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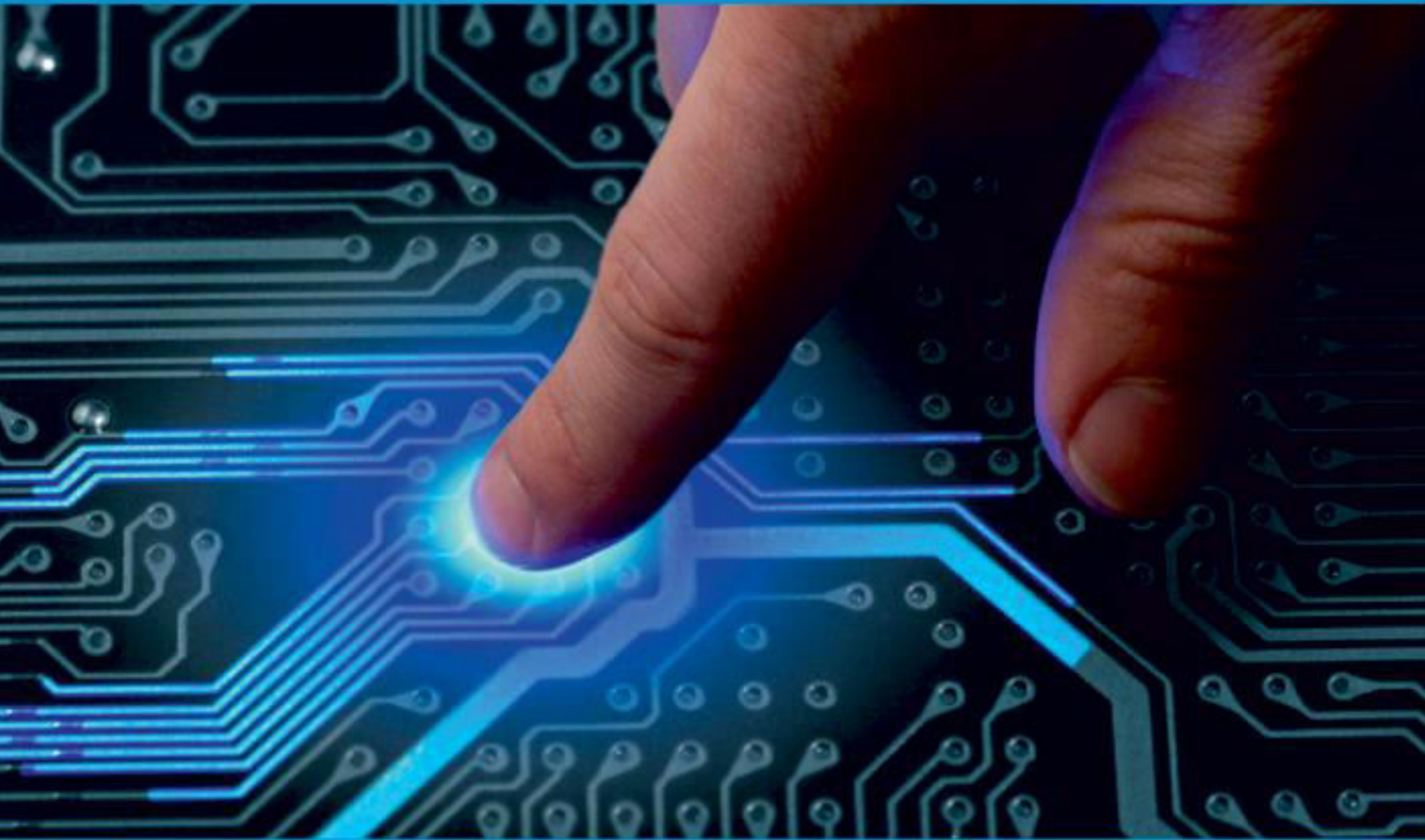

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AI-ML Based De-Smoking/De-Hazing Algorithm

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ABSTRACT: In recent years, the advancements of AI and machine learning (AI/ML) techniques have revolutionized the field of image processing, particularly in addressing challenges posed by environmental factors such as smoke and haze. Images affected by smoke or haze due to atmospheric conditions often suffer from degraded visibility and reduced contrast, making them difficult to use in applications like surveillance and outdoor videography. Traditional existing methods for mitigating these effects have typically relied on heuristic approaches like image enhancement and image restoration. Enhancement techniques can improve the contrast of hazy images, though they may result in some loss of information. Image restoration, on the other hand, is based on understanding the physical processes that cause haze or smoke. These approaches may struggle to generalize across different conditions and often require extensive parameter tuning. In contrast, AI/ML-based approaches offer a promising alternative by using CNNs (convolutional neural networks). Designing and training deep neural networks specifically for dehazing or de-smoking tasks. By breaking down the input image into individual frames and applying the trained deep learning model to each frame, AI/ML techniques can produce clearer, content-rich outputs.

KEYWORDS: AI/ML (Artificial Intelligence/Machine Learning), CNN (Convolutional Neural Networks), Image Enhancement, Surveillance.

I. INTRODUCTION

In recent years, smoke and haze have become more common due to factors like industrial emissions and wildfires due to global warming. Smoke and haze can significantly degrade the visibility and quality of images and videos, impacting applications such as surveillance, autonomous driving, and environmental monitoring. When the visibility is compromised, it can result in significant issues, such as delayed emergency responses and increased risks to safety in transportation and security. Traditional methods such as image processing filters and heuristic-based approaches used for enhancing image quality often have difficulty handling the challenges faced by smoke and haze. Due to which the images may still appear unclear or altered. This highlights the need for more advanced and efficient solutions which can be used to improve the image clarity with the help of machine learning algorithms. In this project we have developed an AI/ML-based intelligent algorithm specifically for de-smoking and de- hazing images. In this method we have used techniques like convolutional neural networks (CNNs), with effective image processing strategies to enhance the clarity of images in real time. This not only advances the field of image processing but also helps in providing solutions for challenges posed by smoke and haze and emergency situations like fire accident.

II. RESEARCH METHODOLOGY

The methodology focuses on developing an algorithm which is advanced and efficient to provide a clear de-hazed image, from the existing literature on image processing techniques, we can ensure that multiple images cannot be de-hazed at a time and time taking process, the approaches used are computationally intensive and applying the trained model is slow for high resolution images. To develop perfect working algorithm, we have taken a dataset which consists of both clear and hazy images, from the dataset we need to preprocess the data which basically Standardizing image sizes and normalize pixel values to ensure consistency across the dataset. After these steps the process of image de-hazing gets advanced from the traditional techniques, here the deep learning model has been developed and then 80% of data gets trained from the dataset and remaining 20% of data is used for testing. This developed algorithm can solve the limitations of the existing methods and provide an efficient image de-hazing/de-smoking algorithm.

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III. THEORY

In theory, the algorithm which we have developed using os module which provide functions to interact with the operating system, and libraries like OpenCV for image processing and loading the data, NumPy for numerical computations, matplotlib for visualizing the data, scikit-learn to split datasets into training and testing subsets and finally TensorFlow framework to build and train neural networks.

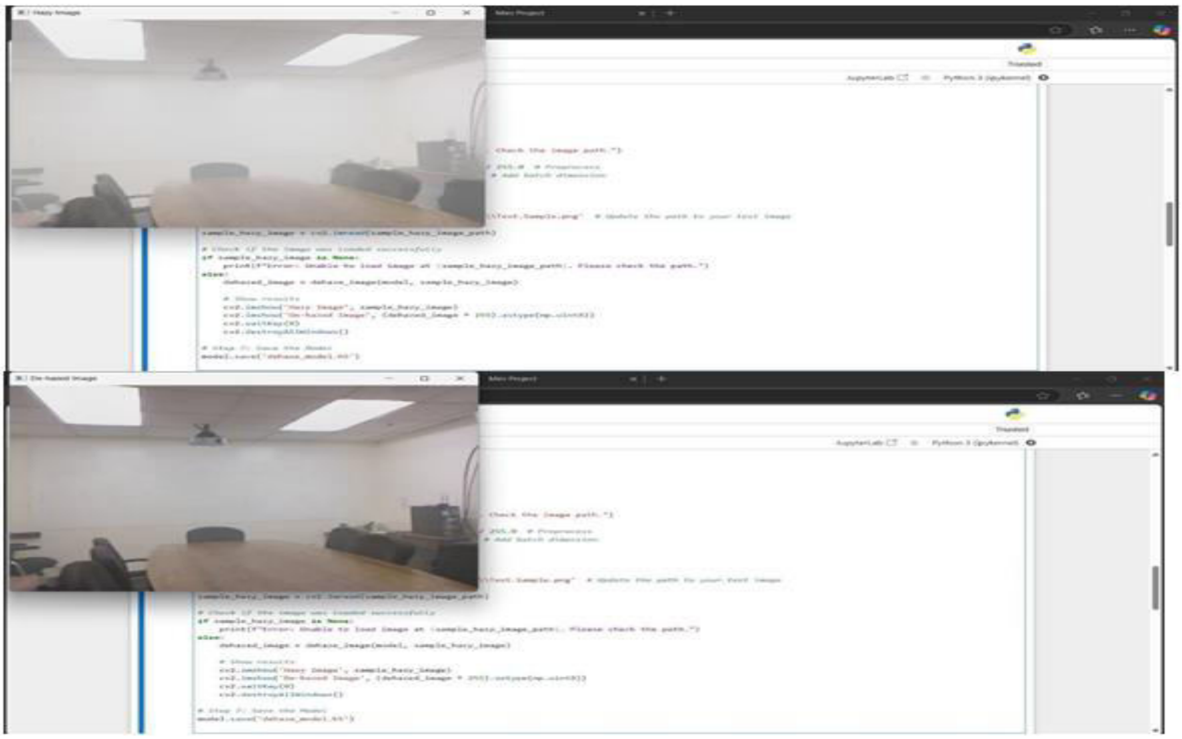
Once all the libraries have been installed, we load the data from specified paths, once the dataset is loaded, preprocessing of the data will be started which includes resizing of the images for uniformity, converting lists into NumPy arrays and finally splitting the dataset into training and testing sets.

After this the model development process starts from designing a convolutional neural network (CNN) tailored for image preprocessing tasks, which include three layers for performing three different tasks. Convolutional layers for feature extraction, Pooling layers to reduce dimensionality and finally Fully connected layers for final predictions. From here training of model starts which includes data splitting into training, validation and testing sets, ensuring a representative distribution of haze and smoke levels. After training, model evaluation and optimization are the steps followed to get the model evaluated and refined based on the evaluation results.

Once the model is developed and trained with the help of datasets, the final step includes implementation or execution where we test the improved model with different images according to the level of haze to see how well it works and how reliable it is.

IV. RESULTS AND DISCUSSION

The implementation of the developed algorithm provides us with clear de-hazed/de-smoked image. Once the data gets preprocessed the process of de-hazing begins where the hazy image is taken from the path given and then the model runs based on the given number of iterations, the more number of iterations results in high clarity image.



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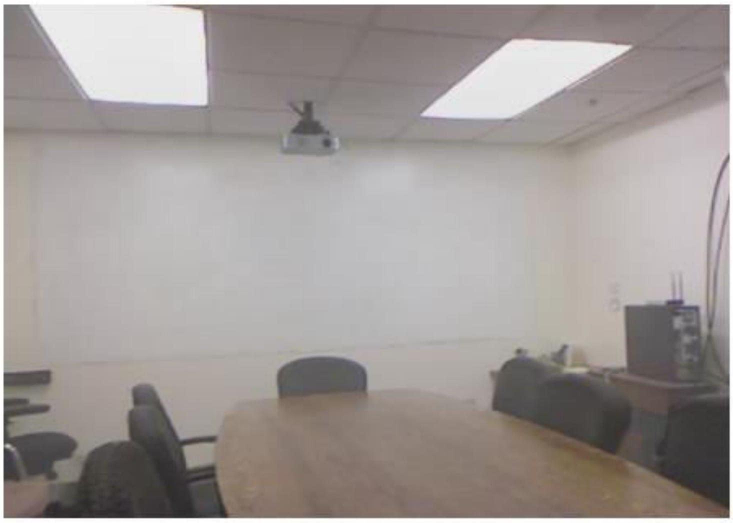
Before De-hazing:

After De-hazing:



4.1 Preparation of Figures

The figures below represent the operation and the embedding of the various components of the working of the AI-ML Based intelligent de-smoking / de-hazing algorithm.

4.1.1 Formatting Figures

Deployment Diagram: The deployment diagram is used to show the physical arrangement of the software and the hardware used in the project that are deployed. It demonstrates how components are distributed across different nodes and how they interact through potential communication paths. In the diagram below we can see that the user upload images through the AIML-based UI, and these images are sent to the web server, then the trained AI model is passed from the AI model server to the web server, where it is used to process images.

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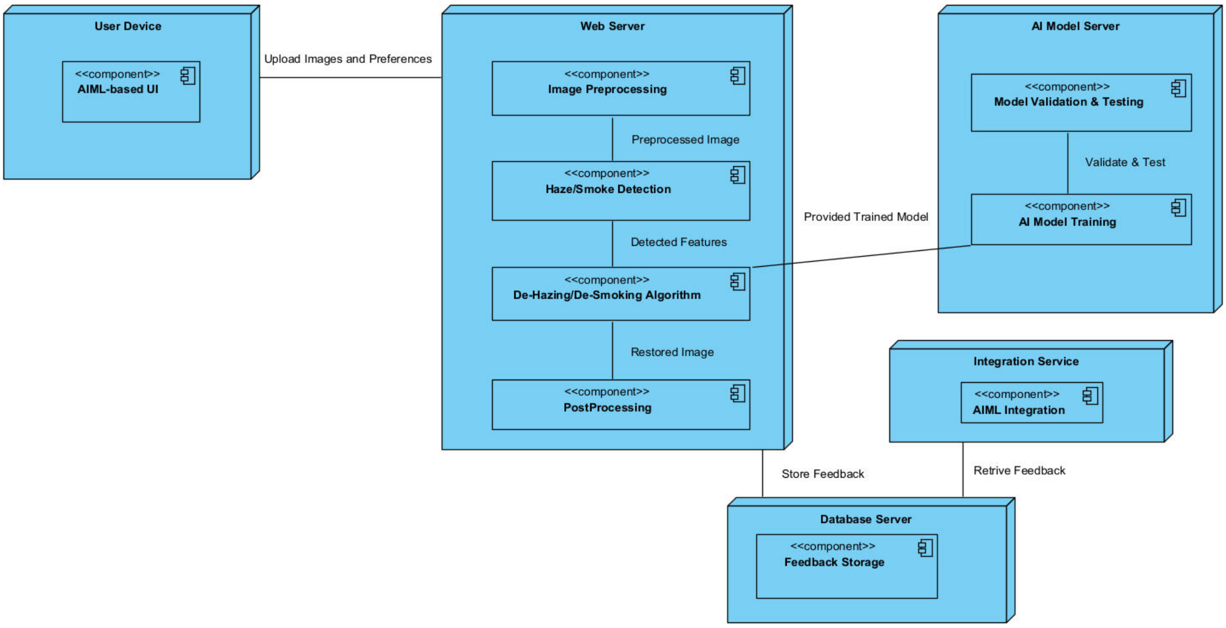

Figure 1: Deployment Diagram

Component Diagram: This diagram depicts the organization and the relationships of the components through dependencies and interfaces. The component diagram below consists of seven different components and the process begins from the user uploading an image and image preprocessing cleans it up, AI model removes haze or smoke and then the postprocessing clears and fine-tunes the image and finally it displays the result. Where logging and monitoring monitors the systems performance. Along the way, Data Storage saves everything, and Logging & Monitoring keeps track of the process.

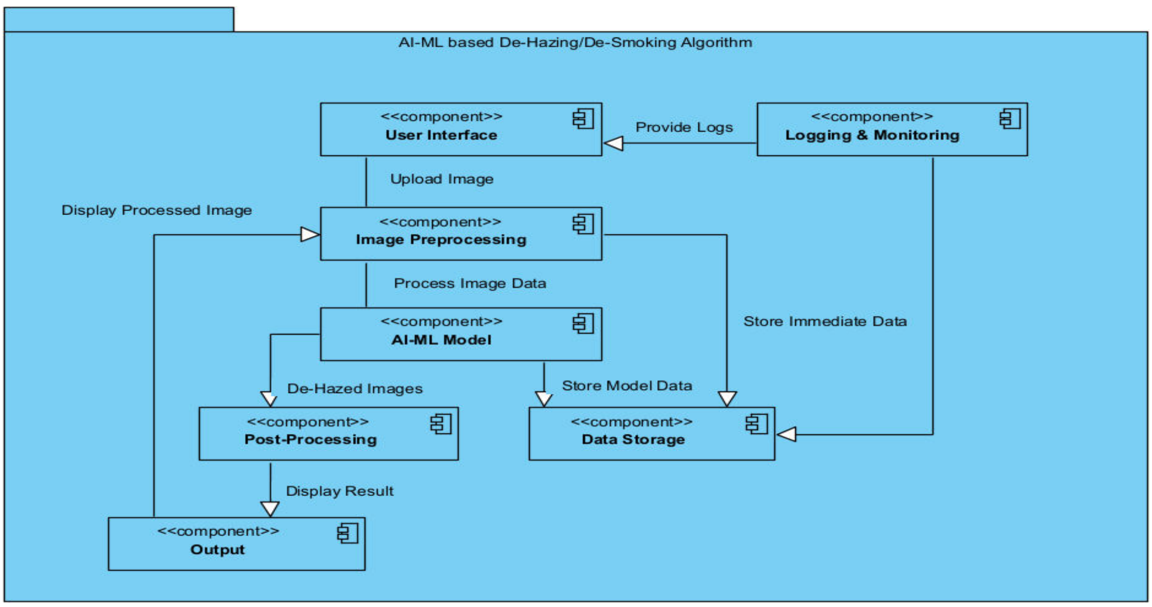

Figure 2: Component diagram

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Activity Diagram: It models the workflow of the system or the process while highlighting the sequences of decisions and activities, The diagram helps in visualizing a step-by-step process of the basic working system that the platform follows. In this case, the process begins with the user providing images that need to be de-hazed/de- smoked. The system first preprocesses the image and then if the image is valid the system moves to next step if it is not valid the further processing is stopped. After this the system first runs the image through de-hazing module to remove haze, if the output is ok then the process is complete otherwise the system repeats the de-hazing and de-smoking process until the final output is satisfactory.

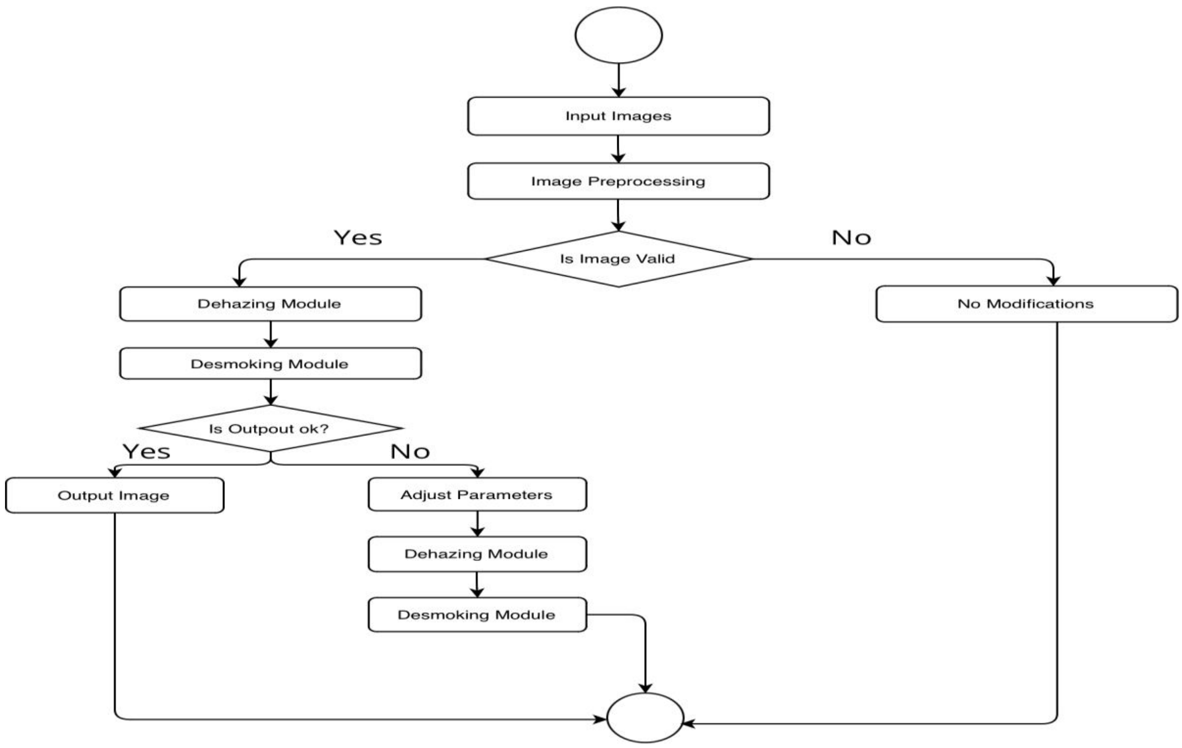

Figure 3: Activity diagram

V. CONCLUSIONS

The AI/ML -based intelligent de-smoking/de-hazing algorithm is developed that effectively enhances the image quality which are affected by haze and smoke due natural disasters or environment disturbances. By doing proper research and experimentation we have provided our approach by developing an algorithm using Convolutional neural network including different libraries, modules and framework to make it an efficient and advanced algorithm which can run in real-time also. This not only solves the limitations of the existing image processing methods but also has practical applications in many fields such as environment monitoring, surveillance and self-driving cars. One more real-world problem which can be solved by this algorithm is we can find the cause of the fire accidents by de-hazing the images captured by security cameras using this algorithm. This project provides the valuable insights for enhancing visual clarity.

VI. DECLARATIONS

6.1 Study Limitations

None

6.2 Funding source

None.

6.3 Competing Interests

The authors, hereby declare that there are no or competing interests.

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VII. HUMAN AND ANIMAL RELATED STUDY

The study involves no collection of physical data acquired from humans or animals that are put through rigorous testing nor do they have to give a sample of their fluids or any other bodily secretions or excreta.

7.1 Informed Consent

All of the e-mails made were done with consent as test e-mails provided by the authors themselves.

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