FYP Document

For

Detection of Road Bumps

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1. Overview

Our objective is to develop a system that addresses the current challenges in detecting speed bumps. Traditional approaches have relied on camera-based sensors, utilizing image-based datasets for detection. However, these methods often struggle with accuracy, particularly in identifying speed bumps that lack color or distinct patterns.

We intend to overcome these limitations by integrating radar sensors in place of camera-based sensors. Our approach will involve several key steps: dataset generation, model training, app development, integration of Google Maps into the app, and hardware development and integration.

By following these steps, we aim to achieve optimal performance while maintaining cost efficiency.

2. Dataset Generation (Step 1)

This step is crucial because we were unable to find any numerical datasets suitable for radar sensors; available datasets were primarily image-based. To address this, we have decided to create a custom dataset consisting of approximately 30-60 data entries. Initially, we plan to include four key labels, though these may be adjusted as the project progresses:

- **Serial Number:** A unique identifier assigned to each speed bump.
- **X-Dimension:** The calculated distance value along the x-axis.
- **Y-Dimension:** The calculated distance value along the y-axis.
- **Z-Dimension:** The calculated distance value along the z-axis.

Our approach involves using a gyroscope sensor to calculate the x, y, and z values. Based on the signals generated in the gyroscope graph, we will record the corresponding x, y, and z values into the dataset.

3. Training the Model (Step 2)

In this step, we will focus on training a machine learning model to accurately detect and classify speed bumps using the radar sensor data collected. Supervised learning techniques, such as Support Vector Machines (SVM), Decision Trees, or Artificial Neural Networks (ANN), will be employed to identify patterns in the data that indicate the presence of speed bumps. The model will be trained using the custom dataset we generate, with a focus on optimizing accuracy and efficiency. We will also perform model validation and hyperparameter tuning to ensure the model is well-suited for deployment on the embedded system, maintaining a balance between performance and resource constraints.

4. App Development (Step 3)

Our app will feature a user-friendly interface, with the potential for additional features to be incorporated based on project requirements. The primary functionality of the app is to notify the driver when a speed bump is detected.

The app will also maintain historical data on detected speed bumps, allowing users to receive warnings even if the sensor does not detect a bump in real-time. The gyroscope will detect speed bumps by recording their x, y, and z values, while GPS coordinates will be used to locate them. When the vehicle approaches a known bump stored in our dataset, the app will alert the user to its proximity.

4.1 Integration of Google Maps (Step 3.1)

In this step, we will integrate Google Maps into the previously developed app to enable real-time vehicle tracking. This integration will allow the app to mark the location of detected speed bumps directly on the map. Consequently, when the vehicle revisits the same location, the app will automatically recognize the speed bump through the map, even without the sensor's input. This approach enhances the app’s functionality by utilizing real-time map tracking to identify and alert the driver of previously detected speed bumps.

5. Hardware Development (Step 4)

During this phase, our primary focus will be on the hardware development of the project. We will assemble a hardware system using the following components:

- Embedded Controller
- Radar Sensor Module
- Power Supply Unit
- Enclosure
- GPS Module (Optional)
- Miscellaneous (Wiring and Additional Components)

Additional materials may be incorporated as needed based on evolving project requirements. This hardware development phase will be implemented after completing the software aspects in the preceding steps.

5.1 Hardware Integration & Testing (Step 4.1)

This step follows the hardware development phase, with a primary focus on integrating the software components into the hardware. We will ensure that the radar sensor effectively detects speed bumps within its specified range. Detection capabilities may vary depending on the type of sensor used, as some sensors offer 360-degree coverage, with differing angles based on the sensor model.

We will tailor the software integration to suit the specific sensor type, ensuring optimal functionality. Upon completing the integration, we will proceed to the testing phase, where the system will be tested on various speed bumps to confirm that it performs as expected.

6. Conclusion

The primary objective of this project is to address the shortcomings of conventional speed bump detection methods by utilizing radar sensors integrated with a robust machine learning model and a mobile application. Our goal is to develop a system that, through meticulous dataset creation, model training, app development, and hardware integration, delivers reliable real-time alerts to drivers when a speed bump is detected, thereby enhancing road safety and the overall driving experience.

6.1 Advantages

- **Reliable Detection:** Radar sensors are expected to detect speed bumps more reliably, especially in situations where traditional image-based methods fail.
- **Timely Warnings:** The integrated mobile app provides timely warnings to drivers about approaching speed bumps.
- **Cost Efficiency:** The approach enhances cost efficiency by replacing complex camera systems with radar sensors.

6.2 Drawbacks

- **Limited Dataset Availability:** Limited availability of datasets may result in a smaller custom dataset, potentially affecting the model's ability to generalize.
- **Sensor Dependency:** The system's performance is highly dependent on the type and quality of the radar sensor used.
- **False Alerts:** There is a risk of the system occasionally misidentifying non-speed bump objects, leading to false alerts.
- **Obstruction by Other Vehicles:** The presence of a vehicle in front may obstruct the radar sensor's view, preventing it from detecting the speed bump in time. Although the integration of Google Maps can help identify previously marked bumps, this solution is only effective for revisits and does not address new or unknown locations.