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Pre Processing Methods for Runway Pictures Taken in Poor Visibility Conditions using Single Scale Retinex Algorithm

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***Abstract*: The paper covers the methods of image Preprocessing approaches which might be effectively used in Enhanced flight vision systems (EFVS). Modern Enhanced flight vision systems (EFVS) designs focus on all-weather vision, which can be accomplished by Intelligently fusing images and data from cameras operating in visible light, infrared, and milli metre-wave. Covered methods should provide better characteristics of pictures of runways taken in poor visibility conditions above and below the decision Height. Results of this work are relevant to the tasks of avionics, computer vision and image processing using single scale retinex algorithm.**

***Keywords*: Enhanced flight vision systems; contrast; image processing**

1. Introduction

Poor visibility related to weather condition change might lower vehicles using efficiency and safety, such as means of land, air, water transport and heavy construction mechanisms. The relevance of the task of the objects visibility improving is confirmed by the increased interest of many researchers. Withal, as flight safety foundation researches show, about 75% of aircraft crashes during approach and landing happens in poor visibility conditions in airports, where precision approach instruments are not available or not presented. Thus one of the most important directions in avionics improvement is development of enhanced flight vision systems.

2. Enhanced flight vision systems

Situational awareness loss during approach and landing in harsh weather conditions is one of the major causes of aviation accidents and disasters. That explains the relevance of the task of aviation vision system development which would provide the crew with the "enhanced vision" of the outer environment on the basis of processing information from sensors of different spectral ranges (first of all, television and infrared) and navigation sensors. Nowadays most of the certified commercial aviation systems for enhanced vision presented on the market are simply non-intelligent “sensor-display” systems which provide direct image from sensors to displays only the most important part of the new generation EFVS should be a computer vision system that performs the following main functions:

- Multispectral video information acquisition and Digitization;
- Multispectral video information aggregation,
- Automatic detection of runways and other typical Objects of interest in the absence of navigation data,
- Distinguish ability of objects improving,
- Automatic detection of runway obstructions.

It is quite important to provide the pilots with runway Images with improved objects distinguishability along with passing it to the computer vision system, which would perform objects detection and linking to the navigation data.

3. Preprocessing methods

Degrading distinguish ability of objects on images taken in inadequate visibility generally is due to lowering contrast and Colour saturation. Low image contrast might be the consequence of inconsistency of image and display device dynamic ranges. Spatial unevenness is specific to lowering contrast of objects on images taken in poor visibility conditions as a rule image areas displaying remote objects have a small dynamic range and are characterized by low contrast. In turn, the image areas displaying the objects of the near scene have a large dynamic range and contrast. Methods of contrast correction are expected to increase the dynamic range of the image and match it to the dynamic range of the display device. Thus, the task of improving the distinguishability of objects through contrast correction can be considered as the task of matching the dynamic ranges of different image areas with the dynamic range of the display device. Methods to increase the contrast can be divided into global and local. the main concept of global methods is the conversion of the brightness scale using the transformation function, which is the same for all levels of brightness. Local methods, also called adaptive, differ from global ones in that the amount of brightness variation of each pixel depends on the characteristics of the surrounding neighborhood. at the same time, depending on the form of the brightness transformation function, contrast correction methods are divided into linear and nonlinear. Preprocessing is a common name for operations with images at the lowest level of abstraction in both input and output are intensity images. The aim of preprocessing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing.

Four categories of image preprocessing methods according to the size of pixel brightness:

- Pixel brightness transformations,
- Geometric transformation,
- Preprocessing methods that use a local neighbourhood of the processed pixel.

4. Methods

Local tone mapping operation is an image produces a vital number of characteristic effects. The local operation may end up even with canvas like appearance due to the dark objects around them and shadows in the input image. The camera response curve is obtained in the local tone mapping with the help of real world brightness of the pixels ranging from 0-255. Multiple exposure images are taken as the input the HDR radiance map is computed with weighted sum of all the inputs. Keeping the contrast of the HDR radiance map other contrast and the luminance is compressed while preserving the details. Let the image g be the RGB values of the input radiance which is the input. The intensity of the image has to be calculated. The image be represented in the following matrix and ij be the no of rows and columns of the image pixels. The intensity of the pixel can be calculated with different methods which depend on the intensity and brightness of the image. the brightness can also be taken as the arithmetic mean of the colours red, green and blue.

$$\infty = \frac{RED + GREEN + BLUE}{3}$$

5. Global tone mapping

The main objective of tone mapping is to replicate the given scene or an image close to the real world brightness matching the human view in the display devices. Appropriate metrics are chosen for various input images depending on the application. In tone mapping the contrast distortions are weighted according to the individual visibilities approximated by human visual systems. An objective function based tone map is created. There are different filters like bayer's filters and other filters are used for tone mapping. These filters can also be extended to videos. As many scenes contain more information in the mid tones than in low and high luminance areas, s-shaped curves compress these areas. Instead of s-shaped curves, use a function that only compresses the highlights. They also introduce a clipping since it is not always desirable to bring all luminance within display range. The histogram adjustment method is not directly inspired by the zone system but is based on similar principles. It is an extension of histogram equalization, which redistributes pixel values so that the treated image histogram has a uniform distribution. In the histogram adjustment method, the histogram equalization is performed on the log luminance image. The goal of histogram adjustment is to conserve the perceived contrast while preventing details that were not visible to the human eye in original scene to become visible in the image after processing. A model of glare is also used in the post-processing stage to further improve the displayed image realism.

6. Sophisticated global tone mapping

Many global tones mapping methods take inspiration from the traditional photography Technique called zone system. Global tone mapping algorithms range from basic functions (logarithm, power function, sigmoid) to more sophisticated ones that are image dependent. Their goals can be to approximate the hvs non-linearity, to compensate for the display characteristics, or to render visually more appealing images. Display devices have a non-linear relationship between input voltage and display luminance. This non-linearity is described by a power law and is commonly called gamma. The method of reinhardt maps the log average luminance to a display. If the scene is low key or high key, the log average is mapped to a lower or higher value, respectively. As many scenes contain more information in themed tones than in low and high luminance areas, s-shaped curves compress these areas.

7. Black and white point correction

Tone mapping always includes an operation that matches the perceived black to the darkest display luminance and the perceived white to the brightest display luminance. It is critical for a pleasing reproduction of images. Black and white point correction can be automatically included in the tone mapping algorithm such as with histogram equalization method, or it can be performed as a pre-or post-processing in addition to the tone mapping operator. Here, we present the black and white point correction method that we implemented as a post-processing of our tone mapping operator based on a histogram scaling. The black and white points of the input image cannot simply be determined by the darkest and brightest pixel. Group of pixels of low and high digital values must be used.

8. Single scale retinex algorithm (SSR)

In this paper, we present an improved image formation model and propose a colour image enhancement using single scale retinex based on the model. Single scale retinex, is the most basic method for retinex algorithm. A low pass filter is applied on ii (x, y) which is the input image to estimate the illumination. This illuminations log signal is subtracted to get the output colour image Ri(x,y).it is given by,

$$Ri (x, y) = \log ii (x, y) - \log [f (x, y)\, ii (x, y)]$$

Here, f (x, y) = k exp [−(x2 + y2)/c2] is surround function, s is the number of spectral bands, c is surround constant or scale value and selection of k is such that

$$\int \int f(x,y)\, dxy = 1.$$

A canonical gain offset is used as a post retinex signal processing. A space constant of 80 pixel is a good compromise between dynamic range compression and tonal rendition. A single scale can simultaneously provide dynamic range compression and tonal rendition. Single scale based algorithm was tested on images taken during landing of airbus a320 aircraft in ULLI at CAT I Visibility category. Results of testing in comparison with other Commonly used methods are shown in figures. As one could see, it provides better distinguishability of remote areas of the scene yet improving the contrast of the near scene.

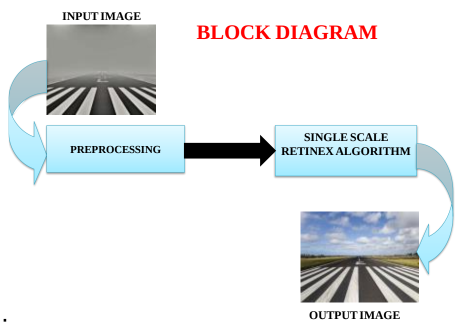

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Fig. 1. Block diagram

The output of the natural logarithm function must be Scaled back to the digital image range of [0,255] . It's better to Scale it to a wider range of [-40,295] and then clamp the Values to [0,255] in order to reduce the effect of outlier pixels.

Fig. 2. Original image

Fig. 3. Single scale retinex algorithm

Any pixels that were not selected as a center in any color channel have their values fixed during this smoothing step. This prevents from blurring of useful information in the original image. A selection of "centers" is calculated by considering the distance in each color channel and the Euclidean distance in color space. Algorithm targets pixels that have an intensity change but no significant color change. Pixels that are not selected have their values fixed with no Smoothing applied. Retinex-based algorithm was tested on images taken during landing of airbus a320 aircraft in ULLA at CAT invisibility category. Results of testing in comparison with other commonly used methods are shown in figures 4 and 5. As one Could see, it provides better distinguishability of remote areas of the scene yet improving the contrast of the near scene.

9. Result

Fig. 4. Original image in poor visibility condition

Fig. 5. Output image after using single scale retinex algorithm

10. Conclusion

This paper presents a short description of various image enhancement techniques in order to make familiar with the enhancement of a blurred image, noise removal, setting the brightness, contrast and other degradations in image processing .success with single scale retinex processing depends on the amount of noise in the input image. A more powerful and general method of managing noise would further improve the algorithm's performance and reduce the need for pre- or post-processing. Single scale retinex processing performs well on the task of improving the contrast of the image, taken in poor visibility conditions. The distant areas, invisible in the original, are clearer in the processed image. Methods to increase the contrast differ in used approaches: histogram methods, gamma-correction, AINDANE, LTSNE, RETINEX based methods.

11. Future work

In future some powerful and general method of managing noise would further improve the algorithm's performance. The usefulness of proposed method should be measured by subjective testing in the context of a particular application or task.

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