

True and Relative Trails with Moving Platform

How to use the SPx scan conversion library to support displays based on true or relative motion, with target history shown as true or relative trails in a different colour.

Summary

Cambridge Pixel's SPx radar scan conversion software provides a powerful and flexible means of displaying layered maps, radar video and target/own ship symbology, with the display either referenced to the world (true motion) or to the platform (relative motion) based on navigational input to the display system notifying updates to own ship position.

The display can be referenced as north-up (world referenced) or heading-up/course-up (referenced to platform heading or course).

A further enhancement to the radar display uses trails to show the historical position of targets as a trail of slowly fading video, typically presented in a different colour from live radar video for clarity.

These trails can be shown either as true trails (where motion relative to the world is shown) or as relative trails (where any motion relative to own ship, including fixed artefacts such as coastlines as well as static or moving targets, is shown). Trails may be ground stabilised (true trails are stationary relative to the ground) or sea stabilised (true trails are stationary relative to the sea).

This application note presents and illustrates these different modes of presentation, and describes corresponding example code.

True Motion, North-Referenced

A true motion north-referenced display preserves the location of fixed (e.g. land areas) on the screen while allowing the platform to move around the screen according to platform motion. The top of the display normally points towards north. In this mode, history trails may be either one of these two types:

- True trails, showing the motion of displayed objects relative to the world. In this mode, only objects that are actually in motion have trails associated with them. Trails are not preserved when the operator pans across the display or changes range scale. This is illustrated in Figure 1.
- Relative trails, showing the motion of objects relative to the platform. In this mode, any objects that have motion relative to the radar platform have trails. This includes any fixed objects such as coastline or buoys, as well as any moving targets that are not moving with the same speed and course as the radar platform. Trails are preserved and redrawn when the operator performs a pan or zoom operation on the display. This is illustrated in Figure 2.

In this document, historic video (trails) is shown in blue and new video is shown in yellow. Note that the length of the trails is fully configurable in software.

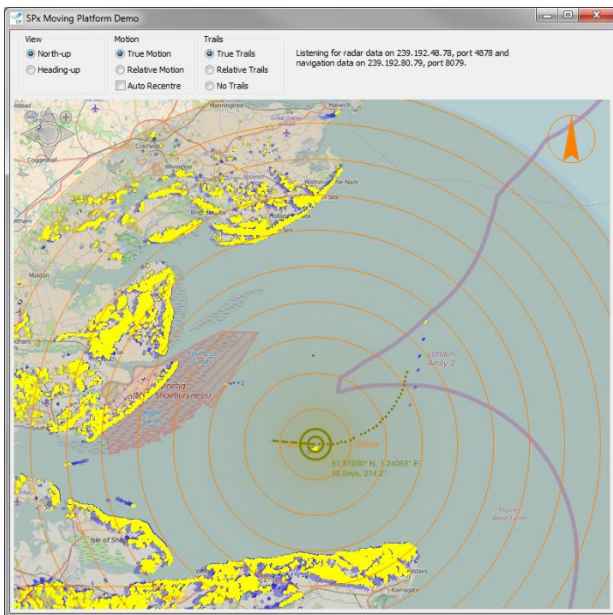


Figure 1: True motion, true trails. World view stays constant, platform moves within window. Trails visible for moving objects. Trails are lost when display is panned or zoomed.

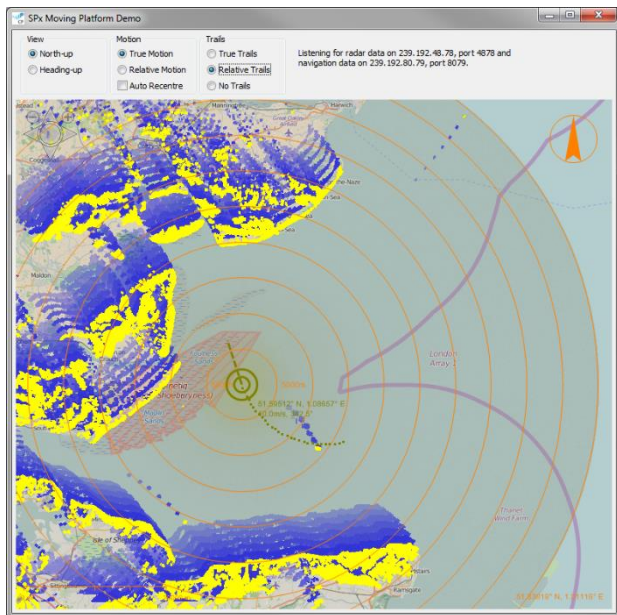


Figure 2: True motion, relative trails. World view stays constant, platform moves within window. Trails visible for all objects that have motion relative to the platform. Trails are retained on panning or zooming.

Relative Motion, North-Referenced

A relative motion north-referenced display keeps the platform at a fixed point in the window (unless relocated by the operator), either centrally located or offset, and allows other display artefacts including coastline and targets to move relative to this fixed point. Again, in this mode history trails may be one of two types:

- True trails, showing the motion of displayed objects relative to the world. In this mode, only objects that are actually in motion have trails associated with them. Trails are redrawn with the motion of the platform, but are not preserved when the operator pans across the display or changes range scale. This is illustrated in Figure 3.
- Relative trails, showing the motion of objects relative to the platform. In this mode, any objects that have motion relative to the radar platform have trails. This includes any fixed objects such as coastline or buoys, as well as any moving targets that are not moving with the same speed and course as the radar platform. Trails

are preserved and redrawn when the operator performs a pan or zoom operation on the display. This is illustrated in Figure 4.

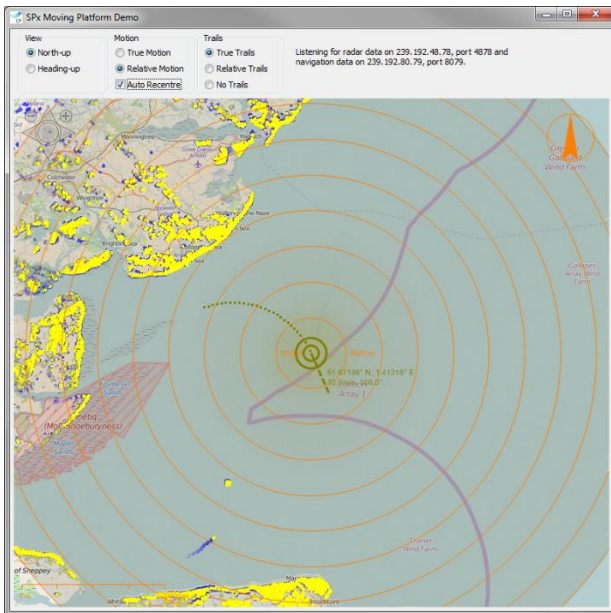


Figure 3: Relative motion, true trails. Platform remains in fixed position within window, rest of view moves within window. Trails visible for moving objects. Trails are lost when display is panned or zoomed.

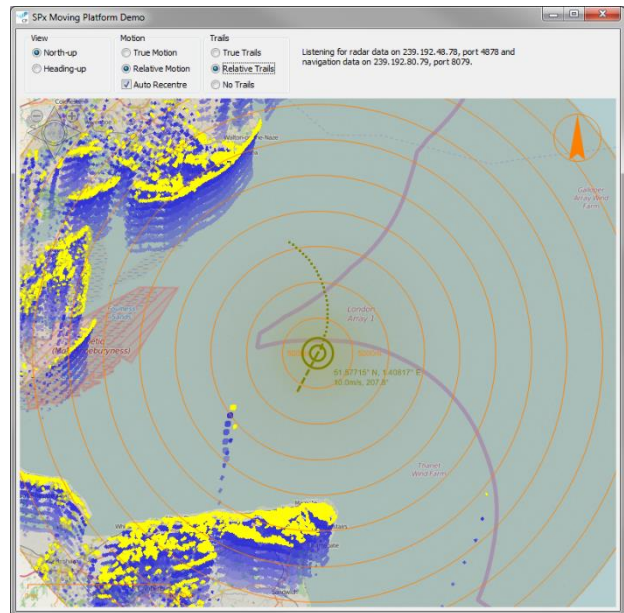


Figure 4: Relative motion, relative trails. Platform remains in fixed position within window, rest of view moves within window. Trails visible for all objects that have motion relative to the platform. Trails are retained on panning or zooming.

Heading-Up / Course-Up with Relative Trails

In heading-up or course-up mode, the display is oriented such that the vertical axis is aligned with the heading or course of the moving platform. True and relative motion are both supported, but trails, if enabled, are by default relative to the platform. True and relative motion are illustrated in Figure 5 and Figure 6 respectively.

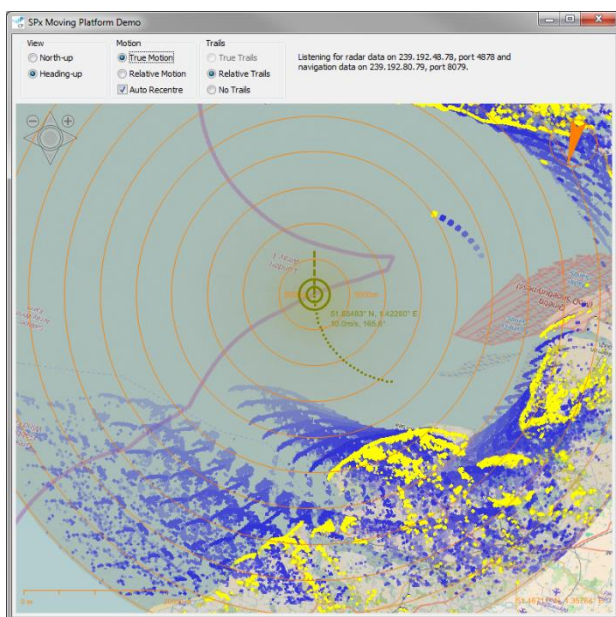


Figure 5: Heading-up, true motion, relative trails. World view is rotated, platform moves within window. Trails visible for all objects that have motion relative to the platform. Trails are retained when display is panned or zoomed.

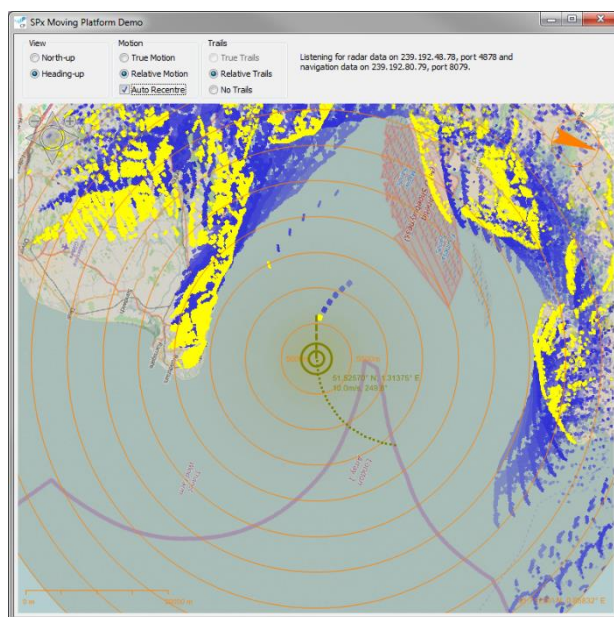


Figure 6: Heading-up, relative motion, relative trails. Platform remains in fixed position within window, rest of view moves and rotates within window. Trails visible for all objects that have motion relative to the platform. Trails are retained when display is panned or zoomed.

Heading-Up / Course-Up with True Trails

In this mode, scan conversion is initially performed north-up referenced and a rotation is then performed to correct for course or heading. This rotation is only supported by some scan conversion destinations, and may also be computationally intensive for those destinations. Specifically, this mode is not supported for the `SPxScDestDisplayWin`, `SPxScDestDisplayWinRaw` and `SPxScDestDisplayX11` scan conversion destinations. The mode is supported by the `SPxScDestBitmap` and `SPxScDestTexture` classes when the `GetDisplayMatrix()` function of those classes is used to query the necessary transformation required and the resulting matrix applied to the rendering of the bitmap. Finally, the `SPxScDestBitmapD2D` class provides the convenience function `DrawBitmap()` to draw the Direct2D bitmap, which additionally applies the required display transform required when rendering heading or course-up radar video with true trails, while the SPx Qt library also provides direct support for the transformation. Please refer to the relevant sections of CP-25-110-01 (SPx Radar Video Processing and Display:

Programming Reference Manual) for further details, and to the example application **SPxD2DMovingPlatform** as appropriate.

Ground and Sea Stabilisation

Trails may be ground stabilised or sea stabilised. Ground stabilised true trails show the movement of objects relative to the ground. Ground stabilised relative trails show the movement of objects relative to own ship's movement over ground. Ground stabilised trails require either own ship position information or own ship speed and course over ground information. Sea stabilised true trails show the movement of objects relative to the water. Sea stabilised relative trails show the movement of objects relative to own ship's movement through the water. Sea stabilised trails require own ship speed and course over water information.

Using the SPx Library

Figure 7 shows the configuration of objects and the sequence of processing from the radar input data store into the display. Two scan converter objects output their images into the same window to give a single composite picture. The second scan converter is configured to be on top of the first (higher window priority), with *no* fading (in SPx this is called replacement mode) and the radar colour is chosen to be different from that of the first scan converter. As illustrated, there are two SPx processes, both `SPxProScanConv`. The first of these is the scan converter that handles the trails (configured with sweep fade). The second of these is the scan converter that handles the new video (configured with no fade).

The windows associated with these scan converters must have a stacking order that puts the New Video scan converter on top of the Trails scan converter. This is achieved by creating the Window for the New Video after the Window for the trails. Both scan converters are configured to access video data from the same PIM.

To support trail history retention, an additional process is introduced that preserves the trail history when the view changes. It means that once trails have established, the view in the radar picture can be changed and the historical video remains. The `SPxProHistory` process manages the history using the additional History PIM. When the first scan converter (the one handling the trails) needs to refresh the radar image at a new scale or if the display is panned, it uses the history PIM, instead of the normal input PIM. This functionality is only relevant for relative trails, since true trails are not redrawn on display change.

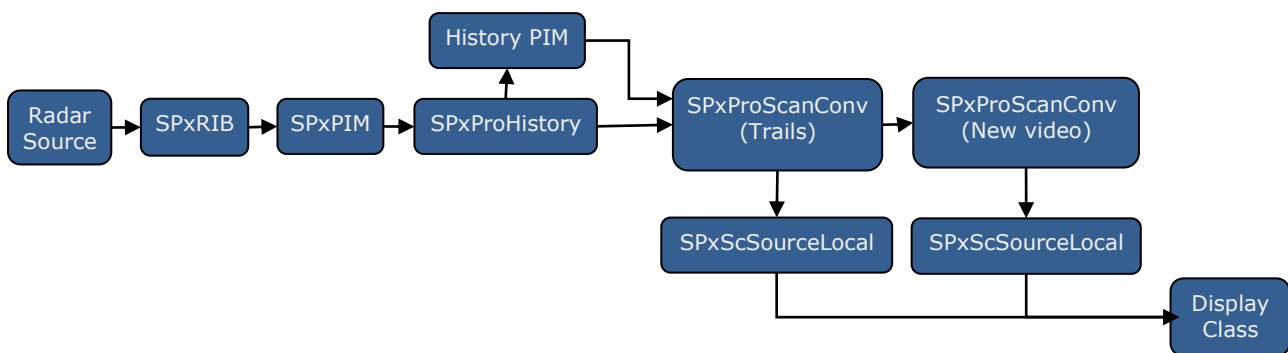


Figure 7: Configuration of SPx objects to implement trail history retention and dual-colour scan conversion

Please refer to the Cambridge Pixel application note CP-16-110-97 (Scan Conversion Trails Colour) for a fuller description of the use of dual scan converters for two-colour trails.

The example application **SPxWinMovingPlatform** was used to generate the illustrations in this application note, and is supplied as source code as part of the SPx developer software release. The code below shows how the trails mode is set.

```
/* Tell the view control about true or relative motion. */
m_viewCtrl->SetDisplayMotionMode(trueMotion ? SPxViewControl::MOTION_MODE_TRUE
                                   : SPxViewControl::MOTION_MODE_RELATIVE);

/* Tell the view control about north or heading-up display. */
m_viewCtrl->SetDisplayRefMode(northUp ? SPxViewControl::REF_MODE_NORTH
                              : SPxViewControl::REF_MODE_HEADING);

/* See what sort of trails we want - none, true or relative. */
SPxScMpTrailsMode_t trailsMode = SPX_SC_MP_TRAILS_NORMAL;

/* True or relative trails? */
if( trueMotion && (!trueTrails) )
{
    /* Relative trails in true motion. */
    trailsMode = SPX_SC_MP_TRAILS_RELATIVE_FROM_TRUE;
}
if( (!trueMotion) && trueTrails )
{
    /* True trails in relative motion. */
    trailsMode = SPX_SC_MP_TRAILS_TRUE_FROM_RELATIVE;
}

/* Update the scan converter. */
m_scanConv->SetMovingPlatformTrailsMode(trailsMode);
```

< End of document >