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DEEP LEARNING BASED ON MULTISTAGE PROCESS FOR IMAGE REFINING SYSTEM

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ABSTRACT:
Rain, Adverse weather conditions like rain, fog, and haze significantly degrade outdoor image quality, affecting visibility and image detail restoration. Traditional image enhancement techniques struggle with these challenges due to poor pixel restoration and high noise. This paper presents a multistage deep learning-based image refining system that leverages Dark Channel Prior (DCP), Transmission Map Refinement via Deep Learning, Atmospheric Light Estimation, and Guided Image Filtering (GIF) to enhance visibility in affected images. The system improves driver assistance, surveillance, and traffic management efficiency by enabling clearer image outputs in real-time.

Keywords:
Rain Removal, Fog Detection, Haze Dehazing, Deep Learning, Image Enhancement, OpenCV, Transmission Map, Dark Channel Prior, Guided Image Filtering, Traffic Safety.

1. INTRODUCTION

Adverse weather conditions such as rain, fog, and haze often result in poor visibility, affecting road safety and surveillance system performance. Conventional methods fail to process and refine such images effectively under varying lighting and atmospheric conditions. This study introduces a deep learning-based multistage image refining framework that aims to restore the clarity of weather-affected images using advanced computer vision techniques. The history of removing rain, fog and floods to prevent accidents is an interesting mix of scientific advancement, technological innovation and social change. During early days, Ancient civilizations learned how to navigate in foggy rain by using celestial bodies as guides. The ancient Egyptians used star charts, while the Polynesians relied on wave patterns and bird behaviour. Overland travellers relied on landmarks and local knowledge to navigate foggy conditions. In some cultures, bells were rung on foggy days to warn travellers of dangers. During the 17th and 18th centuries, scientific understanding of weather and climate began to develop. Scientists such as Leonardo da Vinci and Antoine Lavoisier made important contributions to Our understanding about fog. During the 19th century, the advances in optics and meteorology led to the development of the first fog prediction systems and improvements in ship and lighthouse detection technology.

RELATED WORK

Several techniques have been developed to address image degradation due to weather. Methods like histogram equalization, optical flow, and dehazing algorithms (e.g., CLAHE, Wiener Filter) have shown limited success in handling real-time scenarios. Dark Channel Prior-based methods gained popularity for haze removal, while Deep Learning models like CNNs and CycleGANs enhanced dehazing. However, issues with low-light accuracy and real-time performance persist. This paper builds upon prior work by integrating DCP with guided filters and deep learning-based map refinement for improved output.

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SYSTEM DESIGN

Our system integrates atmospheric light estimation, DCP for haze estimation, and deep learning-based transmission map refinement. These components work sequentially to detect and remove visual noise caused by rain, fog, and haze.

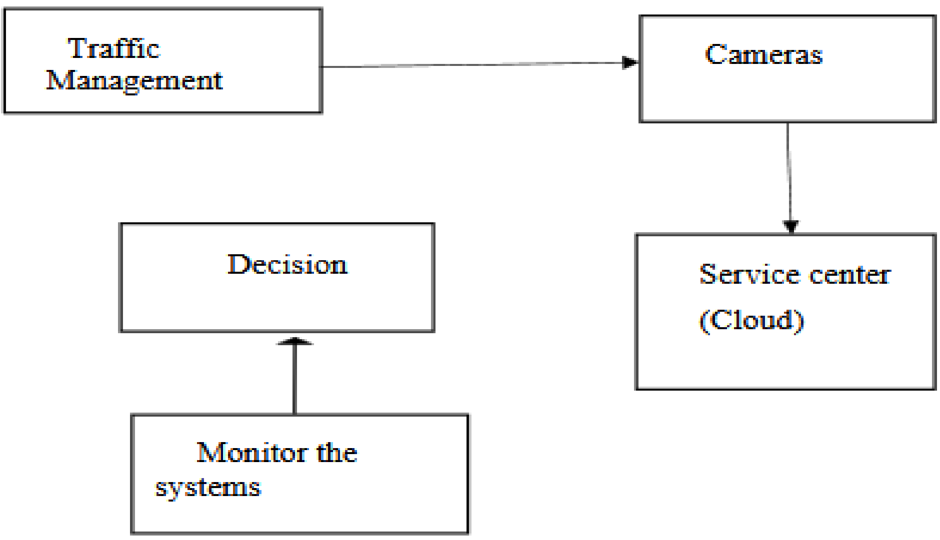

Figure 1.1 Block diagram about motivation for rain, fog and haze removal

METHODOLOGIES

1. Rain/Fog/Haze Detection: A histogram-based classifier compares image pixel distributions to identify weather conditions.
2. Dark Channel Prior (DCP): Calculates haze impact by analysing low-intensity pixels across RGB channels.
3. Deep Learning-Based Transmission Map Refinement: A neural network improves initial transmission map estimation.
4. Atmospheric Light Estimation: Adjusts lighting parameters to better restore image brightness.
5. Guided Image Filtering (GIF): Smooths the refined output, removing residual noise while preserving image edges.

5.RESULTS

Testing was performed on real-world weather-affected images using OpenCV and TensorFlow. The model produced enhanced images with significantly improved PSNR, SSIM, and entropy values. The output images were visually clearer, and structural features were well restored compared to traditional models. Sample outputs showed successful removal of rain streaks and foggy overlays.

- **PSNR (Peak Signal-to-Noise Ratio)**: >30 dB
- **SSIM (Structural Similarity Index)**: >0.90
- **MSE (Mean Squared Error)**: Reduced significantly
- **Image Brightness, Contrast, and Entropy**: Enhanced significantly

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Fig1: result 1

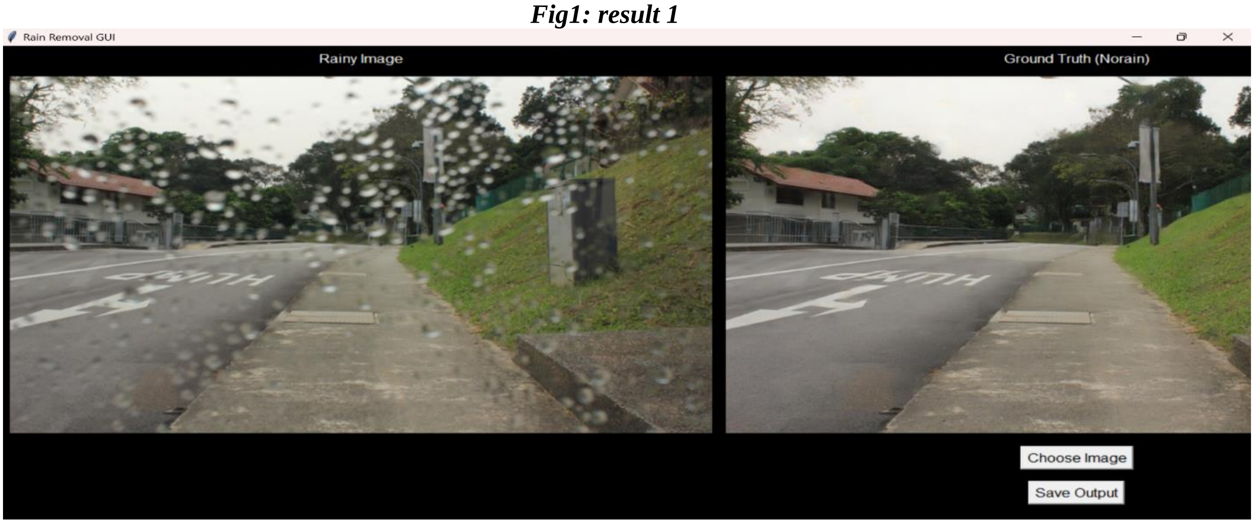

Fig:5.2 result 2

Fig:5.3 result 3

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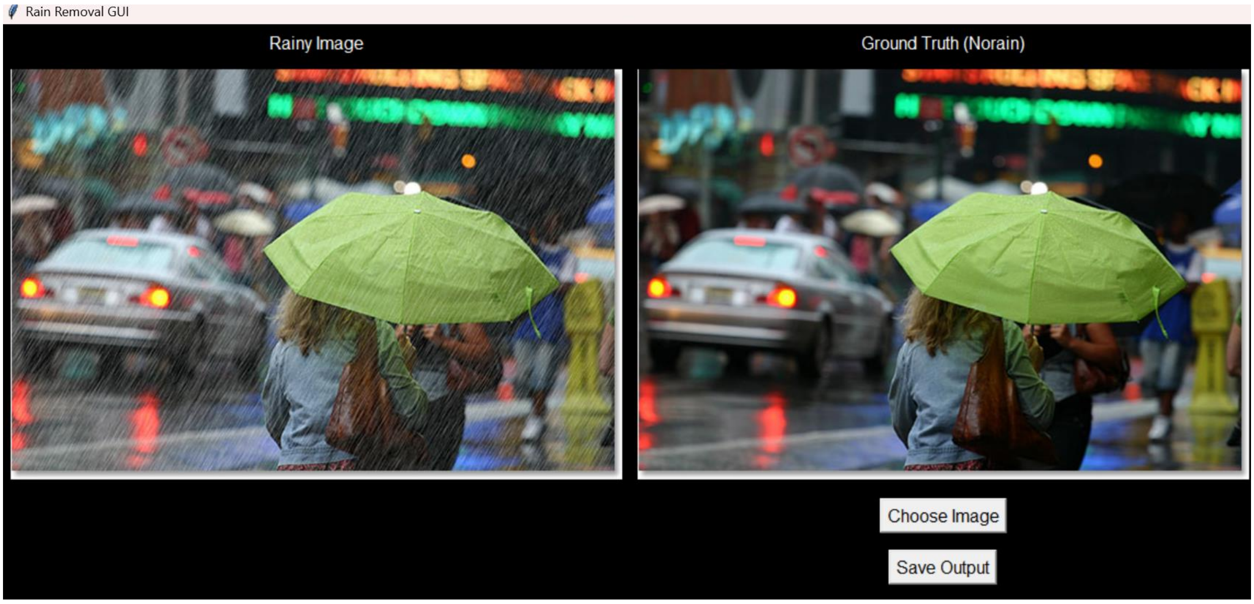

Fig:5.4 result 4

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CONCLUSION AND FUTURE WORKS

This research successfully demonstrates a robust framework for image refining under adverse weather using a combination of traditional and deep learning techniques. Future enhancements include optimizing the model for real-time implementation, integrating IoT sensor data, and expanding to autonomous driving systems.

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