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Novel Approach on Filtration and Rain Reclamation of Video

Mahesh V Korade*
CSE Department
India

S R Choudhari
CSE Department
India

Abstract— Rain recovery is useful in security, traffic, movie editing applications. The existing system uses motion segmentation which has better result in dynamic videos. The proposed method based on the segmentation and noise removal in which rain detection, rain removal methods are applied on rain affected pixels to understand the dynamic behavior. Further rain pixel recovery uses spatial and temporal properties. The proposed method gives better result for the video which has dynamic objects. The quality of the video is upgraded with factors like PSNR and MSE. The enhancement in the quality factors improves the clearity of video.

Keywords— Noise Filter, Segmentation, Rain Recovery, Rain Detection, PSNR, MSE

I. INTRODUCTION

Many videos clarity get affected due to weather conditions, camera movement or some objects movement which causes the variation in the pixel intensity. Rain recovery is important technique to improve clarity of the video in movie editing, safety investigation, gesture recognition applications, traffic monitoring system. There are many algorithms present to restore rain affected pixels into its original form. The basic part of the rain removal is the Motion segmentation which improves the percentage of rain recovery as compared to other algorithms. The rain changes the intensity value of the pixel by either changing frequency or changing RGB values. The main task is to bring those pixels to their original values. This is the powerful technique in safety services to clear the rainy videos and increase the clarity [1].

Weather conditions can be static and dynamic where static include fog, mist and haze and dynamic means are snow fall, rainfall, hail. In static conditions the movement of fog in air is too slow but for dynamic scenes has rainfall and snowfall whose movement is 1000 times faster than static [2]**.** In proposed system input videos are affected by the major dynamic component rain. The pixels affected by rain, lost their original intensity, to restore it pixel intensity needs to be checked and then replace them with their original value. The rain drop is very small but its high velocity shows angular projection and forms rain streaks. Raindrop has varying size from 0.1mm to 3.5 mm and the density of drops decreases exponentially with the drop size. The shape of drop depends on its size. Smaller raindrops are generally circular in shape while larger drops are of different shape. Rain has large number of droplets of different sizes dispersed in the image and falling at high rates [3]. All these drops are transparent, refracting and reflecting in nature, due to which the light towards camera gets changed. Such property of drop changes temporal property of intensity in images and videos. Intensities due to rain are motion blurred due to some vulnerability of the camera therefore depends on the background intensities. So visual perception of rain is combined effect of photometric characteristics of environment and motion of rain. Rain has different properties as follows

A. Spatial-Temporal properties: - Video is divided into frames each frame may contain rain but at particular time the pixel in each frame may not affected by rain.

B. *Chromatic properties:* - The drop when stationary can be considered as lenses. When light passes through the drop its brightness gets changed with respect to background.

C. *Photometric properties:-* The photometric properties are physical properties of the rain which contain size and velocity of the drop which should be same. It also contain drop with low chromatic properties [4].

The motion segmentation is the core part of the rain recovery algorithm. The photometric and chromatic properties are considered for rain streak. The filters are applied on the pixel for the rain detection and rain removal. Algorithm adapts spatial and temporal properties of the pixels for rain recovery. The algorithm has better performance compared to other methods.

II. LITERATURE SURVEY

There are lots of existing algorithms with varying methodology and respective pros and cons. Jie Chen and Lap-Pui Chau proposed method to remove rain from the highly dynamic scenes having basic technique of motion segmentation. The photometric and chromatic constraints are applied for rain detection after which rain removal filters are used to remove the rain where dynamic property of the pixels and motion obstruction are considered. To recover rain pixel both spatial and temporal properties have utilized. Fig 1 shows the basic flow of the rain removal algorithm. In motion segmentation obtained output are motion cues and local cues which helps to differentiate moving and the static regions in the frame. In next step rain affected pixels are identified by applying various constraints and thresholds. The affected pixels in moving region, static region and pixels not affected are stored in buffers. Rain removal filters are applied to remove rain. At last 88-spatial–temporal neighbourhood technique is used to recover the scene [1].

The photometric, chromatic and temporal properties are used to recover the rain. The assumptions are made that rain drop affect a pixel in only single frame. This assumption gives false results because when the physical property of rain is observed, it varies drop by drop [3]. The intensity of rain covered pixel is equal in two consecutive frames. The false detection can be avoided by using linear photometric properties but it has limitations of heavy rain. In heavy rain the rain streak can affect same pixels in two to three frames. One more assumption is made that pixel with rain has same properties because it is weakly affected by its background. This assumption again increases false detections. The reason could be varying velocity and size but the assumption of velocity and directions of the rain constant which limits the performance. The method is not suitable for the rain drops which are not visible easily or the pixels with rain affected by brighter background. The new method of Zhang based on chromatic and temporal properties. In temporal property the same pixel of one video may not have rain due to randomly distribution. In chromatic property pixels affected by rain can have same RGB intensity change. In chromatic property it is difficult to detect rain in gray area or moving gray area. For Zhang method camera needs to be stable if camera is not stable then the background can be static before removing rain and make it dynamic after removing rain. The disadvantage of Zhangs method is that it is applicable to videos with static background. For some colors it gives false result [5]. By using statistical features and spread asymmetry Tripathi proposed probabilistic spatial-temporal model in which classification the rain affected pixels is done. It is better method to deal with dynamic scenes but not all statistical features works properly some works poorly and gives false results [6].

Existing methods calculate rain affected pixels original value by simply taking their temporal mean in which moving area get distorted and important information get deleted and undesired ghost effect comes into picture by which picture quality hampered. Li-Wei Kang, Chia-Wen Lin, Yu-Hsiang Fu have worked to remove the rain from single image by decomposing it and used bilateral filter, sparse coding to divide image into low frequency (LF) and high frequency (HF). Low frequency carries basic information of image where high frequency carries other texture and rain pixels [7]. Starik and Werman used temporal median filter to remove the rain pixels but the method is not suitable for the heavy rain and for the night scenes or day scenes with some unclearness [8].Barnum used frequency space to detect the rain. This method is applied on the video to detect rain or snow in particular frequency space. The output result is then transferred to image space. The limitation of this method is that it does not suit to light rain, where there is no distinction in the pattern formed in frequency space [9]. Zhao and Liu proposed the histogram technique to detect the rain in videos. This method typically based on K-means algorithm of clustering. The method is limited to videos with stationary scenes and the camera position must be fixed [10]. Another method is calculating intensity of the rain affected pixels by using Kalman filtering given by Park and Lee. But again this technique is suitable for steady camera and static background. Brewer and Liu implemented model of rain streaks based on the ratio of the physical properties of the rain like size, shape, velocity and aspect. All these properties are depends on disclosures time of the camera. In heavy rain condition if disclosures time is unknown then rain and non-rain areas are segmented but it does not work satisfactory and not suited in heavy rain [11]. Liu and Xu remove false rain detections by developing discriminant function for which chromatic property is used. This model also has limitations for static background, fixed camera, and chromatics threshold value. The method is recovered by motion segmentation of moving objects and rain in every video which gives better and effective results [12].

The histogram model can be used in rain detection as proposed by Bossu. In this, presence of rain streaks in the video decided by the histogram. The rain streaks can be located in different areas in video and those areas are connected with geometric method. Then using Gaussian mixture model the data of histogram retrieved and then by decision criteria applied on histogram to find presence or absence of rain. The rain pixels found easily in image then rain intensity calculated as well. This method is limited to heavy rain which is visible to the eyes. For light rain the Gaussian model give irrelevant result where in absence of rain also it detects the presence of rain [13].

The basic part of the rain recovery algorithm is motion segmentation. In motion segmentation motion and local cues are considered for rain recovery. Also spatial and temporal properties are of pixel adopted for the rain pixel recovery due to which this algorithm has better performance as compared to other algorithms.

III. PROPOSED SYSTEM

In proposed system rain is removed with basic steps of rain detection and recovery. The existing system not worked on the other type of noise in the image. In proposed model first step is to remove the noise and then work on detection and removal of the rain to improve the clarity and change the result. The flow of the proposed model is given in the fig 2. In proposed system video quality is upgraded with removal of rain streaks and noise found in the pixel. Fig 2 shows that the first step is to extract the frames from the video so that further operations are performed on the frames. Rainy video provided as input to the system. User will work on each and every frame therefore input video need to be divided into number of frames. The video is converted to frames by passing time interval for the frame generation. The performance of the system can be calculated for different count of the frames for different time interval. The count of frames those are extracted from the videos is displayed. Pre-processing contains removing background noise, standardize the intensity of the separate elements from images, removing echoes and covering portion of frames. In the pre-processing frames extracted are converted to the gray scale frames. Every pixel has RGB color intensity this intensity is converted to gray scale by multiplying RGB intensity with particular weights where resultant value is similar to gray. Gray scale images are extracted in black, white, and all the glooms of gray in between. The RGB encoding of any gray values is a set of three equal numbers, i.e., (x, x, x), where x is some integer between 0 and 255. For instance, white is (255,255,255), black is (0, 0, 0) and medium gray is (127,127,127). Higher the numbers, lighter the gray. To convert a non-neutral color to its equivalent gray scale value, you must compute a weighted average of the red, green, and blue values. The gray scale image helps to easily differentiate between the intensities of the pixels. The gray scale image is given to the segmentation step. It is the technique to separate out pixels of an image according to content. It also intended to partition the image into regions. Segmentation requires finding out regions of connected pixels with similar properties. the pixel intensity is compared with the middle value, if the intensity is higher than 128 the pixel is considered as white i.e. 1 and the intensity lower than the 128 are considered as black i.e. 0. The resultant image is the binary image i.e. having only black and white color.

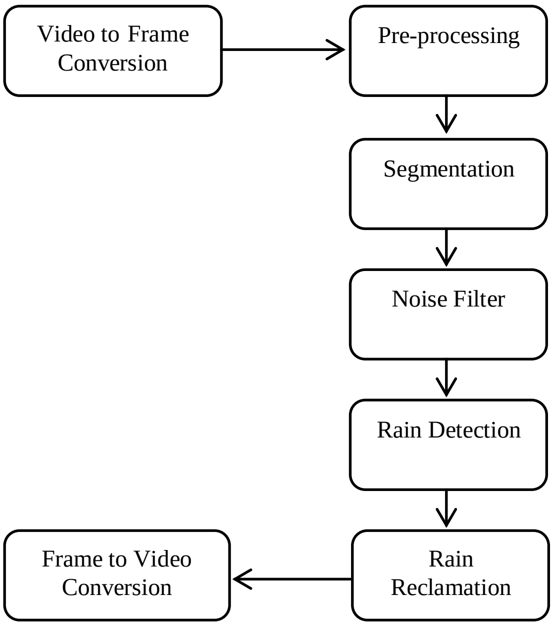

Fig.1. Flow of proposed rain recovery algorithm

In the input video pixels are affected by rain and changes the intensity. The affected pixels can be counted. The input video can be imposed with noise of different categories. In noise removal step without considering all categories, Gaussian filters are used to remove Gaussian noise. Noise remove constraints improve the quality of the video. Gaussian noise is a linear noise which has same effect on whole image. The pixels original intensity is updated with some random value of the noise. The probability Density Function gives the value of spread noise also known as Gaussian distribution. The method of mean filtering smooth's the image by modifying the pixels intensity difference. It is frequently used to decrease noise in images. The mean filter simply replace each pixel value in an image with the mean value of its neighbours, including itself.

The noise removed frame is given input to this function. The pixels which are found in the segmentation are stored into the array. This array is compared with the output image of noise filter. In which the segmented image and noise removed image is compared with one another to find out region in which rain is going on. That region is highlighted by using needle map. The region which contain rain pixel is going to recover in the rain recovery.

This function recovers rainy pixels to its original value. The original value of the pixel is found by considering the color intensity of all surrounding pixels. The mean of the surrounding of the surrounding pixel values is put as an original value of the affected pixel. The surrounding pixels of 'i' are found by (row-1, col-1), (row-1, col), (row-1, col), (row, col-1), (row, col+1), (row+1, col-1), (row+1, col), (row+1, col+1). The original pixel value is calculated as an average of the intensity of surrounding pixels found. The processed frames are converted to video again. The main idea is that user create a media writer, add some stream information to it, encode input media (the screenshot images), and close the writer.

A. Mathematical Model:-

The proposed system is given by the set 'S'

S = {I, F, O}

The proposed system has setoff inputs, outputs and functions.

I = {f1, f2, f3 . . . . . . fn}

'I' is set of input frames extracted from the input video.

F = {Extract, RGBtoGray, Segmentation, ImageFilter, RainDetection, RainRemoval, FrametoVideo}

Where,

1) Extract: It is a conversion function which extracts frames with noise (fn) from the input video. Rainy video provided as input to proposed system. User will work on each and every frame therefore input video divided into number of frames. Frames are buffered so less memory required.

Extract (V1) → Extract {fn1, fn2... fnn} ∀ O1 - - - - - - - - - - - - - - - (1)

Where O1 = {fn1, fn2... fnn} is set of extracted frames containing noise as well as rain.

2) RGBtoGray: Frames with noise extracted from the video are given input to RGBtoGray function. All frames converted into gray scale for detection of rain affected pixels. Here the method of weighted sum is applied to convert Red, Green and Blue color into gray colors.

RGBtoGray (fn) → RGBtogray {fg1, fg2... fgn} ∀ O2 - - - - - - - - - - - - - - - (2)

Where, O2 = {fg1, fg2... fgn} is gray scale frame with rain and noise

Gray scale images are rendered in black, white, and all the shades of gray in between. The RGB encoding of any gray values is a set of three equal numbers, i.e., (x, x, x), where x is some integer between 0 and 255. For instance, white is (255,255,255), black is (0, 0, 0) and medium gray is (127,127,127). Higher the numbers, lighter the gray. To convert a non-neutral color to its equivalent gray scale value, you must compute a weighted average of the red, green, and blue values. Consider where r, g, and b are integers between 0 and 255 show the RGB value of a color. The gray scale weighted average, x, is given by the formula,

$$x = 0.299 * r + 0.587 * g + 0.114 * b \qquad (3)$$

Note that the colors are multiplied by different values of weights because of different intensity of colors.

3) Segmentation: the gray scale frames generated from the previous function are segmented by using thresholding method. User will select a threshold value (Middle) value for the RGB intensity. The intensity higher than the middle value will be consider white and below middle value will be consider as a black.

Segmentation (fgn) →Segmentation (fs1, fs2...fsn) ∀ O3 - - - - - - - - - - - - - - (4)

Where O3= (fs1 ….fsn) is a set of segmented frame.

Higher intensity pixels that are rain affected pixels are highlighted and counted as a rain pixel count in the image. The background with low intensity is emphasized as a black so that all moving objects are get hide and white pixels are comes into picture. The formulae for black and white pixels are as follow,

$$\text{Black Pixel} = \sum_{fg0}^{fgn} \quad fg < It \qquad (5)$$

$$\text{White Pixel} = \sum_{fg0}^{fgn} \quad fg > It \qquad (6)$$

Where 'I_t' is the threshold intensity

4) ImageFilter: the gray scale image is given input to the filter to remove the noise from the frame. In proposed system the filter is to remove Gaussian noise. The filter considers the variance and mean value initially to find out probability density function value as follow,

$$P(x) = \frac{1}{\sigma\sqrt{2\pi}} * e^{-\frac{(x-\mu)^2}{2*\sigma^2}} \qquad (7)$$

ImageFilter (fgn) → ImageFilter (fr1, fr2….frn) ∀ O4 - - - - - - - - - - - - - - - (8)

Where O4 = (fr1, fr2…….frn) is the set of rainy frame without noise

5) RainDetection: the noise removed frame is given input to this function. In which the segmented image and noise removed image is added with one another to find out region in which rain is going on. That region is highlighted by using needle map.

RainDetection(fr) → RainDetection(fm1, fm2, ..fmn) ∀ O5 - - - - - - - - - - - - - - - (9)

Where O5 = (fm1, fm2, fm3 ……..fmn) is a set of frames with needle map at the region of the frame.

6) RainRemoval: this function recovers rainy pixels to its original value. The original value of the pixel is found by considering the color intensity of all surrounding pixels. The mean of the surrounding of the surrounding pixel values is put as an original value of the affected pixel.

RainRemoval(fr) → RainRemoval(f1, f2, f3 …..fn) ∀ O6 - - - - - - - - - - - - - - -(10)

Where O6 = {f1, f2, f3 ……..fn} is a set of frames without noise and rain.

7) FrametoVideo: the frames recovered from the rain are collected together to form again a video. The video will be the output of the system where noise is not present but rain is also recovered and quality of the video is improved.

FrametoVideo(fn) → RainRemoval(V1) ∀ O7 - - - - - - - - - - - - - - - - (11)

Where O7 = {V1} is set of video created from the quality frames

IV. PERFORMANCE ANALISYS

The literature survey focuses on the various methods, techniques and algorithm to remove various environmental effects on images and videos. By referencing old papers it is observed that much of work has been done on the images affected by fog, rain, smoke. The images can be gray scale or color. The methods to remove the effects from the image are quite easy but after the dynamic videos it becomes necessity to remove such effects to improve the quality of the video. The survey on rain removal algorithm suggests making a motion segmentation which separate out moving objects and static objects to work on them distinctly. The methods used for segmentations are intensity based, hierarchical, region growing, and manual. The rain detection algorithm follows properties of the rain. Previously researchers have used such properties but the variation in there considerations make the method weak. The photometric property suggest the size and speed of the rain where in one paper it is considered as a constant but in real the dynamic video contains rain streaks with different size and density. The chromatic property measured by reflection of light through the rain streak. The reflection is done due to the camera movement, background scene. The light from the background passes through the rain drop so that the light will get somewhat reflection. It also effects on the intensity of the color of red, green, blue. The video can be divided into frames. Same pixel in each frame may or may not be affected by rain. At one time in one space it is affected or may not be affected called spatio-temporal property. Tripathi has used this property to find out spatio-temporal mean which gives result of ghost effect of clarity.

After considering these three properties, buffers are created called as video frame buffer, rain buffer, motion buffer. Lastly scene is recovered by considering nine consecutive frames and The pixel values in the neighbourhood frame will be used to predict the centre rain covered pixel by a weighted sum. The original value of the pixel found by this weighted sum. Literature review gives techniques which have used on color, gray scale, under water, 3D images. The survey finds the types of the noise as linear and non-linear. Linear noise has same effect on the image. There are various filters available to recover the noise present in the image or video. After applying filters and recovering rain pixels original value the quality of image or video will get improved.

The survey observes various techniques to check the quality of the image. One of them is calculating PSNR and MSE. MSE is the error between the final and original image. This enables us to compare mathematically as to which method provides better results under same conditions like image size noise. PSNR is the approximation of ratio between peak signals to noise. It is an calculation used to signify the relation of maximum possible control of image (signal) and the control of the corrupting noise that affects the quality of its illustration. The review observes that PSNR and MSE are converse to each other. The quality of the image get improved by increasing PSNR and decreasing the MSE

V. CONCLUSION

The proposed system retrieves the pixels original value which is changed by rain drop. The filter is the additional component for improving the resultant video. That will make the image smoother and noise free to give better result in terms of MSE and PSNR. The quality is analysed on the basis of value of MSE recorded from original and de noised image. The MSE must be mini mum so that both images have very slight difference. The PSNR of the images must get increased to upgrade the video visually. The frame count generated from the video must effect on the value of the MSE and PSNR. The size of the video will change slightly as modification occurs at the pixels intensity during noise and rain recovery. The pixels affected by rain can be measured and compare with the count of pixels recovered. All these metrics can be used to evaluate performance of the proposed system than the existing system.

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