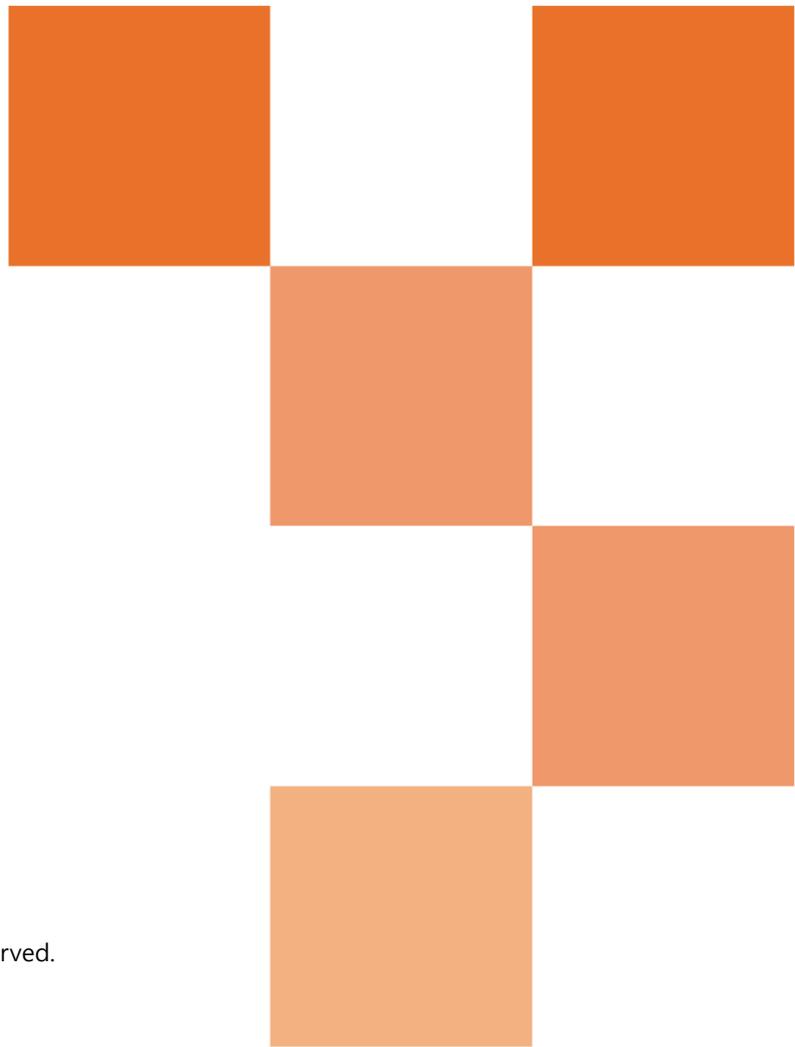


White Paper

Image Stabilization Technology

February 2026



Contents

1. Introduction
2. Background
3. Image Stabilization Technologies
 - 3.1. DIS (Digital Image Stabilization) Technology
 - 3.2. OIS (Optical Image Stabilization) Technology
4. Technology Guide for Optimal Performance
 - 4.1. DIS Operation Across Wide ↔ Tele
 - 4.2. OIS Operation Across Wide ↔ Tele
 - 4.3. Effective Operation Review
5. Conclusion



1. Introduction

This whitepaper outlines the mechanical and algorithmic principles of Digital Image Stabilization (DIS) and Optical Image Stabilization (OIS) technologies. Designed for telephoto lenses in long-range monitoring, these systems provide a multi-layered defense against image blur.

OIS performs hardware-based correction by compensating for 3D rotational motion, while DIS applies software-based correction through 2D motion or shift analysis.

When combined, these systems effectively suppress vibration across wide amplitude and frequency ranges, delivering optimized stabilization performance in diverse monitoring conditions.

Based on real-world measurement data, this document shows how the complementary nature of OIS and DIS reduces operator fatigue and enhances situational awareness in mission-critical environments such as urban and defense surveillance.

2. Background

Long-range surveillance cameras are often mounted on elevated structures such as poles or towers, where they are highly exposed to wind and structural vibration. These vantage points enable 360° coverage but also make the system prone to significant image shake.

At high zoom magnifications, even minimal vibrations translate into noticeable displacement in telephoto imagery. Historically, video surveillance systems emphasized zoom ratio or detection range as key specifications. However, modern security standards now recognize high-performance image stabilization as equally essential.

Currently, two primary stabilization architectures exist: Digital or Electronic Image Stabilization (DIS/EIS), which applies software-based frame correction but sacrifices some effective resolution; and Optical Image Stabilization (OIS), which uses mechanical lens adjustments to maintain premium image quality, albeit with higher optical complexity and cost.



3. Image Stabilization Technologies

Image stabilization technologies are generally classified into Optical (OIS) and Digital (DIS) systems. OIS provides hardware-level correction to counteract mechanical shake at the moment of image capture, while DIS applies algorithmic processing to refine geometric distortions and compensate for broader motion patterns in the captured frames.

In high-magnification surveillance, current advancements increasingly adopt a hybrid approach: OIS delivers the primary stabilization by minimizing physical motion, and DIS further enhances image quality by correcting residual distortions and rolling shutter effects

3.1. DIS (Digital Image Stabilization) Technology

Digital Image Stabilization (DIS) employs advanced algorithms to detect and correct camera shake during video capture. The industry typically distinguishes between two implementations—gyro-based and motion-analysis-based stabilization (often labeled as EIS for the former). For consistency, Hanwha Vision unifies both approaches under the DIS designation.

Through its proprietary Wisenet SoC, Hanwha Vision delivers high-performance stabilization via an integrated video analysis engine, achieving correction levels comparable to sensor-based systems without requiring a physical gyroscope. For third-party chipsets, gyro-assisted DIS ensures stable, high-quality imaging across diverse environmental conditions.

DIS operates by capturing a wider field-of-view (FOV) than the final output, using the "buffer" area to shift frames and suppress motion. While higher levels of shake increase peripheral FOV loss, DIS remains highly advantageous for wide-angle surveillance where vibration ratios are lower. Notably, DIS outperforms Optical Image Stabilization (OIS) in correcting "jelly-like" rolling shutter distortion by analyzing pixel-level data and "warping" the image to straighten bent areas. Furthermore, DIS provides smoother handling of pan/translational motion (up/down, left/right), more smoothly than OIS, despite edge cropping, making it an essential tool for long range monitoring.

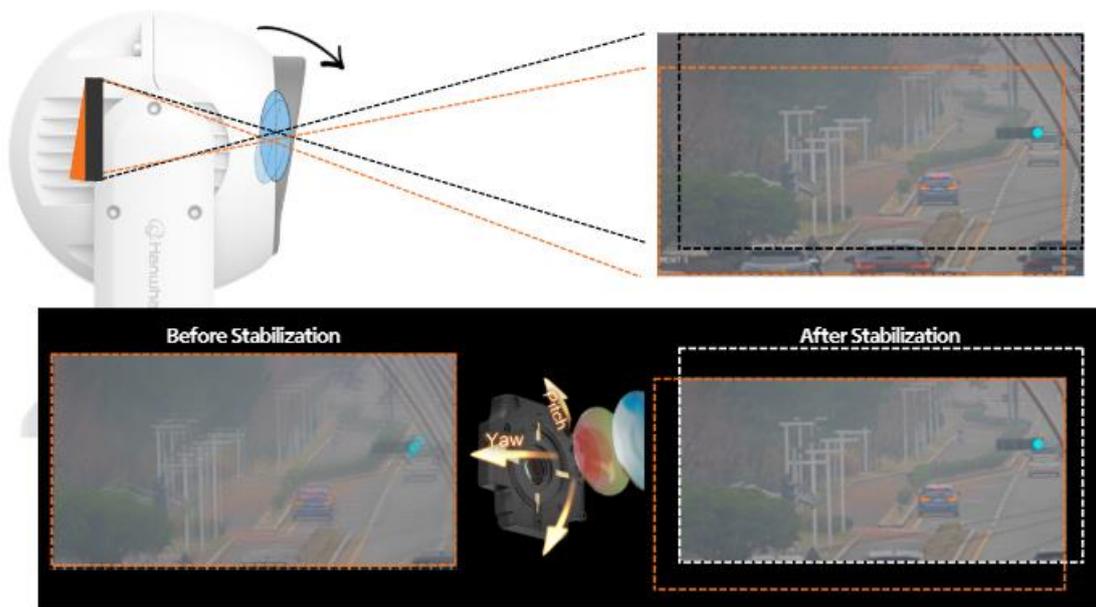


Figure 1: DIS stabilization using Gyro Sensor (peripheral cropping varies with shake intensity)

3.2. OIS (Optical Image Stabilization) Technology

Optical Image Stabilization (OIS) utilizes a hardware-based lens-shift mechanism to counteract camera movement. Within the lens module, an integrated gyroscope sensor detects both linear motion and 3D rotation across the X, Y, and Z axes. The motion data is transmitted to an OIS microcontroller (MCU), where control algorithms calculate the precise distance and direction required for optical correction.

Driven by this data, actuators shift the lens in the opposite direction of the detected vibration, effectively stabilizing the optical path before the image reaches the sensor. While some systems move the image sensor or entire optical block, lens-shift adjustment remains the most widely adopted approach due to its precision and responsiveness.

Unlike digital methods that rely on software-based frame shifting, OIS performs purely physical correction, thereby preserving full sensor resolution and avoiding the edge cropping often associated with DIS. This makes OIS particularly effective for large-amplitude vibrations where maintaining both sharpness and field of view is essential.

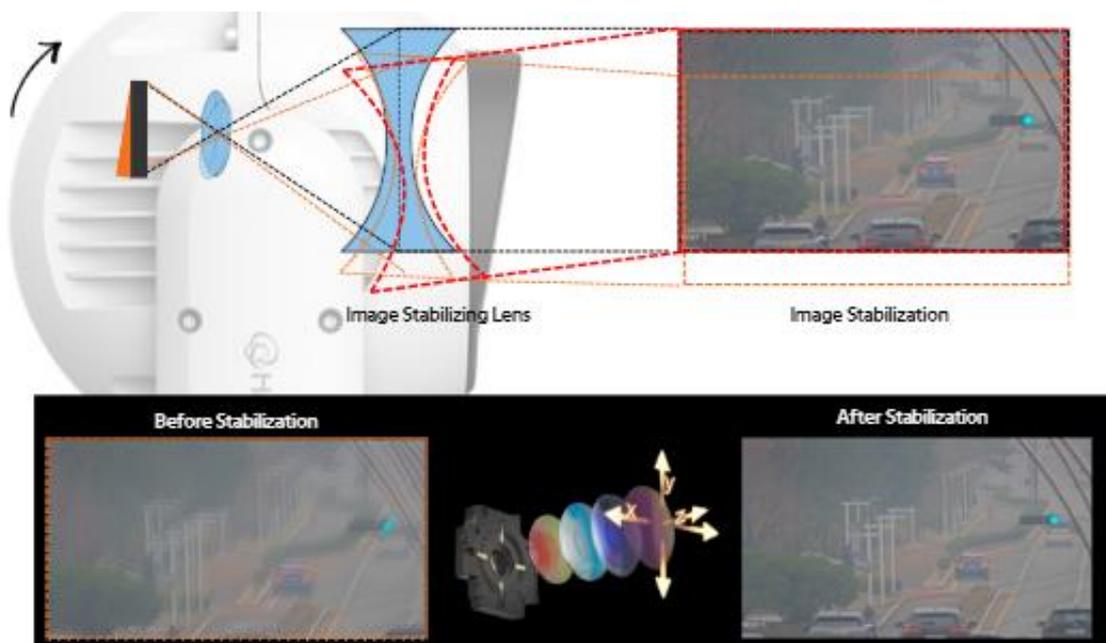


Figure 2: OIS stabilization using image stabilization lens



4. Technology Guide for Optimal Performance

The effectiveness of image stabilization is determined by the synergy between physical hardware (OIS) and algorithmic software (DIS), as well as the specific installation environment. To maximize system potential, it is vital to account for each of these variables. While OIS performance is largely defined by hardware specifications and software varies by manufacturer, the environment remains a critical factor. For example, pole-mounted CCTV systems are frequently subjected to the **Kármán Vortex Street** effect. This phenomenon occurs when wind passes a cylindrical pole, creating alternating vortices that induce consistent left-right oscillation. These environmental vibrations can be mathematically modeled as:

$$f_s = \frac{St \times V}{D}$$

- St (Strouhal number): e.g., 0.2 for cylinders
- V (wind speed (m/s)): e.g., 5 m/s for breeze
- D (pole diameter(m)):e.g., 0.1-0.2 m

At 5 m/s on a 10 cm pole, ~10 Hz shake can occur.

Beyond wind-induced forces, poles exhibit an inherent sway frequency typically ranging from 0.5 to 2 Hz. Consequently, high-mounted, long-range cameras are frequently subjected to a vibration spectrum of 1 to 10 Hz. Addressing this specific range is essential for ensuring effective image stabilization in high-magnification systems.

4.1. DIS Operation Across Wide ↔ Tele

The maximum threshold for digital correction is fundamentally limited by field-of-view (FOV) loss. In low-magnification (wide-angle) settings, the same physical vibration results in a smaller relative shake ratio, allowing for more stable and effective correction. Table 1 evaluates these performance domains using a three-tier scale: “●” for effective stabilization, “△” for partial correction, and “×” for ineffective results. The evaluation is mapped across two variables: vibration amplitude (X-axis: ±0.01 to ±0.05) and frequency (Y-axis: Hz).

While DIS provides comprehensive coverage for low and standard amplitudes in wide-angle modes, its performance degrades in telephoto settings when subjected to high-frequency or high-amplitude vibrations.

| | DIS Operation Wide Scene (Zoom 1x) | | | | | DIS Operation Mid Scene (Zoom 20x) | | | | | DIS Operation Tele Scene (Zoom 43x) | | | | |
|-----|---------------------------------------|-------|-------|-------|-------|---------------------------------------|-------|-------|-------|-------|--|-------|-------|-------|-------|
| | ±0.01 | ±0.02 | ±0.03 | ±0.04 | ±0.05 | ±0.01 | ±0.02 | ±0.03 | ±0.04 | ±0.05 | ±0.01 | ±0.02 | ±0.03 | ±0.04 | ±0.05 |
| 1Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | △ |
| 2Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | △ |
| 3Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | △ |
| 4Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | △ | △ |
| 5Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | × | × |
| 6Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | × | × |
| 7Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | ● | ● | △ | × | × |
| 8Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | △ | ● | △ | × | × | × |

Table 1: DIS performance by frequency/amplitude across wide ↔ tele scenes

4.2. OIS Operation Across Wide ↔ Tele

In contrast to the limitations of digital methods, OIS remains highly effective during high-amplitude (± 0.03 – ± 0.05) and high-frequency (3+ Hz) vibrations, regardless of the focal length (wide or telephoto). This physical correction distinguishes OIS from DIS, which suffers from significant FOV loss and resolution degradation at higher amplitudes. Specifically, the rapid response of the OIS gyroscope excels in high-zoom applications and unstable environments, such as pole-mounted installations, effectively complementing the domains where DIS reaches its technical ceiling.

| | OIS Operation Wide Scene (Zoom 1x) | | | | | OIS Operation Mid Scene (Zoom 20x) | | | | | OIS Operation Tele Scene (Zoom 43x) | | | | |
|-----|---------------------------------------|------------|------------|------------|------------|---------------------------------------|------------|------------|------------|------------|--|------------|------------|------------|------------|
| | ± 0.01 | ± 0.02 | ± 0.03 | ± 0.04 | ± 0.05 | ± 0.01 | ± 0.02 | ± 0.03 | ± 0.04 | ± 0.05 | ± 0.01 | ± 0.02 | ± 0.03 | ± 0.04 | ± 0.05 |
| 1Hz | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × |
| 2Hz | × | × | ● | ● | ● | × | × | ● | ● | ● | × | × | ● | ● | ● |
| 3Hz | × | ● | ● | ● | ● | × | ● | ● | ● | ● | × | ● | ● | ● | ● |
| 4Hz | △ | ● | ● | ● | ● | △ | ● | ● | ● | ● | △ | ● | ● | ● | ● |
| 5Hz | △ | ● | ● | ● | ● | △ | ● | ● | ● | ● | △ | ● | ● | ● | ● |
| 6Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 7Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 8Hz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

Table 2: OIS performance by frequency/amplitude across wide ↔ tele scenes

4.3. Effective Operation Review

Although evaluation criteria for DIS and OIS traditionally differ, the data presented here utilizes OIS-standard conditions to provide a unified reference. By overlaying the effective performance zones of both DIS and OIS in telephoto modes, the synergistic effect of a hybrid system becomes clear. This hybrid activation ensures comprehensive coverage across all frequency and amplitude ranges, neutralizing vibrations that would exceed the capabilities of either technology used in isolation.

DIS/OIS evaluation criteria differ; data compares under OIS-like conditions for reference only. Overlaying tele DIS/OIS effective zones (from 4.1/4.2) shows hybrid activation covers all areas.

| Stabilization Technology | | Tele Scene (Zoom 43x) | | | | |
|--------------------------|-----|-----------------------|-------|-------|-------|-------|
| | | ±0.01 | ±0.02 | ±0.03 | ±0.04 | ±0.05 |
| OIS Operation | 1Hz | × | × | × | × | × |
| DIS Operation | | ● | ● | ● | △ | △ |
| OIS Operation | 2Hz | × | × | ● | ● | ● |
| DIS Operation | | ● | ● | ● | △ | △ |
| OIS Operation | 3Hz | × | ● | ● | ● | ● |
| DIS Operation | | ● | ● | ● | △ | △ |
| OIS Operation | 4Hz | △ | ● | ● | ● | ● |
| DIS Operation | | ● | ● | △ | △ | △ |
| OIS Operation | 5Hz | △ | ● | ● | ● | ● |
| DIS Operation | | ● | ● | △ | × | × |
| OIS Operation | 6Hz | ● | ● | ● | ● | ● |
| DIS Operation | | ● | ● | △ | × | × |
| OIS Operation | 7Hz | ● | ● | ● | ● | ● |
| DIS Operation | | ● | ● | △ | × | × |
| OIS Operation | 8Hz | ● | ● | ● | ● | ● |
| DIS Operation | | ● | △ | × | × | × |

Table 3: Overlapping effective zones of DIS and OIS by frequency

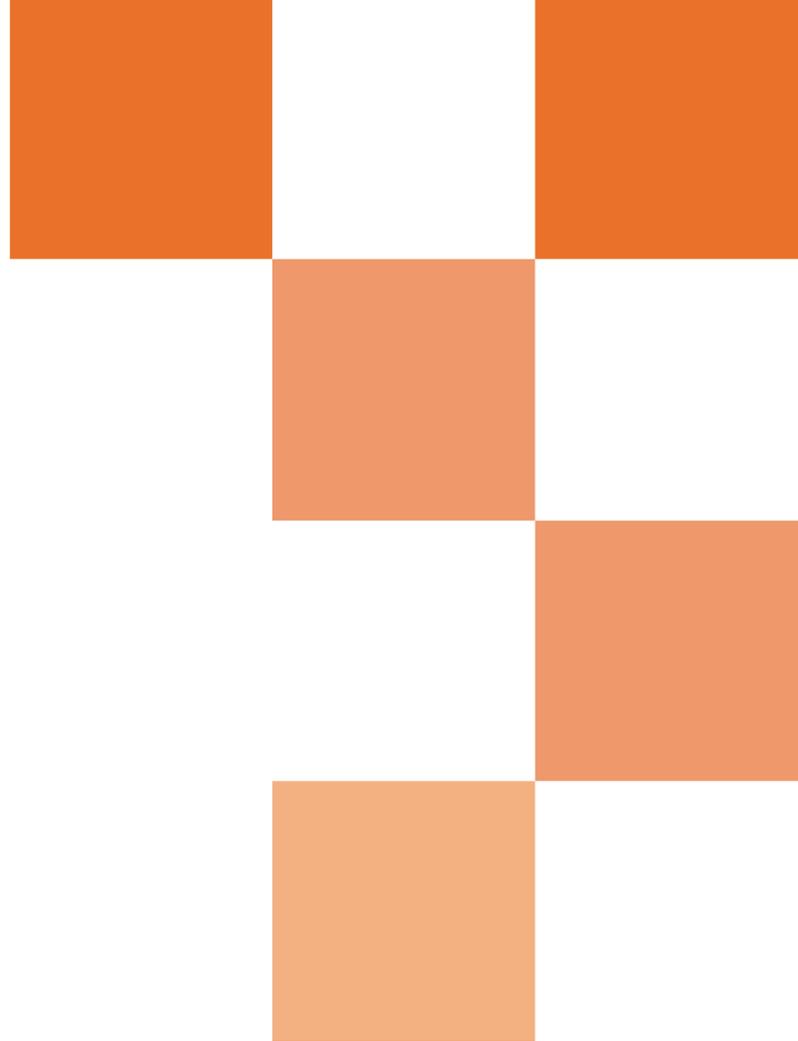


5. Conclusion

Hanwha Vision achieves peak stabilization performance through its advanced Hybrid OIS+DIS architecture. This integrated approach delivers unparalleled image stability across the entire focal range, from wide-angle to high-magnification telephoto. By addressing the full spectrum of real-world vibrations, including the 1–10 Hz oscillations typical of wind-exposed poles, Hanwha Vision ensures actionable clarity in the most demanding environments.

While standalone OIS is the premier choice for long-range defense and urban monitoring where high-frequency correction and resolution are paramount, standalone DIS offers a cost-effective solution for fixed, mid-range views where rolling shutter and geometric correction are prioritized. Ultimately, by selecting the optimal OIS/DIS configuration based on installation height, structural integrity, and FOV requirements, organizations can minimize operator fatigue and maximize situational awareness.

Hanwha Vision remains committed to pushing the boundaries of adaptive hybrid stabilization to meet the evolving needs of global security.



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