A

SYNOPSIS REPORT

On

"AI-ML BASED INTELLIGENT DE-SMOKING/DE-HAZING ALGORITHM"

Submitted to

Autonomous Institute,

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ABSTRACT

The integration of intelligent AI-ML desmoking and dehazing algorithms into firefighting operations represents a significant advancement in enhancing the safety and efficiency of rescue missions during indoor fire hazards. This abstract encapsulates the essence of a groundbreaking mini project aimed at developing a state-of-the-art technological solution to address the challenges faced by firefighters in smoke-filled and hazy environments. The core objective of this project is to leverage artificial intelligence and machine learning techniques to create an advanced algorithm capable of effectively removing smoke and haze from visual data captured in real-time. By harnessing the power of image processing, deep learning, and computer vision technologies, this innovative system aims to provide firefighters with clearer, more detailed imagery to improve situational awareness and decision-making in emergency scenarios. Through the seamless integration of desmoking and dehazing capabilities into firefighting equipment or wearable devices, this project seeks to empower first responders with enhanced visibility and operational effectiveness when navigating through hazardous environments. By enabling rapid access to clearer visual information, this AI-ML algorithm has the potential to revolutionize rescue operations by facilitating quicker response times, more precise navigation, and ultimately, saving lives. In conclusion, the development of an intelligent AI-ML desmoking and dehazing algorithm holds immense promise for transforming the landscape of firefighting technology. By combining cutting-edge artificial intelligence with practical applications tailored for real-world firefighting scenarios, this project represents a significant step forward in enhancing the safety, speed, and success rates of rescue missions during indoor fire hazards.

INTRODUCTION

In the realm of firefighting and emergency response, the ability to effectively navigate through smoke-filled and hazy environments is paramount for ensuring the safety of both firefighters and individuals in need of rescue. Recognizing the critical importance of visibility in such challenging conditions, a pioneering mini project has been initiated to develop an intelligent AI-ML desmoking and dehazing algorithm tailored specifically to enhance rescue operations during indoor fire hazards. This innovative endeavor represents a significant leap forward in leveraging cutting-edge technology to support and empower firefighters in their life-saving missions. The primary goal of this project is to harness the power of artificial intelligence and machine learning to create a sophisticated algorithm capable of rapidly and accurately removing smoke and haze from visual data captured in real-time. By integrating advanced image processing techniques, deep learning algorithms, and computer vision technologies, this intelligent system aims to provide firefighters with enhanced visibility and clarity in smokeobscured environments, thereby enabling them to make informed decisions swiftly and effectively during rescue operations. The development of this AI-ML desmoking and dehazing algorithm is driven by a commitment to revolutionize the way firefighting and rescue missions are conducted in indoor fire hazard scenarios. By equipping firefighters with state-of-the-art technological tools that enhance their situational awareness and operational capabilities, this project seeks to optimize response times, improve decision-making processes, and ultimately save lives in emergency situations. Through the seamless integration of desmoking and dehazing functionalities into existing firefighting equipment or wearable devices, this project aims to provide firefighters with a clear advantage when faced with challenging visibility conditions. By enabling real-time enhancement of visual data captured in smoke-filled environments, this AI-ML algorithm has the potential to significantly enhance the safety, efficiency, and effectiveness of rescue missions, thereby mitigating risks and maximizing outcomes during critical operations. In conclusion, the development of an intelligent AI-ML desmoking and dehazing algorithm represents a groundbreaking advancement in the field of firefighting technology. By combining cutting-edge artificial intelligence with practical applications tailored for real-world firefighting scenarios, this project stands poised to redefine the capabilities of rescue operations during indoor fire hazards, setting a new standard for safety, innovation, and effectiveness in emergency response efforts.

AIM & OBJECTIVES OF PROJECT

Aim:

The aim of the project is to develop an intelligent AI-ML desmoking and dehazing algorithm specifically designed to enhance visibility and support firefighters during indoor fire hazards. This cutting-edge technology aims to revolutionize rescue operations by providing advanced desmoking and dehazing capabilities to improve situational awareness and operational efficiency in smoke-filled environments.

Objectives:

- Enhance Visibility: Develop an AI-ML algorithm that can effectively remove smoke and haze from visual data captured in real-time, enhancing visibility for firefighters during rescue operations.
- Improve Decision-Making: Enable firefighters to make informed decisions swiftly and effectively by providing clearer, more detailed imagery of their surroundings in hazardous conditions.
- Optimize Response Times: Integrate desmoking and dehazing functionalities into firefighting equipment or wearable devices to empower first responders with enhanced visibility, leading to quicker response times during emergencies.
- Ensure Safety: Enhance the safety of firefighters by providing access to clearer visual information in smoke-obscured environments, minimizing risks and improving operational effectiveness during rescue missions.
- Facilitate Efficient Rescue Efforts: Support firefighters in navigating through challenging indoor fire hazard scenarios by equipping them with state-of-the-art technological tools that streamline rescue operations and maximize outcomes.

By achieving these objectives, the project aims to significantly enhance the capabilities of firefighters during indoor fire hazards, ultimately contributing to saving lives, reducing property damage, and improving the overall effectiveness of rescue missions.

LITERATURE REVIEW

The evolution of technology has played a pivotal role in enhancing the capabilities of firefighters and first responders in dealing with complex emergency situations, particularly in environments compromised by smoke and haze. The integration of artificial intelligence (AI) and machine learning (ML) technologies has opened up new avenues for developing advanced desmoking and dehazing algorithms tailored to improve visibility and operational efficiency during indoor fire hazards. This comprehensive literature review delves into the existing research, methodologies, and technologies that underpin the development of intelligent AI-ML desmoking and dehazing algorithms aimed at supporting firefighters in challenging rescue operations. Let's see some literature reviews:

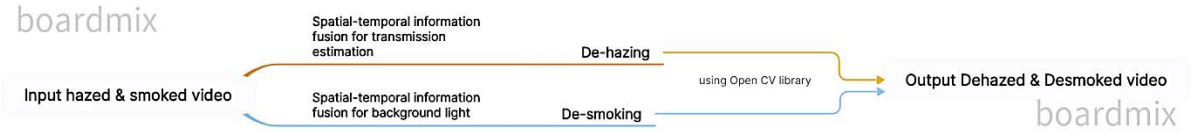
- In this paper, an algorithm based on the hardware conditions of the intelligent fire helmet platform is proposed, which improves dark channel prior. Filtering partition and sampling are respectively used to quickly and accurately evaluate and repair the transmittance with a guided filter. [1]
- The proposed method is based on the smoke mixing model and consider the sparseness of smoke and the global and local consistency of clean video. [2]
- To solve these problems, we present a novel color-dense illumination adjustment network (CIANet) for joint recovery of transmission matrix, illumination intensity, and the dominant color of aerosols from a single image. Meanwhile, to improve the visual effects of the recovered images, the proposed CIANet jointly optimizes the transmission map, atmospheric optical value, the color of aerosol, and a preliminary recovered scene. Furthermore, we designed a reformulated ASM, called the aerosol scattering model (ESM), to smooth out the enhancement results while keeping the visual effects and the semantic information of different objects. [3]
- This paper reports an optical method, called violet illumination, coupled with deep learning, to significantly increase the effectiveness in searching for and identifying rescue targets during a fire. [4]
- In this paper we propose a method able to detect fires by analyzing the videos acquired by surveillance cameras. [5]

- Our network aims to estimate both a dehazed image and a fully scaled depth map from a single hazy RGB input with end-to-end training. [6]
- This model consists of atmospheric light, transmission map and also includes a glow. The input is glow image and it is separated into the glow and glow free images through a quadratic optimization problem. [7]
- Based on a newly presented haze-free image prior - dark channel prior and a common haze imaging model, for a single input image, we can estimate the global atmospheric light and extract the scene objects transmission. [8]
- Dehazing methods based on deep learning are mainly divided into supervised ID and unsupervised ID. There is not too much work about semi-supervised dehazing. In general, supervised methods require pairs of hazy images and haze-free images/transmission maps. The unsupervised methods often take unpaired images as the training set. [9]
- Instead of relying on explicitly estimating the key component of atmospheric scattering model, we present end-to-end CNN model, which directly recovers the clear images from hazy images. [10]
- In this paper we propose a novel end-to-end convolution dehazing architecture, called De-Haze and Smoke GAN (DHSGAN). The model is trained under a generative adversarial network framework to effectively learn the underlying distribution of clean images for the generation of realistic haze-free images. [11]
- DCP method needs to find the transmission map which gives the strength of the fog in the image. Major parts in this algorithm are the estimation of the dark channel, finding the transmission map, refining the transmission map, and reconstructing the image without haze. [12]
- We automate the process of air-light estimation using smoke features which is the key parameter for dehazing. To reduce color artifacts a color normalization is applied to the dehazed image using the detected non-smoky reference image. The results of the proposed approach shows a reduction in color artifacts and outperforms other methods reported in the literature. [13]
- We have experimented using benchmark dataset consisting of both synthetic and real-world hazy images. The obtained results are evaluated both quantitatively and qualitatively. Among these techniques, the DHSGAN gives the best performance. [14]

- This paper proposes a novel Transformer–Convolution fusion dehazing network (TCFDN), which uses Transformer's global modeling ability and convolutional neural network's local modeling ability to improve the dehazing ability. [15]
- Inspired by Generative Adversarial Network (GAN), we propose an end-to-end attentive DesmokeGAN which implements the visual attention into the generative network to effectively learn the smoke features and their surroundings. [16]
- In this paper, an efective image dehazing method is proposed, which is based on improved color channel transfer and multiexposure image fusion to achieve image dehazing. First, the image is preprocessed using a color channel transfer method based on k-means. Second, gamma correction is introduced on the basis of guided fltering to obtain a series of multiexposure images, and the obtained multiexposure images are fused into a dehazed image through a Laplacian pyramid fusion scheme based on local similarity of adaptive weights. Finally, contrast and saturation corrections are performed on the dehazed image. [17]
- In this work, a new approach is employed for dehazing in real-time which reads the orientation sensor of mobile device and compares the amount of rotation with a pre-specified threshold. [18]
- The proposed method uses a multilayer perceptron to compute the transmission map directly from the minimum channel and a contrast stretching technique to improve the dynamic range of the restored images. [19]
- Our detailed survey and experimental analysis on DCP-based methods will help readers understand the effectiveness of the individual step of the dehazing process and will facilitate development of advanced dehazing algorithms. [20]
- The proposed method is adapted for RGB Colour model and advantageously also for HSI colour model involving reduced computational requirements and be user friendly and Supposed to have wide application and use. [21]
- In this paper, a novel fast haze removal algorithm from multiple images in uniform bad weather conditions which bases on the atmospheric scattering model is proposed. The key idea is to establish an overdetermined system by modeling the hazy images and corresponding images taken in clear days so that the transmission and global airlight can be obtained. [22]

- The proposed algorithm in this paper can restore images more clearly, with more image edge details retained, and effectively improve visual effect of the scene in haze weather. [23]
- In this paper, we propose a simple but effective image prior - dark channel prior to remove haze from a single input image. [24]
- This paper studies the state-of-the-art in this area and puts forwards their strengths and weaknesses. Through experiments the efficiencies and shortcomings of these algorithms are shared. [25]

PROPOSED WORK



Technology used:

- **Front End**- HTML, CSS, Java Script: HTML, CSS, and JavaScript work together to create web pages: HTML structures content, CSS styles it, and JavaScript adds interactivity and dynamic behavior to enhance user experience.
- **Back End**- Python (libraries: Open CV, sklearn): Python, along with its OpenCV library, provides a powerful platform for computer vision tasks, offering a wide range of functions and tools for image & video processing and analysis.
- **Tools**:
    1. Firebase: Firebase Realtime Database allows for efficient real-time data retrieval and manipulation through asynchronous listeners and database references.
    2. Figma: Figma is a collaborative web application for user interface design emphasizing real-time collaboration, vector graphics editing, and prototyping tools.
    3. Github: GitHub is a web-based version control and collaboration platform that enables software developers to store, track changes, and collaborate on projects efficiently through features like repositories, branches, commits, and pull requests
    4. VSCode: Visual Studio Code is a lightweight yet powerful source code editor that supports various programming languages, offers intelligent code completion, debugging tools, and extensive customization options for efficient development workflows.

PROPOSED METHODOLOGY

In this section, let's see the way to solve the given problem;

- **Image Dehazing**:

  - Leveraging OpenCV for image processing tasks such as color space manipulation and filtering to enhance visibility through haze.

  - Implementing algorithms like Dark Channel Prior (DCP) using OpenCV's extensive library of image processing functions.

  - Employing machine learning techniques integrated with OpenCV, such as Support Vector Machines (SVMs) or Random Forests, for haze estimation and removal.

- **Video Processing**:

  - Utilizing OpenCV's video processing capabilities for real-time dehazing of video streams.

  - Employing multi-threading techniques with OpenCV's VideoCapture and Video Writer classes to achieve parallel processing of video frames.

  - Optimizing video processing algorithms using OpenCV's GPU module (cv::cuda) for faster computation on compatible hardware.

- **Smoke Removal**:

  - Adapting image processing techniques from OpenCV for detecting and removing smoke from video frames.

  - Employing background subtraction algorithms like Gaussian Mixture Models (GMM) or BackgroundSubtractorMOG for smoke detection.

  - Integrating custom deep learning models for smoke removal using OpenCV's Deep Neural Networks module (dnn).

➢ **Web Integration**:

- Developing a web interface using HTML, CSS, and JavaScript to interact with OpenCVpowered backend services.

- Utilizing OpenCV's Python bindings to integrate image and video processing functionalities into web applications.

- Implementing server-side processing using frameworks like Flask or Django, with OpenCV handling the heavy computational tasks.

➢ **Model Deployment**:

- Deploying OpenCV-based dehazing and desmoking models on cloud infrastructure using platforms like AWS or Azure.

- Leveraging OpenCV's compatibility with various platforms and architectures for seamless deployment across different environments.

- Ensuring scalability and reliability through containerization using Docker and orchestration with Kubernetes.

➢ **Evaluation and Testing**:

- Conducting performance evaluation of OpenCV-based models using standard image and video quality metrics.

- Implementing automated testing frameworks with OpenCV for regression testing and performance benchmarking.

- Integrating OpenCV's high-level GUI functionalities for visualizing and comparing results during testing.

CONCLUSION

In conclusion, this detailed literature review underscores the significance of intelligent AI-ML desmoking and dehazing algorithms in reshaping rescue operations during indoor fire hazards. By synthesizing research on desmoking techniques, computer vision applications, real-time image processing, and wearable technology for firefighters, this project aims to push the boundaries of technological innovation to enhance visibility, safety, and operational efficiency in firefighting scenarios. The convergence of these diverse research areas sets a solid foundation for developing advanced solutions that empower firefighters with the necessary tools to navigate challenging environments effectively and save lives efficiently.

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