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Digital Night Vision Enhancement using Histogram Processing

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***Abstract:*— A poor image puts a contrast constraint to the human eye visibility at night,which is one of the main reasons for increase in accidents at night.Digital Night Vision Enhancement is a processing technique to improve night vision by image processing. These techniques can enhance the images captured by ordinary cameras under low light conditions and can be implemented completely in software. This work deals with few basic techniques like histogramequalization,adaptive histogram equalization, contrast limited adaptive histogram equalization and their implementation using python. Also the related work in this field and proposed work using homomorphic filtering has been discussed in brief.**

***Keywords*—Histogram equalization, adaptive histogram equalization, CLAHE, Retinex, homomorphic filtering**

I. INTRODUCTION

Night Crash statistics reveals that poor visibility at night has been a major issue in night driving, as well as in security and surveillance systems([1],[2],[3]). Gadgets like night-time driving goggles are available for better vision but they are not very popular due to their high-end costs [4]. Digital Night Vision Enhancement is a processing technique to improve night vision by image processing. These techniques can enhance the images captured by ordinary cameras under low light conditions and can be implemented completely in software. They do not require the use of infrared light and special devices. One of the popular and efficient algorithms for adjusting the contrast of an image is a nonlinear contrast enhancement technique called histogram equalization.

[4] Night vision enhancement scopes or devices enable machines or people to form images when illumination in the visible band of the electromagnetic spectrum is inadequate. Although it is not possible to form images in absolute darkness, that is, in the absence of any electromagnetic radiation whatsoever, it is possible to form images from radiation wavelengths to which the human eye is insensitive. [2]There are two basic approaches to imaging scenes in which visible light is inadequate for human vision:

a) Low-level visible light that is naturally present may be amplified and presented directly to the viewer's eye. (Light in the near-infrared part of the electromagnetic spectrum [0.77–1.0 microns], either naturally present or supplied as illumination, may also be amplified and its pattern translated into a visible-light pattern for the viewer's benefit.) This technique is termed image intensification.

b) Light in the infrared part of the spectrum (>0.8 microns) is emitted by all warm objects and may be sensed by electronic devices. A visible-light image can then produced for the user's benefit on a video screen. This technique is termed thermal imaging.

Night Vision Enhancement Systems (NVES) are classified as : active, near infrared (NIR) systems, which require an IR source but give a complete picture of the scene in front of the driver, and passive, far infrared (FIR) systems, which do not need an IR source but only enhance relatively warm objects[2]. NVES are based on non-visible radiation, which directly or in reflected form is sensed by special sensors (cameras), processed, and presented to the driver on a display.

In case of the Digital NVES, an almost-instantaneous feed of the images of the road ahead or the surveillance area is required to the concerned person. The original image has poor visibility, hence a drastic improvement in the vision is also another demand on the NVES. Due to these requirements, the efficiency of the technique used is of critical importance. The end result must be suitable for the application of object detection and pattern recognition algorithms which would otherwise not have been possible for images captured in the dark. The ground costs involved must be typically affordable to the Organization (for security purpose) and to the end –user for the driving application.

II. RELATED WORK

Reference [5] on Night Vision Enhancement included enhancement using 'Selective Retinex Fusion algorithm'in which the brightness component of the image is improved by separating the luminance and reflection component image. As the luminance component contained maximum dynamic range information whereas the reflection component contains the essentials details,the reflection component undergoes enhancement using the Retinex algorithm of s-curve. After this, selective non linear gray mapping was done to give the information about the light source in the image and its effect on the image, related to the distance and luminance. In the end, these two undergo weighted addition to give the final pixel value.

Real time night vision enhancement paper [2] helped us to understand the basics of histogram equalization, the technique used to improve the contrast of the image, and its types.It made use of global histogram equalization. The pixel values were increased from the maximum value in the image to 255. At each level, the peak signal to noise ratio (PSNR) was evaluated. It was seen that PSNR followed a pattern. Initially it increased, and after a certain value, it started decreasing. Furthermore, the maximum PSNR value wasn't found to be at gray level 255.Thus, the optimum value for maximum value of gray levels was found and this method was termed as incremental histogram equalization. However, here noise was not dealt with. So extension of this method would be working on characteristics of noise and noise removal.

III. PROPOSED PROBLEM ANDMETHODOLOGY

In this work, we intend to do the following.

i) Acquire realistic night time images and videos on city highways and roads and study their gray level distribution. Also, perform regular noise removal on them.

ii) Perform "Adaptive Histogram Equalization", "CLAHE (Contrast Limited Adaptive Histogram Equalization)", "Optimum Histogram Equalization" and "Homomorphic filtering using Retinex Algorithm" on these and compare their performance using standard quality measures.

iii) Compare these existing techniques with a proposed Histogram Matching Technique and a parameterized Homomorphic Filtering technique with automated parameter selection. Slopes of the Filtering curve will be decided by sensing the brightness level of the acquired, noise removed image.

iv) Extend the well-studied technique on images, to videos of moderate size (640x480) for demonstration purpose.

v) Though we propose to work on videos, at present our main concern is to get a good enhanced night vision through our proposed technique, and not the speed of processing.

vi) Validate our technique through qualitative performance measures like opinion poll on live videos, and through standard measures like PSNR.

vii) We intend to use Python as the image processing tool because it is open source software.

Contrast stretching is typically a linear transformation which can be applied to images taken under poor illumination conditions. The basic idea behind it is to increase the dynamic range of the gray levels in the image being processed.

Global histogram equalization refers to the conventional histogram equalization approach in which the equalization operation is applied to the image as a whole taken under low light. However, this approach may not produce effective results if the illumination in the original scene is uneven.

Adaptive histogram equalization first separates the image into small blocks and then applies the conventional histogram equalization technique on each of these blocks. It is a local image processing method. However, this technique can still lead to discontinuities between blocks and noise amplification. An advantage of global histogram equalization over the adaptive approaches is that it is very efficient to compute and can be applied to real-time video without making any major changes in the algorithm.

Therefore to overcome this,Contrast Limited Adaptive Histogram Equalization(CLAHE) is implemented as CLAHE differs from ordinary adaptive histogram equalization in its contrast limiting, the contrast limiting procedure has to be applied for each neighborhood from which a transformation function is derived. CLAHE was developed to prevent the over amplification of noise that adaptive histogram equalization can give rise to.

This is achieved by limiting the contrast enhancement of AHE. The contrast amplification in the vicinity of a given pixel value is given by the slope of the transformation function. This is proportional to the slope of the neighborhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value. CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF. This limits the slope of the CDF and therefore of the transformation function. The value at which the histogram is clipped, the so-called clip limit, depends on the normalization of the histogram and thereby on the size of the neighborhood region. Common values limit the resulting amplification to between 3 and 4.

Another method used was homomorphism filtering. This is used when there is uneven distribution of illumination. It works on the fact that illumination varies slowly and reflectance varies abruptly and rapidly over the image. Homomorphism filters attenuate low frequencies (illumination) and increases high frequencies (reflectance). Here, filtering is done in frequency domain and used when non-linear function present in the image.

With all these, we also have Retinex algorithm followed by selective gray mapping. This algorithm first separates the luminance and reflectance parts of the image. The reflectance, which determines essential details of the image, is retained and processed using Retinex algorithm. After this, the second stage involves adding of luminance again to the reflectance by determining the light source in the image.

IV. RESULTS AND DISCUSSIONS

As mentioned earlier, we have processed the images using global histogram equalization and CLAHE. Fig. 1 shows six night images in the grayscale. We can see that the details of these images are not very visible.

Fig. 2 shows the images after global histogram equalization was performed on the six images. Here, though a few details are better visible and the contrast is improved, it can be seen that even noise is amplified to a high level. Furthermore, already bright areas (like the light sources, here, headlights), become more bright and destroy the image.

Fig. 1 Unprocessed night images

Fig. 3 shows the six images afterimplementation of CLAHE. Comparing Fig. 3 and Fig. 2, it can be said that CLAHE gives better enhancement of images than histogram equalization.

Fig. 2 Histogram Equalized images

Fig. 3 Contrast Limited Adaptive Histogram Equalized images

After seeing this result on images, CLAHE was implemented on real time night videos. Fig. 4 shows CLAHE improved video frames. The frame after implementation of CLAHE, shows better contrast and optimum brightness, giving better visibility.

Fig. 4 CLAHE extended to videos

V. CONCLUSION & FUTURE WORK

In this work, we describe the problem of Digital Night Vision Enhancement, NVES, its relevance and utility. We survey the existing methods, techniques and their limitations. Four major techniques AHE, CLAHE, OHE, and Homomorphic filteringfor obtaining an enhanced night vision image are discussed in detail. We propose to perform HM and parameterized homomorphic filtering that suits for a given night time image and compare our results with existing techniques. We intend to validate our results through standard measures of performance. We will develop the algorithms, using aWindows operating system, with Intel core i3 (Dual core), having memory speed 1600MHz and run time (upto) 4.5 sec,in Python, which is an open source software.

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REFERENCES

[1]Kare Rumar, *Night Vision Enhancement System: What should they do and what more do we need to know?*. The University of Michigan, Transportation Research Institute, 2901 Baxter Road, Ann Arbor, Michigan, U.S.A.

[2]NishikarSapkota, *Real Time Digital Night Vision Using Nonlinear Contrast Enhancement*, in “Masters Theses,” University of Nevada, Las Vegas.

[3]Erik Hollnagel and Jan-Erik Kallhammer, *Effects of a Night Vision Enhancement System on Driving*, University of Linkoping, Autoliv Research, Swden.

[4]Peter Mayer and George Edelmayer, *Electronic Vision Enhancement System*, JURCA Optoelectronic GmbH, Eschborn, Germany.

[5]XueboJin, JiaBao and Jingjing Du, *Image Enhancement Based On Selective-Retinex Fusion Algorithm*,in “Journal of Software,” vol 7, No. 6, June 2012.

[6]Omer Tsimhoni and Paul Green, *Night Vision Enhancement Systems for Ground Vehicles: The Human Factors Literature*, Technical Report, No. 5, The University of Michigan, Transportation Research Institue, U.S.A.

[7]Dr. Jahid Ali and RohitVerma, *Comparative Study of Various Types Of Image Noise and Efficient Noise Removal Techniques*, in “International Journal of

Advance Research in Computer Science and Software Engineering," vol 3, Issue 10.

[8]Vladimir I. Ponomarev and Olesksiy B. Pogrebnyak, *Image Enhancement by Homomorphic Filter.*