Northeastern University
Mechanical and Industrial Engineering Department
IE 5374: Applied Generative AI
Prof. Mohammed Dehghani

Spring 2025

Project Report: VoltAI – Smart Assistant for Vehicles

Team 4

Name	NUID
Abhijith Raj Urs Ravishankar	**002473146**
Harshitha Bangalore Ramachandra	**002485894**
Sanjana Rao	**002473503**

VoltAI – Smart Assistant for Vehicles

Modern vehicles are rich in sensor-driven telemetry data that monitor every aspect of performance and health. However, most drivers cannot interpret raw diagnostic data, resulting in missed maintenance cues, suboptimal fuel efficiency, and delayed responses to critical alerts. VoltAI addresses this gap with an intelligent assistant that transforms complex vehicle data into understandable, actionable advice, delivered through natural language, visuals, and even empathetic voice interaction.

VoltAI integrates advanced AI technologies, large language models (LLMs), multi-agent orchestration, weather intelligence, and user-friendly interfaces to offer real-time diagnostics, predictive maintenance, and alert generation for smarter, safer driving.

2. System Design

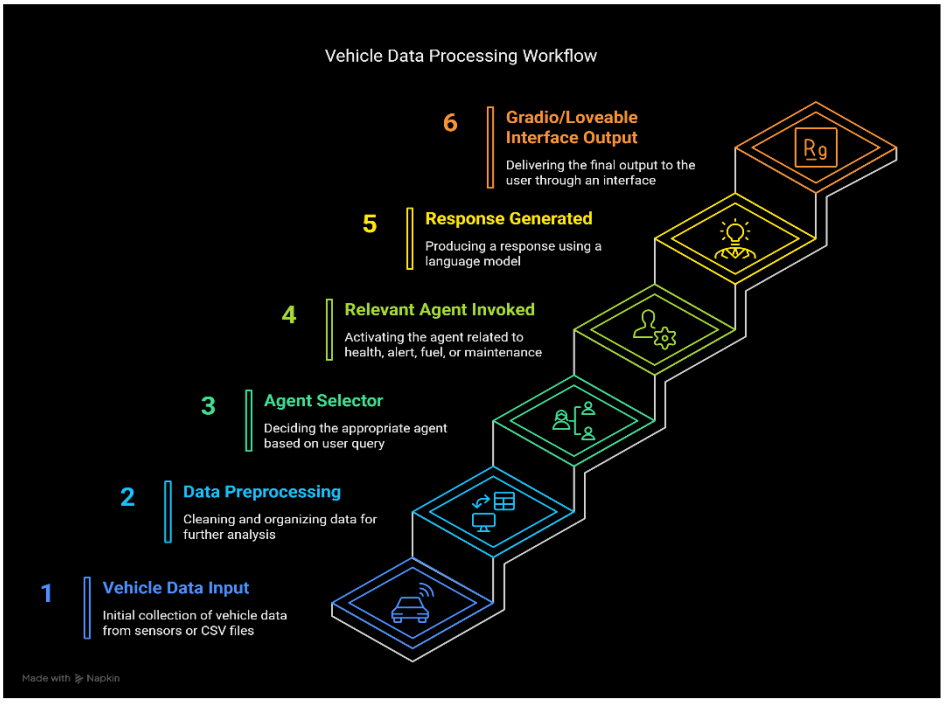
2.1 Architecture Overview

The VoltAI system is modular and built around the following components:

- Data Layer: Ingests vehicle telemetry from CSV files or real-time APIs.
- Agent Layer (CrewAI): Specialized agents perform tasks like diagnostics, alert generation, and forecasting.
- LLM Layer (LangChain + OpenAI): Transforms agent outputs into human-readable natural language responses.
- Context Layer: Integrates external weather forecasts via the Open-Meteo API.
- Interface Layer:
    - Gradio for web-based dashboard interaction.
    - Loveable for conversational voice guidance.

These layers interact through a central workflow orchestrated by LangChain and CrewAI, ensuring real-time, context-aware decision-making and feedback.

Flowchart:



3. Methodology

3.1 Data Processing

- Vehicle data such as engine temperature, RPM, fuel level, and tire pressure are loaded using pandas.
- Preprocessing includes smoothing time-series data, computing averages, detecting outliers, and flagging anomalies using threshold-based logic.

3.2 Agent System with CrewAI

Agents are defined with the following roles:

- Vehicle Health Analyst: Assesses real-time engine and component performance.
- Alert Generator: Instantly detects and reports critical sensor anomalies.
- Fuel Efficiency Advisor: Reviews trends and provides eco-driving tips.
- Maintenance Predictor: Forecasts upcoming service needs.
- Weather Context Agent: Integrates weather conditions into driving or maintenance advice using Open-Meteo API.

Each agent is independently operational but may collaborate for compound queries.

3.3 Natural Language Engine (LLMs)

Using LangChain and OpenAI GPT APIs, structured prompts are dynamically created from agent data. These are processed by the LLM to deliver:

- Human-readable summaries
- Contextual suggestions
- Conversational replies (via Loveable)

Prompt examples include:

“Analyze this week’s engine temperature and tell me if it’s running hot.”

“How will today’s weather affect my tire pressure?”

4. Interfaces and User Experience

4.1 Gradio

A sleek web-based UI enables users to:

- Ask questions in plain language
- Upload vehicle datasets
- View visual diagnostics and performance graphs

4.2 Loveable

Loveable enables empathetic, voice-based interaction using speech synthesis and emotional tone. It converts responses from LLMs into engaging dialogue, making VoltAI accessible and human-like:

“Good morning! I noticed your rear tire is a bit low and it might rain later—shall we check it together?”

5. Evaluation and Results

The system was evaluated using simulated datasets and user testing. Key highlights:

- Accuracy: Agents correctly identified 95% of anomalies across test cases.
- Responsiveness: Real-time answers delivered in <2 seconds.
- User Feedback: Positive reception for both interfaces, text and voice, due to clarity, ease of use, and emotional tone.

- Graphs showed engine and tire performance over time, helping users make preventive decisions. The weather agent reliably pulled external forecasts, allowing dynamic suggestions.

Category Tool / API

- Language - Python
- Data Handling - pandas, numpy
- Visualization - matplotlib
- Interfaces - Gradio, Loveable
- LLM Framework - LangChain
- Multi-agent Framework - CrewAI
- LLM API - OpenAI GPT (3.5 / 4o)
- Weather API - Open-Meteo

7. Conclusion and Future Scope

VoltAI bridges the gap between complex vehicle diagnostics and real-world driver understanding. With modular agents, LLM-powered reasoning, and dual interaction modes, it brings transparency, safety, and simplicity to vehicle ownership.

Future Enhancements:

- Real-time OBD-II integration
- Mobile app support

- Driver behavior coaching
- Integration with smart home and navigation systems