Forward Collision Avoidance System (FCAS)

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Problem Statement: Enhancing Automotive Safety

Proximity sensing is crucial in modern automotive systems for adaptive cruise control, collision avoidance, and autonomous driving. This project addresses the need for a simplified simulation of vehicle behavior in response to obstacle distance, utilizing minimal hardware to demonstrate core functionalities.

Project Objectives

Simulate Vehicle Speed Response

Adjust vehicle speed based on the detected obstacle distance.

LED for Motor Speed

Utilize an LED to visually represent the simulated motor speed.

Buzzer for Emergency Stop

Incorporate a buzzer to signal an emergency stop condition.

Distance Measurement

Employ the Grove Ultrasonic Ranger v2.0 for accurate distance readings.

Hardware Components

TI CC3200 LaunchPad

- Wi-Fi-enabled microcontroller with ARM Cortex-M4.
- Programmed using Energia (Arduino-like IDE).

Grove BoosterPack

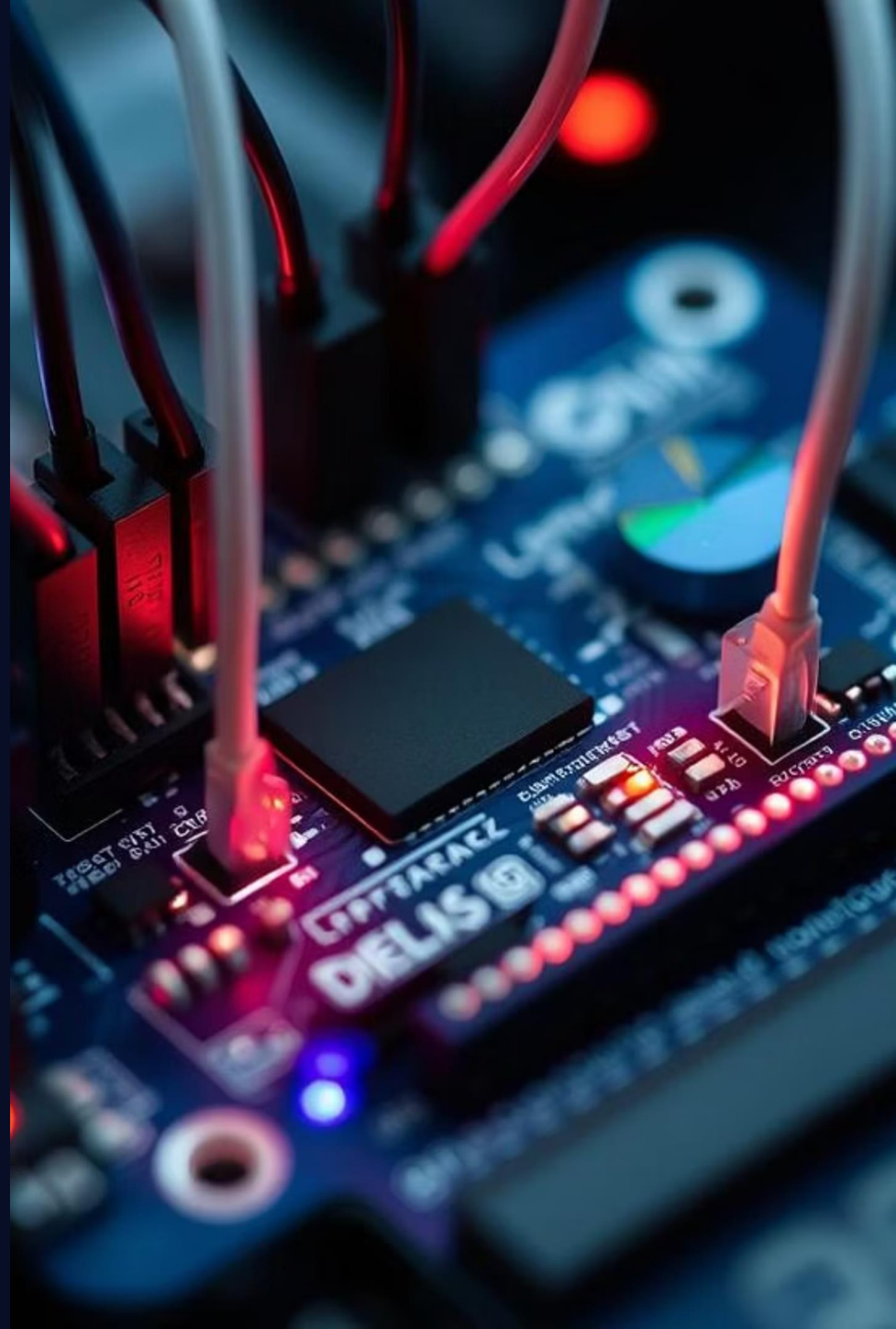
- Provides Grove-compatible ports (Digital/Analog/UART).

Grove Ultrasonic Ranger v2.0

- 3-pin proximity sensor utilizing a single SIG pin for trigger and echo.

Buzzer + Onboard Red LED

- Simulates motor behavior and provides collision alerts.



Port Mapping

Ultrasonic SIG	J6(A)	Analog	64
Buzzer	J10	Serial	57
Red LED (D7)	– (onboard)	Digital	64

The sensor's SIG pin is efficiently shared for both trigger and echo functions, minimizing hardware complexity.

Working Principle: Distance-Based Responses

The ultrasonic sensor emits a pulse and measures the time taken for the echo to return, calculating the obstacle distance. This distance then dictates the vehicle's simulated behavior:

Distance > 50 cm

LED ON (Vehicle at full speed).

25–50 cm

LED blinks slowly (Vehicle reducing speed).

10–25 cm

LED blinks fast (Vehicle slowing down significantly).

< 5 cm

LED OFF, Buzzer ON (Emergency stop).

System Flow Diagram

Start

Initiate system operation.

Send Trigger Pulse

Ultrasonic sensor emits a pulse.

Read Echo Time

Measure time for pulse return.

Calculate Distance

Determine obstacle distance.

Respond to Distance

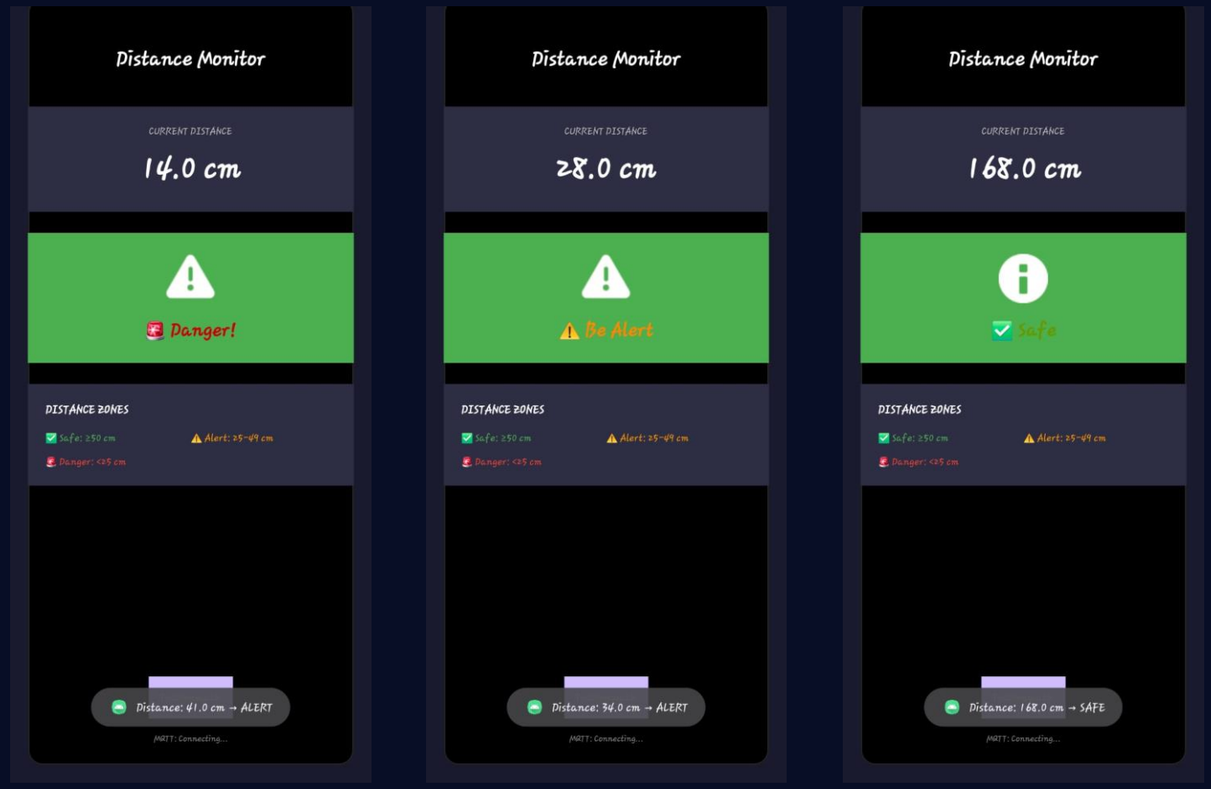
Adjust LED/Buzzer based on distance thresholds.

Mobile App Integration

To determine the obstacle's farthest distance remotely, an integrated Android application was developed. The CC3200 Launchpad is in communication with the application.

The CC3200 is interactive since it uses MQTT to send the real-time distance data to the mobile app. For data sharing, both devices are linked to the same hotspot network.

The app was developed through Android Studio, made with Kotlin/Java and Material UI for a clean, user-friendly interface



Results and Simulation Efficacy

Dynamic LED Behavior

The LED successfully changes its blinking pattern and state, accurately reflecting the simulated vehicle speed based on object distance.

Collision Warning

The buzzer effectively activates when an object is too close, providing a clear and immediate warning of a potential collision.

Realistic Vehicle Reaction

The simulation accurately replicates how a vehicle should react in real-world conditions, demonstrating the core principles of a forward collision avoidance system.

Future Improvements

Real Motor Integration

Replace the LED with a physical motor for a more realistic speed simulation.

OLED Display

Incorporate an OLED screen to display real-time speed and distance data.

Multiple Sensors

Implement additional sensors for comprehensive 360° obstacle awareness.

Autonomous Braking

Extend the system to include autonomous braking capabilities for real-world automotive applications.

Thank you

Evaluation