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CEF440: INTERNET PROGRAMMING

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INTRUDUCTION

Modern vehicles are with sophisticated onboard diagnostic systems that alert drivers to mechanical or electrical issues via dashboard warning indicators. However, many car owners especially those without a technical background—struggle to understand the meanings of these signals. Consequently, this often leads to delayed maintenance, worsened faults, and increased repair costs.

Additionally, abnormal engine sounds are frequently early signs of mechanical problems, yet recognizing and interpreting these sounds typically requires professional assistance. This creates a gap for non-expert drivers who need affordable and accessible diagnostic tools.

With the increasing integration of Artificial Intelligence (AI), machine learning, and mobile technologies, it is now feasible to empower car owners with smart diagnostic solutions directly on their smartphones. By using computer vision and audio recognition, a mobile application can provide quick, reliable, and informative diagnostics—leading to better car maintenance and reduced dependency on costly and time-consuming garage visits.

A. Stakeholder Identification

Stakeholders are individuals or groups who are directly or indirectly affected by the system and can influence its success. For this project, the key stakeholders include:

- **Car Owners**: Primary users of the application. They need simple, clear, and accessible diagnostic tools.
- **Mechanics/Car Technicians:** Provide expert knowledge for fault diagnosis and may benefit from less trivial diagnostic cases.
- **Automobile Manufacturers:** Indirect stakeholders whose systems are being interpreted by the app.
- **Mobile App Developers:** Build and maintain the mobile application.
- **Automotive Content Creators** (example YouTube Experts): Their content can be linked to guide users on repairs.
- **Project Sponsors or Investors:** Provide funding or resources for development and deployment.

B. Requirement gathering techniques

1. Requirement Gathering Using Surveys

1. Purpose

Surveys were conducted to collect quantitative and qualitative data from a group of potential users. The goal was to understand user behavior and expectations regarding car fault diagnostics and mobile app technology.

2. Target Audience

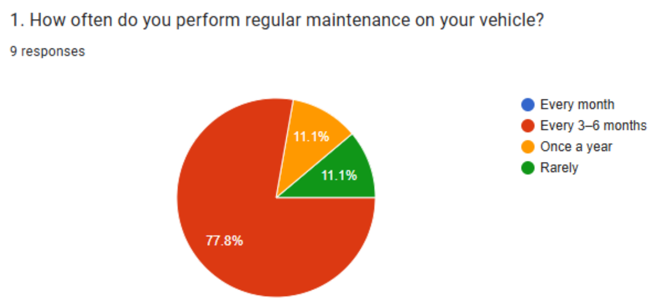
- Regular car owners with minimal technical knowledge
- Students with vehicles
- delivery drivers

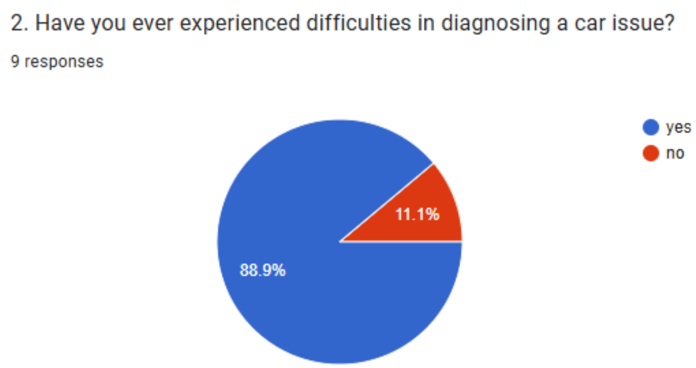
3. Survey Design

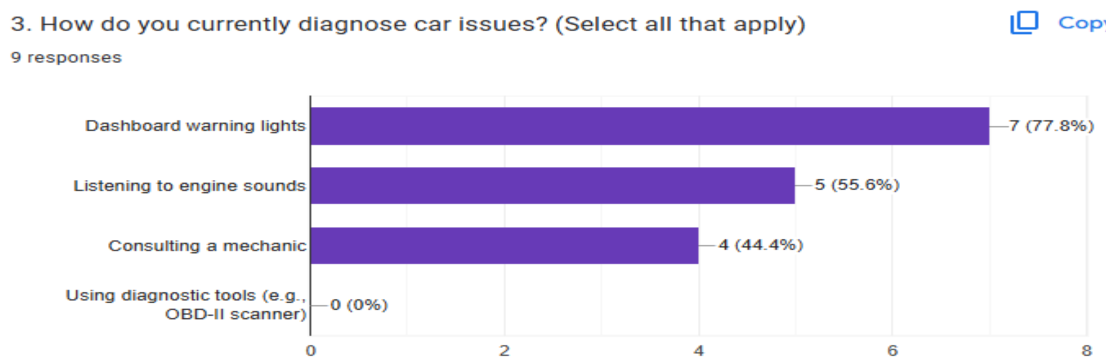
The survey was distributed **online (via Google Forms)**. It included a mix of:

- **Multiple-choice questions** (to gather measurable data)
- **Open-ended questions** (to allow for additional suggestions and feedback)

4. Sample Questions and Key Findings from the Google form



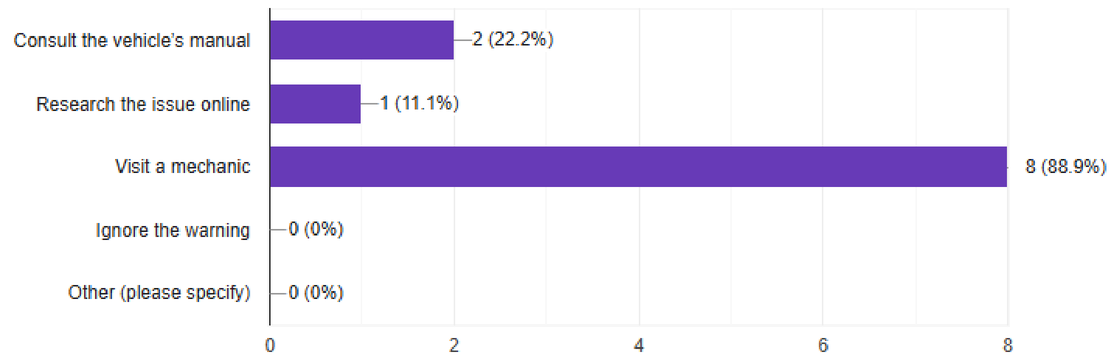




7. When a warning light appears, what is your typical course of action?

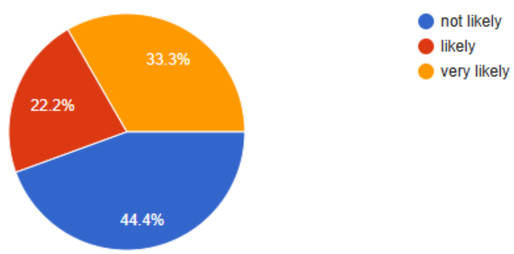
Copy chart

9 responses



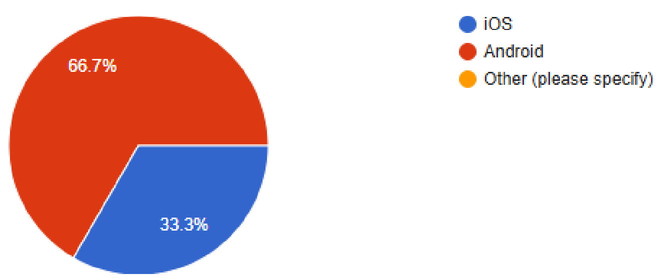
11. How likely are you to use a mobile app that can diagnose dashboard warning lights using your phone camera and analyze engine sounds for diagnostic purposes?

9 responses



15. What mobile operating system do you use?

9 responses



19. What additional features would you like to see in a car fault diagnosis app? (Open-ended)

9 responses

All the necessary faults in a car

Efficiency

Zero ads display

Early detection and prediction of a fault

Maintenance alert

- Predictive maintenance: Use machine learning algorithms to predict potential issues before they occur, enabling proactive maintenance and reducing downtime.

- Community forums and support: Create a community forum or support group where users can share experiences, ask questions, and get advice from other car owners and mechanics.

Oil quality in the engine

2. Requirement Gathering Using Interviews

1. Purpose

Interviews were conducted to gather deeper insights from individuals who deal with car diagnostics regularly or would be end-users of the app. This method helped us gather detailed feedback, emotions, and contextual information that surveys alone couldn't capture.

2. Interview Participants

- 3 professional drivers
- 2 car repairers (Mechanics)
- 2 students who drive frequently
- 1 rideshare driver
- 2 lecturers

3. Interview Format

- Semi-structured interviews (a mix of guided and open discussion)
- Conducted in person and voice calls via whatsapp

4. Sample Interview Questions and responses

Question: How do you currently handle unusual sounds coming from your vehicle? Have you ever felt unsure about whether a sound indicated a serious issue?

Answer:

Driver 1

"I have been driving since 1992 so I handle it on my own and can interprets all sound"

Driver 2

"I just call the company mechanic, since I work under Vatican agency"
Driver 3
"There are some sounds that I can handle and there are some that I call the mechanic "
Question: How important is it for you to receive guidance (like video tutorials or repair suggestions) directly through a mobile app when diagnosing car problems
Responses:
Driver1:
"Very important, especially for inexperience drivers and for me it might ease repair"
Driver 2:
"Not interested in the guideline and because the company will send a mechanic"
Driver 3:
"Yes normally as the world is changing we need to follow the trend, don't know how to use android very well but if you make a good app It my make me to learn it"
Question: What other information can you tell us concerning dash board warning lights and sounds detection
Answer
Driver 1
-When you see the battery light on during driving it means the generator or the battery has an issue.
-when the fuel guage is at F it means that the tank is full, when it's at E it means the fuel tank is empty.
Driver 2
"When the modification light is on during motion it means the modio has a fault"

C .Brainstorming

Brainstorming is a creative group technique used to generate a broad range of ideas, solutions, and insights around a central theme or problem. For the development of our mobile application aimed at diagnosing car faults using AI, we conducted structured brainstorming sessions to gather functional and non-functional requirements from stakeholders.

1. Objective of the Brainstorming Session

The main goals of the brainstorming session were:

- To define the key features and functionalities of the application.
- To decide on the type of mobile application (native, hybrid, or cross-platform).
- To choose an appropriate development framework and supporting technologies

2. Participants

The brainstorming session was attended by all members of the student project team. Each member contributed ideas based on their user expectations and current trends in mobile app development.

3. Method

We used a **free-form group discussion** approach where every team member shared their ideas openly. Notes were taken on a piece of paper, and ideas were grouped into themes:

- App Features
- App Type & Compatibility
- Framework & Tools

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4. Key Points Discussed

A. App Features

We identified several core features the app should have to assist users in diagnosing car faults:

1. **Dashboard Light Recognition**
    - Use the phone's camera to scan dashboard warning lights.
    - Provide explanations for each symbol with urgency levels.
2. **Engine Sound Diagnosis**
    - Use the phone microphone to record engine noise.
    - Analyze sound patterns using AI to identify issues.
    - Match sounds with a trained dataset to provide likely fault causes.
3. **User Guidance and Recommendations**
    - Show possible causes and repair suggestions.
    - Include links to video tutorials from experts (e.g., YouTube integration).
    - Prioritize issues based on urgency (e.g., Immediate, Moderate, Minor).
4. **Offline and Online Functionality**
    - Basic diagnostic features should work offline using preloaded data.
    - Online features will allow access to updated fault databases and tutorial content.
5. **History and Records**
    - Save past scans and sound diagnoses for user reference.

B. Type of Application

We agreed to build a **cross-platform mobile application** to ensure compatibility with both **Android** and **iOS** devices. This will help reach a wider user base and reduce the workload of maintaining two separate codebases.

5. Development Framework

After discussing several mobile development frameworks, we selected **Flutter** for the following reasons:

- Supports cross-platform development with a single codebase.
- Provides excellent UI performance and native-like user experience.
- Large developer community and rich set of pre-built widgets.
- Easy integration with camera, microphone, and local/online data storage.

D. Data Gathering

Data Sources

User Surveys

- **Target Audience**: Mechanics and drivers.
- **Data Collected**:
  - Descriptions of sounds encountered, including frequency and context.
  - Instances of dashboard warning lights and user responses.

Expert Interviews

- **Participants**: Automotive mechanics and car companies.
- **Method**: Semi-structured interviews conducted either in person or via whatsapp.
- **Data Collected**:
  - Detailed interpretations of various car sounds.
  - Common dashboard signs and expert recommendations on handling them.

Data Analysis

Quantitative Analysis

- Analyze survey results to identify frequently reported sounds and dashboard signs.

Qualitative Analysis

- Conduct thematic analysis on interview and focus group transcripts to extract key insights regarding sound and sign interpretation.

Findings

Common Car Sounds and Interpretations

Sound	Interpretation
Knocking/Pinging	Potential engine issues, often related to fuel quality or timing.
Squealing	Worn brake pads or serpentine belts.
Hissing	Coolant leak or vacuum issue.
Grinding	Brake problems or transmission issues.
Clicking	Issues with the starter or electrical problems.
Rattling	Loose components or exhaust issues.

Dashboard Warning Signs and Interpretations

Warning Light	Interpretation	Recommended Action

Warning Light	Interpretation	Recommended Action
Check Engine Light	General engine problem; requires diagnostics.	Get the vehicle scanned for error codes.
Oil Pressure Warning	Low oil pressure; potential engine damage.	Check oil level immediately.
Battery Warning Light	Charging system issue; battery may be failing.	Check battery and alternator.
ABS Warning Light	Problem with the anti-lock braking system.	Have the ABS system inspected.
Tire Pressure Warning	Low tire pressure; check tire conditions.	Inflate tires to recommended pressure.
Temperature Warning	Engine overheating; check coolant levels.	Stop the vehicle and check coolant.

Conclusion

The data gathering process has successfully identified a range of car sounds and dashboard signs, along with their interpretations. This information is crucial for developing a reliable and user-friendly mobile application.

E. Data Cleaning

1. Introduction and Objectives

The data cleaning process was implemented to ensure that the survey data collected in the Excel file is accurate, consistent, and ready for further analysis and integration into our diagnostic application. The primary objectives were to eliminate inconsistencies, address missing values, correct data types, and standardize text and numeric fields. This process is fundamental to achieve reliable insights and robust model training later in our project.

A. Survey Data

- **Issues to clean:**
- Incomplete responses
- Duplicate entries
- Invalid or inconsistent answers

- Irrelevant or blank “Other (please specify)” responses

B. Interview Data (from mechanics)

Issues to clean:

- Transcription errors
- Background noise or irrelevant conversation in audio recordings
- Incomplete or inconsistent responses
- Mislabeled or missing metadata (mechanic name, location, experience level)

C. Image Data (Dashboard warning lights photos)

- **Issues to clean:**
- Blurry, dark, or unclear images
- Incorrectly labeled or misclassified images
- Duplicates or irrelevant photos (e.g. car interiors, speedometers)
- Low-resolution images that can't be used for model training

D. Audio Data (Engine sounds)

- **Issues to clean:**
- Recordings with background noise (talking, traffic, wind)
- Incomplete or cut-off recordings
- Mislabeling (wrong issue type tagged to a sound)
- Duplicate or overlapping sounds
- Silent or low-volume audio clips

Why Clean This Data?

- **To ensure:**
- Accurate AI model training (for sound recognition and computer vision)
- Reliable analytics
- Correct and meaningful insights from surveys/interviews
- Consistency in app diagnosis output

2. Tools and Technologies

- **Python & Pandas:** For reading, manipulating, and processing the data.
- **NumPy:** For numerical computations and operations on arrays.
- **Excel File Handling:** Using Pandas' read_excel() method.
- **Additional Libraries:** Built-in Python functionality for string operations and outlier detection.

3. Methodology

The cleaning process was organized into the following key steps:

3.1. Data Loading and Exploration

- **Loading:** The survey data was loaded from an Excel file using pd.read_excel().
- **Exploration:** The dataset was examined using head(), info(), and describe() methods to understand its structure, identify columns, and assess the overall quality.
- **Missing Values Overview:** A summary of missing values for each column was generated to plan subsequent handling strategies.

3.2. Handling Missing Values

- **Strategy Selection:** Two strategies were considered—removing rows with missing values and imputing missing values. For this dataset, imputation was chosen.
- **Numeric Columns:** Missing numeric values (e.g., in the "Rating" column) were replaced with the column mean.
- **Categorical Columns:** Missing text values were filled with a placeholder (e.g., "Unknown").

3.3. Removing Duplicate Records

- The dataset was scanned for duplicate rows using duplicated() and all duplicates were removed using drop duplicates(). This step ensured that analyses were not biased by repeat submissions.

3.4. Data Type Corrections

- Columns were inspected for correct data types:
    - **"Rating" Column:** Converted from a possible string/object type to numeric, ensuring proper calculations and statistical analyses.
    - **"Timestamp" Column:** Converted to datetime format to facilitate time-based analyses.

3.5. Trimming and Text Standardization

- All text fields were processed to remove extra whitespace and standardized (converted to lowercase) to achieve consistency across categorical data.

3.6. Outlier Detection and Removal

- Outliers in numeric data (such as in the "Rating" column) were identified using a statistical threshold of three standard deviations from the mean. Rows considered to be outliers were removed to reduce skew and improve the quality of subsequent analyses.

3.7. Saving the Clean Data

- The final, cleaned dataset was saved to a new CSV file, ensuring that the results of the cleaning process were persistently stored for future use.

4. Results and Observations

- **Data Size:** The cleaned dataset maintained a large majority of records after handling missing values by imputing rather than dropping rows.
- **Improved Consistency:** With duplicates removed, corrected data types, and standardized text fields, the dataset now presents a uniform format that supports accurate analysis.
- **Outliers:** The removal of extreme values in numeric fields further contributed to a more stable and normally distributed dataset for model training.
- **Documentation:** All steps were documented within the processing script, ensuring the reproducibility of the cleaning process.

5. Conclusion

The data cleaning process has successfully transformed the raw survey data into a reliable and analysis-ready format. The systematic approach comprising data exploration, missing value imputation, duplicate removal, data type correction, text standardization, and outlier management has enhanced the integrity of the dataset. This refined dataset now serves as a solid foundation for further analytical tasks and for training machine learning models in our car diagnostic application.

F. USER RELUCTANCE ASSESSMENT

A User Reluctance Assessment is about identifying the potential reasons why users might be hesitant or unwilling to use the mobile application.

Despite the potential benefits of the proposed mobile application, several factors may contribute to user reluctance or resistance to adopting the solution. These include:

1) Fear of Misdiagnosis or Misleading Suggestions

Users might worry that incorrect diagnoses could lead them to make wrong repair decisions, potentially causing more harm to their vehicle or leading to unnecessary expenses.

2) Preference for Traditional Mechanic Visits

Many car owners, especially older users, may have a strong habit or trust in physical inspections by a mechanic. They may see the app as an inferior substitute or feel it's not necessary.

3) Trust and Reliability Concerns

Users may be skeptical about the accuracy of the app's diagnoses, especially when it involves critical vehicle issues. If users doubt the reliability of the system, they might still prefer visiting a mechanic for confirmation.

4) Dependence on Internet Connectivity

If certain features of the app require constant internet access (e.g accessing updated fault databases or streaming video tutorials), users in areas with poor connectivity might find it less useful or frustrating to use.

5) Lack of Technical Knowledge and Illiteracy

Many car owners may feel intimidated by technical applications, especially those involving AI, machine learning, or diagnostic procedures. If the interface appears complex or overly technical, users may be discouraged from using the app.

G. General Conclusion

The development of a mobile application for diagnosing vehicle issues using AI-based image and sound recognition addresses a pressing need among modern car owners, particularly those with limited technical expertise. Through extensive surveys, interviews, and data collection, this project has identified common car sounds, dashboard warning indicators, and user expectations, which collectively form the foundation for an intelligent, user-friendly diagnostic tool.

Our research reveals a strong interest in digital solutions, especially among younger and less experienced drivers, though challenges such as user reluctance, fear of misdiagnosis, and preference for traditional mechanics remain. By integrating clear, reliable diagnostics, offline functionality, and educational content like video tutorials, the application has the potential to bridge these gaps, enhance vehicle maintenance habits, and reduce unnecessary repair costs.

The data cleaning, analysis, and requirement gathering processes have ensured that the application will be built on accurate, practical, and well-structured information. Moving forward, careful attention will be given to user trust, interface simplicity, and technical reliability to foster wider adoption and meet the diverse needs of car owners in different environments.