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ENHANCED FOG REMOVAL AND OBJECT DETECTION FOR VEHICLE NAVIGATION

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Abstract

The proposed model utilizes a series of steps to enhance images and provide a warning system for drivers to avoid accidents. The process begins by collecting test images from a public database. These images serve as input for subsequent operations. The first step is to extract a transmission map based on the previous dark channel. The dark channel prior is a statistical property of natural images that characterizes the presence of haze or blur. By analyzing this information, the model can estimate the transmission map, which represents the amount of haze or blur in different regions of the image. Once the transmission map is obtained, it is used to remove the blur in the image. This process aims to restore the original details and improve the overall sharpness and clarity of the image. To achieve further enhancement, a controlled filter is applied, which helps to refine the restoration and optimize the image quality. Next, the enhanced image is segmented, which means dividing it into different regions or objects based on certain criteria. In this case, the segmentation is performed to identify and isolate vehicles present in the image. This is done by generating a salient map, which highlights the most relevant or distinctive features associated with vehicles. After vehicle detection, the model calculates the distance between the detected object and the vehicle mounted on the camera. This distance calculation is crucial for assessing the potential danger or risk of collision. By accurately estimating the distance, the model can provide timely warnings to the driver, alerting them to the presence of nearby vehicles and helping them avoid accidents. Finally, based on the calculated distance, a warning system is provided to the driver. This system may utilize visual or auditory cues to attract the driver's attention and indicate the proximity of other vehicles. By incorporating this warning mechanism, the model aims to enhance driver awareness and assist in preventing accidents. Overall, the proposed model employs image

enhancement techniques, vehicle detection, distance estimation, and warning systems to improve driver safety. It combines computer vision and image processing algorithms to mitigate blur, detect vehicles, and provide real-time information to drivers, enabling them to make informed decisions and potentially avoid accidents

1 Introduction

In recent years, transportation systems have played a crucial role in the development of intelligent transportation systems enabled by IoT fog robotics. Fog robotics refers to the cloud and robotic servers used for data capturing and storage. However, several issues such as security and privacy, latency, and bandwidth limitations have been faced by fog robotics [46]. Nevertheless, fog robotics is essential in activating IoT devices and robots in homes and warehouses to connect with edge sources and cloud data centers. For instance, fog robotics is used in airports to communicate with other robots for information availability . The primary contribution of fog robotics is the efficient allocation of resources between the edge and clouds. Line-of-sight is also a critical aspect defined as the sight between an object and the subject. Currently, vehicles and networks are being integrated into transportation systems in smart cities. The intelligent transportation system combines communication and information technology to create a mobility management interface with other transport means. The usability of traffic control systems and traffic management reflects traffic patterns. The speed camera is an example of a traffic control system used to measure the speed of vehicles at sharp points on the road. It uses conventional cameras and radar detection, with vehicles that exceed the speed limit being fined according to their driving license. The camera is installed on the roadside and linked to the number plate while recognizing the average speed. Intelligent speed adaptation (ISA) is another technology used to indicate the speed limit's location, with active and passive ISA being the two types. This system uses information about the position and speed to improve road safety and the physical surroundings of vehicles, directly linking to applications and techniques. Furthermore, this technology helps in communication among cars on the road. The decentralized localization in a wireless sensor network is introduced to calculate the density of the wireless sensor network. This approach helps improve the decision-making process for wireless sensor networks and provides accurate information to improve road safety. In conclusion, intelligent transportation systems are essential for the efficient management of traffic in smart cities, and fog robotics and IoT play a crucial role in this system. The use of wireless sensor networks (WSNs) in traffic monitoring and control is becoming increasingly popular. These networks establish a routing matrix between the WSN nodes to facilitate communication and data exchange. In this context, the volume of vehicles is monitored using WSN sensors to assess traffic conditions, while vehicle speed is calculated based on sensors that scan number plates. If a vehicle is found to be exceeding the speed limit, a fine is automatically sent to the registered owner. The effectiveness of traffic management is determined by considering the impact of speed and the level of service provided. A rate measurement system is proposed to evaluate these factors [13]. Additionally, the traffic volume is analyzed to understand its effects on overall traffic conditions. To ensure safety in urban environments, autonomous algorithms are employed in non-linear dynamic robots to avoid collisions between vehicles and pedestrians, as well as between vehicles themselves. A flocking framework is utilized for connected automatic systems to achieve alignment and collision avoidance. One prominent component of driver assistance systems is the collision avoidance system (CAS), which aims to prevent collisions or minimize their severity. A CAS, also referred to as a forward collision warning system, pre-crash system, or collision mitigation system, utilizes basic configurations to measure a vehicle's speed, the speed of the vehicle ahead, and the distance between them. If the system detects that the vehicles are approaching too closely, it alerts the driver and may even take actions to prevent an accident. The deployment of collision avoidance technology has the potential to reduce fatality collisions by 30% and injury crashes by 40%. Flocking theory, a cooperative autonomous method, is employed in the development of automated driving technology. It enables the performance of driving control by considering the principles of flocking behavior. Autonomous driving heavily relies on sensors that observe other vehicles in the line of sight [20]. However, establishing communication with neighboring vehicles can be challenging. Therefore, the decision-making process of autonomous vehicles is complex and requires careful consideration. In summary, wireless sensor networks are used to create a routing matrix for efficient communication in traffic monitoring systems. Vehicle volume and speed are monitored using sensors, and fines are issued for speeding violations. The impact of speed and service levels is measured to improve overall traffic management. Autonomous algorithms and flocking frameworks are employed to ensure the safety of urban environments by avoiding collisions between vehicles and pedestrians. Collision avoidance systems play a crucial role in preventing accidents, and the deployment of such systems can significantly reduce fatality and injury rates. Flocking theory is used in the development of automated driving technology, and autonomous vehicles rely on sensors to observe other vehicles for decision-making purposes Free-space detection is a critical task for autonomous or automated vehicles as it determines the safe area for vehicle navigation. Typically, in structured environments, the free-space area primarily consists of the road surface. This area is usually identified using color or texture segmentations, derived from stereovision-based obstacle detection, or a combination of both approaches. However, these methods face challenges when dealing with foggy weather conditions. In foggy weather, the reduced contrast with distance poses difficulties for classical segmentation techniques that assume the color or texture of the road remains constant. Similarly, stereovision techniques relying on local correlation may not function effectively. To address this problem, one possible solution is to restore the contrast of the image. By enhancing the contrast, classical free-space detection techniques can be applied to the restored image. There are various methods available for restoring the contrast of foggy images. These methods typically involve enhancing the visibility of the scene by reducing the effects of fog and increasing the overall contrast. One common approach is based on image dehazing algorithms. Dehazing techniques aim to estimate and remove the atmospheric veil caused by fog, thereby enhancing the visibility of objects in the scene. Image dehazing algorithms often rely on the assumption that the degradation of the image is caused by the scattering and absorption of light by atmospheric particles. These algorithms estimate the transmission map, which represents the portion of light that reaches the camera from the scene, and then use it to recover the scene radiance. The recovered radiance provides a restored image with improved contrast and visibility. Once the image contrast is restored, classical free-space detection techniques can be employed. These techniques may include color or texture-based segmentation algorithms or stereovision-based approaches that rely on obstacle detection. With the restored image, these methods can accurately identify the free-space area, allowing autonomous or automated vehicles to navigate safely even in foggy conditions. It is important to note that while contrast restoration techniques can enhance the visibility in foggy weather, there may still be limitations in extreme cases where the fog density is extremely high. In such scenarios, additional sensor modalities, such as radar or LiDAR, may be necessary to complement the visual information for reliable free-space detection. In summary, free-space detection for autonomous or automated vehicles is crucial for safe navigation. In foggy weather, contrast restoration techniques can help overcome the challenges posed by reduced visibility. By restoring the contrast of foggy images, classical free-space detection methods can be effectively applied, enabling vehicles to navigate safely in adverse weather conditions.

2. Literature Survey

[1] Nicolas Hautiere et.al provides an analysis of different fog removal techniques. The study reveals that each technique has its own unique features and limitations. However, the methods presented in the paper overlook two important aspects: enhancing the haze image and addressing the issue of noise reduction in the output images generated by existing fog removal algorithms. Specifically, two techniques, namely Clahe and object detection using Curvelet Transform, have been neglected. These techniques have drawbacks such as low detection accuracy rate and the absence of distance calculation to effectively alert the driver. To elaborate on these points, the paper primarily focuses on evaluating various fog removal techniques. It highlights the distinct characteristics and drawbacks associated with each method. However, it fails to address the need for enhancing the clarity and visibility of haze-infused images, which can significantly impact the overall quality of the output. One such technique that has been overlooked is Clahe, which stands for Contrast Limited Adaptive Histogram Equalization. Clahe is a widely-used image enhancement technique that aims to improve the visibility of images affected by haze or fog. By effectively increasing the contrast and reducing the loss of detail caused by haze, Clahe can significantly enhance the clarity of images. Another neglected technique is object detection using Curvelet Transform. Curvelet Transform is a multi-scale, multi-directional transform that has proven to be effective in detecting and extracting objects from images. By leveraging this technique, fog removal algorithms can not only remove the haze but also accurately detect objects in the scene. However, the existing fog removal algorithms in the paper fail to incorporate this important capability. Despite their potential advantages, Clahe and object detection using Curvelet Transform also possess certain limitations. Clahe may suffer from reduced detection accuracy due to its inability to account for complex atmospheric conditions or varying haze densities. Additionally, the object detection technique using Curvelet Transform lacks an implemented distance calculation method, which hinders its ability to effectively alert drivers about potential hazards or obstacles. In conclusion, while the paper offers valuable insights into various fog removal

techniques, it fails to acknowledge the importance of enhancing haze-infused images and mitigating the issue of noise in output images. The overlooked techniques, such as Clahe and object detection using Curvelet Transform, can address these shortcomings but have their own drawbacks in terms of detection accuracy and distance calculation. Future research should aim to incorporate these techniques while considering their limitations to develop more comprehensive and robust fog removal algorithms.

Gagandeep singh [2] et.al. provides a comprehensive review of different fog removal algorithms, also known as visibility restoration techniques, that aim to reduce or eliminate degradation in digital images caused by fog. The study examines various fog removal methods and highlights their individual characteristics and limitations. However, one aspect that seems to have been overlooked in the presented methods is the reduction of noise in the output images produced by existing fog removal algorithms. Additionally, there has been limited focus on exploring the integrated approach of combining CLAHE (Contrast Limited Adaptive Histogram Equalization) and Dark Channel Prior techniques. Furthermore, the issue of uneven illumination in foggy images has been largely neglected by most researchers. In this paper, the authors evaluate numerous fog removal techniques and discuss their respective strengths and weaknesses. Despite the advancements in fog removal algorithms, a crucial concern that remains unaddressed is the presence of noise in the processed images. The introduction of noise reduction techniques would significantly enhance the overall quality of the output images obtained through fog removal processes. Furthermore, the integration of CLAHE and Dark Channel Prior methods shows promise in overcoming some of the limitations observed in individual approaches. By combining these techniques, researchers may achieve improved results in fog removal applications. Moreover, the issue of uneven illumination in foggy images has been overlooked by many researchers. Uneven lighting conditions can further obscure visibility in foggy scenes, making it challenging to accurately restore the image quality. Future studies should consider the development of algorithms or techniques that explicitly tackle the problem of uneven illumination, possibly through image preprocessing or incorporating additional image enhancement methods. In conclusion, while this paper offers a valuable analysis of various fog removal algorithms, there are certain areas that require further exploration and development. Addressing the noise issue in output images, exploring the integrated approach of CLAHE and Dark Channel Prior, and considering the problem of

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uneven illumination are important directions for future research in the field of fog removal and visibility restoration

[3] Wu Sijiu et.al In this paper, the authors conducted a comparison of image haze-removal algorithms for both image restoration and image enhancement purposes. Specifically, they analyzed and discussed the principle behind the image haze-removal algorithm that utilizes the dark channel prior. During their analysis, they identified certain shortcomings of this algorithm. To address these shortcomings, the authors proposed an alternative image haze-removal algorithm that incorporates the dark-channel prior based on wavelet decomposition. The proposed algorithm involves three main steps. First, the image undergoes a three-channel wavelet transform. Then, the dark-channel prior is applied to the low-frequency components of the image, serving as the basis for haze removal. Finally, the high-frequency components are subjected to upgrading sharpening techniques. The experimental results presented in the paper demonstrate that the proposed algorithm not only enhances image resolution after haze removal but also performs better in preserving image details. Additionally, the algorithm effectively reduces the computational time, leading to improved operational speed. To improve the clarity and structure of the sentence, here's a revised version. The paper presents a comparative analysis of image haze-removal algorithms for image restoration and enhancement. The authors investigate the principle behind the dark channel prior algorithm for haze removal and identify its limitations. To overcome these limitations, they propose a new approach that combines the dark-channel prior with wavelet decomposition. The proposed algorithm consists of three main steps. Firstly, a three-channel wavelet transform is applied to the input image. Next, the dark-channel prior is utilized on the low-frequency components to remove haze. Finally, the high-frequency components undergo upgrading sharpening techniques. The experimental results demonstrate that the proposed algorithm significantly improves image resolution and preserves fine details during haze removal. Furthermore, it achieves a reduction in computational time, leading to improved processing speed.

3 Methodology

The proposed project aims to improve visibility in foggy images using various image processing techniques such as contrast enhancement, brightness correction, and color correction. The overall process is visually represented in the block diagram. The first step involves acquiring foggy images from Google or any other suitable source. These images serve as the input for further processing. In the second step, a fog removal technique is applied to the

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acquired foggy images. This technique helps in reducing or completely eliminating the adverse effects of fog, thereby enhancing the overall image quality and visibility. Once the fog has been removed, the enhanced image undergoes a segmentation process. Segmentation involves dividing the image into distinct regions or objects based on certain characteristics, such as color, texture, or intensity. This segmentation step helps in isolating the relevant parts of the image for further analysis. Following the segmentation, the project focuses on vehicle detection using a saliency map. A saliency map highlights the most salient or visually significant regions in an image. By utilizing this map, the project identifies and detects vehicles present in the enhanced and segmented image. After detecting the vehicles, the next step involves calculating the distance between the detected objects and the camera-mounted on the vehicle. This distance calculation helps in determining the proximity of the objects relative to the vehicle. Finally, based on the calculated distance of the objects from the camera-mounted vehicle, appropriate messages or warnings are generated for the driver. These messages can provide crucial information about the detected objects' proximity and help the driver make informed decisions while navigating through foggy conditions. By combining various image processing techniques and computer vision algorithms, the project aims to improve visibility in foggy conditions, enhance object detection, and provide valuable information to the driver for a safer driving experience.

4 Block Diagram

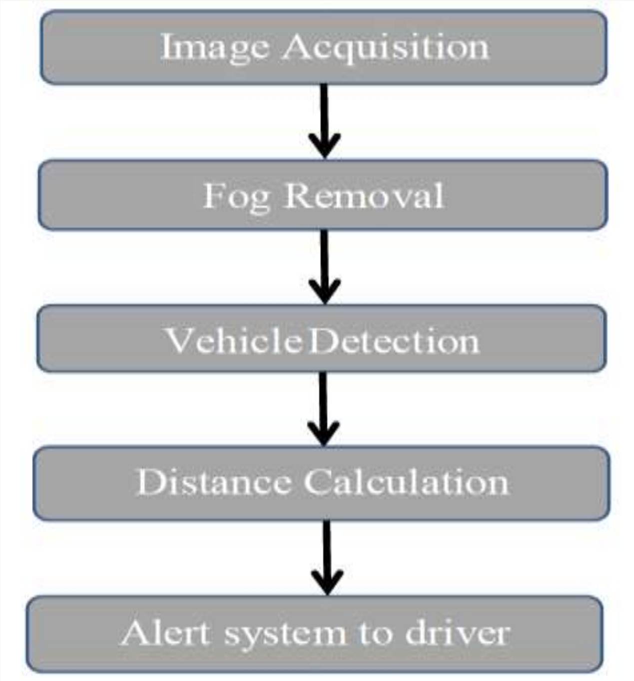

Fig 1 Block diagram

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5 Flow Chart

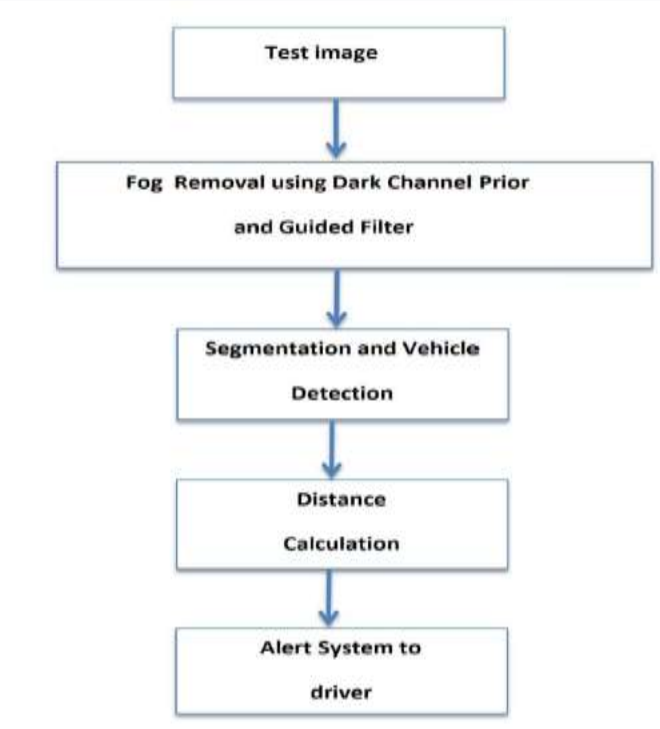

Fig 2 Flow chart

The provided flowchart illustrates the step-by-step process of our project. In this project, test images refer to the input images or sample images containing fog. We employ the fog removal technique, which involves utilizing the dark channel prior and guided filter. The guided filter is a widely used image processing technique that enhances images and improves the visibility of objects captured in foggy conditions. Next, we perform segmentation, which is necessary for object detection. Segmentation models provide precise outlines of objects within an image. They offer pixel-level details for each object, as opposed to classification models that identify the content of an image or detection models that place bounding boxes around specific objects. Following object detection, we calculate the distance between the detected object and the camera-mounted vehicle. This distance value is initially obtained in pixels. To clarify, we convert the distance value from pixels to a more meaningful representation.

Results

Fig 3 Sample fog images of bus

Fig 4 sample fog images of car

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Fig 5 Sample fog images of motor cycle

Fig 6 Sample fog images of truck

Conclusion

Enhancing images affected by fog has emerged as a highly active field in image processing. A combination of Dark Channel Prior and Guided Filter techniques is employed to filter fog images, followed by the extraction of vehicles from the enhanced fog image using the Saliency

Map approach. Consequently, the distance between the detected vehicle and the camera-mounted vehicle is calculated, enabling the development of an efficient automatic vehicle detection and warning system. This advancement holds immense potential in reducing accidents on roads and highways by enhancing visibility and aiding drivers. The future prospects of fog removal and object detection for vehicle navigation appear promising. As machine learning and computer vision continue to advance, these technologies are expected to achieve higher levels of accuracy and efficiency, further enhancing safety and reducing accidents caused by fog-induced poor visibility. Furthermore, object detection can greatly contribute to the identification and avoidance of obstacles, thereby improving the performance of autonomous vehicles. Consequently, these technologies are poised to play an increasingly significant role in the automotive industry in the foreseeable future.

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