An Industrial Oriented Mini Project / Summer InternshipReport on

MOBILE APP FOR REMOVAL OF HAZE, SMOKE AND FOG FOR ENHANCED VISUAL CLARITY

Submitted in Partial fulfillment of requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

INFORMATION TECHNOLOGY

By

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DEPARTMENT OF INFORMATION TECHNOLOGY

KESHAV MEMORIAL INSTITUTE OF TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
Accredited by NBA & NAAC, Approved by AICTE, Affiliated to JNTUH.
Narayanaguda, Hyderabad, Telangana-29

2024-25

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CERTIFICATE

This is to certify that this is a bonafide record of the project report titled "MOBILE APP FOR REMOVAL OF HAZE, SMOKE AND FOG FOR ENHANCED VISUAL CLARITY" which is being presented as the Industrial Oriented Mini Project / Summer Internship report by

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In partial fulfillment for the award of the degree of Bachelor of Technology in Information Technology affiliated to the Jawaharlal Nehru Technological University Hyderabad, Hyderabad

Internal Guide
(Dr. G. Narender)

Head of Department
(Dr. G. Narender)

Submitted for Viva Voce Examination held on _____

External Examiner

Vision of KMIT

- To be the fountainhead in producing highly skilled, globally competent engineers.
- Producing quality graduates trained in the latest software technologies and related tools and striving to make India a world leader in software productsand services.

Mission of KMIT

- To provide a learning environment that inculcates problem solving skills,professional, ethical responsibilities, lifelong learning through multi modal platforms and prepares students to become successful professionals.
- To establish an industry institute Interaction to make students ready for the industry.
- To provide exposure to students on the latest hardware and software tools.
- To promote research-based projects/activities in the emerging areas of technology convergence.
- To encourage and enable students to not merely seek jobs from the industry but also to create new enterprises.
- To induce a spirit of nationalism which will enable the student to develop, understand India's challenges and to encourage them to develop effectivesolutions.
- To support the faculty to accelerate their learning curve to deliver excellent service to students.

Vision of IT Department

To produce globally competent graduates to meet the modern challenges through contemporary knowledge and moral values committed to build a vibrant nation.

Mission of IT Department

- To create an academic environment, which promotes the intellectual andprofessional development of students and faculty.
- To impart skills beyond university prescribed to transform students into a well-rounded IT professional.
- To nurture the students to be dynamic, industry ready and to have multidisciplinary skills including e-learning, blended learning and remote testing as an individual and as a team.
- To continuously engage in research and projects development, strategic use ofemerging technologies to attain self-sustainability

PROGRAM OUTCOMES (POs)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis:** Identify formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

3. **Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretationof data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage:** Create select, and, apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to societal, health, safety. Legal und cultural issues and the consequent responsibilities relevant to professional engineering practice.

7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to analyze the common business functions to design and develop appropriate Information Technology solutions for social upliftments.

PSO2: Shall have expertise on the evolving technologies like Python, Machine Learning, Deep learning, IOT, Data Science, Full stack development, Social Networks, Cyber Security, Mobile Apps, CRM, ERP, Big Data, etc.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will have successful careers in computer related engineering fields orwill be able to successfully pursue advanced higher education degrees.

PEO2: Graduates will try and provide solutions to challenging problems in theirprofession by applying computer engineering principles.

PEO3: Graduates will engage in life-long learning and professional development byrapidly adapting to the changing work environment.

PEO4: Graduates will communicate effectively, work collaboratively and exhibit highlevels of professionalism and ethical responsibility.

PROJECT OUTCOMES

P1: Accurately remove haze,smoke and fog from images/videos.

P2: Media uploads are restricted to specific formats enhancing compatibility.

P3: Resulting media can previewed before sharing or downloading.

P4: Processes images within 15-20 seconds.

MAPPING PROJECT OUTCOMES WITH PROGRAM OUTCOMES

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
P1	H	H	H	H	H	L	M	M	H	M	H	H
P2	M	M	M	M	M	-	-	L	H	M	M	M
P3	H	H	M	M	M	-	M	L	H	M	H	-
P4	H	H	M	M	M	-	L	M	H	M	M	M

L – LOW M –MEDIUM H– HIGH

PROJECT OUTCOMES MAPPING PROGRAM SPECIFIC OUTCOMES

PSO	PSO1	PSO2
P1	H	H
P2	M	L
P3	H	M
P4	M	H

PROJECT OUTCOMES MAPPING PROGRAM EDUCATIONAL OBJECTIVES

PEO	PEO1	PEO2	PEO3	PEO4
P1	H	H	M	H
P2	L	M	M	H
P3	M	M	M	M
P4	-	L	M	-

DECLARATION

We hereby declare that the results embodied in the dissertation entitled "MOBILE APP FOR REMOVAL OF HAZE, SMOKE AND FOG FOR ENHANCED VISUAL CLARITY"' has been carried out by us together during the academic year 2024-25 as a partial fulfillment of the award of the B.Tech degree in Information Technology from JNTUH. We have not submitted this report to any other university or organization for the award of any other degree.

STUDENT NAME	ROLL NO
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ACKNOWLEDGEMENT

We take this opportunity to thank all the people who have rendered their full support to our project work. We render our thanks to **Dr. B L Malleswari**, Principal who encouraged us to do the Project.

We are grateful to **Mr. Neil Gogte**, Founder & Director, **Mr. S. Nitin,** Director for facilitating all the amenities required for carrying out this project.

We express our sincere gratitude to **Ms. Deepa Ganu**, Director Academic for providing an excellent environment in the college.

We are also thankful to **Dr. G Narender**, Head of the Department for providing us with time to make this project a success within the given schedule.

We are also thankful to our guide **Dr. G Narender**, for his valuable guidance and encouragement given to us throughout the project work.

We would like to thank the entire IT Department faculty, who helped us directly and indirectly in the completion of the project.

We sincerely thank our friends and family for their constant motivation during the project work.

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ABSTRACT

This project is focused on developing a real-time mobile application that performs image and video dehazing, significantly improving visibility in environments affected by fog, haze, smoke, or low-light conditions.The application uses a deep learning model built with PyTorch, incorporating advanced techniques like Dark Channel Prior (DCP) for estimating haze transmission and atmospheric light, along with Attention Mechanisms to enhance important image details. These methods work together to recover fine details, restore clarity, and produce high-quality visuals, even in challenging environments.

Developed with React Native and Expo, this mobile app features an intuitive, user-friendly interface for dehazing images and videos. Designed for both Android and iOS platforms, the app works seamlessly with both images and videos, making it particularly useful for applications such as surveillance, environmental monitoring, and photography.Whether used for enhancing security footage, improving outdoor photography in foggy conditions, or restoring environmental images for research, this app offers an effective solution to restore visibility and improve image quality in real time.

The project addresses several real-time applications across domains:

- **Environmental Monitoring**: Improving satellite and drone imagery for better air quality monitoring and urban planning.
- **Surveillance and Security**: Improving the effectiveness of security footage in low-visibility conditions.
- **Geographical and Scientific Research**: Enhancing images for more accurate data analysis in research.
- **Photography and Visual Arts**: Enhancing outdoor images by removing haze and improving clarity.
- **Consumer Electronics**: Enabling mobile devices and cameras to capture better images in low-contrast environments.
- **Autonomous Vehicles**: Enhancing vehicle cameras' visibility for safer navigation in poor weather conditions.
- **Aerospace and Aviation**: Enhancing aerial imagery for aviation safety in poor visibility.

LIST OF DIAGRAMS

LIST OF SCREENSHOTS

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CHAPTER - 1

1. INTRODUCTION

1.1. Purpose of the Project

The purpose of this project is to develop a real-time mobile application designed to enhance the visibility of images and videos in environments impacted by adverse conditions like fog, haze or smoke. By leveraging algorithms, such as the Dark Channel Prior (DCP) and neural networks with attention mechanisms, the app aims to restore clarity and recover fine details in degraded visuals. This application will provide a user-friendly, cross-platform solution for de-hazing, enabling users to process images and videos in a variety of practical scenarios, including surveillance, environmental monitoring, and photography.

In addition to improving visual clarity, the app is designed for real-time processing, ensuring fast and efficient results suitable for on-the-go use. Its accessibility and performance will bridge the gap between cutting-edge image processing technologies and real-world applications, making advanced de-hazing tools available to a wide audience. By offering a mobile solution that can be used across different environments, this project aims to empower users with a practical tool to enhance the quality of their visuals, whether for security, research, or photography in challenging conditions.

1.2. Problems with Existing Systems

Current de-hazing solutions face several challenges that limit their effectiveness, especially in real-world, mobile, and dynamic environments:

- **Inaccessibility on Mobile Platforms** : Few de-hazing solutions are specifically designed for mobile platforms like Android and iOS, limiting the availability of portable, high-quality tools for users. Additionally, existing mobile apps often lack advanced functionalities necessary for effective de-hazing, restricting their ability to handle challenging environmental conditions.
- **Poor Generalization Across Use Cases**: Many of the current de-hazing methods are optimized for static images and do not work well with videos. These methods often struggle to handle varying levels of haze or different types of distortions, making them less adaptable to real-world use cases.
- **Lack of Video Solutions**: While some systems can de-haze static images effectively, they often fail to maintain consistency in videos. Real-time processing of video content remains a challenge for many existing systems, limiting their practical applications in dynamic environments.
- **Inadequate Edge and Detail Restoration**: Conventional de-hazing methods often fail to restore fine details and sharp edges, resulting in images that appear overly smooth or unnatural. This lack of detailed recovery compromises the overall quality of the resulting output, leading to visuals that lack depth and clarity.

1.3. Proposed System

The proposed system is a mobile application for real-time image and video de-hazing, designed to improve visibility in environments affected by fog, haze, smoke, or low-light conditions. The frontend, built with React Native and Expo, provides an intuitive interface for users to upload images and videos for processing. The backend is a Flask application which runs a trained model that handles de-hazing of the media.

This model utilizes an algorithm like Dark Channel Prior (DCP), to estimate haze, atmospheric light and get the transmission map, which is used along with advanced deep learning techniques that incorporate Residual Blocks with Channel and Spatial Attention mechanisms. These components work together to recover fine details, restore clarity, and enhance the quality of images, even in challenging visual conditions.

1.4. Scope of the Project

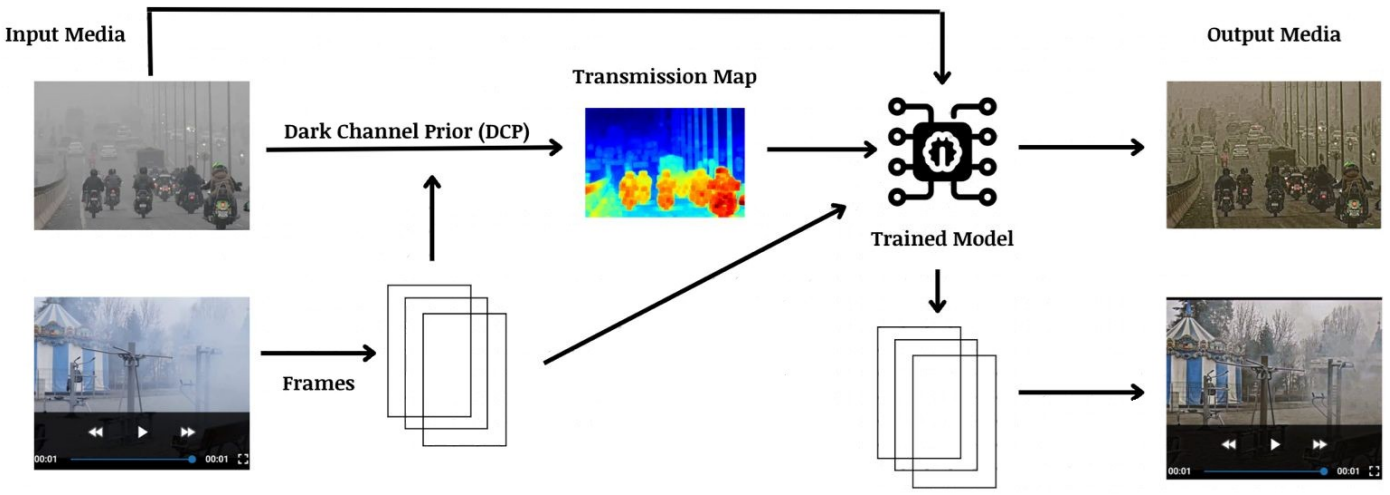
The proposed mobile application for real-time image and video de-hazing is designed to improve visibility and image quality in environments affected by haze, fog, smoke, or low light. The scope of this project includes the following key components:

- **Enhanced Visual Clarity :** The application will enable the real-time removal of haze, fog, and smoke from images and videos, enhancing visual quality and recovering lost details for better clarity.
- **Cross-Platform Accessibility :** Built with React Native and Expo, the application is designed to be cross-platform, ensuring compatibility with both Android and iOS devices, making it accessible to a broad user base.
- **Versatile Usage :** The app will cater to various practical applications, including:
    - **Surveillance and Security**: Enhancing visibility in CCTV footage for better monitoring in challenging environmental conditions.
    - **Environmental Monitoring**: Providing clearer images for research, climate studies, and pollution monitoring.
    - **Outdoor Photography**: Assisting photographers in capturing high-quality images in hazy, foggy, or low-light weather.
- **Real-Time Processing :** The app's architecture will support real-time de-hazing, ensuring minimal latency and immediate results for users, making it suitable for on-the-go use in dynamic environments.
- **Scalable and Adaptable Framework :** The backend is powered by Flask, which has a trained deep learning model in the ONNX format that gives de-hazed results. This architecture allows for scalability, enabling future enhancements such as batch processing, additional image processing filters, and support for higher-resolution media.

- **Educational and Research Applications :** The app will also serve as a valuable tool for students and researchers in fields like image processing, environmental science, and machine learning, providing a hands-on platform for learning and experimentation.

By combining advanced de-hazing techniques and a flexible framework, this application aims to address a wide range of practical and academic needs, offering value in both professional and personal domains.

1.5. Architecture Diagram



CHAPTER - 2

2. LITERATURE SURVEY

- **Foundational Work in Image Dehazing** :
    - Dark Channel Prior (DCP) (He et al., 2011): Introduced a method that estimates haze transmission by assuming minimum intensity in non-sky patches. While effective, it is computationally expensive for real-time use.

- **Improvements in Dehazing Models** :
    - DehazeNet (Cai et al., 2016): A CNN-based model that directly predicts transmission maps for dehazing, improving over traditional methods.
    - AOD-Net (Li et al., 2017): A unified deep learning model that estimates clean images and transmission maps, enhancing dehazing efficiency.

- **Advancements in Real-Time Dehazing** :
    - GAN-Based Models: GANs (e.g., CycleGAN, Pix2Pix) map hazy images to clear ones, generating high-quality outputs in real-time.
    - Attention Mechanisms: Channel and Spatial Attention (Hu et al., 2018; Woo et al., 2018) improve model focus on key image features, enhancing fine detail recovery.

- **Mobile Application Frameworks** :
    - Flask: Lightweight backend for serving dehazing models via REST APIs.
    - React Native/Expo: Enables cross-platform mobile apps for real-time dehazing on Android/iOS.

- Deep learning advancements, including CNNs, GANs, and attention mechanisms, improve dehazing quality. By leveraging tools like ONNX and React Native, real-time mobile dehazing is achievable, though challenges in performance optimization and dataset availability remain.

CHAPTER - 3

3. SOFTWARE REQUIREMENT SPECIFICATION

3.1. Introduction to SRS :

The Software Requirements Specification (SRS) is a comprehensive document that outlines the functional and non-functional requirements for the Mobile Application for Real-Time Image and Video Dehazing. This document serves as a foundation for the development, guiding the design, implementation, and validation processes of the project.

Importance of SRS : The SRS is crucial for several reasons:

- **Clear Communication** : It serves as a reference point for all stakeholders, ensuring that developers, project managers, and end-users share a common understanding of the project requirements and goals.
- **Baseline for Testing** : The requirements outlined in the SRS provide a foundation for creating test cases, ensuring that the final application meets both functional and quality expectations.
- **Scope Management** : It defines the project boundaries, reducing the risk of scope creep by establishing what features and functionalities are included or excluded in the application.

3.2. Role of SRS :

The Software Requirements Specification (SRS) plays a critical role in the Mobile Application for Real-Time Image and Video Dehazing by providing a clear and detailed outline of the application's requirements and functionalities. It serves as a foundational document ensuring that all key stakeholders—developers, project managers, and end-users—are aligned in their understanding of the project’s goals.

By defining functional requirements, such as image and video upload, dehazing processing via the ONNX model, and output display, as well as non-functional requirements related to performance, scalability, and usability, the SRS acts as a reference for design and implementation. Furthermore, it facilitates effective communication and sets the stage for testing and validation, ensuring that the final product meets user expectations and performs reliably.

In essence, the SRS is vital for managing the project’s scope and guiding its development lifecycle, ensuring that the application leverages advanced techniques like DCP, spatial attention, and channel attention to deliver accurate and efficient dehazing results.

3.3. Requirement Specification Document :

1. Introduction

Purpose

This document outlines the requirements for the real-time mobile application designed to enhance the visibility of images and videos in environments impacted by adverse conditions like fog, haze or smoke, enabling users to remove haze from images and videos using deep learning and neural networks.

Scope

The application consists of a React Native frontend developed with Expo, offering a user-friendly interface for uploading hazy images and videos, and a Flask backend powered by an ONNX-trained model. The model, leveraging algorithms such as Dark Channel Prior (DCP), spatial attention and channel attention mechanisms along with residual blocks in neural networks, processes the inputs to generate dehazed outputs. Users can view, download, and share the dehazed results directly from the application.

2. Functional Requirements :

User Interface :

- **Image/Video Upload :** Users can upload hazy images and videos for processing.
- **Preview** : Display the uploaded content for user verification before dehazing.
- **Buttons :** Include buttons for saving and sharing the results.

Backend :

- **Request Handling :** Accept HTTP POST requests containing images or videos.
- **Dehazing Process :** Use the ONNX-trained model, incorporating Dark Channel Prior (DCP), spatial attention, and channel attention mechanisms, to dehaze the input.
- **Response :** Return the dehazed image or video in base64 format for seamless frontend integration and the media is deleted from the server automatically.

3. Non-Functional Requirements :

Usability :

- Ensure a simple and intuitive interface, with clear instructions for users at each step.

Performance :

- Process images or short video clips within 15–20 seconds.

Reliability :

- Guarantee 99% uptime, with minimal downtime for backend maintenance.

Security :

- Safeguard user-uploaded content through secure data handling and storage mechanisms and immediate deletion after processing.

4. Acceptance Criteria :

- All functional and non-functional requirements are met.
- Successful upload, dehazing, downloading, sharing and deletion of processed images and videos.
- Accurate outputs that visibly improve clarity and reduce haze, fog or smoke.

5. Future Enhancements :

- Extend functionality to apply dehazing directly to live camera feeds.
- Enable batch dehazing of multiple images or video files.
- Optimize for real-time dehazing of longer video streams.

3.4. Functional Requirements :

Image/Video Upload :

- Allow users to upload hazy images or videos for processing.

Image Preprocessing :

- Preprocess the input images/videos, including resizing, normalization, and format validation.

Dehazing Process :

- Utilize the ONNX-trained model, enhanced with Dark Channel Prior (DCP) to remove haze from the input.

Image/Video Output :

- Generate and return a dehazed version of the uploaded image or video in a downloadable format.

Interactive UI :

- Provide an intuitive user interface with options for previewing uploaded content, initiating the dehazing process, and downloading and sharing the results.

Security :

- Stores the data from the user and the result in a secure folder which is deleted automatically upon closing.

3.5. Non-Functional Requirements :

Performance :

- Process input images or short videos within 10–15 seconds to ensure a smooth user experience.

Usability :

- Ensure the interface is user-friendly, with clear navigation and actionable buttons for each feature.

Reliability :

- Ensure 99% system uptime, with robust error handling for failed requests.

Compatibility :

- Support multiple platforms (iOS, Android, and web browsers) for a consistent user experience.

Maintainability :

- Design the system to allow easy updates to the ONNX model or backend components without disrupting functionality.

Scalability :

- Ensure the backend can handle increased workloads, such as higher user traffic or larger image/video files.

Security :

- Implement secure data transfer protocols (e.g., HTTPS) and safeguard user-uploaded content from unauthorized access or leaks.

3.6. Performance Requirements :

Latency :

- The system should process and return dehazed images within 10–15 seconds.

Throughput :

- Handle simultaneous dehazing requests from multiple users with minimal delay.

Scalability :

- Support increased user traffic and larger input file sizes without performance degradation.

Availability :

- Ensure 99% uptime for continuous accessibility, with minimal downtime for maintenance.

Efficiency :

- Optimize resource usage for both the mobile app and backend server.

Responsiveness :

- Maintain a responsive user interface with real-time feedback on user actions like uploads and processing status.

3.7. Sofware Requirements :

Frontend Requirements :

- **React Native with Expo :** For cross-platform mobile app development.
- **HTML5, CSS3, JavaScript :** For building an intuitive and responsive user interface.
- **Axios or Fetch API:** For seamless communication with the backend.
- **Local Storage or Secure Storage API :** To temporarily save user data or settings.

Backend Requirements :

- **Flask==3.0.0 :** Lightweight backend framework for handling API requests.
- **Flask-CORS==5.0.0 :** For enabling secure cross-origin requests.
- **ONNX Runtime==1.20.1 :** For deploying the trained dehazing model.
- **Pillow==10.1.0 :** For image processing.
- **Opencv-python==4.9.0.80 :** For video frame extraction, reading and writing.
- **NumPy==1.26.2 :** For numerical computations.
- **Torch==2.4.1 :** For tensor calculations.

3.8. Hardware Requirements :

Development Requirements :

- **Operating System :** Windows 10 or Linux (Ubuntu 20.04).
- **Processor :** Intel Core i5 or AMD Ryzen 5 equivalent.
- **RAM :** 16GB DDR4 for smooth development and testing.
- **Storage :** 512GB SSD for faster file handling and storage.
- **Internet Connection :** Minimum 5 Mbps for backend-server communication.

User Device Requirements :

- **Operating System :** iOS 12+/Android 8.0+.
- **RAM :** Minimum 3GB for mobile devices
- **Browser :** Chrome or Edge (if accessing via web).
- **Display :** HD or higher resolution for better visualization of results.

CHAPTER - 4

4. SYSTEM DESIGN

4.1. Introduction to UML :

The Unified Modeling Language (UML) is an essential component of software engineering, providing a standardized way to visualize the design of a system. In the context of Software Requirements Specification (SRS) documentation, UML serves as a powerful tool to capture and communicate the system's requirements and structure effectively. It facilitates better understanding among stakeholders, including developers, project managers, business analysts, and clients.

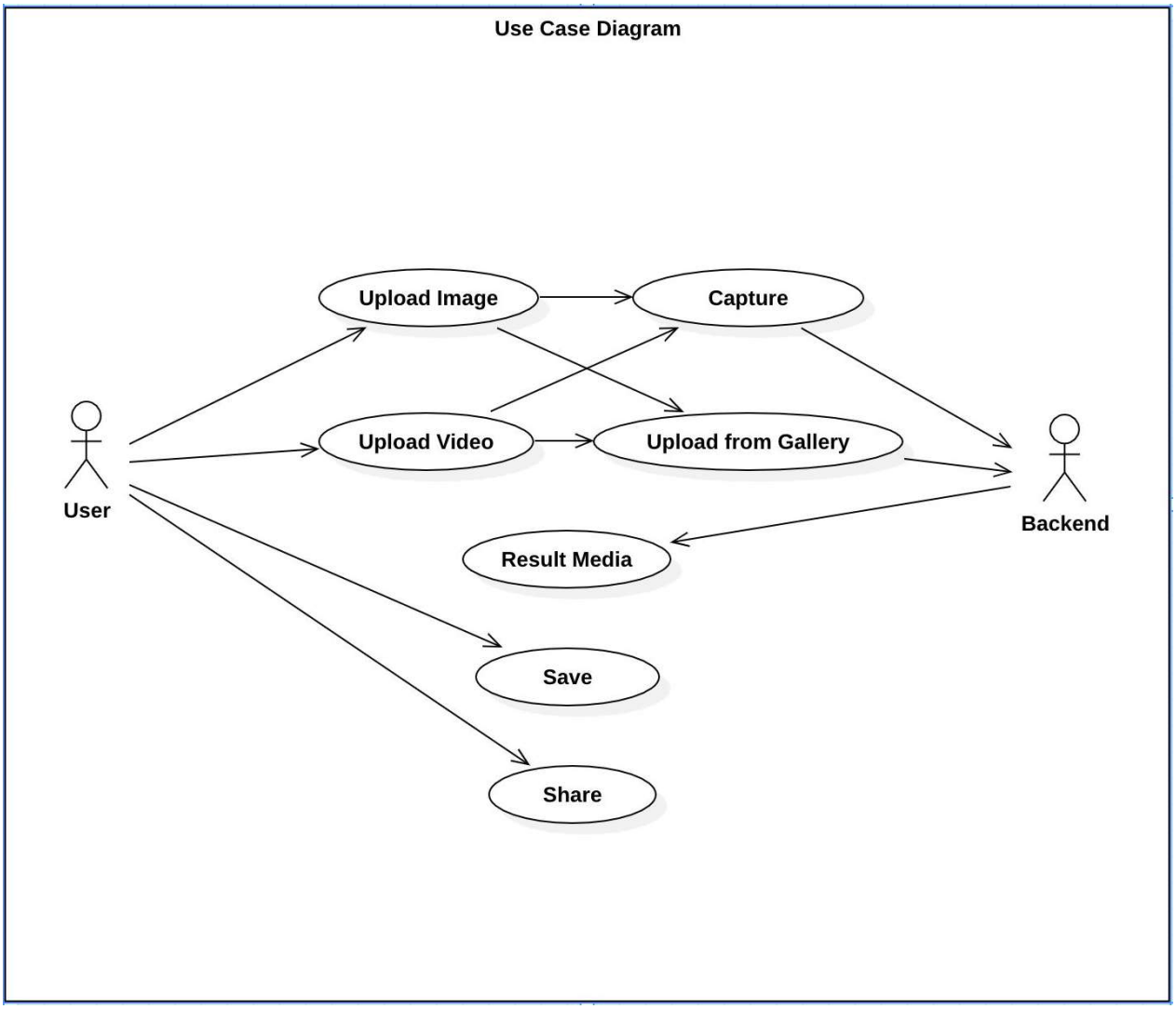
UML is particularly beneficial in an SRS because it offers various diagram types that can represent different aspects of the software system. These diagrams help in illustrating both the static and dynamic characteristics of the system, making the requirements more accessible and understandable. The use of visual representations allows for easier identification of relationships between components, system behavior, and overall architecture.

In an SRS, UML diagrams can be categorized into two main groups: structural diagrams and behavioral diagrams.

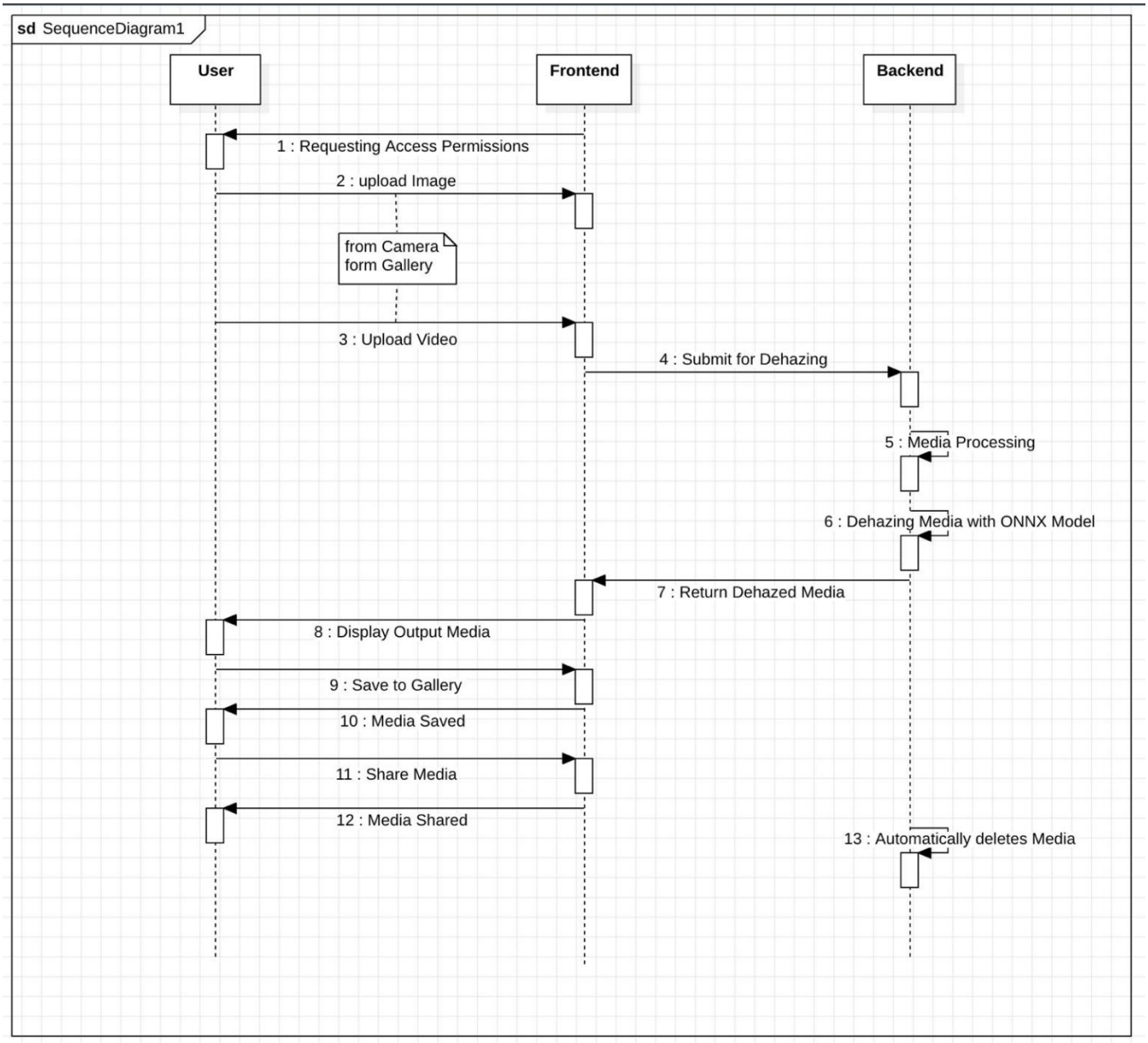
1. **Structural Diagrams :** These diagrams depict the organization and relationships among various components of the system. Key structural diagrams include:
   - **Class Diagrams :** Illustrate the system's classes, their attributes, methods, and the relationships between them, helping to define the system's static structure.
   - **Component Diagrams :** Show how components are wired together to form larger systems, focusing on the organization and dependencies of various modules.
   - **Deployment Diagrams :** Represent the physical deployment of artifacts on nodes, helping stakeholders understand how the software will be distributed in a runtime environment.
2. **Behavioral Diagrams :** These diagrams illustrate the interactions between the system and external actors, highlighting how the system behaves under different scenarios. Key behavioral diagrams include:
   - **Use Case Diagrams :** Identify the functional requirements of the system by showing the interactions between users (actors) and the system. Each use case represents a specific functionality that the system must provide.
   - **Sequence Diagrams** : Detail how objects interact in a particular sequence, outlining the flow of messages between components over time. This is crucial for understanding how various parts of the system communicate and operate.
   - **Activity Diagrams :** Depict workflows of stepwise activities and actions, showing the flow from one activity to another, which is useful for modeling the overall process of system operations.

4.2. UML Diagram :

4.2.1. Use Case Diagram :

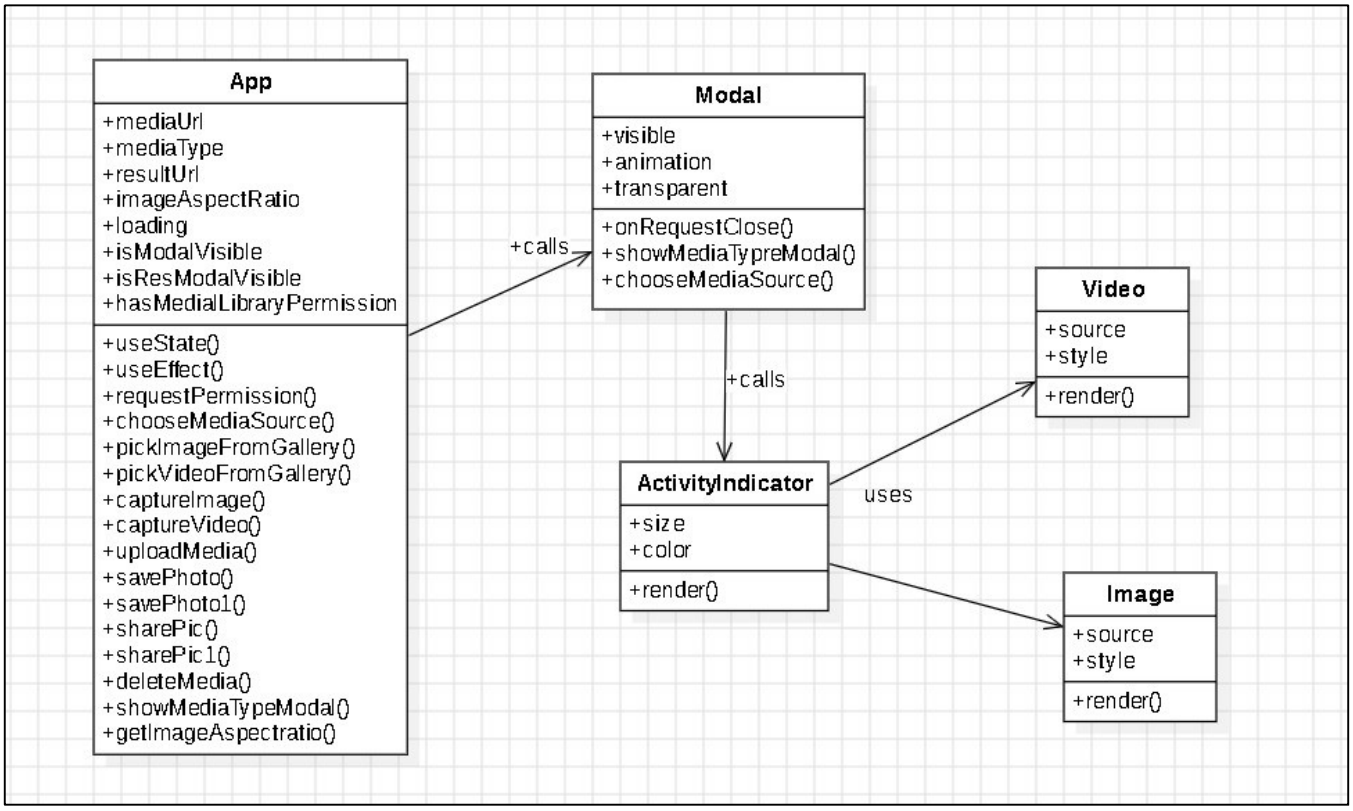


4.2.2. Sequence Diagram :

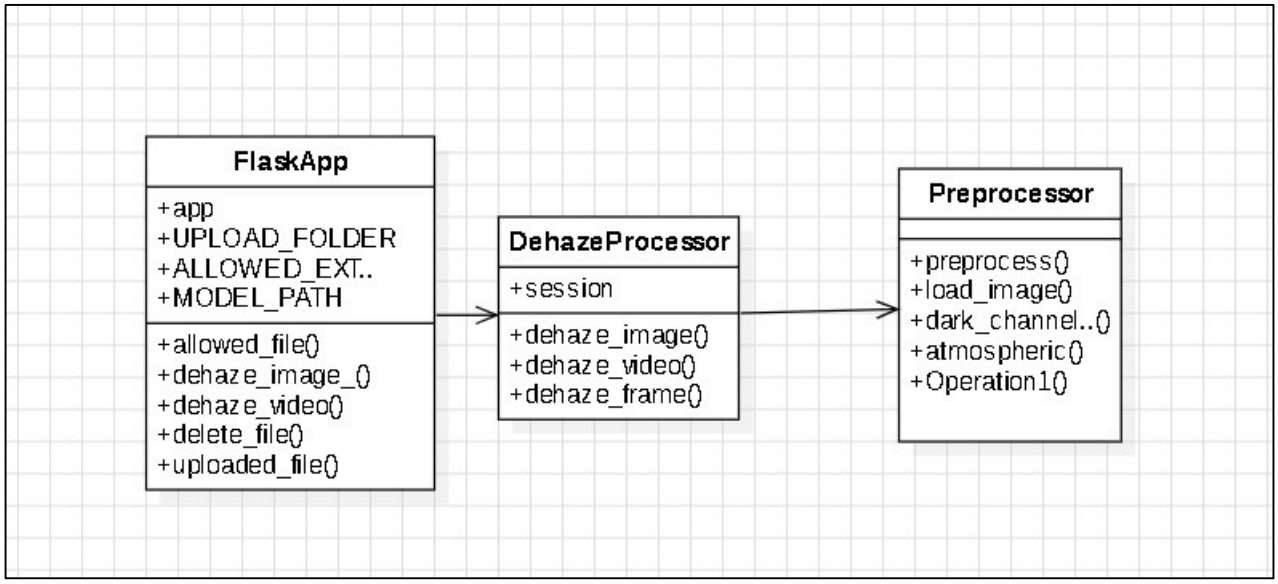


4.2.3. Class Diagram :

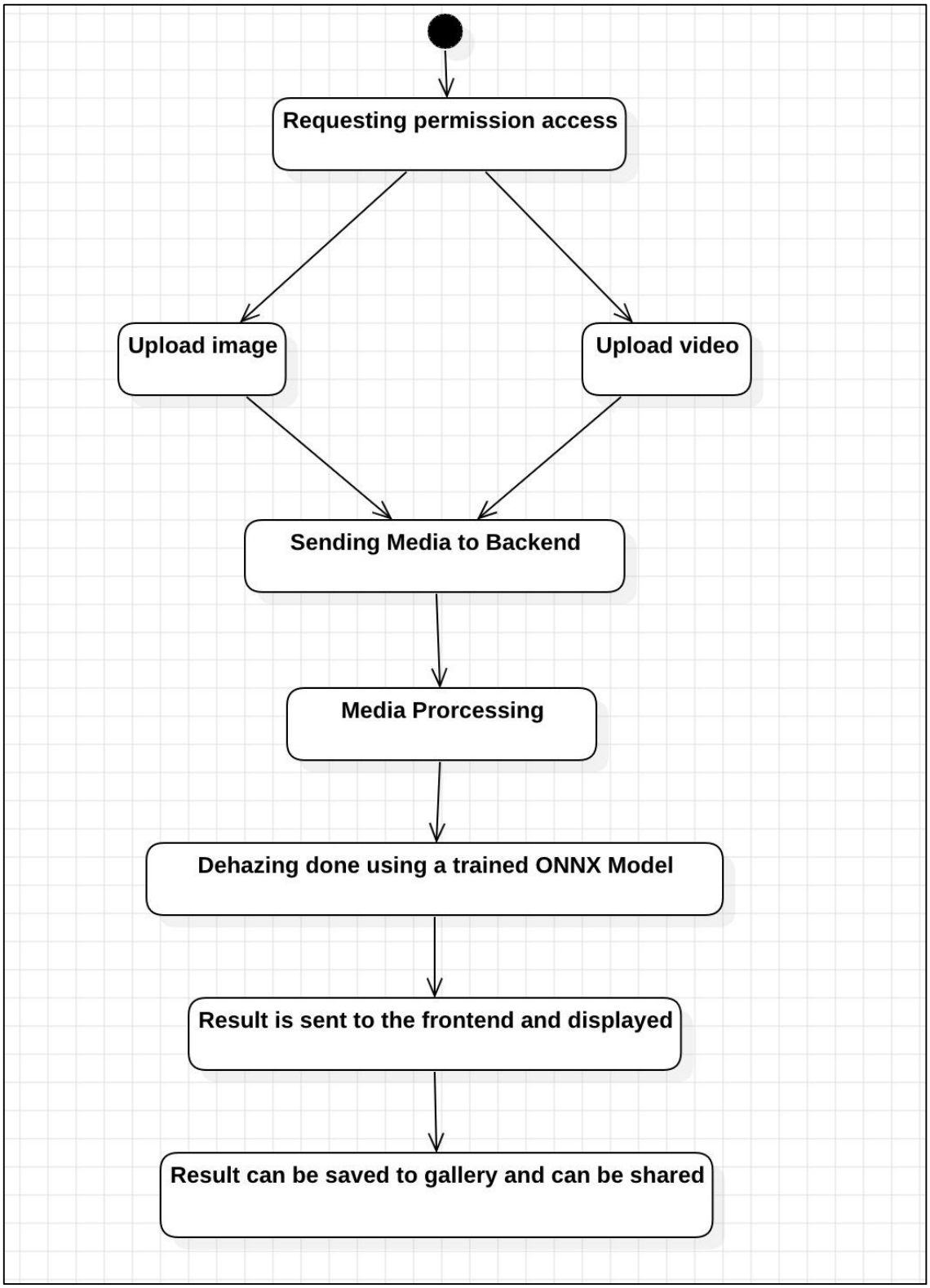
Frontend :



Backend :



4.2.4. Activity Diagram :



4.3. Technologies Used :

Frontend :

- **React Native:** A framework for building cross-platform mobile applications for both iOS and Android, allowing seamless user interaction with the dehazing features.
- **Expo:** A tool that helps in building and deploying React Native apps quickly, providing additional features like easy camera access and image/video selection.
- **HTML5, CSS3, JavaScript:** Used for structuring, styling, and adding interactivity in the web-based UI (applicable in a hybrid mobile app scenario).

Backend :

- **Python:** Core language for backend development, facilitating integration with machine learning models and handling API requests.
- **Flask (==3.0.0):** Lightweight web framework for building APIs that handle requests from the frontend and interact with machine learning models for dehazing.
- **Flask-CORS (==5.0.0):** Middleware used to enable Cross-Origin Resource Sharing (CORS), allowing the frontend and backend to communicate securely across different domains or ports.

Image/Video Processing and Model Training :

- **ONNX :** Open Neural Network Exchange format used for deploying trained deep learning models for dehazing.
- **PyTorch (==2.8.0) :** PyTorch is used for tensor operations, neural network layers, optimization, and more. From torch.nn for neural network layers and optim for optimaization of training of deep learning models.
- **NumPy (==1.26.2) :** Library for numerical computing, used extensively for matrix manipulations and image processing tasks, such as handling image arrays.
- **Pillow (==10.1.0) :** Python Imaging Library used to load, save, and manipulate images for preprocessing (e.g., resizing, format conversion) and postprocessing after dehazing.
- **Opencv (==4.9.0.80) :** Used for image manipulation tasks such as reading, resizing, and filtering images, and also for post-processing during the evaluation phase.

Testing :

- **Postman :** Used for testing API endpoints by simulating frontend-backend communication, ensuring that the image upload, dehazing, and download processes are working as expected.
- **OpenCV :** Open Source Computer Vision library, used to validate image transformations programmatically by comparing key metrics such as resolution, pixel intensity, and image clarity after dehazing.

CHAPTER - 5

5. IMPLEMENTATION

5.1. Steps for Setting up Environment :

1. Prepare the Environment :

- **Set Up Python Environment :** Install Python.
- **Install Dependencies :** Use pip to install required libraries (e.g., PyTorch, Flask, OpenCV, Pillow).

2. Train the model :

- **Datasets :** Collect datasets of hazy and clear images for trianing the model.
- **Pre-Process the Images :** Pre-Process the images such as resizing and normalization.
- **Transmission Map :** Calculate transmission map using dark channel priori algoithm.
- **Architecture of neural networks :** Define class for neural network layers and other classes such as Residual blocks, Channel Attention and Spatial Attention mechnisms.
- **Train the model :** Train the model on the neural network with the hazy images and transmission maps, with learning rate and early stopping mechanism, for 30 epochs.
- **Test the model :** Test that the model is giving proper outputs.
- **Convert to Onnx format :** Convert model to onnx format for simplified use.

3. Set Up a Backend API (Using Flask) :

- **Create Flask App :** Set up a Flask application to handle incoming HTTP requests with endpoints to accept inputs and return outputs.
- **Apply Model to Uploaded Image :** In the endpoint handler, process the uploaded image through the dehazing model.

4. Load the Trained Dehazing Model :

- **Model Loading :** Load your trained model using onnx.InferenceSession().

5. Implement Image Preprocessing :

- **Resize Image :** Resize the uploaded hazy image to a fixed size that the model expects.
- **Normalize Image :** Normalize the image.
- **Convert Image to Tensor :** Convert the image into a numpy array before passing it to the model.
- **Calculate Transmission map :** The transmission map is calculated using Dark Channel Priori Algorithm.

6. Implement Video Processing :

- **Extract frames :** Extract frames from the video and process same as image.
- **Create dehazed video :** Write the dehazed frames to video and return to frontend.

7. Apply the Dehazing Model :

- **Feed Image to Model:** The preprocessed image and the transmission map are passed to the trained dehazing model to get the dehazed output.

8. Post-process the Model Output :

- **Convert Image :** Convert the model's output back to Image.

9. Integrate with Frontend :

- **Frontend Image Upload :** Allow users to upload hazy media from gallery or camera via the frontend.
- **Send Request to Backend :** Send the uploaded media to the Flask backend for dehazing via a POST request.
- **Display Dehazed Result :** Receive the processed (dehazed) media from the backend and display it in the frontend.

10. Options for user :

- **Save and Share :** The user is given option to save the media to gallery or share it.

11. Privacy and Security :

- **Ensure Privacy:** User-uploaded images are not stored permanently on the server and are only processed temporarily and deleted after displaying to the user.

5.2. Coding the Logic :

Model Architecture (ModelTrain.py) :

```
import torch, torch.nn as nn, torch.optim as optim, torch.nn.functional as F, torchvision.transforms as
   transforms
from torch.amp import GradScaler, autocast
from torch.optim.lr_scheduler import ReduceLROnPlateau
from PIL import Image, ImageFilter
import numpy as np, cv2, os, random

def dark_channel_prior(image, window_size=15):
    dark_channel = np.min(image, axis=2)
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (window_size, window_size))
    dark_channel = cv2.erode(dark_channel, kernel)
    return dark_channel
def atmospheric_light(image, dark_channel):
    num_pixels = image.shape[0] * image.shape[1]
    num_brightest = int(max(num_pixels * 0.001, 1))
    indices = np.argsort(dark_channel.ravel())[-num_brightest:]
    brightest_pixels = image.reshape(-1, 3)[indices]
    A = brightest_pixels.mean(axis=0)
    return A
def transmission_estimate(image, A, omega=0.95, window_size=15):
    norm_image = image / A
    transmission = 1 - omega * dark_channel_prior(norm_image, window_size)
    return transmission

class ResidualBlock(nn.Module):
    def _init_(self, in_channels, out_channels, stride=1, padding=1):
        super(ResidualBlock, self)._init_()
        self.conv1 = nn.Conv2d(in_channels, out_channels, kernel_size=3, stride=stride, padding=padding)
        self.bn1 = nn.BatchNorm2d(out_channels)
        self.relu = nn.ReLU(inplace=True)
        self.conv2    =    nn.Conv2d(out_channels,    out_channels,    kernel_size=3,    stride=stride,
padding=padding)
        self.bn2 = nn.BatchNorm2d(out_channels)
        self.skip_connection  =  nn.Conv2d(in_channels,  out_channels,  kernel_size=1,  stride=stride,
padding=0) if in_channels != out_channels else None

    def forward(self, x):
        identity=x
        if self.skip_connection:
            identity=self.skip_connection(x)
        out = self.conv1(x)
        out = self.bn1(out)
        out = self.relu(out)
        out = self.conv2(out)
        out = self.bn2(out)
        out += identity  # Add skip connection
        out = self.relu(out)
        return out

class ChannelAttention(nn.Module):
    def _init_(self, in_channels, reduction=16):
        super(ChannelAttention, self)._init_()
        self.avg_pool = nn.AdaptiveAvgPool2d(1)
        self.max_pool = nn.AdaptiveMaxPool2d(1)

        self.fc = nn.Sequential(
            nn.Conv2d(in_channels, in_channels // reduction, 1, bias=False),
            nn.ReLU(inplace=True),
            nn.Conv2d(in_channels // reduction, in_channels, 1, bias=False)
```

```
        )
        self.sigmoid = nn.Sigmoid()
    def forward(self, x):
        avg_out = self.fc(self.avg_pool(x))
        max_out = self.fc(self.max_pool(x))
        out = avg_out + max_out
        return self.sigmoid(out) * x

class SpatialAttention(nn.Module):
    def _init_(self, kernel_size=7):
        super(SpatialAttention, self)._init_()
        assert kernel_size in (3, 7), 'Kernel size must be 3 or 7'
        padding = (kernel_size - 1) // 2
        self.conv = nn.Conv2d(2, 1, kernel_size, padding=padding, bias=False)
        self.sigmoid = nn.Sigmoid()
    def forward(self, x):
        avg_out = torch.mean(x, dim=1, keepdim=True)
        max_out, _ = torch.max(x, dim=1, keepdim=True)
        out = torch.cat([avg_out, max_out], dim=1)
        out = self.conv(out)
        return self.sigmoid(out) * x

class ImprovedDehazeNet(nn.Module):
    def _init_(self, num_residual_blocks=5):
        super(ImprovedDehazeNet, self)._init_()
        self.initial_block = ResidualBlock(4, 64)
        self.residual_layers = nn.ModuleList()
        in_channels =64
        for i in range(num_residual_blocks):
            out_channels = in_channels * 2 if i % 2 == 0 else in_channels
            self.residual_layers.append(ResidualBlock(in_channels, out_channels))
            in_channels = out_channels
        self.spatial_attention = SpatialAttention()
        self.channel_attention = ChannelAttention(in_channels)
        self.deconv1 = nn.ConvTranspose2d(in_channels, 128, kernel_size=3, padding=1)
        self.deconv2 = nn.ConvTranspose2d(128, 64, kernel_size=3, padding=1)
        self.deconv3 = nn.ConvTranspose2d(64, 3, kernel_size=3, padding=1)
        self.dropout = nn.Dropout(0.5)
    def forward(self, x, dcp_features):
        x = torch.cat((x, dcp_features), dim=1)
        x = self.initial_block(x)
        for layer in self.residual_layers:
            x = layer(x)
        x = self.spatial_attention(x)
        x = self.channel_attention(x)
        x = F.relu(self.deconv1(x))
        x = self.dropout(F.relu(self.deconv2(x + x)))
        x = self.deconv3(x + x)
        return x

def train_model(model, train_loader, val_loader, num_epochs=40, lr=1e-4, patience=3, factor=0.5,
early_stopping_patience=20, max_grad_norm=1.0, perceptual_weight=0.1):
    model.to(device)
    optimizer = optim.Adam(model.parameters(), lr=lr)
    scheduler = ReduceLROnPlateau(optimizer, mode='min', patience=patience, factor=factor)
    mse_loss = torch.nn.MSELoss()
    vgg_weights_path = '/kaggle/input/vgg16-39/vgg16-397923af.pth'
    perceptual_loss = PerceptualLoss(vgg_weights_path)
    best_val_loss = float('inf')
    epochs_no_improve = 0
    train_losses = []
    val_losses = []
    scaler = GradScaler()
    for epoch in range(num_epochs):
        model.train()
```

```
        running_loss = 0.0
        for hazy_images, clear_images, dcp_images in train_loader:
            hazy_images, clear_images, dcp_images = hazy_images.to(device), clear_images.to(device),
dcp_images.to(device)
            optimizer.zero_grad()
            with autocast(device_type='cuda'):
                outputs = model(hazy_images, dcp_images)
                mse = mse_loss(outputs, clear_images)
                perc_loss = perceptual_loss(outputs, clear_images)
                loss = mse + perceptual_weight * perc_loss
            scaler.scale(loss).backward()
            torch.nn.utils.clip_grad_norm_(model.parameters(), max_grad_norm)
            scaler.step(optimizer)
            scaler.update()
            running_loss += loss.item()
        avg_train_loss = running_loss / len(train_loader)
        train_losses.append(avg_train_loss)
        print(f"Epoch [{epoch+1}/{num_epochs}], Training Loss: {avg_train_loss}")

        val_loss = validate_model(model, val_loader, mse_loss, perceptual_loss, perceptual_weight)
        val_losses.append(val_loss)
        print(f"Epoch [{epoch+1}/{num_epochs}], Validation Loss: {val_loss}")
        scheduler.step(val_loss)
        if val_loss < best_val_loss:
            best_val_loss = val_loss
            save_checkpoint(model, optimizer, epoch, best_val_loss)
            epochs_no_improve = 0
        else:
            epochs_no_improve += 1
            print(f"No improvement in validation loss for {epochs_no_improve} epoch(s)")
        if epochs_no_improve >= early_stopping_patience:
            print(f"Early stopping at epoch {epoch+1}")
            break
    print("Training Complete")
```

Converting model to ONNX :

```
hazy_image = load_image(‘sample_image.jpg')
hazy_tensor = image_to_tensor(hazy_image).to(device)
dark_channel = dark_channel_prior(hazy_image)
A = atmospheric_light(hazy_image, dark_channel)
transmission = transmission_estimate(hazy_image, A)
dcp_tensor = image_to_tensor(transmission).to(device)
onnx_model_path = 'model_converted.onnx'
try:
    torch.onnx.export(model,   (hazy_tensor,   dcp_tensor),onnx_model_path,   input_names=['hazy_image',
'dcp_features'],               output_names=['output'], dynamic_axes={'hazy_image': {0: 'batch_size'},
'dcp_features':    {0:    'batch_size'},        'output':    {0:    'batch_size'}},    opset_version=12,
do_constant_folding=True, keep_initializers_as_inputs=False   # Keep initializers as inputs (useful for
certain models) )
    print(f"Model has been successfully converted to ONNX and saved at: {onnx_model_path}")
except Exception as e:
    print(f"Error during ONNX export: {e}")
```

Frontend (App.js) :

```
import React, { useState, useEffect, useRef } from 'react';
import { View, Button, Image, Text, StyleSheet, Alert, ActivityIndicator, ScrollView,
TouchableOpacity,Modal,ImageBackground} from 'react-native';
import * as ImagePicker from 'expo-image-picker';
import * as VideoPicker from 'expo-media-library';
import * as FileSystem from 'expo-file-system';
import axios from 'axios';
import { Video } from 'expo-av';
import { shareAsync } from 'expo-sharing';
import * as MediaLibrary from 'expo-media-library';

export default function App() {
  const [mediaUri, setMediaUri] = useState(null);
  const [mediaType, setMediaType] = useState(null);
  const [resultUri, setResultUri] = useState(null);
  const [imageAspectRatio, setImageAspectRatio] = useState(1);
  const [loading, setLoading] = useState(false);
  const videoRef = useRef(null);
  const [isModalVisible, setModalVisible] = useState(false);
  const [isResModalVisible,setResModalVisible]=useState(false);
  const [hasMediaLibraryPermission, setHasMediaLibraryPermission] = useState();
  const showMediaTypeModal = (type) => {setMediaType(type);setModalVisible(true);};

const chooseMediaSource = (source) => {
    if (source === 'gallery') {
      mediaType === 'image' ? pickImageFromGallery() : pickVideoFromGallery();
    } else if (source === 'camera') {
      mediaType === 'image' ? captureImage() : captureVideo();
    }
    setModalVisible(false);
  };
  const requestPermissions = async () => {
    const { status } = await ImagePicker.requestMediaLibraryPermissionsAsync();
    const cameraStatus = await ImagePicker.requestCameraPermissionsAsync();
    const videoStatus = await VideoPicker.requestPermissionsAsync();
    const mediaLibraryPermission = await MediaLibrary.requestPermissionsAsync();

    if (status !== 'granted' || cameraStatus !== 'granted' || videoStatus.status !== 'granted') {
      Alert.alert('Permission Required', 'Permission to access gallery or camera is required!');
    }
  };

  useEffect(() => {requestPermissions();}, []);
  const pickImageFromGallery = async () => {
    let result = await ImagePicker.launchImageLibraryAsync({
      mediaTypes: ImagePicker.MediaTypeOptions.Images,
      allowsEditing:true,
      quality: 1,
    });
    if (!result.canceled) {
      setMediaUri(result.assets[0].uri);
      setMediaType('image');
      getImageAspectRatio(result.assets[0].uri);
      uploadMedia(result.assets[0].uri, 'image');
    } else { Alert.alert('No Image Selected', 'Please select an image to proceed.');}
  };

  const pickVideoFromGallery = async () => {
    let videoResult = await ImagePicker.launchImageLibraryAsync({
      mediaTypes: ImagePicker.MediaTypeOptions.Videos,
      allowsEditing:true,
    });
    if (!videoResult.canceled) {
      setMediaUri(videoResult.assets[0].uri);
      setMediaType('video');
```

```
      uploadMedia(videoResult.assets[0].uri, 'video');
    } else { Alert.alert('No Video Selected', 'Please select a video to proceed.');}
  };

  const captureImage = async () => {
    let result = await ImagePicker.launchCameraAsync({quality: 1});
    if (!result.canceled) {
      setMediaUri(result.assets[0].uri);
      setMediaType('image');
      getImageAspectRatio(result.assets[0].uri);
      uploadMedia(result.assets[0].uri, 'image');
    } else { Alert.alert('No Image Captured', 'Please capture an image to proceed.');}
  };

  const captureVideo = async () => {
    let result = await ImagePicker.launchCameraAsync({mediaTypes:
ImagePicker.MediaTypeOptions.Videos,quality: 1, videoStabilization: true});
    if (!result.canceled) {
      setMediaUri(result.assets[0].uri);
      setMediaType('video');
      uploadMedia(result.assets[0].uri, 'video');
    } else {Alert.alert('No Video Captured', 'Please capture a video to proceed.');}
  };

  const uploadMedia = async (uri, type) => {
    setLoading(true);
    setResModalVisible(true);
    setResultUri(null);
    try {
      const formData = new FormData();
      formData.append(type, {uri,name: type === 'image' ? 'image.jpg' : 'video.mp4',type: type ===
'image' ? 'image/jpeg' : 'video/mp4'});
      const response = await axios.post('http://192.168.93.170:5000/dehaze-' + type, formData, {headers:
{ 'Content-Type': 'multipart/form-data' }});
      if (response.data.image_path || response.data.video_path) {
        const timestamp = new Date().getTime();
        setResultUri('http://192.168.93.170:5000/uploads/' + (response.data.image_path ||
response.data.video_path) + `?t=${timestamp}`);
      } else {Alert.alert('Error', 'No processed media path returned');}
    } catch (error) {
      console.error('Error uploading media:', error);
      Alert.alert('Error', error.response?.data?.message || 'There was a problem uploading the media.
Please try again later.');
    } finally {setLoading(false); }
  };

  const deleteMediaFile = async () => {
    try {
      if (mediaUri) {
        console.log("Deleting mediaUri:", mediaUri);
        await axios.post('http://192.168.93.170:5000/delete-file', { uri: mediaUri });
        console.log('File successfully deleted from server.');
      }
    } catch (error) {
      console.error('Error deleting file:', error);
    } finally {
      setResModalVisible(false);}
  };

  return (
      <View style={styles.container}>
        <Text style={styles.header}>Dehaze</Text>
      <TouchableOpacity style={styles.button} onPress={() => showMediaTypeModal('image')}>
        <Text style={styles.buttonText}>Image</Text>
      </TouchableOpacity>
      <TouchableOpacity style={styles.button} onPress={() => showMediaTypeModal('video')}>
        <Text style={styles.buttonText}>Video</Text>
      </TouchableOpacity>
```

```
      {isModalVisible && (
        <Modal visible={isModalVisible} transparent={true} animationType="slide"onRequestClose={() =>
deleteMediaFile()}>
          <View style={styles.modalOverlay}>
            <View style={styles.modalContent}>
              <Text style={styles.modalHeader}>Select Media Source</Text>
              <TouchableOpacity style={styles.modalButton}onPress={() => chooseMediaSource('gallery')}>
                <Text style={styles.modalButtonText}>Gallery</Text>
              </TouchableOpacity>
              <TouchableOpacity style={styles.modalButton} onPress={() => chooseMediaSource('camera')}>
                <Text style={styles.modalButtonText}>Camera</Text>
              </TouchableOpacity>
              <TouchableOpacity style={[styles.modalButton]} onPress={() => setModalVisible(false)}>
                <Text style={[styles.modalButtonText, { color:'black' }]}>Cancel</Text>
              </TouchableOpacity>
            </View>
          </View>
        </Modal>
      )}
      {isResModalVisible && (
        <Modal visible={isResModalVisible} transparent={true} animationType="slide" onRequestClose={()
=> deleteMediaFile()}>
            <View style={styles.resModalOverlay}>
            <View style={styles.resModalContent}>
            <ScrollView contentContainerStyle={styles.scrollContainer}>
              {mediaUri && mediaType === 'image' && (
                <Image source={{ uri: mediaUri }} style={[styles.mediaPreview,{aspectRatio:
imageAspectRatio }]}/>
              )}
              {resultUri && mediaType === 'image' && !loading && (
                <Image source={{ uri: resultUri }} style={[styles.mediaPreview,{aspectRatio:
imageAspectRatio}]}/>
              )}
              {mediaUri && mediaType === 'video' && (<View style={styles.videoContainer}>
                <Video source={{ uri: mediaUri }} style={styles.video} useNativeControls
resizeMode="contain"/>
                </View>
              )}
              {resultUri && mediaType === 'video' && (<View style={styles.videoContainer}>
                <Video source={{ uri: resultUri }} style={styles.video} useNativeControls
resizeMode="contain" />
                </View>
              </>
              )}
              </ScrollView>
            </View>
          </View>
        </Modal>
        </>
      )}
      </View>
  );
};
```

Backend (server.py) :

```
import os
import cv2
import numpy as np
import torch
import onnxruntime as ort
from flask import Flask, request, jsonify, send_from_directory
from werkzeug.utils import secure_filename
from PIL import Image
from flask_cors import CORS

app = Flask(__name__)
CORS(app)
```

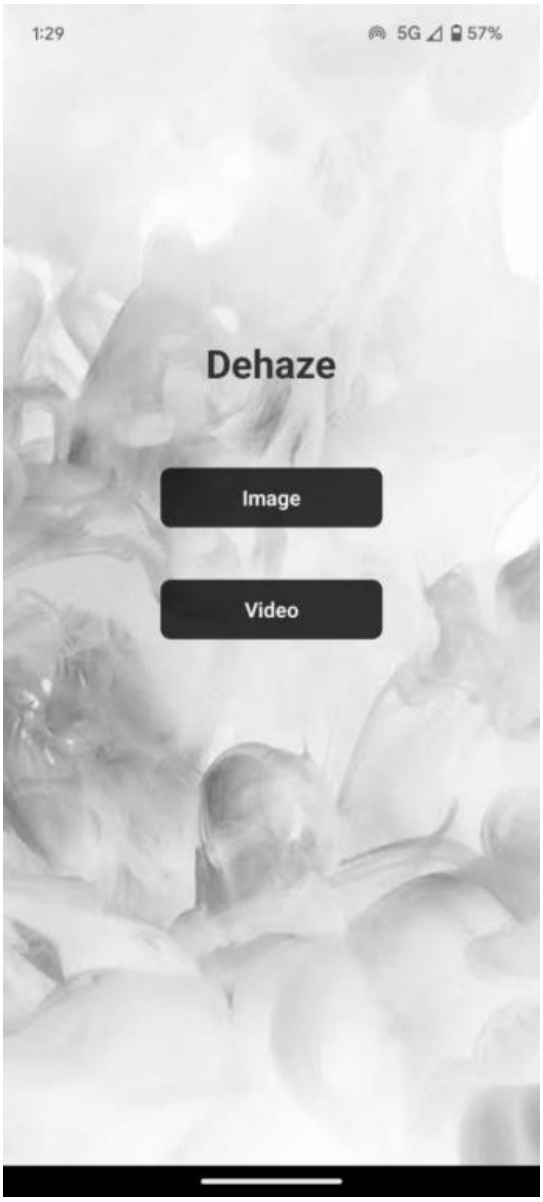
```
UPLOAD_FOLDER = 'uploads'
ALLOWED_EXTENSIONS = {'png', 'jpg', 'jpeg', 'mp4', 'avi'}
MODEL_PATH = 'model_converted (3).onnx'

session = ort.InferenceSession(MODEL_PATH)

def allowed_file(filename):
    return '.' in filename and filename.rsplit('.', 1)[1].lower() in ALLOWED_EXTENSIONS

def dehaze_image(image_path):
    image = load_image(image_path)
    original_size = Image.open(image_path).convert('RGB').size
    inputs=preprocess(image)
    outputs = session.run(None, inputs)
    dehazed_image = tensor_to_image(outputs[0])
    dehazed_image_resized = Image.fromarray((dehazed_image * 255).astype(np.uint8))
    dehazed_image_resized = dehazed_image_resized.resize(original_size, Image.LANCZOS)
    result_image_path = os.path.join(UPLOAD_FOLDER, 'dehazed_image.png')
    dehazed_image_resized.save(result_image_path)
    return result_image_path

@app.route('/dehaze-image', methods=['POST'])
def dehaze_image_api():
    if 'image' not in request.files:
        return jsonify({'error': 'No image part'}), 400
    file = request.files['image']
    if file.filename == '' or not allowed_file(file.filename):
        return jsonify({'error': 'Invalid file format'}), 400
    filename = secure_filename(file.filename)
    image_path = os.path.join(UPLOAD_FOLDER, filename)
    file.save(image_path)
    dehazed_image_path = dehaze_image(image_path)
    return jsonify({'image_path': 'dehazed_image.png'})

def dehaze_video(video_path):
    cap = cv2.VideoCapture(video_path)
    frame_width = int(cap.get(cv2.CAP_PROP_FRAME_WIDTH))
    frame_height = int(cap.get(cv2.CAP_PROP_FRAME_HEIGHT))
    fps = cap.get(cv2.CAP_PROP_FPS)
    total_frames = int(cap.get(cv2.CAP_PROP_FRAME_COUNT))
    output_video_path = os.path.join(UPLOAD_FOLDER, 'dehazed_video.mp4')
    fourcc = cv2.VideoWriter_fourcc(*'mp4v')
    out = cv2.VideoWriter(output_video_path, fourcc, fps, (frame_width, frame_height))  # Use original
size
    frame_counter=0
    while cap.isOpened():
        ret, frame = cap.read()
        if not ret:
            break
        frame_counter += 1
        if (frame_counter%10==0):
            print(f"Processing frame {frame_counter}/{total_frames}...")
        dehazed_frame = dehaze_frame(frame)
        if dehazed_frame is not None:
            dehazed_frame_resized = cv2.resize(dehazed_frame, (frame_width, frame_height))
            dehazed_frame_resized = cv2.cvtColor(dehazed_frame_resized, cv2.COLOR_RGB2BGR)
            dehazed_frame_bgr = (dehazed_frame_resized * 255).astype(np.uint8)
            out.write(dehazed_frame_bgr)
    cap.release()
    out.release()
    return output_video_path

def preprocess(img):
    dark_channel = dark_channel_prior(img)
    A = atmospheric_light(img, dark_channel)
    transmission = transmission_estimate(img, A)
    transmission_tensor = image_to_tensor(transmission)
    hazy_tensor = image_to_tensor(img)
    hazy_image_np = np.asarray(hazy_tensor.detach().numpy())
```

```
    dcp_tensor_np = np.asarray(transmission_tensor.detach().numpy())
    inputs = {'hazy_image': hazy_image_np,'dcp_features': dcp_tensor_np}
    return inputs

def dehaze_frame(frame):
    frame_rgb = cv2.resize(frame, (512,512))
    frame_rgb = cv2.cvtColor(frame_rgb, cv2.COLOR_BGR2RGB)
    frame_rgb = frame_rgb / 255.0
    inputs=preprocess(frame_rgb)
    outputs = session.run(None, inputs)
    dehazed_frame = tensor_to_image(outputs[0])
    return dehazed_frame

@app.route('/delete-file', methods=['POST'])
def delete_file():
    files_to_delete = ["image.jpg","dehazed_image.png","dehazed_video.mp4","video.mp4"]
    for filename in files_to_delete:
        file_path = os.path.join(UPLOAD_FOLDER, filename)
        if os.path.exists(file_path):
            try:
                os.remove(file_path)
            except Exception as e:
                print(f"Error deleting file {filename}: {e}")
    return jsonify({'message': 'Files deleted successfully'}), 200

@app.route('/dehaze-video', methods=['POST'])
def dehaze_video_api():
    if 'video' not in request.files:
        return jsonify({'error': 'No video part'}), 400
    file = request.files['video']
    if file.filename == '' or not allowed_file(file.filename):
        return jsonify({'error': 'Invalid file format'}), 400
    filename = secure_filename(file.filename)
    video_path = os.path.join(UPLOAD_FOLDER, filename)
    file.save(video_path)
    dehazed_video_path = dehaze_video(video_path)
    return jsonify({'video_path': 'dehazed_video.mp4'})

def load_image(path, size=(512,512)):
    image = Image.open(path).convert('RGB')
    image = image.resize(size, Image.LANCZOS)
    image = np.asarray(image) / 255.0
    return image

def dark_channel_prior(image, window_size=15):
    dark_channel = np.min(image, axis=2)
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (window_size, window_size))
    dark_channel = cv2.erode(dark_channel, kernel)
    return dark_channel

def atmospheric_light(image, dark_channel):
    num_pixels = image.shape[0] * image.shape[1]
    num_brightest = int(max(num_pixels * 0.001, 1))
    indices = np.argsort(dark_channel.ravel())[-num_brightest:]
    brightest_pixels = image.reshape(-1, 3)[indices]
    A = brightest_pixels.mean(axis=0)
    return A

def transmission_estimate(image, A, omega=0.95, window_size=15):
    norm_image = image / A
    transmission = 1 - omega * dark_channel_prior(norm_image, window_size)
    return transmission

def image_to_tensor(image):
    if len(image.shape) == 3 and image.shape[2] == 3:
        image = torch.FloatTensor(image).permute(2, 0, 1).unsqueeze(0)
    elif len(image.shape) == 2:
        image = torch.FloatTensor(image).unsqueeze(0).unsqueeze(0)
    else:
```

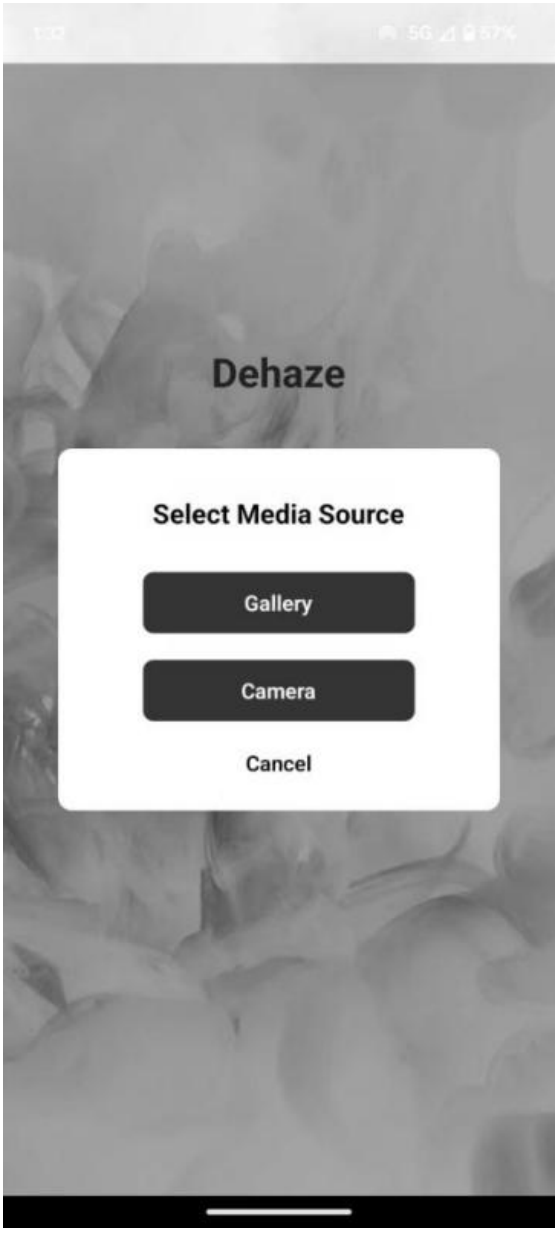
```
            raise ValueError("Unsupported image dimensions")
        return image

    def tensor_to_image(tensor):
        if isinstance(tensor, np.ndarray):
            image = np.squeeze(tensor)
            image = np.transpose(image, (1, 2, 0))
            image = np.clip(image, 0, 1)
        return image

    @app.route('/uploads/<filename>')
    def uploaded_file(filename):
        return send_from_directory(UPLOAD_FOLDER, filename)

    if __name__ == '__main__':
        app.run(debug=True, host='0.0.0.0', port=5000)
```

5.3. Screenshots

5.3.1. Frontend UI :

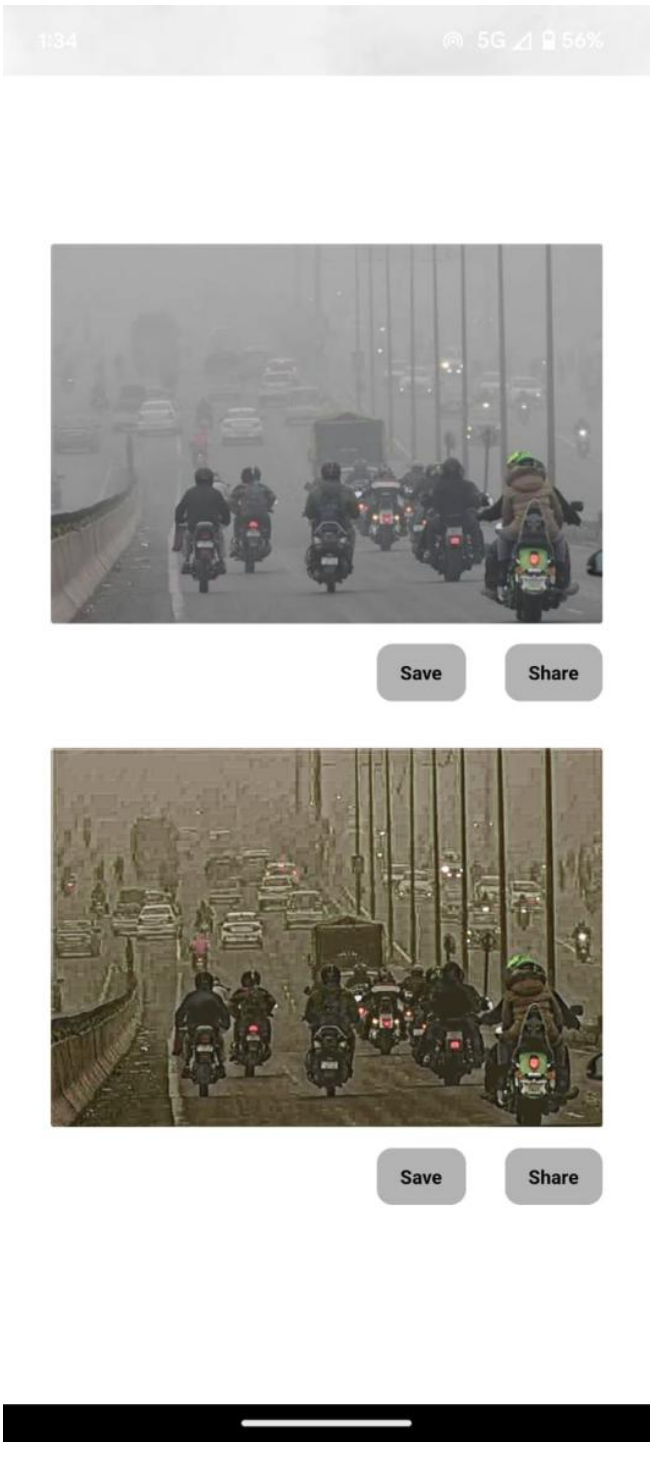


5.3.2. Selecting Source :



5.3.3. Result Screen :

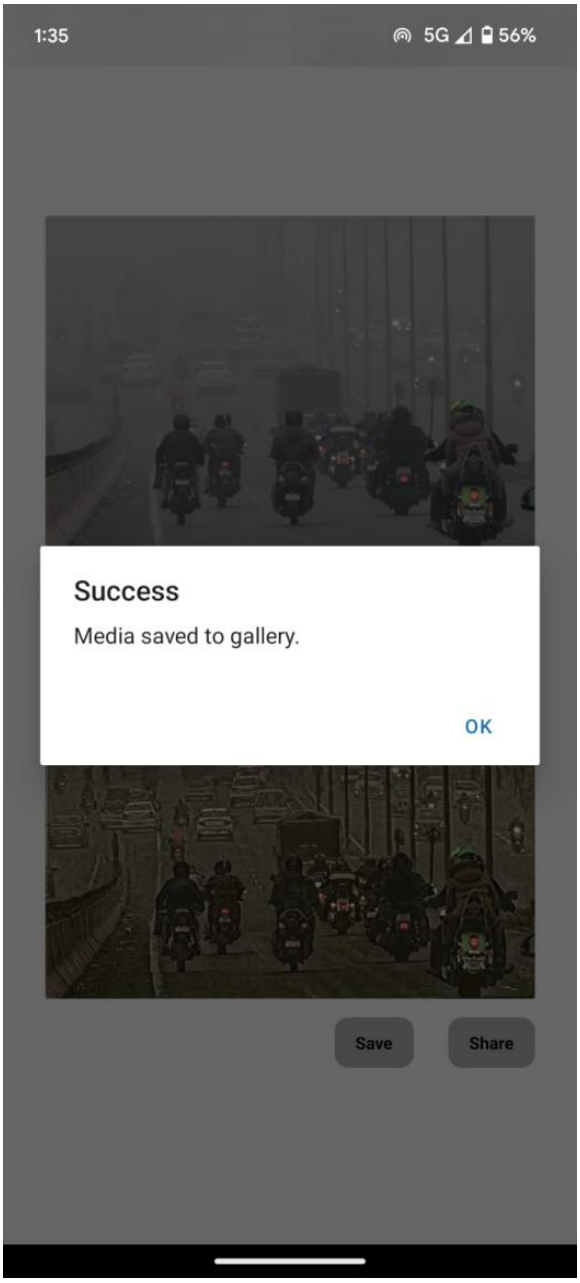
Image :



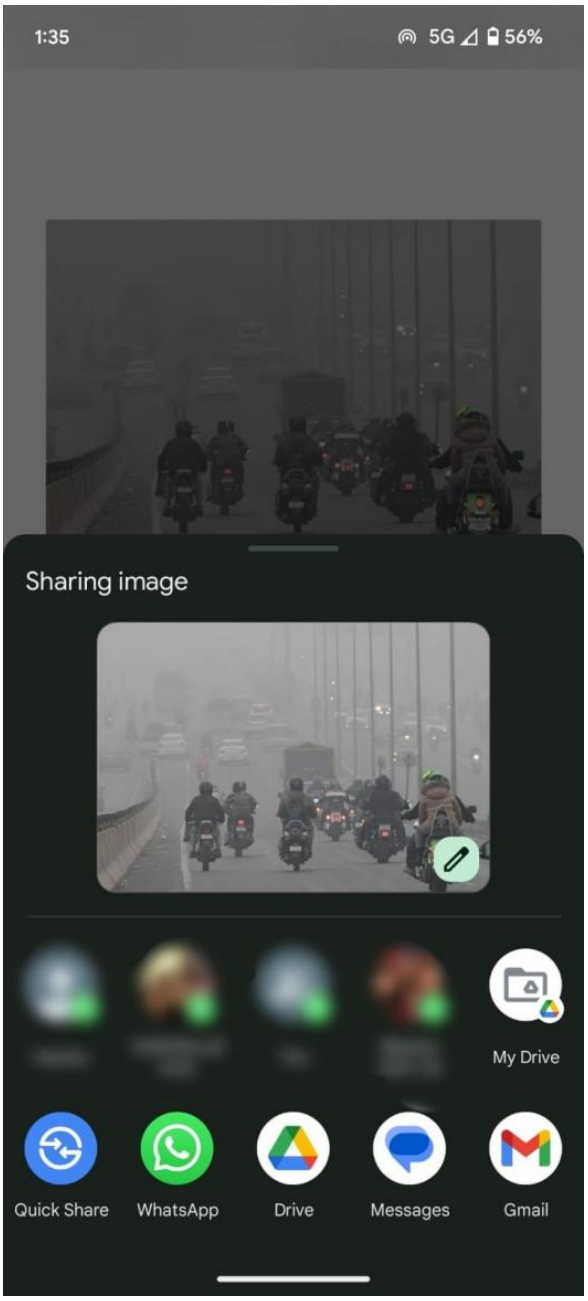
Video :

5.3.4. Saving and Sharing :

Save :



Share :



CHAPTER - 6

6. SOFTWARE TESTING

6.1. Introduction :

Software testing is a critical phase in the development life cycle, aiming to ensure that the DeHazing Mobile App project meets functional, performance, and security standards. This process validates that the system behaves as expected and provides a smooth experience to users, covering user upload, dehazing process, download and sharing functionalities.

6.1.1. Testing Objectives :

The primary objectives of testing the DeHazing Mobile App are :

- To verify that the application accurately removes haze, fog or smoke form the user uploaded media.
- To ensure media format restrictions work correctly, displaying appropriate error messages when requirements are not met.
- To confirm that the UI provides real-time feedback during processing and handles error states gracefully.
- To ensure data privacy by deleting the media uploaded and processed.

6.1.2. Testing Strategies :

The testing strategies for the DeHazing Mobile App project include :

- **Unit Testing:** Testing individual functions such as media validation, processing and format checking.
- **Integration Testing:** Validating interactions between the frontend and backend, ensuring data flows smoothly and CORS settings are effective.
- **System Testing:** Conducting end-to-end testing on the entire application to verify user actions from upload to download.
- **Performance Testing:** To ensure the system performs well under load and meets performance standard.
- **User Acceptance Testing (UAT):** Ensuring the application meets user expectations for design, usability, and functionality.

6.1.3. System Evaluation :

System evaluation assesses the DeHazing Mobile App system's ability to fulfill user requirements. Key evaluation criteria include:

- **Functionality:** The system should remove haze,fog or smoke from the uploaded media accurately.

- **Usability:** The UI should be user-friendly, intuitive, and should respond quickly to user inputs.
- **Reliability:** The system should handle multiple requests without crashing, ensuring consistent performance.
- **Privacy**: User-uploaded media is stored securely in the database and deleted immediately after processing, aligning withprivacy standards.

6.1.4. Testing New System :

Testing the new system involves verifying that all features work as expected in the livve enviroment. This includes :

- **Functionality Testing**: Confirming that all primary features (upload, dehazing, download, sharing) operate seamlessly.
- **Postman :** Validates API endpoints between the frontend and backend, ensuring correct data flow(e.g., sending an image to the backend and receiving the dehazed image).
- **Compatibility Testing:** Testing the project across devices to ensure a consistent user experience.
- **Exception Handling:** Checking that the application gracefully errors, by displaying clear messages.

6.2. Test Cases :

Test Case 1 : User Image/Video Upload with Valid Format.

- **Description** : Verify that the app accepts images in .jpg, .png, or .jpeg format for images and mpv4 for videos.
- **Expected Outcome** : The media is accepted, and ready for processing.
- **Original Outcome** : The app successfully accepts valid formats, allowing for dehazing.

Test Case 2 : User Image/ video Upload with Invalid Format.

- **Description:** Attempt to upload an unsupported image format (e.g., .pdf).
- **Expected Outcome:** The app does not consider these formats defaultly.
- **Original Outcome:** Opens media only with supported formats.

Test Case 3 : Image Dehazing within Time Constraint.

- **Description:** Upload a hazy image and apply dehazing. Measure the processing time to ensure it completes within a reasonable time frame (e.g., 15-20 seconds).
- **Expected Outcome:** The dehazing process completes successfully within the expected time limit.
- **Original Outcome:** The image is dehazed in approximately 18 seconds, meeting the time constraint for processing.

Test Case 4 : Download Dehazed media.

- **Description:** After the media has been processed, attempt to download the dehazed media.
- **Expected Outcome:** The user should successfully download the dehazed media in the correct format (e.g., .png or .jpeg for images and mpv4 for videos).
- **Original Outcome:** The user is able to download the dehazed media without any issues in the correct format.

Test Case 5 : Admin Dashboard Functionality (If applicable).

- **Description:** Test the admin's ability to view user actions (e.g., tracking uploaded images, dehazing requests).
- **Expected Outcome:** The admin should be able to view a list of user actions, including uploads, dehazing requests, and results.
- **Original Outcome:** The admin dashboard correctly displays user interactions and dehazing history.

Test Case 6 : Error Handling for Network Issues.

- **Description:** Simulate a network issue or internet disconnect while the dehazing process is in progress.
- **Expected Outcome:** The system should display an appropriate error message and allow the user to retry the process once the connection is restored.
- **Original Outcome:** The system detects the issue, displays an error message such as "Network Error. Please check your connection," and allows the user to retry the dehazing process once connectivity is restored.

Test Case 7 : Privacy Check for Uploaded Images.

- **Description:** Verify that uploaded images are not stored in the database or server once they have been processed.
- **Expected Outcome:** The image should be processed and discarded immediately, with no storage of the original or dehazed images in the backend, respecting user privacy.
- **Original Outcome:** Uploaded images are only processed temporarily in memory and are not stored on the server or in any database, ensuring user privacy.

Test Case 8 : Handle Large Files.

- **Description:** Test uploading and processing of large files (e.g., >5MB).
- **Expected Outcome:** The system should be able to handle large media files and still provide dehazed results without crashing or freezing.
- **Original Outcome:** The app successfully processes large files within the expected time frame and without issues like crashes or unresponsiveness.

Test Case 9: User Interface Responsiveness.

- **Description:** Verify that the mobile application's interface remains responsive during the dehazing process (i.e., no freezing or crashing).

- **Expected Outcome:** The app should remain responsive to user inputs (e.g., cancelling the process, uploading new images) during media processing.
- **Original Outcome:** The interface remains fully functional while the dehazing process is ongoing, with users being able to cancel, upload new media, or navigate the app without issues.

Test Case 10: Handling of Extremely Hazy Images.

- **Description:** Upload an image with extreme haze or fog and test how well the dehazing model performs.
- **Expected Outcome:** The dehazing model should improve the clarity of the image, even in extremely hazy conditions, while ensuring that the output remains realistic.
- **Original Outcome:** The app successfully enhances the image, showing clear improvement in terms of brightness, contrast, and visibility, even for highly hazy images.

Test Case 11: Mobile Device Compatibility.

- **Description:** Test the app on multiple mobile devices (iOS and Android) and screen sizes.
- **Expected Outcome:** The app should work seamlessly across various devices and platforms (both Android and iOS), adjusting the UI layout to fit different screen sizes and resolutions.
- **Original Outcome:** The app performs consistently across different devices, with the layout adapting appropriately for each screen size.

CONCLUSION

The Dehazing Mobile Application project successfully demonstrates the ability to enhance the visibility of hazy, foggy or smoky media through a trained deep learning model, providing a valuable tool for users seeking to improve the clarity of their images/videos. By integrating modern technologies such as React Native, Expo, and Flask, the application delivers an intuitive user interface with a seamless backend powered by the trained model.

Throughout the development process, the key focus was on optimizing the user experience, ensuring that the application could easily handle the upload, dehazing, downloading and sharing of media. With a strong emphasis on performance, the application processes hazy media quickly, within a reasonable time frame, offering users fast and efficient results. Additionally, the app's user-friendly interface ensures smooth interaction, from uploading the media to receiving the final, dehazed output.

The application also prioritizes data privacy, ensuring that the media is being are stored securely during processing and deleted immediately, which aligns with user privacy expectations. Through thorough software testing, including functional, performance, and compatibility tests, the system was validated for various scenarios, guaranteeing its reliability and robustness.

Overall, this Dehazing Mobile Application provides a simple yet powerful solution to improve image/video visibility, enhancing the visual appeal of hazy, smoky and foggy media. It is a practical example of leveraging machine learning models for real-world applications, and it holds potential for future enhancements, such as batch processing, integration with live camera feeds, expanding its utility and accessibility even further.

FUTURE ENHANCEMENTS

- **Real-Time Camera Feed Dehazing :** Extend functionality to apply dehazing directly to live camera feeds.
- **Batch Processing :** Process multiple images or videos at once, with customizable dehazing levels and background processing.
- **Optimized Video Stream Dehazing :** Real-time dehazing for longer video streams, optimized for performance without lag.
- **AI-Powered Adaptive Dehazing :** Use AI to automatically detect and adjust dehazing levels based on content and environmental factors.
- **Interactive Before/After Comparison :** Side-by-side or slider comparison of original and dehazed images/videos to visualize results.
- **Advanced Image Enhancement :** Combine dehazing with color correction, contrast, and sharpness adjustments for improved clarity.
- **Cloud-Based Dehazing :** Offload heavy processing to the cloud for faster, high-quality dehazing without taxing device resources.
- **AR-Based Dehazing Preview :** Visualize real-time dehazing effects in your environment using augmented reality.
- **Custom Dehazing Profiles :** Save and apply custom dehazing settings for different environments, such as fog, snow, or cityscapes.
- **Cross-Platform Integration :** Integrate with drones, cameras, and external devices for seamless dehazing on footage from any source.
- **User Feedback for Algorithm Improvement :** Collect user feedback to refine the dehazing algorithm and improve results for specific conditions.
- **Offline Dehazing Mode :** Enable dehazing functionality without an internet connection, allowing users to process images and videos offline.

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