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WHITE PAPER

Hikvision
Digital Defog Technology

Background

Since surveillance cameras are often installed outside and are expected to stand the test of 24/7 operation, they are frequently exposed to strong light, rain, snow, and fog. These environmental conditions have a great influence on the image quality of the surveillance camera, especially the fog. The aerosol particle containing moisture and fumes in the fog is the main cause for the degrading of the image quality. The low contrast ratio when foggy decreases the image quality so that the details of the scene can't be seen clearly. Therefore, defog technology is one of the imperative technologies for outdoor surveillance.

At present, one common approach for defogging an image is to use a specific optical component that senses more IR information in fog. One of the liabilities of this physical means is its high cost. Advancements in the development of digital technology brings about the defog image processing technology. This technology adjusts the distribution of the information captured by the image sensor, and enhances the color and details of the surveillance target to decrease the information loss during subsequent processing, such as ISP and encoding compression.

In this paper, we will go through the digital defog technology.

Classification of Digital Defog Technology

There are two known digital defog algorithms, the non-model image enhancement and the model image recovery method. The non-model image enhancement method increases the contrast ratio to realize the defog function on the basis of the subjective visual judgment. The model image recovery method investigates the reasons why the image quality deteriorates and modularizes the process of the deterioration, and then reverses the process and finally recovers the original image quality.

The typical ways of non-model image enhancement include the histogram equalization, the filter transformation and the fuzzy logic based theory. The histogram equalization can be divided into the global histogram equalization and the partial histogram equalization. The global histogram equalization has a low computation cost but the enhancement of the detailed information is not sufficient. The partial histogram equalization enhancement has a better effect, but a blocky effect may be caused, and noises are also enhanced.

The filter transformation algorithm provides good image quality, but the computation cost and resource consumption are so high that it is not good for the live view surveillance. The defog effect of the known fuzzy logic based theory is not ideal enough.

All in all, the non-model image enhancement methods can increase the image quality to some extent and the region of interest can be further enhanced to increase the image quality. But in this way, the cause of the image deterioration is never addressed, and it only changes the visual effects and does not enhance the image quality in an effective way.

The model image recovery method includes the filtering method, the maximum entropy method and the degraded image function estimation method. The filtering method, such as the *Kalman filtering*, generally requires heavy computation. The maximum entropy gets a high resolution but it is a non-linear algorithm with huge computation and the calculating process is too complicated. The degraded image function estimation method is normally designed based on a certain physical model, such as the atmospherically scattering model and the polarization property defog model. This algorithm requires the image capture at different times as a reference to determine the parameters of the physical model and since this is a non-real-time method, it is hard to apply for surveillance use.

The complicated surveillance environment and the bad weather demands a requirement of high power consumption, convenience, effectiveness, and adaptability of the surveillance products. Te best practice of the technology must integrate the image enhancement and restoration and be based on the atmospheric transmittance model in order to get a relatively ideal image.

Hikvision Digital Defog

With a full analysis and research on the strength and weakness of the current defog theories and algorithms, and with the consideration of the specific requirement of the defog function in the video surveillance industry, Hikvision developed a video defog technology for live video. The technology is based on the atmospheric optics theory. When defogging, it distinguishes the depth of field and fog density of different areas and uses the filter process to get a correct and natural defogged image.

In the defog image process, we usually use the following module to indicate the image of the scene with fog.

$$I(x) = J(x)t(x) + A(1-t(x))$$

I represents for the image, and J is the light intensity, A refers to the atmospheric optical components, t is the light which is not diffused when passing through the media. The aim of the defog is to restore the J, A and t value. J is the result image after the defog process. The $J(x)t(x)$ is the direct decaying items, representing the light remained after decaying when transmitting in the media. $A(1-t(x))$ is the light in the atmosphere caused by the front light diffusing.

The flow chart of the real-time defog process is shown below in figure 1. The input video data is in the dot format, and the output video data is processed however the same as the input video data. The real-time defog process can restore the image detail and enhance the video quality, therefore, it's also very effective for the compressed video data. Thus the input video data can either be the original video data or the data after lossy compression. However, compared to that of the compressed video data, when the input data is the original video data, the defog processing result is more ideal.

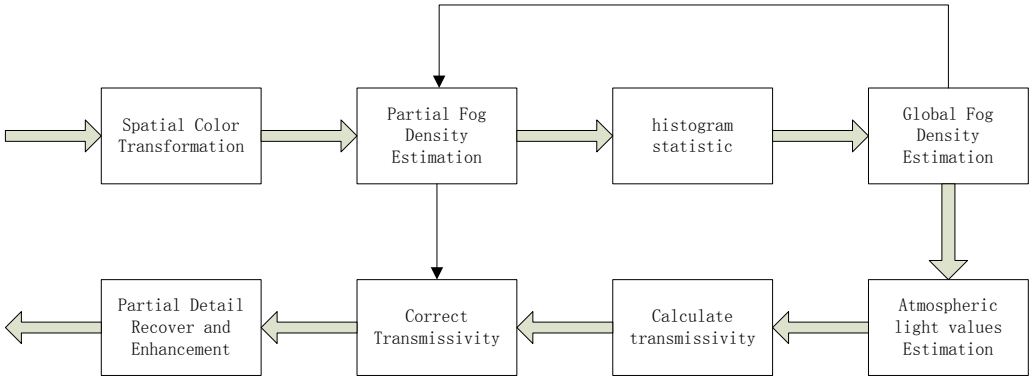

Figure 1 Flow Chart of the Video Defog Process

For the foggy input video, this method uses the Atmospheric Imaging model to analyze and estimates the atmosphere light value A and the transmittance t. Based on the computer vision and image processing technology, this method uses the histogram statistic, contrast ratio enhancement and filtering to realize the real-time defogging.

Due to the integration of the global and partial fog density estimation, the real-time video defog technology automatically adjust to be adaptive to a variety of changing scenes and partial areas inside the scene to avoid the blurring and darkness caused by the defogging process. Meantime, the balance of the efficiency and complexity of the defog process is also taken into account.

Defog Technology Applications

The digital defog technology can be implemented in a multitude of outdoor surveillance projects, such as the surveillance on highways, railways, seaports, airport runways and other open areas for traffic. The defog function is also important for any perimeter protection or critical infrastructure application. From the application perspective, the defog function is most applicable for outdoor cameras and speed domes to increase the image quality in fog. The back end products like DVRs can't make the most use of the defog function due to the process of video signal process and data loss that may be caused by the compression algorithms.

Figure 2 A Comparison of before and after Contrast Ratio Enhancement

Figure 3 A Comparison of the Details Before and After Enhancement

Figure 4 A Comparison of the Text in Scene Before and After Enhancement

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About Us

Hikvision is the world's largest supplier of video surveillance products and solutions. The company specializes in video surveillance technology, as well as designing and manufacturing a full-line of innovative CCTV and video surveillance products. The product line ranges from cameras and DVRs to video management software. Since its inception in 2001, Hikvision has quickly achieved a leading worldwide market position in the security industry.

Hikvision possess the world's largest R&D team and state-of-art manufacturing facilities; both allow Hikvision's customers the benefit of world-class products that are designed with cutting-edge technology. As further commitment to its customers, Hikvision annually reinvests 7% of its revenue into R&D for continued product innovation and improvement.

Hikvision operates 31 domestic branches in China and 14 overseas regional branch offices, in conjunction with over 30,000 partners all over the world to achieve a truly global presence. Hikvision is now publicly listed on the Shenzhen Stock Exchange. For more information, please visit Hikvision's website at www.hikvision.com.