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Review about applications of Remove haze from images

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ABSTRACT

The problem of removing haze from images is a problem that researchers have been interested in, because of its importance in various fields in computer vision and image processing. The photos are usually taken in nature, like forests, cities, streets, etc., and are generally accepted in terrible weather conditions, especially fog. This is because the light is a critical factor in obtaining clear images, assuming the cameras' quality. The presence of various types of haze (smoke, fog, and dust) reduces the light rays that are reflected from the scenes to be photographed, so removing the haze was the researchers' primary concern. Moreover, many computerized devices use these cameras and imaging devices in various fields. Through this research, we will mention a number of those applications that use this biotechnology "dehazing."

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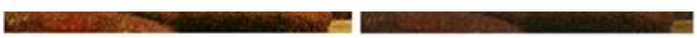
1. Introduction

The distinction between noise and haze is that noise is created by sensor inaccuracy (measurement), which is magnified throughout the imaging process. Denoising is a noise reduction method[1]. Haze is particles suspended in the atmosphere, obstructing the arrival of the light beam to the object and thus reducing the reflected light to the lens. In clear weather, the air is pure in clear weather, and the only particles present are air molecules. Because visible light has longer wavelengths than its size, it can pass through with minimum alterations. In the atmosphere that suffers from fog, the images are of low or non-existent quality in some cases, which causes the loss of many details of the image and thus not obtaining sufficient information from the image[2], see figure(1.1).



(a): Haze Free Image (b): Input Haze Image

Figure (1.1): Shows the difference between a hazy image and an image without haze or taken in a clear atmosphere.

The figure (b) shows that the image suffers from insufficient clarity and contrast in colors, and therefore poor image quality. As for the second figure(a), the image is clear, with clear features and colors.

There are many and varied reasons that cause haze, we take some of them[3]:

- Haze: They are minutes of dust suspended in the atmosphere.
- Fog: It is a drop of water suspended in the atmosphere (humidity), which spreads over a few areas and does not dissipate quickly when the sun rises.
- Mist: They are droplets of water suspended in the atmosphere, which spread over large areas and dissipate quickly at sunrise.
- Smoke: It is the spread of smoke in the atmosphere and prevents or reduces vision, due to fires, or because of smoke from factories or car supports.

There are other reasons such as icy fog, steam and other air pollutants that cause the deterioration of the captured images[4, 5].

2.Atmospheric Scattering Model (ASM)

Image dehazing has been extensively researched in order to improve photographs acquired under adverse weather situations, which frequently result in dense haze. Because of rapid and convenient capturing interfaces, mobile device photography has increased [6]. However, these images typically fade when the image is hazy with significant landscape erosion, See figure (2.1).

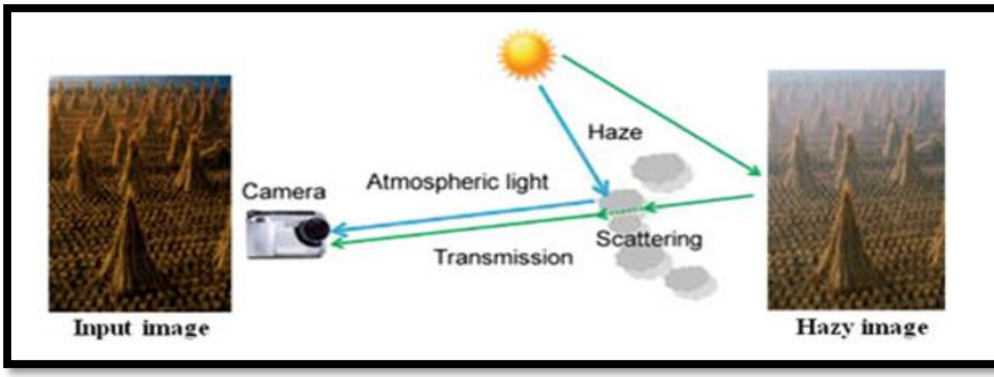


Figure (2.1): ASM model[7].

The physical haze model, given by the equation(2.1) below, was introduced decades ago in [8].

$$I(x) = J(x)t(x) + A\big(1 - t(x)\big) \quad (2.1)$$

Where I is the perceived hazy image, J is the actual scene radiance, A is the global atmospheric light, indicating the intensity of the ambient light, t is the transmission map, and x is the pixel position. The transmission map is distance-dependent is given by the equation (2.2).

$$t(x) = e^{-\beta d(x)} \quad (2.2)$$

"β which is the atmosphere's attenuation coefficient and d is the scene depth "[9].

3.Methods of dehazing

There are many ways to dehazing from images. Some of them depend on an ASM and some of them do not[10]. Since the advent of machine learning(ML) and this has developed with the development of these technologies, including deep learning(DL), with amazing results, the methods are divided into supervised learning[11], unsupervised learning[12], and semi-supervised learning[13]. Finally, there are not many studies. Removing the haze using deep learning techniques, is one of the most important methods used recently, which has attracted wide interest by researchers, because of the amazing results it achieved[14].There are several ways to remove haze from images, mainly divided into two parts: Additional-information Approaches and Based of input image (Single Input Image and Multiple Inputs)[15].

4. Applications of dehazing images

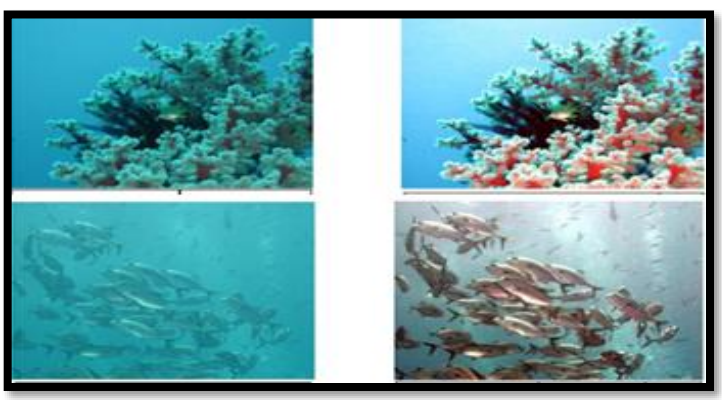
The field of artificial intelligence is a widespread field, especially after the development of ML and DL technologies. These technologies have been used in wide fields and these technologies have been developed[16], these techniques were used to distinguish writing, for example [17] [18]. The development of ML recently, especially after the emergence of DL, has achieved impressive results in the medical field[19] .One of the most common uses of ML is in the fields of image processing, to get rid of the deterioration of the problem of blur due to the atmosphere .The technique of removing dehazing from images has entered many important horizons[20]. Obtaining a high-quality image and thus obtaining reliable information was and still is the goal of dehazing technique[21] .We will briefly explain some of the countless applications:

- **Remote Sensing (RS):**

RS is a new technology used to collect data that aids in exploring more information about the Earth's surface. However, the RS data captured by the satellite is susceptible to suspended particles during the imaging process, particularly for data in the visible light band. Many experiments and efforts have recently been conducted to recover individual blurry data without any additional information to compensate for this shortcoming. Because getting the same scene under varied conditions is challenging, utilizing a single image is preferable to using many images[22]. RS has been widely employed in military matters[22-24] , such as missile early warning[22, 25] and military surveillance[22, 26]. It is also increasingly being utilized for civilian reasons, such as land planning and crop production studies, because of the recent proliferation of satellites [22]. Regardless of its use, RS pictures or satellite data are readily damaged by fog or haze during the imaging process, resulting in images with low contrast or fading color[26] and reducing the effectiveness of computer vision tasks such as object detection[27] . This negative consequence affects the visual quality of RS photos and effectively limits the use of this valuable RS data.

- **Underwater Image**

An endeavor that has been fruitfully begun in the direction of the evolution of image processing techniques and approaches has been effective over the last few years [28, 29]. There has been minimal research into the processing of underwater photographs. Because of the light's absorption and scattering effects, as well as the environment's inherent lack of structure, underwater photography poses unique problems and significant issues[30]. Figure (4.1) depicts underwater photographs taken before and after treatment.



Figure(4.1) : Shows underwater image before and after treatment [30] .

Image processing can help developers investigate the underwater world. Underwater image processing is used to identify tiny underwater objects and for landscape scanning, mine detection, telecom cables, and autonomous underwater vehicles. Because of artificial light absorption Figure (2.11), scattering, color distortion, and noise, underwater photographs appear hazy, and blue or greenish[20]. The reason for the appearance of underwater images in a blue or bluish green color is that the visible blue rays extend to a greater extent, figure (4.2) as shown in the following image.

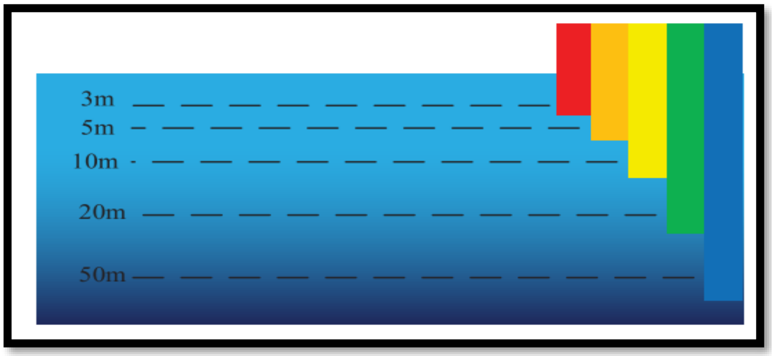
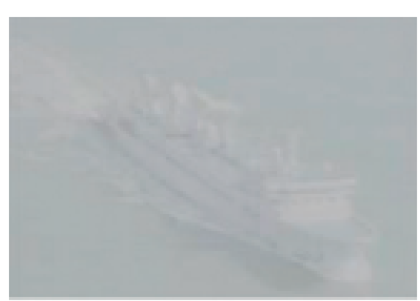


Figure (4.2): Blue's wavelength is shortest[20].

Intelligent transportation systems (ITS).

Maritime video surveillance systems have long been an essential component of maritime oversight. The picture obtained by the marine surveillance system's imaging equipment is always of poor quality because of microscopic droplets in the air. Poor visibility, edge deterioration, color distortion, and texture distortion are all phenomena. This negative impact will immediately impact the deployment of sophisticated vision tasks like ship recognition and tracking [31, 32] . Many augmentation strategies for marine photos have been proposed as a result of rapid advancements in computer vision[33, 34] . Because haze is easily formed in the marine environment and significantly impacts the visual impression, it is also vital to investigate the dehazing of maritime photographs. Dehazing has become a severe challenge in computer vision-driven inference in (ITS). Image dehazing aims to replicate the hazy counterpart's latent haze-free image, and video surveillance has long been utilized in marine monitoring. The imaging technology of the maritime surveillance system captures low-quality photographs due to minute air droplets[35]. Figure (4.3)is an example of one of the pictures taken during a foggy weather, through one of the surveillance cameras, and the result after the treatments.



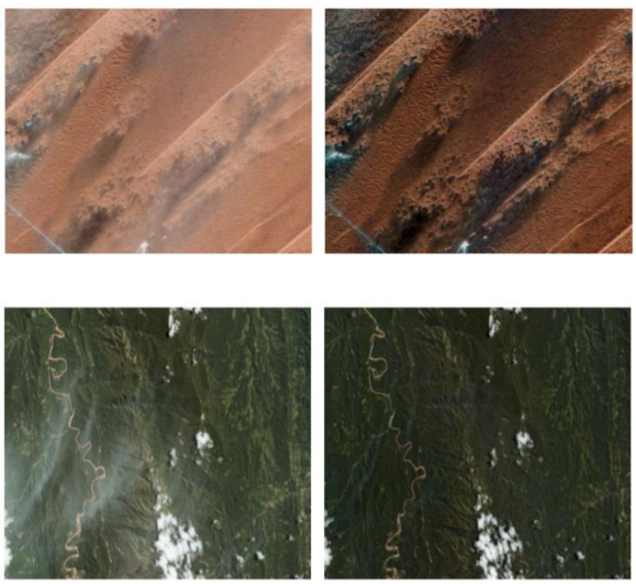
(a) Dehazed images generated (b) Synthetic haze image

Figure (4.3): The image captured by the (ITS) devices before and after processing it[35] .

The figure (4.3)(b) shows that the image suffers from hazy (dense haze), which affected the quality and efficiency of the captured image. The figure (a) shows the clear image after it has been processed by one of the methods of removing the haze.

Satellite Images.

The sunlight that reaches the satellite after it has been reflected by the earth has to go through the atmosphere twice. That will result in both path radiance and contributions from neighboring areas. It is only the direct reflection that is wanted so in order to get the true image the other contributors must be removed or compensated for[36]. Atmospheric correction is the task of removing the path radiance and the radiance reflected from the neighborhood to extract only the radiation reflected from the pixel of interest. Dehazing is the process of removing thick layers of haze that not only results from the scattering of light in the atmosphere. Haze is irregular compared to atmospheric scattering. In some areas, the ground is visible, but partially obscured by a layer of haze [37]. In the following images figure (4.4), you can see the images captured by satellites and in return the images after processing them by removing the haze.



Figure(4.4): satellite images before and after processing[38].

- **Smart cities**

Smart cities can use ML,DL, and computer vision technologies to save money and improve the quality of human life in these modern cities[39]. Using the intelligent cameras that were used in those cities for monitoring, would govern and plan cities[40]. As we mentioned that haze reduces the rays falling on the body and thus reduces the reflected rays of the camera, so it is very necessary to use the technique of removing haze from the images to obtain high quality images and thus the quality of the information extracted from them[41].

5. Methods of dehazing

The most important modern applications used to remove hazing from images have been clarified; these applications are examples and are not limited. The development of technologies is continuous, and this technology will certainly be used in several other fields[42].

As for the methods of treating blur, we mention them and are not limited to; there are several methods, and one of the most important of these methods is the dark channel. The dark channel is considered one of the essential image processing techniques. It suffered from many limitations, such as the increase in the image's darkness despite its clarity, but it suffered from some loss of image details[43].

Then, after a while, the color channel was used, which addressed the problems of the dark channel but sometimes led to an increase in the image's saturation[44]. But after the tremendous development in deep learning and the discovery of convolutional neural networks, it is considered the most critical type of deep learning[45]. The acceptance of researchers has increased, and it has been suggested a large number of networks that have obtained good results in getting image free-haze[46].

6. Conclusion

Removing the haze has entered all aspects of life as we have seen, and this technology will remain in continuous development and growth for several reasons, first for its entry into all medical, military, agricultural and other facilities. Secondly, because of the development and increasing growth of computers, and the field of artificial intelligence. Thirdly, to achieve amazing results, this excellent technology will be developed in several areas, especially in modern cameras and mobile phones. In our future research, we will develop several grids to remove blur from images, this is our next project.

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