

GSS VIDEO TRACKER USER GUIDE

TARGET TRACKING BEST PRACTICES

TRACK BOX SIZING

- It is important to configure the system for the type of tracking that fits the conditions starting with setting the size of the track box. The track box encompasses the area within the frame that the tracker is constantly attempting to track. This is only relevant to the Vehicle, Stationary, No Registration and Drone tracking modes.
- The optimal size of the box should encompass the entire object being tracked. A slight (~10%) region around the object is optimal to provide a good foreground/background difference.
- Users should focus on including features with high contrast within the track box. These include corners (for example windows in a car) or other edges. In certain situations, this may not be possible.
- Once a track has been initiated and the tracker is following the target, it is possible to nudge the track box to get better coverage of the entire target. It is also possible to resize the existing target. The tracker uses the existing target position and re-trains a model on the new adjusted location and size.
- Nudging and resizing the target is preferable to re-designating the target due to latency (user input) and pixel coordinates being received by the hardware. When nudging or resizing, ensure the object being tracked is completely visible to avoid retraining the model on something else.
- Processing at a constant frame rate is important for tracking performance. The display processing load can be reduced by:
 - setting a display frame step or capture frame step (see EAN-Performance-and-Latency)
 - turning off enhancement
 - choosing a faster encoder (MPEG4 for 1500-OEM board) and smaller output frame size
 - reducing registration search space (set Maximum Zoom to 0 and if there is no rotation, set Maximum Rotation to 0)

TRACKING MODES

- **Vehicle:** Used for tracking any type of moving object. The camera may be stationary or moving in this instance.
- **Stationary:** Used for tracking a fixed object such as a house. The camera may be stationary or moving in this instance. If the object is sometimes stationary and sometimes moving, use Vehicle or Drone mode.
- **Scene:** Also known as Scene Tracking. Keeps the entire scene in the frame. The camera platform is moving, and no single object is selected to track. Although it is a mode exposed by the tracker, it can also be implemented by using the scene translation results directly. SightLine recommends using the scene translation results directly for a more tightly integrated solution (see FAQ below for details).
- **No Registration:** Used to track moving or non-moving objects when it is difficult to accurately estimate frame-to-frame registration. For example, when attempting to track an airplane against a blue sky.

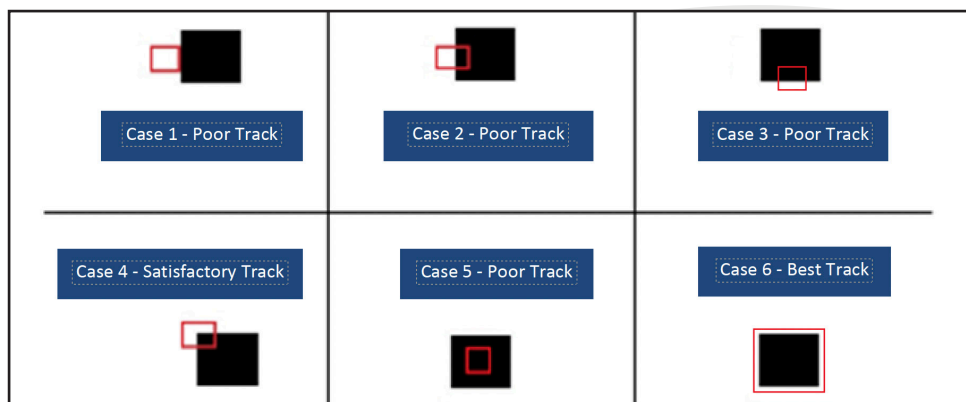
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TRACKING MODES (CONTINUED)

- **Static:** Not an object tracking mode. It is used to specify specific camera coordinates for temperature data reporting, for more details see the EAN-Infrared Temperature.
- **Drone:** Optimized for fast and inconsistently moving objects such as quad copters. It can handle objects that quickly change in size and appearance. Designed to work either as part of a ground based or aerial system.
- **Person:** Optimized for tracking slow and inconsistently moving objects such as people. It is better at handling quick changes in appearance as a person rotates, bends, etc. Designed to work either as part of a ground-based or aerial system. The default overlay for Person mode is a different color to help indicate the mode it is in. Use the Set Overlay Mode (0x06) message to adjust the reticle color.

TRACK BOX SELECTION

The diagram below shows six examples of attempts to initialize a track. In all cases, the object being tracked is represented by the dark rectangle. The tracking box is depicted in red.



Case 1: The tracking was not initialized on the object. The tracker stays on the edge of the object. If there are other good features in the background, the tracker may follow them instead of the tracked object. This often happens when there is a delay in the communication to the tracker or latency in the video because the object moves from the time the user sees it on the display to the time the track command reaches the tracker.

Case 2 and Case 3: A slightly better initialization of track. Notice that the only feature to track is a single edge. The tracker will likely drift up and down (or left and right) along that edge resulting in an erratic track.

Case 4: Better than Case 2 and 3. There are two edges (a corner) for the tracker to follow. Tracking should be good if the background has no stronger features.

Case 5: Since there are no visible features for the tracker to work with. The tracker will either fail to initialize altogether, or it will drift to an edge or corner of the rectangle.

Case 6: Optimally, the tracking box is sized to encompass the entire object that is being tracked. This gives the tracker the most features to work with, and a minimum number of features from the background.

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VEHICLE TRACK MODE EXAMPLES (REAL-WORLD EXAMPLES PROVIDED BY SIGHTLINE)



EXAMPLE 1: TRACKING BOX TOO SMALL

In this example the car is not fully enclosed by the tracking box, but there are still good features with high contrast. This is not optimal but still works well.



EXAMPLE 2: TRACKING BOX TOO LARGE

In this example the tracking box is too large and encompasses more than the vehicle, but the tracking area contains enough good features and still tracks well.



EXAMPLE 3: TRACKING BOX OPTIMAL

In this example the tracking box is sized for optimal tracking performance. It includes the object and a small amount of background features allowing the track to persist through occlusions and background changes.

PERSON TRACK MODE EXAMPLES

Many of the principles of track box selection for Vehicle Mode apply for Person Track Mode. However, when tracking people, there are additional considerations.

FIGURE 1 shows a square track box. The square track box includes too much background and is more likely to fail over time. This example will track well for a few minutes then slide off the person.

FIGURE 2 shows a track box sized for optimal performance with minimal background. It is placed on the upper half off the body with a rectangular shape. This track works well through background changes, quick changes in velocity, and if the person bends over and stands up.

FIGURE 1

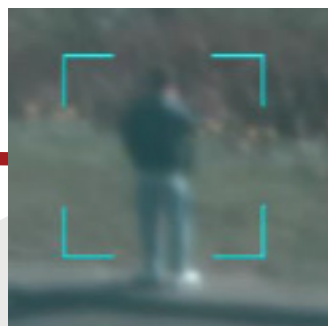


FIGURE 2



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ACQUISITION ASSIST

Acquisition Assist is designed to help users select an optimal size and location for track boxes. When this mode is enabled through the Set Tracking Parameters (0x0C) message, an algorithm runs on track-start that will search an area around the initial track location for the optimal track box size and location. The size of the search region is based on the track box size setting, so it is still important to set the size and location. This algorithm is designed to be set close and still get good tracking results.

Tracking moving objects from a moving platform creates challenging issues. Over time, the optimal track box at initialization may not last. To resolve this, manually re-designate the track, nudge the track, or adjust the track size. Another option is to use Modify Track Index (0x17) message and send the Reinitialize Command. This will rerun the acquisition assist logic. If successful, it will replace the current track box with the new optimal track box. Another option is to use intelligent assist to automatically readjust under certain conditions.



ACQUISITION ASSIST ON

In this example the track box is centered on the car and contains enough background for optimal tracking.



ACQUISITION ASSIST OFF

In this example the track box is centered but contains too much background content and will not track as well as the example with acquisition assist on.

RESIZING WITH ACQUISITION ASSIST

There are cases when running acquisition assist will not result in an optimal track box size. Once you are tracking if you send the Set Tracking Parameters (0x0C) message to adjust the size this will result in acquisition assist logic running again and you may still not end up with an optimal track box size. Alternatively, once a track is started use the Modify Track Index (0x17) message with flags 8 or 9 to adjust the track size with or without re-running acquisition assist. A common use case is to start the track with acquisition assist enabled to get a good initial estimate and then adjust with the Modify Track Index (0x17) message without acquisition assist to get an optimal track box.

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INTELLIGENT ASSIST

Intelligent Assist is designed to automatically reinitialize targets when changes are detected in the target appearance. These changes are currently limited to turning objects in vehicle mode and changing sizes in drone mode. This will be expanded to cover other cases in the future.

Enabling this mode is designed to be low-risk. Instead of swapping out the old track for the new one, it migrates to the new track over time. Intelligent assist requires acquisition assist to be enabled since it uses the acquisition assist algorithm to estimate the new optimal track box size and position.

REINITIALIZE PRIMARY

If acquisition assist does not provide the optimal track box size, reinitializing the track is a low-risk way to update the track box size. Sending the reinitialize command as part of the Modify Track Index (0x17) message causes the acquisition assist logic to run again. A new track will start in the background. If there is high confidence that this track is better than the original, it will replace the original after ~1 second.

It is important to note that acquisition assist has limits and will not find an optimal track box size much different from the current size. In this case, adjusting the track box size is the best option. Adjusting the track box with acquisition assist enabled causes acquisition assist to run instantaneously instead of in the background.

DETECTION TRACK CUEING

Starting a track on a moving target can be difficult. Using any of the detection modes outlined in EAN-Detection-Modes can make this easier. Vehicle and Drone MTI modes were specifically designed to aid in starting tracks on moving objects, however the following logic could be used for any of the other modes as well. The following sections outline a couple of different ways to transition a detection to a primary track.

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TRACKING THROUGH OCCLUSIONS

The ability to track through occlusions is a key feature of the tracker but there are a couple of things that can be done at a system level to improve performance.

Coasting State

It is important to understand when the tracker is in a coasting state. Look for the high bit of the track confidence to be set in the telemetry messages to indicate that the tracker is coasting. Using hard coded values is not enough since the confidence used internally may vary by algorithm.

Nudging / Resizing During Coast

While coasting it is important not to adjust the track box size. Adjusting the tracker box during coasting may cause the track to be lost because the tracker will refocus on the object that is occluding the target causing the track to be lost.

Nudging during a coast will adjust the estimated target position but will not cause the tracker to re-train. If the tracker velocity estimate is off by a small trace and the track box is drifting from the target during a long occlusion, this can be a useful way to correct these errors. To do this it may be required to use larger nudge values than you may typically use during active tracking.

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APPENDIX 1

CRITERIA	EXPECTED PERFORMANCE
Minimum Target Size (Pixel)	2x2 pixels - Robust tracking at 10x10 pixels
Minimum Target Contrast with respect to background	1% (tested in a simulated environment)
Frame Rate / Telemetry Output Rate	Typically used at 30 Hz. 60 Hz possible on 4000-OEM and 3000 OEM at some frame rates
Tracking Gate Position Modes	Manually movable over the entire FOV. Automatically moveable while tracking a target within the FOV.
Handling of Lost Track	During obscuration, maximum coasting during hidden target is 8.5 seconds. In real world example, 4-5 seconds is typical.
Tracking Accuracy	The center of the track box is reported with Subpixel resolution.
Minimum size of the Tracker Window	Minimum track box size (not target size) is 4x4 pixels. Using intelligent assist mode, the tracker window automatically changes size to maintain an optimal ratio with respect to the changing target size. See the Intelligent Assist section for more information.
Maximum size of the Tracker Window	500 x 500 pixels
Maximum Tracking Velocity	Set by registration change maximums. $\frac{1}{4}$ frame-per-frame is a safe estimate of max velocity. Once tracking is started and you are slewing the gimbal, the frame-to-frame shift in pixel space is typically much smaller since the system is working to keep the camera centered on the tracked object.
Maximum Acceleration	20 pixels/frame for vehicle mode 40 pixels/frame for drone mode