

PROJECT REQUIREMENTS SPECIFICATION

**Video Defogging**

**UE20CS390A – Capstone Project Phase – 1**

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# TABLE OF CONTENTS

|  |  |
| --- | --- |
| 1. Introduction | 3 |
| 1.1 Project Scope | 3 |
| 2. Product Perspective | 3 |
| 2.1 Product Features | 3 |
| 2.2 Operating Environment | 3 |
| 2.3 General Constraints, Assumptions and Dependencies | 3 |
| 2.4 Risks | 4 |
| 3. Functional Requirements | 4 |
| 4. External Interface Requirements | 4 |
| 4.1 User Interfaces | 4 |
| 4.2 Hardware Requirements | 4 |
| 4.3 Software Requirements | 4 |
| 4.4 Communication Interfaces | 5 |
| 5. Non-Functional Requirements | 5 |
| 5.1 Performance Requirements | 5 |
| 5.2 Safety Requirements | 5 |
| 5.3 Security Requirements | 5 |
| Appendix A: Definitions, Acronyms and Abbreviations | 5 |
| Appendix B: References | 5 |

1. **Introduction**

This document is a Project Requirements Specification for a video defogging system. The purpose of this document is to define the requirements for a software system that can remove fog from videos, making them clearer and more usable. The video defogging system is intended to be used by individuals or organizations that require clear video footage for various purposes, such as surveillance, analysis, and entertainment.

# Project Scope

The video defogging system is designed to take input video data, process it using a set of algorithms, and output a defogged video. The system's primary goal is to improve the clarity and visibility of videos captured in foggy or hazy conditions, thereby enhancing their usability for various applications.

The benefits of the video defogging system include the ability to:

* Improve the quality and clarity of videos captured in foggy or hazy conditions
* Enhance the accuracy and effectiveness of video-based analysis and surveillance
* Enable the use of previously unusable video footage for entertainment and other purposes

The objectives of the project are to:

* Develop a robust and reliable video defogging system that meets the specified requirements
* Optimize the system's performance to achieve high-quality results in a timely manner
* Ensure the system is easy to use and integrate with existing workflows

The goals of the project are to:

* Produce a fully functional video defogging system that meets the specified requirements and objectives
* Provide a user-friendly interface for the system that enables easy operation and integration
* Ensure the system is reliable, efficient, and scalable to meet future needs

The coverage of the system includes the processing of video data captured in foggy or hazy conditions, with the goal of producing clear and usable output. The limitations of the system include its inability to remove all types of visual obstructions, such as rain or snow, and its dependence on the quality of input video data for optimal performance.

# Product Perspective

The context and origin of a video defogging product can be traced back to the need for enhancing visibility in foggy or hazy weather conditions, particularly in outdoor surveillance and transportation applications. Fog, smoke, or haze can cause significant image degradation, leading to poor video quality and reduced visibility.

The development of video defogging technology began in the field of computer vision and image processing, with researchers exploring various algorithms and techniques to remove the effects of fog and haze from images and videos. This technology has since evolved to become a commercial product, with several companies offering video defogging solutions for a wide range of applications.

The origin of the specific video defogging project can vary, but it likely emerged from the need to provide a more effective and efficient video defogging solution. This could have been prompted by customer demand for better performance or a desire to outperform existing products in the market.

# Product Features

* Fog and Haze Removal: The product should be able to effectively remove fog and haze from video footage, improving visibility and image quality.
* User-Friendly Interface: The product should have an intuitive and user-friendly interface, making it easy for users to operate and adjust settings.
* Customizable Settings: The product should allow for customizable settings, such as adjusting the degree of defogging and other parameters, to meet specific user requirements.
* Compatibility: The product should be compatible with a wide range of cameras and video formats, allowing for seamless integration with existing systems.
* High-Quality Output: The product should produce high-quality output, with clear and detailed images that accurately reflect the scene being recorded.
* Efficient Processing: The product should be able to perform the defogging process efficiently, without causing significant delays or performance issues.
* Cost-Effectiveness: The product should provide a cost-effective solution for improving video quality in foggy or hazy conditions, with low maintenance requirements.

# Operating Environment

The video defogging system operate on a hardware platform with the following minimum specifications:

* CPU: Intel Core i5 or equivalent
* RAM: 8GB or higher
* GPU: Nvidia GTX 1060 or equivalent
* Storage: 500GB or higher
* Operating System: Windows 10, 64-bit

The system requires the following software components:

* Python 3.7 or higher
* OpenCV 4.0 or higher

# General Constraints, Assumptions and Dependencies

* The video defogging system must comply with any regulatory policies and guidelines related to the use of machine learning and image processing algorithms.
* The system's performance may be limited by hardware limitations, such as the processing speed and memory capacity of the CPU and GPU.
* The video defogging system is critical in certain applications, such as video surveillance and traffic monitoring, where accurate and timely processing is necessary.
* The system must adhere to safety and security considerations, such as data privacy and protection, to ensure the integrity of the video data and user information.
* It is assumed that the system will be thoroughly tested and validated to ensure its accuracy and reliability.
* Dependencies:
* The system's performance may depend on the availability and compatibility of third-party libraries and APIs, such as OpenCV and TensorFlow, used in the system's development.
* The system's accuracy and reliability may depend on the quality of the training data used to train the machine learning models.
* The system's performance may be affected by changes in the hardware and software environment in which it operates.

# Risks

|  |  |
| --- | --- |
| **Risk** | **Description** |
| Data quality | The system relies on high-quality input data, and poor input data may result in inaccurate output. |
| Resource requirements | The system requires significant computational resources, and a lack of resources may impact its performance. |
| Performance issues | Any delay in processing may lead to incomplete or inaccurate results. |
| Model overfitting | Overfitting may lead to poor performance and inaccurate results. |
| Security risks | A security breach may lead to the loss of critical data and breach of privacy. |
| Legal and ethical risks | The system's use may raise legal and ethical concerns that can impact its reputation and financial performance. |

# Functional Requirements

| **Req ID** | **Functional Requirement** | **Description** |
| --- | --- | --- |
| R1 | Image and video | The system should be able to take in input in the form of video files that need to be defogged. |
| R2 | Pre-processing | The system should have a pre-processing module that processes the input data to remove noise, adjust brightness and contrast, and apply any other necessary transformations to prepare the data for defogging. |
| R3 | Frame formation | The system should be able convert the video into image frames. |
| R4 | Defogging algorithms | The system should have one or more algorithms that can effectively remove fog from the input data. |
| R5 | User input | The system should allow users to adjust parameters such as the strength of the defogging algorithm. |
| R6 | Video formation | The system should be able convert the defogged frames to a video. |
| R7 | Output | The system should output defogged video files in a format that is easily accessible and viewable by the end-users. |
| R8 | Quality metrics | The system should provide some quantitative measures of the quality of the defogging. |
| R9 | Error handling | The system should be able to handle errors that may occur during processing, such as file format errors, memory errors, or other unexpected errors. |
| R10 | User interface | The system should have an intuitive and easy-to-use interface that allows users to interact with the system and control the defogging process. |
| R11 | Compatibility | The system should be compatible with different operating systems and hardware configurations to ensure it can be used on a wide range of devices. |

# External Interface Requirements

* 1. **User Interfaces**

| **Req ID** | **Interface Requirement** | **Description** |
| --- | --- | --- |
| UI1 | User Interface | The system should provide a user-friendly graphical user interface (GUI) with clear and intuitive screen layouts, colors, and styles. |
| UI2 | Standard Functions | The GUI should include standard functions such as Open File, Save, Zoom In/Out, Play/Pause, and Stop, which should be placed in a logical and consistent manner across all screens. |
| UI3 | Help Function | The system should provide a Help function that is easily accessible from any screen, and it should provide clear and concise explanations of the system's features and functions. |
| UI4 | Relative Timing | The system should have relative timing of inputs and outputs. For example, when the user clicks the "Play" button, the video should start playing immediately without any delay. |
| UI5 | Error Messages | The system should provide informative and clear error messages whenever a user performs an incorrect or inappropriate action. |
| UI6 | Compatibility | The system interface should be compatible with different operating systems. |
| UI7 | Preview and Adjustments | The system should provide a feature to preview the video defogging output. |

# Hardware Requirements

N/A

# Software Requirements

|  |  |
| --- | --- |
| Video Defogging App | Name and description, version/release number, databases, |
|  | operating systems, tools and libraries, source (if any) |
| Databases | Name and description, version/release number, operating systems, |
|  | tools and libraries, source (if any) |
| Tools and Libraries | Name and description, version/release number, operating systems, |

# Communication Interfaces

N/A

# Non-Functional Requirements

# Performance Requirement

| **Req ID** | **Performance Requirement** | **Description** |
| --- | --- | --- |
| NFR-1 | Performance | The system should be able to process foggy videos in real-time, with a maximum delay of 100ms. |
| NFR-2 | Reliability | The system should have a minimum success rate of 95% in removing fog from videos. |
| NFR-3 | Robustness | The system should be able to handle videos of different resolutions and formats (e.g. MP4, AVI). |
| NFR-4 | Availability | The system should be available 24/7 with a maximum downtime of 30 minutes per month for maintenance purposes. |
| NFR-5 | Scalability | The system should be able to handle multiple requests simultaneously without compromising performance. |
| NFR-6 | Usability | The system should have a user-friendly interface that is easy to use, with clear instructions for uploading and processing videos. |

# Safety Requirements

| **Req ID** | **Safety Requirement** | **Description** |
| --- | --- | --- |
| NFR-7 | Safety | The system should not cause harm or danger to users, equipment, or the environment. Appropriate safety measures should be taken to prevent any accidents or malfunctions. |

# Security Requirements

| **Req ID** | **Security Requirement** | **Description** |
| --- | --- | --- |
| NFR-8 | Security | The system should ensure the confidentiality, integrity, and availability of user data. Identity authentication should be required for accessing the system and its functionalities. |
| NFR-9 | Privacy | The system should comply with data protection regulations and ensure the privacy of user data. User data should not be shared with third parties without the user's explicit consent. |

# Appendix A: Definitions, Acronyms and Abbreviations

[Provide definitionof all terms, acronyms and abbreviations required for interpreting this Requirements Specification.]

# Appendix B: References

[Provide the list of the documents or web addresses to which the Requirement Specification refers. It may include user interface style guides, standards, system requirements specificationand use cases. The reference documents shall describe the title, version number, dates, authors and publishers, whatever is applicable.]