Designing a Site with Avigilon Self-Learning Video Analytics

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Introduction

Avigilon video analytics cameras and appliances are easy to install and can achieve positive analytics results without ongoing software adjustments. Avigilon's patented video analytics is designed to automatically adjust to the camera's field of view without configuration or adjustment.

There are two modes of video analytics:

- **Classified Object** mode detects and classifies objects such as a person or a vehicle. You can set up rules and alarms based on this detection in the Avigilon Control Center (ACC) software or the Avigilon Blue™ cloud platform.
- **Unusual Motion** mode detects motion and compares the speed, direction, and location of movement with what is typical for a scene. It displays anomalies so you can review recorded video that might not otherwise be seen. This feature is only available on ACC™ software version 6.8 or later.

For video analytics to perform effectively, the analytics cameras (or cameras connected to an Avigilon Artificial Intelligence (AI) Appliance or an ACC ES Analytics Appliance) must be installed correctly. Not all devices support each analytics mode. For more information, see your device's datasheet.

Video analytics enabled cameras must be installed:

- Within the height and angle guidelines.
- Within sight of the area of interest.
- Where there is sufficient light in the area of interest.
- Where there is sufficient contrast to detect foreground motion.
  For example, a person walking in white clothes in a snow-covered field of view may provide poor results.

The installation guidelines for Classified Object mode are more strict than the guidelines for Unusual Motion mode. If you think that you may want to switch between these two modes, follow the Classified Object guidelines. Cameras installed according to the guidelines for Classified Object mode will also work for Unusual Motion mode.

The following information provides a basic set of installation parameters. Read through the entire document before installing cameras.

For site configurations that differ from the listed recommendations, or when in doubt, consult an Avigilon representative before installing the cameras.

Designing for Classified Object Detection

Design your site with the following guidelines to use video analytics in Classified Object mode.

General Guidelines

In general, cameras should be installed according to the following guidelines to achieve optimal analytics performance.

Mounting Height and Angle
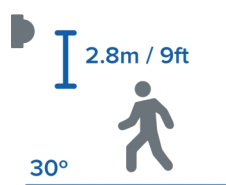
- Cameras should be mounted at a minimum of 2.8 meters (9 feet) level to the horizon and ground plane (for outdoor or large indoor areas).
- Cameras can be tilted within 30° from the horizontal for optimal object classification.
  - Increasing the tilt angle can help in detecting targets that are directly approaching the camera.
  - The camera should be tilted no more than 45° from the horizontal.
- Cameras should be mounted to a stable surface to minimize vibration and movement.
- Select a lens, mounting height and tilt angle to capture the required level of detail for Classified Object detection within the scene.
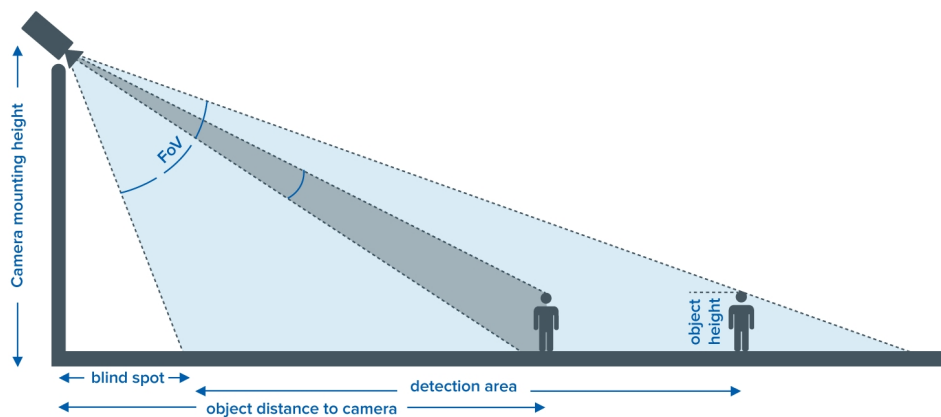
Field of View
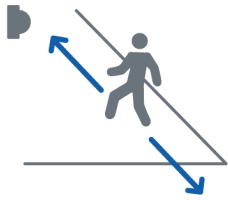
- Camera field of view must be level with the horizon.
- People in the field of view should be walking upright.
- People and cars moving parallel to the field of view provide better results than objects moving to or from the camera.

Object Speed

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- H5A cameras are designed to detect stationary and moving objects immediately.
- H4A and H3A cameras are designed to detect moving objects that are in the field of view for at least 2 seconds. However, 5 seconds is recommended.
  - Objects that enter the field of view from behind the camera may take up to 4 seconds to be classified.
  - If fast, lateral-moving vehicles are expected, use a wider field of view to increase the available observation time.

Analytics Location Mode

In the ACC Client software, set the camera to use the Location mode that best describes the scene:

- **Outdoor** — suitable for most outdoor environments. This setting optimizes the camera to identify vehicles and people.
- **Large Indoor Area** — only detects people and is optimized to detect people around obstructions, like chairs and desks, if the head and torso are visible.
- **Indoor Overhead*** — optimized for cameras mounted directly overhead and should only be used when a torso cannot be seen in the camera field of view. Any movement is assumed to be human. Use in areas with limited space but with high ceilings, or to monitor doors. Do not use with the Avigilon Appearance Search feature, Face Recognition, the Self-Learning feature, or to detect people traveling against the crowd.
- **Outdoor High Sensitivity*** — optimized to run with higher sensitivity for detecting people and vehicles in challenging outdoor scenes. This option may generate more false positives. Only use this option if you require the system to be more sensitive than the Outdoor setting.
- **Long Range Night*** — prioritizes outdoor long-range object detection at night over object classification and tracking during the day. Uses external IR illumination rather than built-in IR illumination from the camera. Object classification and tracking accuracy during the day is reduced compared to other outdoor modes. Available for H4A cameras only.

  * These modes are not available for H5A cameras.

Reflected Light
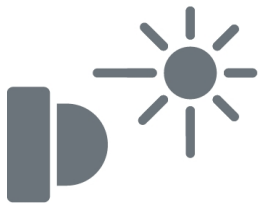
- Avoid direct light sources.
    - The camera may be temporarily blinded if bright light sources shine directly at the camera.
- Position the camera so that the sun, headlights, or other light sources do not shine directly into the lens.
- Avoid installing the camera in areas with drastic changes in lighting throughout the day. For example, avoid installing the camera in an indoor space with direct sunlight through a skylight or large windows.
    - Significant changes in lighting cause large shadows and different coloring in the space. Such changes may generate inconsistent detection results.
- Be conscious of indirect light sources, including reflections from built-in or external IR illuminators, to avoid lens flares and loss of contrast in the image.
    - Cameras with wide dynamic range (WDR) may be able to overcome this issue in some instances.
- Avoid mirrors and other reflective surfaces (like shiny floors and ceilings). Reflections may cause additional false detections.

Headlights

Headlights can pose a challenge to video analytics, combining low-light conditions with extreme differences in lighting.

Headlights can interfere with video analytics when:

- The light shines directly into the camera.
- The surrounding environment is too dark.
- The light reflects on wet, snowy, or icy roads.
    - This happens mainly at night, but can also occur during the day when headlights are reflected into the camera from wet pavement.
- The light is reflected back at the camera from an enclosed environment, such as a tunnel.

Camera positioning and testing prior to installation are important to minimize reflected light.

- Position the camera so objects are viewed from the side and not from the front.
- Use thermal cameras instead of visible cameras. Thermal cameras are less likely to be affected by stray headlights and reflected light.
- Add additional illumination (IR or white light) to help balance extreme lighting contrasts.

Contact your Avigilon representative for advice on installing cameras when headlights are present in the field of view.

Adaptive IR

Adaptive infrared (IR) functions by adjusting the IR output dynamically to prevent oversaturation in the scene as the light changes throughout the night.

- Cameras using only built-in IR for illumination at night detect targets at a much shorter distance. Additional illumination is required to consistently detect targets.
- Be aware that IR may also blur the outline of objects and negatively impact the accuracy of the video analytics.
    - You can disable adaptive IR to help improve Classified Object detection in the scene.

Lux on Target
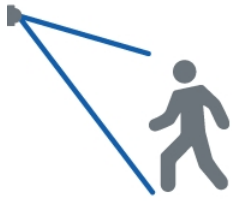
- The recommended minimum illumination is 8 lux on target for analytic cameras.
- For non-analytic, third-party cameras that are connected to the Avigilon video analytics appliance, the minimum illumination requirement varies from camera to camera.
  - Generally, more light is required if the third-party camera does not have an infrared cut filter or a monochromatic night mode.
- For illuminating distances, it is important to account for lighting, weather, contrast and camera stability conditions.
  - In bad weather with low visibility, analytics should be combined with other detection methods to ensure a secure system.

Contact your Avigilon representative for advice on installations in challenging lighting situations.

Obstructions

To identify objects accurately, the scene must be clear.

- For outdoor applications, avoid placing a camera where the field of view includes foliage, terrain or large objects that occlude the subjects of interest.
  - Also pay attention to obstructions that can reflect infrared (IR) illumination back to the camera and cause reduced contrast or overexposed video at night. This can be corrected by any of the following:
    - Separating the IR illuminators.
    - Adjusting the camera placement.
   - Correcting the aim of the IR illuminators or the camera.

- For indoor applications, a person may be detected as long as their upper body, including head and shoulders, is visible.
  - It is recommended that a person be fully visible for the Avigilon Appearance Search feature to provide better matching search results.

  For more information, see *Analytics Location Mode* on page 3.
- For H4A and H3A cameras, avoid using analytics in crowded areas where people are likely to overlap and block each other from the field of view.

  H5A cameras will be able to detect more objects in a crowd, however overlapping objects in the scene may cause the system to miss potential results.

Coverage Area
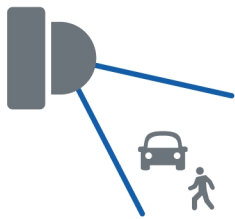
- For H4A and H3A cameras, install the camera in a location where each object appears in the field of view for at least 2 seconds. H5A cameras are designed to detect objects within fractions of a second.
  - If an analytic rule or alarm uses a region of interest (ROI) or beam crossing to trigger an event, make sure objects are detected in the camera field of view for at least 2 seconds before entering the ROI or crossing a beam.
- For advanced users, use the following pixel on target recommendations:
  - 24 to 36 pixels per meter (8 to 11 pixels per foot) based on 2.0 MP resolution.
  - Maximum target size = 2/3 height of the field of view.
  - For the Avigilon Appearance Search feature:
    - 72 pixels per meter (22 pixels per foot) based on 2.0 MP resolution.

Use the Avigilon System Design Tool to help you estimate the required coverage area. The System Design Tool is designed to incorporate Avigilon analytic needs and determines the camera's maximum video analytics detection area in a given scene. To access the System Design Tool, go to **https://sdt.avigilon.com**.

Outdoor Areas

Be careful not to select a coverage area that is too large, as objects may become obscured by rain or fog even when there is enough lighting and contrast.

Indoor Areas

Make sure the indoor coverage area is not too small. Low ceilings or confined spaces (such as a man-trap area between secured doors) may pose problems with establishing a scene that fits the recommended criteria.

- field of view should be at least 9 m (30 ft) wide, even if the region of interest is much smaller.

Outdoor Camera Placement

- Make sure the camera field of view overlaps to ensure adequate coverage in the blind spot immediately below a camera.
- Mount cameras on a central building or structure looking out towards the perimeter.
- Exceptions:
    - Mount cameras on the perimeter if covering exceptionally large areas.
    - Do not mount on the central building if there is no suitable mounting location, or if there are obstructions in important areas of the field of view.

Self-Learning

Avigilon cameras can use Self-Learning and Teach by Example algorithms to reduce false detection and alarm rates.

Self-Learning is enabled by default in the ACC system. It allows cameras or appliances to actively learn when there is movement in the scene.

The learning progress requires approximately 200 high-confidence detections throughout the entire field of view. The time needed to complete the learning progress varies from scene to scene, depending on the activity in the scene. The algorithm does not learn if the scene is empty or has low illumination.

In some cases, the Self-Learning Progress Bar may not reach 100%. There may be more false detections, but true detections will not be affected.

Enable Self-Learning for all video analytics devices, except if:

- People or vehicles are not expected in the device's field of view.
- Objects move at different heights. For example, overhead pedestrian bridges, train platforms, hills and underpasses.
- The device is in Indoor Overhead mode. Self-learning is not used, even if enabled. All detected objects are classified as people. The Progress Bar will display 100% and cannot be reset.

To disable Self-Learning, see the *Avigilon Control Center Client User Guide*.

Teach By Example

Teach by Example is a feature that allows users to provide feedback by validating the accuracy of classifications done by the system.

Teach by Example is not required, but is recommended if the system reports a high number of false alarms after Self-Learning is complete or disabled.

If you disable Self-Learning after performing a Teach by Example exercise, conduct a new Teach by Example exercise to account for classified object results that were previously filtered by the Self-Learning algorithm.

Resetting the Learning Progress

Always reset Self-Learning and Teach by Example after a camera is physically moved or adjusted, and if the focus or zoom level is changed. The change in the camera's field of view affects the video analytic results.

Reset the Self-Learning progress once the camera is stable after initial configuration. During installation, a camera is frequently adjusted, so any Self-Learning during that time becomes invalid.

If there are lighting changes in a scene, or an IR installation, you do not need to restore the Teach By Example settings. You can add more true and false examples with the new lighting to improve results. However, you should reset The Self-Learning progress if there are lighting changes.

You can reset Self-Learning and Teach by Example from the ACC Client software. For more information, see the *Avigilon Control Center Client User Guide*.

Designing for the Avigilon Appearance Search™ Feature

With the ACC software's Avigilon Appearance Search feature, operators can find all recorded instances of a person or vehicle across their site.

The following devices do not currently support the Avigilon Appearance Search feature:

- ACC ES Analytics Appliances
- ACC ES Analytics Cameras
- Thermal cameras
- Cameras with wide-angle or fisheye/panoramic lenses

To use the Avigilon Appearance Search feature, the system must be running ACC Enterprise edition software version 6.0 or later, with one of the following:

a. A network video recorder (NVR) with a graphics processing unit for use with cameras that support the Avigilon Appearance Search feature.

b. An NVR connected to an Avigilon AI Appliance for use with cameras without Classified Object video analytics.

For optimal performance, the camera needs to capture full-body and face images.

- Position the camera to collect predominantly front-facing images that use the following number of pixels on the target object:
    - **Minimum** — 236 pixels per meter (72 pixels per foot) based on 2.0 MP resolution. This translates to approximately 40 pixels on the width of a face.
    - **Recommended** — 394 pixels per meter (120 pixels per foot) based on 2.0 MP resolution. This translates to approximately 65 pixels on the width of a face.
- If the camera cannot capture good face images, the search is performed on full-body images only.
- Avoid having mirrors and other reflective surfaces like shiny floors and ceilings in the field of view. Reflections may cause additional false detections.
- Only enable the Avigilon Appearance Search feature on cameras using Outdoor or Large Indoor Area location mode.

For more information about the ACC software and Avigilon Appearance Search system requirements, see the ACC software datasheet or the *Avigilon Control Center Client User Guide*.

Camera Placement

- Focus the field of view of the camera to important junction points. This is especially important when using Avigilon Appearance Search technology because it helps investigators understand where people travel over time. Some important junction points include:
    - Entrances and exits
    - Hallway junction points
- To help enhance Avigilon Appearance Search results, position some cameras close to eye level to detect front-profile face images for face analytics.
    - For optimal results, tilt the camera 10-15 degrees from the horizontal.
    - Do not tilt the camera more than 25 degrees from the horizontal.
- Avoid busy environments where images of people often overlap.
    - It is difficult for the camera to clearly distinguish different objects in the scene if it is too busy.
    - For busy environments, you can use several cameras to focus on each junction or exit so that you can use the Avigilon Appearance Search feature to plot the general movement of people of interest. Use non-analytics cameras for situational awareness.

Video Intercom Placement

- In general, for the Avigilon Appearance Search technology to detect a person's face in most situations, install the Avigilon Video Intercom at a height approximately 1.4 meters (4.5 feet) from the top of the camera to the ground. Follow your local accessibility guidelines for intercom placement.
- Operators can search for a person detected by the Video Intercom across the site using Avigilon Appearance Search technology. To detect a person's face:
    - The person must be close enough to touch the Video Intercom button.
        - The scene width is approximately 1.5 meters (5 feet). People in the periphery will not be detected.
    - The person must be looking directly at the camera.
    - The face must be close to the center of the camera's field of view.

> **Note:** Classified Object events are not available for this camera and cannot be used to trigger ACC rules.

Face Recognition

ACC software version 7.4 or later supports Face Recognition. Face Recognition requires an additional license, and can only be enabled on cameras that are already enabled with the Avigilon Appearance Search feature.

Face Recognition also requires an NVR with the ACC Analytics Service and one of the following:

- The NVR Analytics Kit (HD-NVR-ANK2-1).
- An NVIDIA GPU that meets the following requirements:
  - 4 GB RAM
  - NVIDIA Pascal™ GPU architecture or NVIDIA Quadro P1000 video card
  - CUDA compute capability 6.1
  - Windows x86_64 Driver Version 418.39

Optimal Face Recognition depends on cameras capturing a good image of a face and matching it to a high-quality profile image or enrollment image on the Face Watch List.

- For best results, position the camera to capture front-facing images of people. Both the eyes and nose of a person should be visible, not looking down.
- Ensure there is sufficient lighting to capture facial features.
- A minimum of 60 pixels on the width of a face is required, although 120 pixels is recommended.
- A good watch list profile image should:
  - Follow the recommendations above, but use at least 90 pixels on the width of the face.
  - Include the person's shoulders and some distance above top of head.

Designing for Unusual Motion Detection

The Unusual Motion algorithm continuously learns and adapts to the camera's field of view and flags unusual motion, which can be reviewed in recorded video.

Design your site with the following guidelines to optimize the video analytics in Unusual Motion mode.

> **Note:**
> - If you plan to switch between different video analytics modes, follow the installation guidelines for Classified Object mode as those settings will likely work for Unusual Motion mode as well.
> - Avigilon video analytics appliances, ACC ES Analytics Cameras, and thermal cameras do not currently support the Avigilon Unusual Motion detection feature.

Coverage Area
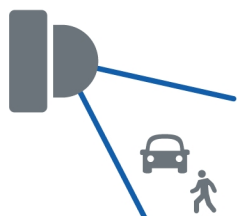
- Select a mounting height and tilt angle to capture the desired level of detail for the motion in the scene. The camera does not need to be level with the horizon.
    - Position the camera so that it can observe the speed and direction of motion in the scene.
        - To detect unusual motion from fast-moving objects such as vehicles, use a wider field of view to ensure the object is in the camera's field of view for at least a few seconds.

            For example, a downward-facing camera installed at 7 feet may not detect unusual motion from a fast-moving bicycle because the bicycle may only be in the field of view for approximately one second.
    - Position the camera so that the height of the objects in the field of view are generally less than 20% of the height of the field of view.
        - Rare and infrequent motion that is up to 66% of the field of view can be tolerated, but very large frequent objects may cause undesired motion learning.
- For advanced users, use the following pixel on target recommendations:
    - 16 to 32 pixels per meter (5 to 10 pixels per foot) based on 2.0 MP resolution.
    - Maximum target size = 2/3 height of the field of view.

Lighting

Fast lighting changes can generate Unusual Motion events.

- Constant, consistent lighting will result in better results.
- Avoid headlights and reflections.

Expected Results

Unusual Motion mode only detects motion in the field of view, and do not differentiate between objects. For example:

- Although a vehicle driving on a busy sidewalk is unusual, the event may not be flagged as unusual because motion is typically seen on the sidewalk in the field of view.
- Infrequent, tall vehicles like trucks or buses may be flagged as unusual motion events because motion is typical in the field of view where cars appear, but not where taller vehicles appear.

For More Information

If after reading this document you discover that your site requirements deviate from the recommendations in this document, consult an Avigilon representative before installing the cameras. We may not be able to help you troubleshoot potential issues with Classified Object or Unusual Motion detection if you do not follow our recommendations or seek assistance before installing cameras.

To contact an Avigilon representative in your area, see: **avigilon.com/contact-us**.

For more information about configuring Self-Learning, Teach by Example and other video analytics features that are available in the ACC software, see *Avigilon Control Center Client User Guide*.