EEL 4599 Final Project

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GitHub Repository
Demo Video

Application

This project implements a real-time IoT sensor network to enhance environmental awareness in autonomous vehicles. It consists of:

- ESP32 Node: Uses an ultrasonic sensor for obstacle detection
- Raspberry Pi Pico Node: Integrates an MPU6050 IMU for orientation tracking
- Sink Node (Laptop): Receives data via XBee and forwards it to ThingSpeak for cloud-based visualization and analysis

Source Nodes

The system features two wireless source nodes, each designed for a specific sensing function:

1. ESP32 Node – Obstacle Detection

- Sensor: HC-SR04 Ultrasonic Rangefinder
- Function: Measures distance to nearby obstacles in front of the vehicle
- Sampling Rate: ~10 Hz
- Data Output: Distance in centimeters
- Transmission: Sends distance readings over XBee in API mode

2. Raspberry Pi Pico Node – Orientation Tracking

- Sensor: MPU6050 (3-axis Accelerometer + Gyroscope)
- Function: Tracks vehicle orientation and motion (linear & angular acceleration)
- Calibration: Offset-corrected IMU data for improved accuracy
- Data Format: AX, AY, AZ, GX, GY, GZ values sent as a single UART message
- Transmission: Sends data via XBee at 9600 baud every 0.5 seconds

Sink Node

- Receives API packets sent from both XBees
- Uses Python script to unpack and manipulate raw Zigbee data
- Sends data every 15 seconds to ThingSpeak (ThingSpeak API free edition has rate limits of 15 seconds)
- ThingSpeak was configured with 7 fields: Gyroscope X, Y, and Z, Accelerometer X, Y, and Z, and Ultrasonic data
    - Each of these were given their own line graph over time
    - Accelerometer X/Y/Z and Gyroscope X/Y/Z graphs were consolidated into two graphs using a custom MATLAB visualization with ThingSpeak's API