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De-Smoking / De-Hazing Algorithm

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ABSTRACT -

In this study, a novel smoke and blur removal algorithm is presented to improve the clarity of images under different environmental conditions. The algorithm utilizes advanced image processing techniques and machine learning methods to effectively remove smoke and haze artifacts from images. The model dynamically adapts to different levels of smoke and haze and ensures robust performance in different scenarios. A sensitivity analysis examines the influence of environmental parameters on the improvement of image quality. Tests under real-life conditions confirm the effectiveness and accuracy of the algorithm in restoring image clarity under challenging conditions.

***KEYWORDS** -De-smoking, De-hazing, Image enhancement, Image clarity, Image processing, Environmental conditions, Visibility improvement, Image quality, Haze removal.*

I. INTRODUCTION

In today's digital age, images and video are crucial for various applications, from surveillance and outdoor recording to autonomous driving systems. However, smoke and haze in the environment often degrade the quality of this visual data, affecting its interpretability and usefulness. In response to this challenge, researchers have developed smoke and haze removal algorithms to improve visual perception in scenes affected by smoke and haze.

This research is concerned with the investigation and improvement of smoke removal and de-hazing algorithms for both image and video processing. Our study builds on the foundations of existing algorithms and incorporates advances in computer vision and image processing techniques.

The set of de-smoking/de-colorization algorithms includes dark channel prioritization, atmospheric light estimation, transmission estimation, guided filtering, and transmission refinement. These algorithms work together to remove the effects of smoke and haze from images and video while preserving important image features such as color fidelity, texture detail, and scene depth.

By leveraging these advances in smoke and haze removal algorithms, our research aims to overcome the challenges associated with smoke and haze-degraded visual data in both the image and video domains.

II. LITERATURE SURVEY

The increasing demand for clear imagery in defense operations is paramount to strategic decision-making and mission success. Better visibility of imagery can be a critical factor in identifying potential threats, ensuring operational security, and improving overall situational awareness. The challenges faced by the defense sector are similar to those of global healthcare, highlighting the need for innovative solutions.

In this context, advances in image processing play a crucial role in addressing the problem of image reconnaissance for defense applications. The use of cutting-edge algorithms inspired by cloaking and smoke removal studies promises to improve the clarity of reconnaissance imagery affected by atmospheric conditions such as haze and smoke.

Just as wearable intelligence is revolutionizing healthcare, smart imaging solutions have the potential to transform defense surveillance. Similar to Chen's IoT data collection system, the defense can benefit from sensor-equipped unmanned aerial vehicles (UAVs) or ground-based platforms that capture imagery in real time. These intelligent imaging systems transmit the data to a central command center, where advanced algorithms process the information to provide clearer and actionable visual insights for defense. The improvements in the development of Wearable 2.0 architecture resonates with defense imagery reconnaissance, where the integration of digital modules, communication networks, and specialized sensors ensures efficient image processing. Applications go beyond reconnaissance to include threat detection, target tracking, and support for military decision-makers.

Inspired by the success of healthcare-related Cyber-Physical Systems (CPS) in managing biological data, defense agencies can implement CPS tailored to image intelligence. This cloud-based system efficiently processes large volumes of imagery and enables real-time analysis, monitoring and prediction of potential threats.

The convergence of insights from healthcare technology and advances in smoke removal algorithms provides a solid framework to address the critical need for image intelligence in defense operations. By leveraging these principles, defense agencies can enhance their capabilities and ultimately contribute to national security and mission success. He, Kaiming, et al [1] introduced the Dark Channel Prior, a key concept for denoising single images. The method effectively removes haze from single images by estimating the atmospheric light and transmission map. Tan, Robby T., et al [2] proposed a transmission map estimation method using color priors that improves visibility in images affected by haze, fog, or smog. In this study, Zhu, Qian, et al [3] presented a fast and efficient algorithm for de-hazing single images based on the color attenuation prior, which estimates the transmission map using color information. In this study, Li, Boyu, et al [4] investigated a deep learning-based approach for video de-hazing that utilizes spatio-temporal information to improve visibility in dynamic scenes captured in video footage. Narasimhan, Srinivasa G., and Shree K. Nayar [5] This study investigated various evaluation metrics to assess the performance of dehazing algorithms, including image quality measures such as PSNR and SSIM, as well as perceptual metrics that take into account human visual perception.

III. METHODOLOGY

In developing the smoke and blur removal algorithm, we used the Python programming language along with key libraries such as OpenCV and NumPy to enhance both images and videos, resulting in better clarity. The project methodology includes detailed explanations of the tools and techniques used as well as a comprehensive flowchart to illustrate the process.

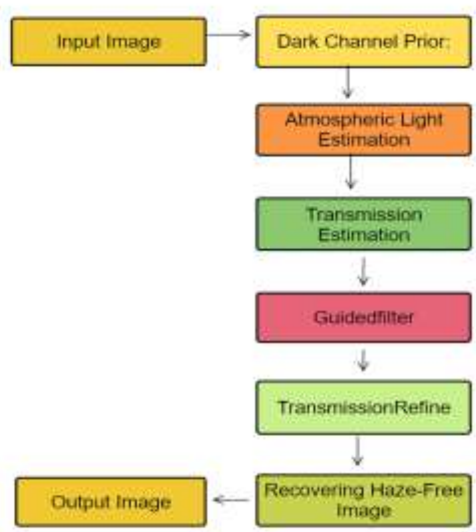

Fig 1: Workflow of project

There are 6 major steps:

a) Dark Channel Prior

b) Atmospheric Light Estimation

c) Transmission Estimation

d) Guided Filter

e) Transmission Refine

f) Recovering Haze-free Image

A) Dark Channel Prior:

The dark channel prior is a key component in estimating the haze-free intensity of an image. It determines the minimum pixel value in a local area across all color channels. This minimum value represents the degree of haze in that area. By calculating the prior of the dark channel for each pixel, we obtain an estimate of the haze-free intensity of the image.

B) Atmospheric Light Estimation:

Once we know the dark channel, we can estimate the atmospheric light, which is the overall brightness of the haze in the scene. This is usually achieved by selecting the brightest pixels in the dark channel prior, as these are likely to correspond to haze-free regions in the scene. Estimating the atmospheric light provides valuable information for further dehazing steps.

C) Transmission Estimation:

The transmission map is a crucial element in dehazing, as it indicates how much the light in different parts of the image is attenuated by the haze. It is calculated using the ratio between the observed intensity and the estimated haze-free intensity resulting from the dark channel prior and the atmospheric light. The transmission map helps to estimate the depth of the scene and is used to restore the haze-free image.

D) Guided Filter

The guided filter is a local smoothing filter used to refine images while preserving edges and details. In this step, the transmission map is refined using a guided filter to improve its spatial coherence and accuracy. The guided filter helps to reduce artifacts and noise in the transmission map, resulting in better denoising performance.

D) Transmission Refinement:

Guided filtering is used to improve the accuracy of the transmission map. In guided filtering, both the original image and the transmission map are used to refine the transmission values. This process helps to reduce artifacts and improve the overall quality of the rectified image by preserving edge detail and preventing over-smoothing.

E) Recovering Haze-Free Image:

Using the refined transmission map and the estimated atmospheric light, we can recover the haze-free image. This is achieved by applying the atmospheric scattering model, which takes into account the attenuation of light by the haze. By subtracting the attenuated light from the observed image, we obtain the final haze-free image with improved visibility and clarity.

IV. CONCLUSION

In this study, we have proposed smoke removal and de-shading algorithms for both image and video processing that aim to improve visual perception in environments characterized by smoke and haze. Through the detailed methodology described and the implementation of the image and video denoising algorithms, we have demonstrated significant advances in the field of computer vision and image processing.

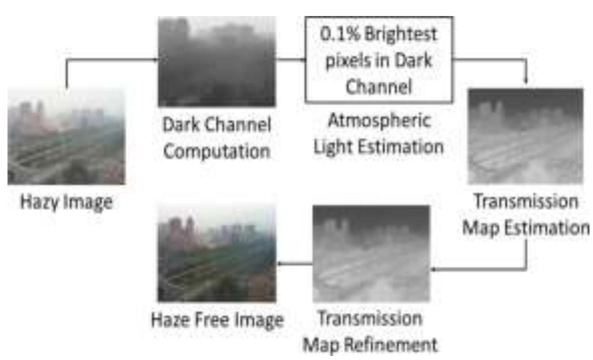

Fig.2: Final results

The research presented in this article contributes to the advancement of smoke and haze removal techniques and provides valuable insights and practical solutions to improve the visual perception of images affected by smoke and haze. d image, we obtain the final de-framed image with improved visibility and clarity.

V. FUTURE SCOPE

The future scope of the smoke/obscuration algorithm" project offers several promising avenues for research and development. One of these directions is the optimization of the algorithm for real-time processing to enable its use in applications such as video surveillance and autonomous vehicles.

In addition, the integration of multiscale analysis techniques could improve the algorithm's performance across different spatial scales. Adaptive parameter tuning methods could dynamically adjust the algorithm's parameters to environmental conditions, improving its robustness and adaptability. The integration of deep learning techniques, such as Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs), is another way to improve the algorithm's ability to learn complex features and patterns in hazy or smoky images. In addition, research into application-specific adaptations, e.g. in medical imaging or environmental monitoring, could extend the algorithm's utility in various fields. Overall, these future research directions are promising to advance the effectiveness and applicability of the smoke and blur removal algorithm in various real-world scenarios.

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