White Paper

Defocus Detection and AF Technologies

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1. Preface

The word Camera is originated from Latin ‘Camera Obscura’ meaning ‘room (Camera)’ and ‘dark (Obscura).’ The initial form of a camera was just a dark box with a small hole on one side of the box letting lights in. By making some distance adjustment, it was able to see images projected through the hole on the opposite surface to the opening as a reversed and inverted image (left to right and upside down). To get clear image from this initial camera, you had to move the whole box to get right focus while it took a long time for a photo shoot also. Larger opening could have shorten the shooting time, but this resulted in light reflecting from the object to overlap, creating a blurry image.

This problem was solved with the development of lenses that could focus lights more effectively than a simple hole. In order to have clear image, light rays coming from multiple directions should selectively be gathered together to have same direction. This is where camera lens comes in. A camera lens consists of multiple lenses to correct aberrations and focus defects caused by light of various colors and different wavelengths. This combination of multiple lenses makes it possible to adjust the viewing angle and focus much easier.

However, as camera film has been switched into digital image sensor now, advanced sensor technology brought us that high resolution is no longer hard to achieve and became very common for us now. This change made blurry and unsharp images more noticeable when it goes out of focus. Because video surveillance cameras deal with recording sensitive or important information, it is very important and essential to quickly detect when the image is out of focus and adjust the focus to obtain clear images in different environments.
2. Defocus Detection Technology

Defocus Detection Technology detects when the clarity of the video has been compromised due to the camera's lens being out of focus. If the lens is out of focus due to a camera malfunction or if the focal point changes due to unintended changes in camera position, it results in blurry images, making it difficult to determine the content of the image and even affect other functions of the camera.

Hanwha Techwin's Defocus Detection technology triggers a Defocus event when the image loses sharpness and becomes unclear due to changes in camera lens’ focus. As camera is able to detect the defocus situation itself and notify event to the users, it helps the users to take right actions at right time as they need.

Image 1. Overview of Defocus Detection Process
2.1. Level-based Defocus Detection

The Defocus Detection Technology is applied to all Wisenet X series cameras along with our own development achievement Wisenet5 chipset. This technology measures high-frequency components inside current image, converts them into absolute value, and shows in level rather than measuring relative changes.

Users are able to view this Defocus Detection technology featured on Wisenet X series through web viewer interface in a leveled graph in real time. The graph shows how much the image lost its focus, and the graph value increases as the image gets blurrier. The final event alarm is triggered when the level value has been detected for longer than the defined Minimum Monitoring Duration.

Image 2. Example of Blurry Image and Level Graph
2.2. Defocus Detection Event Alarm

The Defocus Detection featured on Wisenet5 SoC embedded cameras offer two alarm systems: the "Event Start" and the "Event End." When a camera loses its focus at normal condition and image starts to blur, Defocus Detection technology starts detecting the image condition. If the image is observed at above detection level for longer than the Minimum Monitoring Duration, “Event Alarm” is sent to the user. This lost focus can be fixed by the camera’s Auto Focus function or the user can manually adjust the camera focus in order to solve the problem. When the observed level falls below the detection level, “Event End” alarm is sent to end.

Once an "Event Start" alarm is sent, the system does not send another "Event Start" alarm until an "Event End" alarm is sent. If you do not see an “Event End” log after an “Event Start” log when you checked the event logs, it means the problem still continues and defocus has not been corrected yet.

2.3. Setting the Event Triggering Conditions

The operator can set Parameter Settings to define the event triggering conditions for Defocus Detection.

2.3.1. Level of Detection

An alarm is triggered when current observed level stays above the defined detection level. As you set the Detection Level lower, it gets more sensitive and detects even smaller focus change.

Images with a high amount of fine contour components have high-frequency components while simple images have less high-frequency components. Therefore, high-frequency components changes due to subject and environment to be photographed. Therefore, the Detection Level must be set by considering the margin of changes on a normal screen based on the level measured after determining the camera's installation position.
2.3.2. Sensitivity

As you set the sensitivity higher, the graph shows higher level for the same image. If the graph shows higher level above 0 (Zero) even though the current image is correctly focused, you can lower the defined sensitivity value to adjust the graph level. Likewise, if the graph shows 0 (Zero) level even if the image is out of focus, you can higher the defined sensitivity value to adjust the graph.

2.3.3. Minimum Monitoring Duration

An alarm is triggered when observed level stays higher than the defined Detection level for the “Minimum Monitoring Duration.” If the defined Minimum Monitoring Duration is short, the system can detect even short time changes at the moment and triggers an alarm quickly, but it may cause false alarm due to momentary level rise from temporary cause. Likewise, if the defined Minimum Monitoring Duration is long, it prevents from false alarm caused by momentary level rise, but it also may cause delayed alarm trigger.
3. Focus Adjustment Technology

3.1. Auto Focus and Simple Focus

There are different auto focus methods, such as PDAF (Phase Detection Auto Focus), CDAF (Contrast Detection Auto Focus), TTLAF (Through The Lens Auto Focus) and Hybrid AF. Among them, Hanwha Techwin takes CDAF and the working method is as follows;

A Camera receives lights by image sensor through the lens. When it is well focused, the edges of the subject look sharp and clear, and image signal’s high frequency component increases. It is the Contrast Detection Auto Focus that a camera finds focus by moving the Focus Lens to where contains high frequency components.

![Image of focus adjustment technology](image)

**Image 3. Example of Changes in High Frequency Components by Changes in Image's Focus**

Simple Focus is a function that Hanwha Techwin is offering to the Vari-focal lens camera users for their installation convenient. Simple Focus automatically adjust the focus based on auto focus algorithm.
3.2. Hanwha Techwin's Focus Adjustment Technology

Zoom in/out operations also cause images to become unfocused due to the physical characteristics of the lenses. For current existing camera, you had to manually adjust the focus or use simple focus feature in order to get correct angle of view. The Wisenet5 SoC embedded cameras with electric Vari-focal lens offer Fast Simple Focus, which adjusts the view angle and focus fast and easy by utilizing Focus Curve Data from the focus step information gathered from the distance information between the zoom position and distance to the subject.

Image 4. Comparison of Conventional Focus Adjustment Method and Fast Simple Focus Method
Unlike the existing method which requires for checking entire drive range of the lens to find the focal point when adjusting the zoom, Fast Simple Focus find exact focal point very quickly by scanning the expected focal range based on zoom magnification.

Together, Hanwha Techwin’s Fast Simple Focus makes you able to experience the further benefits below.

- Eliminates the repetitive process of adjusting zoom and focus to set the view angle on the installation site, making it much faster and convenient!
- Improve the accuracy and speed of Simple Focus by using Focus Step Index which utilizes information based on zoom position and distance from the subject.
- Improves focus degradation caused by vibration in the distribution process.

※ AF method can be selected in the Camera Settings menu according to user's preference.
- Manual: Focus is adjusted manually according to zoom magnification
- Auto: Focus is adjusted automatically according to zoom magnification
- Focus Adjustment: Focus adjustment is performed once after zoom operation
4. Conclusion

Having a correct focus and adjusting to maintain a sharp focus in a variety of different environments are the most basic, yet the most essential requirement for achieving clear images.

Hanwha Techwin’s Defocus Detection technology and Fast Simple Focus technology are made possible thanks to the Wisenet5 chipset, an SoC (System on Chip) developed with Hanwha Techwin’s accumulated know-how, which quickly notifies users of defocus events to allow for timely corrective measures. Furthermore, accurate and convenient focus adjustments, combined with Hanwha Techwin’s outstanding optimal engineering, WDR and low-light compensation technologies, provide clear images in various environments.