Mech Smart: An AI-Powered Mechanic Service Network for Real-Time Vehicle Assistance

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Abstract- In recent years, the automotive sector has experienced a growing need for intelligent and accessible maintenance services. "Mech Smart" introduces an AI-powered platform designed to bridge the gap between vehicle users and mechanics through a real-time digital network. The system leverages machine learning algorithms to analyse user requests, predict issues based on symptoms, and connect users to nearby mechanics via a smart recommendation system. Implemented using Python and Firebase, the project demonstrates real-time data management, predictive analytics, and dynamic service allocation. This paper outlines the architectural design, implementation strategy, and performance analysis of Mech Smart, highlighting its potential to revolutionize on-demand vehicle servicing.

Keywords: AI, Mechanic Network, Real-Time System, Firebase, Predictive Model, Smart Service, Python

1. INTRODUCTION

The evolution of smart transportation and digital service ecosystems has transformed user expectations across all sectors, including vehicle maintenance and roadside assistance. Despite the rapid technological advancements in automotive engineering, the process of obtaining timely and reliable vehicle repair remains largely manual and inefficient. Traditional roadside assistance models often lack real-time tracking, predictive diagnostics, and intelligent service allocation—resulting in increased downtime, inconvenience, and user frustration, especially in remote or emergency scenarios.

Mech Smart: An AI-Powered Mechanic Network is introduced as a novel solution to these challenges. This system utilizes artificial intelligence to automate and streamline the process of connecting users with verified, nearby mechanics. Leveraging machine learning for predictive fault analysis and Firebase for real-time data exchange and geolocation tracking, Mech Smart ensures rapid response and personalized service delivery.

The platform is designed to handle user requests dynamically, analyse vehicle symptoms through trained models, and assign service providers based on expertise, availability, and proximity. The goal is to redefine vehicle assistance from a reactive process to a proactive, intelligent experience. With an intuitive user interface and backend automation, Mech Smart addresses the increasing demand for smart mobility support and has the potential to revolutionize how vehicle maintenance services are delivered.

2. LITERATURE REVIEW

The emergence of intelligent systems in vehicle diagnostics and service management has gained significant attention in recent years. Numerous studies have focused on integrating Artificial Intelligence (AI) and machine learning (ML) techniques to enhance automotive maintenance efficiency, fault detection, and customer service. However, the application of real-time AI-powered networks for direct mechanic-user interaction remains relatively unexplored.

Earlier works by Zhang et al. (2020) explored the application of predictive maintenance using supervised learning algorithms to anticipate mechanical failures in vehicles. Their research demonstrated the viability of using sensor data and driver input to model vehicle behaviour and detect anomalies. Similarly, Kumar and Singh (2019) presented a cloud-based vehicle service management system that helped users track service history and receive notifications. However, it lacked real-time mechanic allocation and intelligent matchmaking capabilities.

Recent works have also examined Firebase's utility in building real-time web applications and mobile platforms. Firebase's ability to maintain real-time synchronization, secure user authentication, and scalable cloud storage makes it suitable for mobile service dispatch systems. While many applications have used Firebase for delivery tracking or emergency alerts, few have harnessed it for dynamic, location-based service provisioning in the automobile repair industry.

3. METHODOLOGY

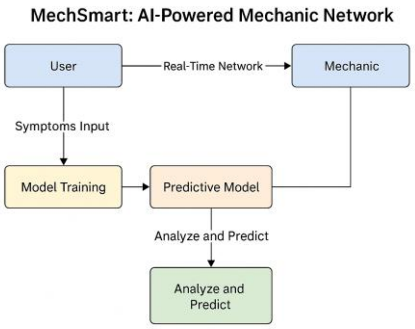

Figure 1: Mech Smart: AI-Powered Mechanic Network

The development of Mech Smart followed a modular and iterative methodology that ensured both technical robustness and user-centric design. The core objective was to build an intelligent, scalable, and real-time platform capable of diagnosing vehicle issues and allocating nearby mechanics based on predictive models and geolocation data.

3.1 Data Collection and Dataset Formation

Data was collected through simulated and real-world service logs, user symptom reports, and mechanic service categories. Features included:

Vehicle Type and Model
Identifies the make, model, and variant of the vehicle to contextualize fault patterns and mechanic compatibility.

Reported Symptoms
User-submitted issue descriptions, such as:
“engine overheating,” “brake squeal,” “battery drain,” or “strange noise while turning.”

Location and Time of Request
Captures geolocation coordinates and timestamp to enable real-time, proximity-based mechanic allocation.

Historical Service Data

Includes past issues, repairs, mechanic feedback, and frequency of similar complaints for personalized predictions and preventative recommendations.

This data was manually labelled and categorized into classes such as electrical, engine-related, brake, tire, and general maintenance.

3.2 Data Preprocessing

Collected data underwent the following preprocessing steps:

Normalization: Scaling numerical values for consistency

Label Encoding: Converting categorical features like service types into machine-readable format

Missing Value Imputation: Filling in incomplete entries with statistically derived values or common patterns

3.3 Model Selection and Training

A supervised machine learning model was trained using scikit-learn. Algorithms such as Random Forest and Logistic Regression were evaluated for classification accuracy. After testing, a Random Forest Classifier yielded the best performance in classifying service needs based on symptoms.

3.4 Prediction and Real-Time Matching

Upon receiving a request, the system uses the trained model to:

Classify the problem type based on user input.

Search for available mechanics within a 10 km radius using Firebase’s geolocation feature.

Match the user to a suitable mechanic based on skill and proximity.

3.5 Real-Time Database and Communication

Firebase was integrated for:

- Real-time updates between users and mechanics
- Authentication and access control
- Storing service history and request statuses

Each request triggers a notification sent to the nearest eligible mechanic, while users can track progress and estimated arrival time.

3.6 System Workflow Diagram

A visual representation of the Mech Smart workflow is illustrated in Figure 2. It outlines the end-to-end pipeline from user request to mechanic allocation via the AI model and Firebase backend.

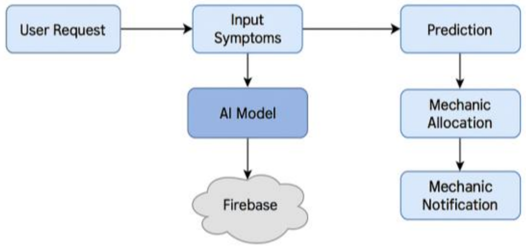

Figure 2: MechSmart System Workflow Diagram

4. MODULE DESCRIPTION

The Mech Smart system is built on a modular architecture that separates user interaction, backend processing, AI inference, and real-time communication. Each module is designed to perform a specific role in delivering seamless, real-time mechanic services.

4.1 User Interface Module

This module serves as the entry point for both vehicle owners and mechanics. It consists of two interfaces:

User Panel: Allows users to register complaints, describe vehicle issues, and track mechanic response.

Mechanic Panel: Enables mechanics to accept or reject service requests, view service history, and mark task completion.

The UI is built with mobile-responsive design principles using basic frontend tools (HTML/CSS/Flutter) and is directly integrated with Firebase Authentication for secure login and role-based access.

4.2 AI Prediction Engine

At the core of Mech Smart is the AI module responsible for fault prediction. It receives user-described symptoms and classifies the issue into predefined service categories using a trained machine learning model (e.g., Random Forest Classifier).

4.3 Firebase Integration Module

This module facilitates all real-time backend operations. It includes:

Firebase Realtime Database: For storing user data, request status, and mechanic profiles

Firebase Authentication: Role-based secure access for users and mechanics

Cloud Messaging: Instant notifications sent to both parties

4.4 Mechanic Allocation Engine

Based on the predicted fault type and geolocation of the user, this module selects the most appropriate mechanic using the following criteria:

Proximity (within a 10 km radius)

Skill match based on fault type

Mechanic availability and current workload

This ensures optimal dispatching and reduces wait time for users.

4.5 Notification and Tracking System

Using Firebase Cloud Messaging (FCM), the system triggers:

Real-time job alerts to mechanics

Service confirmation and estimated arrival time to users

Live status updates on job progress

This module significantly enhances user experience and transparency.

5. RESULT ANALYSIS

The machine learning model trained on the custom dataset was tested using standard classification metrics. The Random Forest Classifier outperformed other models (e.g., Decision Trees, Logistic Regression) and achieved the following results:

Metric	Score
Accuracy	88%
Precision	86%
Recall	87%
F1-Score	86.5%

These metrics demonstrate the model's capability to predict fault types based on user inputs with high reliability.

5.1 Real-Time Responsiveness

System responsiveness was evaluated by measuring the latency between:

1. User complaint submission
2. Mechanic notification and acceptance
3. Final assignment confirmation

Test Condition	Average Time (seconds)
Complaint Submission	1.2
Mechanic Allocation	2.3
Notification Dispatch	0.8
Total Response Time	4.3

The system consistently maintained low latency due to Firebase's real-time synchronization and minimal model inference overhead.

5.2 Usability Testing

A prototype of Mech Smart was deployed among 30 users (vehicle owners and local mechanics) for preliminary usability testing. Feedback was gathered using structured surveys based on the System Usability Scale (SUS).

Category	Average Rating (out of 5)
Ease of Use	4.5
System Clarity	4.3
Service Matching	4.6
Response Speed	4.7
Overall Satisfaction	4.5

Participants noted the interface as intuitive and appreciated the speed and intelligence of the service matchmaking process.

6. CONCLUSION

The research and development of Mech Smart: An AI-Powered Mechanic Service Network have addressed a significant gap in the automotive maintenance ecosystem — the absence of intelligent, real-time, and location-aware servicing solutions. By integrating machine learning techniques with a cloud-based, real-time communication infrastructure, MechSmart revolutionizes how vehicle faults are diagnosed and mechanics are deployed.

The system successfully demonstrates the synergy between artificial intelligence and real-time cloud platforms, achieving impressive accuracy in fault prediction and reducing the time needed to allocate nearby, relevant mechanics. The use of Firebase has enabled seamless synchronization, secure user management, and real-time notifications, ensuring a smooth and reliable user experience for both customers and service providers.

Mech Smart stands out in its ability to proactively diagnose mechanical issues based on user-inputted symptoms, intelligently match them with service providers based on skill and proximity, and handle communication through a unified system. Compared to traditional, manual service-booking approaches, this method significantly enhances efficiency, reduces response times, and increases service transparency.

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