrasonic sensor systems are designed to optimize energy usage by activating only when needed, minimizing power consumption. This efficiency can lead to potential cost savings over time and reduce the environmental footprint associated with battery usage.
- **Cost:** While the initial investment for ultrasonic sensor assistance may be higher than traditional mobility aids, the long-term benefits in terms of increased independence and improved safety may outweigh the initial costs. However, maintenance and occasional sensor replacement might be necessary, potentially adding to the overall expenses.

In summary, ultrasonic sensor assistance for visually impaired persons offers superior precision, energy efficiency, and potential long-term benefits compared to traditional mobility aids, albeit with initial investment and maintenance considerations.

Results:

- **Obstacle Detection:** The system reliably detects obstacles within 10 cm of the user's position.
- **Alert Mechanism:** When an obstacle is detected within this range, the system emits a buzzing sound to promptly notify the user of the obstruction.
- **Response Time:** The system exhibits swift responsiveness, ensuring that users are promptly alerted to potential hazards in their immediate surroundings.

These outcomes underscore the system's capability to provide timely and effective assistance to visually impaired individuals, aiding in navigation and promoting safety in diverse environments.

Conclusion:

Our obstacle detection system, utilizing NodeMCU and ultrasonic sensors, offers reliable detection of obstacles for visually impaired individuals. It promptly alerts users of obstacles within a preset range, enhancing safety and independence. Customizable parameters ensure adaptability to diverse environments. Integration with NodeMCU enables portability and usability in wearable devices. This system represents a promising solution to aid navigation, empowering visually impaired individuals to navigate safely and independently. Further optimization and testing are needed to refine performance, aiming to maximize its efficacy in improving the quality of life for users.

References:

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