# VIDEO ENHANCEMENT AND RESTORATION FOR ARCHIVAL PHOTOGRAPHS

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## ABSTRACT

This paper presents a Flask-based web application designed for real-time video enhancement using the Retinex algorithm, optimizing video quality in diverse lighting conditions. The system supports both live video streaming and uploaded videos, processing each frame by separating its RGB channels. Gaussian filtering is applied to smooth the illumination component, followed by the Retinex algorithm, which decomposes the video into illumination and reflectance components. Enhancing the reflectance improves contrast and visibility in low-light areas, resulting in a clearer and more visually appealing output. The enhanced video is rendered in real-time, ensuring a fluid viewing experience. With support for both streaming and file uploads, the application offers an intuitive user interface for seamless video enhancement. Built with Python, OpenCV, and Flask, the system facilitates efficient processing and deployment, making it applicable to various domains such as surveillance, video conferencing, and autonomous driving. This study underscores the effectiveness of integrating advanced image processing techniques with web-based applications to achieve real-time video enhancement.

## INTRODUCTION

Long acknowledged as a potent instrument in image processing, the Retinex algorithm excels in enhancing photos in a variety of lighting scenarios. Maintaining consistent quality in a variety of settings is still a significant difficulty in the field of video processing, particularly in circumstances with strong contrast or low light levels. In real-time situations, traditional picture enhancing methods sometimes fall short of expectations because of their processing complexity or incapacity to manage dynamic illumination changes. In real-time applications where precision and clarity are crucial for both performance and safety, such video streaming, surveillance, and autonomous driving, this constraint becomes even more significant.

The Retinex algorithm, modeled after the human visual system's ability to adapt to different lighting conditions, enhances video clarity by decomposing each frame into illumination and reflectance components. This technique is particularly beneficial for real-time video enhancement, where boosting visibility in low-light areas, adjusting brightness, and

uncovering hidden details are crucial. However, implementing it in real-time presents challenges in computational efficiency and user experience. To overcome these hurdles, we propose a web-based solution that integrates the Flask framework for Retinex-based video enhancement. The system accommodates both live video streaming and file uploads, ensuring flexibility and ease of use. It employs preprocessing techniques such as RGB channel separation, Gaussian filtering for noise reduction, and Retinex-based illumination and reflectance processing. By refining the reflectance component, the system significantly enhances contrast and visibility, delivering high-quality video output in real time.

## EXISTING METHOD

Traditional video enhancement techniques aim to improve video quality in low-light conditions or unclear visuals but often come with limitations. Histogram equalization enhances contrast by redistributing pixel intensity levels, yet it frequently leads to over-enhancement and detail loss. Similarly, gamma correction adjusts brightness but may distort the natural color balance. Noise reduction techniques like median and bilateral filtering are commonly used in video streaming to suppress noise; however, they are computationally intensive and struggle with fast-moving objects in real-time scenarios. The Retinex algorithm, which enhances image quality by separating illumination and reflectance components, addresses some of these issues but remains computationally demanding for real-time applications. Convolutional Neural Networks (CNNs) have been integrated for feature extraction, yet their dependency on large datasets and high computational power makes real-time deployment challenging. Real-time video enhancement using Flask and web technologies is still emerging, with existing solutions often facing latency and scalability issues, especially for high-resolution video processing. While combining deep learning with traditional methods shows potential, current approaches still struggle to meet the real-time performance demands of high-speed applications, making it an ongoing area of research.

## PROPOSED METHOD

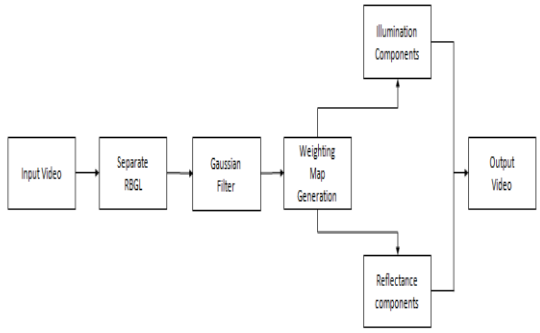
The proposed real-time video enhancement method utilizes the Retinex algorithm to enhance video quality by separately processing the RGB channels and applying Gaussian filtering. The system operates on both live video streams and uploaded files, breaking down each frame into its Red, Green, and Blue (RGB) components. Gaussian filtering is then applied to each channel to reduce noise and refine image clarity.

Following this, the Retinex algorithm isolates the illumination and reflectance components, enhancing brightness while preserving intricate details to maintain image sharpness, even in low-light environments. The processed components are then merged, resulting in a more vibrant and visually clear video output.

A Flask-based web application serves as the user interface, enabling seamless interaction with both live and uploaded videos. Optimized for real-time performance, the system ensures minimal latency while delivering high-quality video enhancement, significantly improving

visibility in challenging lighting conditions.

# BLOCK DIAGRAM




# DESCRIPTION OF PROPOSED WORK

**Real-Time Video Enhancement System with Flask and Retinex Algorithm**

The proposed system is a comprehensive framework for real-time video enhancement, leveraging the Retinex algorithm within a Flask-based web application. The process consists of several key stages, from user authentication to real-time video processing and enhancement.

**1. Secure User Authentication**

The system ensures restricted access through a login and signup mechanism. Users create an account by providing a valid email, username, and password. During login, credentials are verified against the database. If authentication fails, users are redirected to the signup page. This security layer guarantees that only authorized users can upload or view enhanced videos.

**2. Video Input: Upload or Live Streaming**

After authentication, users can choose between two video input options:

- **Video Upload** – Select and upload a video from their device.
- **Live Streaming** – Capture real-time video using a webcam or external camera.

Both input methods follow the same enhancement workflow.

**3. RGB Channel Separation**

Each video frame is decomposed into its Red, Green, and Blue (RGB) channels. This step enables independent processing of each channel to improve color accuracy and contrast before enhancement.

**4. Gaussian Filtering for Noise Reduction**

To enhance visual clarity, Gaussian filtering is applied to the illumination component of each frame. This technique smooths the image, reduces noise, and balances uneven lighting, preparing the video for further processing.

**5. Retinex Algorithm for Illumination and Reflectance Enhancement**

At the core of the enhancement process, the Retinex algorithm decomposes each frame into:

- **Illumination Component** – Represents overall lighting conditions.
- **Reflectance Component** – Captures the finer details of the image.

The algorithm enhances the reflectance to improve contrast, making darker regions more visible while preserving natural image details. The adjusted illumination and reflectance are then merged to reconstruct a high-quality frame.

**6. Video Enhancement and Reconstruction**

Once processed through the Retinex algorithm, the enhanced illumination and reflectance components are recombined, producing a clearer, sharper, and more vibrant video. This improves visibility, particularly in low-light conditions.

**7. Real-Time Processing and Display**

For both uploaded videos and live streams, the Flask application renders and displays the enhanced video frames in real-time. The system ensures smooth playback with minimal latency by continuously processing and refining the video feed.

**8. User Interface and Interaction**

The Flask-based web application offers an intuitive and user-friendly interface with features such as:

- Video upload and live streaming options
- Login and account management
- Side-by-side comparison of original vs. enhanced video
- Controls for starting/stopping streams and playback

**9. Deployment and Performance Optimization**

Built using Flask (Python) and OpenCV, the system is optimized for real-time performance. It supports various video resolutions and frame rates, ensuring smooth processing with minimal delays, even during live streaming.

## ADVANTAGES

1. Enhanced Image Quality
2. Noise Reduction
3. Color Restoration
4. Damage Repair
5. Preservation of Historical Records
6. Automation and Efficiency
7. Scalability

## DISADVANTAGES

1. Loss of Authenticity
2. High Computational Demand
3. Need for Manual Intervention
4. Challenges in Severe Damage Recovery
5. Risk of Artificial Artifacts

## APPLICATIONS

1. Historical Archiving
2. Film and Media Restoration
3. Genealogy and Family Archives
4. Academic and Research Studies
5. Forensic Investigations
6. Publishing and Media
7. Art Conservation

**CONCLUSION AND FUTURE SCOPE:**

The implementation of the Retinex algorithm for real-time video enhancement within a Flask-based system has proven to be an effective solution for improving video clarity, especially in challenging

lighting conditions. By integrating RGB channel separation, Gaussian filtering, and illumination-reflectance processing, the system significantly enhances video quality, making finer details more visible and well-defined.

With its ability to process videos in real-time, coupled with a secure authentication system and seamless video streaming and uploading, the system ensures smooth and efficient performance. These capabilities make it highly applicable in surveillance, medical imaging, and live broadcasting, where visibility enhancement and noise reduction play a crucial role in improving video quality.

While the system performs efficiently for standard video resolutions, future improvements could focus on optimizing performance for high-resolution video processing, enabling real-time support for 4K and HD video streams. Additionally, integrating AI and machine learning could allow the system to dynamically adjust enhancement settings based on real-time lighting conditions and video content, further improving its adaptability.

To refine the enhancement process, advanced filtering techniques could be explored, enhancing noise reduction and sharpening for superior image quality. Moreover, expanding the system to support multi-stream video processing would increase its relevance in applications such as surveillance monitoring and live event broadcasting, where handling multiple video feeds is essential.

By incorporating these advancements, the system can further enhance accuracy, efficiency, and scalability, making it an even more powerful solution for real-world video processing applications.

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