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A Survey on Haze Removal Techniques in Satellite Images

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ABSTRACT

The loss of images in remote sensing images from the outdoors is often caused by natural situations such as fog, haze, and water particles. These contaminants cause the images to become blurred, noisy, and colour distorted. The photos were processed in various ways in the current literature. This paper discusses various computer algorithms, providing detailed information on each one to answer the various questions. The proposed method incorporates histogram equalization, bilateral filters, and phase function consistency checking; with an additional enhancement, hybrid technique is all uses multi-retinex theory to avoid unwanted artifacts and enhance the clarity of the appearance of the results.

Keywords: *Image processing, Satellite images, Haze removal, Remote sensing.*

1. Introduction

Haze, fog, mist, and other parts of atmospheric degradation are often seen in images of outdoor scenes induced by particles in the atmospheric medium absorbing, and when light passes from source to viewer, it is reflected. This phenomenon affects remote sensing image perception. As a result, a good haze removal system is essential for making remote sensing images more visible. Many experimental methods for eliminating image distortion were used to solve image de-hazing problems [1]. So far, methodologies such as dark channel prior (DCP), multiple wavelet, histogram equalization, wavelet retinex theory, prior-based dense network, multiple exposure fusion, and others have been used [2].

The photos are enhanced using these techniques. Divide the images into several small regions and add the histogram features to the input to get better results. When you have figured out how loud it is, you can move on to the next, and when the noise level is estimated, the proposed method is visually equivalent to the first method. It proved to be better at preserving information [3].

The above approach for eliminating haze in outdoor images does not provide an exact detailed result; instead, it provides a basic histogram equalization procedure, which is a simple but effective image contrast enhancement technique that usually produces satisfactory results. The drawbacks of the current system are that the conversion method causes the satellite image to look identical to a noisy denoised image, resulting in the image losing its fine qualities. Image contrast enhancement technique that produces generally acceptable results.

2. Literature Survey

Images taken in foggy or hazy conditions accurately capture the scene as seen by the viewer. However, in some applications, such as plane landing systems or an automated car driving systems, it is essential to see through haze or fog-obscured artifacts. Algorithms that depend on lot of pictures, ii) apriori material, iii) just one picture are the three broad categories of haze removal methods. For haze removal, a polarising filter-based algorithm employs at least two photos. The algorithm is based on the polarization of the image 'air light'. Another haze-removal algorithm developed by few scientists employs several photos taken in various weather conditions. Apriori haze removal algorithms require either depth data supplied by the customer or a three-dimensional model. Haze reduction models based on a single image have recently been proposed [4]. The Koschmieder developed a haze formation physical model that is used in these simulations.

In comparison to a hazy image, a haze-free image has more local contrast, he discovered. By increasing the local contrast in the hazy picture, he was able to achieve a haze-free result [5]. Since this strategy isn't built on any physical model of haze formation, the haze-free photographs look unnatural due to color saturation. While this approach yields although it produces good results, it is computationally intensive [6]. As light travels from the source to the viewer, the ambient medium absorbs and scatters it, resulting in a haze, fog, and other forms of atmospheric depletion in images of outdoor scenes. While this effect can be beneficial in an artistic context, it is sometimes essential to reverse it. Many computer vision algorithms, for example, assume that the image used as input accurately represents the brightness of the scene, i.e., the absence of haze [7]. Algorithmic errors can be disastrous if this presumption is broken. It's easy to see how a navigation device in a car works that depend on visual input from the environment ahead of it might be problematic but ignores this impact might have disastrous consequences. Haze estimation approaches split into two different types in current haze removal research: those that rely on additional data and those that rely on a prior assumption [8]. Multiple polarised images of the same scene, multiple images taken in different weather conditions, and methods that provide user-supplied depth information or a 3D model are examples of methods that depend on additional information. While these may produce good results, the additional knowledge needed is often unavailable, so a more versatile strategy is preferred. In recent years, significant progress made in the elimination of single images [9,10]. The author noticed that a picture with no haze has more contrast than a hazy image, and he achieves better results by optimizing contrast in an input image. However, since a physical mode isn't used in this approach, the final findings are often abnormal due to over-saturation. By assuming that surface shading and transmission are uncorrelated locally, the authors were able to achieve good performance [11]. Based on this premise, he uses independent component analysis to obtain the transmission map. This is a mechanically sound technique, but it struggles in gray areas where the various parts are challenging to distinguish. Finally, the author suggests a simple but powerful method that uses dark pixels to get a coarse approximation of the transmission diagram, refined performing an image matting technique. This approach achieves results comparable to or superior to other cutting-edge algorithms, and then it also works with hazy scenes. When restoring hazy images, noise can be a significant issue even when the haze material is known. The works described above often avoid the problem by presuming a noise-free image or dehazing until minimal noise. There are two basic approaches to dealing with noise in the existing literature: denoising before dehazing and denoising during dehazing. They then use a variant on the dark channel system to dehaze it. In scene radiance recovery, Schechner and Averbuch estimate haze using a polarization-based approach and answer as a regularization term, There is also a local penalty word equal to the transmission value. Since the regularization is so quick, hazy areas are effectively blurred while non-hazy areas remain sharp [12].

The authors suggest a more complex variation on this theme; for regularization, it employs a total variation approach based on Beltrami flow. The application of complex PDE approaches, which necessitate minimization of the overall image, is a major downside, despite their effectiveness [13]. Furthermore, each of the works listed uses several photographs. The following are the key contributions to this paper, which address how restoring a complex problem determines a single chaotic, hazy image's underlying scene radiance. The first is a look at how noise affects haze estimation using the dark channel prior [14]. After obtaining a haze calculation, for scene radiance recovery, two different methods are proposed and compared. The first method is to use a state-of-the-art denoising algorithm to denoise the image before dehazing (BM3D13), which can be translated as Joshi and Cohen's single image adaptation. 1 The second technique uses iterative non-parametric regression is used in this method to simultaneously denoise and dehaze. This can be viewed as both a single-picture adaptation and a multi-picture adaptation and simplifying the approaches. The following are the three individuals of prior job that has the most impact on our current issue. The literature covers some of the techniques used, including desensitization, image synchronization, optical flow, and dehazing. Desensitization is a term used to describe removing an extensive and comprehensive body of literature published on image denoising methods [15]. The majority of methods deal with a single image's denoising. A weighted average is calculated for each pixel a local neighborhood is calculated. As in Bilateral Filters, The weights can be as basic as a Gaussian with radial symmetry defined by their similarity to the smoothed pixel, or they can be based on local higher-order statistics (as in Bilateral Filters). When there are multiple identical copies of an image, each with its Gaussian noise, the noise can be extracted by averaging the each picture's corresponding pixels are stacked in time. Similarly, video denoising works. Typically, the spatial neighbourhoods in each frame are first aligned in an alignment step. The weights for pixels in the aligned spatiotemporal neighborhood are then calculated. Weights may be based on alignment trust, temporal similarity, equivalent to bilateral spatial filtering, and other local statistics to prevent averaging over moving objects. We use a weighted average of the pixel stacks in our case, with the weights calculated using local (spatial and temporal) statistics and a model to prevent spatial resampling of pixel values due to sub-pixel alignment. We can heavily weigh a small percentage of the pixels while still achieving robust denoising since we have such a big stack to choose [16]. As a consequence, we apply concepts from lucky imaging to astronomy.

Alignment and Flow: Our work involves rigid image alignment due to tiny camera rotations, and Owing to time-varying air turbulence, local pixel alignment has occurred [17]. Szeliski gives an excellent description of stitching and alignment techniques. Likewise, the optical flow has wide literature pixels that shift a small amount from one frame to the next are tracked. Since the motion is spatially smooth, there are no occlusions, and the motion is small enough to use a simple patch-dependent SSD search after the global alignment, our case is relatively simple compared to finding general flow.

Dehazing: The removal of haze from photos has taken a long time. The haze is dictated by the scene's depth, which is in most cases unidentified, making haze removal difficult. Multiple images are used in many methods, Photos taken in different weather conditions or a pair with and without a polarising filter [18]. The

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differences between the photos are used to estimate the depth and color of the air light and remove hazards. Depth can be extracted from external sources in some cases by geo-registering an image with known 3D models. Using a robust previous, the removal of haze from single images has recently progressed. In order to measure the effect of haze, Fattal believes that surface shading and transmission are unrelated locally. A new dark channel prior is proposed by him and his colleagues. They discovered that any local area of a haze-free image contains at least one channel of one pixel that is dark for outdoor scenes. The darkest pixel channel in any local area is used to determine the presence and amount of haze. In our processing, we'll use a variant of this job. When dehazing distant objects that a thick layer of haze has obscured, none of the approaches above resolve the issue of noise. The majority of the findings show that "adding back a little haze" improves the visual quality of distant regions. For single image haze elimination, various methods have been suggested, merging various images of the same scenery, 3D geometrical model, polarisation filters, 3D geometrical model, 3D geometrical model, 3D geometrical model and so on. Collecting several photographs of the same scenery in real-time applications, on the other hand, is not always possible [19]. Dehazing models were also suggested with clear and persuasive assumptions. The haze-free picture, according to the author, had a higher contrast than the hazy scene. So, based on the above premise, they eliminated haze by optimizing the hazy image's local contrast. This approach fails when the hazy image has a depth discontinuity and produces blocking artifacts.

The above methods revealed a connection between haze content and color models, as well as their benefits. As a result, understanding how all of the assumptions work together would help predict haze density more accurately [20]. Because a single statement cannot always be relied upon to be correct, it can fail in situations where there are many complex structures. As a result, used to learn the mapping between the hazy input image and the transmission map that corresponds, convolutional neural networks were used to build a more robust method [21]. A dark (low-light) setting, however, introduces color distortion. Since the cardinal channel information is lost in the first convolutional layer, these networks are ineffective. The authors have made an observation that helps them to break the cardinal channels and predict haze distribution.

3. Conclusion

We addressed several methodologies for extracting haze and other phenomena from photographs, then restoring the affected image and providing better results in this survey. In conclusion, when compared to other approaches, the combination of histogram equalisation, phase consistency function, and multiple wavelet retinex can provide better results. The suggested approach would remove the haze while also enlarging the image so that the detailed details from the desired input can be seen. As a result, for remote sensing images in the outdoors, the proposed dehazing algorithm is more effective and important.

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent to participate

Not Applicable

Consent for publication

We declare that we consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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