A Review: Fog Removal Techniques with its Types and Limitation

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***Abstract*— this paper provides a description of different methods for the elimination of haze. Fog brings issues for most graphics PC vision uses while it decreases the exposure of a scene. Fog is created by two fundamental phenomena. that could be attenuation and light of air. Attenuation decreases contrast & light of air increases the whiteness of the scene. Fog removal (FR) systems recover the color & contrast of the scene. Reported algorithms for FR were reviewed in this journal. Fog reduces (FRD) the illumination of the scene so the performance of more than different computer vision algorithms use features information. It's the fog formation Perform depth of fog. Analysis of depth data is a constraint barrier if a single image is available. Consequently, the removal of fog require assumptions or prior data. FR algorithms estimate the depth of the data quite a lot of assumptions, that are mentioned in important points right here. FR algorithm has a broad application in navigation & monitoring, entertainment industries & electronics.**

Keywords*— *Radiation; Advection; Upslope; Freezing; Evaporation or Mixing; Dark Channel Prior; CLAHE; Bilateral Filtering; MIX – CLAHE and Trilateral Filtering, etc

I. INTRODUCTION

It is well known that hazy or foggy weather conditions reduce visibility in an outdoor environment. This can be particularly critical with regards to traffic safety. Images or videos taken under such conditions also suffer from lack of quality, unless the hazy appearance is wanted for artistic purposes. For instance for televised transmissions of outdoor sports events, such as cross-country skiing or ski jumping, hazy weather can seriously affect the quality of experience of television audiences.

Several algorithms have been planned to enhance the quality of images taken under foggy conditions, focusing for instance on visibility. However, there is a need to develop methodologies for evaluating such algorithms with regards to their perceptual quality. One method dedicated for visibility enhancement algorithm evaluation was planned by Hautière *et al.* [1]. This method computes two indicators: Rate of current visible geometric & edges mean visibility of ratios.

Figure 1. Foggy image and after remove fog based image

Fog(F) is a set of ice crystals and water droplets & suspended in air near the earth's surface. F is often stratus in the form of a cloud as a cloud of stratus. F is outstanding from the most efficient fog through its density. FRD exposure is less than 1 km as F decreases exposure to just not less than 1 km. [2].

FRD Visibility & Distinction of the Image Stage. To make a stronger the great image different improvement ways are used. The image is processed step-by-step over an image, collect an image from the actual world turn into a form readable process, the size of the picture noise output. Different forms of interference that has an effect on a picture. As a consequence, an image enhancement approach is needed to produce the best image. After enhancing the large image, restore the image again. There are actually two methods for the removal of fog varieties-

- Fog correction(FC)
- Fog removal (FR)

FC is established for the alteration of contrast level. Colour correction(CC) Strategy are used in HSV Color Space. The CC Method produces a transmission map & gauges of atmospheric light from a defogging image. More making use of the CC method more powerful video is developed. The FC procedure improves the quality of foggy pixel, however, the fog level over the image is discovered & eliminated in the FR system. Figure 1. Figure 1. Shows the normal model to remove images.

Fog, Blending two parts of airlight & direct lessening, corrupts the quality of the picture and makes of issues in video observation following & navigation. Gentle These droplets are scattered from the lightweight & atmosphere reflected from the object, As a result of the degradation of quality images [3].

Henceforth It could be said F is the consequence of AE & constriction to an image represented in a numerical statement (1) given underneath:

Fog = Direct Attenuation + Air- mild (1)

Constriction was a slow loss of power of some type of medium stream. Scientifically, this could Express as follows:

direct attenuation = J(x).T(x) (2)

If J(x) Was the t(x) & Scene Radiance is Medium(T). Direct Attenuation is a description of radiance and decay of a scene in a medium; This is a multiplicative distortion of the radiance of the image. If air is homogeneous, (T) t(x) can be defined as:

$t(x) = e^{-\beta d(x)}$ (3)

II. Where the coefficient of dispersion of atmosphere is β, Or d is a depth of the Xth pixel scene. A formula (3) shows the radiance of the scene is restricted exponentially by range. They could get a T, They could also retrieve depth to an unknown scale.

III. TYPES OF FOG

Fogs that are made totally or for the most part out of water droplets are for the most part arranged by physical procedure which delivers immersion or even close diffusion of air. sort of fog are:

1) Radiation Fog(RF): A type of F formation in the night under clear skies to calm wind, once the heat of the earth's surface is transmitted to space in the middle of the day. like earth's surface keeps cooling, when long as there is a sufficiently deep A surface of humid air near the ground, moisture is 100 percent & F is formed. RF ranges from 3 feet to about 1,000 feet in the top to bottom and is consistently found at ground level, but more often than not stays stationary. This type of F can sometimes decrease view by almost zero or make driving extremely harmful. Valley F is a form of RF that's very common in the eastern Kentucky mountains. At a stage, if the Air along sides of The hills starts to recharge since sunset, the air is thick & heavy, and the valley floors drop untouched. As the air in the VF keeps cooling due to radiation cooling, the air will be soaked and frames will be F. Valley F can be extremely thick now or again, making Driving is very risky Because of reduced visibility. Method F begins to dissipate as soon as the sun rises & the F layer begins to dissipate.

Figure 2. Radiation Fog image

2)Advection Fog(AE): AE also appears like radioactive F and is also a result of condensation. Notwithstanding, The build-up to such a condition is not due to a decrease in the surface temperature (T), Somewhat, a horizontal creation of warm humid air around the icy surface. The implies shift in weather conditions F can some of the time be recognized From the F by to the horizontal along the ground. Sea F is always advection of F, on the grounds that seas don't emanate warm similarly as area thus never cool adequately to create radiation F. F develops at sea as hot air, mixed with warm water, floats across cold current & condensation. Now or again, this F is drawn inland through low weight, as is often the case on north America of Pacific shorelines. Advection F might likewise shape If the sea or ocean is moist, the air drifts through a cold inland area. It occurs more often than not in the evening when the T of land decreases due to radiation cooling.

Figure 3. Advection fog image

3)Upslope Fog(UF): UF is created If the light winds shift the humid air upslope or up the mountain to a level where it is.air is concentration happens & immersed. Sort of F as rule structures a decent separation from the crest of the slope and the spreads & mountain a large area. UF happens in all the mountain ranges of North America. It, for the most part, happens throughout the middle of winter months, if cold air floats westward Inside the cold front & east side of the Rocky Mountains. Like cold moist air ascends inclines of a mountain, there are extensive areas & condensation happens of F structure on the lower slants of a mountain. A type of F is created if the air temp is below zero but is entirely made of tiny ice crystals that are noticeable & suspended everywhere. Ice F is shown in Polar air / cold Arctic In most situations, Temperature is 14 F and cold to allow ice F a form[4].

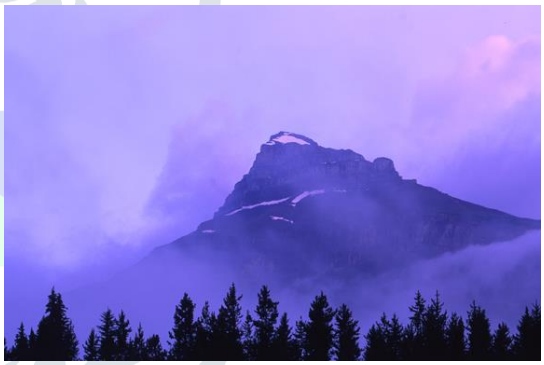

Figure 4. Upslope fog image

4)Freezing Fog(FF): FF happens if the water beads made of fog are "supercooled." Supercooled water beads stay in a liquid state before we come into contact with a surface that they can freeze. of this reason, some object with which The FF comes into contact lined with the ice. The same thing occurs with freezing rain and drizzle.

Figure 5. Freezing fog image

5)Evaporation and Mixing Fog: A type of F is developed if sufficient water vapor is implemented into the atmosphere by evaporation & moist air is combined with cooler, Fairly dry

air. 2 common forms are front fog (FRF) & steam fog (SF). SF moves over hot water such as cold air. If cool air blends with The cozy, nice, moist air over water, Moist air cool if the moisture does not exceed fog forms (FFs) or 100 per cent.F variety has the presence of smoke wisps rising outside water. Another form of evaporation fog (FRF) is known. A sort of F variety when warm raindrops evaporate into cooler closes the ground of more dry layer air. As soon as sufficient rain has evaporated into the cool surface layer, A humidity of air exceeds fog forms & a hundred percent.

Figure 6. Evaporation or Mixing Fog image

IV. VISIBILITY RESTORATION TECHNIQUE

For the elimination of F, the F from the image uses several techniques. Common Haze Image Restoration Systems:

A) Dark Channel Prior(DCP)

The DCP (Wang, Yan, et al, 2010) is used to measure the atmospheric mildness of the image to achieve a much more realistic result. This method is mostly used for non-sky patches; its intensity of a single color channel is very small at few pixels. Low temperature is prevalent in the DCP to three components.. :

- Shadows (car shadow & buildings etc.)
- Colorful objects and surfaces
- Dark items and surfaces(dark tree trunk and stone)

Figure 7. Dark channel prior image

B) CLAHE

CLAHE (Xu, Zhiyuan, et al, 2009) is the short form of the contrast Limited equalization is a histogram of Adaptive, CLAHE is using improve low-contrast images. Technique does not need prediction weather information to prepare a clouded image. Next, the camera image in cloudy condition is converted to RGB (blue, red and green) Shading space is modified HSV (saturation, worth & hue) space color. An image is changed on grounds that human sense colors are correspondingly represented like HSV colors.

Figure 8. Contrast limited adaptive histogram equalization image

C) Bilateral Filtering (BF)

BF smoothes images or It preserves edges, with a non-linear combo of close-to-image views. Bilateral is not iterative, simple & close-by. Gray levels or colors are merged with bilateral light filter .of the spatial proximity and the photometric similarity, slopes towards close values for inaccessible properties in both extent & area. BF smooth edges towards piecewise steady game plans BF doesn't provide more grounded noise reduction.

Figure 9. Bilateral filtering image

D) MIX – CLAHE

Hitam et al. (2013) Suggested approach for upgrading underwater images uses a mixture of Contrast Specific Adaptive Histogram Equalization. The improvement phase successfully enhances the perception of underwater images & produces the highest PSNR & lowest MSE values. As a result, a blending strategy based on CLAHE has been shown to be promising in identifying coral reefs, especially when visual cues are available.

Figure 10. mix-CLAHE image

E) Trilateral Filtering

It filtering (Cheng, F.C et al, 2012) smoothes images by disturbing edges, using a neighboring image values of non-linear mix. In this stream, every pixel is replaced by a weight midpoint in a pixel of its neighbor. A weight allocated to every neighbor pixel decreases with separation of image plane & separation of power axis. This channel allows We're going to get better, like contrast by others. as use the trilateral network they use post & pre-process tasks for better results Histogram stretching was used as post-processing as pre-processing & histogram equalization [5].

Figure 11. Trilateral Filtering image

V. LITERATURE SURVEY

Christina L (2016) et al exhibit that Titan, A dense, Nitrogen-dominated atmospheres are seen from terrestrial observation & satellite to harbor for methane F. Examining not whether atmospheric elements, eg. clouds, It can be seen from titan of surface, The information collected with SLI (Side Looking Imager) onboard Huygens since arrival were dissected in order to detect any potential climatic elements A total of 82 SLI images are calibrated, analyzed & prepared for elements. calibrate images show smooth vertical inclination of illumination over images of no discernible features. Following The subtraction of mean-frame, 6 images included in increased flat attribute with a radiance value that was outside the 95 percent reliability of the radiance expected if evaluate to lower & superior districts into images. A difference across optical depth such elements was observed to be 0.005 and 0.014 alike. It's seen that such components eventually start from the vicinity of the F bank near a horizon, which falls & rises in period of vision. [6].

Zhongli Maa (2016) et al presents that so as to enhance Clarity of the sea F image of the operational system vessel visual of surface; In the light of the combination system, they introduce the novel defogging algorithm. The primary steps of an algorithm are as follows. To begin with, the main input image of the combination procedure is gotten by means of a straightforward transformation of linear. Second, in view of directed image filtering, an Enhanced high-performance filtering algorithm is suggested for the acquisition of a fusion process of a second input image. Third, a basic combination technique Used to merge the two images below. A final defogging is the basic white parity method. An exploratory results show that our proposed algorithm also improves the perspective of a sea F image but has high computational reliability. [7].

Miclea Razvan (2015) et al present that the most recent inquires about In the automotive field, the emphasis is on increasing the safety & security of travelers. Automotive companies are investing the considerable measure in testing their products prior to conveyance, the reason the autos are exceptional security starting here of perspective. A large portion of the accidents these days happen as a result of the driver, brought about by bad visibility, hurry, and inattention. In this study, A system for the identification of perception in a foggy area has been developed, that gives the driver a critique of a perception of separation & guideline for adjusting speed to a value at which car could be stopped under safety situations if an obstacle occurs on a road. [8].

Fan-Chieh Cheng (2015) et al present that Fog phenomena result in the generation of airlight & corrupt perception of a color image taken from the camera. Airlight estimation(AE) is important for the removal of image fog in order to increase perception. As airlight is very bright, the customary techniques straightforwardly choose splendid pixels for AE. Nonetheless, Many bright pixels produced from light sources, for example, train headlights, might meddle by exactness of aforementioned techniques. This paper, we suggest another AE strategy. Taking into account Gaussian dissemination, the proposed strategy chooses the airlight applicants in the brightest area of the data picture. In addition, the shading likeness estimation is likewise connected to progressively process competitors. The normal shading of refined applicant pixels is then recorded for AE. Trial results show that the suggested technique was more accurate than other AE strategies but has low time complexity [9].

Cong Li (2014) et al present that With the fast improvement of highway, the dispersion of observation cameras has turned out to be progressively serious, which conveys vital hugeness to traffic safety so as to wellbeing permeability of fog utilizing reconnaissance video. In this paper, a fog level detection strategy taking into account grayscale elements is proposed. Now and then there is no legitimate alignment format on highway. With the specific aim of meeting the need for a transport regulation on visibility, they qualitatively identify fog as broad fog, A small of fog & no fog by analyzing the change in the avg gray value with coordinate under different weather conditions. The results of the experiment demonstrate that this approach classifies precisely, easily & widely applicable[10].

L. Yi (2014) et al present that The novel technique was introduced by F / retrieve low stratus top statues by a Specific position to surroundings and yellow Sea, taking into account GEO information as of (MTSAT-2) & (MTSAT-1) & LEO data MODIS sensor on Terra and Aqua & infrared (IR) split-window bands and JAMI water vapor detector. Two examples of Good data scope are discussed where F heights and low stratus are contrasted with CALIPSO cloud top heights or replicated data using a model of the WRF mesoscale. Association to JAMI recoveries with spatial data source utilized demonstrate empowering precision (RMSE and around 300 m, root-mean-square mistake) contrast with further recovery plans stand on IR information up to this point distributed. An approval of recoveries for position for two Radiosonic stations use usable sounding data of 7 foggy days, far & far superior quality with normal deviation to 184 m (standard deviation of 132 m) are recorded. [11].

Honghua Wang (2014) et al present that traditional methods for position precision were Not high or get a lot of longer-consuming issues. The actual-time position algorithm is suggested to focus on better median filters for people stuck in a thick F. firstly, after initialization, The graphical mapping of the heavy fog region is configured for the standard filtering process of the heavy F region, And high F in Earth was not peered pixel bounce recurrence measure, drop times too little than 15 of the significant F picture is background area, pixel area personnel are stranded over 15 lines and Introducing spatial location criteria, measuring position coordinates for People are trapped in thick F, previous edge detecting technologies with of edge an aid number of region technologies, provides a precise location for individuals caught in such a thick F. Test results show that enhanced strategy of a conventional situating approach is high accuracy, good real-time execution, large application space & short time-consuming. [12].

Mihai Negru (2013) et al present that A propelled driving assistance system (ADAS) should likewise consider the weather conditions. A standout amongst the most hazardous climate the existence of fog was the condition of driving situations. So the key challenge for driving aid framework is to discern the existence of F Measure the strength of the fog and determine the separation of a driver. Our approach depends on the single in-vehicle camera and will be a real change Existing F identification approaches in terms of accuracy & frequency. They may notice daytime F in broad variety by situations, like town scenario. In consideration of the existence of F in considering & image strength of F, they can process the elimination of the perception and notify the operator about the weather conditions of the environment [13].

VI. COMPARISON TABLE OF FOG TECHNIQUE THEIR FEATURES AND LIMITATIONS

AUTHORS	TECHNIQUES	FEATURES	LIMITATIONS
Tripathi, A. K.	fog removal algorithm bilateral filter	independent of density of fog or does not require user intervention	Not much effort has focused on the integrated approach of the AHE and ACO
Shuai	Wiener filtering based on the dark channel before	shortens a running time	The problem of uneven illumination is neglected
Cheng	lowest level channel prior	uses the precise O(1) bilateral channel for superior performance	The issue of the uneven enlighten is likewise neglected
Xu, Haoran	fast bilateral filtering combined with dark colors prior	improve the adaptability and fast execution speed	Neglected the techniques to reduce the noise issue
Sahu	color image contrast Fog removing algorithm	efficient & reliable choice for F remove	Problem of the uneven illumina te is also neglecte d
Matlin	iterative, adaptive, non-parametric regression method.	denoise the image	The problem of the uneven illumina te is also neglecte d
Kang	single-image-based rain removal framework	preserves most original image details	Neglected the techniques to reduce the noise issue
Yuk	foreground decremental preconditioned conjugate gradient	Improve the quality of visualization effectively	The problem of the uneven illumina te is also neglecte d
Hitam	Mix Contrast Limited Adaptive Histogram Equalisation	enhances the visual quality of underwater images	Issue of the uneven light up is additionally neglected
Huang	dark channel prior	restore the fogging image effectively and reduce the time complexity	Neglected the techniques to reduce the noise issue
Ghani	Rayleigh distribution	Improves image contrast, reduces the blue-green effect or minimizes under & over-reinforced areas in an output image	The problem of the uneven illumina te is also neglecte d
Wang	dark channel prior	improve the operational efficiency	Neglected the techniques to reduce the noise issue

Conclusion

Images were taken a foggy situation frequently suffer as of clarity & poor visibility. Images of the outdoor scene taken under bad weather conditions show haze-like atmospheric degradation fog, smoke-induced by particles present in the atmosphere resulting in scattering and absorption of light, That travels from point of view of an observer. Consequently of the presence of more than a few atmospheric particles (like fog, smoke, mist, water-droplets or so forth.) There is corresponding deterioration in the color & differentiation of the images captured under bad weather conditions. These images often show some loss of value that might be dependent on distance. It may also make it hard to identify objects in a hazy image or scene. So, if the depth and atmospheric conditions are known, we can improve the image by compensating for a fog effect. This paper discusses quite a lot of haze removal strategies Clear the haze from shot haze images & enhance the increasingly expanded quality of haze free images.

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