Target Tracking Guide

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Purpose

This document will provide some guidelines regarding the different parameters to set for optimal target tracking and scene tracking performance, as well as a list of commands used for tracking.

For tracking what works best in one case may not be ideal in another. This document provides some high level recommendations, but the best way to learn what works for a specific scenario is through experimentation.

If you encounter cases where the tracker is not tracking effectively, SightLine Applications would greatly appreciate a copy of the original video (ideally without stabilization or overlays whenever possible) for us to review and use to improve our tracking algorithms.

Best Practices Target Tracking

First of all, configure the system for the type of tracking you are performing. In SLA-PANEL-PLUS, you can set one of five modes: Vehicle, Stationary, Scene, Static, and No Registration. These modes are explained in more detail below.

The second most important configuration to set is the size of the "track box"; the area within the frame that the tracker constantly tries to keep track of. This is only relevant to the **Vehicle, Stationary, and No Registration** modes. The optimal size of the box is one which results in encompassing the entire object being tracked, with a slight (~10%) region around the object to provide good foreground/background difference. This is sometimes not entirely possible, so the user should focus on including features with high contrast within the track box. These include corners (for example windows in a car) or other edges.

Once a track has been initiated, and the tracker is following the target, it is possible to "nudge" the track box slightly up, down, left, or right to get better coverage of the entire target. It is also possible to re-size the existing target. The software uses the existing target position and retrains a model on the new adjusted location and size. Nudging and re-sizing the target is preferable to "re-designating" the target of interest due to latency between a user click and the pixel coordinates being received by the hardware. When nudging or resizing ensure the object being tracked is completely visible to avoid re-training the model on something else.

Processing at a constant frame rate is also important for tracking performance. The display processing load can be reduced by setting a display frame step, turning off enhancement, choosing a faster encoder (MPEG4 for 1500) and smaller output frame size (1500), and setting the Prioritize Telemetry option. Panel+ Menu → Display → Show Performance Graph shows the time used by the processing steps.

Tracking Modes

To understand how to set the tracking parameters, it is first important to understand what it is that we are tracking. The five tracking modes we support are:

A) **Vehicle Mode:** Used for tracking any moving object be it a person or a vehicle. The camera may or may not be stationary in this instance:

B) **Stationary Mode:** Used for tracking any fixed object such as a house. Again, the camera may be stationary or moving in this instance.

C) **Scene Mode**: Another type of tracking that is more broad in the sense that while the camera platform is moving, there is no single object that we are tracking, but rather we are interested in keeping the entire scene in our frame. This is known as scene tracking and although it is a mode exposed by the tracker it can also be implemented by using the scene translation results directly. Using scene translation results directly is the recommended implementation.

D) **No Registration Mode**: Used to track moving or non-moving objects when it is difficult to accurately estimate frame-to-frame registration, for example when trying to track an airplane against a blue sky. This mode should only be used as needed as it can lead to additional track failures in cluttered environments.

E) **Static Mode**: This isn't really an object tracking mode, it is used for temperature data reporting, for more details see the EAN on Infrared Temperature.

F) Drone Mode (New in 2.24): This mode is optimized for fast and inconsistently moving objects such as a quad copter. This mode is designed to work either as part of a ground based or aerial system. This mode is also designed to better handle objects that quickly change size and appearance.

Track Box Selection

As stated above track box size and location is important. In the diagram below, there are four examples of attempts to initialize a track. In all cases, the object the user is trying to track is the dark rectangle, and the tracking box is depicted in red.

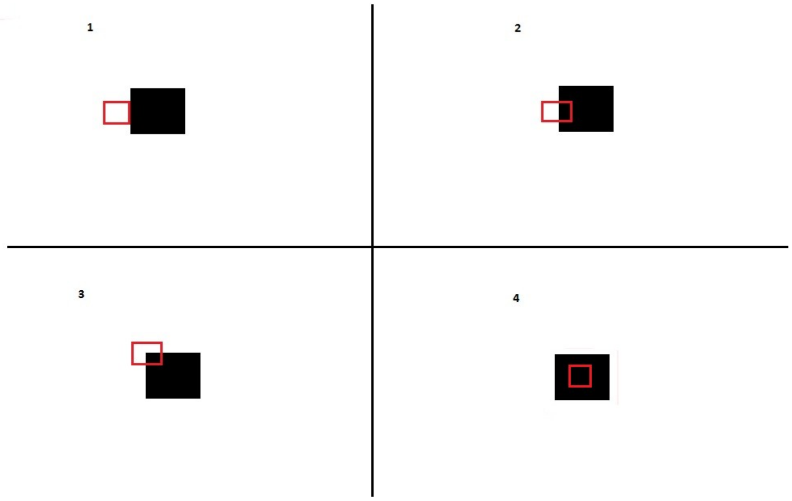


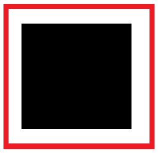
Illustration 1: Designating targets example

Case 1 (top left) the tracking was initialized off of the object to be tracked. The tracker might just cling to the edge of the object, but if there are other good features in the background, the tracking would be on those features, rather then the required object. This often happens when there is a delay in the communication to the tracker, or latency in the video, which results in the object moving just enough from when the user sees it on the display to the time the track command reaches the tracker.

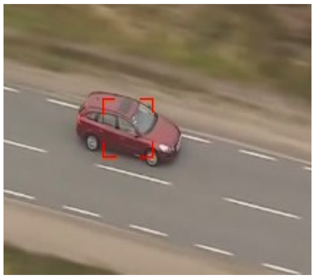
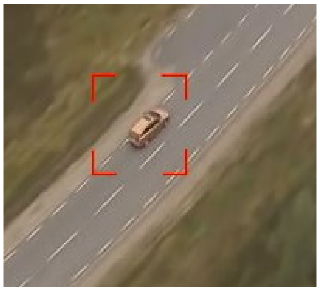
Case 2 shows a better initialization of track, but notice how the only feature to track is a single edge. The tracker will likely drift up and down along that edge, resulting in an erratic track.

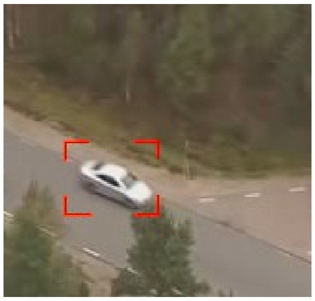
Case 3 is better than Case 2, because at least there are two edges (a corner) for the tracker to track. This track should be solid, as long as the background has no stronger features.

Case 4 is bad, since there are no visible features for the tracker to work with. The track will either fail to initialize altogether, or it will immediately drift to an edge of the rectangle.

Optimal case – the tracking box is sized to encompass the entire object we want to track, and nothing much else. This gives the tracker the most features to work on, and a minimum number of features from the background:	

Real Life Examples

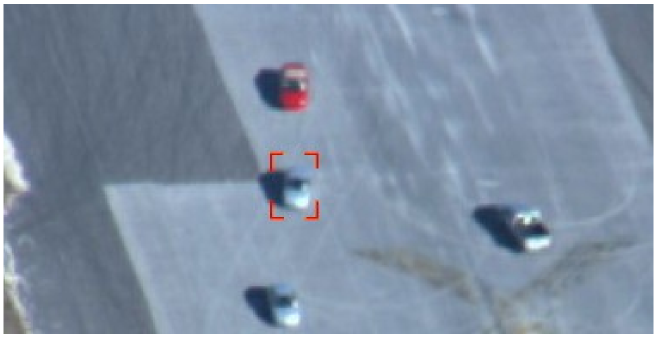
In this example the car is not fully enclosed by the tracking box, but good features with high contrast are. This is not optimal but works well in this case.	
In this example the tracking box is too large and encompasses more than the vehicle the user is tracking, but the tracked objects contains good features and the tracking mode is Vehicle so it still tracks well in this case.	

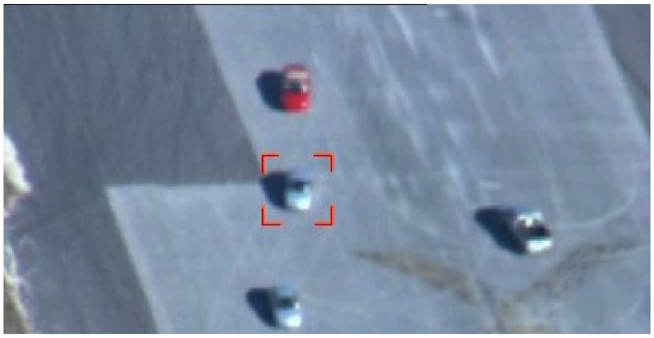
In this example the tracking box is sized for optimal tracking performance. It includes the object and a small amount of background allowing the track to persist well through occlusions and changes in the background.	

Acquisition Assist (New in 2.22)

Acquisition assist mode was designed to assist users in selecting an optimal size and location for track boxes. When this mode is enabled through the Set Tracking Parameters (0x0C) message an algorithm will run 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, however this algorithm is designed to allow you to set it close and still get great tracking results.

Tracking moving objects from a moving platform creates a number of challenging issues. One of these issues is that the optimal track box at initialization may not be the optimal track box after a while. One way to deal with this is to manually re-designate the track, nudge the track or adjust the track size. Another option is to use Modify Track By Index (0x17) message and send the “Reinitialize” command which will re-run the acquisition assist logic and if successful replace the current track box with the new optimal track box. A final option is to use intelligent assist described below to automatically re-adjust under certain conditions.

Acquisition Assist On – In this example the track box is centered nicely on the car and contains primarily the car with just enough background for optimal tracking.	

Acquisition Assist Off – In this example the track box is centered fairly well, however it contains a little bit too much background content and won't track as well as the case above.	

Intelligent Assist (New in 2.22)

Intelligent assist mode was designed to automatically reinitialize targets when we detect changes in the target appearance.   These changes are currently limited to turning objects but the intent is to expand this to cover other cases in the future.   Enabling this mode is designed to be low risk, instead of simply swapping out the old track for the new 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.

(New in 2.24) In drone tracking mode this algorithm can be a little bit more aggressive as it deals with quickly changing target sizes. In most cases it is recommended to use this mode to optimize the track box size while in drone mode, however there are some cases where the background clutter is very high that this mode could negatively impact performance.

Tracking Through Zoom and Rotation

The tracker will work through slow changes in zoom and/or rotation, however to track through faster changes the tracker must have an accurate estimate of the changes.   To do this set the registration parameters "Maximum Zoom" and/or "Maximum Rotation" to non zero values, 5 is a good starting point. Increasing these values will increase the overall system processing load so it is a good idea to look at system performance metrics like output frame rate before and after adjusting the parameters.

Vehicle MTI (SV)

Another tool designed to assist in track initialization is the Vehicle Moving Target Indicator (MTI). This mode works well to highlight larger, faster moving objects and once highlighted you can interact with them like you would any other tracks by designating them as primary, selected, etc. More details about Vehicle MTI as well as the other MTI modes can be found in the Detection Modes EAN.

Command And Control

The following packets are used to setup and control the tracking algorithms. Details on these can be found in the IDD-SLA-Protocol.pdf.

Reporting Results

- Tracking Position (0x43)
- Current Tracking Positions (0x51)
- Set Coordinate Reporting Mode (0x0B)
- Set Packet Destination (0x64)

Display Related Commands

- Set Overlay Mode (0x06)
- Set Display Parameters (0x16)

Tracking Related Commands

- Modify Tracking (0x05)
- Modify Track By Index (0x17)
- Stop Tracking (0x09)
- Designate Select Track Primary (0x32)
- Shift Selected Track (0x33)
- Stop Selected Track (0x3C)
- Set Tracking Parameters (0x0C)
- Nudge Tracking Coordinates (0x0A)
- Set Registration Parameters (0x0E)

Trouble Shooting / FAQ

It is too complicated to always switch tracking modes which mode should I use if I have to pick only one?	Although the tracking mode is important, if you always use vehicle mode you will be able to track moving or stationary targets under most scenarios. Choosing stationary mode would result in poor tracking performance on moving objects.
What is the difference between scene tracking mode and using the registration results to implement a scene tracker?	Our scene tracking mode is a simple implementation of a scene tracker that takes the registration information and outputs the results in the Tracking Position (0x43) packet in camera coordinates. If you were to use the registration results directly you would still look at the Tracking Position packet but you would use the scene translations and these would be offsets from zero instead of positions in camera coordinates. The benefit to using the registration results directly is that you have a more control on how you feed forward user control of the camera system.
I don't see a way to set up a track box with a different width and height, how can I do this?	This isn't supported directly at this time, however using acquisition assist or vehicle MTI you can get track boxes that are non square.
What is the minimum size object I can track?	We have shown tracking to work with as few as 4 pixels (2x2 box), however for more robust tracking we recommend tracking objects that are at least 100 pixels (10x10 box).

User Interface Overview

SightLine Applications provides a Windows based user interface to the SLA-HARDWARE, which communicates using the SightLine Video Protocol over Ethernet or RS-232. This user interface, SLA-PANEL+, is intended as a "getting started" example that wraps most of the functionality defined in the SightLine Video Protocol. For more details on controlling the tracking algorithms from SLA-PANEL+ see the Panel+ Users Guide.

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