AI-POWERED SOLUTIONS FOR BREAKDOWN CHALLENGES WITH ELECTRIC VEHICLES

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Project Proposal Report

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Declaration

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Abstract

In the realm of vehicle breakdown assistance, the efficient procurement of spare parts stands as a critical challenge. This research delves into the innovative use of artificial intelligence and image processing techniques to revolutionize the way vehicle owners locate and acquire the necessary spare parts. Traditional methods often entail a time-consuming process of identifying suitable spare parts, matching them with requirements, and locating nearby shops. To address this, our study presents an AI-powered solution that employs machine learning models trained on diverse datasets to accurately identify spare parts based on images captured in real time. By leveraging cutting-edge image processing techniques and mapping the shapes of spare parts, this system streamlines the process of spare part identification. Upon capturing an image using a real-time camera, the system displays comprehensive details, including manufacturing specifics, pricing, available shops, contact information, and inventory availability. The proposed approach not only enhances the accuracy of spare part identification but also provides vehicle owners with real-time access to a wealth of information, enabling informed decision-making and expediting the repair process. To support this solution, collaboration with spare parts shop owners is essential, necessitating their timely registration to ensure seamless integration into the system.

Overall, this research presents a novel paradigm in vehicle assistance, where AI-driven image processing transforms the spare parts procurement landscape, fostering quicker, more informed decisions during breakdown challenges.

Contents

1. Introduction

In today's fast-paced world, owning and maintaining a vehicle is an essential aspect of modern life. However, vehicle breakdowns can occur at the most inconvenient times, often leaving individuals stranded in unfamiliar areas. The challenges faced by vehicle owners during these breakdowns are not just limited to the inconvenience of the situation but also include the complexities of identifying compatible spare parts and locating reliable repair shops promptly.

To revolutionize the vehicle assistance experience, we present an innovative solution that leverages cutting-edge technology to streamline the process of identifying, sourcing, and locating spare parts for vehicles. Our image-based spare part identification and sourcing solution aims to provide a seamless, user-friendly, and efficient way for individuals to overcome the challenges associated with breakdowns and repairs.

The Challenge - One of the primary challenges faced by vehicle owners is accurately identifying the damaged spare part, especially for those with limited automotive knowledge. Additionally, finding the right spare part quickly and locating trustworthy repair shops can be daunting, particularly in unfamiliar areas.

Our Solution - Our solution combines the power of artificial intelligence, image processing, and real-time data integration to address these challenges comprehensively. By enabling vehicle owners to capture images of damaged parts and processing these images using advanced machine learning models, we empower users with accurate spare part identification. Moreover, our system's integration with compatibility databases and shop availability data ensures that users are presented with precise compatibility information and nearby shop options.

Key Features

- Accurate Part Identification - Our machine learning model accurately identifies spare parts from images, eliminating the guesswork for vehicle owners.
- Compatibility Information - Users receive real-time compatibility information between the identified spare part and their vehicle make and model.
- Shop Availability - The solution provides a curated list of nearby shops that stock the required spare part, ensuring users can source it conveniently.
- User Feedback Integration - The system learns from user interactions and feedback, continuously improving its identification accuracy.
- Privacy and Security - We prioritize user data privacy and employ secure communication protocols to protect sensitive information.
- User-Friendly Interface - With an intuitive and easy-to-use interface, users can capture images, receive results, and make informed decisions effortlessly.

Benefits

Our image-based spare part identification and sourcing solution not only saves time and reduces frustration during breakdowns but also empowers vehicle owners to make informed decisions about their repairs. By leveraging the latest advancements in AI, image processing, and data integration, we aim to enhance the overall vehicle assistance experience, providing individuals with the confidence and convenience they deserve.

1.1 Background & Literature survey

The use of AI and image processing techniques to assist vehicle owners in finding the right spare parts represents a significant advancement in the field of automotive technology. The below section provides an overview of the relevant background and existing literature related to the proposed solution. There several areas the research looked at some of them are AI-Powered Spare Part Identification, Spare Parts Management and E-commerce, Image-Based Auto Parts Catalogs, Object Detection and Localization, Location-Based Services and Mapping AI-Powered Spare Part Identification

The utilization of AI and image processing for spare part identification has gained traction in recent years. Machine learning algorithms, particularly deep learning models such as Convolutional Neural Networks (CNNs), have demonstrated remarkable capabilities in image recognition tasks. Researchers have applied these techniques to recognize various objects, including spare parts, in images. Techniques like transfer learning allow models pre-trained on large datasets to be fine-tuned for specific tasks like identifying vehicle components. [1] [2] The e-commerce sector has been utilizing AI for enhancing the shopping experience. Online marketplaces and e-commerce platforms have integrated image recognition capabilities to assist users in finding products based on images. This concept can be extended to spare parts, where users can upload images of damaged parts, and AI-driven systems can match those images with available spare parts in various online shops. [3] [4] Some companies and researchers have explored the creation of image-based catalogs for auto parts. These catalogs use images of parts, along with relevant information such as part numbers, dimensions, and compatibility. Leveraging AI and image recognition, users can identify and order the correct parts by comparing images of their damaged parts with those in the catalog. [5] Object detection and localization techniques within the realm of computer vision play a crucial role in identifying and locating objects within images. These techniques can be applied to detect and localize various components of a vehicle, assisting in accurately identifying the required spare parts.[6] [7] Integrating location-based services with spare part identification can enable users to not only identify the correct part but also find nearby shops that have the required part in stock. Research in this area explores the seamless integration of mapping and geolocation with online platforms.[8]

1.2 Research Gap

There is currently a lack of an AI-based solution that can accurately identify, and map vehicle spare parts needed for repair vehicles using image processing and machine learning models. While some image recognition models have been developed to identify spare parts in general, they are not specifically trained to recognize electric vehicle spare parts and are not optimized for identifying the spare parts needed for specific electric vehicle breakdowns. Furthermore, there is limited research on mapping the spare parts with their available shops' locations which are nearest are limited.

Therefore, there is a need for a comprehensive AI-based solution that can accurately identify electrical vehicle spare parts needed for obtaining necessary components and map their locations for alleviate the challenges faced by individuals,

While the proposed solution of using image processing and machine learning for real-time identification and location of spare parts is innovative and promising, there are several research gaps that can be addressed to enhance its effectiveness and practicality.

The research "A" ImageNet Classification with Deep Convolutional Neural Networks by A. Krizhevsky, I. Sutskever, and G. Hinton (2012) is a pivotal contribution in the realm of deep learning and computer vision. This influential paper presents the groundbreaking architecture known as AlexNet, which revolutionized image classification tasks. Addressing the limitations of traditional methods, the authors proposed a deep convolutional neural network that automatically learns intricate features from raw image data. With its five convolutional layers followed by three fully connected layers, the architecture demonstrated a significant leap in depth, enabling the model to capture complex patterns, textures, and object parts. The use of Rectified Linear Units (ReLU) as activation functions and innovative techniques such as data augmentation and dropout enhanced the model's performance and generalization capabilities. This paper's remarkable achievement was showcased through its participation in the ImageNet Large Scale Visual Recognition Challenge, where it achieved a significantly lower error rate compared to prior approaches. The lasting impact of this paper lies in its role in catalyzing the resurgence of neural networks and laying the foundation for the deep learning revolution that has transformed various domains of artificial intelligence.[1]

The research “B” Feature Extraction & Image Processing authored by M. S. Nixon and A. S. Aguado in 2014 delves into the crucial realm of feature extraction within image processing. Focusing on the extraction of meaningful attributes from raw image data, the paper highlights the pivotal role of feature extraction in enhancing various image analysis tasks. It presents a comprehensive overview of diverse feature extraction methods, ranging from basic intensity-based approaches to more advanced techniques like edge detection, texture analysis, and shape descriptors. The paper emphasizes the importance of selecting appropriate features that capture distinct characteristics of objects or patterns within images. Additionally, it explores applications of feature extraction, encompassing object recognition, image segmentation, and content-based image retrieval. Overall, the research underscores the significance of feature extraction in optimizing the accuracy and efficiency of image analysis, enabling researchers and practitioners to better interpret and utilize image data across a wide spectrum of applications.[3]

The research “c” An image-based auto parts catalog by N. Jain et al. (2017) introduces an innovative approach to simplify the identification and selection of automotive parts through images. The paper addresses the challenges of traditional text-based catalogs by proposing a catalog structure primarily centered around images of auto parts. Each image is linked to essential information such as part numbers, dimensions, and compatibility details. The objective is to enhance usability and accessibility, enabling even individuals with limited technical knowledge to intuitively identify and choose the correct auto parts. The visual matching concept allows users to compare damaged or needed parts with catalog images, streamlining the identification process. The paper also discusses the technical aspects of implementing such a system, covering database design, image storage, and user interfaces. The proposed image-based catalog holds promise in revolutionizing the automotive parts identification process, offering benefits to mechanics, vehicle owners, and suppliers by providing a more visual and user-friendly approach to part selection.[5]

Features	Research A	Research B	Research C	Proposed System
Spare Parts Identification	X	X	X	✓
Usage of image processing	X	✓	✓	✓
Spare parts Identification	✓	✓	✓	✓
Representative datasets	X	✓	✓	✓
Noise sensitivity	X	✓	X	✓
Using of auto	X	X	X	✓

machine Learning				✓
Technology Used	CNNs/ReLU	FET/ IP	IP Algorithms/DB Design	CNN/SVM

Table 1:Research gap

2. Research Problem

The automotive industry plays a pivotal role in our modern society, providing individuals with unparalleled mobility and convenience. However, the occurrence of vehicle breakdowns remains an inevitable challenge that vehicle owners face, often leading to inconvenience, stress, and financial implications. The research problem at hand is centered around transforming the traditional vehicle assistance paradigm by addressing the complexities associated with identifying compatible spare parts and sourcing reliable repair options in a time-efficient and user-friendly manner.

when we talk about Key Aspects of the Research Problem,

Accurate Identification, Sourcing Challenges, Limited Vehicle Knowledge, and Timely Assistance are the Key Aspects of the research problem. The accurate identification of damaged spare parts is crucial for effective repairs. Traditional methods reliant on vehicle owner knowledge or mechanic expertise can be prone to errors, leading to incorrect repairs, additional costs, and extended downtimes. Locating trustworthy repair shops that stock the required spare parts can be a challenging endeavor, especially for individuals stranded in unfamiliar areas. Without proper guidance, vehicle owners may encounter unskilled mechanics or unreliable service providers. Many vehicle owners lack in-depth knowledge about their vehicles' intricate components and the compatibility of spare parts. This knowledge gap can hinder effective decision-making during breakdown situations. Vehicle owners require swift solutions during breakdowns to minimize disruptions to their daily routines. Delays in identifying spare parts and locating repair options can lead to frustration and inconvenience.

3. Objectives

3.1 Main Objective

The main objective of my research is to design and implement an image processing solution for real-time identification and sourcing of vehicle spare parts using machine learning techniques. This solution aims to provide vehicle owners with accurate and convenient access to information about compatible spare parts, availability, and nearby shops through the capture and analysis of images.

3.2 Specific Objectives

- Collection of images of different spare parts and labeling them.
- Pre-processing of the collected images, such as resizing and normalization
- Splitting the data into training, validation, and testing sets.
- Training a machine learning model using pre-processed image data.
- Evaluating the model on the validation set to identify areas of improvement.
- Collecting and processing large amounts of image data from various shops areas to map the shapes of spare parts.
- Fine-tuning the model based on the evaluation results.
- Testing the final model on the testing set to measure its accuracy and robustness.
- Implementing the model in a software application for practical use.

As novelty improvement,

Using continual learning/transfer learning to improve accuracy. (**Also, can incorporate Auto Machine Learning to make it easier to add new spare parts.)**

4. Methodology

The methodology to achieve these objectives involves.

- Collect a dataset of spare parts images - need a dataset of labeled images of spare parts for training your machine learning model.
- Preprocess the data - need to preprocess the data by resizing the images, normalizing the pixel values, and splitting the dataset into training and validation sets.
- Feature extraction - You will need to extract features from the images that can be used to train your machine learning model. There are several feature extraction techniques available, such as Histogram of Oriented Gradients (HOG), Scale-Invariant Feature Transform (SIFT), and Convolutional Neural Networks (CNNs).
- Train the machine learning model - Once you have extracted the features, you can train your machine learning model. There are several algorithms that can use for classification, including Decision Trees, Random Forests, Support Vector Machines (SVMs), and Neural Networks.
- Test and Evaluate - After training the model, will need to test it using a separate dataset and evaluate its performance. You can use metrics such as accuracy, precision, recall, and F1 score to evaluate the performance of the model.
- Deploy the system - Finally, can deploy the system and make it accessible to users.

4.1 System architecture

Users can add images or take a capture and ask the system that is this the correct spare part, what are the places that spare part can be identified. The added images are uploaded to the cloud and then the user’s current location and the images will be combined and passed to the data layer. Here all the uploaded images are transferred to the temporary database at first, and images are filtered and verified here. After all the images are transferred to the spare part's information database the images are reading the training images. Then it subjects to preprocessing, validating the deep learning model. Finally, the user can view the response and get the correct idea to buy the relevant one.

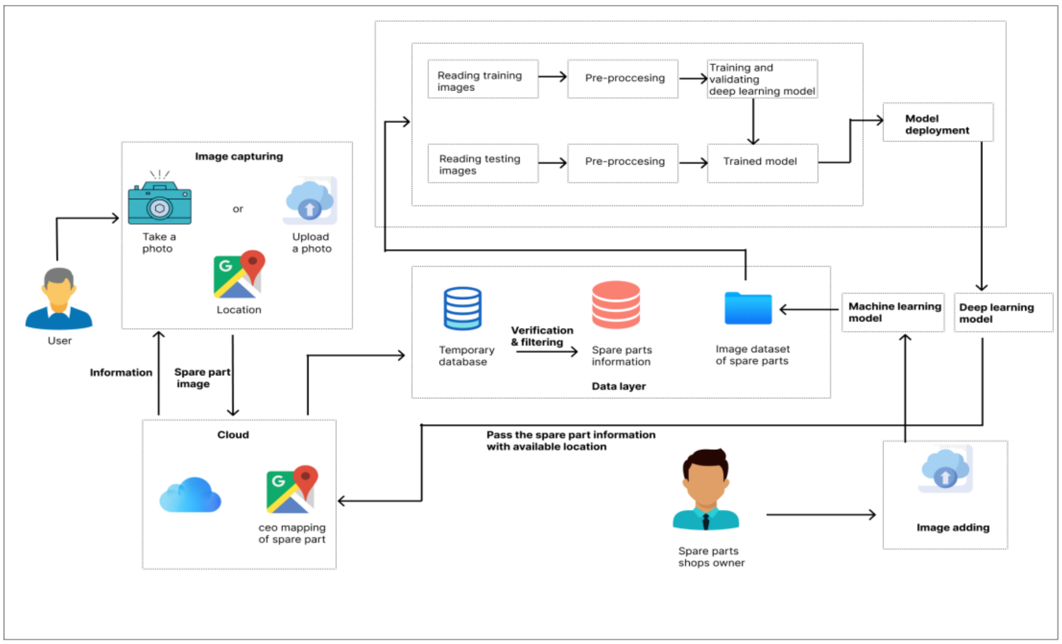

Figure 1:system architecture diagram

4.2 Technologies and techniques

Technologies	• React Native • Python • Expo • Node Server • Google Map
Techniques	• Image processing • Auto Machine Learning (AML)
Algorithms	• Support Vector machine (SVM)/Random Forest
Architectures	• ResNet

Table 2:Technologies and techniques

Software solution

The Software Development Life Cycle (SDLC) is a structured and systematic approach to software development that aims to ensure code accuracy and consistency. In the conventional approach to software development, when requirements change, developers are often unable to go back to earlier steps and are therefore forced to carry out all the remaining steps in the correct order. However, by using agile methodology in SDLC, developers have more flexibility to adapt to changes.

Agile methodology is all about embracing change and allowing for more flexibility in the development process. Scrum is thought to be superior to other agile frameworks in terms of effectiveness. Compared to other agile frameworks, Scrum is considered the most effective. It is a portable framework for agile project management that may be used to handle and resolve tricky adaptation issues. Scrum emphasizes teamwork, transparency, and continuous improvement.

Figure 2:Software development life cycle

This shows the six essential Scrum processes. Product backlog, sprint planning, sprint backlog, daily scrum, sprint review, and sprint retrospective are some of these procedures. A prioritized list of features that need to be produced is called a product backlog. The process of choosing items from the product backlog and establishing the work to be completed within the sprint is known as sprint planning. The team commits to finishing each item on the sprint backlog before moving on to the next one. At a daily stand-up meeting called a "scrum," the team reviews progress and plans for the next day. The team presents the work produced during the sprint during the sprint review, a meeting held at the conclusion of the sprint. The team gathers for a sprint retrospective meeting to discuss the sprint and pinpoint areas for improvement.

In conclusion, developers may more readily react to changing needs and have more flexibility in the development process by implementing agile techniques in SDLC. The most effective agile framework, Scrum, provides a structured method for managing projects that places an emphasis on collaboration, openness, and continuous improvement. A framework for managing and resolving complex adaptive issues in software development is provided by Scrum's six core processes.

4.3 Requirement gathering

4.3.1 Collecting information from datasets from internet.

I have gathered data from www.kaggle.com as part of my research endeavor.

4.3.2 Data gathering

Firstly, we read a dozen published research for initial understanding and got some basic ideas by reading and browsing through a few articles. Our supervisors had a few meetings with us to discuss the initial methods for data gathering and discussed about data we need to continue with. In future the other necessary data and images will be collected from the master service stations around Colombo.

4.4 Feasibility study (Planning)

4.4.1 Economic feasibility

Economic feasibility is a critical aspect of any project's success, as it determines whether or not the project is financially viable. The economic feasibility report analyzes the development costs and benefits of the project, and if a proper economic feasibility plan is not in place, the project is likely to fail. Therefore, it is crucial that the proposed system is both cost-effective and efficient in order to ensure its success.

4.4.2 Scheduled feasibility

Scheduled feasibility is another essential factor to consider when undertaking a project. A schedule feasibility assessment examines the timelines for the planned project, and any delays or missed deadlines can have a significant impact on the project's success. Therefore, it is vital that the proposed system completes each task within the allotted time period as specified to ensure that the project stays on schedule.

4.4.3 Technical feasibility

Technical feasibility planning is also crucial in the development of any system. It involves evaluating the required skills and expertise necessary for mobile and web application development, as well as the ability to understand software architectures and communicate effectively with stakeholders to obtain the necessary information. Without proper technical feasibility planning, it is unlikely that the proposed system will be successfully developed and implemented. Therefore, it is essential to have the necessary technical skills and communication abilities to move forward with the system's development.

4.5 Design (system and software design documents)

After the planning phase, system and software design documents are created which contributes to the overall system diagram.

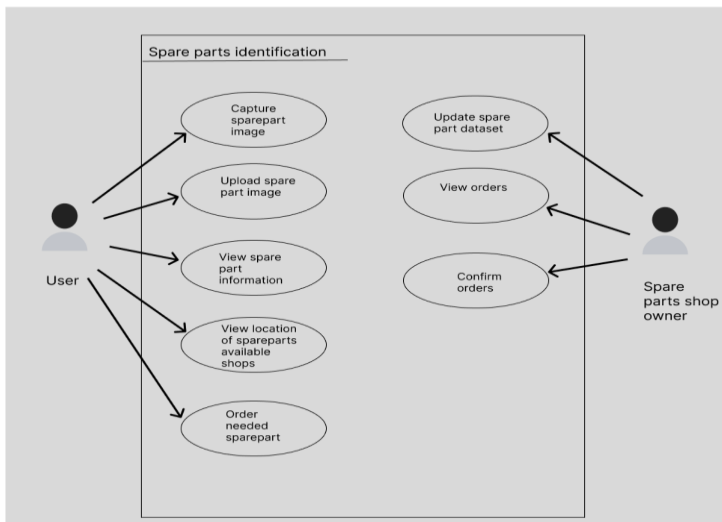

Figure 3:Use case diagram

4.6 Implementation (Development)

The implementation process, as discussed in the methodology, includes the development of below functionalities to satisfy user requirements providing the ultimate solution with high accuracy and reliability.

Collection of images of different spare parts and labeling them - This involves gathering images of different spare parts and labeling them with their corresponding names. The images should be of high quality, with good lighting and minimal noise.

Pre-processing of the collected images - The collected images need to be pre-processed to ensure that they are suitable for training the machine learning model. This can involve resizing the images to a uniform size, normalization to reduce the effects of variations in lighting, color, and contrast, and data augmentation to increase the amount of training data.

Splitting the data into training, validation, and testing sets - To evaluate the performance of the machine learning model, the data needs to be split into training, validation, and testing sets. The training set is used to train the model, the validation set is used to evaluate the performance of the model during training and adjust the hyperparameters, and the testing set is used to evaluate the final performance of the model.

Training a machine learning model using pre-processed image data - A deep learning model such as a convolutional neural network (CNN) can be trained on the pre-processed image data to classify the different spare parts.

Evaluating the model on the validation set - The model is evaluated on the validation set to identify areas of improvement. This can involve adjusting hyperparameters, changing the architecture of the model, or incorporating new features into the model.

Collecting and processing large amounts of image data - Collecting and processing large amounts of image data from various shapes can help to map the locations of shops and improve the accuracy of the model.

Fine-tuning the model based on the evaluation results - The model is fine-tuned based on the evaluation results to improve its performance.

Testing the final model on the testing set: The final model is tested on the testing set to measure its accuracy and robustness.

Implementing the model in a software application: Once the model is trained and tested, it can be implemented in a software application for practical use.

As a novelty improvement, you can use continual learning/transfer learning to improve accuracy. Continual learning allows the model to learn from new data as it becomes available, which can help to improve its performance over time. Transfer learning involves using a pre-trained model and fine-tuning it in a new task, which can save time and improve accuracy.

4.7 Testing (Track and Monitor)

During the software development lifecycle, the testing phase is a crucial stage that ensures the quality and effectiveness of the software. This phase involves a comprehensive evaluation of the software to identify any system gaps, missing requirements, errors, and bugs that need to be fixed. The primary objective of this testing phase is to improve the overall quality of the software and ensure that it meets the intended purpose. The testing phase consists of various testing processes that are carried out to achieve the desired outcome. These processes include unit testing, component testing, integration testing, system testing, and user acceptance testing. Each of these testing processes focuses on a specific aspect of the software and is designed to identify any issues that may arise in that area.

Unit testing involves testing each module or component of the software individually to ensure that it functions correctly. Component testing is done to check the software's functionality by combining various individual components. Integration testing evaluates the interactions between different software components and identifies any issues that may arise from their integration. System testing examines the entire software system to ensure that it meets the specified requirements and performs as expected. User acceptance testing evaluates the software's usability and ensures that it meets the user's requirements and expectations. Through these testing processes, the software is thoroughly evaluated and tested to identify any issues that may affect its performance, usability, or functionality. By fixing these issues, the software's quality is improved, and its effectiveness is assured.

5. Project requirements

5.1 Functional Requirements

- The system should allow users to upload images of spare parts for identification.
- The system should allow users to capture images of spare parts for identification.
- The system should be able to identify spare parts based on the uploaded images and provide information about the spare parts 's name, manufacture details, price, available shops, available quantity, contact numbers and other relevant details.
- The system should be able to identify spare parts based on the uploaded images and provide information about the spare parts' available location.
- The system should have a high accuracy rate in identifying spare parts.
- The system should integrate with a database of spare parts information to provide accurate and up-to-date information about the identified spare parts. The system should allow users to provide feedback on the accuracy of spare parts identification.
- The system should allow us to make it easier to add spare parts.

5.2 Non-Functional Requirements

- Performance: The system should be able to handle a large number of requests simultaneously, without significant delay or response time degradation.
- Usability: The system should be easy to use and navigate, with clear instructions and feedback provided to the user.
- Reliability: The system should be always reliable and available, with minimal downtime for maintenance or upgrades.

- Security: The system should be secure, with appropriate measures in place to protect user data and prevent unauthorized access.
- Compatibility: The system should be compatible with a range of devices and platforms and be able to operate seamlessly with other software applications.
- Maintainability: The system should be designed and built with maintainability in mind, with clear documentation and easily maintainable code.
- Scalability: The system should be designed to scale up or down as needed, with minimal impact on performance and functionality.
- Accessibility: The system should be accessible to all users, regardless of their physical abilities or disabilities.
- Regulatory compliance: The system should comply with relevant laws and regulations, such as data protection and privacy laws.

5.3 System Requirements

- Image processing capabilities: The system should be able to process images of spare parts uploaded by users and extract relevant features for spare parts identification.
- Machine learning algorithms: The system should use machine learning algorithms, such as deep neural networks or decision trees, to identify spare parts species based on the extracted features.
- Database integration: The system should be able to integrate with a database of spare parts information to provide accurate and up-to-date information about identified spare parts.
- Mobile compatibility: The system should be accessible on mobile devices as well as desktops, and the user interface should be optimized for mobile devices.
- Scalability: The system should be designed to handle a large number of spare parts identification requests, with the ability to scale up or down as needed.

- Performance: The system should be able to provide fast and accurate spare parts identification results, with minimal delay or response time degradation.
- Usability: The system should have a user-friendly interface that is easy to use and navigate, with clear instructions and feedback provided to the user.
- Security: The system should have appropriate security measures in place to protect user data and prevent unauthorized access.
- Reliability: The system should always be reliable and available, with minimal downtime for maintenance or upgrades.
- Integration with third-party APIs: The system should be able to integrate with third-party APIs for image processing, data storage, or other functionalities.
- System backups and data recovery: The system should have regular backups and data recovery procedures in place to ensure the safety and availability of user data.

5.4 User requirements

- User interface: The system should have a user-friendly interface that is easy to navigate and understand.
- Image uploading: The system should allow users to easily upload images of spare parts for identification.
- Plant identification accuracy: Users expect the system to have a high accuracy rate in identifying spare parts based on uploaded images.
- Plant locations identification: Users expect the system to find location based on uploaded images.
- Information display: The system should display relevant information about identified spare parts 's name, manufacture details, price, available shops, available quantity, contact numbers and other relevant details.
- Feedback mechanism: The system should allow users to provide feedback on the accuracy of spare parts identification to improve the system's performance.
- Search functionality: The system should provide search functionality that enables

users to search for spare parts by name, manufacture details, price, available shops, available quantity, contact numbers or other relevant parameters.

- Mobile compatibility: Users expect the system to be accessible on mobile devices as well as desktops.
- Speed and responsiveness: Users expect the system to be fast and responsive, with quick loading times and minimal delays.

5.5 Expected test cases

- User Authentication and Registration

Test user registration -

Verify that users can create accounts with valid credentials.

Confirm that users cannot register with duplicate or invalid email addresses.

Test user login -

Ensure users can log in with correct credentials.

- Verify that users cannot log in with incorrect credentials.

Test password recovery -

Check if users can reset their passwords through the recovery process.

- Image Capture and Processing

Test image capture -

Confirm that users can capture images of damaged parts using their device's camera.

Test image preprocessing -

Verify that captured images are appropriately resized and enhanced before processing.

- Spare Part Identification

Test spare part identification -

Check if the machine learning model accurately identifies different types of spare parts from captured images.

Test identification speed -

Measure the time taken for the model to identify spare parts and ensure it meets acceptable response times.

- Localization and Compatibility

Test part localization -

Verify that the system accurately determines the location and orientation of identified parts within images.

Test compatibility information -

Confirm that the system provides correct compatibility details between identified parts and vehicle models.

- Shop Availability Information

Test shop availability -

Ensure the system displays a list of nearby shops with accurate availability information for identified spare parts.

Test shop sorting -

Check if shops are sorted by proximity and availability, with the nearest and most stocked shops displayed first.

- User Interaction and Feedback

Test user feedback submission -

Verify that users can provide feedback on identified parts, compatibility information, and shop options.

Test adaptation mechanism -

Check if the system adapts based on user feedback, leading to improved spare part identification over time.

- User Profile Management

Test profile editing -

Confirm that users can edit their profiles, including personal information and communication preferences.

Test account deletion -

Check if users can delete their accounts, ensuring that associated data is removed securely.

- Shop Owner Portal

Test shop registration

Verify that spare parts shop owners can register their shops and update availability data.

Test shop data update -

Check if shop owners can manage their shop profiles and inventory through the dedicated portal.

- Performance Testing

Test response times -

Measure the time taken for various operations, including image capture, processing, part identification, and data retrieval.

Test scalability -

Simulate increased user load to assess the application's performance and response times under high traffic conditions.

- Security and Privacy Testing

Test data encryption -

Ensure that data transmission between the application and server is encrypted using HTTPS.

Test data protection -

Verify that sensitive user data, including login credentials, is securely stored and protected.

- Usability and User Experience Testing

Test user interface -

Evaluate the intuitiveness and user-friendliness of the interface for capturing images, viewing results, and interacting with options.

Test ease of use -

Assess how easily users can capture images and understand the spare part identification and shop availability information.

- Adaptation and Learning Testing

Test user feedback integration -

Confirm that user interactions and feedback lead to improved spare part identification accuracy over time.

Test model adaptation -

Check if the model's accuracy and relevance improve based on user feedback and interactions.

6. Gantt chart

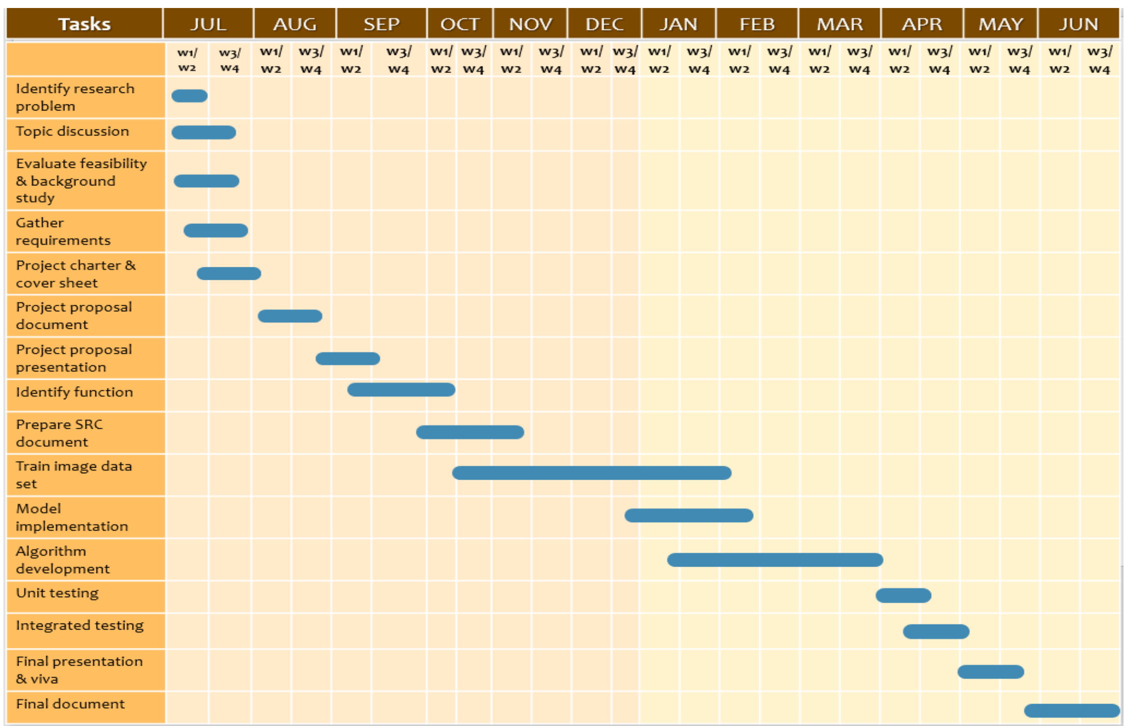

Figure 4:Gantt chart

7. Work breakdown chart

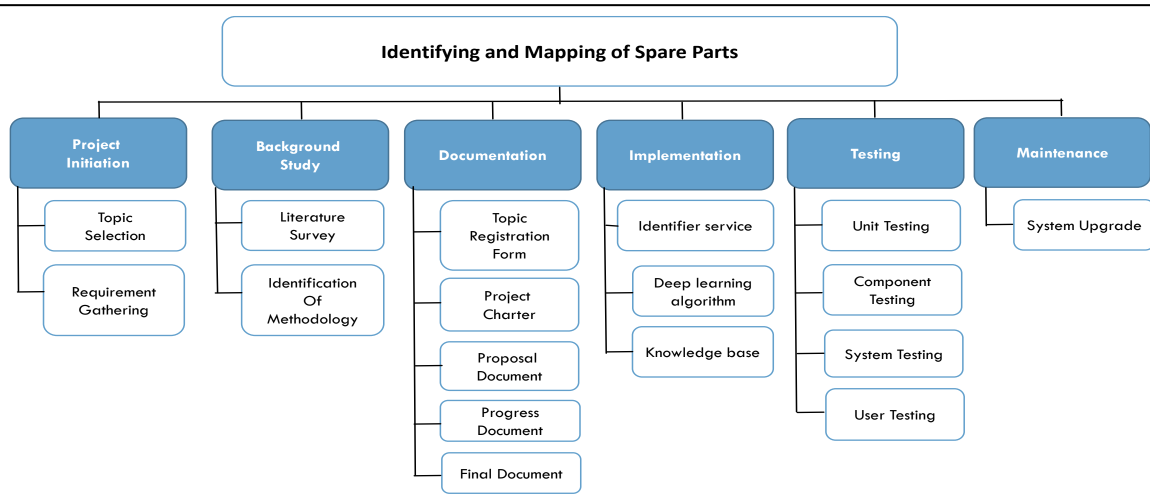

Figure 5:Work breakdown chart

8. Budget and budget justification

Expenses	
Requirement	**Cost ($)**
Travelling cost for data collection	15
Cost of Deployment	2
Cost of hosting in Play Store (one-time registration fee)	25
Cost of hosting in App Store (annual developer account fee)	99
Google NLP (per 1,000 units of sentiment analysis)	1
Google Maps Distance Matrix API charges (per request for up to 100,000 elements)	0.005
Mongo DB	-
Approximate total	142.005(use of mentioned units)

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10.Appendices

10.1 List of abbreviations

Abbreviation	**Description**
AI	Artificial Intelligence
ML	Machine Learning
EHR	Electronic Health Records
AML	Auto Machine Learning
CNN	Convolutional Neural Network
SVM	Support Vector Machine
SDLC	Software Development Life Cycle
HOG	Histogram of Oriented Gradients
SIFT	Scale-Invariant Feature Transform
WBS	Work Breakdown Structure