SIMPLE FUSION BASED NIGHT VIDEO ENHANCEMENT

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Abstract

In modern days there are lots of improvements on digital cameras and their capability. But it may struggle while capturing videos under low lighting conditions. Night video enhancement is important for meet those limitations and for getting visual pleasing videos and there by making easier for video analysis and object detection and tracking. There are different low light video enhancement approaches that are either self enhancement or fusion based enhancement. This paper focuses on fusion based enhancement includes background model creation, object detection and its enhancement. It creates much more visual perception for the video in terms of the overall lighting such as static illumination, color maintanance and object tracking. Experimental results and quality metrics are analyzed to show the effectiveness of the algorithm

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1. INTRODUCTION

Night video enhancement is important for different applications where digital video is acquired, processed and used, such as surveillance systems, facility protection, monitor operations, public safety , traffic monitoring etc. The videos that are captured under low lighting condition are difficult for analysis due to less illumination and higher noise that results challenging problem towards night video enhancement.

Video enhancement can be classified as self enhancement and fusion based enhancement [1-2]. Fusion based enhancement gives better result as compared with self enhancement since the darker part or lost information cannot able reconstruct so that fusing day reference image solve the problem, also it eases the location recognition that are important for different application.

The main methods for processing Video can be categorized as: spatial-based domain video enhancement, such as histogram equalization (HE), power-law transformation, or tone mapping, and transform-based domain video enhancement which are based on spectral component of an image. Using either of these method may results in highly noisy videos, improper illumination and contrast of the images, false colour distribution and loss of static illumination like traffic light, building etc.

There are different methods for night video enhancement [3-8] to produced improved results. Denighting [3] used retinex theory that produces illumination and reflectance component, illumination component is enhanced through the day time image. Finally the image is reconstructed by reflectance component and colour component. But in [3] it may results in unusual artifacts, improper lighting like static illumination is not maintained like traffic light, for example if the background of traffic light is sky, then fusing with day image with white sky results in no traffic lights. Objects that are having problems, due to foreground is mixed with the background. Li et al. [4] proposed illumination and fusion based enhancement which extracted meaningful context or the highly illuminated area and moving object region segmented out and fused with day reference image. But it results in object segmentation which is not an impressive one. Day color transfer method [5] uses day color transfer based scheme that maintain lighting of the night image but lack the enhancement of objects that are appeared in the video. Jiang et al. [6] self enhancement method that is focus on histogram based contrast enhancement and moving objects region enhancement but it is not suitable when require high degree of brightness preservation and lost details of more darker areas. Most of the papers are based on retinex theory in which an image can be represented as the product of illuminance and reflectance component. Retinex theory having lot of advantages and is more simple for use. But it may washed out the overall image in terms of illumiantion.

Fig -1:Input night video **Fig -2**:Result of Proposed framemethod

The above mentioned problems are solved, by considering the fact that all the lights that are appeared on the night time like street lights, lights from building, etc. are maintained on the enhanced result by the use of the most visible part of the input night image and there by creating a background model creation and also proper object detection. Here firstly the background model is created that maintain all the lighting conditions and proper colour maintenance for each video frames. Secondly the object detection has been done and enhance the objects and fuse with the background model that is created.

The paper is organized as follows. Section 2 presents the proposed system. Section 3 describes the experimental results and performance evaluation of our methods. Conclusion is described in section 4.

2. THE PROPOSED SYSTEM

The proposed methodology organized as two step process. Firstly the background model is created by using the input frame and the day image.In which the most visible part of the input image retained such that it gives a perfect illumination for the output background model image. Secondly the background image of the night input sequences is estimated in order to apply for background subtraction algorithm. The objects are detected using background subtraction method. Finally the objects that are detected are enhanced further for better visual perception.

2.1 Background Estimation From The Night Input Video

The background image is estimated from the night input video for further processing in which each frames are taken and foreground are removed and done simple maximum for combining all the remaining still background.

NI(x,y) be the input frames from the video input, then mask NB(x,y) can be computed as follows:

Mask NB(x,y)= $\begin{cases} 0 & if\ \ foreground\det ected \\ NI(x,y) & otherwise \end{cases}$

Then do simple maximum for fusing each mask obtained from the image sequences.

2.2Background Model Image Creation By Using Day Image

In order to maintain all the static illumination, lighting and colour maintenance, made a simple method in which the most visible part of the image is retained and used with day image for the creation of the background model image. It follows as:

1). The image from video sequence is taken and split the image into two components that is based on the mean value of the image-the most visible component and remaining part of the input image. If the mean value is lower put a lower threshold to get most visible part else put a higher threshold value.

2).Pixel wise subtraction is done for the day image and the night input frames, the resultant will become the more illuminated area present in day image as compared with night input image.

3).In order to maintain all the static illumination, limit the more brighter area of resultant image (2) based appropriate threshold value.

4).The above result (3) is fused with input image NI(x,y) the following for getting all the illumination.

$$BMI_P = \alpha * DI(x,y) + (1-\alpha) * NI(x,y)$$

Here is taken as .65 for getting more illumination from the day image.

5).The most visible part from (1) is then fuse to the above result to get BMI(x,y).

2.3Object detection based on background image

Object detection involves frames from the video sequences are taken and converted to gray scale images and then applied

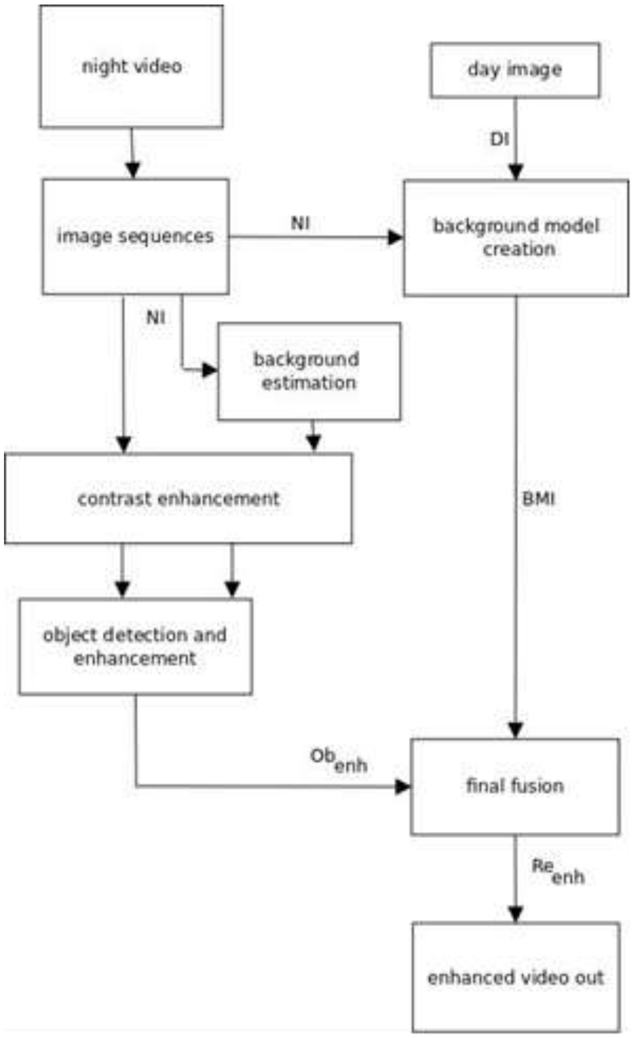

Fig -3: Proposed System Architecture

guassian filtering for removing much illuminated areas so that it will ease object detection.

The objects that are appeared on the frames are detected using background subtraction algorithm. Background subtraction algorithm [11] has to modified for images with low lighting conditions. So that different threshold has to apply on the same image.

Object detection is as organised as firstly enhance the images frames by contrast enhancement based on advanced histogram equalization, then apply object detection algorithm on it.

1).Apply Contrast enhancement for the input images and background image that estimated:
Bi-histogram equalization based on pixel based information[10] is used for contrast enhancement which gives better result as compared with BBHE.
The main steps as follows:
Consider an image I(x, y) of N with gray level [0, L-1]. Evaluate the distribution of details by using canny edge detection technique. In which an edge detected image E(x, y) is obtained from the original image I(x, y)such that E(x, y) is zero (0) in areas of constant gray level and is one (1) where there is change in gray levels. Form D(x, y) by pixels from I(x, y) which are responsible to give the value of one in binary edge detected image E(x, y). Detect the pixel (M) of maximum occurrence from D(x, y).
Now divide the original image into two sub-images (I L and I U) based on the value of M (pixel of maximum probability in D(x, y).

$$\begin{cases} IL(x,y) & if\ I(x,y) \le M \\ IU(x,y) & otherwise \end{cases}$$

Calculate the cumulative distribution function (CDF) of each sub-image. Equalize the sub-images independently based on their respective histograms using classical HE technique.

2) Perform denoising using NLM algorithm in order to smooth out noise that may present in the result of contrast enhancement of the input image.

3)Object detection based on background subtraction method by using [11],which is modified for the low lighting conditions as follows:

Applying different threshold based on following conditions:
1.If NI(x,y) < NB(x,y)

$$\text{Mask } M(x,y) = \begin{cases} 1 & |NB - NI| > T1\& \\ & |NB - NI| < T2 \\ 0 & otherwise \end{cases}$$

2. If NI(x,y) < T_f

$$\text{Mask } M(x,y) = \begin{cases} 1 & |NB - NI| > T1 \\ 0 & otherwise \end{cases}$$

The threshold values T_f, T1 and T2 are determined empirically in order to have better result.
From the above binary result, apply background subtraction algorithm [6], Let w(x,y) be the mask 3×3 matrix with all elements values are 1, and M(x,y) be the binary matrix from the above method.

Convolution of mask w(x,y) with M(x,y) that gives Ob(x,y) as:

$$Ob(x,y) = \begin{cases} 1 & if \sum_{s=-1}^{1}\sum_{t=-1}^{1} M(x+s, y+t) > 4 \\ 0 & otherwise \end{cases}$$

After applying convolution, it will smooth out noise and fill small holes. Then median filtering, morphological closing and morphological opening are applied for getting better object shapes.

4)Segment the object from the input frames NI(x,y),such that

$$Ob_{det} = \begin{cases} \beta * NI(x,y) & if\ Ob(x,y) = 1 \\ (1-\beta) * NI(x,y), & otherwise \end{cases}$$

β is taken as 1.
5) Enhancement of the dark region of the detected objects:
After object segmentation enhance the dark region of the object using gamma correction with gamma value as 1.2.

$$Ob_{enh} = 255 * \left(\frac{Ob_{det}}{255}\right)^{1/\gamma}$$

2.4. Final Fusion For Enhanced Image

The enhanced object is fused with the background model image that are created as follows, Re_{fin}defined as

$$\begin{cases} (1-\beta) * BMI(x,y) + \beta * Ob_{enh}(x,y), & if Ob(x,y) = 1 \\ \beta * BMI(x,y) + (1-\beta) * Ob_{enh}(x,y), & otherwise \end{cases}$$

After final fusion of each background model image and the enhanced object, combine each enhanced frames $Re_{f\,in}$ to get final enhanced video output.

3. EXPERIMENTAL RESULTS

The proposed system implemented in OpenCV and tested with the PRBuilding dataset [7], and Fig-9 shows the experimental results of our method as compared with other methods and tested through performance parameters in Table-1. Fig-4 shows frame from the input video sequences. Fig-5 and Fig-6 shows the enhanced result through traditionalcontrast enhancement using tone mapping and global histogram equalization. Some of the related papers denighting [3] and day colour transfer based approach [5] are also implemented and is shown in the Fig-7 and Fig-8. The result of proposed method are also compared with these method and is tabulated in Table-1

It shows the proposed system perform well as compared with the denighting and colour transfer based approach.

In order to demonstrate the performance of the method, used different quality parameter such as:

Absolute mean brightness error(AMBE) [12] which is the absolute difference between the mean value of the input image and mean value of the output image.

Peak signal to noise ratio(PSNR) [9] is the ratio of maximum power of the image to the noise of the image which measures how noisy an image.

Structural quality(SSIM) [13] measures the similarity between two images.

Table shows proposed method performs well as compared with method in [3] and [5].

The below Fig-4 is the input night frame and Fig-5 and Fig-6 shows the result of traditional enhancement method by tone mapping and histogram equalization.

Fig -4: Input night frame161

Fig-5: Tone mapped result

Fig-6: Histogram equalization

The following Fig-7, Fig-8 shows result of denighting [3] and day color transfer based method [5] and Fig-9 shows the result of proposed method.

Fig-7:Denighting method

Fig-8: Day color transfer

Fig-9: Proposed method

Table-1 shows the overall comparison of denighting method, day color transfer based method and proposed method based on different quality parameters.

Table-1 Quality Assessment Results

METHODS	AMBE	PSNR	SSIM
Denighting [1]	62	31.28	.59
Color transfer [2]	93	33.56	.56
Proposedsystem	**53**	**48.96**	**.70**

The table shows performance evaluation of proposed method as compared with other method. From this it can be noticed that the proposed system gives more effectiveness than other method. The quality metrices shows proposed system performs better by having less noise, preservation of overall brightness and contrast. However the visual quality of the results also comparatively better for the proposed system.

4. CONCLUSION

The proposed night video enhancement method looks more efficient, experimental result shows that the proposed method perform better than denighting and color transfer based method. The proposed system involves the background model creation with use of day image, object detection and its enhancement and final fusion of the images which results a better visual performance as compared with other method. The method need improvements on object detection that may suffer when both object and image background having same color. However the results of the system shows the effectiveness of the method.

REFERENCES

[1]. Rao, Yunbo, and Leiting Chen. ”A survey of video enhancement techniques.” Journal of Information Hiding and Multimedia Signal Processing 3.1 (2012): 71-99.

[2]. Yawalkar, Ms Pallavi H., and Mr PN Pusdekar. ”A Review on Low Light Video Enhancement Using Image Processing Technique.”International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, January 2015

[3]. Yamasaki, Akito, et al. ”Denighting: Enhancement of nighttime images for a surveillance camera.” Pattern Recognition, 2008. ICPR 2008. 19th International Conference on. IEEE, 2008.

[4]. Li, Jing, et al. ”Illumination and motion-based video enhancement for night surveillance.” Visual Surveillance and Performance Evaluation of Tracking and Surveillance, 2005. 2nd Joint IEEE International Workshop on. IEEE, 2005.

[5]. Soumya, T., and Sabu M. Thampi. ”Day color transfer based night video enhancement for surveillance system.” Signal Processing, Informatics, Communication and Energy Systems (SPICES), 2015 IEEE International Conference on. IEEE, 2015.

[6]. Jiang, Dongqin, Mingdong Li, and Jiali Mao. ”An effective method for night time video enhancement.”

Natural Computation (ICNC), 2013 Ninth International Conference on. IEEE, 2013.

[7]. Cai, Yinghao, et al. ”Context enhancement of nighttime surveillance by image fusion.” Pattern Recognition, 2006. ICPR 2006. 18th International Conference on. Vol. 1. IEEE, 2006.

[8]. Rao, Yunbo, Weiyao Lin, and Leiting Chen. ”Image-based fusion for video enhancement of night-time surveillance.” Optical Engineering 49.12 (2010): 120501-120501

[9]. Raju, A.”A comparative analysis of histogram equalization based techniques for contrast enhancement and brightness preserving.” (2013).

[10]. Moniruzzaman, Md, Md Shafuzzaman, and Md Faruque Hossain. ”Brightness preserving Bi-histogram equalization using edge pixels infor-mation.” Electrical Information and Communication Technology (EICT), 2013 International Conference on. IEEE, 2014.

[11]. Pawaskar, Mr Mahesh C., Mr NS Narkhede, and Mr Saurabh S. Athalye. ”Detection Of Moving Object Based On Background Subtraction.” Inter-national Journal of Emerging Trends Technology in Computer Science (IJETTCS) Volume 3 (2014).

[12]. Mohammadi, Pedram, Abbas Ebrahimi-Moghadam, and Shahram Shi-rani. ”Subjective and Objective Quality Assessment of Image: A Survey.” arXiv preprint arXiv:1406.7799 (2014).

[13]. Gayathri, S., N. Mohanapriya, and B. Kalaavathi. ”Survey on Contrast Enhancement Techniques.” International Journal of Advanced Research in Computer and Communication Engineering 2.11 (2013): 4176-4180.