Design and Implementation of a CANBus-Based Eco-Driving monitoring and Control systems

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How to Cite this Article:

Sanjay.R, , Sundar.T.Y, S., Moorthy.S, U. & N.Janakiraman, (2026). Design and Implementation of a CANBus-Based Eco-Driving monitoring and Control systems. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(03). https://doi.org/10.55041/ijcope.v2i3.255

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Abstract

The increasing demand for fuel efficiency and environmentally responsible driving has led to the development of intelligent vehicle monitoring systems. This project presents the design and implementation of a Controller Area Network (CAN) based eco-driving monitoring system with real-time fuel consumption measurement. The proposed system simulates vehicle operating conditions using embedded hardware and sensor-based data acquisition. A potentiometer is employed to emulate accelerator pedal input, while a hall effect sensor is used to estimate vehicle speed through rotational pulse detection. To achieve real-time fuel measurement, a water-based fuel emulation mechanism is implemented, where a controlled DC pump represents engine fuel demand and a flow sensor measures water consumption equivalent to fuel usage. The acquired parameters are processed using STM32 microcontrollers and transmitted between nodes via CAN bus communication, replicating modern automotive electronic control unit (ECU) networking. The received data is displayed on a software dashboard that provides real-time visualization of speed, throttle position, fuel flow rate, total fuel consumed, and driving behavior classification. The system demonstrates how embedded communication and physical consumption measurement can be integrated to analyze driver efficiency and promote eco-driving practices. The developed prototype serves as a scalable model for intelligent vehicle monitoring and energy-efficient transportation systems.

Keywords: CANBus, Eco-driving, Fuel efficiency, Driver behavior, Real-time feedback

I. Introduction

Public transportation systems play a vital role in urban mobility, but they also contribute significantly to fuel consumption and carbon emissions. One of the major factors affecting fuel efficiency is driver behavior, including acceleration, braking, and speed management.

Eco-driving techniques aim to reduce fuel consumption and emissions by promoting efficient driving habits. However, studies show that the impact of eco-driving training diminishes over time without continuous monitoring and feedback.

To address this issue, this project proposes a CANBus-based eco-driving system that continuously monitors vehicle data and evaluates driver performance. Unlike traditional systems, this approach provides real-time feedback to drivers and ensures fair performance comparison by considering similar driving conditions.

II. Proposed Methodology

A. System Overview

The proposed system follows a structured workflow:

- Vehicle Data Collection via CANBus
- Data Transmission to Server
- Performance Evaluation
- Real-Time Feedback to Driver
- Report Generation for Operators

B. Data Collection

Vehicle data is collected using the CANBus interface. The parameters include:

- Fuel consumption
- Vehicle speed
- Engine speed (RPM)
- Distance traveled

Data is recorded periodically and transmitted to a central server.

C. Comparison-Based Evaluation

To ensure fairness, drivers are evaluated under similar conditions:

- Same route
- Same direction
- Same vehicle type
- Same time of day
- Same traffic conditions

This grouping eliminates external factors affecting performance.

D. Performance Calculation

Driver performance is calculated using:

- Driver fuel consumption (D)
- Group average consumption (C)

Economy percentage:

$$E = 100 - (D/C \times 100)$$

- Positive E → Efficient driving
- Negative E → Inefficient driving

E. Real-Time Feedback

Drivers receive instant feedback through a visual interface:

- Green → Efficient driving
- Orange → Average performance
- Red → Poor performance

This helps drivers adjust their behavior immediately.

III. System Architecture

The system consists of an On-Board Unit (OBU), a central server, and a driver interface. The OBU collects data, the server processes it, and the interface displays feedback.

The system consists of three main components:

A. On-Board Unit (OBU)

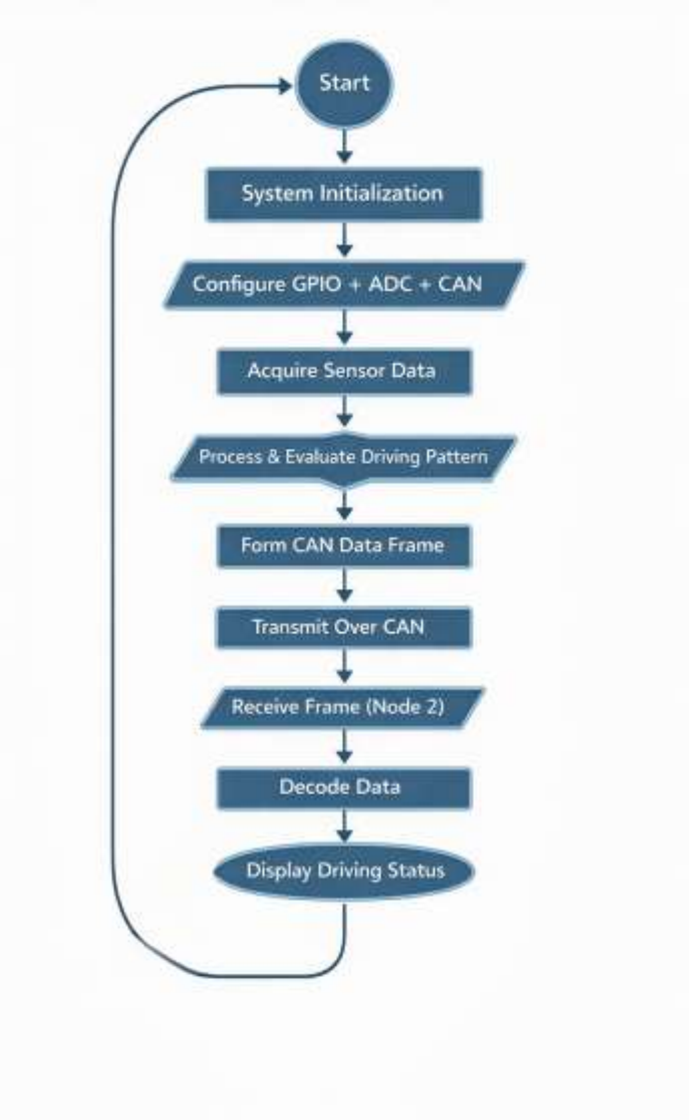
- Connected to CANBus
- Collects real-time vehicle data
- Sends data to server via wireless communication

B. Central Server

- Stores and processes data
- Calculates driver performance
- Generates reports

C. Driver Interface

- Displays real-time feedback
- Uses color indicators for performance



IV. Implementation

The system is implemented in a public transport environment with multiple buses.

A. Working Process

- CANBus collects vehicle data every few seconds
- Data is stored locally in OBU
- Data is transmitted to server periodically
- Server processes and evaluates performance
- Feedback is displayed to driver in real-time

B. Reports Generated

- Driver performance reports
- Fuel consumption analysis
- Comparison graphs
- Company-wide fuel usage

V. Results and Discussion

The system was tested in real-world conditions over several months.

- Fuel savings:
  - ~2.5% to 4.5% monthly
  - Up to 5% annually
- Improved driver behavior
- Reduced fuel consumption variability
- Positive response from drivers and operators

VI. Applications

The proposed system can be used in:

- Public transport buses
- Logistics and delivery fleets
- Government transport systems
- Smart city transportation

VII. Conclusion

This paper presents a CANBus-based eco-driving system that effectively improves fuel efficiency and driver performance. By combining real-time monitoring, fair evaluation, and instant feedback, the system ensures sustainable driving practices.

The results demonstrate significant fuel savings and improved operational efficiency, making the system suitable for large-scale deployment in transportation networks.

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