WISENET

White Paper

Fog Detection and Defog Technology

2017. 7. 21.

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Contents

1. Preface

Fog is made up of small droplets of water floating near the surface as the water vapor in the atmosphere condenses. As fog particles are larger than air, they causes the light to scatter more. In foggy images, light reflected from the object and light in the atmosphere are scattered by the particles between the camera and the object, lowering visibility, contrast and color saturation.
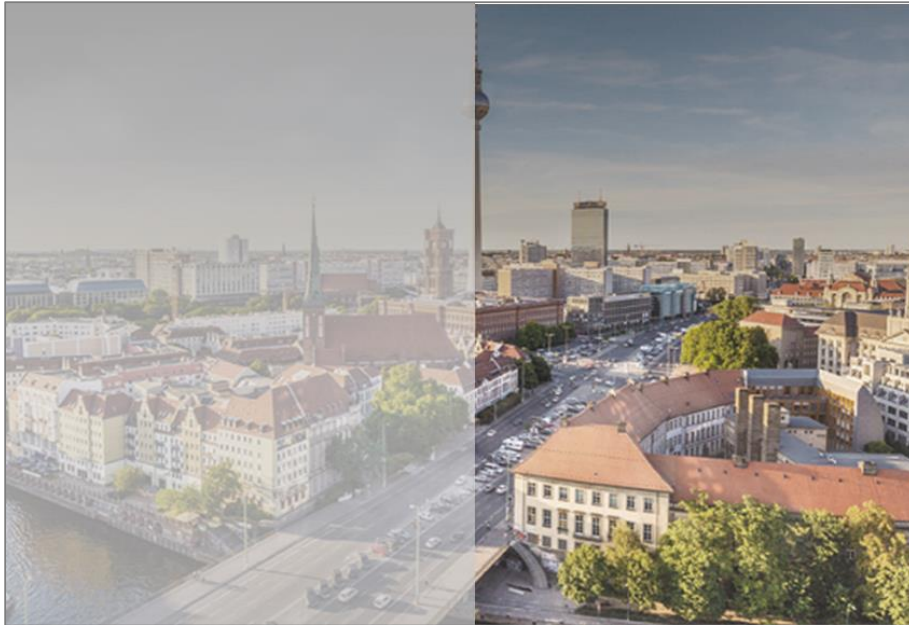
When the visible distance is shorter due to fog or dust in the air surrounding the camera, it reduces color and edge information, resulting in a significantly lower recognition rate in image processing. In areas that require full-time outside monitoring, such as airports and ports, a function for removing fog, which counts as noise, is crucial to improving the recognition rate.

Removing fog requires information about the conditions of each location, including the distance to the object and the density of the fog. Such information can be acquired by using two different polarizing lenses, two cameras or by comparing a foggy image to images from a clear day. However, this approach poses challenges as it requires two or more cameras or image data of every location. To overcome this challenge, recent defogging algorithms focus on researching ways to remove fog from a single video input.

2. Fog Detection

Fog Detection Technology detects when the clarity of the video has been compromised by fog on the site where the camera is installed. If the fog causes image to be blurry, the camera automatically detects the fog and triggers an event signal to notify the operator, allowing the operator to implement suitable measures.
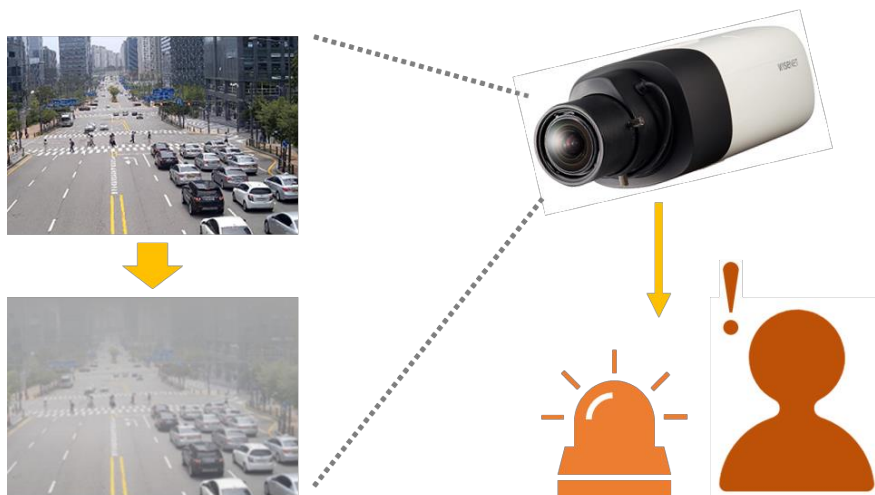

Figure 1. Example of an Event Alarm Triggered by Foggy Image

2.1. Level-based Fog Detection

Fog Detection Technology, featured in Wisenet X series cameras equipped with Wisenet5 chipset, measures the degree of blurriness and converts it to levels using absolute values.

The Fog Detection feature provides a graph, showing the level of image blurriness in real-time through a web viewer interface. The graph values become higher as the images become blurrier. The final event alarm is triggered when the level value has been detected for a period longer than the defined Minimum Monitoring Duration.

2. Fog Detection

Figure 2. Example of Foggy Image and Level Graph

2.2. Fog Detection Event Alarm

Fog detection provided in Wisenet X series offers two types of alarms: "Event Start" and "Event End". "Event Start" alarm is sent when the image starts to become foggy and the fog level remains above the Level of Detection for longer than the Minimum Monitoring Duration. If the fog clears, the image becomes visible and fog level falls below the Level of Detection, an "Event End" alarm is sent.

Once an "Event Start" alarm is sent, the system does not send another "Event Start" alarm until an "Event End" alarm is sent. To receive the "Event Start" alarm again after the event is triggered, the image must resolve into a clear image at least once. Therefore, if there is no "Event End" log after "Event Start" has been logged when checking the log, it means that there is fog surrounding the camera and it has not cleared yet.

2. Fog Detection

Wisenet X series cameras automatically execute the Defog feature when a fog detection event has been triggered and processes the image for clarity. However, the image processing by Defog does not affect the event alarms. Even if the Defog feature is activated, the "Event End" alarm will not be sent to the operator until the actual fog has been cleared.

2.3. Setting Event Triggering Conditions

The operator can define the conditions for which fog events will be triggered through the Parameter Settings.

2.3.1. Level of Detection

Alarms will be triggered when the current fog level remains higher than the defined Level of Detection. The lower the defined Level of Detection value, the smaller the level of blurriness in the image that can be detected.

2.3.2. Sensitivity

The higher the sensitivity, the higher the graph is drawn for an identical image. If the graph level is shown as being higher than 0 on a clear day without fog, you can lower the graph level by lowering the defined sensitivity value. On the other hand, if the graph level is shown as 0 on foggy day, you can raise the graph level by increasing the defined sensitivity value.

2.3.3. Minimum Monitoring Duration

An alarm is triggered when the fog level higher than the defined Level of Detection lasts for longer than the defined "Minimum Monitoring Duration." If the defined Minimum Monitoring Duration is short, the system can detect changes that occur for short durations and will trigger the alarm more quickly. However, it may also cause false positives as even temporary increases may trigger alarms. On the other hand, lowering the Minimum Monitoring Duration may prevent false positives caused by temporary level increases, but will also cause the alarm to be triggered later.

3. Defog Technology

Image processing technology for overcoming short visible distances resulting from blurry images caused by fog or fine dust that works by increasing image clarity is called Defog technology. Defogging is achieved by one of the two following basic mechanisms.

3.1. Fog Color and Depth Map Estimation Based Defog

A Fog Color and Depth Map Estimation Based Defog mechanism assumes that light of the same color is added to reflections of objects as light scatters over the entire image, and predicts the difference between the expected color by measuring the distance from the camera and the object using distance sensors, stereo cameras, or single or multiple images.

Distance sensors, stereo cameras or multiple images are used to create an accurate depth map, but using them significantly increases costs. On the other hand, calculating the distance between the camera and the object in one image, which is crucial for defogging performance, is difficult to achieve and less accurate. It results in outstanding defogging results when the distance calculation is accurate, but causes worse results otherwise.
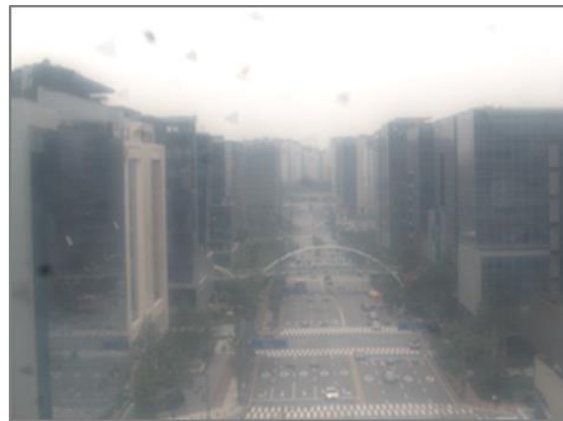
3.2. Contrast Stretching Based Defog

A Contrast Stretching Based Defog mechanism assumes that the overall contrast is lowered due to the fact that the light reflected by the bright part of an object becomes darker through light scattering before reaching the camera while the light reflected by the dark part of an object becomes brighter through the scattered light from other places. Under this assumption, it increases contrast to achieve defogging.

By making the dark parts darker and bright parts brighter, it increases the overall contrast and results in a level of visibility equal to that of a clear day. However, when the contrast is stretched incorrectly, darker parts can become darker and bright areas or objections can become saturated, resulting in lower visibility.
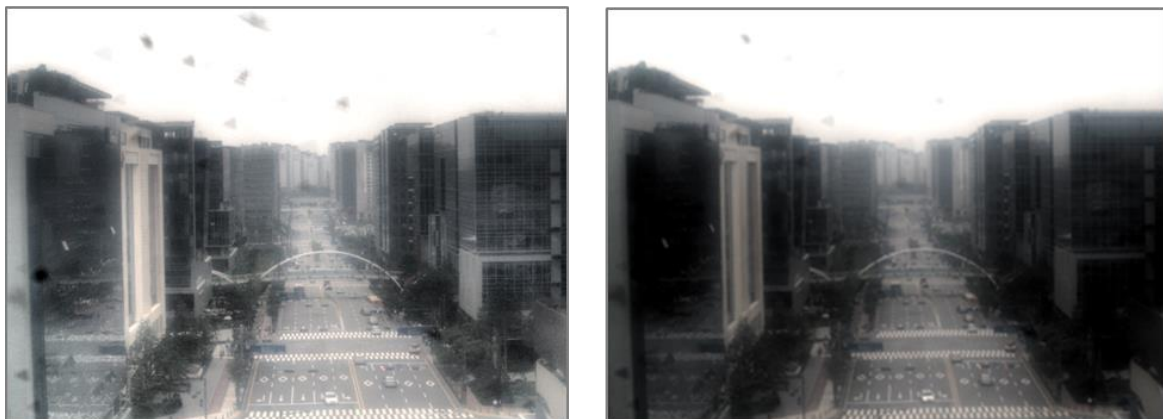
3.3. Hanwha Techwin's Defog Technology

While it is possible to adjust the contrast of relatively darker or brighter objects/areas by setting a certain part of the image as the baseline, setting the baseline area to be too narrow can compromise the balance of the brightness compensation.

To prevent such side effects, Hanwha Techwin uses a defogging method that applies alpha blending images with higher contrast applied on the entire image with images with higher contrast applied only on certain parts of the image.

Original Foggy Image

Lower Visibility Due to Side Effects of a Defog Feature

Figure 3. Example of Side Effects of Contrast Stretching Based Defog

4. Conclusion

Hanwha Techwin's Defogging technology is made possible with the Wisenet5 chipset, an SoC (System on Chip) developed by Hanwha Techwin's accumulated know-how, that delivers optimal results by minimizing side effects in less ideal conditions. Through this technology, the system provides clear images with effective defogging in areas that require full-time monitoring such as outer perimeters and the key infrastructure of airports and ports.

Original Foggy Image

Fog-removed Image with Hanwha Techwin's
Defog Feature

Figure 4. Hanwha Techwin's Defogging Effect

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