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INTEGRATED LOW LIGHT IMAGE ENHANCEMENT IN TRANSPORTATION SYSTEM

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Abstract: Recent Intelligent Transportation System (ITS) focuses on both traffic management and Homeland Security. It involves advance detection systems of all kind but proper analysis of the image data is required for controlling and further processing. It becomes even more difficult when it comes to low light images due to limitation in the image sensor and heavy amount of noise. An ITS supports all levels like (Transport policy level, Traffic control tactical level, Traffic control measure level, Traffic control operation). For this it uses several split systems like Real time passenger information (RTPI), Automatic Number Plate Recognition (ANPR), Variable message signs (VMS), Vehicle to Infrastructure (V2I) and Vehicle to Vehicle (V2V) system. While analyzing critical scenarios, mostly for the development of the application for Vehicle to Infrastructure (V2I) System several cases are taken into consideration. From these cases some are very difficult to analyze due to the visibility of the background as the detail structure is taken into consideration. Here Direct processing of low light images or video frames like day images leads to loss of required data, so an efficient enhancement method is required which gives allowable result for further transformation and analysis with minimal processing. So an Adaptive Enhancement Method is presented here which applies different enhancement methods for day light and low light images separately. For this purpose a combination of image fusion, edge detection filtering and Contourlet transformation is used for low light images; tone level adjustment and low level feature extraction for enhancement of day light images.

Keywords*: Staggered pulse repetition interval, quadrature data, range-gated zone, holography, range delay, interferometry.*

I. INTRODUCTION

Analyzing and Controlling traffic in urban areas is a complex, multi-functional process which involves diverse agencies. For a successful traffic management system each partner agency will have a clearly defined role, which is distinct yet complementary to those of other partners. ITS plays a key role in supporting and facilitating each partner and also being a key technical tool in delivering core output of coordinated management policies.

1.1: Intelligent Transportation System

The goals of this system are to promote usage of sustainable modes; the use of cleaner vehicles; to reduce number of incidents. But there is no universal tool of traffic management. A range of applications have been developed over many years. For a particular management system required applications are being integrated and used as ITS for that particular system. The key goals of ITS are

1. Reduce Congestion
2. Reduce energy consumption and traffic emissions
3. Improve quality of life in city centers
4. Increase market share of clean vehicles in private and public fleets
5. Increase efficiency of the transport system
6. Facilitate freight delivery and servicing
7. Enhance road safety
8. Decrease parking pressure

Here for achieving the goals different applications are made like Traffic Signal Control (TSC), Real time passenger information (RTPI), Automatic Number Plate Recognition (ANPR),

Variable message signs (VMS), Vehicle to Infrastructure (V2I) and Vehicle to Vehicle (V2V) system. For developing and supporting some of these applications like VMS,V2I and V2V periodically information need to be given either as images or video frames or analysis report from the earlier two.

For this purpose several images are taken into consideration ranging in all light conditions, weather condition in all available surveillance support areas. Before developing a particular application these image data are properly analyzed after some necessary processing. These processing involves deblurring, enhancement, feature extraction. Here the enhancement is very important processing mechanism without which the further processing is impossible [1], [8]. But the enhancement technique becomes very complex if the visibility of the background is poor or if heavy amount of noise is present.

1.2: Low Light Image Enhancement

A different method need to be carried out for low light images as the information of it is not enough for proper analysis (Because of the lack of Background context due to poor illumination). So a combination of Image Fusion, Contourlet transformation is used for image enhancement. By taking several similar images in various light conditions the image fusion is done to get a good result but to get edges and alignments in the image the fusion need to be done

using Contourlet transformation. The Contourlet transformation consists of 2 steps (Sub band decomposition and Directional Transform). The pixel fusion is done as it contains the original information.

1.3: Day Light Image Enhancement

Day light image enhancement is little easier comparing to that of low light but generally day light images are having multiple luminance in different areas. So multiple exposure images are considered and by analyzing their tone levels we can enhance by fusion method or for some information low level feature extraction is done.

2: MODEL STUDY AND ANALYSIS

As there is no universal Intelligent transportation system several split applications are developed which can be integrated to a particular ITS. As mentioned, the goals of ITS system are to promote usage of sustainable modes; the use of cleaner vehicles; to reduce number of incidents.

According to the Emergency Traffic Control & Scene Management Guidelines, Incident objectives should be established based on the following incident response priorities:

Priority 1: Life safety
Priority 2: Incident stabilization
Priority 3: Preservation of property and the environment

The main focus of this research work is on the second priority (i.e. Incident stabilization), if it can be done perfectly then the other two priorities can also be maintained. So the proper sources should be given to the ITS system. A periodic study of several similar images and previous incidents should be taken into consideration.

For developing the application for the infrastructure previous reports are considered along with repeat update. When the previous reports (Images or Video frames) are prepared then it is considered for all along the 24 Hrs and also for all weather conditions. Before analyzing these they need to be Deblurred, Denoised and Enhanced.

Some good Deblurring methods are Blind Deconvolution and Deblurring using Regularized filtering [4], [6]. As the frame contains some objects those are in motion so a distracted image is captured for a particular frame. These images cannot be processed directly before Deblurring. Sometimes the images are also being taken from the traffic control motor vehicle, so An Adaptive motion detection method should be used for the Deblurring purpose [2]. A particular function is attached in the blurred image called Point Spread Function (PSF) which is calculated or estimated depending on the availability of the resources and then used for the deconvolution process.

$$DI = H_O * I + H_B * I + N$$

Where, DI: Degraded or blurred image

H_O: Distortion operator that describes the degree to which an optical system blurs (spreads) a point of light when the object is in motion.

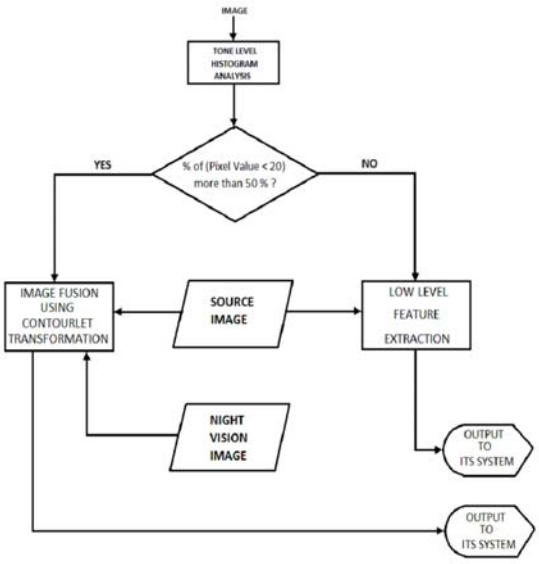
H_B: Distortion operator that describes the degree to which an optical system blurs (spreads) a point of light when both the object and the camera are in motion.

N: The Additive noise, introduced during image formation, that degrades the image

Denoising is sometimes also done in the Deblurring process by calculating or estimating the Noise power to Signal Power ratio (NSR) from the distracted image.

3: DESIGN AND METHOD:

The method for enhancement for multiple light conditions is explained here. The flow chart given below describes the sequence of processes carried out on a particular image for enhancement before giving as source to the ITS.



(Figure 1: Method Flow Chart)

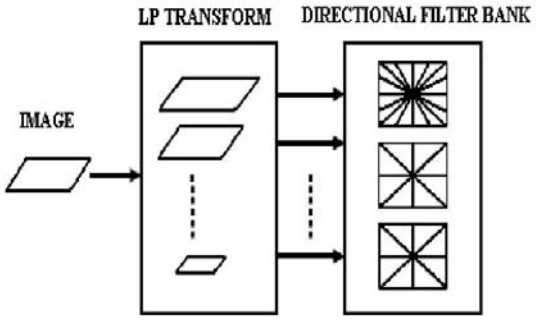
First the source image is given to the tone level histogram analysis for calculation of the % of pixel count. If it is more than the image is a low light image and the enhancement is done using the fusion of two images (i.e. the Source image and the Night Vision Image). In the other case the low level extraction is done for the enhancement and outputs are given to the ITS for further processing.

Various enhancement methods can be applied to a same image to get a better result provided the order of enhancement method and the form of the intermediate image should be correct. If night vision systems are used then the following problems may arise in low light conditions

1. Very Lack of Color Information
2. Bright around the Illumination Sources (Street Lamps, Car Light)
3. Dark where less light is present

An adjustment method can be applied here like Retinex Algorithm. The idea of the Retinex is to decompose the source image into two different images, i.e., the luminance component image and the reflection component image. The reflection component image is the final enhanced image.

One other type of enhancement method is the enhancement by Fusion in Contourlet transformation. Wavelet based transformation is having some limitations, because they are not well adapted to the detection of highly anisotropic elements such as alignments in an image. Contourlet transform has better performance in representing the image salient features such as edges, lines, curves and contours than wavelet transform because of its anisotropy and directionality. It is therefore well suited for multi-scale edge based color image enhancement [10].



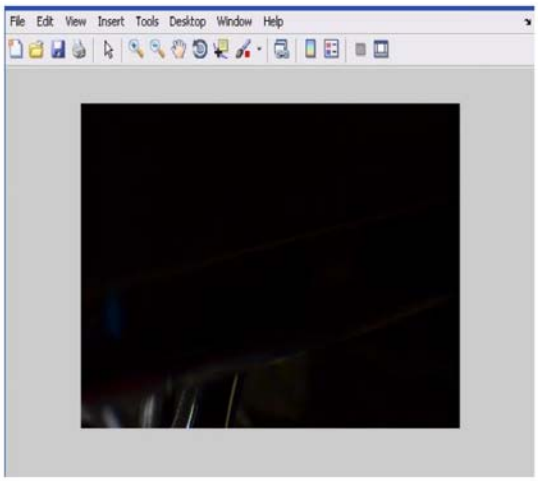
(Figure 2: Contourlet Transformation)

The contourlet transform consists of two steps which is the sub band decomposition and the directional transform. A Laplacian pyramid is first used to capture point discontinuities, then followed by directional filter banks to link point discontinuity into lineal structure. The overall result is an image expansion using basic elements like contour segments, thus the term contourlet transform.

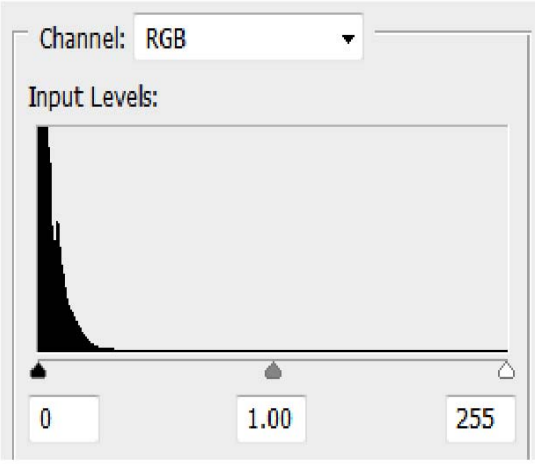
For day light generally some tone adjustment for enhancement and low level feature extraction is done and can be used directly as information rather than an enhanced image. There are some texture feature extraction models are present. Generally four texture feature extraction methods are present which generate a multi - scale, multi - directional representation of an image.

4: RESULTS

One of the low light images is taken for the analysis for the enhancement and the tone levels are found which gives the information for the amount of pixels present at different levels of pixel value.

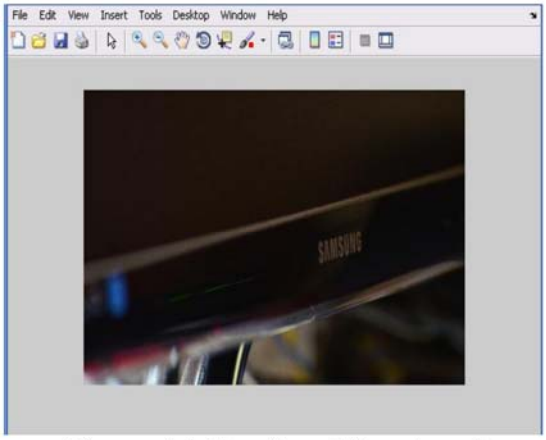


(Figure – 3: Low Light Image)

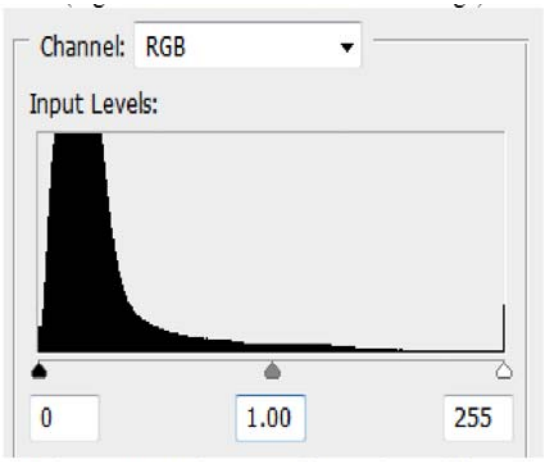


(Figure – 3.2: Histogram of low light image)

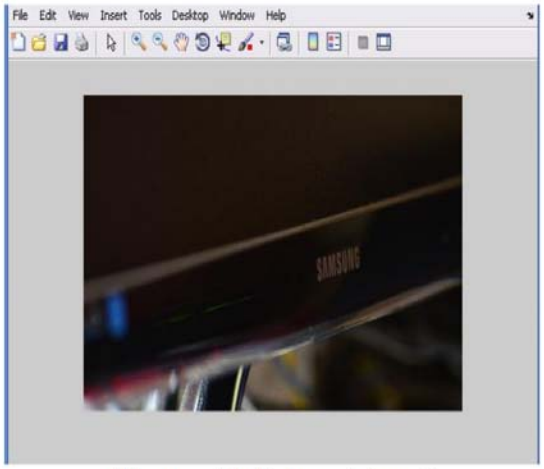
It is clear that most of the pixels are present at the extreme left (Shadows or Pure Black) and some are tending to the extreme right (Highlights or Pure White).Very less no of pixels are present at the midtone. These types of images are very difficult to enhance as they lack of information.



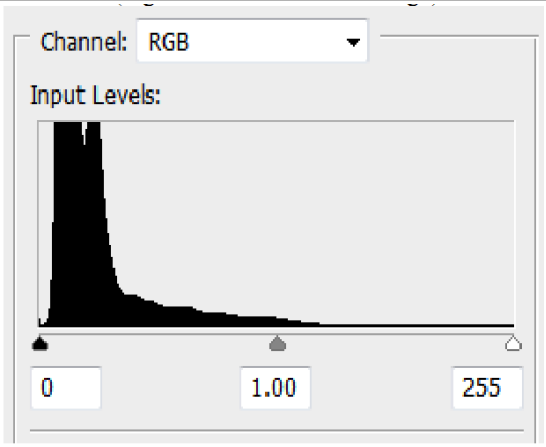
(Figure – 4.1: Transformed frame image)



(Figure – 4.2: Histogram of Transformed frame)



(Figure – 5.1: Enhanced image)



(Figure – 5.2: Histogram of Enhanced image)

Some visible amount of information is present on the change but it is difficult to enhance further or analyze as it is not containing midtone levels and also containing heavy amount of noise. So we need images at different light conditions for image fusion in contourlet transformation or a night vision image of the same at the same light condition for finding a composite image for visible enhancement.

5: CONCLUSION

One of the low light images is analyzed for the enhancement and by adjusting the tone level of the day light image some visible extractions are possible but for low light images just the tone level adjustment is not enough for enhancement. So an adjustment method can be applied here like Retinex Algorithm. The idea of the Retinex is to decompose the source image into two different images, i.e., the luminance component image and the reflection component image. The reflection component image is the final enhanced image.

One other type of enhancement method also can be used which is the enhancement by Fusion in Contourlet transformation. Contourlet transform has better performance in representing the image salient features such as edges, lines, curves and contours than wavelet transform because of its anisotropy and directionality. It is therefore well-suited for multi-scale edge based color image enhancement. Also multi-sensor image fusion can be done for best result as sensors having optical system are having limitations to calculate all the attributes of an image.

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