COMSATS University Islamabad
Abbottabad, Pakistan

ROBUST CAR MODIFICATION SIMULATION SYSTEM USING AI

By

Basit Iqbal	**CIIT/FA21-BSE-050/ATD**
Fatima Aftab	**CIIT/FA21-BSE-088/ATD**
Syed Shah Hussain Badshah	**CIIT/FA21-BSE-172/ATD**

Supervisor

Dr Ahmed Saeed Khattak

Bachelor of Science in Software Engineering (2021-2025)

The candidate confirms that the work submitted is their own and appropriate credit has been given where reference has been made to the work of others.

COMSATS University Islamabad
Abbottabad, Pakistan

ROBUST CAR MODIFICATION SIMULATION SYSTEM USING AI

A project presented to
COMSATS University of Information Technology, Islamabad

In partial fulfillment
of the requirement for the degree of

Bachelor of Science in Software Engineering (2021-2025)

By

Basit Iqbal	CIIT/FA21-BSE-050/ATD
Fatima Aftab	CIIT/FA21-BSE-088/ATD
Syed Shah Hussain Badshah	CIIT/FA21-BSE-172/ATD

DECLARATION

We hereby declare that this software, neither whole nor as a part, has been copied out from any source. It is further declared that we have developed this software and accompanied the report entirely on the basis of our personal efforts. If any part of this project is proved to be copied out from any source or found to be reproduction of some other. We will stand by the consequences. No Portion of the work presented has been submitted of any application for any other degree or qualification of this or any other university or institute of learning.

Basit Iqbal	Syed Shah Hussain Badshah	Fatima Aftab
--------------------------	--------------------------	-------------------------

CERTIFICATE OF APPROVAL

It is to certify that the final year project of BS (SE) “ROBUST CAR MODIFICATION SIMULATION SYSTEM USING AI ” was developed by **Basit Iqbal (CIIT/FA21-BSE-050)** , **Fatima Aftab (CIIT/FA21-BSE-088)** and **Syed Shah Hussain Badshah (CIIT/FA21-BSE-172)** under the supervision of “SIR DR AHMED SAEED KHATTAK” and that in her opinion; it is fully adequate, in scope and quality for the degree of Bachelors of Science in Software Engineering.

Supervisor

External Examiner

Head of Department
(Department of Computer Science)

EXECUTIVE SUMMARY

The Robust Car Modification Simulation System using AI is a smart tool for modification shops. It helps users see how changes like new , paint s, or spoilers will look on their actual car before making real modifications. The system works by analyzing photos of the car by using AI to apply virtual changes, giving a realistic preview.

RCMS system using AI has several key features. Operators can upload car photos, and the system automatically detects parts like wheels, headlights, and body panels. It then lets Operators try different modificationns from a catalog, showing how each change will appear on their specific car. The AI ensures modifications blend naturally, so users get an accurate idea of the result.

For businesses, RCMS system using AI makes the customization process smoother. Customers can experiment with designs and save their favorite looks. The system keeps track of past modifications, making it easy to revisit or adjust designs later. This saves time and reduces mistakes, leading to happier customers.

Overall, RCMS system using AI is a practical solution that brings car modifications into the digital age. By combining AI with an easy-to-use interface, it helps modification shops visualize changes with confidence. The system is designed to grow, with plans to add more car models and features in the future.

ACKNOWLEDGEMENT

All praise is to Almighty Allah who bestowed upon us a minute portion of His boundless knowledge by virtue of which we were able to accomplish this challenging task.

We are greatly indebted to our project supervisor **"Sir Dr Ahmed Saeed Khattak"**. Without their personal supervision, advice and valuable guidance, completion of this project would have been doubtful. We are deeply indebted to them for their encouragement and continual help during this work.

And we are also thankful to our parents and family who have been a constant source of encouragement for us and brought us the values of honesty & hard work.

Basit Iqbal   Syed Shah Hussain Badshah   Fatima Aftab

--------------------------   --------------------------   -------------------------

ABBREVIATIONS

RCMS	Robust Car Modification Simulation
3D	3 Dimensional
UC	Use Case
AI	Artificial Intelligence
SRS	Software Requirement Specification
SDD	Software Design Document
2D	2 Dimensional
AR	Augmented Reality
DB	Database
SAM	Segment Anything Model
YOLO	You Only Look Once
UI	User Interface
UX	User Experience
API	Application Program Interface
DFD	Data Flow Diagram

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

This chapter gives an overview of the Robust Car Modification Simulation System Using AI. This project helps users see how car modifications look by applying changes to car images using AI. It solves the problem of customers not being able to visualize the modifications such as , spoilers, or paint s will appear on their cars before applying them physically.

The system uses AI to detect car parts and apply modifications to images in a realistic way. This helps users make better decisions and feel more confident about their choices. By using AI and image processing, the system ensures that modifications fit the car accurately and looks natural.

This chapter will also explain the background of the project, research on AI models used in project, and the steps taken to develop this system.

1.1. Brief

The car modification industry is growing quickly as more people want to customize their cars. However, there is a big problem, customers cannot easily see how modifications will look before making changes. To get an idea of modifications like , spoilers, and paint s, car owners usually look at static images and catalogs. But these do not always give an accurate picture, which can lead to disappointment and less trust in modification services.

The Robust Car Modification Simulation System using AI solves this problem using advanced AI techniques like part detection and image segmentation. Unlike real-time systems, this solution works with images of the car, allowing precise changes like replacing , headlights, or painting directly on the image. This way, users can see realistic previews of modifications that match the details of their cars, making it easier to decide with confidence.

The system uses powerful AI algorithms to detect and separate car parts in images, ensuring that modifications look natural and accurate. It also includes a user-friendly feature that lets users save their modification choices and review past modifications.

By giving customers clear previews of their car modifications, the system improves the customization experience. It helps customers make better decisions and builds trust with modification service providers. This proposal explains the system's structure, its image-based modification features, and how it enhances customer experience in car customization shops.

1.2. Relevance to Course Modules

The Robust Car Modification Simulation System using AI is closely related to several courses studied during the Bachelor of Software Engineering (BSE) program. Here's how it connects to different areas:

Artificial Intelligence (AI) and Machine Learning: The project relies on AI-based image processing, including part detection, segmentation, and modification overlay. This directly relates to courses covering AI, computer vision, and deep learning techniques.

Computer Vision: The system detects and identifies car parts from images using computer vision algorithms. This connects to courses that teach image processing, object recognition, and AI-powered visual analysis.

Software Development: The project involves coding the system using technologies like Next.js, and Python along with AI libraries such as OpenCV and TensorFlow. Students apply their programming and software design knowledge to develop a working application.

Web Application Development: Since the system is a web-based tool, it relates to web development courses where students learn about front-end and back-end technologies, database management, and API integration.

Database Management: The system uses a database to store modification options, user preferences, and car model details. This links to database management courses where students learn to structure and manage data efficiently.

User Experience (UX) Design: Ensuring an easy-to-use interface for car modification centers and customers is essential. The project incorporates UX principles learned in courses (HCI) that focus on designing interactive and user-friendly applications.

Project Management: The development of the system follows an iterative and incremental approach, like Agile methodologies. This relates to project management courses that teach students how to break down tasks, collaborate in teams, and handle project timelines efficiently.

Overall, this project integrates various concepts from the Software Engineering curriculum, allowing students to apply their theoretical knowledge to a real-world application that enhances the car modification experience using AI.

1.3. Project Background

The Robust Car Modification Simulation System using AI is designed to help car owners and modification shops to visualize car modifications before making real changes. Many car enthusiasts want to customize their cars, but they often struggle to imagine how different modifications such as new , spoilers, or paint s will look on their specific car models. This uncertainty can lead to disappointment if the result does not meet their expectations.

Traditionally, car modification shops use catalogs with static images to show different customization options. However, these catalogs do not provide a realistic preview of how a modification will look on a customer's car. As a result, customers may feel unsure about their choices, leading to hesitation or dissatisfaction with the results. To solve this problem, the RCMS using AI uses artificial intelligence and computer vision to create realistic, image-based previews of car modifications**.**

The system works by detecting car parts in an image, such as , headlights, and spoilers, and then applying selected modifications directly to the image. This allows users to see an accurate and realistic representation of their customization choices before deciding. The AI ensures that modifications are properly placed and appear natural, improving customer confidence and satisfaction.

Research shows that visualization tools help users make better decisions when customizing products. By providing a realistic preview, the RCMS reduces the risk of dissatisfaction and helps modification shops build trust with their customers. It also makes the customization process more engaging and efficient by eliminating guesswork.

Overall, this project aims to bridge the gap between imagination and reality in car modification by providing a smart, AI-powered tool that enhances customer experience. By combining artificial intelligence, image processing, and user-friendly design, the system makes car customization easier, more accurate, and more satisfying.

1.4. Literature Review

The Robust Car Modification Simulation System Using AI follows the latest trends in artificial intelligence and computer vision, especially in customizing car images**.** Research shows that AI tools can help people make better design choices, including car modifications. A study by Zhang et al. (2020) found that AI-based image processing helps users see modifications more clearly, reducing confusion and making them more satisfied. By using AI for car customization, the RCMS using AI gives users realistic previews of changes, helping them make better decisions.

Some tools already allow users to change car designs, but most use static images or 3D models, which may not work for every car model. Apps like 3D Tuning and AR Car allow some modifications, but they do not properly place changes on real car images. Traditional catalogs in car shops also fail to give a real preview, which can lead to customer disappointment. RCMS using AI fixes this problem by using AI to detect and replace car parts in images, making the process more accurate and easier to use**.**

Research also shows that good visual tools help people choose better. According to Smith & Lee (2021)**,** customers feel more confident in their choices when they see a realistic preview before deciding. RCMS using AI follows this idea by allowing users to see how their car will look after modifications before finalizing changes.

By using AI, computer vision, and a simple interface, this project helps car owners see modifications before applying them**.** It provides a better, more accurate, and easier way to explore car modifications, solving a common problem in the car industry.

1.5. Analysis from Literature Review

Table 1.1:Analysis and Literature Review

Application Name	Features	Weakness	Solution
3D Tuning	Provides 3D customization options, allowing users to modify various car parts and view them in 3D	Requires high-quality 3D models and lacks adaptability for all car models; limited by model availability	The Robust Car Modification Simulation System uses 2D image-based customization with AI-driven part detection, allowing accurate overlays on diverse car images without requiring 3D models.
AR Car (Android APP)	Uses augmented reality to apply basic modifications, allowing users to visualize parts on their car through a mobile camera feed	Relies on real-time AR, requiring high-quality camera feeds; lacks model-specific customization accuracy and can have limited part options	The system provides static image-based modifications, allowing Modification centers to use accessible image uploads with AI-driven segmentation, ensuring realistic previews without real-time AR limitations.
Interactive Garage	Offers customization with a catalogue of parts for different car models, including paint and accessory options	Limited customization options; lacks realistic overlays and specific placement of modifications on car images	This system uses AI-powered detection and part segmentation for precise modification placement, providing realistic previews tailored to customer-selected parts and accurate overlay on car images.

1.6. Methodology and Software Lifecycle of The Project

The methodology and SDLC model selected for RCMS is:

Design Methodology Choice: Procedural

Software Process Model Choice: Iterative and Incremental

1.6.1. Rationale behind Selected Methodology

The method we are using to develop the RCMS System using AI is the Iterative and Incremental Model**.** This model is best for handling complex features like AI-based image processing and part segmentation because it allows the system to improve step by step. In the iterative part, we build and test one part of the system at a time and then make changes based on feedback. For example, first we can create a simple user interface and image upload option, and in later steps, we add advanced features like part detection and segmentation. In the incremental part, every finished feature is tested and added to the main system. This helps us find and fix problems early and makes sure each part works properly before moving on to the next one.

2. Problem Definition

2.1. Problem Statement

Modification shops find it hard to see how modifications will look before making real changes. Traditional methods, like catalogs and sample images, do not give an accurate preview of modifications on a specific car. This can cause confusion, disappointment, and extra costs if the result is not what the customer expected.

Some existing tools use 3D models or AR, but they have problems. 3D-based apps need detailed models for each car, which are not always available. AR-based apps require good cameras and strong processing power, which not all users have. Because of these issues, there is a need for a simple AI-powered system that can show realistic modifications on car images without requiring advanced technology.

RCMS using AI solves this problem by using AI to detect car parts and apply modifications directly to uploaded images. Users can easily see

changes like new , spoilers, or paint s without needing complex 3D models or AR systems.

Our system will provide an easy-to-use tool for car modification shops and customers. It will ensure that modifications look realistic and accurate before making any real changes. By using AI-powered car part detection, realistic image editing, and a large customization library, RCMS will help users make better decisions, reduce confusion, and feel more satisfied with their car modifications.

2.2. Deliverable and Development Requirements

2.2.1. Deliverables

Completed RCMS System: A fully functional web-based AI-powered car modification simulation system that allows users to visualize car modifications on images.

Image Capture and Upload Module: Enables users to upload car images for modification.

AI-Driven Part Detection and Segmentation: Uses computer vision to identify car parts such as , headlights, and spoilers, ensuring accurate modifications.

Stitching of Detected Parts: Ensures that modified parts are accurately placed and blended into the uploaded car image.

Modification Library and Database: A collection of customization options including , spoilers, and paint s, allowing users to select from a variety of choices.

Customization Module: Provides an interactive interface for users to apply, compare, and preview modifications before making final decisions.

User Management Module: Allows customers and shop staff to manage accounts, save modification preferences, and access past customization history.

Administration and Configuration Module: Enables modification centers to manage modification options, update the customization catalog, and configure system settings.

Data Security and Privacy Module: Ensures secure handling of user data, maintaining privacy and compliance with data protection standards.

SRS: **A** document outlining the system's functional and technical requirements.

SDD: A document detailing the architecture, design, and workflow of the system.

2.2.2. Development Requirements

MongoDB, Next.js: Used for building the web-based platform and managing data efficiently.

Python & OpenCV: For AI-based image processing, car part detection, and segmentation.

YOLO & SAM: For object recognition and precise part segmentation in images.

TensorFlow: For AI and machine learning-based detection and processing.

Figma: For UI/UX design before system implementation.

Agile Methodology: Follows an iterative and incremental development approach, allowing flexibility based on feedback.

User Testing: Conducted with car modification shops and customers to evaluate system usability and effectiveness.

Functionality Testing: Ensures that all system features work correctly, smoothly, and efficiently before deployment.

3. Requirement Analysis

The following parts of the SRS report should be included in this chapter.

3.1. Use Case Diagram

A Use Case UML Diagram is a visual representation that shows how users called actors interact with a system. It highlights the system's main functions known as use cases and the relationships between users and those functions. This diagram helps in understanding what the system should do and who will use it. It's commonly used in the early stages of software design.

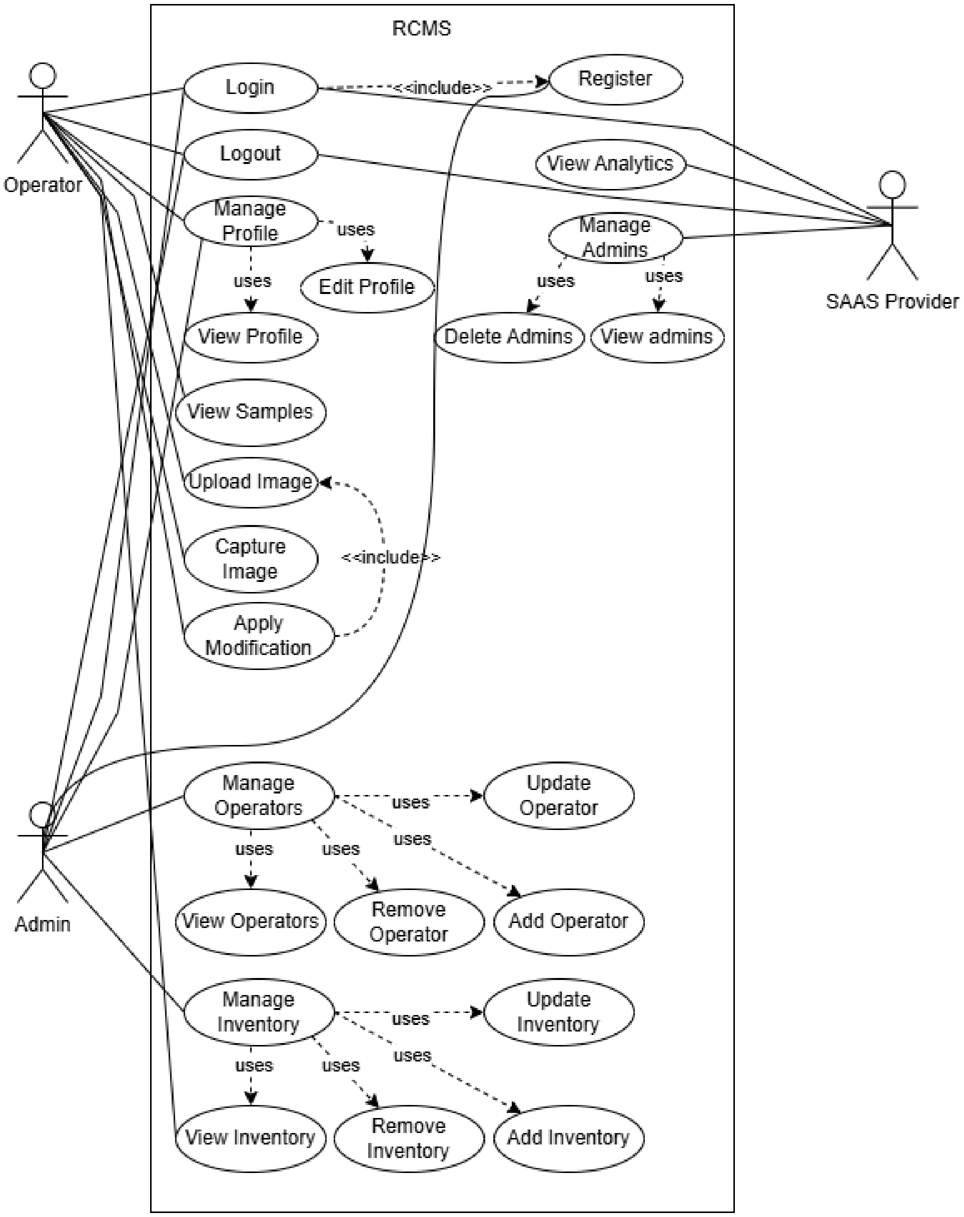


Figure 3.1: Use Case Diagram

3.2. Detailed Use Case

A detailed use case explains how users interact with a system to complete a specific task. It describes step-by-step actions, system responses, and possible errors.

Table 3.1: UC 01 Login

Use Case ID	**UC-1**
Use Case Name	Login
Actors	**Primary Actor**: Admin, Operator ,SAAS Provider
Description	This use case allows users to access the system by providing their registered credentials, such as email and password. Upon successful authentication, the system grants access to role-specific features. This use case ensures secure access by verifying user credentials, preventing unauthorized entry into the system.
Trigger	The users navigate to the login page and provide their credentials.
Preconditions	1. The user must have a valid email and password. 2. The user must be registered in the system.
Postconditions	1. The user is successfully logged into the system. 2. The system provides access to features based on the user's role.
Normal Flow	1. The user navigates to the login page. 2. The user enters their email and password. 3. The user submits the login form. 4. The system validates the credentials. 5. Upon successful validation, the system grants access to the user's dashboard.
Alternative Flows	**1. Incorrect credentials:** a. The system displays an error message and prompts the user to try again. b. The user re-enters the credentials and submits the form. **2. Empty fields:** a. The system prompts the user to fill in the required fields.
Exceptions	1. If the user fails to provide correct credentials after multiple attempts, the system may lock the account temporarily. 2. If the system encounters a technical error, it displays an appropriate message.
Business Rules	**BR-1:** Only registered users can log in.

Assumptions	1. Users have been informed about password requirements and recovery options. 2. The system uses secure methods to store and validate credentials.

Table 3.2: UC 02 Logout

Use Case ID	**UC-02**
Use Case Name	Logout
Actors	**Primary Actor**: Admin, Operator ,SAAS Provider
Description	The Logout use case allows users to securely end their session in the system. Once logged out, the system ensures that all active sessions are terminated, preventing unauthorized access to sensitive features. This use case helps maintain security by ensuring users log out when their tasks are completed.
Trigger	The users initiate the logout action from the system.
Preconditions	User must be logged into the system.
Postconditions	1.User is logged out, and session is terminated. 2.System no longer allows access to restricted areas without re-authentication.
Normal Flow	1. User clicks on the logout button in the system. 2. System logs out the user, ending the active session. 3. Users are redirected to the landing page.
Alternative Flows	**User cancels logout action:** 1. User cancels the logout prompt. 2. System continues the current session and returns the user to the previous screen.
Exceptions	**System failure during the logout process:** 1. System encounters an error while logging out the user. 2. System displays an error message and prompts the user to try again.
Business Rules	**BR-1:** Users must log out after completing their session to prevent unauthorized access.
Assumptions	1. Assume that the session timeout mechanism is in place, logging out users automatically after a set period of inactivity.

Table 3.3: UC 03 Register

Use Case ID	**UC-03**
Use Case Name	Register
Actors	**Primary Actor:** Admin, Operator
Description	The Register use case allows Admins to register themselves in the system by providing their name, email, and other information. Once registered, Admins can log in to the system and manage Operator registrations. Admins can register Operators by providing their details, such as name and email. Registered Operators can then log in to the system using their registered email and credentials.
Trigger	Admin accesses the registration page to register an Admin or Operator.
Preconditions	**Admin Registration:** 1. Admins must click on sign up button. **Operators Registration:** 1. Admin is logged into the system. 2. Admin has the required permissions to register (add) Operators.
Postconditions	1. User registration is stored in the system. 2. Users can log in using registered credentials.
Normal Flow	**For Admins** 1. Admin clicks on sign up button. 2. Admin fills in the registration details. 3. Admin submits the registration form. 4. System validates the input information. 5. System stores the registration information and confirms registration. 6. Admin can log in using their credentials. **For Operators (add operators use case)** 1. Admin selects "Add Operator." 2. System prompts Admin to enter Operator details. 3. Admin provides details and submits the form. 4. System creates the Operator account and confirms the action.

Alternative Flows	**Invalid Input in fields** 1. Admin enters invalid registration details. 2. Input fields field incorrectly will be highlighted **Duplicate Email** 1. Admin enters an email that is already registered. 2. System display a message that email is already registered.
Exceptions	**Invalid Email Format** 1. System informs Admin that the email format is incorrect. 2a. Admin corrects the email format and re-submits. 2b. Admin cancels registration, and the process is terminated.
Business Rules	**BR-1** Admin must have proper privileges to register Operators. **BR-2** Email must be unique for each user.
Assumptions	1. Assume that only Admins have the authority to register Operators. 2. Assume that each user has a unique email address.

Table 3.4: UC 06 View Samples

Use Case ID	**UC-06**
Use Case Name	View Samples
Actor	**Primary Actor:** Operator
Description	The View Samples use case allows Operators to view examples of previous car modifications. These samples represent the work completed by the Operator and are saved in the system for future reference. Operators can use this feature to showcase their past modifications and help customers make informed decisions. This use case is exclusively for Operators, enabling them to manage and view the modifications they have applied to cars.
Trigger	The Operator clicks on view samples button in the system.
Preconditions	1. The Operator is logged into the system. 2. The Operator has previously completed car modifications that are saved in the system.
Postconditions	Operator is presented with a list of previously applied car modifications.
Normal Flow	1. Operator navigates to the "View Samples" section in the system. 2. System displays a list of previously completed car modifications. 3. Operator selects a specific sample to view. 4. System displays detailed information about the selected car modification, including images and modification details. 5. Operator can scroll through additional modification samples or return to the main page.
Alternative Flows	**No previous samples available** 1. Operator navigates to the "View Samples" section in the system. 2. The system informs the Operator that no samples are available.
Exceptions	**E1 System failure during sample retrieval** 1. The system encounters an error while fetching the modification samples. 2. The system displays an error message and prompts the Operator to try again.
Business Rules	**BR-1:** Modification samples must be linked to the Operator who performed the modification.
Assumptions	Assume that all car modifications made by the Operator are automatically saved in the system for future reference.

Table 3.5: UC 07 Upload Image

Use Case ID	**UC-07**
Use Case Name	Upload Image
Actors	**Primary Actor**: Operator
Description	The Upload Image use case allows Operators to upload image of cars into the system. These images will be used as the basis for the car modification process. Once uploaded, the system processes the image to apply the selected modifications, helping users visualize potential changes.
Trigger	An Operator initiates the image upload process.
Preconditions	- The Operator is logged into the system. - The system is ready to receive images.
Postconditions	- The system processes the image for modification.
Normal Flow	1. Operator selects the option to upload an image. 2. The system prompts the Operator to choose a file to upload. 3. The Operator selects an image file from their device. 4. The system uploads the image and processes it. 5. The system displays a confirmation message and previews the uploaded image.
Alternative Flows	**Invalid Image:** 1. The Operator uploads an unsupported file (not a car image). 2. The system informs the Operator that the image is not a car. 3. The Operator selects a valid image. 4. Return to step 4 of the normal flow.
Exceptions	**The image file fails to upload** 1. The system informs the Operator that the image failed to upload by error message. 2a. The Operator retries the upload. 2b. The Operator cancels the upload process.
Business Rules	**BR-1:** The image file must be in JPG or PNG format. **BR-2:** The image file size must not exceed 10MB.
Assumptions	1.Assume that 90% of Operators will upload images in supported formats. 2.Assume that Operators have access to a stable internet connection for image uploads.

Table 3.6: UC 08 Capture Image

Use Case ID	**UC-08**
Use Case Name	Capture Image
Actors	**Primary Actor**: Operator
Description	The Capture Image use case allows Operators to take pictures of cars using a camera placed in a controlled environment. This function is especially useful for capturing car images on-site for modification purposes.
Trigger	Operator initiates the image capture process.
Preconditions	1.Operator is logged into the system. 2.Camera system is operational and ready.
Postconditions	1.The captured image is stored in the system. 2.The image is available for use in the modification process.
Normal Flow	1. Operator accesses the Capture Image feature from the system interface. 2. System displays the camera interface. 3. Operator positions the car for the image capture. 4. Operator triggers the camera to take a picture. 5. System captures and displays the image for review. 6. Operator confirms and uploads the image.
Alternative Flows	**Image Capture Failed:** If the image cannot be captured due to technical issues 1. System notifies the operator of the failure. 2. Operator may retry or cancel the process.
Exceptions	**Camera Malfunction:** If the camera system fails to capture the image 1. System alerts the operator of the malfunction. 2. Operator may either attempt to restart the camera or notify maintenance.
Business Rules	**BR-1**: Car images must be clear and in focus for modification analysis.
Assumptions	1.Assume that the camera system will have 99% uptime during operational hours. 2.Assume that operators are trained in basic image capture operations.

Table 3.7: UC 09 Apply Modification

Use Case ID	**UC-09**
Use Case Name	Apply Modification
Actors	**Primary Actors:** Operators
Description	The Apply Modification use case allows Operators to apply selected modifications to the images they have uploaded or captured. This enables users to visualize the result of the modifications on the car images. The process ensures that Operators can see how the changes will look before implementing them, helping users make informed decisions.
Trigger	The Operator selects a modification option and indicates they want to apply it to an uploaded or captured image.
Preconditions	1.The Operator is logged into the system. 2.An image of the car has been uploaded or captured by the Operator.
Postconditions	1.The modified image is displayed to the Operator.
Normal Flow	1. Operator uploads a car image. 2. Operator chooses a modification option from the available list. 3. The system applies the selected modification to the image. 4. The modified image is displayed for Operator's review. 5. Operator confirms the modification or chooses to adjust.
Alternative Flows	**No Modification Selected** 1. Operator attempts to apply without selecting a modification. 2. Modification not applied to image.
Exceptions	**Error in AI model** 1. System encounters an error in overlaying the modification parts to the image. 2a. System displays an error message stating, “Unable to apply the selected modification. Please try again or contact support.” 2b. Operator chooses to retry or cancels the process.
Business Rules	**BR-1:** Only registered Operators can apply modifications.
Assumptions	1. Assume Operators have basic knowledge of image modifications. 2. Assume the modification preview system works efficiently, generating results in under 5 seconds.

Table 3.8: UC 10 Manage Operator

Use Case ID	**UC-10**
Use Case Name	Manage Operators
Actors	**Primary Actor:** Admin
Description	The admin oversees and controls Operator accounts within the system. Admins can perform tasks such as adding new Operators, viewing Operator details, updating Operator information, and removing inactive or unnecessary accounts.
Trigger	Admin selects the "Manage Operators" option from the system menu.
Preconditions	1. Admin is logged into the system. 2. Admin has the required permissions to manage Operators.
Postconditions	1. The Operator accounts are updated as per Admin actions. 2. System database reflects all changes made by the Admin.
Normal Flow	1. Admin navigates to the "Manage Operators" section. 2. System displays the list of Operators. 3. System processes the selected action and displays a confirmation message. 4. System updates Operator details in the database.
Alternative Flows	None
Exceptions	**System Error** 1. If the system encounters an error, it displays an error message. 2. Admin cancel the error message and try again to perform certain action.
Business Rules	**BR-1:** Only Admins can manage Operator accounts.
Assumptions	1.Admins are trained on the system. 2. The system is functioning without downtime.

Table 3.9: UC 10.1 View Operator

Use Case ID	**UC-10.1**
Use Case Name	View Operator
Actors	**Primary Actor:** Admin
Description	Admin views the list of all Operators in the system along with their details.
Trigger	Admin selects the "View" option from the "Manage Operators" menu.
Preconditions	1. Admin is logged into the system. 2. Admin has the required permissions to view Operators.
Postconditions	The system displays a list of all Operators and their details.
Normal Flow	1. Admin selects "View" from the menu. 2. System displays the detail in a box.
Alternative Flows	
Exceptions	
Business Rules	**BR-3:** Only Admins can view the list of Operators.
Assumptions	The system database is up to date.

Table 3.10: UC 10.2 Add Operator

Use Case ID	**UC-10.2**
Use Case Name	Add Operators
Actors	**Primary Actor:** Admin
Description	Admin adds a new Operator by providing the necessary details such as name, email, password.
Trigger	Admin selects the "Add Operator" option from the "Manage Operators" menu.
Preconditions	1. Admin is logged into the system. 2. Admin has the required permission to add Operators.
Post conditions	1. A new Operator account is created and stored in the system. 2. The Operators can login via email.
Normal Flow	1. Admin selects "Add Operator." 2. System prompts Admin to enter Operator details. 3. Admin provides details and submits the form. 4. System creates the Operator account and confirms the action.
Alternative Flows	**Duplicate Email** 1. If the email provided is already in use, the system displays “User Already Exists”. 2. Admin modifies the email and resubmits the form.
Exceptions	**Mandatory Fields Missing** 1. If mandatory fields are not filled, the system prompts Admin to complete them.
Business Rules	**BR-4:** Operators must have unique email addresses.
Assumptions	The admin has the correct details for the new Operator.

Table 3.11: UC 10.3 Update Operators

Use Case ID	**UC-10.3**
Use Case Name	Update Operators
Actors	**Primary Actor:** Admin
Description	Admin updates details of an existing Operator, such as changing or updating their information.
Trigger	Admin selects the "Edit Icon" option from the "Manage Operators" menu.
Preconditions	1. Admin is logged into the system. 2. Admin has the required permission to update Operators. 3. Operator to be update must exist in system.
Post conditions	The Operator's details are updated and logged.
Normal Flow	1. Admin selects "Update Operator." 2. System displays a list of Operators. 3. Admin clicks on the edit icon of the operator he wants to update. 4. System saves the updates.
Alternative Flows	
Exceptions	**Error in Updating** 1. If there is an error occur during updating details system will display an error message to inform the admin.
Business Rules	None
Assumptions	The Operator exists in the system.

Table 3.12: UC 10.4 Delete Operator

Use Case ID	**UC-10.4**
Use Case Name	Delete Operators
Actors	Admin
Description	Admin removes an unnecessary Operator account from the system.
Trigger	Admin selects the "Delete Icon" option from the "Manage Operators" menu.
Preconditions	1. Admin is logged into the system. 2. Admin has the required permissions to delete Operators. 3.Operator to be deleted must exist in database.
Postconditions	1. The Operator account is deleted from the system.
Normal Flow	1. Admin selects "Delete Icon." 2. System displays a list of Operators. 3. Admin clicks on the delete icon of the operator he wants to delete. 4. System displays a confirmation message if he wants to delete the account permanently. 4. System removes the account from the database if the admin selects delete button.
Alternative Flows	**Cancel Deletion** 1. If Admin cancels the deletion process, the system exits without removing the Operator.
Exceptions	**Error in Deleting** 1. If there is an error occur during deleting operator system will display an error message to inform the admin.
Business Rules	**BR-1**: Only inactive or unnecessary accounts should be deleted.
Assumptions	Admin identifies the correct Operator to delete.

Table 3.13: UC 11 Manage Inventory

Use Case ID	**UC-11**
Use Case Name	Manage Inventory
Actors	**Primary Actor:** Admin
Description	Admin performs a combination of adding, updating, deleting, and viewing items to efficiently manage the inventory.
Trigger	Admin selects the "Manage Inventory" option from the menu.
Preconditions	1. Admin is logged into the system.
Post conditions	1. Inventory database reflects all changes made.
Normal Flow	1. Admin accesses the "Manage Inventory" section. 2. Systsem displays the list of the Inventory. 3. Admin can perform the operation he wants to perform(delete, view, update, add) 4. System updates the inventory in database.
Alternative Flows	**Insufficient Permissions:** 1. Admin without proper privileges attempts to access the inventory. 2. System denies access and informs the Admin.
Exceptions	**Database is temporarily unavailable:** 1. System notifies Admin of the issue. 2. Admin retries after a specified time.
Business Rules	Refer to business rules for each action.
Assumptions	1. Admins have adequate training on the inventory system. 2. Inventory data follows a consistent format.

Table 3.14: UC 11.1 Add Inventory

Use Case ID	**UC-11.1**
Use Case Name	Add Inventory
Actors	**Primary Actor:** Admin
Description	Admin adds new items to the inventory, specifying details like name, quantity, price, and description.
Trigger	Admin selects the "Add" option in the inventory management module.
Preconditions	1. Admin is logged into the system. 2. Admin has sufficient permissions to modify inventory.
Post conditions	1. New inventory items are successfully stored in the system.
Normal Flow	1. Admin clicks on the "Add" button. 2. System displays a form to input item details. 3. Admin enters item name, quantity, price, and description. 4. Admin clicks "Save." 5. System validates the input. 6. System saves the item in the database and confirms success.
Alternative Flows	**Validation Error:** 1. If the Admin leaves a required field blank or enters invalid data, the system displays an error message. 2. Admin corrects the input and resubmits the form.
Exceptions	**System is unable to connect to the database.** 1. System notifies Admin of the issue and requests a retry.
Business Rules	**BR-1:** Item names must be unique. **BR-2:** Prices cannot be negative.
Assumptions	Admin has item details ready for entry.

Table 3.15: UC 11.2 Remove Inventory

Use Case ID	**UC-11.2**
Use Case Name	Remove Inventory
Actors	**Primary Actor:** Admin
Description	Admin deletes an item from the inventory.
Trigger	Admin selects an item and clicks the "Delete" button.
Preconditions	1. Admin is logged into the system. 2. Admin has deletion privileges.
Postconditions	1. The item is removed from the inventory database.
Normal Flow	1. Admin navigates to manage inventory. 2. System fetch the lists of items and display. 2. Admin clicks the "Delete" button corresponding to each item. 4. System displays a confirmation dialog. 5. Admin confirms the deletion. 6. System removes the item and displays a success message.
Alternative Flows	**Admin Cancels Deletion:** 1. If the Admin cancels at the confirmation dialog, the system terminates the process without any changes.
Exceptions	**Failed to delete** 1. Failed to delete an item.
Business Rules	None
Assumptions	Admin confirms that the item no longer exist.

Table 3.16: UC 11.3 Update Inventory

Use Case ID	**UC-11.3**
Use Case Name	Update Inventory
Actors	**Primary Actor:** Admin
Description	Admin modifies details of an existing inventory item, such as quantity or price.
Trigger	Admin clicks on the Edit icon of the item he wants to delete.
Preconditions	1. Admin is logged into the system. 2. Admin has edit permissions.
Postconditions	1. The updated details are stored in the inventory database.
Normal Flow	1. Admin navigates to manage inventory. 2. System displays list of items. 3. Admin selects the item to edit and clicks "Edit." 4. System displays an editable form with the current item details. 5. Admin updates the desired fields. 6. Admin clicks "Save." 7. System validates and saves the changes. 8. System displays a confirmation message.
Alternative Flows	**Validation Error:** 1. If invalid data is entered, the system displays an error message. 2. Admin corrects the input and resubmits the form.
Exceptions	**The system is unable to connect to the database.** 1. System notifies Admin of the issue and requests a retry.
Business Rules	None
Assumptions	Admin has the required details for the update.

Table 3.17: UC 11.4 View Inventory

Use Case ID	**UC-11.4**
Use Case Name	View Inventory
Actors	**Primary Actors**: Admin, Operator
Description	Users view a list of all items in the inventory, including details such as name, quantity, and price.
Trigger	User selects the "Manage Inventory" option from the menu.
Preconditions	PRE-1: User is logged into the system.
Post conditions	POST-1: Inventory data is displayed to the user.
Normal Flow	1. User navigates to the inventory management module. 2. User clicks the "Manage Inventory" button. 3. System retrieves and displays the inventory list.
Alternative Flows	**No Data Available:** 1. If no inventory items exist, the system displays a "No Items Found" message.
Exceptions	**Database connection fails.** 1. System notifies the user and requests a retry.
Business Rules	None
Assumptions	Inventory data is up to date.

3.3. Functional Requirements

Functional requirements describe what a system should do. They define the specific features, functions, and behavior of the system. These requirements help developers know exactly what needs to be built. They are essential for designing and testing the system. Given below are the functional requirements of our RCMS system using AI.

Requirement ID: FR-001 - Admin Registration

Table 3.18: FR 001 - Admin Registration

Field	Details
Requirement	The system should allow the admins to register themselves by providing necessary details.
Source	System Admin
Rationale	To enable the admins to set up their account for managing the system.
Business Rule	Admin registration must be authorized by the system.
Dependencies	None
Priority	High

Requirement ID: FR-002 - Admin Login

Table 3.19: FR-002 - Admin Login

Field	Details
Requirement	The system shall allow the admins to log in using their registered credentials.
Source	System Admin
Rationale	To allow admins access to manage the system.
Business Rule	Admin credentials must be validated.
Dependencies	FR-001
Priority	High

Requirement ID: FR-003 - Operator Registration

Table 3.20: FR-003 - Operator Registration

Field	**Details**
Requirement	The system shall allow the admins to register operators by providing their details.
Source	System Admin
Rationale	To enable admins to manage operators for system tasks.
Business Rule	Operator registration must be approved by the admin.
Dependencies	FR-001
Priority	High

Requirement ID: FR-004 - Operator Login

Table 3.21: FR-004 - Operator Login

Field	**Details**
Requirement	The system shall allow operators to log in using their registered emails.
Source	System Operators
Rationale	To enable operators to access the system using their personal emails.
Business Rule	Operator credentials must be validated.
Dependencies	FR-003
Priority	High

Requirement ID: FR-005 - Login Credential Validation

Table 3.22: FR-005 - Login Credential Validation

Field	**Details**
Requirement	The system shall validate the credentials of admins and operators during login.
Source	System Admin
Rationale	To ensure only authorized personnel can access the system.
Business Rule	Login failures must trigger appropriate error messages.
Dependencies	REQ-002, REQ-004
Priority	High

Requirement ID: FR-006 - Secure Credential Storage

Table 3.23: FR-006 - Secure Credential Storage

Field	**Details**
Requirement	The system shall maintain a secure and encrypted storage of admin and operator credentials.
Source	System Admin
Rationale	To protect sensitive data from unauthorized access.
Business Rule	Credentials must be stored encrypted.
Dependencies	REQ-002, REQ-004
Priority	High

Requirement ID: FR-007 – Upload Image

Table 3.24: FR-007 – Upload Image

Field	**Details**
Requirement	The system allows operators to upload images of cars.
Source	Operators
Rationale	To enable operators to provide images for car modifications.
Business Rule	Upload size must not exceed 10MB.
Dependencies	FR-004
Priority	High

Requirement ID: FR-008 – Capture Image

Table 3.25: FR-008 – Capture Image

Field	**Details**
Requirement	The system should enable operators to capture a single image using the external camera.
Source	Operators
Rationale	To provide operators with an easy way to capture car images directly.
Business Rule	Image quality must meet system requirements.
Dependencies	FR-004
Priority	Medium

Requirement ID: FR-009 - Image Preview

Table 3.26: FR-009 - Image Preview

Field	**Details**
Requirement	The system shall display a preview of the uploaded image to confirm before proceeding.
Source	Operators
Rationale	To allow them to review their images before finalizing the upload.
Business Rule	Preview must be displayed within 2 seconds.
Dependencies	FR-007, FR-008
Priority	Medium

Requirement ID: FR-010 - AI-Driven Part Detection

Table 3.27: FR-010 - AI-Driven Part Detection

Field	**Details**
Requirement	The system shall identify and segment car parts such as , headlights, and mirrors from the uploaded images.
Source	AI Model
Rationale	To enable the system to identify parts for operator customization.
Business Rule	Initial detection must support 3 car models.
Dependencies	FR-009
Priority	High

Requirement ID: FR-011 - Overlay Custom Parts

Table 3.28: FR-011 - Overlay Custom Parts

Field	**Details**
Requirement	The system shall overlay selected parts onto the uploaded car image.
Source	AI Model
Rationale	To visualize the modifications on the car.
Business Rule	Overlaid parts must fit accurately on the car.
Dependencies	FR-010
Priority	Medium

Requirement ID: FR-012 – Car Parts Catalog

Table 3.29: FR-012 – Car Parts Catalog

Field	**Details**
Requirement	The system shall provide a catalog of car parts including , spoilers, paint options, and headlights.
Source	Admin
Rationale	To allow operators to select parts for modification.
Business Rule	Parts must be categorized by type and model.
Dependencies	None
Priority	High

Requirement ID: FR-013 - Manage Catalog

Table 3.30: FR-013 - Manage Catalog

Field	**Details**
Requirement	The system shall allow admins to add, update, or remove parts from the catalog.
Source	Admin
Rationale	To keep the catalog updated with new parts.
Business Rule	Changes must be logged for auditing purposes.
Dependencies	FR-001
Priority	Medium

Requirement ID: FR-014 - Save Modifications

Table 3.31: FR-014 - Save Modifications

Field	**Details**
Requirement	The system should allow operators to save their customization options.
Source	User
Rationale	To allow users to keep track of their modifications for future reference.
Business Rule	Customization must be saved properly.
Dependencies	None
Priority	Medium

Requirement ID: FR-015 - Retrieve Saved Modifications

Table 3.32: FR-015 - Retrieve Saved Modifications

Field	**Details**
Requirement	The system shall retrieve saved modifications.
Source	Operators
Rationale	To allow operators to continue their work later.
Business Rule	Modifications must be retrieved in a maximum of 10 secs.
Dependencies	FR-014
Priority	Medium

Requirement ID: FR-016 - User Account Management

Table 3.33: FR-016 - User Account Management

Field	**Details**
Requirement	The system allows users to create and manage accounts with personalized profiles.
Source	User
Rationale	To provide users with personalized experiences and custom options.
Business Rule	Users must be able to reset passwords securely.
Dependencies	None
Priority	Medium

3.4. Non-Functional Requirements

3.4.1. Usability

The system shall allow operators to upload a car image and preview detected parts with minimal guidance within 5 minutes of initial use.

The system should include an intuitive and user-friendly interface, enabling users to perform tasks with no more than 3 clicks for any major function (e.g., uploading an image, selecting a modification).

3.4.2. Performance

95% of uploaded images shall be processed and modifications previewed within 5 seconds under normal load conditions.

All API calls for model interaction shall return results within 15 seconds for standard requests.

3.4.3. Scalability

The system shall support the addition of new features or modules (e.g., more car models, additional modifications) without significant impact on system performance.

The system architecture shall allow for horizontal scaling, enabling the addition of servers or resources to handle increased load, with minimal downtime.

3.4.4. Maintainability

The system allows developers to deploy updates and bug fixes without downtime, using a blue-green deployment strategy or equivalent.

The system should include comprehensive and up-to-date documentation for developers, including SRS (software requirement specification) and SDD (software design document).

The system should be modular, allowing individual components (e.g., image upload, AI model integration) to be updated or replaced without affecting other parts of the system.

3.4.5. Accuracy

The system shall achieve at least 95% accuracy in detecting and segmenting car parts from uploaded images, with accuracy metrics validated through regular testing and validation.

3.4.6. Modularity

The system shall be designed with modular architecture, where each core component (e.g., image upload, part detection, user authentication) isolated into independent, replaceable modules.

Each module should have well-defined interfaces, allowing for easy integration or replacement of individual components without affecting other system parts.

The modular design shall ensure that new features (e.g., additional car models or modification options) can be added with minimal impact on existing functionality.

Each module shall be tested independently, ensuring that updates to one module do not inadvertently affect other parts of the system.

3.4.7. Flexibility

The system shall support the easy addition of new car models and parts to the catalog without requiring significant changes to the underlying architecture.

The system shall be extensible, allowing additional modification types (e.g., interior modifications) to be integrated in the future without disrupting existing functionality.

3.4.8. Effectiveness

The system shall enable users to complete the car customization process, from image upload to modification selection, within 3 minutes for a typical user.

The system should provide AI-powered modification previews with 95% accuracy, reducing the need for manual adjustments and ensuring realistic visualizations for users.

4. Design and Architecture

4.1. System Architecture

System Architecture is a high-level design that defines the structure and behavior of a system. It shows how different components like software, hardware, databases, and users interact with each other. It helps in understanding how the system works.

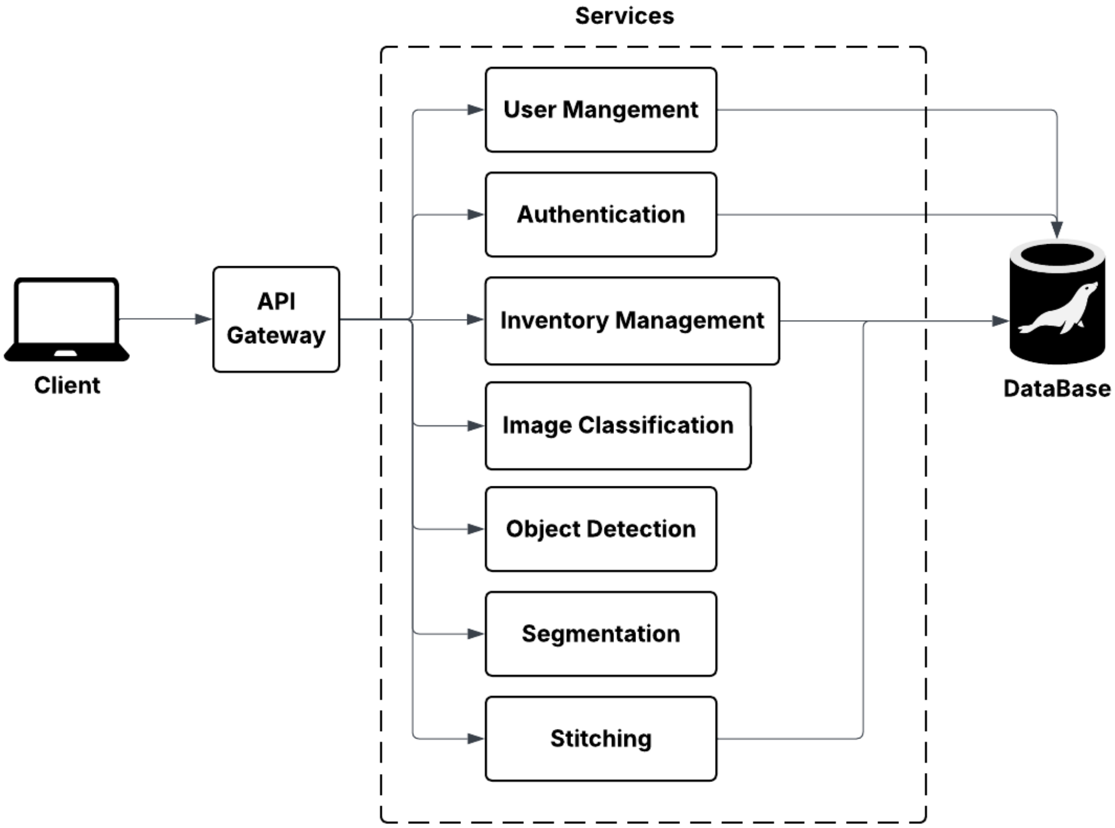


Figure 4.1: Architecture Diagram

4.2. Data Representation

Data Flow Diagram is a visual tool used to show how data moves through a system. It illustrates the flow of information between processes, data stores, and external entities. DFD helps in understanding how inputs are transformed into outputs. It is often used in system analysis and design.

4.2.1. Description (DFD Level 0)

The DFD Level 0 diagram outlines the fundamental workflow of the RCMS System using AI, capturing its main processes and data flows at the highest level. It illustrates how users interact with the system through inputs like login requests and image uploads, which are processed by core functions including authentication and AI-based modification. The diagram shows data moving between external entities SAAS provider, admin, operator and the system, transforming inputs into outputs such as modified images and analytics reports. Key components like user management, image processing, and administrative controls are represented as unified processes.

4.2.2. DFD Level 0

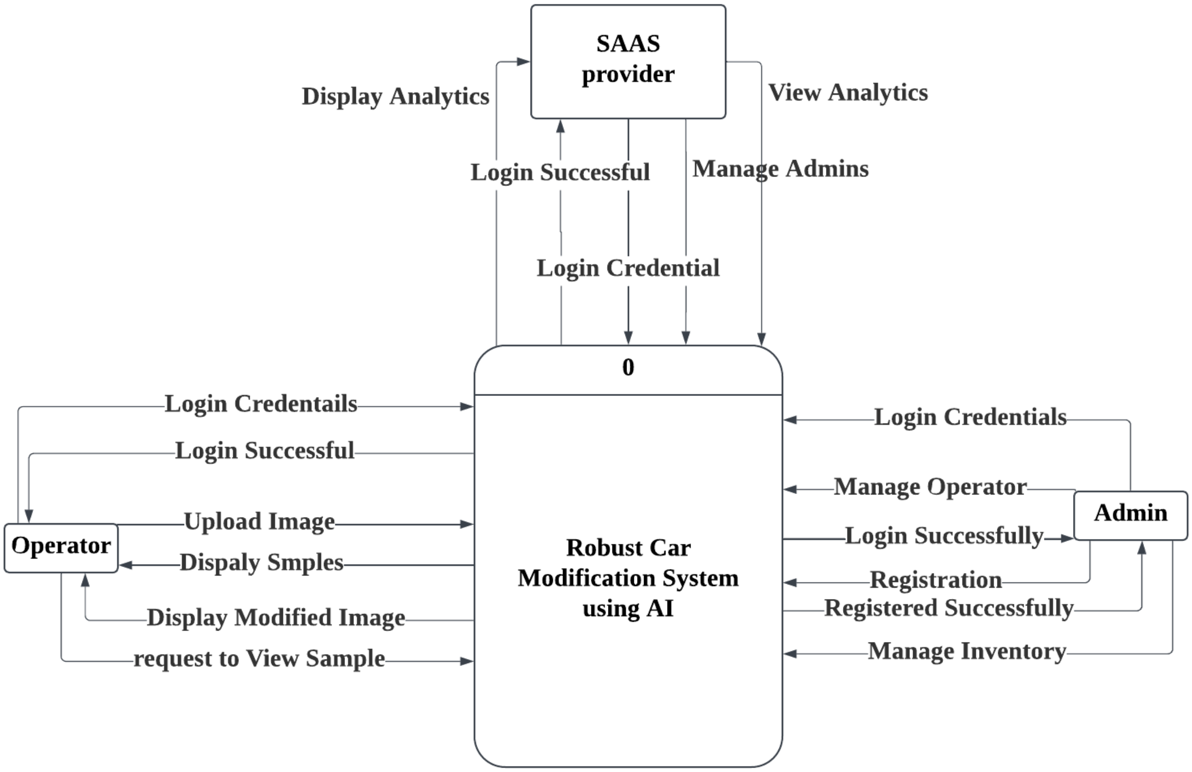


Figure 4.2: DFD Level 0

4.2.3. Description (DFD Level 1)

DFD Level 1 shows the inner working of system that how data goes through different processes

First (1.0) Register, new users enter their details to create accounts, which send credentials to be stored. Then (2.0) Authenticate, users log in by entering their username and password - if correct, they get access to the system.

For administrators (6.0) Manage Operators, they can add or remove staff accounts using user data. They also (7.0) Manage Inventory handle all the car parts and modification options in the system's database.

The main feature (3.0) Apply Modification lets operators upload car pictures. The system processes these to create customized versions, changing s, adding parts, etc. Users can then (4.0) Preview Samples that they have saved in database.

All these parts connect through data flows, user information moves between registration and login, inventory updates affect what modifications are available, and the final modified images get sent back to users. The diagram uses clear labels and arrows to show exactly how information moves from one step to the next in the modification process.

4.2.4. DFD Level 1

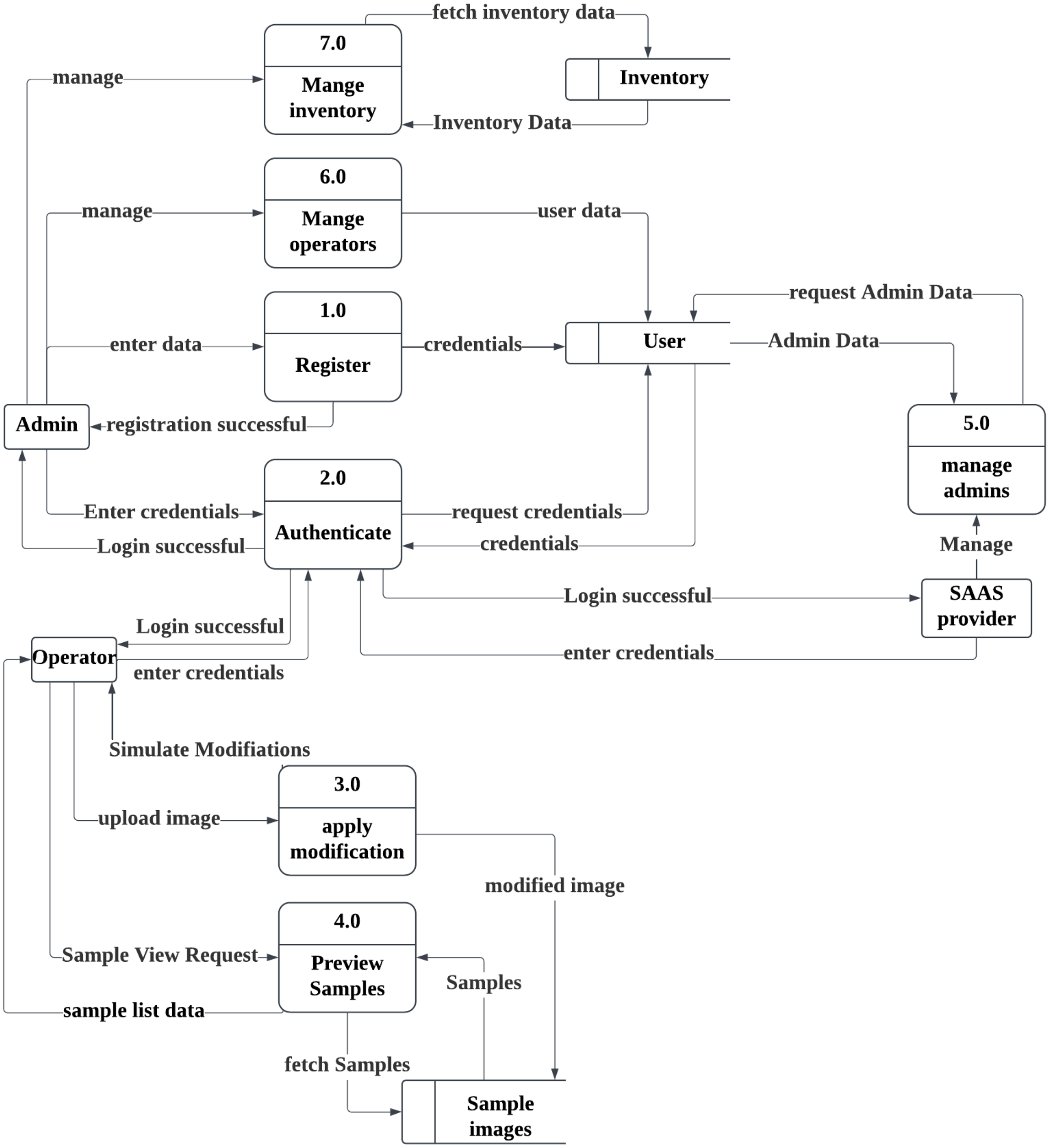


Figure 4.3: DFD Level 1

4.2.5. Description (DFD Level 2)

DFD level 2 shows the more details of process 3 (Apply Modification) and 4 (Preview Samples) of level 1.

The uploaded image by the operator is passed to the classification model which tells whether it's a car or not then if it's a car then it's passed to the Parts Detection Model which will annotate or highlight the part of the car then those parts will be segmented out and at last new parts will be stitched in its place.

In the Detail of process 4, 3 sub process emerged which show how the data flows while previewing the image. The operator requests to view the samples, then the system fetches the data from the database and displays those samples, and the operator can also view the detail of each sample by requesting the details from the system.

4.2.6. DFD Level 2

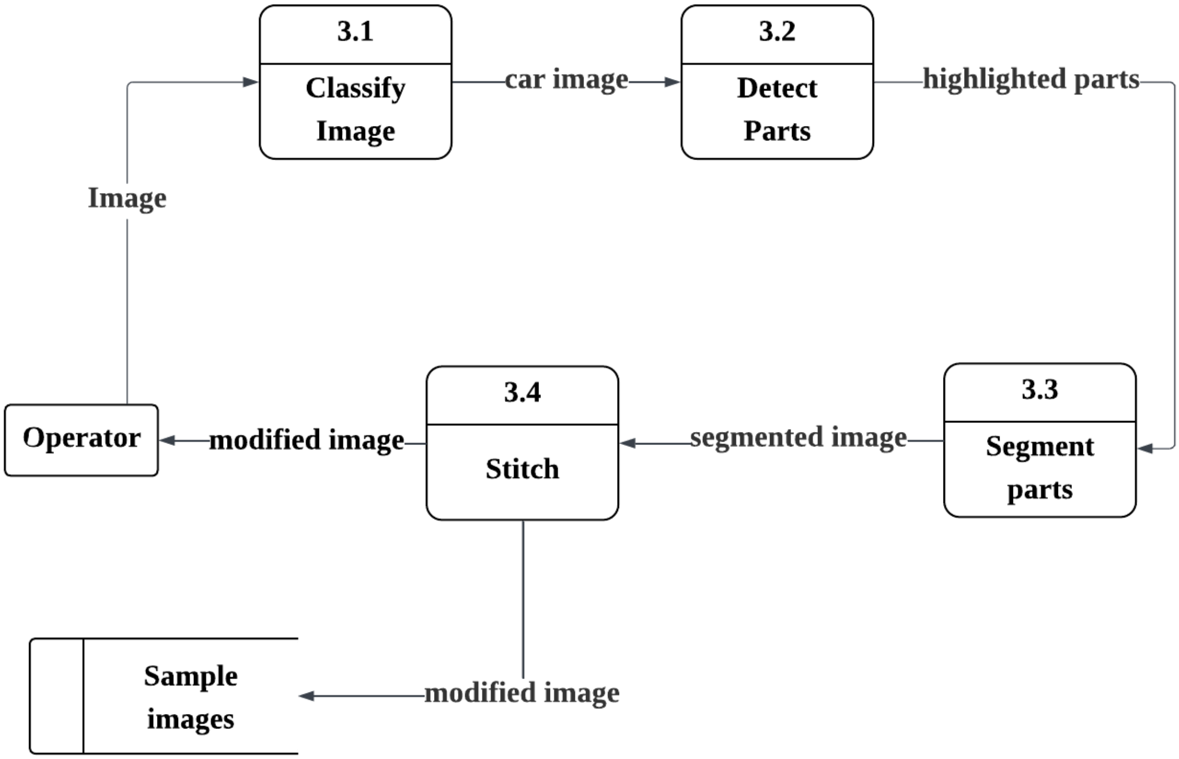


Figure 4.4: DFD Level 2 Apply Modification

4.2.7. Description (DFD Level 2)

In the Detail of process 4, which show how the data flows while previewing the image. The operator requests to view the samples, then the system fetches the data from the database and displays those samples, and the operator can also view the detail of each sample by requesting the details from the system.

4.2.8. DFD Level 2

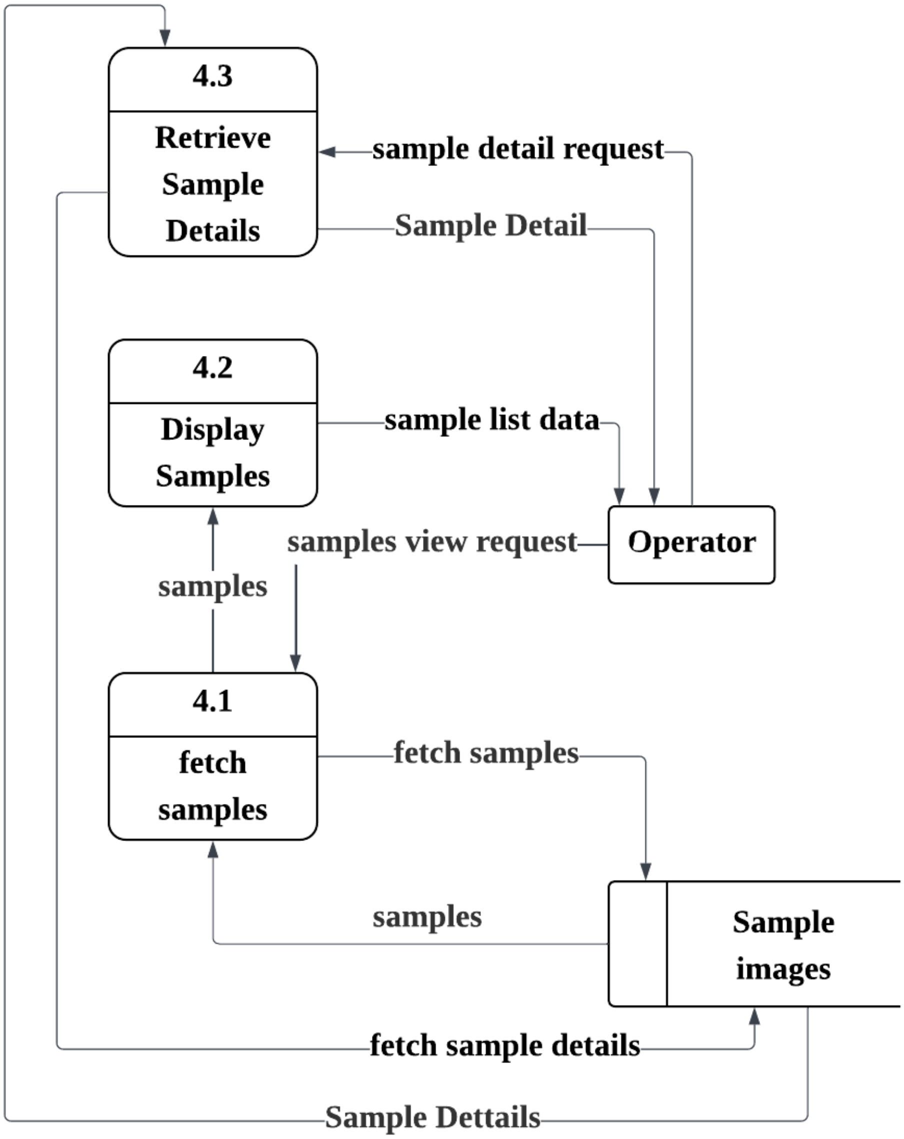


Figure 4.5: DFD Level 2 View Sample

4.2.9. Description (DFD Level 2)

DFD Level 2 shows a more detailed version of process 6 (Manage Operator) of level 1.

From this process emerged 7 sub process showing the more detailed version of how the data flows. As the manage operator contains multiple processes (add, remove, view, update) so for each we need specific process. Like for Adding the operator the Admin has to add the operator data which will be validated by the system and then afterwards save into the database, and for searching the specific admin the user can add the email of the operator, for deleting the operator the admin clicks on the delete button which will pass the operator ID and on the basis of this id the operator will be permanently deleted form the database, for updating the specific operator the admin enters the updated data of the operator and that data will be saved in the database.

4.2.10.DFD Level 2

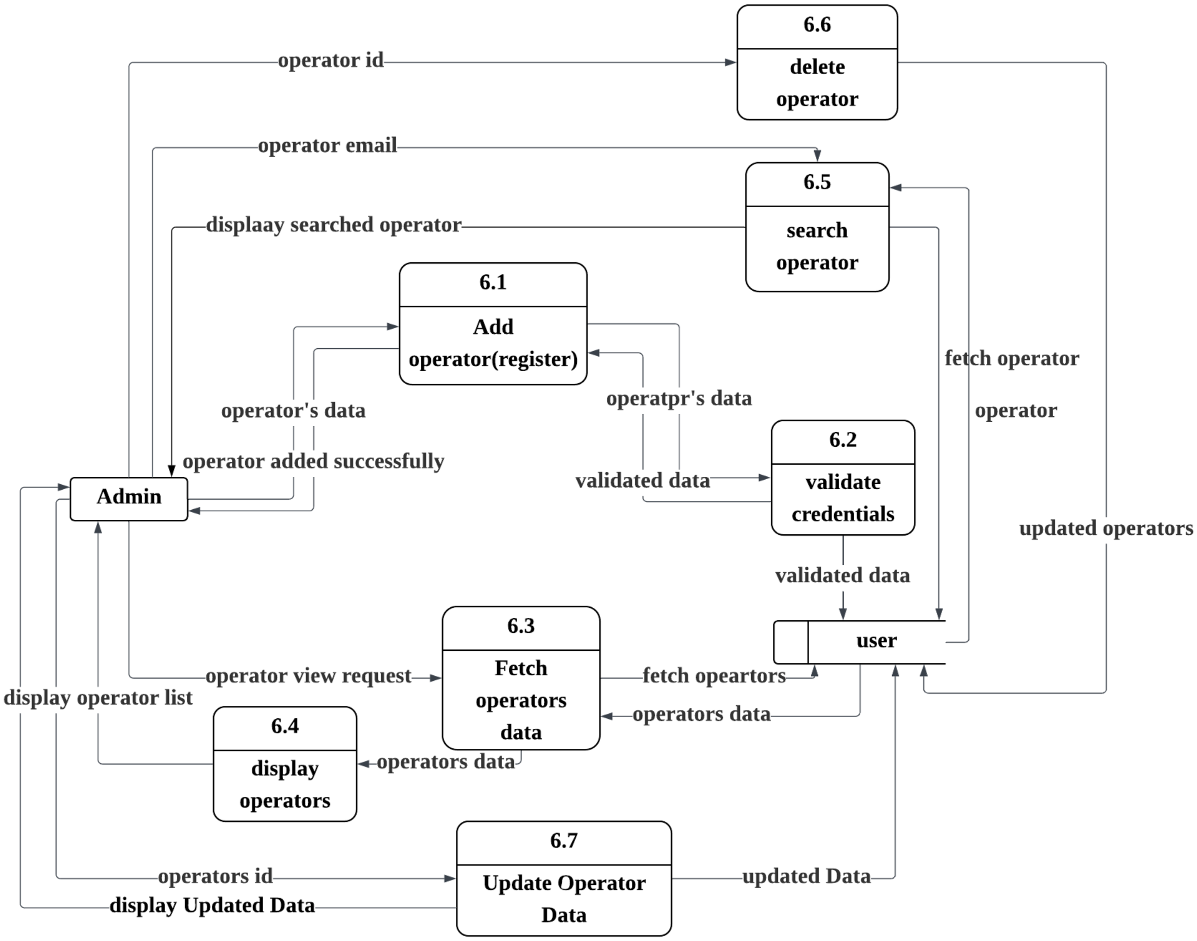
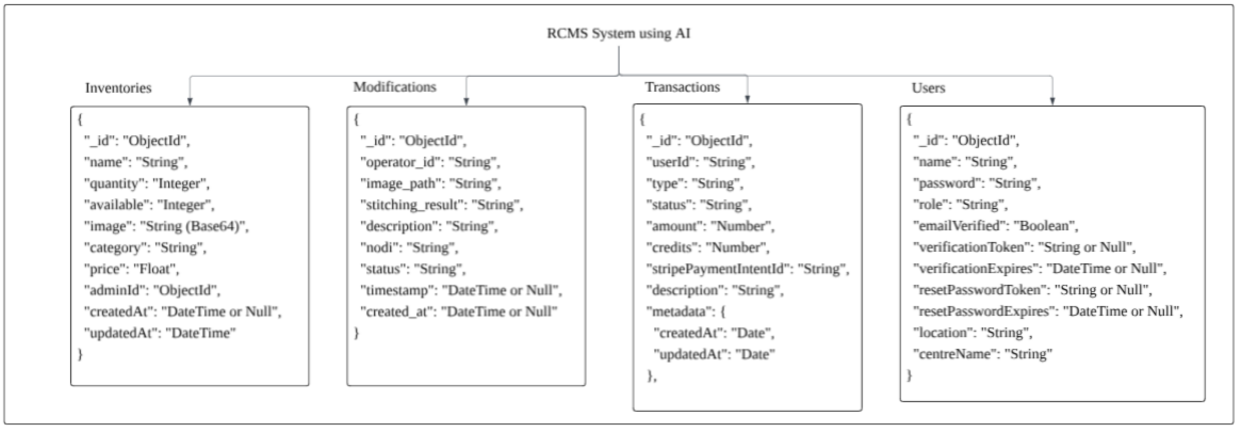


Figure 4.6: DFD Level 2 Manage Operators

4.2.11.Description (Daatabase)

This diagram shows how data is stored in the RCMS system. It has four main parts: Inventories, Modifications, Transactions, and Users. Inventories store car parts like and spoilers. Modifications store changes made to car images. Transactions handle payments, and Users store customer or staff information.

4.2.12.DataBase



```
{
  "_id": "ObjectId",
  "name": "String",
  "quantity": "Integer",
  "available": "Integer",
  "image": "String (Base64)",
  "category": "String",
  "price": "Float",
  "adminId": "ObjectId",
  "createdAt": "DateTime or Null",
  "updatedAt": "DateTime"
}
```

```
{
  "_id": "ObjectId",
  "operator_id": "String",
  "image_path": "String",
  "stitching_result": "String",
  "description": "String",
  "nodi": "String",
  "status": "String",
  "timestamp": "DateTime or Null",
  "created_at": "DateTime or Null"
}
```

```
{
  "_id": "ObjectId",
  "userId": "String",
  "type": "String",
  "status": "String",
  "amount": "Number",
  "credits": "Number",
  "stripePaymentIntentId": "String",
  "description": "String",
  "metadata": {
    "createdAt": "Date",
    "updatedAt": "Date"
  },
```

```
{
  "_id": "ObjectId",
  "name": "String",
  "password": "String",
  "role": "String",
  "emailVerified": "Boolean",
  "verificationToken": "String or Null",
  "verificationExpires": "DateTime or Null",
  "resetPasswordToken": "String or Null",
  "resetPasswordExpires": "DateTime or Null",
  "location": "String",
  "centreName": "String"
}
```

Figure 4.7: DataBase Diagram (JSON Format)

4.3. Process Flow/Representation

Process Flow Representation is a visual diagram that shows the sequence of steps or activities in a process. It helps to understand how a task starts, progresses, and ends. Common symbols like arrows, rectangles, and diamonds are used to represent actions, decisions, and flow direction.

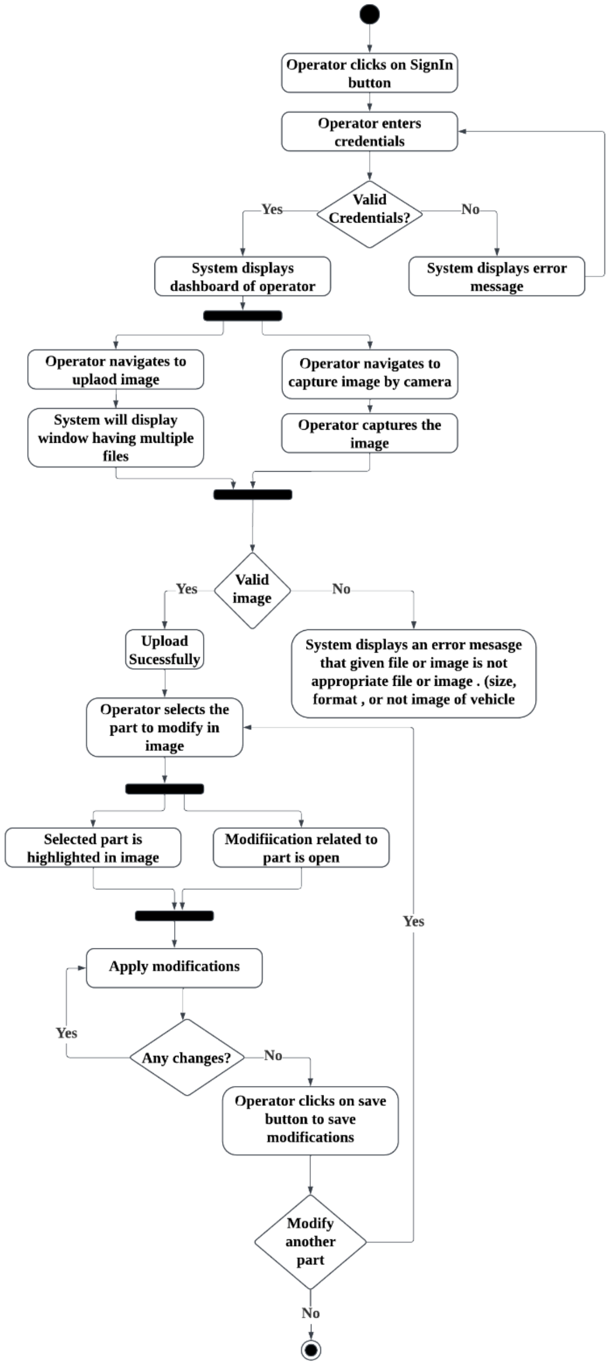

Operator clicks on SignIn button
Operator enters credentials
Valid Credentials?
Yes
No
System displays dashboard of operator
System displays error message
Operator navigates to uplaod image
Operator navigates to capture image by camera
System will display window having multiple files
Operator captures the image
Valid image
Yes
No
Upload Sucessfully
System displays an error mesasge that given file or image is not appropriate file or image . (size, format , or not image of vehicle
Operator selects the part to modify in image
Selected part is highlighted in image
Modifiication related to part is open
Yes
Apply modifications
Yes
Any changes?
No
Operator clicks on save button to save modifications
Modify another part
No

Figure 4.8: Process Flow /Representation

4.4. Desing Models

4.4.1. Description (SSD Operator)

In the RCMS System, the operator begins by logging in using their credentials, which the system validates. If the credentials are valid, access is granted; otherwise, an error message is displayed. After logging in, the operator can upload or capture an image, which is validated by an AI model to check its format, size, and whether it contains a car. Upon successful validation, the operator selects parts of the car in the image, which highlights the selected parts and displays available modification options. Using AI models, the operator applies the desired modifications, which are overlaid on the image. Finally, the operator saves the modified image, which can be accessed later for review or further editing.

4.4.2. Diagram (SDD)

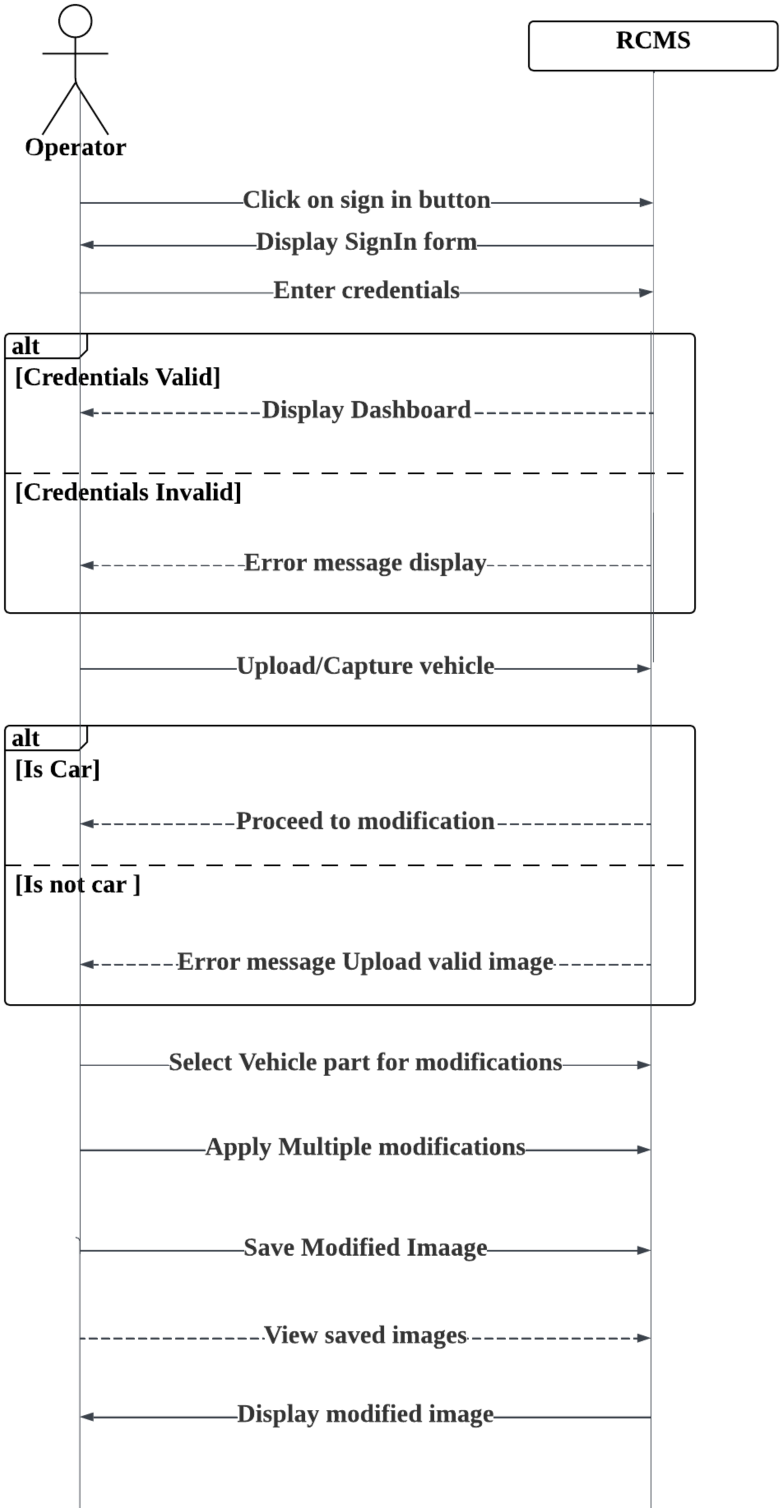


Figure 4.9: SSD Operator

4.4.3. Description (SSD Admin)

In the RCMS System, the admin begins by logging in with secure credentials, which the system authenticates before granting access to the administrative dashboard. Once logged in, the admin can manage operator accounts by viewing, adding, updating, or deleting user profiles, ensuring proper access control. The admin also oversees inventory management, including adding new modification parts, updating existing stock, or removing obsolete items from the system. All changes are validated, with confirmation messages displayed upon successful completion, ensuring system integrity and security.

4.4.4. Diagram

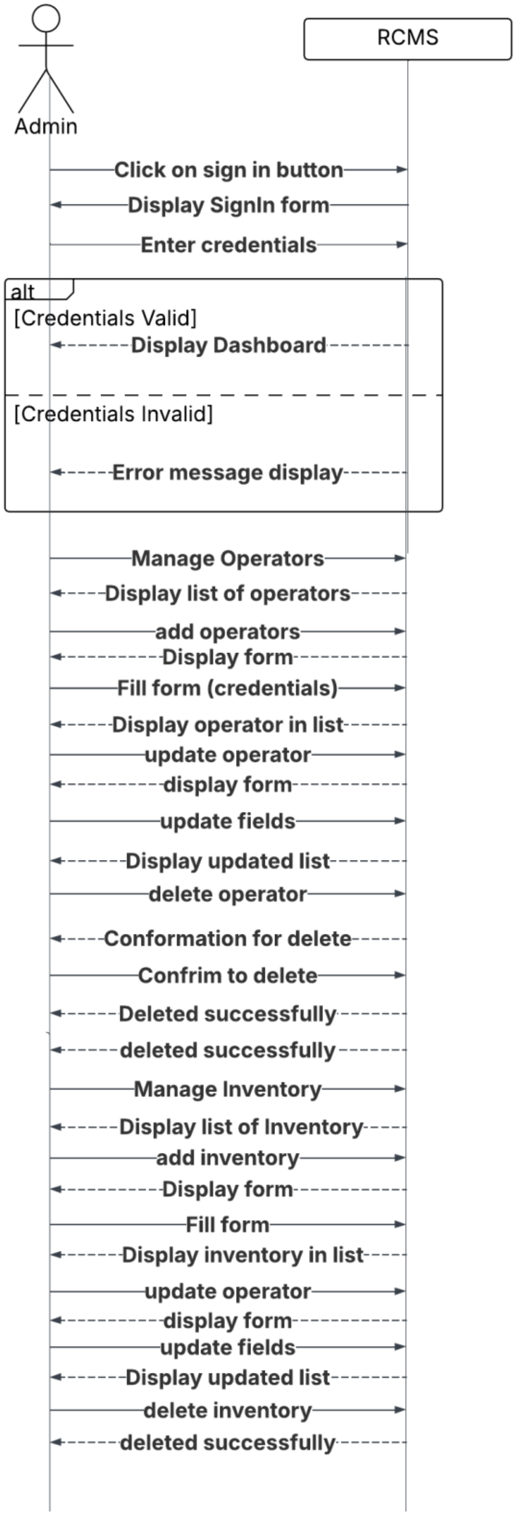


Figure 4.10: SSD Admin

4.4.5. Description (SSD SAAS Provider)

In the RCMS System, the SaaS provider authenticates via secure credentials to access the centralized cloud dashboard, enabling them to monitor system-wide analytics, track tenant usage patterns, and manage administrative accounts by viewing or deleting admins as needed.

4.4.6. Diagram

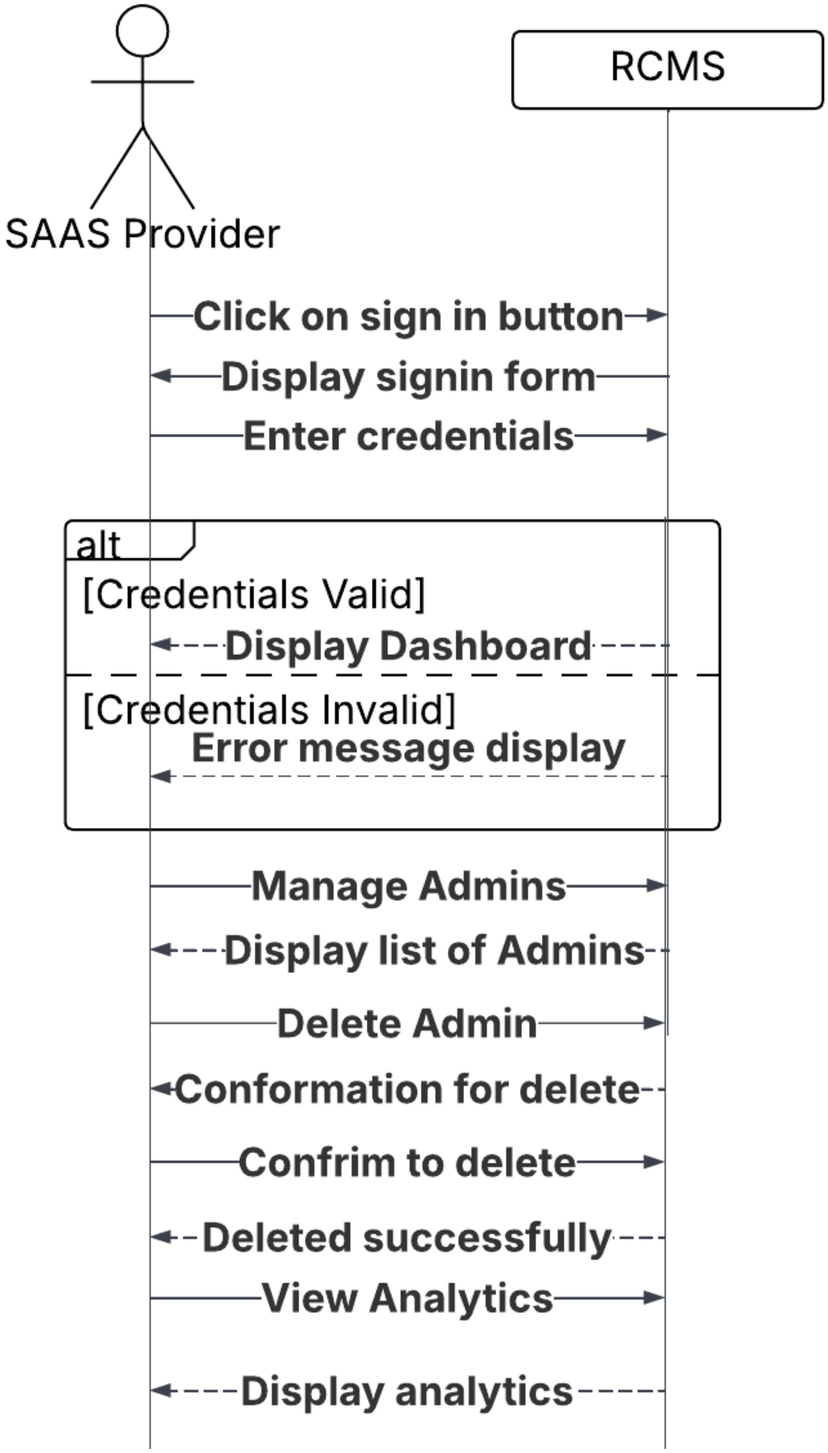


Figure 4.11: SSD SAAS Provider

5. Implementation

This chapter provides an overview of the implementation details for the project RCMS System using AI including algorithms used in the core modules and their functioning explained in natural language. The focus is on describing the key steps of major features of the application without delving into the actual source code.

5.1. Algorithm for Apply Modification Module

Input: Car Image (Capture through camera or Upload from system)

Output: Car Image with applied modifications

Step 1: Operator Opens the website.

Step 2: Operator clicks on Sign in button.

Step 3: Sign in page will display to the operator.

Step 4: Operator input the credentials.

Step 5: Check the credentials of the operator**.**

If operator credentials are correct display the operator dashboard.

If operator credentials are incorrect display the error message.

- Operators must be registered by the admin.
- Forget password option will send the link to entered email.

Step 6: Operator clicks on apply modification module.

Step 7: Modification module screen will display to him.

Step 8: Operator uploads an image from the system.

Step 9: If the image is uploaded

- Image is pass to classification model which is CNN model.
- Model detects that the uploaded image is a car or is not a car.

Step 10: If uploaded image is a car.

- System will display that “This is a car”.

Step 11: If uploaded image is not a car.

- System will display that “This is not a car”.

Step 12: If uploaded image is a car’s image.

- Pass the image to the next model, which is YOLOv8 that is used to detect the car parts in an image.

Step 13: YOLOv8 detects parts of the car in image.

Step 14: Detected parts can be spoiler, bumper, headlights, etc.

Step 15: After detection, the image goes to **SAM (Segment Anything Model)** that segment outs the part.

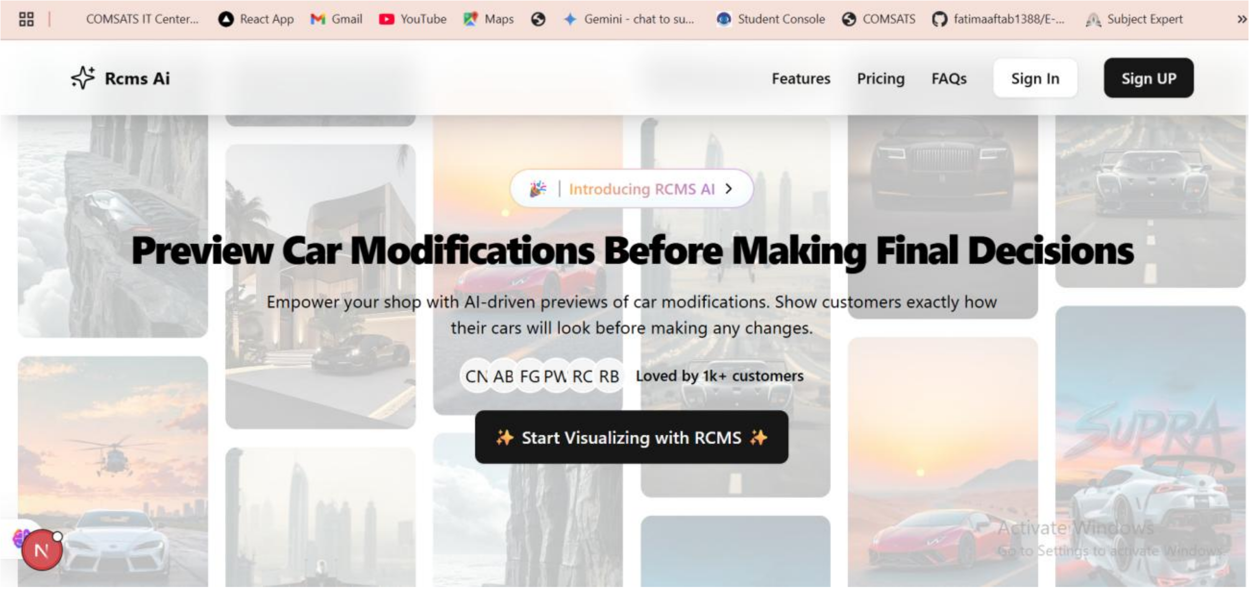
Step 16: SAM segments each detected part from the image.

Step 17: After segmentation, selected parts are ready for modification.

Step 18: Modified part is stitched back to the original image.

Step 19: Final image with modifications is shown to the operator.

5.2. User Interfaces

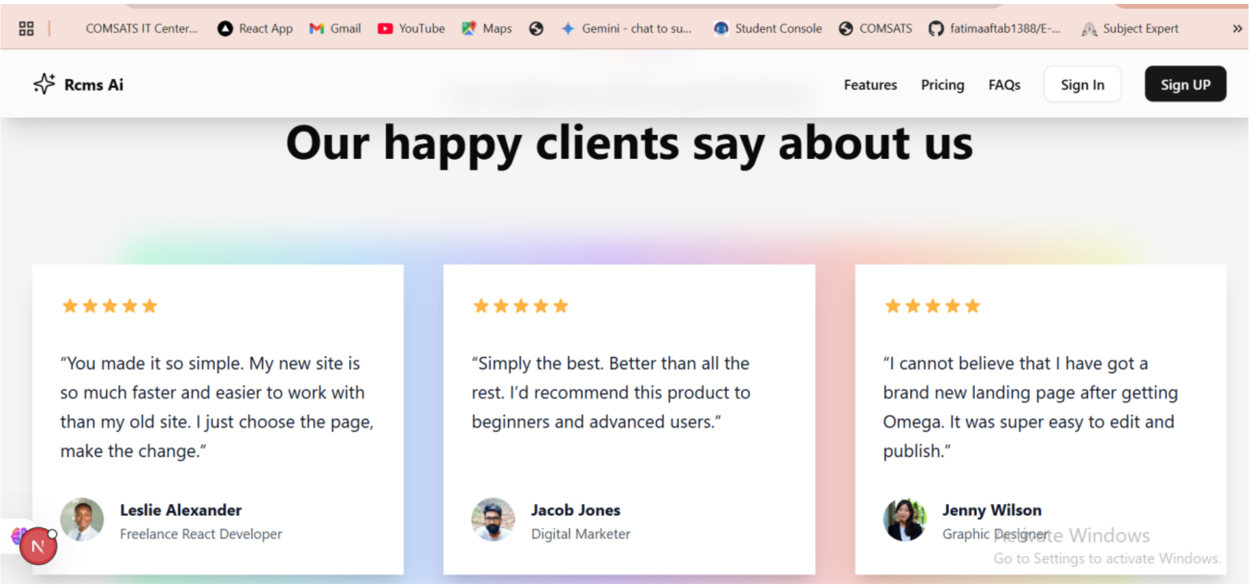


Preview Car Modifications Before Making Final Decisions

Empower your shop with AI-driven previews of car modifications. Show customers exactly how their cars will look before making any changes.

Loved by 1k+ customers

Figure 5.1: Home Page



Our happy clients say about us

"You made it so simple. My new site is so much faster and easier to work with than my old site. I just choose the page, make the change."

Leslie Alexander
Freelance React Developer

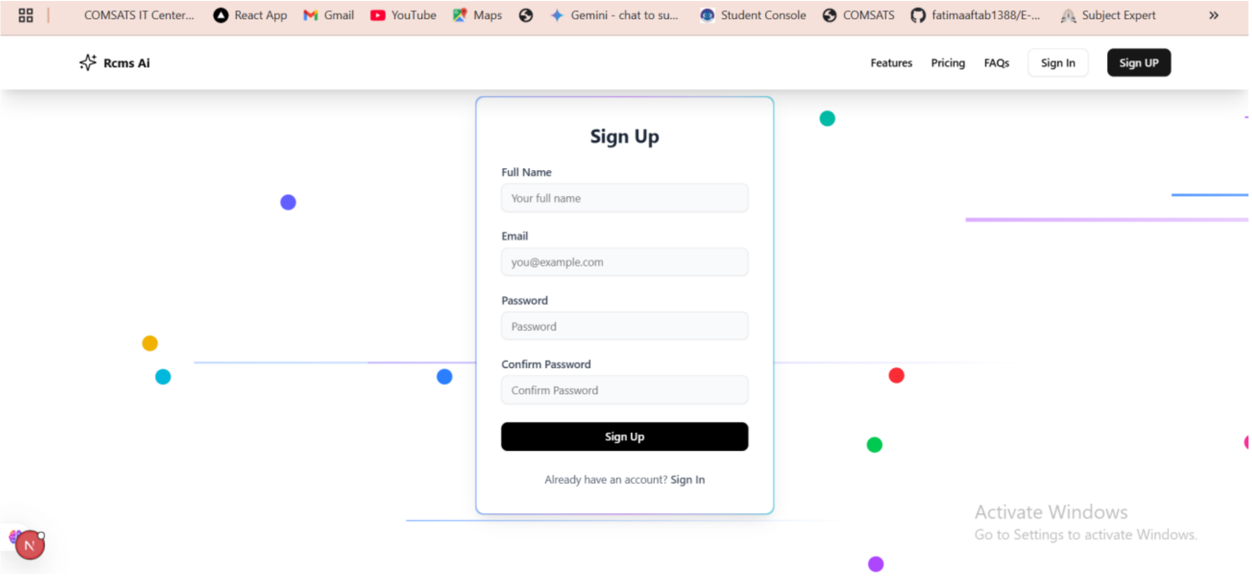
"Simply the best. Better than all the rest. I'd recommend this product to beginners and advanced users."

Jacob Jones
Digital Marketer

"I cannot believe that I have got a brand new landing page after getting Omega. It was super easy to edit and publish."

Jenny Wilson
Graphic Designer

Figure 5.2: Our Happy Customer Page



Sign Up

Full Name

Your full name

Email

you@example.com

Password

Password

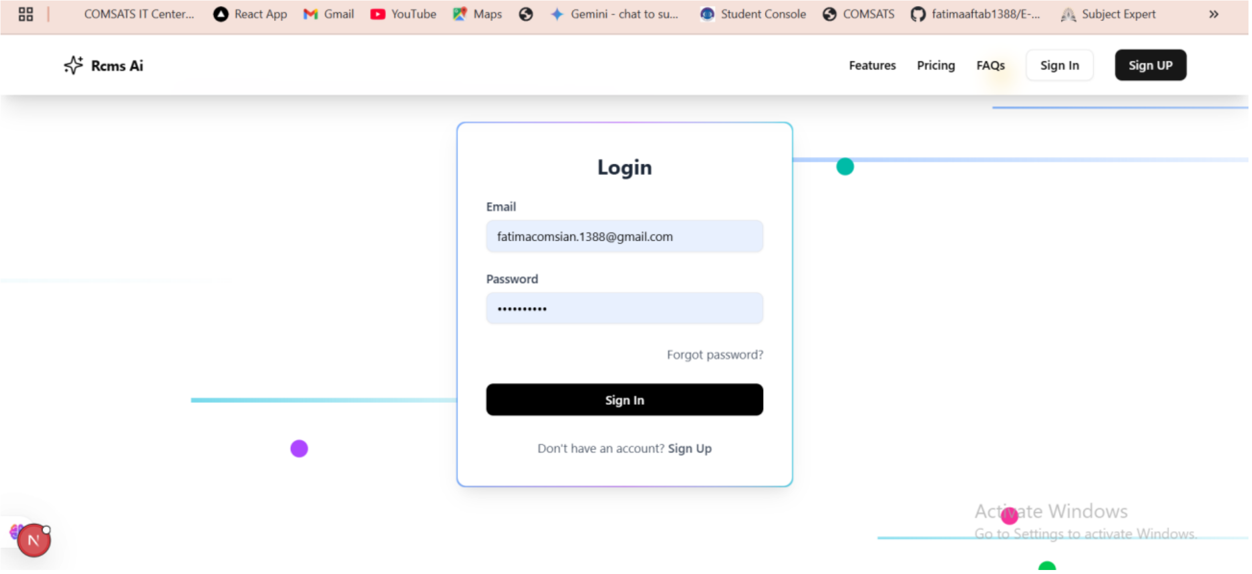
Confirm Password

Confirm Password

Sign Up

Already have an account? Sign In

Figure 5.3: Sign Up Page



Login

Email

fatimacomsian.1388@gmail.com

Password

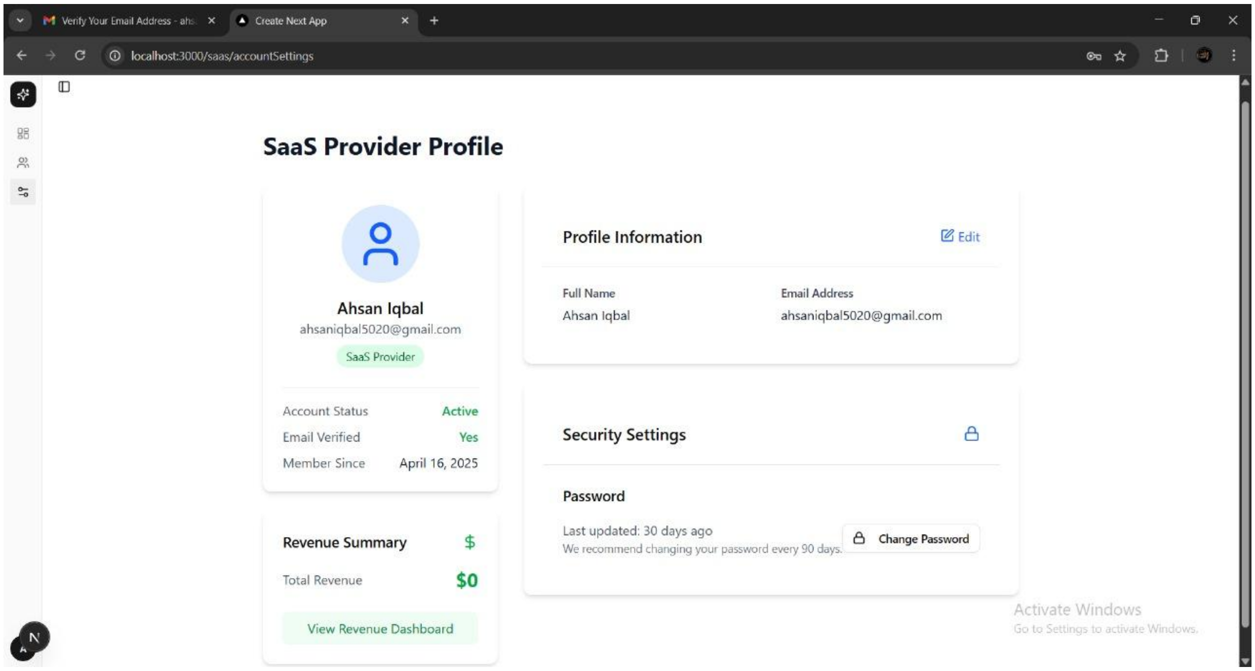
••••••••••

Forgot password?

Sign In

Don't have an account? Sign Up

Figure 5.4: Sign in Page


Verify Your Email Address - ahs
Create Next App
localhost:3000/saas/accountSettings
Activate Windows
Go to Settings to activate Windows.

SaaS Provider Profile

Ahsan Iqbal
ahsaniqbal5020@gmail.com
SaaS Provider

Account Status	Active
Email Verified	Yes
Member Since	April 16, 2025

Revenue Summary $

Total Revenue $0

View Revenue Dashboard

Profile Information Edit

Full Name	Email Address
Ahsan Iqbal	ahsaniqbal5020@gmail.com

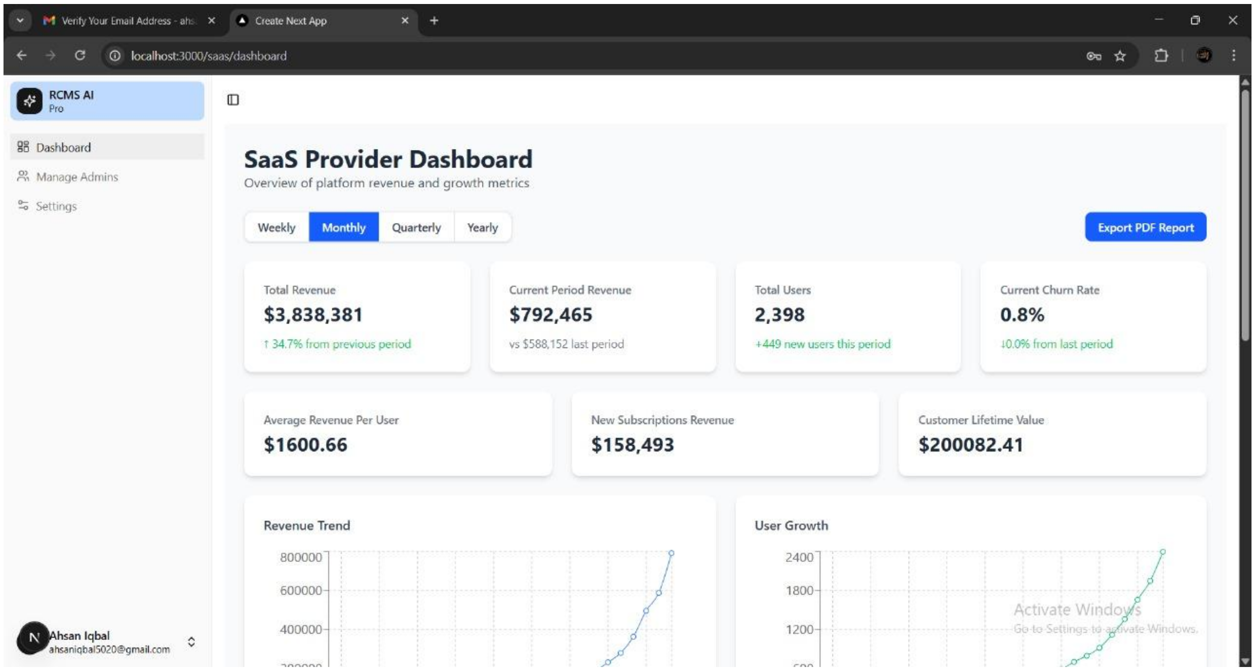
Security Settings

Password

Last updated: 30 days ago
We recommend changing your password every 90 days.

Change Password

Figure 5.5: SAAS Provider Dashboard



SaaS Provider Dashboard

Overview of platform revenue and growth metrics

Total Revenue
$3,838,381
↑ 34.7% from previous period

Current Period Revenue
$792,465
vs $588,152 last period

Total Users
2,398
+449 new users this period

Current Churn Rate
0.8%
↓0.0% from last period

Average Revenue Per User
$1600.66

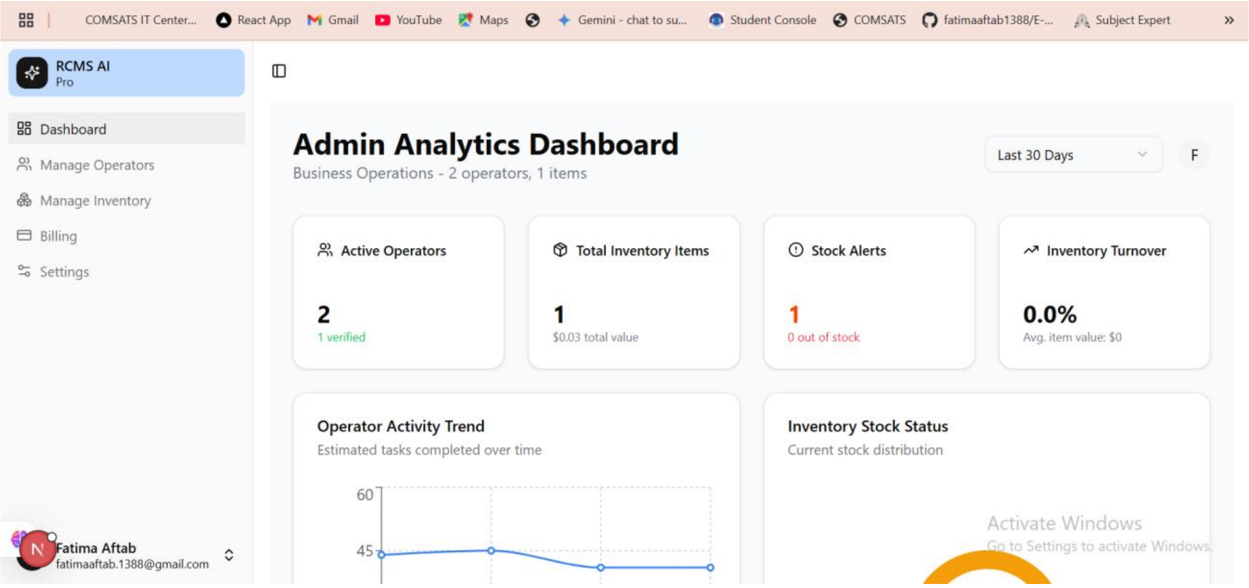
New Subscriptions Revenue
$158,493

Customer Lifetime Value
$200082.41

Revenue Trend

User Growth

Figure 5.6: SAAS Provider Modules



Admin Analytics Dashboard

Business Operations - 2 operators, 1 items

Active Operators: 2 — 1 verified

Total Inventory Items: 1 — $0.03 total value

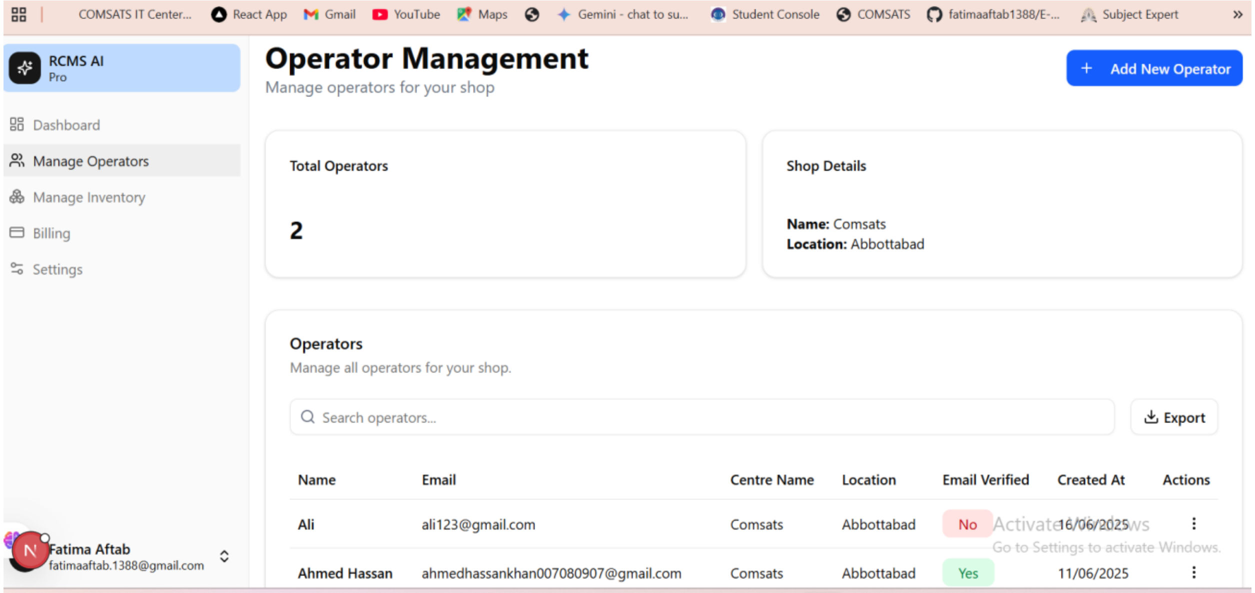
Stock Alerts: 1 — 0 out of stock

Inventory Turnover: 0.0% — Avg. item value: $0

Operator Activity Trend — Estimated tasks completed over time

Inventory Stock Status — Current stock distribution

Figure 5.7: Admin Analytics Dashboard



Operator Management

Manage operators for your shop

Total Operators: 2

Shop Details

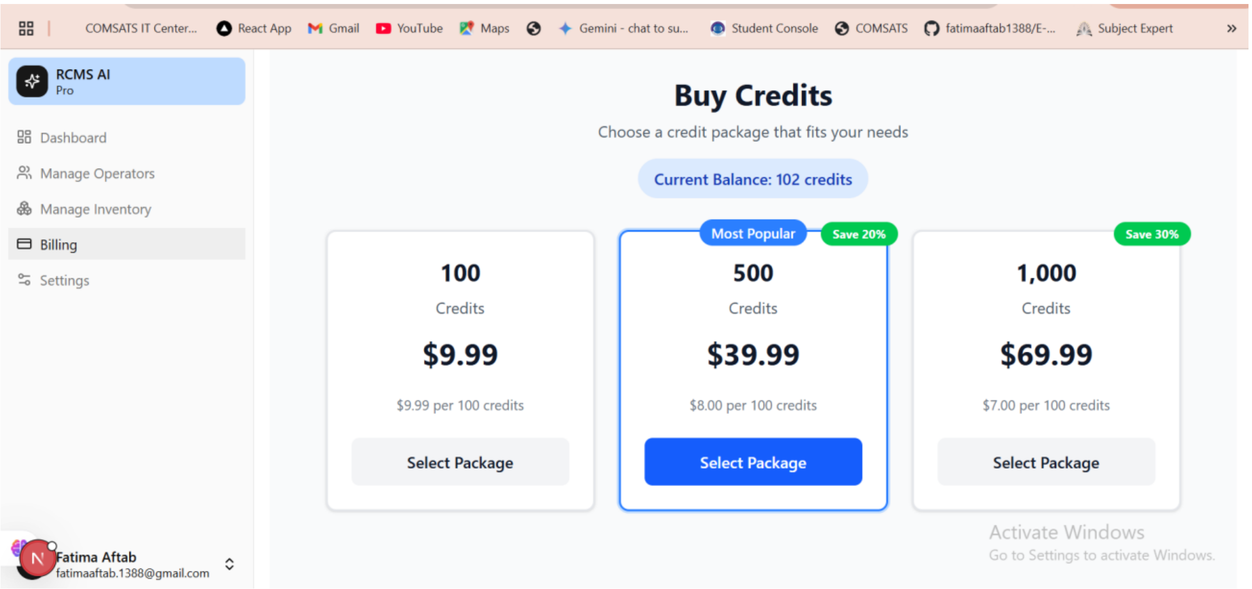
Name: Comsats
Location: Abbottabad

Operators

Manage all operators for your shop.

Name	Email	Centre Name	Location	Email Verified	Created At	Actions
Ali	ali123@gmail.com	Comsats	Abbottabad	No	16/06/2025	⋮
Ahmed Hassan	ahmedhassankhan007080907@gmail.com	Comsats	Abbottabad	Yes	11/06/2025	⋮

Figure 5.8:Manage Operator Page



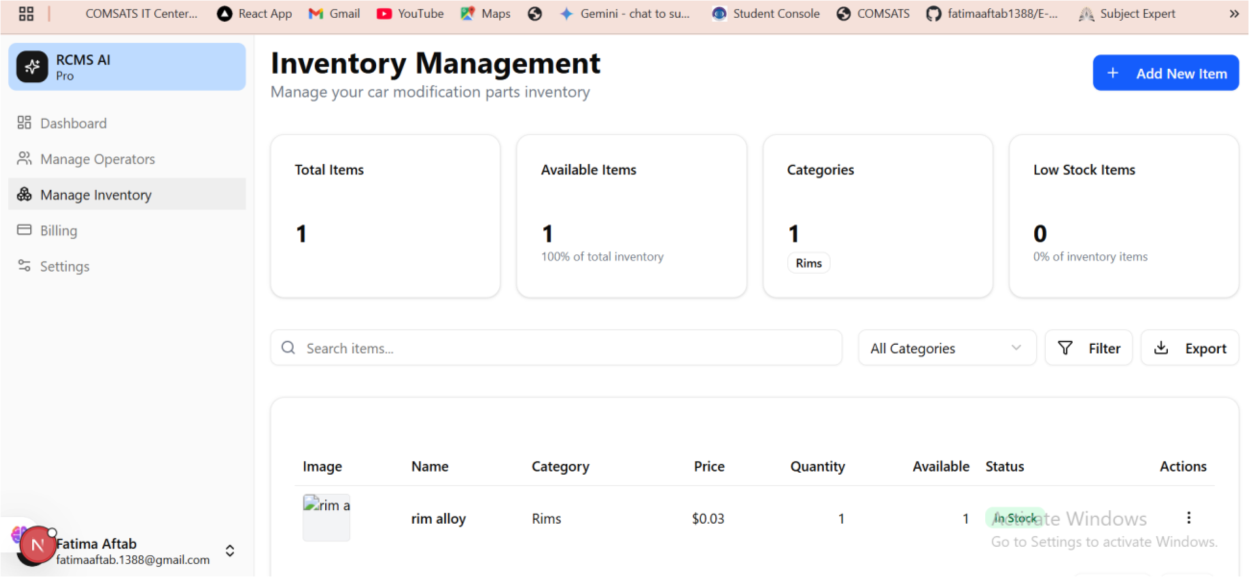
Buy Credits

Choose a credit package that fits your needs

Current Balance: 102 credits

100 Credits	500 Credits	1,000 Credits
$9.99	$39.99	$69.99
$9.99 per 100 credits	$8.00 per 100 credits	$7.00 per 100 credits

Figure 5.9: Admin Billing Page



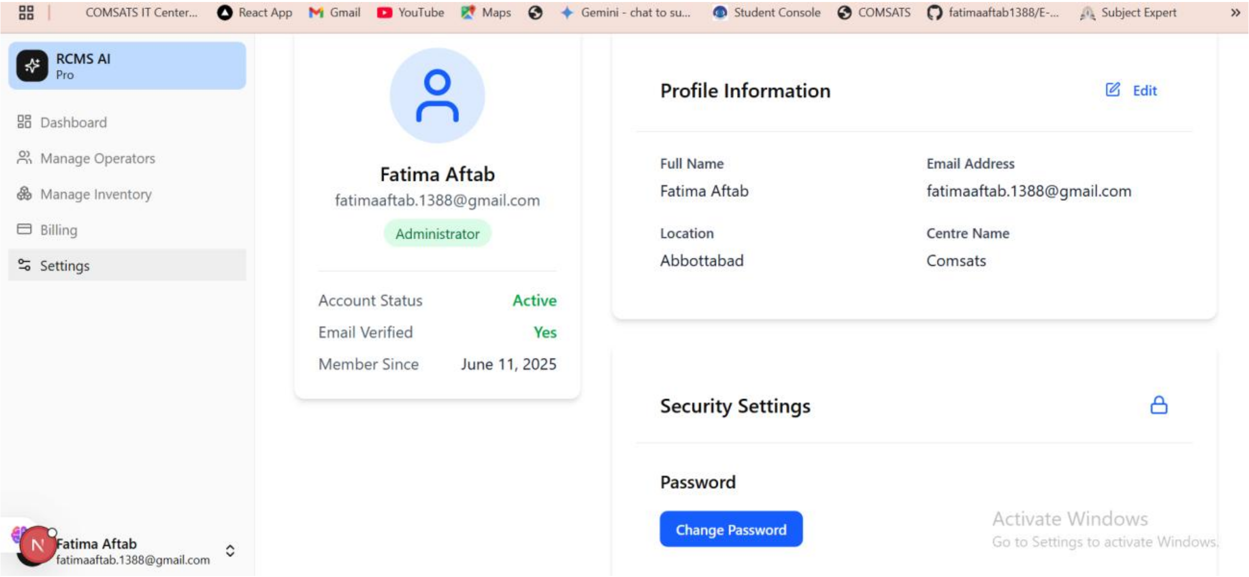
Inventory Management

Manage your car modification parts inventory

Total Items	Available Items	Categories	Low Stock Items
1	1 100% of total inventory	1 Rims	0 0% of inventory items

Image	Name	Category	Price	Quantity	Available	Status	Actions
rim a	rim alloy	Rims	$0.03	1	1	In Stock	⋮

Figure 5.10: Admin Manage Inventory Page



Fatima Aftab
fatimaaftab.1388@gmail.com
Administrator

Account Status: Active
Email Verified: Yes
Member Since: June 11, 2025

Profile Information

Full Name: Fatima Aftab
Email Address: fatimaaftab.1388@gmail.com
Location: Abbottabad
Centre Name: Comsats

Security Settings

Password

Fatima Aftab
fatimaaftab.1388@gmail.com

Figure 5.11: Admin Settings Page

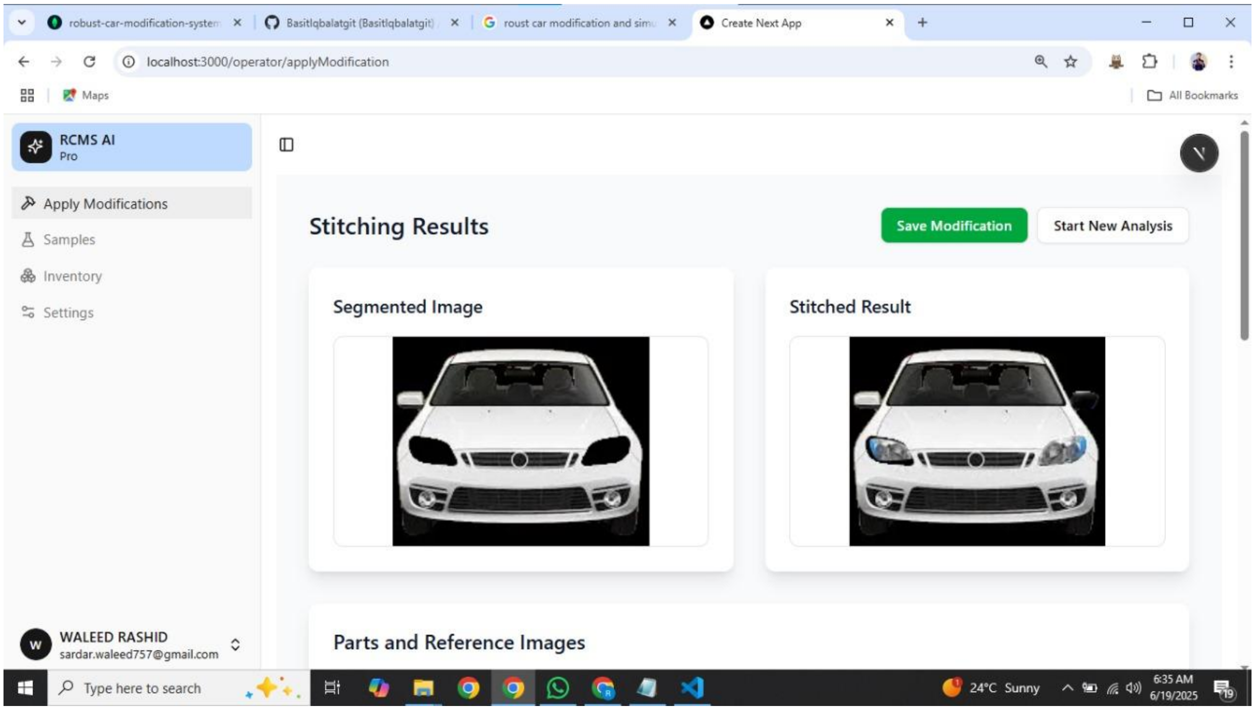
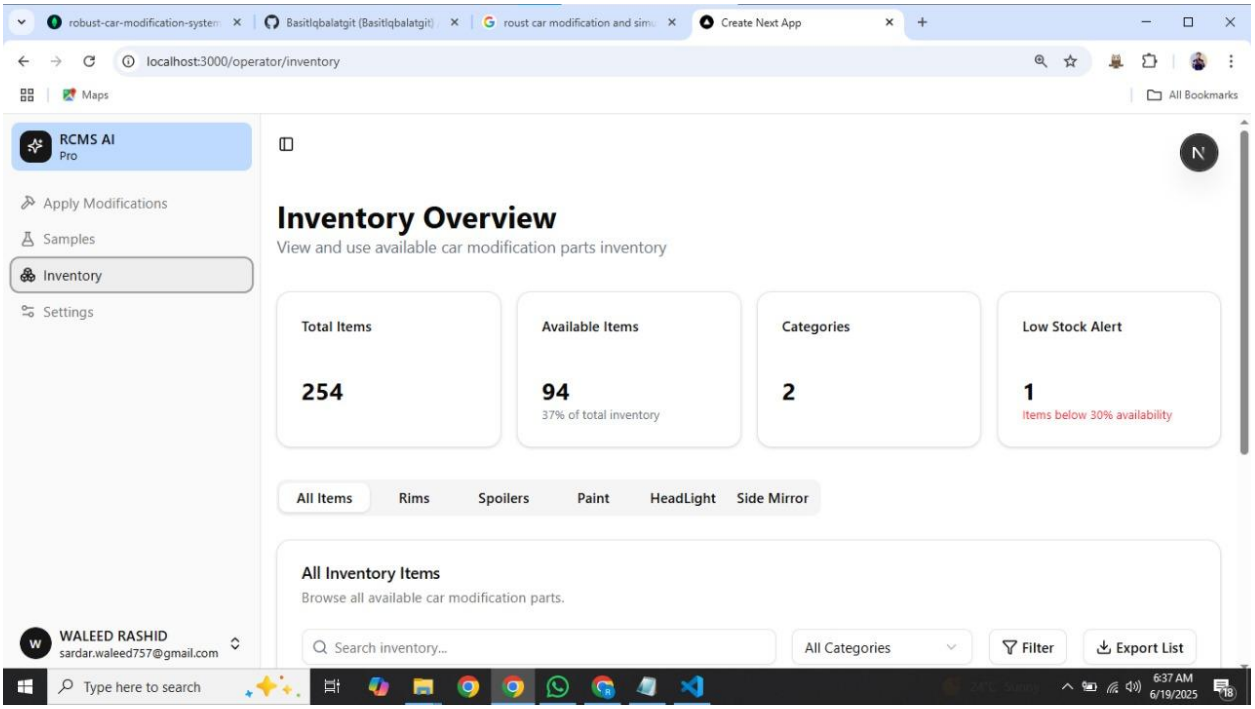


Figure 5.12: Operator Dashboard


robust-car-modification-system
Basitlqbalatgit (Basitlqbalatgit)
roust car modification and simu
Create Next App
localhost:3000/operator/inventory
Maps
All Bookmarks
RCMS AI
Pro
Apply Modifications
Samples
Inventory
Settings
WALEED RASHID
sardar.waleed757@gmail.com
N
Type here to search
6:37 AM
6/19/2025

Inventory Overview

View and use available car modification parts inventory

Total Items	Available Items	Categories	Low Stock Alert
254	94 37% of total inventory	2	1 Items below 30% availability

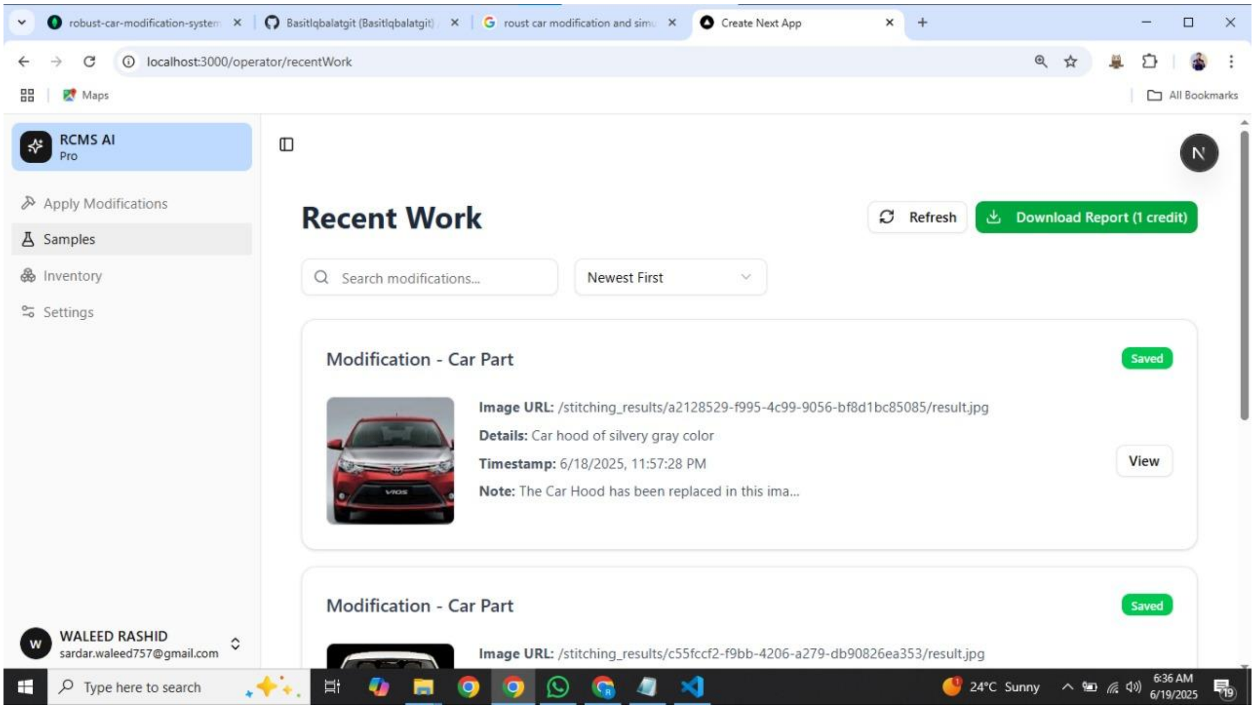
All Items | Rims | Spoilers | Paint | HeadLight | Side Mirror

All Inventory Items

Browse all available car modification parts.

Search inventory... | All Categories | Filter | Export List

Figure 5.13:Operator Inventory Page


robust-car-modification-system
Basitlqbalatgit (Basitlqbalatgit)
roust car modification and simu
Create Next App
localhost:3000/operator/recentWork
Maps
All Bookmarks
RCMS AI
Pro
Apply Modifications
Samples
Inventory
Settings
WALEED RASHID
sardar.waleed757@gmail.com
N
Type here to search
24°C Sunny
6:36 AM
6/19/2025

Recent Work

Refresh | Download Report (1 credit)

Search modifications... | Newest First

Modification - Car Part

Saved

Image URL: /stitching_results/a2128529-f995-4c99-9056-bf8d1bc85085/result.jpg

Details: Car hood of silvery gray color

Timestamp: 6/18/2025, 11:57:28 PM

Note: The Car Hood has been replaced in this ima...

View

Modification - Car Part

Saved

Image URL: /stitching_results/c55fccf2-f9bb-4206-a279-db90826ea353/result.jpg

Figure 5.14: View Samples Page

6. Testing and Evaluation

The testing for the RCMS System is performed manually and automatedly to ensure that the system functions correctly and meets all specified requirements without bugs and errors. This chapter may include the following sections

6.1. Manual Testing

6.1.1. System Testing

System testing was performed on the RCMS system to ensure it works as expected and meets the requirements. This ensured that all major components like authentication, image handling, AI models, and customization flow performed as intended. Each part of the system was tested to ensure smooth performance.

For example, when a user selects a new bumper or wheel, the system should update the car image to reflect the change. This testing also helped find and fix any bugs or issues. Overall, the system testing showed that RCMS is working well and is ready for use. Each module was tested to verify smooth interactions.

6.1.2. Unit Testing

Once the system has been successfully developed, the following unit tests were performed to ensure each individual module works correctly.

Unit Testing 1: Sign In

Testing Objective: To ensure Sign in unit works correctly

Table 6.1: Unit Testing 1 Sign in

No.	Test Case/Test Script	Attribute and value	Expected result	Result
1	Verify Admin can sign in with valid credentials	Valid Email: fatimaaftab.1388@gmail.com Valid Password: F@tima1388	Login Successful, Redirect to admin dashboard.	Pass
2	Verify Operator can sign in with valid credentials	Valid Email: ahmedhassankhan007080907@gmail.com Valid Password: Ahmed1388@	Login Successful, Redirect to operator dashboard	Pass
3	Verify error message displays on invalid credentials of user	Valid Email: fatimaaftab.1388@gmail.com Valid Password: F@tima1300	Error Message: 'Invalid password'	Pass

Unit Testing 2: Logout

Testing Objective: To ensure the Logout unit works correctly

Table 6.2: Unit Testing 2 Logout

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify user can successfully logout	Click on "Logout" button when user is logged in	User session ends and user is redirected to the landing page	Pass
2	Verify access restriction after logout	Attempt to access dashboard URL after logout	System blocks access and redirects to login page	Pass

Unit Testing 3: Sign Up
Testing Objective: To ensure that sign up unit works correctly

Table 6.3: Unit Testing 3 Sign up

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify Admin can sign up with valid credentials	Name: "Fatima", Email: "fatimaaftab.1388@gmail.com", Password: "F@tima1388", Confirm Password: “F@tima1388”	Admin account created, confirmation message shown	Pass
2	Verify empty fields shows error messages	Name: " ", Email: " ", Password: "", Confirm: “”	Highlight each missing field, error messages shown	Pass
3	Verify duplicate email entry	Name: "Fatima", Email: "fatimaaftab.1388@gmail.com", Password: "F@tima1388", Confirm Password: “F@tima1388”	Error: "Use with this email already registered."	Pass

Unit Testing 4: Add Operator
Testing Objective: To ensure the add operator works correctly

Table 6.4: Unit Testing 4 Add Operator

No.	**Test Case/Test Script**	**Attribute and value**	**Expected Result**	**Result**
1	Verify Admin adds a new operator with valid data	Name: "Ali", Email: "ali123@gmail.com", Password: "Ali@123"	Operator Added. Check user email for verification	Pass
2	Verify Admin cannot add an operator with duplicate email	Email: "ali123@gmail.com" (already exists)	System displays "User Already Exists" message	Pass
3	Verify Admin cannot add an operator with missing fields	Name: " ", Password: " "	Highlight each missing field, error messages shown	Pass

Unit Testing 5: Upload Image
Testing Objective: To ensure image upload unit works correctly

Table 6.5: Unit Testing 5 Upload Image

No.	**Test Case/Test Script**	**Attribute and value**	**Expected Result**	**Result**
1	Verify Operator uploads valid image	File: car_image.jpg (10MB, JPG, PNG, GIF format)	Image uploaded successfully and preview is displayed	Pass
2	Verify Operator cannot upload large image file	File: abc.png (15MB)	Error message: "File size exceeds limit (10MB)."	Pass
3	Verify Operator cannot upload non-car image	File: abc.jpg	System displays “This is not a car”	Pass

Unit Testing 6: Capture Image
Testing Objective: To ensure capture image unit works correctly

Table 6.6: Unit Testing 6 Capture Image

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify camera interface loads	Operator clicks on "Capture Image"	Camera interface is displayed	Pass
2	Verify image is captured successfully	Operator positions car and clicks capture	Image is captured and shown in preview	Pass
3	Verify image upload after capture	Operator confirms preview image	Image is shown in the system for modification	Pass
4	Verify cancel action after preview	Operator clicks "Cancel" after preview	Image is not uploaded, and system returns to capture screen	Pass

Unit Testing 7: Apply Modification
Testing Objective: To ensure apply modification unit works correctly

Table 6.7: Unit Testing 7 Apply Modifications

No.	Test Case/Test Script	Attribute and Value	Expected Result	Result
1	Verify Operator applies modification	Upload image + Select "side mirror"	Side mirror applied and preview displayed	Pass
2	Verify can apply modification after capture	Capture car image + Select bumper	Bumper added to captured image	Pass

Unit Testing 8: View Operator
Testing Objective: To ensure view operator unit works correctly

Table 6.8: Unit Testing 8 View Operator

No.	Test Case / Test Script	Attribute and value	Expected Result	Result
1	Verify access to operator list	Admin is logged in and selects “Manage Operators”	The system displays a list of all registered operators with names, emails, center, location, email verified, created at, and actions	Pass

Unit Testing 9: Update Operator
Testing Objective: To ensure Update Operator unit works correctly

Table 6.9: Unit Testing 9 Update Operator

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify Admin updates an operator with valid data	Name = "Ali Ahmed", Email = "ali123@gmail.com"	Operator details updated successfully	Pass
2	Update operator with duplicate email	Email = "existinguser@gmail.com"	System shows error: "Email already exists"	Pass
3	Update operator with missing required field	Name = ""	System shows error: "Name is required"	Pass

Unit Testing 10: Delete Operator
Testing Objective: To ensure the operator unit works correctly

Table 6.10: Unit Testing 10 Delete Operator

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify successful deletion of an operator	Valid operator selected, Admin clicks delete, confirms	Operator account is permanently removed from the system	Pass
2	Verify deletion cancellation	Admin selects delete but clicks "Cancel" on confirmation prompt	Operator account remains in the system	Pass

Unit Testing 11: View Samples
Testing Objectives: To ensure the “view samples” unit works correctly

Table 6.11: Unit Testing 11 View Samples

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify Operator views list of saved modifications	Operator is logged in and has at least one saved modification	List of modified car images with details is displayed	Pass
2	Verify Operator views modification details	Operator selects a specific sample from the list	The system displays full image and modification details.	Pass

Unit Testing 12: Add Inventory
Testing Objectives: To ensure the “add inventory” unit works correctly

Table 6.12: Unit Testing 12 Add Inventory

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify Admin adds an item with all valid inputs	Item Name: *"Alloy "*, Quantity: 10, Available: 10, Price: 150, Category: , Item Image: “”	System displays “Item added successfully “and shown in inventory	Pass
2	Verify leave item name empty	Item Name: "", Quantity: 5, Available: 5, Price: 5000	Error shown: "Item Name is required"	Pass

Unit Testing 13: Remove Inventory
Testing Objectives: To ensure the “remove inventory” unit works correctly

Table 6.13: Unit Testing 13 Remove Inventory

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify successful item deletion from inventory	Click “Delete” on a listed item	The system displays confirmation dialog and deletes the item after confirmation	Pass
2	Verify cancel option in delete confirmation	Click “Delete” → Click “Cancel” in confirmation dialog	Deletion is aborted and item remains in inventory	Pass

Unit Testing 14: Update Inventory
Testing Objectives: To ensure the “update inventory” unit works correctly

Table 6.14: Unit Testing 14 Update Inventory

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify Admin updates inventory item successfully	Name = “Spoiler”, Quantity = 15, Price = 20	Item details updated and confirmation message displayed	Pass
2	Verify Admin cannot update item with empty fields	Name = “”, Quantity = 10, Price = 12000	Highlight each missing field, error messages shown	Pass
3	Verify Admin cancel update mid-process	Admin clicks cancel before saving	From closes, no changes are saved	Pass

Unit Testing 15: View Inventory
Testing Objective: To ensure the “view inventory” unit works correctly

Table 6.15: Unit Testing 15 View Inventory

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify inventory list is displayed for Admin	Role = Admin, clicks "Manage Inventory"	The system displays a list of inventory items including image, name, category, price, quantity, available, and status	Pass
2	Verify inventory list is displayed for Operator	Role = Operator, clicks "Manage Inventory"	Inventory list is displayed correctly with all details	Pass

6.1.3 Functional Testing

The functional testing will take place after the unit testing. In this functional testing, the functionality of each of the modules is tested. This is to ensure that the system produced meets the specifications and requirements.

Functional Testing 1: Admin Sign Up
Objective: To ensure that System allows admins to sign up in the system successfully

Table 6.16: Functional Testing 1 Admin Sign Up

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Register new admin in system	Name: "Fatima", Email: "fatimaaftab.1388@gmail.com", Password: "F@tima1388", Confirm Password: “F@tima1388’	Admin account is created successfully and stored in the Database. Verification email sent to given email.	Pass

Functional Testing 2: Admin Sign In
Objective: To ensure that registered admins can log in successfully using their credentials.

Table 6.17: Functional Testing 2 Admin Sign In

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Admin signs in with valid credentials	Email: fatimaaftab.1388@gmail, Password: “F@tima1388”	Admin signs in successfully and dashboard is shown	Pass

Functional Testing 3: Operator Registration

Objective: To ensure that system allows admins to register operators successfully

Table 6.18: Functional Testing 3 Operator Registration

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Admin registers a new operator	Admin clicks “Mange Operator “then “Add Operator” Enter Credentials Name: “Ahmed”, Email: AhmedHassan123@gmail.com , Password: “ahmed@123”, confirm password: “ahmed@123”	Operator account created successfully, and verification email sent to email.	Pass

Functional Testing 4: Operator Signs In

Objective: To ensure that system allows operators to sign in using their registered emails and passwords

Table 6.19: Functional Testing 4 Operator Signs In

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Operator signs in with valid credentials	Email: AhmedHassan123@gmail.com Password: “ahmed@123”	Operator is signs in successfully and redirected to the dashboard	Pass

Functional Testing 5: Secure Credential Storage

Objective: To ensure that admin and operator credentials are stored in a secure and encrypted format.

Table 6.20: Functional Testing 5 Secure Credential Storage

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Store password in securely in database	Register a new user (admin/operator)	Password is stored in encrypted (hashed) format, not plain text	Pass

Functional Testing 6: Upload Image

Objective: To ensure that system allows operators to upload images of cars successfully

Table 6.21: Functional Testing 6 Upload Image

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Operator uploads valid car image	.jpg, png, GIF image, size =< 10MB	Image uploaded successfully and preview is shown	Pass

Functional Testing 7: Capture Image

Objective: To ensure that System allows Operator to capture images of cars successfully

Table 6.22: Functional Testing 7 Capture Image

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Operator captures car image via integrated camera	Operator clicks “Capture”	Image is captured and preview displayed	Pass

Functional Testing 8: Image Preview

Objective: To ensure that the system displays an image for preview after uploading image

Table 6.23: Functional Testing 8 Image Preview

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Operator previews uploaded image	Upload a valid image	Preview is shown	Pass

Functional Testing 9: AI-driven Part Detection

Objective: To verify that the system correctly identifies and segments car parts using AI from uploaded image.

Table 6.24: Functional Testing 9 AI-driven Part Detection

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify SAM detects car parts	Upload image of car	Detected parts with accuracy	Pass

Functional Testing 10: Overlay Parts (Apply Modification)
Objective: To ensure the system overlay selected parts onto the uploaded car image.

Table 6.25: Functional Testing 10 Overlay Parts (Apply Modification)

No.	**Test Case/Test Script**	**Attribute and value**	**Expected Result**	**Result**
1	Verify Operator applies modification (selected part) to uploaded car image	Click on “side mirror” from catalog	The side mirror is overlaid in the correct position on the uploaded image of car	Pass
2	Verify Operator applies multiple parts on uploaded car image	Click on “spoiler” from catalog	All parts overlay correctly and fit the car without conflict	Pass

Functional Testing 11: Manage Inventory
Objective: To ensure that admins can successfully add, update, and delete Items in the inventory.

Already performed in unit testing

Functional Testing 12: Save Modifications
Objective: To ensure that system allows Operators to save their modifications successfully.

Table 6.26: Functional Testing 12 Save Modifications

No.	**Test Case/Test Script**	**Attribute and value**	**Expected Result**	**Result**
1	Verify Operators saves car modification	Click “Save Modification” after applying parts	Customization saved successfully in samples.	Pass

Functional Testing 13: Retrieve Saved Modifications (View Sample)
Objective: To ensure the system retrieve saved modification successfully

Table 6.27: Functional Testing 13 Retrieve Saved Modifications (View Sample)

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Retrieve modified car list (samples)	Operator clicks “View Samples”	List of saved modifications(sample) appears	Pass

Functional Testing 14: User Account Management
Objective: To ensure the system allows users to manage their profiles.

Table 6.28: Functional Testing 14 User Account Management

No.	Test Case/Test Script	Attribute and value	Expected Result	Result
1	Verify user updates their profile.	User changes profile data from setting menu	Changes saved and reflected in the user's profile	Pass
2	Verify user views in their profile	Click "Settings" in dashboard	User profile details are displayed	Pass

6.1.3. Integration Testing

Table 6.29: Integration Testing

No.	Test Case / Test Script	Attribute and value	Expected Result	Result
1	Open website admin signs up and verifies email	Signup → verify email	Account created successfully and email is also verified	Pass
2	Admin access to dashboard	Sign in → View dashboard	Admin dashboard displays with all modules visible	Pass
3	Admin add and manages operators	Sign in as Admin → Add Operator → View Operator List	Operator added, list updates, email sent	Pass
4	Operator login and upload flow	Operator signs in → Upload car image → Preview image	Image appears in preview section	Pass
5	Operator applies modification	Operator uploads image →image classifies as car →SAM detects parts → Applies selected part → Click save modification	Modified image saved with changes in sample	Pass
6	Operator views Samples	Operator applies modifications → Save modification → Click View Samples	Saved modifications list shown correctly	Pass
7	Apply modifications on capture images using camera	Capture image → apply modifications → Save modifications	Captured image processed and saved with modifications	Pass
8	Admin deletes Operator → Operator tries sign in	Admin deletes Operator account → Try sign in as that Operator	Sign in fails with error.	Pass
9	Admin adds → update → delete Inventory → view Inventory	Admin adds items → updates price → deletes item → views list	Inventory reflects all updates accurately	Pass
10	User logs out → Access control	User logs out → Attempts to access dashboard URL	Access denied, redirected to sign in	Pass

11	Operator views Samples → Select Sample → Display Details	Click View Samples → Select samples	Detailed view with image and details shown	Pass
12	Password reset → sign in	User initiates forgot password → receives reset email → signs in with new password	Reset successful, with new credentials	Pass

7. Conclusion and Future Work

7.1. Conclusion

The Robust Car Modification Simulation System (RCMS) using AI is a smart and helpful tool for both car owners and modification shops. It solves a real problem where people cannot imagine how their cars will look after changes like new , spoilers, or paint s. Our system makes this easier by showing realistic previews using artificial intelligence and image processing.

With RCMS, users can upload a picture of their car, select the parts they want to change, and see how the new modifications will look. This makes decision-making easier and reduces the chances of being unhappy with the final results. The system is simple to use, works on regular images, and does not need any special or expensive technology like 3D models or AR.

This project also connects well with many courses from the Software Engineering program, like AI, computer vision, software development, and UX design. It gave us the chance to apply what we learned in real life and build something useful.

In the future, this system can be improved by adding more car parts, a 3D view, and a mobile app for all users. Overall, RCMS is a step forward in the car customization industry, giving users confidence, better choices, and a more satisfying experience.

7.2. Future Work

In the future, we want to make our system even better. Some of the things we plan to add are:

More Car Parts: Right now, not all car parts can be changed. We will work on adding the remaining parts so users can modify the whole car.

Mobile App for Everyone: At this time, only the modification center can use the system. We want to make a mobile app so all users can use it on their phones easily.

3D Car View: We will add a 3D view of the car. This will help users see their modified car in a better way, from all sides.

Better Viewing Options: We plan to improve how users can see and explore the modified car, making it easier and more fun to use.

8. References

- https://yolov8.com/
- https://segment-anything.com/
- https://www.analyticsvidhya.com/blog/2020/02/learn-image-classification-cnn-convolutional-neural-networks-3-datasets/
- https://www.ijstr.org/final-print/nov2019/Image-Segmentation-Using-Convolutional-Neural-Network.pdf
- https://stackoverflow.com/questions/67353650/extract-part-of-a-image-using-opencv
- https://medium.com/@shamimmahbub230/opencv-taste-of-feature-extraction-in-computer-vision-136f15cc45b1
- https://github.com/fatimaaftab1388/RCMS