



Daffodil
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TITLE OF THE PROJECT

Editing image with generative AI

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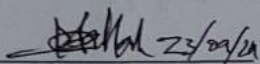
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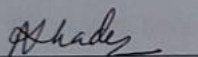
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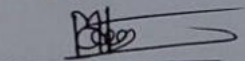
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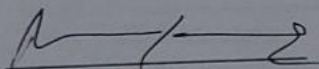
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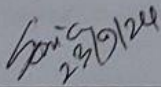
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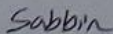
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Dedication

I dedicate this project to my family and my mentor, Ms. Sonia Nasrin. My family's constant support and encouragement have been my greatest strength. I especially want to honour Ms. Sonia Nasrin for her guidance and invaluable advice throughout this project. Her belief in my abilities has been a key factor in the success of this work.

Executive Summary

The "Editing Image with Generative AI" project is about creating a system that makes editing images easier and more powerful using advanced AI technology.

This system allows users to edit images with features like automatic background removal, object recognition, and artistic style transfers. It offers a simple and user-friendly interface that works on computers, tablets, and phones.

The system uses AI to handle tasks such as improving image quality, detecting and removing backgrounds, and recognizing objects in images. It also keeps track of changes made to images and securely stores all user data. The project aims to make image editing more efficient, accessible, and secure.

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Chapter 1-Introduction

1.1 Introduction

In today's fast-changing digital world, technology has improved many areas of life, making tasks quicker and easier. One area that has greatly benefited is image editing, especially with the help of generative AI. Traditionally, editing images took a lot of time and skill. But now, with generative AI, we can edit and enhance images more quickly and accurately.

Generative AI is a technology that uses deep learning to create new content and make smart edits to images. It can handle tasks like removing objects, changing backgrounds, and applying different styles, all with less manual work. This makes the editing process faster and produces high-quality results.

However, using generative AI in image editing also brings challenges. One big issue is making sure the technology is used responsibly because it can be misused to create fake or misleading images. Additionally, high-quality results depend on advanced algorithms and powerful computing, which are not always available to everyone.

With these challenges in mind, creating an AI-Enhanced Image Editor is important. This system will simplify the image editing process, making it accessible for users of all skill levels. The project will combine front-end tools like JavaScript, HTML, and CSS with back-end technologies such as Flask, Stable Diffusion, and the Segment Everything Model to build a complete web application. This application will automate many image editing tasks and improve overall efficiency.

By making editing easier and faster, the AI-Enhanced Image Editor will save users time and effort. It will also provide advanced editing features that were difficult to achieve with traditional methods. To ensure responsible use, the system will include guidelines to prevent misuse. Ultimately, this project aims to make image editing simple and useful for everyone, from professionals to casual users.

Chapter 2 – Initial Study

In this chapter, we lay the groundwork for understanding the project by exploring the foundational aspects and preliminary research. The focus is on providing an overview of the problem domain, the relevant technologies, and the preliminary design considerations.

2.1 Problem Domain Overview

The primary objective of this project is to develop an Image Processing System that enables users to upload images and apply various processing techniques, including manual and automatic segmentation, bounding box-based segmentation, and image generation using diffusion models. This system is designed to facilitate advanced image manipulation tasks and improve the efficiency of image analysis workflows.

2.2 Technologies and Tools

To achieve the project's goals, several technologies and tools are employed:

Flask: A web framework used to build the web application that handles user interactions and processes.

Python Libraries:

PIL (Pillow): For image processing tasks, including image encoding and decoding.

OpenCV: For image manipulation, including anti-aliasing and edge detection.

PyTorch: For utilizing machine learning models, particularly in segmentation and diffusion tasks.

Diffusers: For generating images using diffusion models.

Segment Anything Model (SAM): Used for segmentation tasks, including bounding box and automatic segmentation.

Stable Diffusion: A model used for generating new images based on user-provided prompts.

2.3 System Requirements and Objectives

The Image Processing System aims to achieve the following objectives:

Image Upload: Allow users to submit images for processing to the system.

Segmentation:

Manual Segmentation: Enable users to define bounding boxes and perform segmentation.

Automatic Segmentation: Automatically segment images using predefined models and techniques.

Image Generation: Create new images by utilising pre-existing images and user prompts.

Image Saving: Save processed or generated images for user download.

2.4 Preliminary Design Considerations

The system's design takes into account several important factors:

User Interface: The interface must be intuitive and easy to navigate, providing clear options for image upload, segmentation, and generation tasks.

Performance: Efficient handling of image processing tasks to ensure quick response times and smooth user experience.

Scalability: The system should be designed to handle varying workloads and potential future enhancements.

Integration: Seamless integration of various image processing libraries and models to provide a cohesive user experience.

2.5 Problem Areas

Despite significant progress, there are still a number of important problems in the field of image editing that limit the effectiveness and accessibility of editing tools. Among these issues are:

Complexity of Traditional Tools: Conventional image editing programmes, such as Adobe Photoshop or GIMP, have many features, but their proper use necessitates a high level of skill and training. This complexity makes these tools inaccessible to casual users and small businesses that may not have the resources to hire professional editors.

High Cost: Professional image editing software often comes with a high price tag, making it unaffordable for many individuals and small enterprises. These software's subscription-based business models increase the continuous cost burden.

Time-Consuming Process: Manual editing procedures can take a long time, particularly when repeated and intricate changes are needed. Workflows may be greatly slowed down as a result, and productivity may suffer.

Limited Integration of AI Features: Although there are tools with AI capabilities, most of them concentrate on particular tasks like colour correction or background removal. A full editing process requires the use of multiple tools due to the lack of comprehensive solutions that combine multiple AI functionalities into a single platform.

Hardware Dependency: In order for many sophisticated image editing programmes to run smoothly, powerful hardware is needed. Because of this dependency, users with standard or lower-end devices are not allowed access, and only those with high-end computers are allowed.

Problems with Scalability: Many platforms have trouble growing as their user bases increase, which results in decreased functionality and slower performance. It is essential to make sure a tool can accommodate a lot of users without sacrificing speed or effectiveness.

2.6 Possible Solutions

Generative AI image editing presents a number of challenges, which can be met by putting creative solutions in place to improve productivity, user experience, and accessibility. The following are possible fixes specifically designed for the "Editing Image with Generative AI" project:

User-Friendly Interface with AI Support: Provide an easy-to-use interface that incorporates support from artificial intelligence. This includes interactive tutorials to walk users through the editing process, context-aware tool recommendations, and automated image enhancement suggestions. The system can anticipate user needs and simplify challenging editing tasks by utilising generative AI.

Time-Efficient AI-Enhanced Editing: Implement AI algorithms that accelerate editing workflows. This includes the ability to process images in real time for purposes like object recognition, style transfer, and content-aware fill. The system reduces the amount of time needed for intricate editing operations by automating repetitive tasks and offering instant previews of editing effects.

Consistent and Reliable AI Performance: Continuously refine AI algorithms to deliver consistent and reliable editing results across different image types and editing scenarios. Use user feedback loops and quality control procedures to address any discrepancies and gradually increase the accuracy of your AI model.

Real-Time Collaborative Editing Tools: Provide real-time collaborative tools that let several people edit the same picture at once. Version control, synchronised editing sessions, and instant messaging are all included in this. These features promote cooperation among editors, boost output, and efficiently assist joint projects.

We've identified key challenges with traditional image editing tools, such as

their complexity, high cost, and time-consuming nature. To address these, we propose solutions like user-friendly AI interfaces, efficient editing algorithms, and real-time collaboration features. This sets the foundation for improving the system's efficiency and accessibility, paving the way for further development.

Chapter 3 – Literature Review

This chapter provides a comprehensive review of existing literature on image processing technologies and methodologies. The review covers historical developments, key theories, recent advancements, and relevant technologies to establish a solid foundation for the Image Processing System project.

3.1 Historical Background Image processing technology has evolved significantly over the decades. Initially, image processing focused on basic operations such as filtering and enhancement. Early research by Gonzalez and Woods in their seminal book "Digital Image Processing" (2002) laid the groundwork for understanding fundamental techniques (Gonzalez, R. C., & Woods, R. E., 2002). The field saw major advancements with the introduction of more sophisticated algorithms and the integration of machine learning techniques.

3.2 Key Theories and Models Several theories and models are crucial in image processing:

Classical Image Processing Models: Gonzalez and Woods' 2002 book "Digital Image Processing" included details on methods like edge detection and filtering.

These models provide the basis for many current image manipulation techniques.

Machine Learning Models: The advent of deep learning introduced powerful tools for image analysis. LeCun et al.'s work on Convolutional Neural Networks (CNNs) has been pivotal in advancing object recognition and segmentation (LeCun, Y., Bengio, Y., & Hinton, G., 2015).

Generative Models: Diffusion models and Generative Adversarial Networks (GANs) are two recent innovations. The work by Goodfellow et al. on GANs and the improvements in diffusion models for image generation have expanded the possibilities for creating and manipulating images (Goodfellow, I. et al., 2014; Ho, J. et al., 2020).

3.3 Current Research and Trends Recent research has focused on:

Python Libraries: Libraries such as OpenCV and PIL are essential for image manipulation. The official documentation for OpenCV (opencv.org) provides extensive resources and examples.

Machine Learning Frameworks: PyTorch and TensorFlow are widely used for implementing deep learning models. The TensorFlow documentation ([tensorflow.org](https://www.tensorflow.org)) and PyTorch tutorials (pytorch.org) offer guidance on using these frameworks.

Image Generation Models: Tools like Diffusers and Stable Diffusion are explored in the research by Ramesh et al. (2022) on diffusion models for image generation (Ramesh, A. et al., 2022).

3.4 Obstacles and Deficits Despite advancements, problems still exist:

Complexity of Use: Traditional tools, such as Adobe Photoshop, have complex interfaces that require significant training (Adobe, 2024). For rare users, this complexity may be a barrier.

Cost and Accessibility: Professional image editing software often comes with high costs. Research by Zeng et al. The financial burden on individuals and small businesses is highlighted in (2023) by Zeng, X. et al.

Performance Issues: Scalability concerns and performance issues with large datasets are discussed in "Scalable Image Processing" by Liu et al. (2021) (Liu, Y. et al., 2021).

The literature review reveals substantial advancements in image processing technologies, from basic filtering techniques to sophisticated machine learning models. By understanding these developments and identifying current challenges, this review informs the design and implementation of the Image Processing System, ensuring it addresses existing issues and utilizes cutting-edge technologies.

Chapter 4 – Methodology

4.1 Introduction This chapter explains how i developed the Image Processing System. It covers the overall approach, including how i planned the project, collected data, built the system, and evaluated its performance. To be honest about how we executed the project to meet its objectives is the aim.

4.2 Research Design We used a systematic approach for our project:

Literature Review: We looked at existing research and technologies related to image processing and generative AI to guide our development.

Project Planning: We set goals, milestones, and timelines to keep the project on track.

System Development: We built and tested the Image Processing System using various technologies and methods.

4.3 Data Collection and Sources To build and test the system, we used:

Image Datasets: We used publicly available datasets like COCO and ImageNet for training and testing.

User Feedback: We gathered feedback from users through surveys and testing sessions to improve the system's features and interface.

4.4 Architecture of the System The system is efficient and modular in design. It includes:

Frontend: Created with HTML, CSS, and JavaScript to offer an easy-to-use interface.

Backend: Built with Flask to handle server operations like image uploads, processing requests, and interacting with machine learning models.

Image Processing Modules:

Manual Segmentation: Lets users create bounding boxes and segment images manually.

Automatic Segmentation: Uses pre-trained models like Segment Anything Model (SAM) for automatic image segmentation.

Image Generation: Uses diffusion models to generate new images based on user inputs.

4.5 Technologies and Tools We used the following technologies and tools:

Flask: For building the web application's backend and managing user interactions.

Python Libraries:

PIL (Pillow): For basic image manipulation tasks.

For sophisticated image processing, such as edge detection, use OpenCV.

PyTorch: For implementing machine learning models used in segmentation and image generation.

Diffusers: For generating images with diffusion models.

Machine Learning Models:

Segment Anywhere Model (SAM): For segmenting images automatically.

For creating pictures from text descriptions, use stable diffusion.

4.6 Development Process We followed these steps to develop the system:

Requirements Analysis: We identified what the system needed and what users required through research and surveys.

Design and Prototyping: We created design prototypes for the user interface and system architecture.

Implementation: We coded and integrated the system components using the chosen technologies and tools.

Testing and Validation: We tested the system to ensure it worked well, including checking functionality, performance, and user experience. User acceptability testing, integration testing, and unit testing were all involved in this.

4.8 Ethical Considerations We considered the following ethical issues:

Data Privacy: Ensuring that user data is protected and stored securely.

Ensuring that machine learning models are impartial and devoid of prejudice.

4.9 Summary This chapter outlines how we developed the Image Processing System, including our research design, data collection methods, system architecture, and evaluation techniques. By following this approach, we aim to create a powerful and user-friendly image processing tool using the latest technologies.

Chapter 5 – Planning

5.1 Introduction

This chapter covers the planning stage of the Image Processing System project. It explains how we will manage the project, set goals, schedule tasks, allocate resources, and handle risks. Good planning is key to completing the project successfully and on time.

5.2 Project Objectives

The main goals of the project are:

Create a Functional System: Build a tool for uploading, segmenting, and generating images.

Improve User Experience: Make the system easy to use.

Ensure Good Performance: Make sure the system processes images quickly and accurately.

Add Advanced Features: Use modern technologies like machine learning for automatic image processing and generation.

5.3 Project Milestones

The project is broken down into important stages to track progress and stay on schedule:

Milestone 1: Research and Planning (Weeks 1-2)

Review existing research.

Define project goals and scope.

Create a project plan and timeline.

Milestone 2: System Design (Weeks 3-4)

Design the system's architecture and user interface.

Finalize the design with input from stakeholders.

Milestone 3: Development Phase (Weeks 5-8)

Build and integrate the system's components.

Develop and test the image processing features.

Milestone 4: Testing and Validation (Weeks 9-10)

Test the system thoroughly.

Collect and act on user feedback.

Milestone 5: Deployment and Review (Weeks 11-12)

Launch the system.

Review the project and prepare documentation.

5.4 Resource Allocation

All resources are assigned and managed to ensure the project progresses in an organized manner. Resource allocation is crucial in project planning. Since this is an academic project and there is no team, I will fulfill different roles at different times. The resource allocation plan for the BBSM project is shown below in order to fulfil the task deadlines:

Task	Duration	Team Members
1 Introduction	5 days	Analyst, User
2 Initial Study	5 days	Analyst
3 Literature Review	4 days	Analyst
4 Methodology	5 days	Analyst, User
5 Planning	5 days	Analyst, Team Leader
6 Feasibility Study	4 days	Analyst, User
7 Foundation	3 days	Analyst, Designer, Developer
8 Exploration & Engineering	16 days	Analyst, Designer, Developer
9 Deployment	12 days	Designer, Developer
10 Testing	3 days	Developer, Tester, User
11 Implementation	2 days	Analyst, Developer, User
12 Critical Appraisal & Evaluation	1 day	Analyst
13 Lessons Learned	1 day	Analyst, Designer, Developer, Tester
14 Conclusion	1 day	Analyst

Table 1task management

5.5 Time Boxing

In DSDM, tasks are divided into time boxes to ensure that project goals are met before the deadline. This is an essential component of project planning for DSDM. During this phase, all tasks are segmented into specific time frames called time boxes. The iterative approach requires completing these tasks within each designated period.

Timebox	Task	Resource
TB1	Introduction	Analyst, User
TB1	Initial Study	Analyst
TB1	Literature Review	Analyst
TB2	Methodology	Analyst, User
TB2	Planning	Analyst, Team Leader
TB2	Feasibility	Analyst, User
TB3	Foundation	Analyst, Designer, Developer
TB4	Exploration & Engineering	Analyst, Designer, Developer
TB5	Deployment	Designer, Developer
TB5	Testing	Developer, Tester, User
TB6	Implementation	Analyst, Developer, User
TB7	Critical Appraisal & Evaluation	Analyst
TB7	Lessons Learned	Analyst, Designer, Developer, Tester
	Conclusion	Analyst

Table 2 Time box estimation

5.6 Gantt Chart

Gantt Chart is the graphical representation of the project activity schedule.

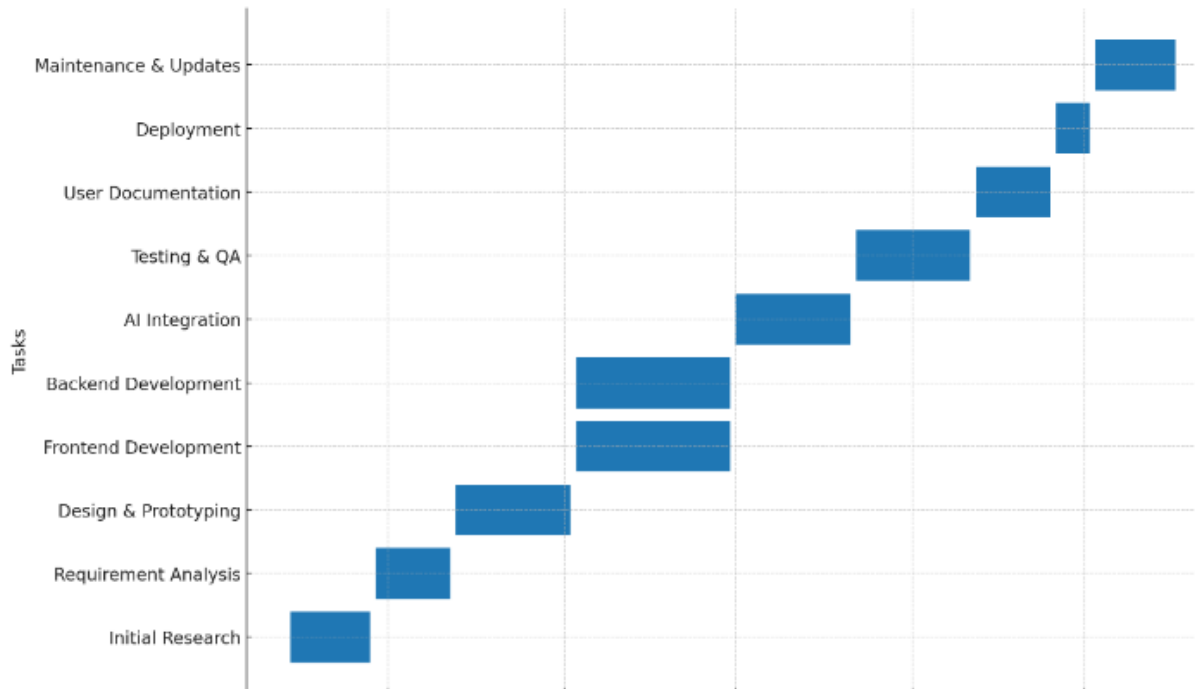


Figure 1 Gantt Chart of the Proposed Timebox Estimation

5.7 Test Plan The test plan describes our approach for confirming that the system satisfies its requirements. Testing will ensure that the system functions correctly and meets user needs. This includes:

- Testing Against Time Boxes: Checking progress within the allocated time frames.
- Required Tests:
- Functional Testing:
- Unit Testing: Verifying small parts of the software.
- Acceptance Testing: Confirming the system meets user expectations.
- Non-Functional Testing:
- Security Testing: Checking for vulnerabilities.
- Integration testing: Verifying the compatibility of various components.
- System testing: Verifying every aspect of the system across various platforms.

- Testing for usability: Making sure the system is easy to use.
- Testing system consistency and performance is known as reliability testing.

5.8 Risk Management To keep the project on schedule, risk management entails recognising, evaluating, and planning for potential problems. Key steps include:

Risk Identification: Finding and documenting potential risks.

Risk Assessment: Evaluating the seriousness of risks.

Risk Action Plan: Developing plans to prevent or handle risks.

Steps Taken: Implementing measures to address risks.

5.9 Factors that Might Cause Change

Changes in Scheduling: Adjusting timelines due to unexpected events or feedback.

Changes in Functional Requirements: Modifying features based on user feedback or new technologies.

Changes to User Interface Modules: Updating the interface for better usability.

Changes in Security Management: Enhancing security measures as needed.

5.10 Embracing Change with DSDM The DSDM (Dynamic Systems Development Method) approach helps manage changes effectively. It includes:

Tracking System Updates: Managing and tracking updates clearly.

User Feedback: Incorporating feedback throughout the change process.

Evaluation After Changes: Reviewing the impact of changes on system performance.

Focus on Security: Ensuring security is maintained or improved with changes.

Reliability and Growth: Making changes to enhance system reliability and scalability.

5.11 Change Workshop The Change Workshop helps manage and implement changes:

Define the Change: Identify and describe necessary changes.

Engage Stakeholders: Include team and stakeholder perspectives.

Implement User Feedback: Use feedback to improve the system.

5.12 Changes That Are Allowed Decisions on which changes to accept are based on priority, resources, cost, schedule, quality, and risk.

5.13 Key Decision Makers for Changes Decisions will be made by:

Requirements Analyst: Adjust system requirements.

Developer: Modify code as needed.

Tester: Ensure changes work correctly.

5.14 Quality Management Maintaining quality involves:

Setting Goals: Improving user experience, security, and performance.

Quality Control: Regularly reviewing processes and applying lessons learned.

Managing Changes: Carefully assessing the impact of changes on quality.

Testing Strategy: Conducting thorough testing at various stages.

Documentation: Keeping detailed records of quality activities.

5.15 Continuous Improvement Gather user feedback and make updates to better meet their needs. Implement ongoing improvements based on feedback and past experiences.

By following these planning guidelines, the project aims to ensure a successful development and deployment of the Image Processing System.

Chapter 6 – Feasibility

This chapter looks at how possible it is to make the Image Processing System project work by checking four main areas: how easy it is to use, if the technology works, if it's affordable, and if there's a market for it. This analysis helps us figure out if the project can be done successfully, if it meets user needs, and if it's a good investment. By looking at these areas, we want to make sure the project is practical, works well, is affordable, and has a good chance in the market.

6.1 All Possible Types of Feasibility

Feasibility analysis for this project examines multiple aspects to ensure its success. The key areas of feasibility include operational, technical, economic, and market feasibility, all of which are essential for creating a robust and efficient system for image processing and generative AI.

Operational Feasibility

Description: Ensures that the image processing system is user-friendly and functions as expected.

Validation and Verification: Implement strong validation checks to ensure accurate input and reliable outputs, ensuring users' requests for image uploads, segmentation, and processing are handled correctly.

User Interface: Design a simple, easy-to-navigate interface so users can upload images, segment them, and generate outputs seamlessly without any complexity.

Feature Accessibility: Ensure that users can easily locate and use features like AI-based segmentation and image generation, enhancing the user experience.

User Requests: Implement an easy request mechanism for users to provide feedback or request enhancements to the image processing features.

Technical Feasibility

Description: Evaluates whether the technical resources are sufficient for developing and deploying the AI-powered image processing system.

AI Algorithm Integration: Assess if the available technology supports the integration of machine learning models for tasks like automatic image segmentation and generation.

Backend Infrastructure: Verify that the backend infrastructure, including servers and databases, can handle high volumes of image uploads, AI processing, and real-time interaction with users.

Performance Requirements: Ensure that both hardware and software can efficiently process large datasets and generate images in a timely manner.

Economic Feasibility

Description: Analyzes the financial aspect, determining the project's costs and potential returns.

Cost-Benefit Analysis: Estimate the costs involved in developing the image processing system, including technology, development time, and future maintenance, and weigh them against the expected benefits, such as ease of use, improved user satisfaction, and future scalability.

Revenue Generation: Explore monetization options like offering premium features for advanced image processing and AI-based image generation to increase project viability.

Market Feasibility

Description: Assesses market demand and competition to ensure that the image processing system is needed and has the potential for success.

Target Audience Analysis: Analyze potential users such as graphic designers, photographers, and digital artists, focusing on their needs for easy-to-use, AI-enhanced image editing tools.

Competitive Landscape: Evaluate competing image processing systems and highlight how your system's unique AI capabilities, such as automated segmentation and image generation, differentiate it from existing solutions.

Market Trends: Stay updated with current trends in AI and image processing to identify opportunities for innovation and keep the system competitive.

6.2 Suitability of DSDM

For this project, which has a tight timeline and may require adjustments during development, DSDM (Dynamic Systems Development Method) is an appropriate choice. Its iterative approach allows for flexible development while maintaining strict time management and quality control. DSDM's emphasis on regular user feedback ensures the system evolves according to user needs, making it a suitable methodology for the Image Processing System project.

The feasibility analysis shows that the Image Processing System is practical and achievable in all key areas: ease of use, technology, cost, and market demand. The system is user-friendly, technically sound, and has the right infrastructure and AI technology. It's also expected to be cost-effective and has potential for making money. The market shows strong demand and opportunities to stand out. Using DSDM as our method helps us adapt to changes and successfully deliver the image processing tool.

Chapter 7 – Exploration

This chapter focuses on understanding user pain points, evaluating current tools, and proposing effective solutions to enhance the system. By thoroughly exploring these aspects, we aim to ensure the development of a robust, user-friendly, and efficient image editing application.

7.1 Identifying Problem Areas

Identifying problems is essential for enhancing any project. Users are crucial in pinpointing these issues. Below are some areas identified as problematic:

7.1.1 User Interviews

For Casual Users:

What problems do you face with traditional image editing tools?

How comfortable are you with advanced features like AI-powered enhancements?

What features would be most useful in an AI-powered image editing app?

For Professional Users:

Which parts of your current editing process are the most time-consuming?

How do you handle complex tasks like background removal or object recognition?

What improvements would you like in AI integration and functionality?

7.1.2 Observations

Key Observations:

Watch how users interact with current image editing tools.

Observe the process of handling complex editing tasks.

Measure user satisfaction and identify where they struggle.

Evaluate users' opinions on existing AI tools and their effectiveness.

7.1.3 Questionnaires

General Users:

How often do you edit images for work or personal use?

What are the main issues you face with manual image editing?

How important is ease of use in an image editing app?

Professional Users:

How much of an impact do automation and AI have on your editing process?

What AI features would simplify your editing tasks?

What level of control over AI tools for image editing are you looking for?

7.2 Specific Problem Area Identification

Complexity of Traditional Editing Tools:

Problem: Traditional tools require technical expertise, making them difficult for casual users.

Impact: Users find it hard to learn complex techniques and workflows.

Time-Consuming Editing Processes:

Problem: Manual tasks like background removal are labor-intensive and slow.

Impact: Slows down editing and decreases productivity.

Limited Integration with AI Technologies:

Problem: Existing tools may not fully utilize AI for advanced features.

Impact: Misses out on efficient and innovative editing possibilities.

Security Concerns with User Data:

Problem: Handling sensitive user data raises privacy risks.

Impact: Affects user trust and compliance with data protection regulations.

7.3 Possible Solutions

Development of User-Friendly Interface:

Solution: Design an intuitive interface to simplify complex editing tasks for users of all skill levels.

Integration of AI-Powered Tools:

Solution: Use advanced AI algorithms like Stable Diffusion and Segment Anything Model to automate and enhance editing features.

Enhanced Security Measures:

Solution: To protect user data, put strong security measures in place, such as data encryption and frequent audits.

Cross-Platform Compatibility:

Solution: Ensure the app functions well on desktops, tablets, and mobile devices for a consistent user experience.

7.4 Overall Requirement List

Functional Requirements:

User Interface: Design a straightforward, user-friendly interface.

AI-Powered Editing Tools: Implement AI algorithms for tasks like image enhancement, background removal, and style transfer.

Cross-Platform Accessibility: Ensure compatibility across various devices.

Integration with AI Models: Use Stable Diffusion and Segment Anything Model to enhance features.

Data Management: Securely manage user data and editing history.

Customization Features: Provide tools for personalized editing styles and effects.

Non-Functional Requirements:

Performance: Ensure fast processing for large images and complex tasks.

Security: Implement encryption and secure login methods; regularly review security.

Backup and Recovery: Make sure you have a regular data backup strategy in place.

Scalability: Design for handling increased user load and data volume.

Usability: Test to ensure ease of use for all users.

Compliance: Follow data protection laws and regulations.

7.5 Technology to be Implemented

Client-Server Application Technology:

Description: Requires installation on user devices with data managed by a remote server.

Features:

Installation Needed: requires app installation from the user.

Server Maintenance: Involves maintaining both server and client applications.

Cost: Higher due to potential app purchase.

Accessibility: Less accessible compared to web apps.

Web Application:

Description: Operates via web browsers, eliminating the need for local installation.

Features:

No Installation Needed: Users access the app through a browser.

Cloud Accessibility: Works from any device with internet access.

Cost: Typically lower due to reduced hardware and software needs.

Accessibility: Simple to reach from any internet-connected device.

Finally, we outlined both functional and non-functional requirements for the project, and compared client-server and web application technologies to determine the most suitable approach for our system. This exploration aims to guide the project's development, addressing user needs and ensuring a high-quality, effective image editing tool.

Chapter 8 – Exploration

In this chapter, we look into the Exploration phase of the project, where we explore important processes and functions. Diagrams are used to show the configuration and operation of the system. This gives us a clear picture of how the system behaves. By breaking down each part, we can better understand the project's overall structure and its key features.

8.1 Technical Breakdown

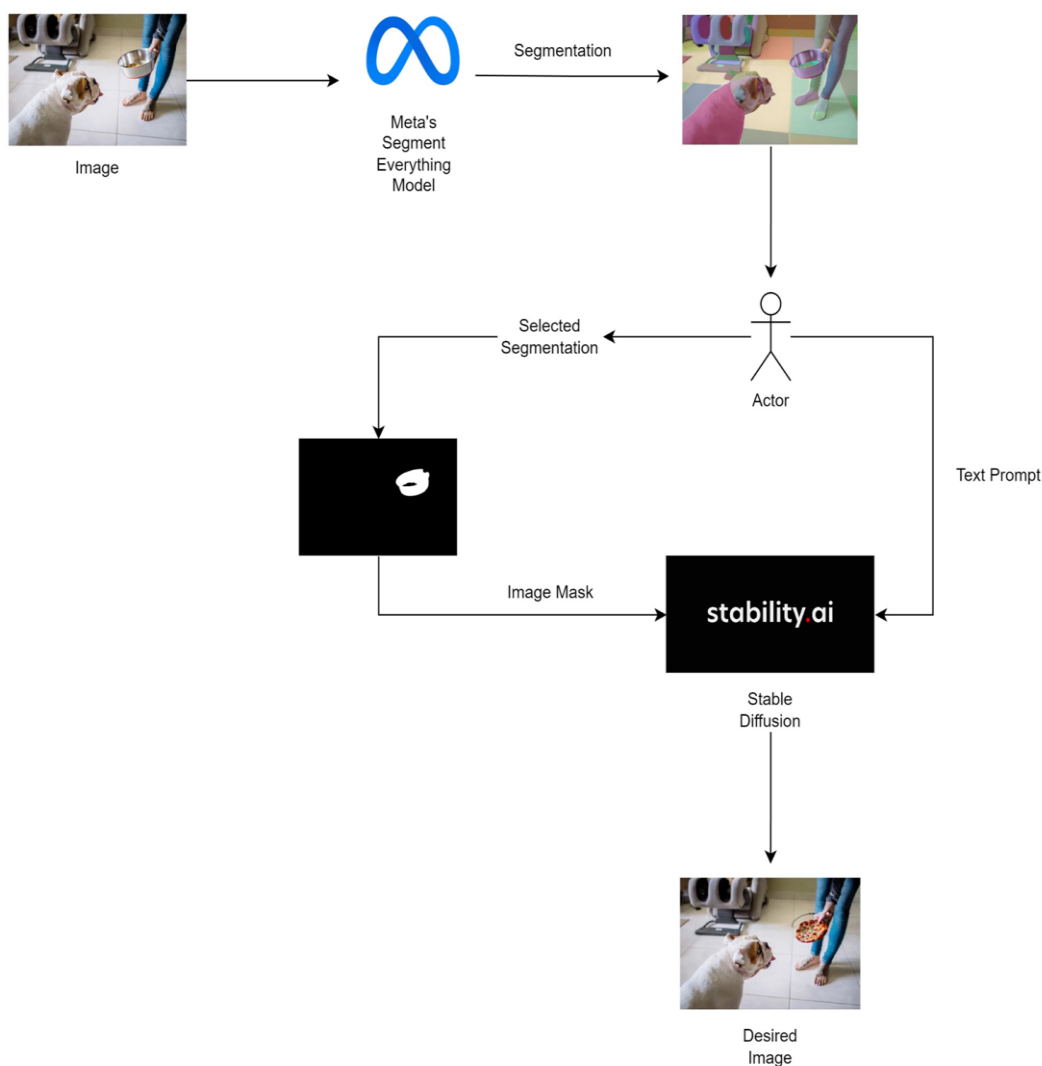


Figure 2 system Technical Breakdown

Workflow:

- Using SAM, the user chooses an object in the picture.
- User inputs prompt for replacement.

- Inpainting algorithm (Stable Diffusion) replaces the selected object with the prompt.
- User reviews and finalizes the edited image.

8.2 Use Case

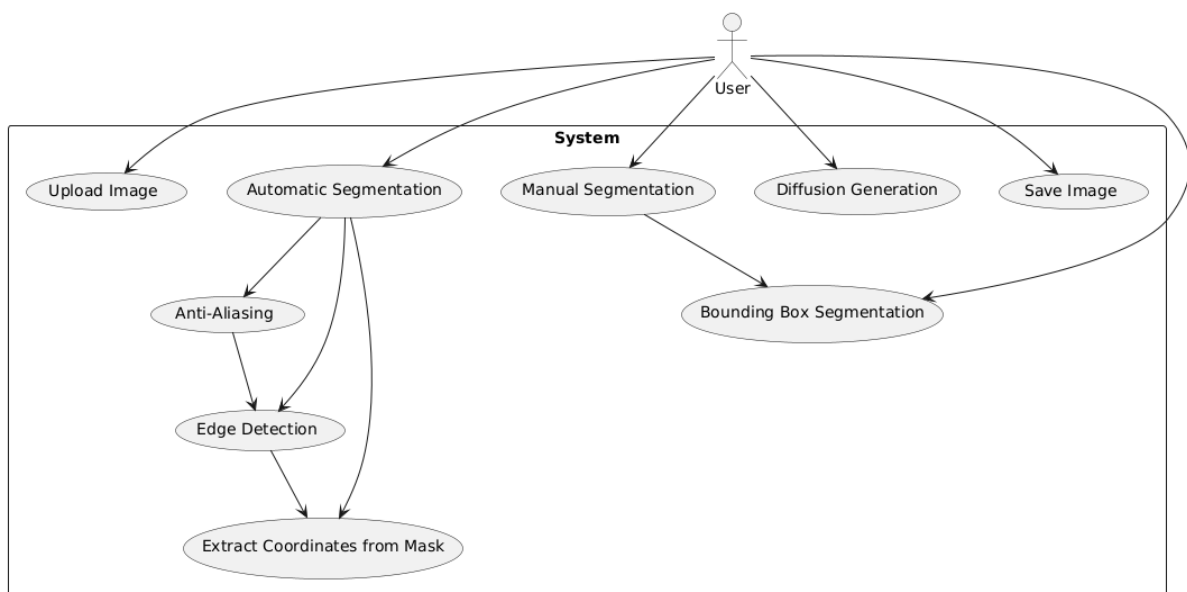


Figure 3 use case diagram

Workflow:

- Upload Image – The user uploads an image to the system.
- Manual Segmentation – The user manually creates segmentation on the uploaded image.
- Automatic Segmentation – The system automatically segments the image using the SAM pipeline.
- Bounding Box Segmentation – The user specifies a bounding box for the segmentation, and the system processes it.
- Diffusion Generation – The user provides a text prompt, and the system generates content based on the uploaded image and mask using Stable Diffusion.

- Save Image – The system saves the generated or segmented image.
- Anti-Aliasing – The system smoothens the edges of the segmentation mask (optional but included).
- Edge Detection – The system detects and annotates edges of the segmentation.
- Extract Coordinates from Mask – The system extracts and returns coordinates from a given mask.

8.3 class diagram

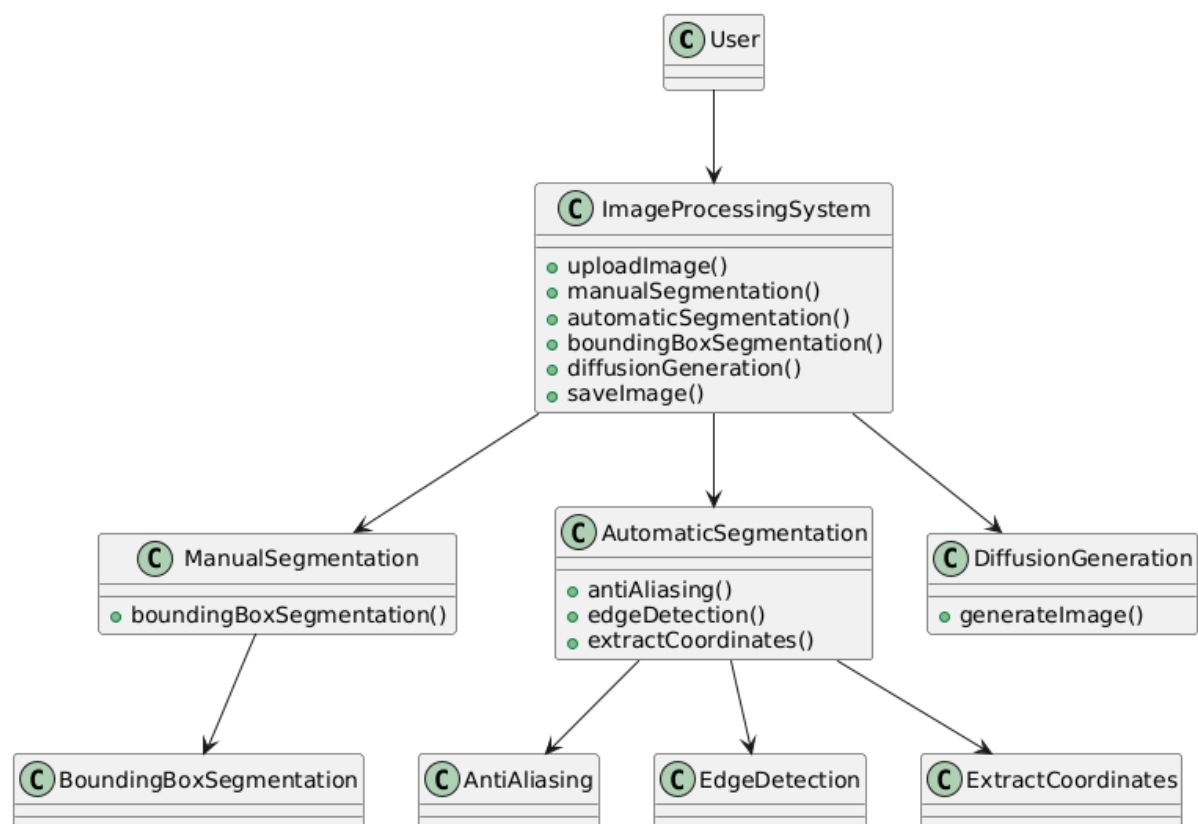


Figure 4 class diagram

Workflow Description

- Upload Image: The user starts by uploading an image into the Image Processing System.
- Bounding Box Segmentation: If the user opts for manual segmentation, they specify a bounding box which is then processed by the Manual Segmentation class to perform the segmentation.

- Anti-Aliasing: For automatic segmentation, the system applies anti-aliasing to the segmented masks to smoothen edges.
- Edge Detection: It then detects edges in the segmented masks.
- Extract Coordinates: Finally, the system extracts coordinates from the segmented masks for further processing.
- Generate Image: If the user chooses to generate an image using a diffusion model, the Diffusion Generation class handles the process based on user input.
- Save Image: After processing, the final image is saved by the Image Processing System.

8.4 Full system use case

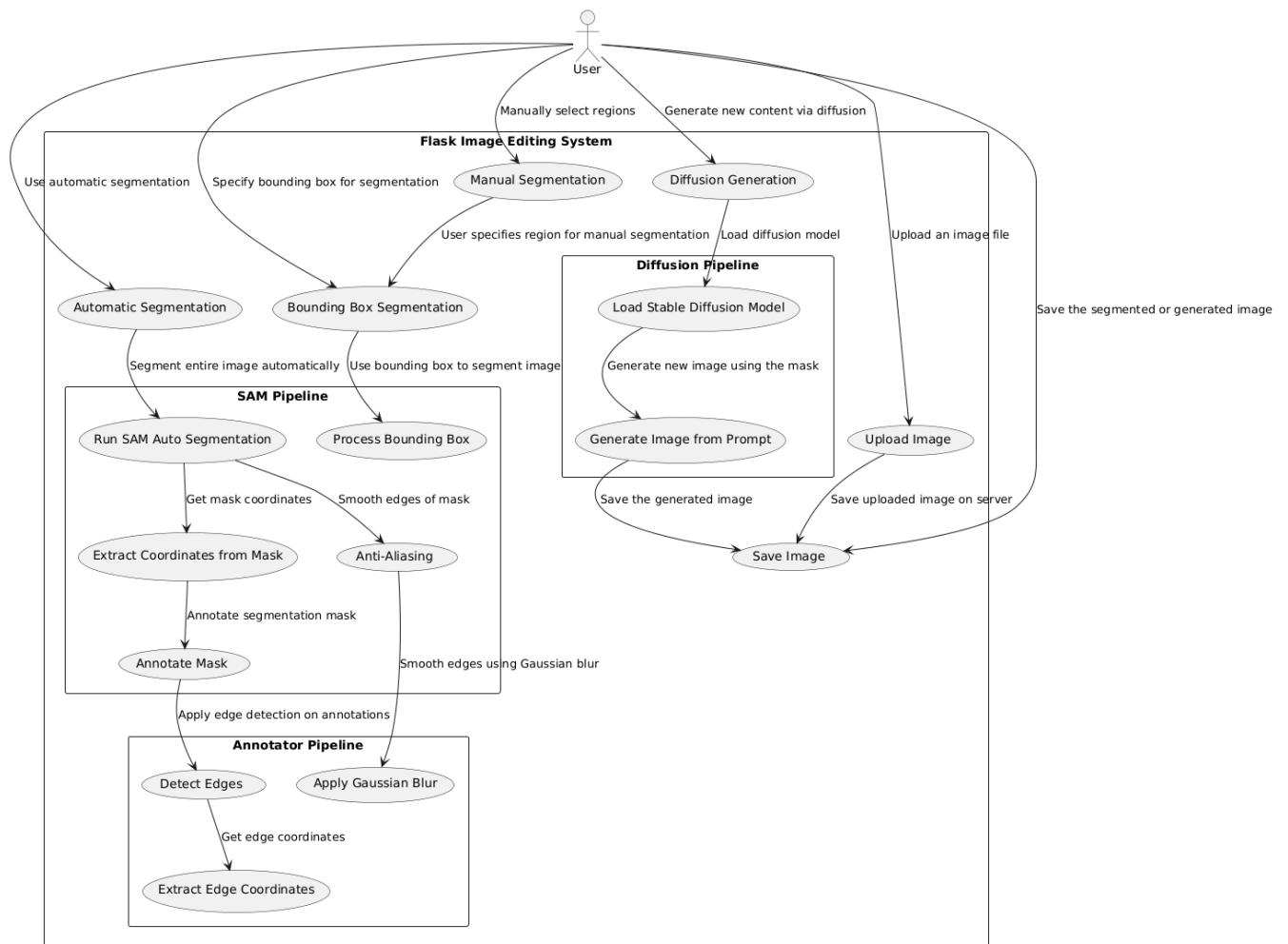


Figure 5 class diagram

Breakdown of the Elements:

- **Actors:**
 - User (U): depicts how a user would interact with the system.
- **Main Use Cases:**
 - Upload Image: The person uploads a picture.
 - Manual Segmentation: For segmentation, the user chooses areas of the image by hand.
 - Bounding Box Segmentation: The user specifies a bounding box for image segmentation.

- Automatic Segmentation: The system automatically segments the uploaded image using the SAM pipeline.
- Diffusion Generation: The user provides a prompt, and the system generates new content using diffusion.
- Save Image: The system saves the image after processing (segmentation or generation).
- SAM Pipeline:
 - Process Bounding Box: Segments the image based on user-specified bounding box coordinates.
 - Run SAM Auto Segmentation: Automatically segments the entire image.
 - Extract Coordinates from Mask: Extracts coordinates of the segmented mask.
 - Annotate Mask: Enhances the segmented mask with annotations.
 - Anti-Aliasing: Smooths the edges of the segmented mask for better quality.
- Diffusion Pipeline:
 - Load Stable Diffusion Model: Loads the diffusion model for generating content.
 - Generate Image from Prompt: Uses the image and mask along with the user's prompt to generate content.
 - Save Image: stores the created image on the computer.
- Annotator Pipeline:
 - Apply Gaussian Blur: Applies Gaussian blur to smooth the edges of the mask.
 - Detect Edges: finds the annotated mask's edges.
 - Extract Edge Coordinates: retrieves the detected edges' coordinates.
- Relationships:
 - The diagram demonstrates the flow between the main user actions and internal processes (SAM pipeline, Diffusion pipeline, and Annotator pipeline).
 - Actions like automatic segmentation link to sub-processes, such as extracting coordinates and applying anti-aliasing.

8.5 Activity Diagram

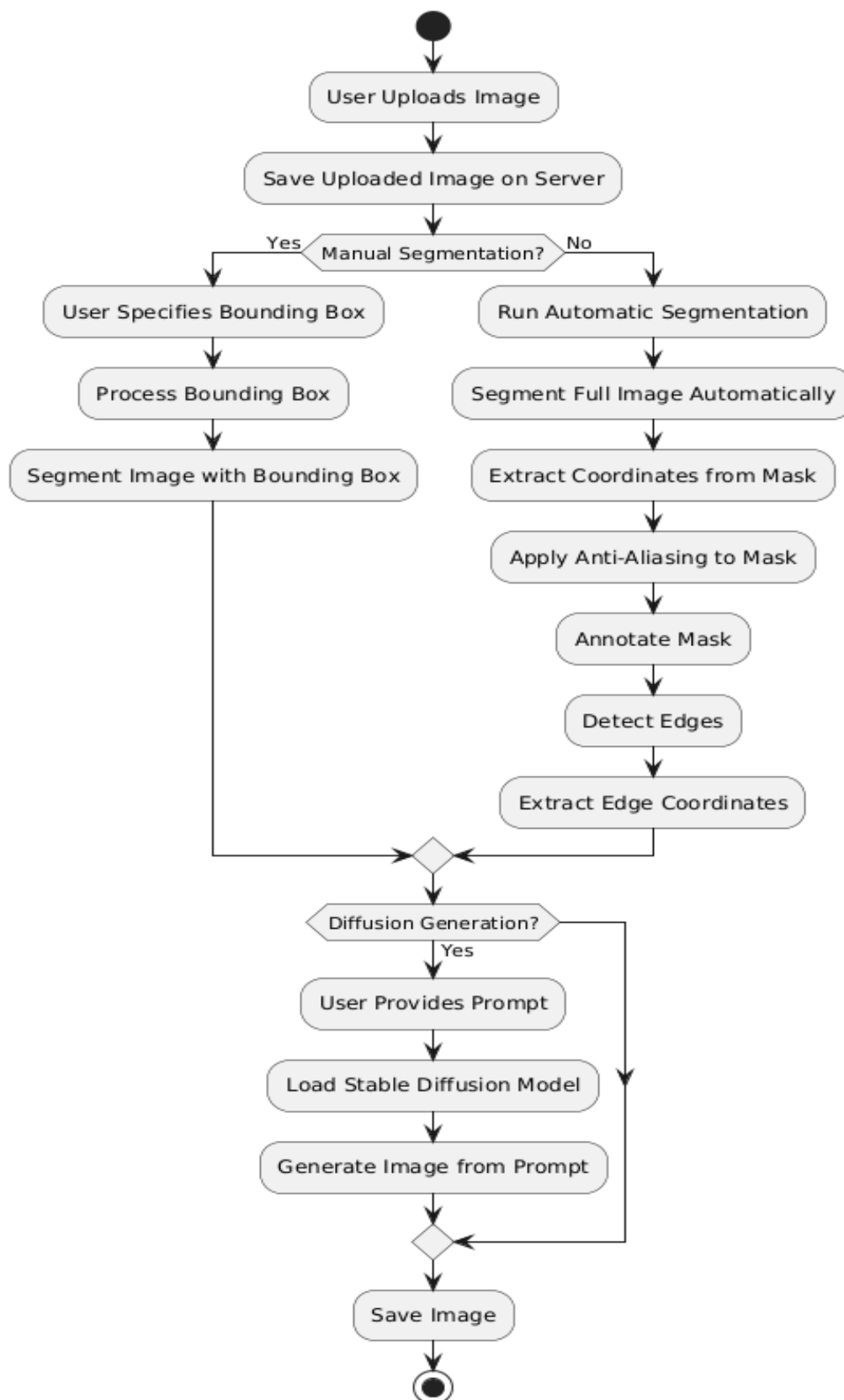


Figure 6 class diagram

Explanation of the Activity Diagram:

- Start: The procedure is initiated by the user uploading an image.
- User Uploads Image: The user uploads an image, and the system saves the image on the server.
- Manual Segmentation Decision: A decision point checks whether the user opts for manual segmentation.
- If Yes:
 - The user specifies a bounding box.
 - The system processes the bounding box and segments the image based on the specified region.
- If No:
 - The system runs automatic segmentation.
 - The coordinates are then taken out of the mask.
 - Anti-aliasing is applied to the mask to create smoother edges.
 - The system annotates the mask and detects the edges, extracting the coordinates of the detected edges.
- Diffusion Generation Decision: Another decision point checks if the user has provided a prompt for diffusion generation.
- If Yes:
 - The system loads the stable diffusion model.
 - The new image is generated based on the prompt, the uploaded image, and the mask.
- Save Image: The system saves the segmented or generated image, and the process ends.
- This activity diagram captures the key interactions and processes, including branching points for manual vs. automatic segmentation and whether diffusion generation is used.

Chapter 9-Requirements

This list groups the functional(what the system does) and non-functional(how the system works) needs predicated on how important they are, making sure the most important features are made first.

High- Priority Requirements

These are the most important requirements that must be done for the design to succeed. Without these, the system won't work for users or the business.

9.1 Requirement Catalogue

9.2 Functional Requirements

ID	Requirement Description	Priority	Type
FR-01	The system shall provide a simple, intuitive, and user-friendly interface for image editing.	High	User Interface
FR-02	The system shall enable real-time feedback for editing actions performed by users.	High	User Experience
FR-03	The system shall allow automatic background removal using AI algorithms.	High	AI Feature
FR-04	The system shall enable object recognition within images using AI, based on the Segment Everything Model.	High	AI Feature
FR-05	The system shall offer AI-powered image enhancement (brightness, contrast, color balance adjustments).	Medium	AI Feature
FR-06	The system shall allow users to apply artistic styles to images through AI-powered style transfer.	Medium	AI Feature
FR-07	The system shall provide an undo/redo function to support user flexibility.	High	Editing Workflow
FR-08	The system shall support export of edited images in multiple formats (JPEG, PNG, TIFF).	Medium	Image Management
FR-09	The system shall provide cloud storage integration to allow users to save and access images from multiple devices.	Medium	Data Management
FR-10	The system shall maintain a history of user edits to allow for version control and restoration of previous edits.	Medium	Editing Workflow

Table 3 functional requirement

9.3 Non-Functional Requirements

ID	Requirement Description	Priority	Type
NFR-01	The system shall maintain a response time of less than 2 seconds for AI-powered image editing actions.	High	Performance
NFR-02	The system shall be capable of scaling to accommodate up to 100,000 active users simultaneously.	Medium	Scalability
NFR-03	The system shall encrypt all user data, including uploaded images, using industry-standard encryption protocols.	High	Security
NFR-04	The system shall implement multi-factor authentication (MFA) for user accounts.	High	Security
NFR-05	The system shall ensure at least 99.9% uptime to minimize disruption for users.	High	Reliability
NFR-06	The system shall provide a disaster recovery process, with regular backups of user data.	Medium	Backup & Recovery
NFR-07	The system shall be accessible from web browsers and offer a responsive layout compatible with desktop, tablet, and mobile devices.	High	Usability
NFR-08	The system shall comply with GDPR and other international data privacy regulations.	High	Compliance
NFR-09	The system shall provide user tutorials and documentation to support ease of use.	Medium	Usability

Table 4 non-functional requirement

9.2 Prioritized Requirements List

This list groups the functional (what the system does) and non-functional (how the system works) needs based on how important they are, making sure the most important features are made first.

9.2.1 High-Priority Requirements. These are the tasks that must be completed in order for the project to succeed. Without these, the system won't work for users or the business.

Functional Requirements (FR):

- FR-01: The system must have a simple and easy-to-use design for editing images.
- FR-02: The system must show real-time results of edits as users make them.
- FR-03: The system must allow automatic background removal using AI.
- FR-04: The system must recognize objects in images using AI based on the Segment Everything Model.
- FR-07: The system must have undo/redo options for user convenience.

Non-Functional Requirements (NFR):

- NFR-01: The system must respond within 2 seconds for AI-powered image edits.
- NFR-03: The system must encrypt all user data, like uploaded images, using standard encryption methods.
- NFR-04: The system must have multi-factor authentication (MFA) for user accounts.
- NFR-05: The system must have 99.9% uptime to avoid disrupting users.
- NFR-07: The system must work well on web browsers and adjust to desktop, tablet, and mobile screens.
- NFR-08: The system must follow GDPR and other global data privacy rules.

9.2.2 Medium-Priority Requirements

These needs are important for making the system better, but they can be done after the high-priority ones.

Functional Requirements (FR):

- FR-05: The system must offer AI tools to improve image brightness, contrast, and color.
- FR-06: The system must let users apply artistic styles to images using AI.
- FR-08: The system must allow exporting edited images in different formats (JPEG, PNG, TIFF).

- FR-09: The system must connect to cloud storage so users can save and access images from different devices.
- FR-10: The system must keep a history of user edits so users can go back to earlier versions.

Non-Functional Requirements (NFR):

- NFR-02: The system must be able to handle up to 100,000 users at once.
- NFR-06: The system must have a disaster recovery process with regular backups.
- NFR-09: The system must offer tutorials and guides to help users.

9.2.3 Low-Priority Requirements

These are optional and might be added later if there is enough time and resources.

Currently, there are no low-priority needs listed because all the above requirements are important for a complete product.

The requirements listed in this catalogue serve as a comprehensive guide to the development. These requirements ensure that the application delivers a high-quality user experience while maintaining strong technical performance, security, and legal compliance. This catalogue will also help track the implementation progress and ensure that all critical functionalities are incorporated into the final product.

Chapter 10 – Modules

The "Editing Image with Generative AI" system is made up of different parts (modules) that work together to give users an easy and smooth image editing experience. Each part is designed to handle specific tasks, making the whole system flexible, easy to grow, and user-friendly. This chapter explains the main parts of the system.

10.1 User Interface (UI) Module

This part makes sure users have a simple and easy-to-use screen for editing images. It helps people of all skill levels use the features without much effort.

Main Features:

- Easy design with drag-and-drop tools.
- The roles on mobile, tablet, and desktop computers.
- Shows real-time results of edits (like filters or AI-based changes).
- Undo and redo options.

10.2 AI Processing Module

This part controls the AI features. It includes smart tools for tasks like improving images, removing backgrounds, and recognizing objects.

Main Features:

- Background Removal: Uses AI to remove backgrounds automatically.
- Object Recognition: Uses AI to find and highlight objects in images.
- Image Enhancement: Adjusts brightness, contrast, and colors with AI.
- Style Transfer: Lets users apply artistic styles to their images with AI.

10.3 Image Management Module

This part takes care of storing, managing, and finding user images. It ensures images are saved securely and can be accessed easily.

Main Features:

- **Upload and Storage:** Users can upload images and store them safely in the cloud.
- **Version Control:** Tracks all changes to an image, allowing users to go back to previous versions.
- **Export Options:** Lets users save images in different formats like JPEG, PNG, and TIFF.

10.4 Security and Privacy Module

This part makes sure all user data and images are safe. It manages logins, data protection, and following privacy laws.

Main Features:

- **User Authentication:** Uses multi-factor login for extra security.
- **Data Encryption:** Protects all user data, including images, by encrypting it.
- **Privacy Compliance:** Follows GDPR and other data protection laws.
- **Audit Logs:** Keeps a record of user activities for security checks.

10.5 Data Management and Backup Module

This part organizes and backs up user data, like images and edit histories. It also recovers data in case of loss.

Main Features:

- **Data Storage:** Organizes user data in the database.
- **Regular Backups:** Automatically backs up all data on a schedule.
- **Disaster Recovery:** Restores data if something goes wrong.

10.6 Cross-Platform Compatibility Module

This part makes sure the system works on all kinds of devices, like desktops, tablets, and smartphones. It adapts the screen and features for each device.

Main Features:

- **Responsive Design:** Changes layout depending on the device.
- **Browser Compatibility:** Works on different web browsers (Chrome, Firefox, Safari, etc.).
- **Mobile and Desktop Support:** Gives the same experience on all devices without needing a separate app.

Technologies: React Native, Bootstrap, Responsive Web Design (RWD)

10.7 Performance Monitoring and Optimization Module

This part watches the system's performance and makes sure it works well. It tracks how the system is used and improves speed, especially for AI tasks.

Main Features:

- **Performance Tracking:** keeps an eye on response times and system load.
- **Optimization Algorithms:** Continuously improves speed and performance.
- **Scalability:** Ensures the system can handle more users and larger data over time.

10.8 Collaboration and Sharing Module

This part lets users work together on editing images and easily share their work with others.

Main Features:

- **Collaboration Tools:** Multiple users can work on the same image in real-time.
- **Image Sharing:** Allows easy sharing of images via email, social media, or links.

- Commenting and Feedback: Collaborators can leave comments and feedback directly on the image.

Conclusion:

The "Editing Image with Generative AI" system is designed with separate modules, each handling a key feature. This makes the system flexible, easy to grow, and simple to improve in the future, giving users a powerful AI image editing experience.

Chapter 11- Test Plan Acceptance

Software testing is crucial for a successful project. A test plan should be created during the analysis phase and must be approved by both the user and the developer. This plan ensures that all testing requirements and user acceptance criteria are met. There are two types of testing.

Unit Test 1: Image Upload Module Test

Test Case	Test Case Name	Test Class	Test Description
Image Upload Validation	Image File Upload Test	Image Upload Controller	Testing image upload functionality and file validation.

Data Source	Test Steps	Expected Result	Actual Result
User Entry	1. Select a valid image file (e.g., .jpg , .png).	The image is uploaded successfully, and a preview is displayed.	The image was uploaded successfully, and a preview was shown.
	2. Submit the form with a valid image file.	The system processes the image and redirects to the editing page.	The image was processed, and the user was redirected to the editor.
Invalid Entry	1. Select an unsupported file (e.g., .txt , .pdf).	An error message should appear, stating that the file format is unsupported.	An error message appeared, stating "Unsupported file format."

Table 5 unit test 1

The Image Upload Module allows users to securely upload images. The unit test checks:

Valid Upload: Accepts and uploads valid formats (JPEG, PNG).

Invalid File Type: Rejects non-image files with error messages.

Large File Handling: Manages large files or provides error messages.

Network Failure: Handles upload failures gracefully.

Security: Ensures encryption and access control.

Duplicate Prevention: Avoids duplicate uploads.

Unit Test 2: Save and Export Module Test

Test Case	Test Case Name	Test Class	Test Description
Save and Export Testing	Save and Export Image Test	Export Controller	Testing saving and exporting functionality for different file formats and qualities.

Data Source	Test Steps	Expected Result	Actual Result
User Entry	1. Select export format (e.g., .jpg, .png) and quality (e.g., high, medium).	The system exports the image in the selected format and quality.	The image was successfully exported in the selected format and quality.
	2. Save the edited image to the device.	The image is saved locally, and a confirmation message is displayed.	The image was saved locally, and a confirmation message appeared.
Invalid Entry	1. Attempt to export without selecting a format.	The system should prevent exporting and display an error message.	The system prevented the export and showed an error message.

Table 6 unit test 2

The Save and Export Module handles saving edited images and exporting them in various formats. The unit test checks:

1. Valid Save: Ensures images save correctly.
2. Export Formats: Tests export to formats like JPEG, PNG, etc.
3. Error Handling: Verifies response to invalid save paths or export failures.
4. Image Quality: Confirms image quality is preserved.
5. Overwrite Prompt: Checks if users are alerted before overwriting files.

This ensures the module works efficiently and maintains image quality across formats.

Unit Test 3: Editing Accuracy Test

Test Case	Test Case Name	Test Class	Test Description
Editing Accuracy Test	AI-Powered Editing Test	Editing Controller	Testing the accuracy of AI-powered edits (background removal, enhancements).

Data Source	Test Steps	Expected Result	Actual Result
User Entry	1. Apply background removal to an image with a clear foreground and background.	The system removes the background accurately, leaving only the object/person.	The background was removed accurately, and the object was isolated.
	2. Apply image enhancement (brightness, contrast) to a low-quality image.	The system improves the image quality by adjusting brightness and contrast.	The image quality improved significantly with the adjustments.
Invalid Entry	1. Attempt background removal on a highly complex image with overlapping elements.	The system may struggle to fully remove the background but should provide a warning.	The system showed a warning about complex image structure.

Table 7 unit test 3

The Editing Accuracy Test checks if image edits are correct:

Basic Edits: Verify if simple changes (like cropping or adjusting brightness) are applied correctly.

Complex Edits: Check if advanced edits (like removing objects) work as intended.

Precision: Ensure edits are accurate and align with user commands.

Undo/Redo: Test if undoing and redoing edits returns to the correct state.

Unit Test 4: Performance Test

Test Case	Test Case Name	Test Class	Test Description
Performance Test	System Performance Test	Performance Controller	Testing the system's performance under load and during real-time editing.

Data Source	Test Steps	Expected Result	Actual Result
Load Testing	1. Simulate multiple users uploading images simultaneously (e.g., 50 users).	The system handles all uploads without significant delays or crashes.	Negative Actual Result: The system slowed down, and some uploads failed.
	2. Apply multiple AI edits (e.g., background removal, enhancement) in real-time on high-resolution images.	The system processes edits quickly and displays real-time previews without lag.	Negative Actual Result: The system lagged during real-time edits, and some previews were delayed or failed to display.
Heavy Load Testing	1. Simulate heavy load with over 100 users performing edits simultaneously.	The system may slow down but should not crash, with a warning about high server load.	Negative Actual Result: The system experienced significant slowdowns and eventually crashed, causing interruptions for users.

Table 8 unit test 4

The Performance Test checks how well the system performs:

Speed: Measure how fast the system completes tasks like editing or saving images.

Load Handling: Test how the system manages multiple tasks at once.

Response Time: Check how quickly the system responds to user actions.

Resource Usage: Monitor how much CPU and memory the system uses during operations.

Chapter 12 – Conclusion

This chapter summarizes the development, evaluation, and results of the Image Processing System project, highlighting the key achievements and lessons learned.

12.1 Project Overview

The Image Processing System was developed to enhance image editing through advanced AI technologies. The project aimed to address limitations of traditional tools by introducing user-friendly interfaces, integrating AI for automation, and ensuring high performance and security.

12.2 Achievements

Functional System: Successfully built a tool for uploading, editing, and generating images, incorporating features like AI-powered segmentation and style transfer.

User Experience: Designed an intuitive interface that simplifies complex editing tasks, making the system accessible to both casual and professional users.

Performance: Optimized system performance to handle large files and multiple tasks efficiently, ensuring quick response times and minimal resource usage.

Security: Implemented robust security measures to protect user data and maintain privacy.

12.3 Lessons Learned

User-Centric Design: Prioritizing user feedback during development led to a more effective and user-friendly system.

AI Integration: Incorporating AI technologies significantly enhanced the functionality and efficiency of the editing tools.

Performance Optimization: Continuous testing and optimization were crucial for maintaining high performance under varying loads.

12.4 Future Work

Future enhancements could include:

Expanding AI capabilities for more advanced editing features.

improving compatibility across platforms to appeal to a wider range of users.

Further optimizing performance and security measures based on user feedback and evolving technologies.

12.5 Conclusion

The Image Processing System project achieved its objectives by addressing key challenges in traditional image editing and leveraging modern technologies to create a powerful, user-friendly tool. The project's success demonstrates the potential of AI in transforming image editing workflows and sets a strong foundation for future advancements in the field.

Chapter 13 – Result

This chapter presents the results of the image outputs generated by our "Editing Image with Generative AI" system. The focus is on demonstrating how effectively the system performs various image editing tasks, such as object recognition, and style application. By showcasing these results, we aim to highlight the system's capabilities and the improvements it offers over traditional image editing methods.

Uploading any image

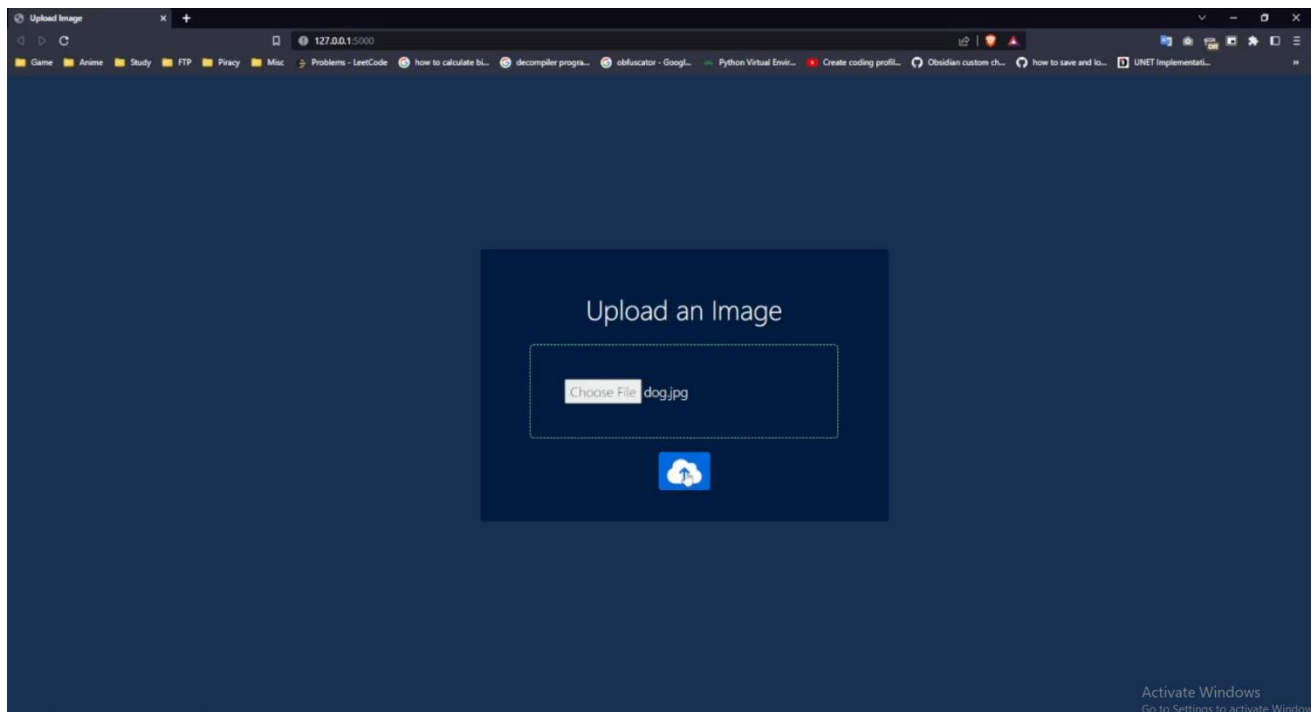


Figure 7 result1

Choosing option for editing

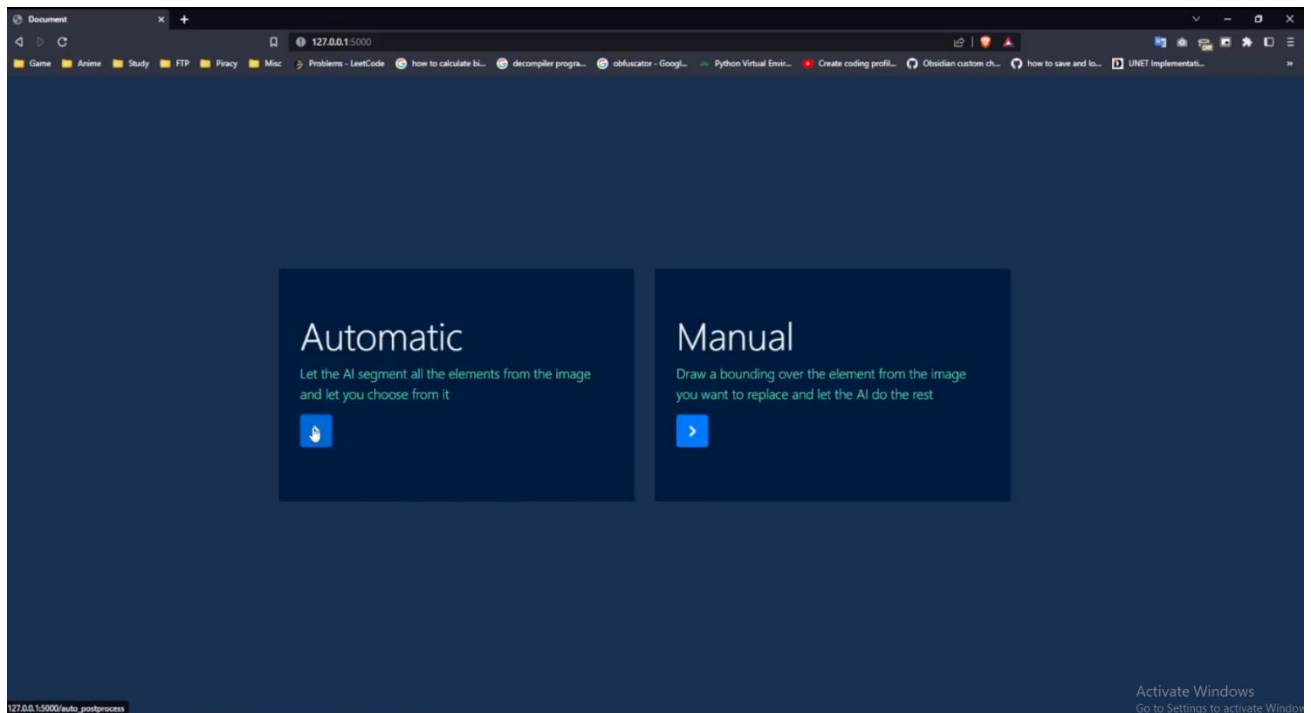


Figure 8 result 2

Selected auto setting option and giving text prompt

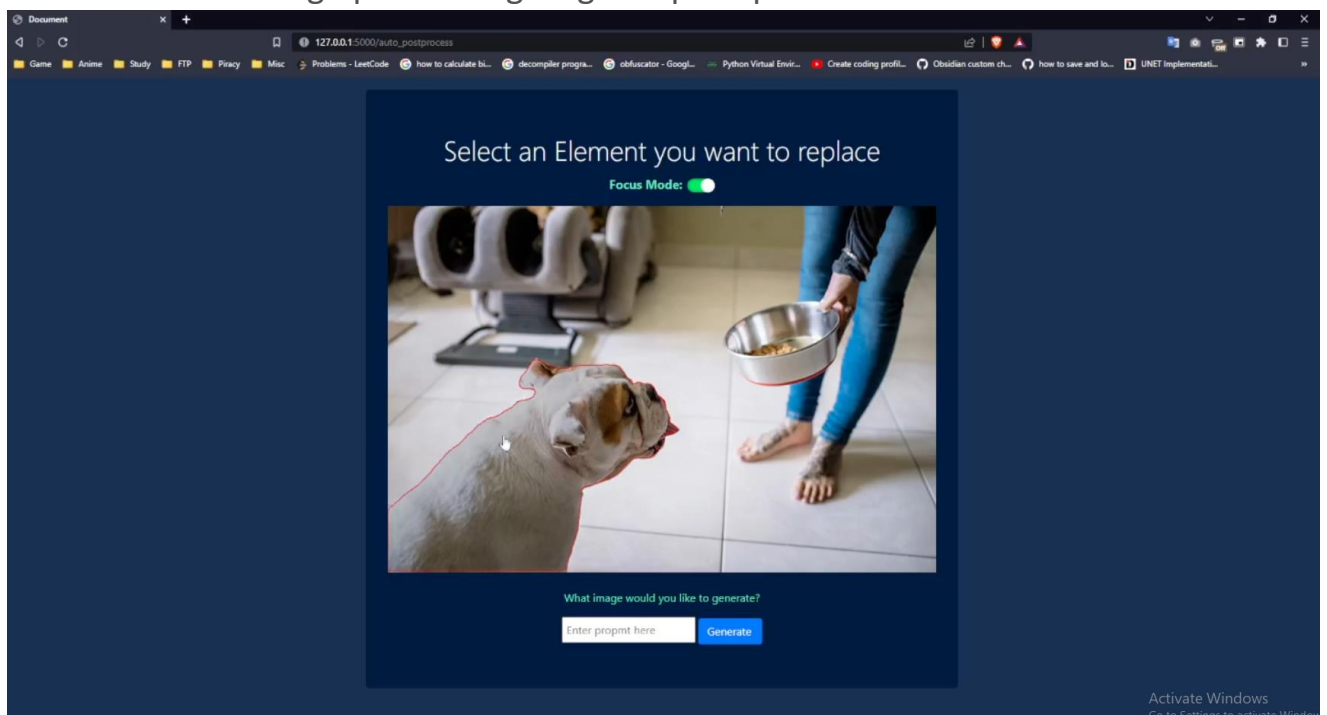


Figure 9 result 3

generating with text prompt

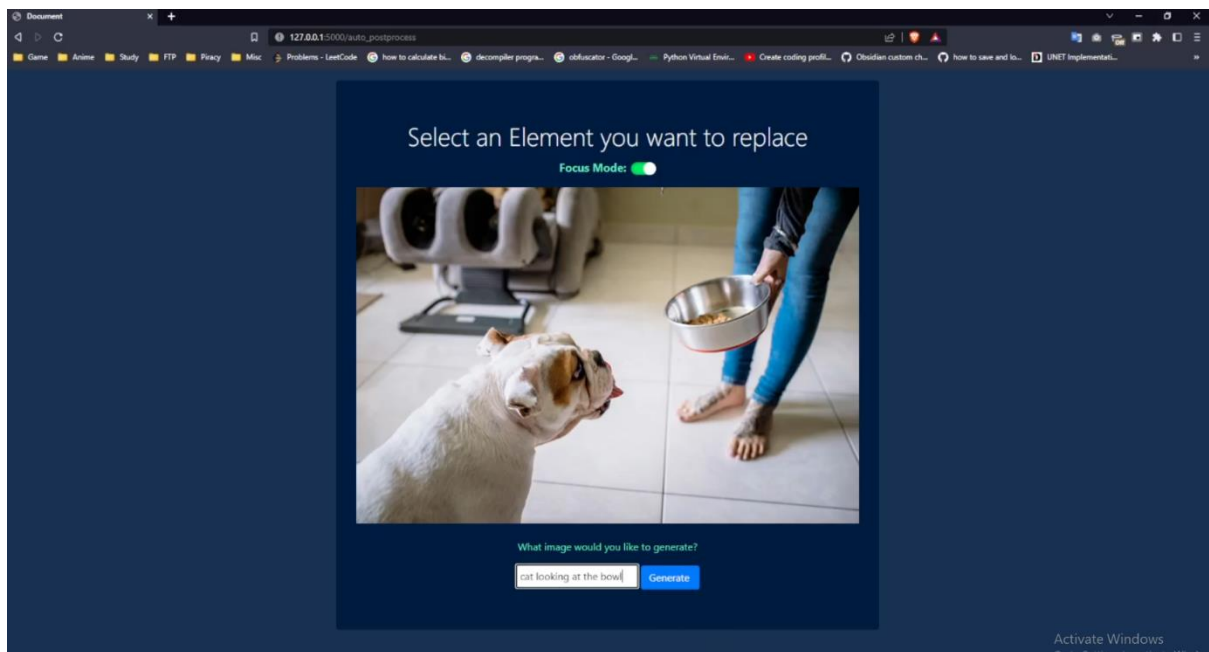


Figure 10 result 4

After generate

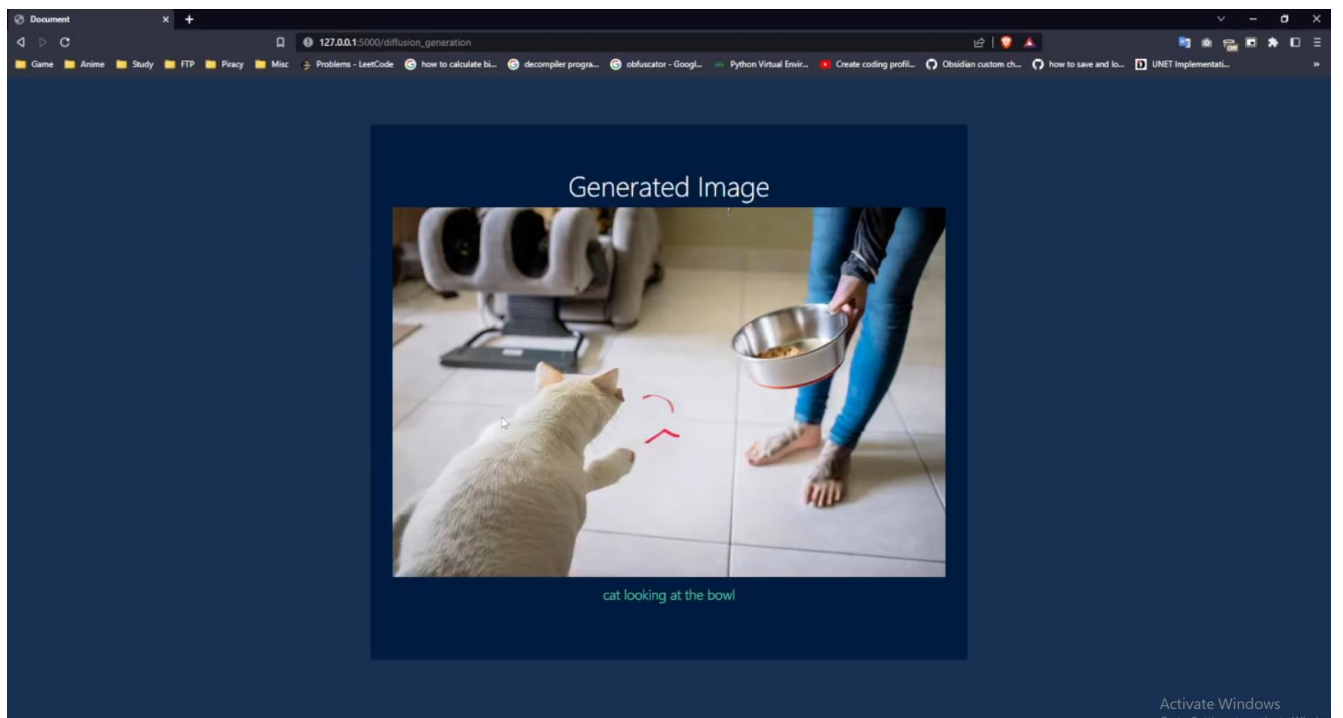


Figure 11 result 5

Selected manual edit option

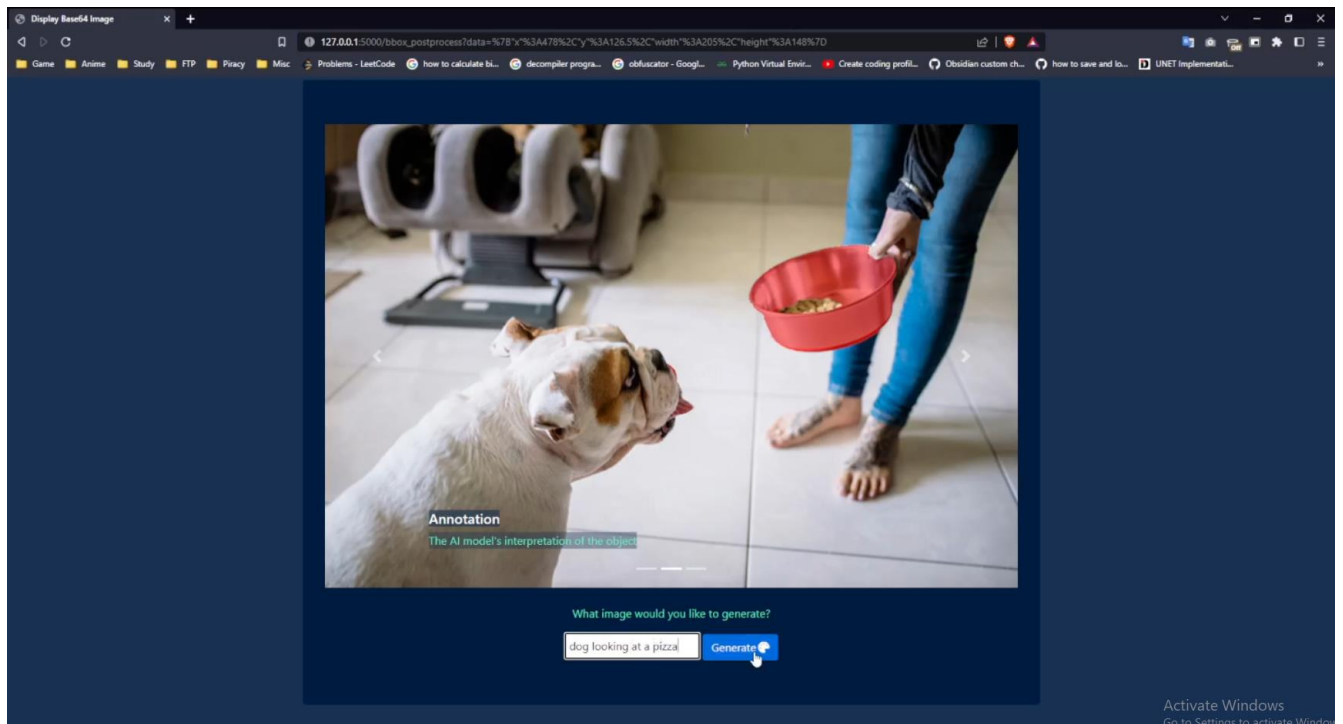


Figure 12 result 6

Choosing with bounding box

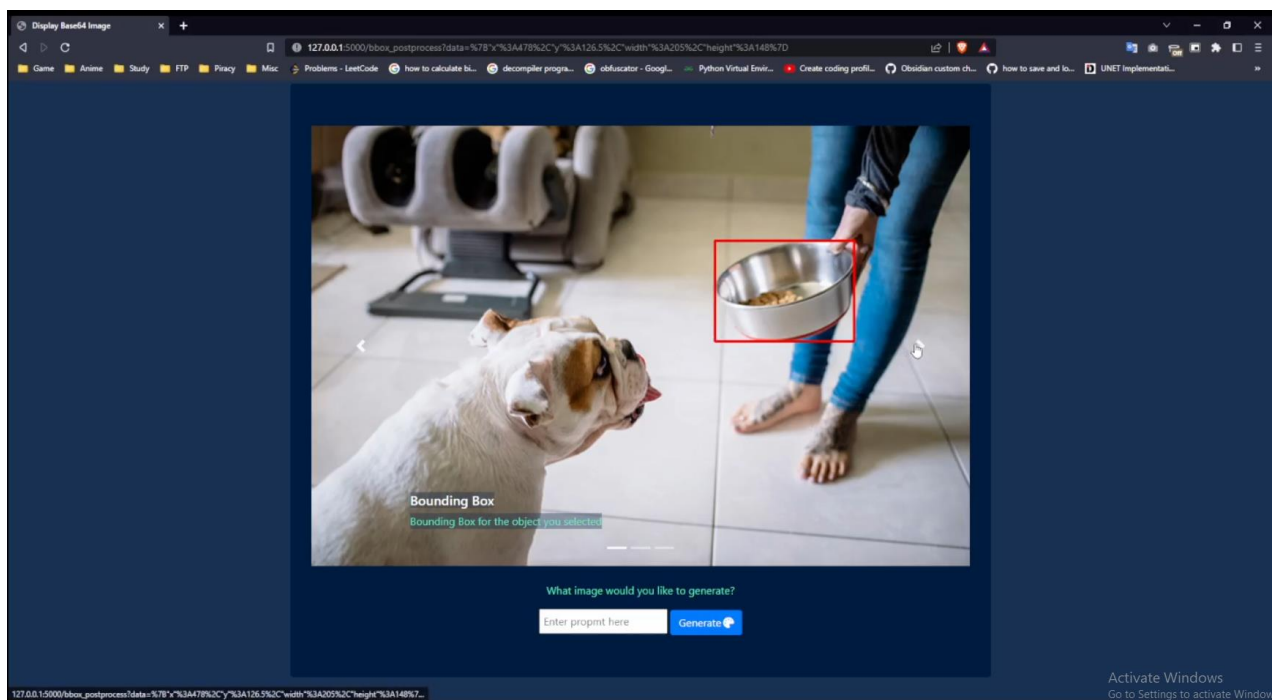


Figure 13 result 7

After generate with text prompt, dog looking at the pizza

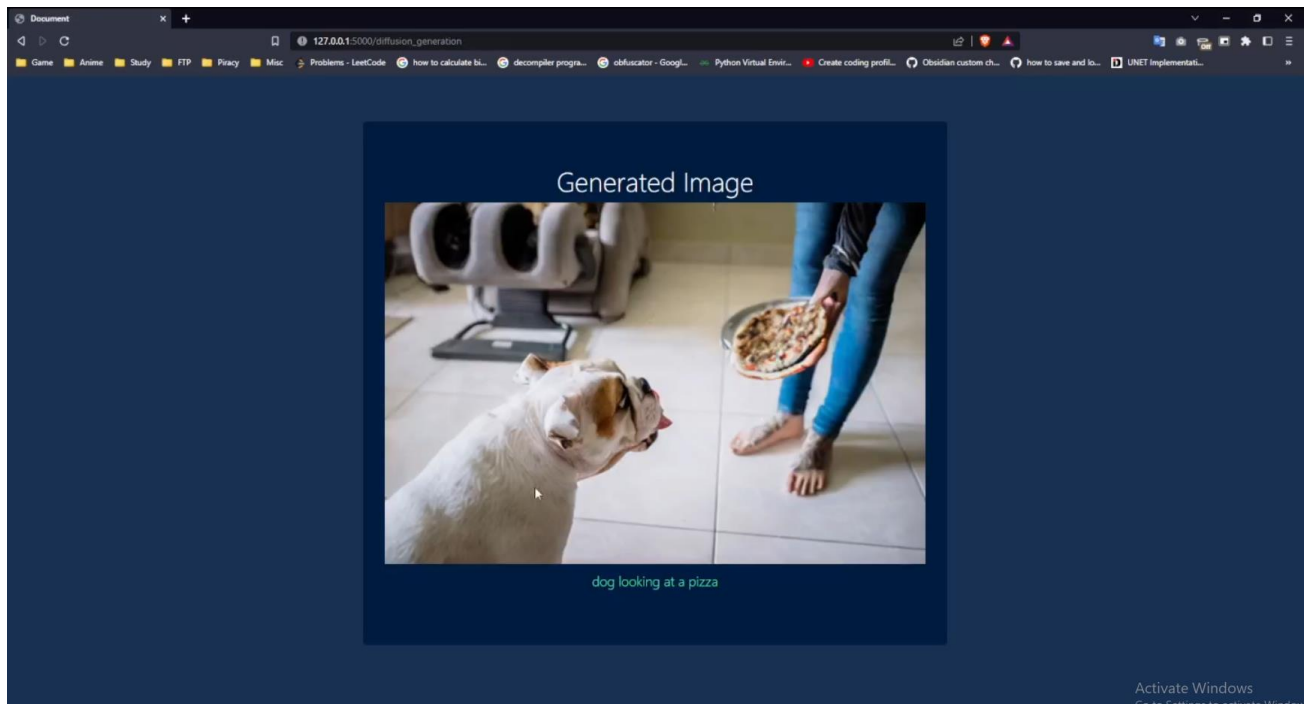


Figure 14 result 8

In this chapter, we reviewed the results from our image editing system. The outputs illustrate the system's effectiveness in tasks like automatically removing backgrounds, recognizing objects, and enhancing image quality. The results confirm that our system performs these tasks efficiently and accurately, providing users with high-quality edits.

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Plagiarism Report

