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FliteScene® 2.13.0 Digital Moving Map Overview

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FliteScene 2.13.0 Digital Moving Map Overview

INTRODUCTION

This document provides an overview of the FliteScene® digital moving map product. FliteScene provides advanced situational awareness for the most demanding conditions faced by military and civilian flight crews. The wide range of features and flexible configuration provided by FliteScene allows the digital mapping system to support a variety of mission needs for all types of aircraft. These advanced map capabilities are described herein.

ENVIRONMENT

FliteScene can be provided as a software library for easy incorporation into applications within an integrator's system. It can also be provided as a stand-alone application complete with a comprehensive bezel key-style human machine interface (HMI), which can be easily reconfigured via an XML file.

Figure 1 shows the high-level interfaces to FliteScene.

FliteScene supports a standard OpenGL interface and can be integrated with commercial off-the-shelf (COTS) processors and graphic accelerators. FliteScene receives messages from the aircraft subsystems that control the map display and tasks to be performed. Responses are sent out to the aircraft subsystems in response to the input command messages and as an indication of FliteScene status. Requests for map data are sent to mass memory. File responses and data are received from mass memory. The interface to the rendering engine (OpenGL SC 1.0.1 or OpenGL ES 2.0) is used to render the map. The interface to the operating system is used for system services and thread control. The operating systems supported by FliteScene include Windows®, INTEGRITY®, INTEGRITY® 178B tuMP, VxWorks®, VxWorks® 653, Linux®, LynxOS®-178, Android™ and iOS (all trademarked entities herein are owned by their respective companies).

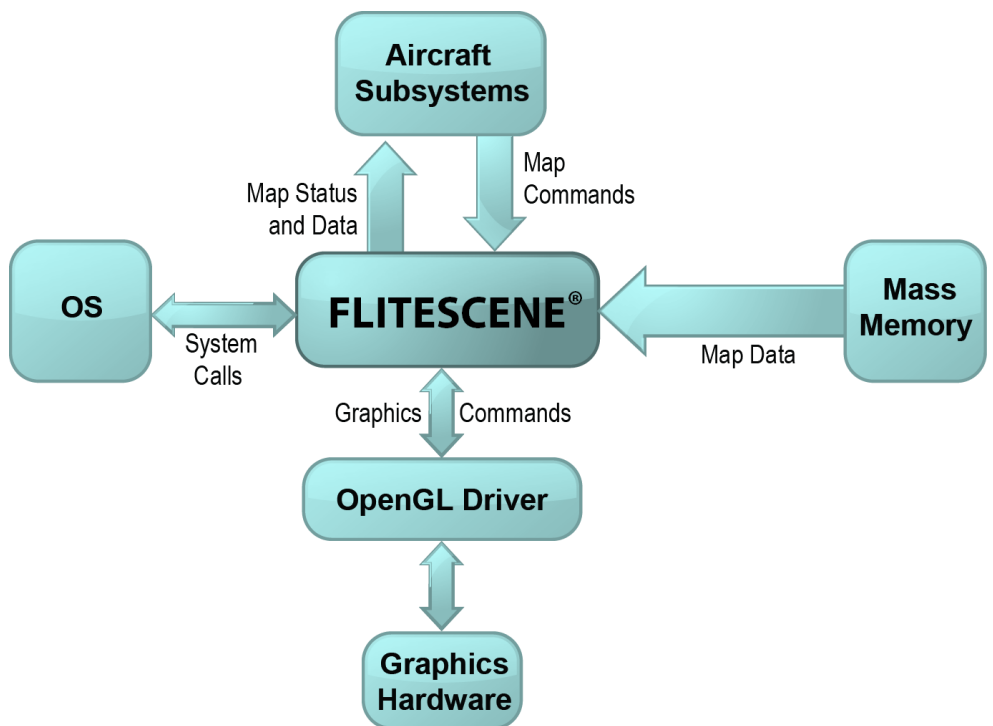


Figure 1 - FliteScene environment

Operational Features



Figure 2 - 2D View with CADRG 1:5M underlay

OPERATIONAL FEATURES

This section provides an overview of the FliteScene features from a functional perspective. The user's interface for command and control of these features varies depending on how FliteScene is used within an integrator's system. A description of the bezel key-style HMI used for the stand-alone configuration of FliteScene can be provided upon request.

DISPLAY MODES

FliteScene display modes are commanded by selecting a view, an underlay product (or products for multilayer maps), and a range. The available views are 2D, 3D, data frame and blank. Underlay products provide the base map/imagery layer and are available in CADRG/ECRG, CIB, MrSID and GeoTIFF (including Street Map) formats at various scales. The range selection allows the user to specify the range of map coverage from top to bottom of the display when the zoom selection is 1.0. All display modes of FliteScene can be rotated, panned and zoomed.

With FliteScene 2.7 and up, users no longer need to specify which elevation scale to use for elevation overlay features such as slope shading, contour lines, elevation bands and height above terrain (HAT). FliteScene will automatically determine the appropriate elevation scale, or depth scale for bathymetric data, to use based on the scale of the selected underlay product and the setting of the REGRID_OPTIMIZATION tag as described in the FliteScene database design document (DBDD). If the desired resolution is not available, FliteScene will automatically attempt to use a lower level resolution (also known as automatic elevation fallback).

2D View

2D view renders the map in plan view, as a paper map would normally be read. The underlay products that can be viewed in this manner are CADRG/ECRG, CIB, MrSID, GeoTIFF (including StreetMap), and Digital Terrain (see "Map Underlay"). Various map overlays can also be viewed (see "Map Overlays").

Figure 2 shows a CADRG 1:5M map in 2D view.

3D View

3D view renders the map in perspective view, as if the user were looking at the actual geographic area. Map images can be draped over a 3D rendering of the terrain. 3D view is offered in two options: cockpit view and wingman view. Additional perspective camera views can be commanded allowing robust control for integrators (e.g. ownship to object, ownship to position, object to ownship, object to position, etc.). A subset of the various map overlays can also be viewed (see "Map Overlays"). Multiple levels of detail can be displayed in the 3D scene, whereby closer locations can be displayed at higher resolutions than distant locations.

Operational Features

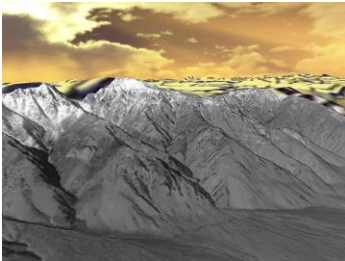


Figure 3 - 3D cockpit view

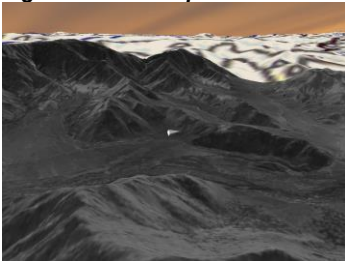


Figure 4 - 3D wingman view

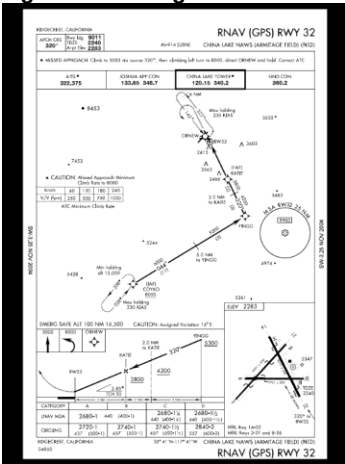


Figure 5 - Data frame view

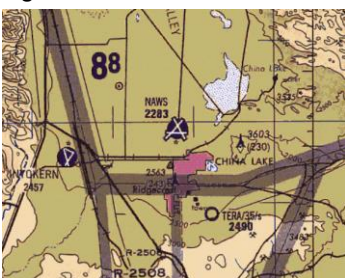


Figure 6 - CADRG underlay



Figure 7 - ECRG underlay

Cockpit View

In cockpit view, the eye-point is set at the ownship position to give the appearance of looking out of the cockpit. The eye-point can be set to match the ownship heading and pitch (i.e., to simulate pilot looking straight ahead), or can be set independent of the ownship heading and pitch (i.e., to simulate pilot looking in other directions rather than straight ahead).

Figure 3 Error! Reference source not found. shows a map in perspective mode, cockpit view.

Wingman View

In wingman view, the eye-point is at a configurable perspective away from the ownship, looking at the ownship position. The eye-point can be set to different depth, tilt and azimuth settings as described in the FliteScene Interface Control Document (ICD).

Figure 4 shows a map in 3D perspective mode, wingman view.

Data Frame View

In data frame view, nongeographically referenced images are displayed. Data frames can be JPEG, JPEG2000, bitmap, TIFF, PDF, PNG or icon images. Examples of potential data frames are checklists, diagrams, approach plates, aerial photography, and flight information publications (FLIP) charts. Data frames can have symbology overlays.

Figure 5 shows a PDF approach displayed in data frame view.

MAP UNDERLAY

FliteScene underlays are created from standard database products provided by the National Geospatial-Intelligence Agency (NGA) and various commercial sources. The standard database products used for the map underlay are the same products used in aircraft mission planning systems, which ensures the maps displayed in the cockpit are identical to those seen during mission planning. In both 2D and 3D views, FliteScene can display multiple map layers concurrently (e.g., Imagery over Chart, High Resolution over Low Resolution, etc.).

Compressed Arc Digitized Raster Graphics (CADRG)

CADRG underlays can be displayed in 2D and 3D views. CADRG underlays are created from scanned aeronautical chart source data (MIL-PRF-89038).

FliteScene provides configurable product codes to support any number of CADRG products at any supported scale. Once a product code has been configured (i.e., assigned) to a map product, then users can enable that map for display using the product code as a reference. FliteScene supports the following CADRG scales:

- > 1:5,000,000, 1:2,000,000, 1:1,000,000, 1:500,000, 1:250,000, 1:200,000
- > 1:100,000, 1:50,000, 1:36,000, 1:35,000, 1:26,000, 1:25,000, 1:24,000
- > 1:23,000, 1:22,000, 1:21,120, 1:21,000, 1:20,000, 1:18,000, 1:17,500
- > 1:17,000, 1:16,666, 1:16,000, 1:15,500, 1:15,000, 1:14,700, 1:14,000
- > 1:12,800, 1:12,500, 1:12,000, 1:11,800, 1:11,000, 1:10,560, 1:8,000

Figure 6 shows a 1:500K CADRG map in 2D view.

Enhanced Compressed Raster Graphics (ECRG)

ECRG underlays can be displayed in 2D and 3D views. ECRG data is derived from digital source maps, like ADRG, but processed and reformatted into an ECRG format (MILPRF-32283). The same data types (scales) supported for CADRG can be displayed for ECRG.

The ECRG feature provides options for full resolution or low resolution, which can be selected based on system resources. ECRG memory options can be configured using the ECRG_ENABLED tag as described in the DBDD.

Figure 7 shows an ECRG map in 2D view.

Operational Features

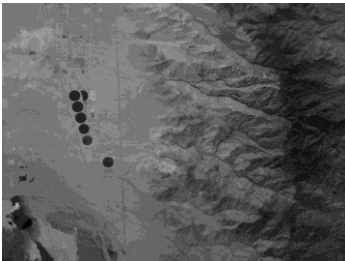
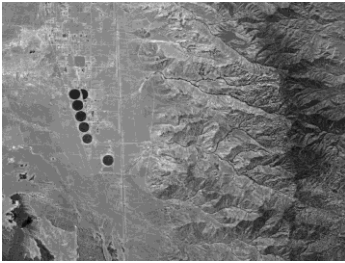


Figure 8 - Image auto contrast
Top: Auto-contrast enabled
Bottom: Auto-contrast disabled

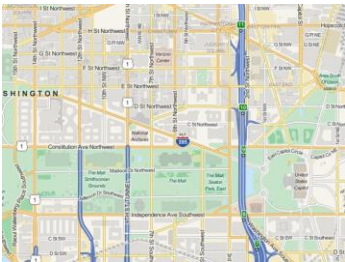


Figure 9 - GeoTIFF Street Map underlay



Figure 10 - MrSID 2D view

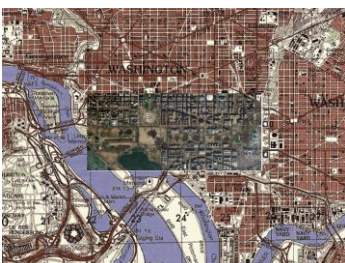


Figure 11 - GeoPDF underlay

Controlled Image Base (CIB®)

CIB underlays can be displayed in 2D and 3D views. CIB underlays are generated from georeferenced satellite imagery source data (MIL-PRF-89041).

FliteScene provides configurable product codes to support any number of CIB products at any supported resolution. Once a product code has been configured (i.e., assigned) to a map product, users can enable that map for display using the product code as a reference. FliteScene supports the following CIB resolutions:

- > 10-meter
- > 5-meter
- > 2-meter
- > 1-meter
- > 0.5-meter

When CIB Auto-Contrast is enabled, FliteScene will automatically adjust the image contrast to improve the displayed image quality.

Figure 8 shows an example of image auto contrast.

GeoTIFF

GeoTIFF underlays can be displayed in 2D view and in 3D* view. GeoTIFF underlays can be created from a variety of sources and can contain a variety of information (e.g., map chart, imagery and/or street maps). A GeoTIFF image uses the TIFF standard but contains GeoKeys specifying a geographic location for the image. GeoTIFF files can contain multiple tiles, where each tile is 256x256 in size.

FliteScene's configurable product code feature is also used for GeoTIFF based maps and imagery. For each configured GeoTIFF product code, the user can configure:

- > Catalog files that specify the location and GeoTIFF files to load for this GeoTIFF product.
- > The meters per pixel that FliteScene should use for sorting the GeoTIFF image tiles associated with this product code. In this sense, meters per pixel provides a mechanism to create multiple scales of GeoTIFF map/image products. This value is also used by FliteScene to determine the appropriate elevation or depth resolution to use for any enabled elevation or depth overlays.

In addition to loading GeoTIFFs from catalog files during initialization, FliteScene supports loading GeoTIFFs dynamically via the Command I/F during run time.

Product codes can be configured for these dynamically loaded GeoTIFFs so that the user can enable and/or disable them like any other map product.

Figure 9 shows a GeoTIFF underlay in 2D view.

Multiresolution Seamless Image Database (MrSID)

MrSID underlays can be displayed in 2D view and in 3D* view. Within FliteScene, MrSID behaves similar to GeoTIFFs. Configurable product codes, catalog files and meters per pixel are all utilized as described above. In addition to loading MrSID from catalog files during initialization, FliteScene also supports loading MrSID dynamically via the Command I/F during run time. Currently, FliteScene only supports MrSID in Windows and Android environments.

Figure 10 shows a MrSID underlay in 2D view.

Geo Registered Imagery

Geo Registered Imagery (e.g. GeoPDF or GeoTIFF) can be loaded through the data frame interface. When enabled, FliteScene will display geo registered data frames as a second layer stitched into the map underlay.

Figure 11 shows a GeoPDF on top of 1:50K CADRG.

*Requires additional OpenGL capabilities beyond SC 1.0.1 (clip planes) or ES 2.0

Operational Features

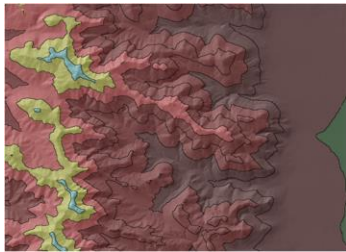


Figure 12 - Digital terrain in 2D View

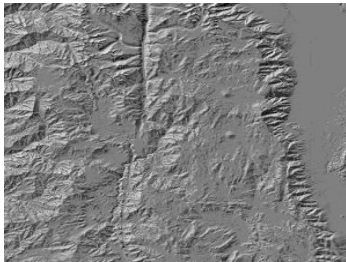


Figure 13 - Slope shading

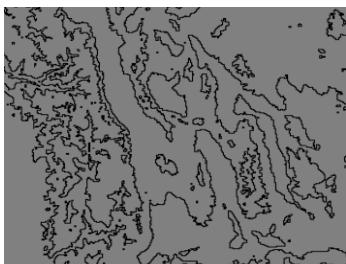


Figure 14 - Contour lines



Figure 15 - Elevation bands

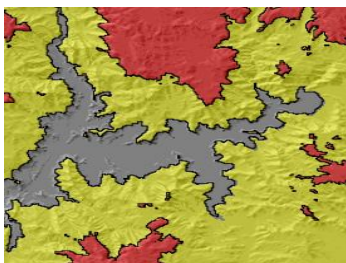


Figure 16 - Three-band HAT

Digital Terrain

Digital terrain can be displayed in 2D and 3D views. The digital terrain underlay is a solid programmable color over which elevation overlay features (e.g., bands, shading and contours) are displayed.

Figure 12 shows a digital terrain map in 2D view.

MAP OVERLAYS

Once the underlay(s) of the digital map has been established, overlay graphics pertinent to situational awareness can be applied. Map overlays are dynamically updated in response to changing map positions, changing aircraft altitude, changing terrain underlying the map position, and new user commanded map values.

Elevation Overlays

The preferred source for the elevation data is Digital Terrain Elevation Data (DTED) Level 0, Level 1 and Level 2 as specified by MIL-PRF-89020B Performance Specification, DTED. FliteScene also supports RegridDED (RDTED) in 750-meter, 150-meter, and 37.5-meter nominal resolution. High-resolution terrain elevation (HRTE) data is also supported and can be used in conjunction with DTED/RDTED.

SLOPE SHADING

Slope shading can be displayed in 2D and 3D views. Slope shading is the lightening and darkening of the base color and certain map overlays to represent a virtual sun position's effect on the slope and orientation of the terrain. The terrain facing toward the virtual sun is brightened, while the terrain facing away from the virtual sun is dimmed. The degree of luminance is based on the pitch of the terrain.

Figure 13 shows a digital terrain underlay in 2D view with slope shading enabled.

CONTOUR LINES

Contour lines can be displayed in 2D and 3D views. Contour lines are drawn where the absolute elevations of adjacent terrain points are above the base elevation and straddle a selected contour elevation. The colors and interval of contour lines are programmable.

Figure 14 shows a Digital Terrain underlay in 2D view with contour lines enabled.

ELEVATION BANDS

Elevation bands can be displayed in 2D and 3D views. Elevation bands are dynamic translucent (tinted) overlays based on elevation range intervals that highlight the terrain at different altitudes. The number of elevation bands, height of elevation bands, and colors of the elevation bands are programmable (up to 8).

Figure 15 shows a 1:5M CADRG map in 2D view with elevation bands enabled.

HEIGHT ABOVE TERRAIN (HAT)

HAT is a subset of elevation bands that can be displayed in 2D and 3D views. A tinted overlay is used to indicate areas on the map where terrain is above the aircraft altitude. Two-band HAT tints the areas where the terrain is above the aircraft altitude. Three-band HAT adds a warning color to indicate when the aircraft altitude is within a configurable warning distance of the terrain. For two- and three-band HAT, the tinted areas change size as the aircraft changes altitude to indicate safe flying areas to the flight crew.

Figure 16 shows digital terrain in 2D view with three-band HAT and contour lines enabled.

Operational Features



Figure 17 - Performance banding

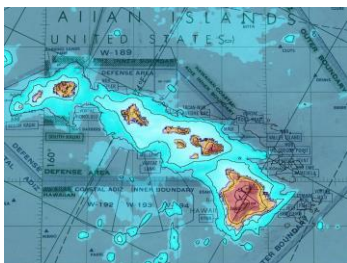
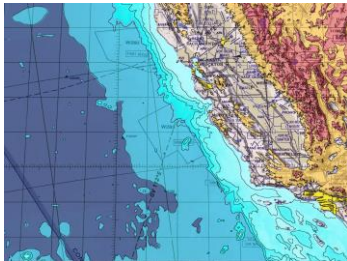
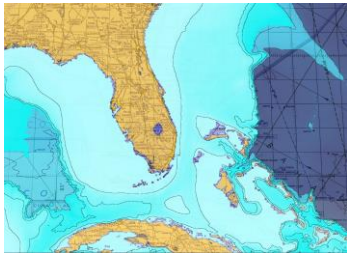


Figure 18 - Depth shading, contours, and bands

FLIGHT PERFORMANCE BANDING

In 2D views FliteScene supports rendering a banding layer based on flight performance model characteristics. The characteristics of the aircraft such as speed, weight, and engine failure can be used to calculate the maximum performance of the aircraft. This altitude can be provided to FliteScene and used to render a performance band. A tinted overlay is used to indicate areas on the map where the altitude is above the capability of aircraft performance. The performance band feature also supports a legend that can be used to display information on the parameters used to calculate the performance band.

Figure 17 show performance banding.

Bathymetry Overlays

In addition to processing elevation data for the slope shade, contour line, elevation band and flight performance band overlays, FliteScene can process bathymetric data and display the following overlays in 2D views:

- > Depth shading
- > Depth contours
- > Vertical bands

These overlays are similar to their elevation overlay counterparts with the following differences:

- > Supported depth data resolutions are 2, 1, 0.5, 0.1, and 0.5 arcminutes. Refer to the FliteScene DBDD for more details on the source data format, which is derived from digital bathymetric data base—Variable Resolution (DBDB-V) data.
- > Up to 64 vertical bands that can be displayed. For each band, the following can be specified via the command I/F:
 - Vertical data type to use elevation or depth data
 - Starting and ending vertical values (band width)
 - Color

Figure 18 shows bathymetry in 2D with depth shading, contours, and 64 vertical bands using depth data.

Object Visibility (aka Intervisibility)

Object visibility is used for any ground object where the range of an object and/or line-of-sight visibility from an object is important (e.g., an airport beacon, on-the-ground radio, etc.). The following discussion uses threats as the object of interest, but this can be applied to any object.

FliteScene manages and displays both predefined and pop-up threat data, which includes threat symbols, threat rings, threat intervisibility (TIV) patterns (2D only), and threat domes (3D only). Predefined threat data can be created from a variety of sources (e.g., FalconView® threat files) that are converted to XML, or Threat Site/Characteristics (XML files) as described in the FliteScene DBDD. Pop-up threat data is sent to FliteScene in real time via the FliteScene command interface. As the map position changes, FliteScene automatically sorts the threats and displays, if enabled, (a) the closest number (configurable) of the threat symbols/rings within the display range, and (b) the closest number (configurable) of TIV patterns. Sorting can be configured based on the ownship position or on the map center.

Threat symbols can be set via a MIL-STD-2525 code or an icon filename, and are displayed, when enabled, at the threat's location. MIL-STD-2525 tactical symbols are described later herein. FliteScene can display any tactical symbol from MIL-STD-2525C Appendix A, D, E and G.

Up to three overlay rings can be displayed for each threat: the detection ring, lethality ring and calculated ring. When enabled, the detection and lethality rings are displayed using the threat's detection and lethality ranges. The calculated ring is only displayed if the calculated threat intervisibility range is less than the detection range. The color of each ring is configurable.

Operational Features

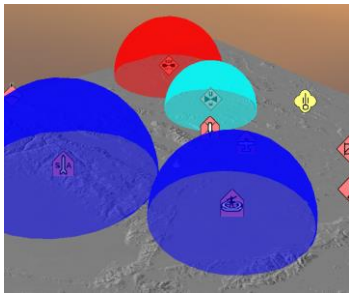
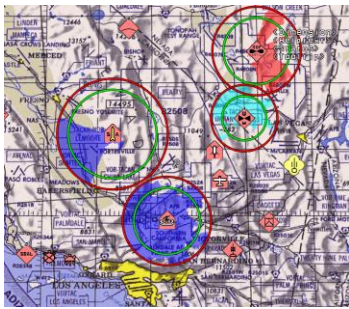


Figure 19 - Top: 2D; bottom: 3D. Object visibility in 2D (area pattern) and 3D views

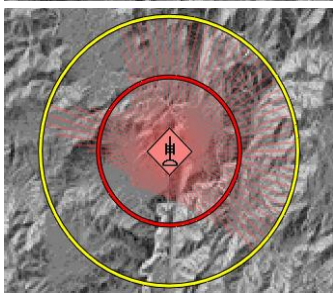
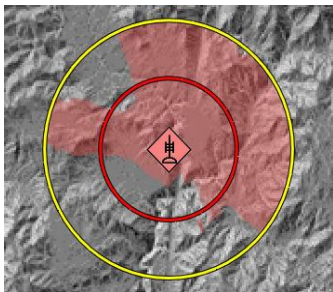


Figure 20 - Top: area; bottom: spoke. Object visibility patterns (area and spoke)

Threat intervisibility patterns are translucent (tinted) overlays that show the areas where the aircraft can be seen from a threat, given its altitude above ground level relative to the surrounding terrain. This pattern can be configured to be an area or spoke pattern as shown in Figure 20. The threat intervisibility overlay is continuously updated as the aircraft altitude (or other provided reference altitude) changes so that tinted areas show where the aircraft could be detected. Conversely, untinted areas depict areas where the aircraft could be hidden from detection by intervening terrain. The color of each TIV pattern is configurable.

Threat detection and engagement domes are translucent (tinted) 3D overlays that show their respective ranges in 3D. The detection and engagement dome radii are equal to the detection and engagement radii. The detection dome color is the same color as the 2D intervisibility pattern color and the engagement dome is the same color as the 2D engagement ring color. No intervisibility calculations are performed when rendering a threat dome. It behaves as a three-dimensional detection/engagement sphere. Threats can be moved, deleted or queried for metadata as described in the cursor section.

Figure 19 shows threat data in both 2D and 3D.

Ownship Visibility

FliteScene can display ownship visibility in 2D view. Ownship visibility is similar to object visibility (discussed in previous section) in that they both graphically convey line-of-sight information. The difference is as follows:

Ownship visibility shows areas that are visible to (can be seen by) the ownship given the ownship's current location and altitude. This pattern changes dynamically as the ownship moves. Tinted areas indicate where the ownship has line-of-sight visibility. This can be useful for determining the lowest altitude the ownship can fly (or hover) and still see an area of interest.

Object visibility shows areas that are visible to ground-based objects given a reference AGL altitude. Tinted areas indicate where the object has line-of-sight visibility to anything at or above the reference altitude. This can be useful for determining the highest AGL altitude an aircraft can fly (or hover) without being seen by the object.

The color and translucency of the visibility pattern can be changed dynamically by the user.

Figure 21 shows three visibility patterns for an ownship at the same location, but different altitudes.

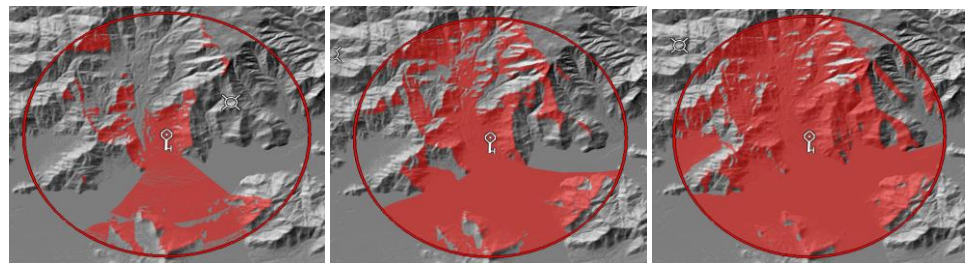


Figure 21 - Left: low altitude; middle: medium altitude; right: higher altitude. Ownship visibility.

Operational Features



Figure 22 - Geo chip



Figure 23 - Ownship symbol 2D



Figure 24 - Ownship symbol 3D

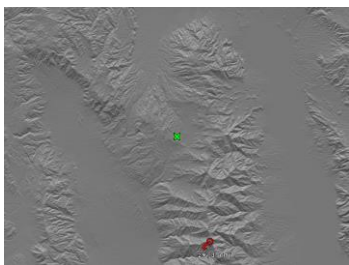


Figure 25 - Ownship off-screen Indicator

Geo Chips

Geo chips can be displayed in 2D view and 3D* view. Geo chips are monochromatic or color bitmap, JPEG, JPEG2000, TIFF, PNG image overlays that are geographically referenced to the map. Geo chips may be translucent or opaque. When a geo chip is too small to be discernable on the map scale currently selected, a “too small” symbol is displayed at the geographic location of a geo chip. When a geo chip file is enabled for display, but the file is not available, a “location” symbol is displayed at the geographic location where the geo chip should be. The “location” and “too small” symbols can be enabled or disabled by the user.

Figure 22 shows a 1:50K CADRG map in 2D view, with a geo chip, “too small” symbol (symbol ☒ located in the upper left corner of the image), and a “location” symbol (symbol ◻ located to the right of the geo chip).

Note: Refer to the GeoTIFF section for an alternative way to display images georeferenced on the map using the static or dynamic GeoTIFF feature. The primary difference between the geo chip feature and the GeoTIFF feature is that geographic information is already contained within the GeoTIFF files, whereas for geo chips, the user must provide geographic information for the image as described in the FliteScene ICD.

Vehicles and Sensors

FliteScene supports a configurable number of vehicles (e.g., ownship, unmanned aerial vehicle [UAV]), and can display various features for each vehicle, including: Vehicle symbol, trend dots and a history trail. In addition, one or more sensors can be configured for each vehicle, and FliteScene can display various sensor features including: sensor overlay pattern and sensor point-of-intercept.

VEHICLE SYMBOL

Vehicle symbols can be displayed in 2D and 3D wingman views. In 2D view, the symbol representing each vehicle is configurable. In 3D view, each vehicle symbol is represented using a configurable 3D model. 3D models are defined using a standard obj file. FliteScene supports defining up to 10 vehicle models that can be selected for use with each vehicle. FliteScene displays each symbol taking into account the heading and position of the vehicle received via the command interface, and the orientation mode of the map (North-up, Heading-up, Slew angle, etc.).

Vehicle symbols can be icon-based or MIL-STD-2525 based and can be changed during run time via a message over the command interface.

Figure 23 shows a 1:2M CADRG map in plain view with the default 2D ownship symbol.

Figure 24 shows a CIB map in perspective view with the default 3D ownship symbol.

Note: FliteScene supports multiple vehicles where each vehicle can be represented by a unique symbol. Ownship is a term that represents the user’s vehicle.

VEHICLE OFF-SCREEN INDICATOR SYMBOL

When the map is slewed in plan view such that the ownship is off screen, FliteScene can display a vehicle off-screen indicator symbol to provide an indication of where the ownship is relative to the screen center. Information conveyed by the vehicle off-screen indicator includes:

- > Distance from the indicator’s location to the ownship’s location
- > Indication of ownship’s heading relative to the underlying map

Figure 25 shows an example where a north-up map has been slewed and the off-screen indicator symbol conveys the following information relative to the screen center: (a) the ownship is south of screen center, (b) the ownship’s heading is north, (c) the ownship is 29.3 nautical miles from screen center. Also shown in Figure 25 is a slew location symbol, which FliteScene displays (when enabled) to indicate the slew position.

Operational Features



Figure 26 - Ownship trend dot symbol

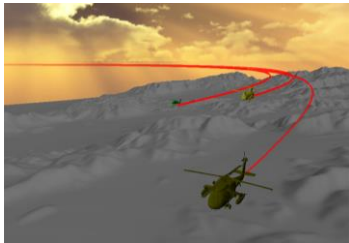
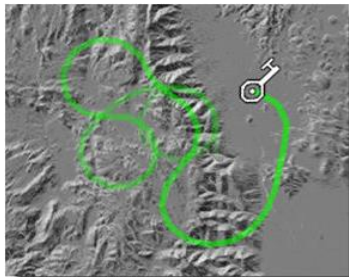


Figure 27 - Top: 2D;
Bottom: 3D Ownship history trail

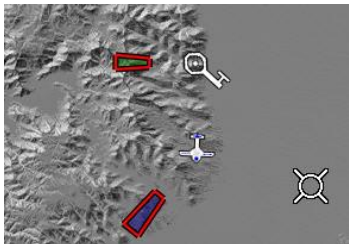


Figure 28 - Sensor overlay patterns

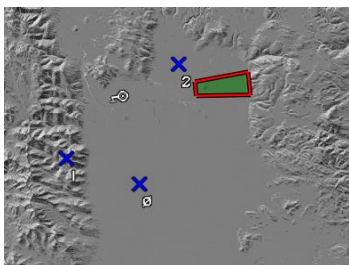


Figure 29 - Sensor capture point

VEHICLE TREND DOT SYMBOLS

Trend dot symbols can be displayed in 2D view. Trend dots are displayed to show the expected progression of a vehicle at given time intervals based on velocity and turn rate. The user can display up to four trend dots at programmable times (seconds from current vehicle position) and in a programmable color. If a trend dot's time is set to 0, then the trend dot is disabled.

Figure 26 shows a 1:500K CADRG map in plan view with the ownship symbol and trend dot symbols displayed.

VEHICLE HISTORY

FliteScene can log and display vehicle history information. The time interval between log events is configurable. When enabled, a vehicle history trail is displayed in 2D and 3D views. The number of locations displayed for the history trail and the display parameters (e.g., color) are also configurable.

Figure 27 shows an ownship with history trail enabled. Note that older locations appear to fade away.

SENSOR OVERLAY PATTERN

For each sensor, FliteScene can display an overlay pattern in 2D view which represents where a sensor is looking, taking into account the sensor's location, altitude, azimuth, pitch, and field of view received via the command interface. The pattern is projected at the sensor's point of intercept elevation, which is recalculated at a configurable interval. If no point of intercept elevation is available, then the pattern is projected at sea level and displayed in a different color. The display parameters of the overlay pattern are configurable.

Figure 28 shows two sensor overlay patterns displayed—one for a sensor onboard the ownship, and one for a sensor onboard a UAV.

SENSOR CAPTURE POINT

For each sensor, FliteScene can display a configurable number of sensor capture point symbols in 2D view, where each symbol represents the point of intercept of where a sensor was looking at a specific moment in time, taking into account the sensor's location, altitude, azimuth, and pitch at the time when the capture command was given. The symbol icon used is configurable. A number is displayed next to each symbol to indicate the sequence number of the capture.

Figure 29 shows three capture points from an onboard sensor.

Operational Features

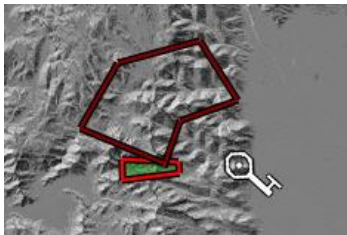


Figure 30 - Sensor perimeter highlighting



Figure 31 - Sensor fusion



Figure 32 - VO dynamic coloring



Figure 33 - Vertical obstruction points

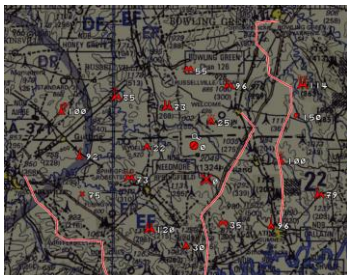


Figure 34 - Manual CHUM lines and points

SENSOR PERIMETER HIGHLIGHTING

For any sensor, FliteScene can display, in 2D view, a perimeter highlight based on a connected series of sensor capture points. With this feature, users can use sensor capture points to highlight an area of interest (e.g., fire, oil slick, search area, danger zone, etc.). The perimeter highlight characteristics are configurable (e.g., max points, line color).

Figure 30 shows a sample perimeter highlight captured from an onboard sensor.

SENSOR FUSION

FliteScene can display a sensor footprint with embedded sensor images blended into the map scene, as shown in *Figure 31*. The sensor footprint and embedded images track the sensor parameters and input images provide to FliteScene resulting in real-time sensor/image display updates within the moving map.

Geo-Symbology

FliteScene manages and displays both predefined and pop-up geographically referenced symbology, which includes vertical obstruction (VO) points, chart updating manual (CHUM), electronic chart updating manual (ECHUM), MIL-STD-2525 tactical symbols, drawing file symbols, local point symbols, route symbols, DAFIF, ARINC 424, Airfield Foundation Data (AFD), shapefiles, keyhole markup language (KML) files, and keyhole markup zipped (KMZ) files. Pre-defined symbols can be created from a variety of sources (e.g., NGA shape files, FalconView® files, XML files, ARINC 424-18 files) as described in the FliteScene DBDD. Pop-up symbology is sent to FliteScene in real time via the FliteScene command interface.

As the map position changes, FliteScene automatically sorts the symbols and displays, and if enabled, all the applicable symbols within the display range. Manual CHUM, drawing files, local points, shapefiles, and KML/KMZ symbols can be loaded when commanded via the command interface and decluttered by filename.

VERTICAL OBSTRUCTION (VO) POINTS

VO points can be displayed in 2D and 3D views. The symbols representing tower, building, pylon, and other VO points are configurable. Each VO point is colored according to the potential danger it poses to an approaching aircraft (see *Figure 32*).

VO points may be decluttered by height and/or by type. An optional text label displaying the above ground-level (AGL) or mean sea-level (MSL) heights in feet can be displayed to the right of the VO point in plan view. In perspective view, VO point symbols are drawn on top of a stem, which marks the position of the VO point on the terrain.

FliteScene supports VO points in digital vertical obstruction format (DVOF) and table formatted aeronautical data set-obstacles (TFADS-O) formats.

Figure 33 shows a 1:5M CDRG map in perspective view with VO points displayed.

MANUAL CHART UPDATING MANUAL (CHUM)

In 2D view, FliteScene can display manual CHUM line and point data read from FalconView® manual CHUM files (*.mch). Manual CHUM data can be decluttered by type (line or point) or by height in the same manner as VO points. The symbols used for manual CHUM point data are configurable.

The manual CHUM line colors are defined by the input files. Manual CHUM point colors can be set to mimic the VO point dynamic colors (*Figure 32*) or can be set to a single color via the command interface. An optional text label displaying the AGL or MSL heights in feet can be displayed to the right of the manual CHUM points.

Figure 34 shows manual CHUM line and point symbols. Note in the figure that the map underlay has been dimmed in to make the symbology stand out. The level of map dim applied can be controlled by the user via the command interface.

Operational Features



Figure 35 - ECHUM points

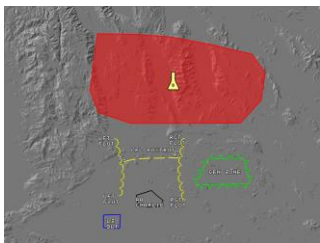


Figure 36 - MIL-STD-2525 tactical graphics

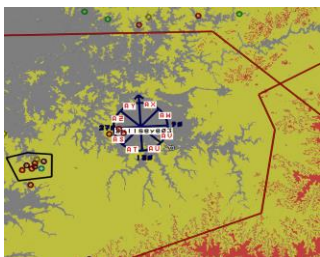


Figure 37 - Drawing file symbols

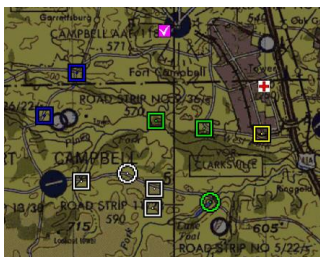


Figure 38 - Local point symbols

ELECTRONIC CHART UPDATING MANUAL (ECHUM)

FliteScene can display ECHUM line and point data in both 2D and 3D views for ECHUM data read from FalconView® ECHUM files (*.ech). Each input file can be associated to its corresponding CDRG product by configuring the ECHUM file to the appropriate map product code. When ECHUM is enabled, FliteScene rasterizes the ECHUM objects onto the associated map. The symbols used for ECHUM point data are configurable. ECHUM line colors are defined by the input files. An optional text label displaying the AGL or MSL heights in feet can be displayed to the right of the ECHUM point symbols.

Figure 35 shows ECHUM point data in red, rasterized onto an ONC 1:1M map.

MIL-STD-2525 TACTICAL SYMBOLS

FliteScene can display MIL-STD-2525 tactical symbols as defined in Appendix A, D, E and G of MIL-STD-2525C, Common Warfighting Symbology. Tactical symbols can be displayed in 2D and 3D views. Tactical symbols are composed of a frame and fill, icon, modifier, optional direction of movement, and optional text label. Tactical symbols can be predefined and loaded during initialization or defined dynamically by the user and set via the command interface. The user can declutter tactical symbols by their affiliation and dimension. Additionally, tactical symbol frame, fill and icon can be configured to be enabled or disabled to assist with decluttering.

The symbol icons and corresponding symbol codes used for tactical symbols are fully configurable via an XML configuration file. The default symbols and codes are defined for MIL-STD-2525C; however, users can modify the XML file to use their own symbol sets for the MIL-STD-2525C codes, or even create their own codes.

Additionally, FliteScene supports a subset of MIL-STD-2525C Appendix B Tactical Graphics. Details regarding the supported subset are defined in the FliteScene ICD.

Figure 36 shows tactical graphics.

DRAWING FILE SYMBOLS

FliteScene can display drawing file symbols in 2D for drawing file data read from both FalconView® and joint mission planning system (JMPS) drawing files (*.xml). Drawing file symbols may be two-point lines, polylines, polygons, rectangles, ellipses, axis of advance, bullseyes, or text. Drawing file symbols are commonly used for, but not limited to, the following:

- > Threat Zone Matrix: Used to depict areas of increased threat activity
- > SAFIRE Tracker: Compilation of recent SAFIRE reports
- > Boundaries: Depicts geographic areas belonging to different controlling agencies
- > Terminal airspace sectors: Control measure for entering and exiting terminal air space without transmitting aircraft position in plan text
- > Operational tactical graphics: Boundaries and phase lines and areas for ground operations

Drawing file objects can be enabled/disabled by filename.

Figure 37 shows drawing file symbols on digital terrain in 2D view.

LOCAL POINT SYMBOLS

In 2D and 3D views, FliteScene can display local point symbols derived from FalconView® local point files (*.lpt) converted to an XML format as described in the DBDD. Up to 216 point types are supported, and the symbol used for each point type is configurable. Local point symbols can be displayed with or without a text label. Common uses of local point symbols include, but are not limited to, the following:

- > Unit points of interest: LZ/PZ locations, FARPs, medical facilities, and other features of interest.
- > Air control points: A series of labeled points covering a geographic area used to enhance air safety and control.

Figure 38 shows local point symbols on a dimmed chart underlay in 2D view.

Operational Features

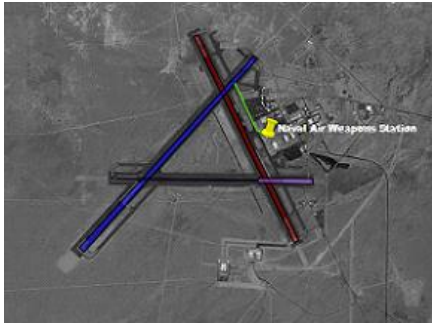


Figure 39 - KML on CADRG in 2D view

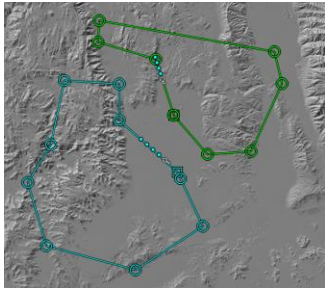


Figure 40 - Route waypoints and legs

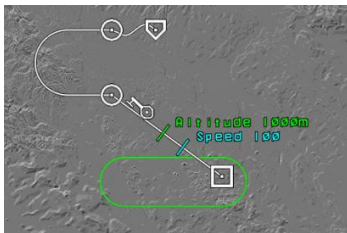


Figure 41 - Enhanced route features

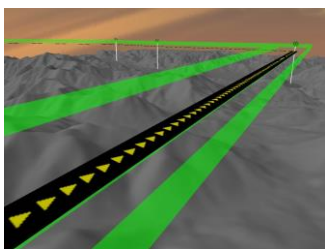


Figure 42 - 3D route display

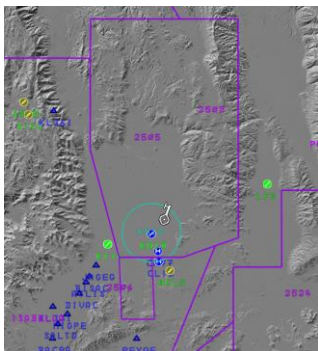


Figure 43 - ARINC 424 symbology

KEYHOLE MARKUP LANGUAGE (KML) AND KEYHOLE MARKUP ZIP (KMZ)

FliteScene can display points lines and polygons in 2D and 3D from open geospatial consortium (OGC) KML files. FliteScene also supports KML data stored in ZIP archives as defined by the Google KMZ standards. KML files are commonly used for rendering vector graphics such as Threat Zone Matrix, SAFIRE Tracker, boundaries, terminal airspace sectors, and operational tactical graphics.

KML/KMZ file objects can be enabled/disabled by filename.

Figure 39 shows KML files on CADRG in 2D view.

ROUTE SYMBOLS

Route symbols, which include waypoints, route legs and corridors, can be displayed in 2D and 3D views. In FliteScene 2.10 the route features have been enhanced for improved performance. The symbol icons for each waypoint type, along with other route display parameters, are configurable. Route data can be decluttered globally, by route, and by type. ID and text labels can be displayed for each waypoint.

Figure 40 shows an ownship route and an UAV route, where each vehicle also has trend dots enabled.

FliteScene also supports the following features, as shown in Figure 41 and Figure 42.

- > Serpentine legs
- > Turning legs
- > Racetracks
- > Speed/altitude gates
- > Route display in 3D

The route line example shown for the 3D route in Figure 42 is a “highway in the sky” texture, which is user configurable. Also shown in this figure are waypoints and corridor lines. All of the route components can be individually decluttered if desired.

ARINC 424 SYMBOLS

ARINC 424 is an international standard file format for aircraft navigation data maintained by Airlines Electronic Engineering Committee and published by Aeronautical Radio, Inc. Many popular navigation databases use the ARINC 424-18 file format, including the FAA National Flight Database and Jeppesen®.

FliteScene can display, in 2D view, the following ARINC 424 symbol types:

- > VHF and NDB nav aids
- > Waypoints
- > Enroute airways
- > Heliports
- > Airports
- > Runways
- > Restricted and controlled airspaces

Each of these types can be individually decluttered. Metadata can also be displayed for any selected point object. The display characteristics (e.g., line color, label color) are configurable. The maximum scale at which a particular type should be displayed is also configurable (e.g., “hide above” declutter).

Figure 43 shows the following ARINC 424 symbols: restricted and controlled airspaces, airports, heliports and waypoints.

Operational Features

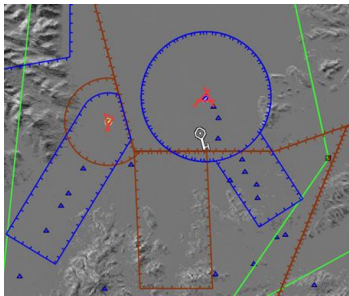


Figure 44 - DAFIF symbology



Figure 45 - Airfield Foundation Data (AFD)



Figure 46 - Generic shape file

DAFIF SYMBOLS

FliteScene reads standard DAFIF-T format files provided by NGA to generate DAFIF symbology—no preprocessing is required.

FliteScene can display the following DAFIF symbol types:

- > Airport
- > Runway
- > Heliport
- > Boundary
- > Route
- > Navaid
- > Special use airspace
- > Waypoint

Each of these types can be individually decluttered. Meta data can also be displayed for any selected point object. The display characteristics (e.g., line color, label color) are configurable. The maximum scale that a particular type should be displayed at is also configurable (e.g., “hide above” declutter).

Figure 44 shows DAFIF objects on slope shaded terrain. As can be seen, DAFIF objects are very similar to ARINC objects.

AIRFIELD FOUNDATION DATA

Airfield Foundation Data (AFD) is an NGA product containing aeronautical information for airfields around the globe. FliteScene requires the ESRI shape file format, due to its ability to be processed quickly in a real-time embedded system. The organization of AFD within shape files is described in full in the AFD (version 2.6) manual. FliteScene will process and render the following AFD feature types:

- > Control tower
- > Navaid
- > ILS component
- > Apron or hardstand
- > Arresting gear
- > Helipad
- > Stopway
- > Runway
- > Runway endpoint
- > Taxiway
- > Displaced threshold points & areas
- > Aircraft hangar
- > Tower
- > Water tower
- > Smokestack

The render parameters (e.g. colors, & icons) for each AFD feature type are configurable. Each AFD feature type can be individually decluttered.

Figure 45 shows AFD features over CIB.

SHAPE FILES

While FliteScene uses shape files for vertical obstruction point and Airfield Foundation Data, generic shape files are also supported. Generic shape files won't provide metadata and some of the enhanced capabilities like the VO and AFD features provide, but it provides a generic way to display just about anything in FliteScene. The shape file feature provides support for point, line and area shape files. The display characteristics of shape files are configurable.

Figure 46 shows vertical obstruction power Lines loaded through the generic shape file interface.

Operational Features

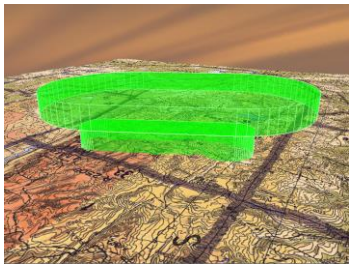


Figure 47 - Multipoint ACO objects displayed in 3D

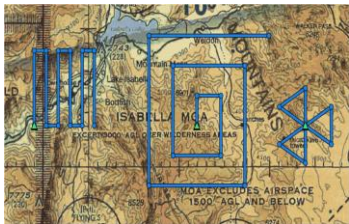


Figure 48 - Search patterns
Left: parallel path, Middle: expanding square, Right: sector search



Figure 49 - Range rings



Figure 50 - Text box

AIRSPACE CONTROL ORDER (ACO) OBJECTS WITH TIME EFFECTIVITY

FliteScene can display ACO symbology in 2D and 3D views, including:

- > Circle
- > Orbit
- > Corridor
- > Line
- > Point
- > RadiusArc
- > PolyArc
- > Polygon
- > Track

FliteScene can also apply time effectivity to ACO symbology to indicate if a symbol is currently active or inactive based on time parameters passed into FliteScene via the command interface.

Figure 47 shows a multipoint ACO in 3D.

SEARCH PATTERNS AND AREAS

FliteScene can display geographically referenced search patterns and areas in 2D view. The number of search patterns and areas is configurable. A search area is a circular expanding area which continues to increase (or decrease) in size based on a specified expansion rate. The initial location and radius of the search area is also specified.

FliteScene also supports the following search pattern types: parallel path, expanding square, and sector search. For each of these types, there are a number of user specified parameters, as shown below:

PARAMETERS	PARALLEL PATH	EXPANDING SQUARE	SECTOR SEARCH
Number of tracks (legs)	✓	✓	
Track length	✓		✓
Track (leg) spacing	✓	✓	
First turn direction	✓	✓	✓
Initial position/heading	✓	✓	✓

Figure 48 shows an example of the various search pattern types.

User-Defined Symbols

User-defined symbols are based on user-commanded parameters. They consist of geographically referenced or screen-referenced lines, polygons, arcs, strings and graphic symbols. User-defined symbols can be displayed in 2D or 3D view. In 2D view FliteScene also supports an off-screen indicator for geo-graphically referenced user-defined symbols.

RANGE RINGS

FliteScene supports range rings in 2D view. Range rings can be pinned to the ownship vehicle, screen or geographic coordinate, or any other symbol in FliteScene (e.g threat, alternate vehicles). Range ring characteristics such as color, number of rings, labels and angle sweep are configurable.

Figure 49 shows an example of range rings.

TEXT BOXES

Text boxes support a variety of usages, including messaging, chat and general text display with scrolling capability. The quantity, size and appearance of text boxes are configurable. Other text box features include:

- > Individual declutter
- > Set/retrieve text
- > Word wrap
- > Text cursor for easy text insertion or deletion

Figure 50 shows an example text box display.

Operational Features



Figure 51 - Bezel key symbology



Figure 52 - CLOS symbology. Top: clear; Middle: blocked; Bottom: unknown

CONFIGURABLE FONTS

In addition to the built-in system font, FliteScene supports user defined true type fonts (TTF). Fonts are defined during initialization via configuration file. FliteScene supports configurable fonts for user-defined symbols, text boxes and range rings. A font loaded at initialization is selected at run time for each individual symbol. FliteScene fonts also support the full extended ASCII set.

BEZEL KEY SYMBOLS

FliteScene provides a plug-in to simplify the display and use of symbology commonly associated with bezel key type displays. These symbols include bezel buttons, labels and list boxes. They are screen referenced and can be displayed in any view. Users specify the screen location and image filename to use for each bezel button. Multiple filenames can be specified for a single button that has multiple states (e.g., selected, not selected). The interface is very flexible to support a wide variety of user display needs.

Figure 51 shows some example bezel key symbols.

Cursor Symbols and Features

A cursor symbol can be displayed in 2D or 3D views and positioned as commanded via the command interface. Up to 16 different sprites can be configured to represent the cursor symbol. In 3D view, the cursor can be used to interact with screen referenced symbology (e.g., selecting bezel keys) and data queries. In 2D view, the cursor can also be used to interact with georeferenced symbology.

FliteScene cursor features include the following:

- > Return latitude, longitude, and elevation at cursor position
- > Returning unique ID(s) associated with cursor selected object(s) (i.e., symbols, geo lines, route legs) that are located within a specified range of the cursor position
- > Return symbol information and metadata for a unique ID
- > Highlight a symbol associated with a unique ID
- > Render a screen referenced copy of a symbol associated with a unique ID
- > Move a symbol associated with a unique ID
- > Delete a symbol associated with a unique ID

These FliteScene cursor features provide a powerful and flexible interface for performing a wide range of user-to-map related interactions. For example, if multiple symbols are within the user-defined cursor range, the user can cycle through the returned unique IDs, highlight a specific symbol, query for symbol information, drag/drop a symbol to another location, or delete a symbol. FliteScene's text box feature could also be used to display queried information as shown previously in Figure 50.

Clear Line-of-Sight (CLOS) Symbol

The CLOS symbol can be displayed in 2D view. When enabled, the CLOS symbol is displayed following a CLOS Data Request (see Clear Line-of-Sight in the Data Requests section). Three configurable colors are used when displaying the CLOS symbol: clear, blocked and unknown. The clear color is used when line-of-sight is clear. When line-of-sight is blocked, the clear color is used up to the obstruction, and the blocked color is used from obstruction to end point. When busy processing, or when the elevation data needed to compute is not available or is invalid, the unknown color is used to draw the line between the two end points.

Figure 52 shows clear, blocked, and unknown CLOS symbols

CLEAR LINE-OF-SIGHT (CLOS)—PIN TO OWNERSHIP

When enabled, FliteScene will automatically tie the CLOS starting point to the ownership location and periodically update the displayed CLOS. This creates a "rubber-band" effect where the CLOS starting point moves with the ownership. The update rate is configurable.

Operational Features

Elevation Profile

When enabled, FliteScene will display an elevation profile in 2D view corresponding to the displayed CLOS symbol. As shown in *Figure 53*, the elevation profile can be scaled to match any portion of the CLOS symbol as indicated by a slider highlighted on the CLOS symbol. This provides detailed 3D terrain awareness in a 2D view. The elevation profile colors match the terrain elevation banding colors set by the user. The X-axis label provides an indication of distance, and the Y-axis provides an indication of height.

Point of Intercept (POI) Symbol

A POI symbol can be displayed in 2D view. When enabled, the POI symbol is displayed following a POI data request (see Point of Intercept in the Data Requests section). The POI symbol is composed of a sprite symbol and a line as shown in *Figure 55*. The sprite symbol is a configurable symbol that is displayed at the point of intercept, if one exists. Two configurable colors are used when displaying the POI line: clear and unknown. When no point of intercept exists, a line is drawn in the clear color from starting point to the end of the elevation scene. If the end of the elevation scene is reached, the unknown line color is drawn from the end of the elevation scene to the edge of the display area as shown in *Figure 54*. When a point of intercept does exist, the clear color is used up to the intercept, and a symbol is drawn at the intercept point. When busy processing, or when the elevation data needed to compute is not available or invalid, the unknown color is used to draw a line from the starting point to the end of the display area as shown in *Figure 56*.

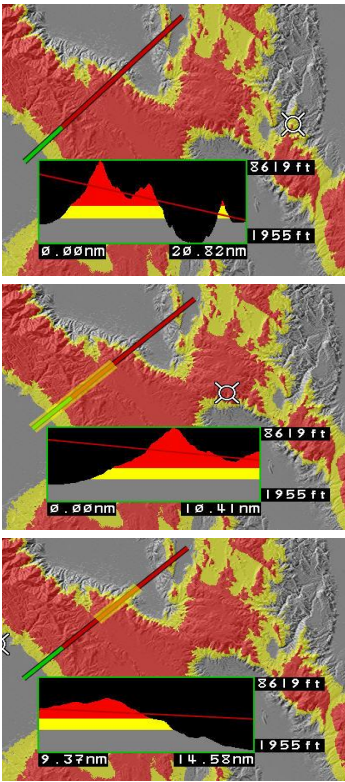


Figure 53 - Elevation profile inset corresponding to CLOS line. Top: full line; middle: half line; bottom: quarter line



Figure 54 - No POI found



Figure 55 - POI found



Figure 56 - POI unknown

Operational Features

Range/Bearing

A range/bearing line can be displayed in 2D view. When enabled, a range/bearing line is displayed between two points following a range/bearing data request (see Range/Bearing in the Data Requests section). The two points are provided via the command interface. A text box could be used to display the range and bearing information that is returned from FliteScene. The display parameters are configurable.

Figure 57 shows range/bearing from the ownship to a specified MGRS grid (displayed using user-defined symbology). The results of the range/bearing data request are displayed using the text boxes feature.

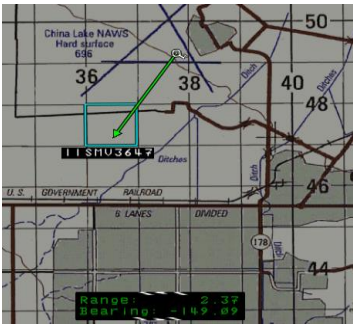


Figure 57 - Range/bearing

North Indicator

FliteScene Screen Symbology can be used to display a north indicator symbol in 2D and 3D view as shown circled in Figure 58. The icon used for this symbol is configurable (e.g., a full compass rose icon could be used if desired).

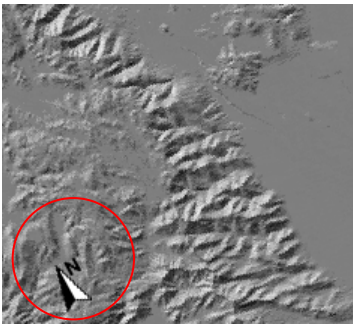


Figure 58 - North indicator

Compass Rose

When enabled, a Compass Rose is displayed about the ownship in 2D view as shown in Figure 59. There are 16 configurable compass rose patterns to choose from, and up to 16 configurable pointers can be displayed on the compass rose. Compass rose display parameters (e.g., color, radius, tick separation, width, outline, etc.) can be changed via the command interface. In addition, a magnetic north offset can be supplied via the command interface.

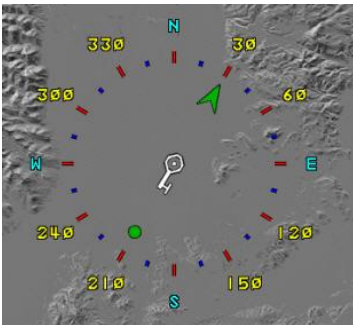


Figure 59 - Compass rose

Landing Zones

When enabled, the landing zone symbols are displayed about the commanded landing zone position as shown in Figure 60 and Figure 61. There are 5 different view modes that can be displayed: beacon, low resolution LZ, medium resolution LZ, high resolution LZ and auto. The auto mode will allow FliteScene to determine which view mode to display based on distance to the landing zone. The landing zone color and approach light colors are commandable, while the rotor diameter, approach light length, beacon height, and blink interval are all configurable.

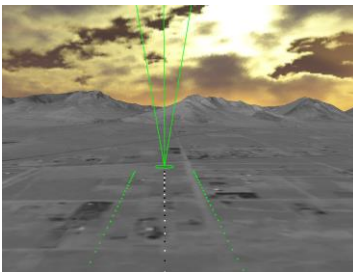


Figure 60 - Landing zone beacon

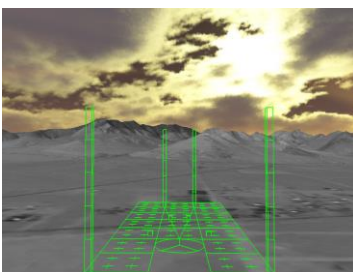


Figure 61 - Landing zone high res

DATA REQUESTS

Coordinate Conversions

In 2D and 3D views, a coordinate conversion request, given a latitude/longitude coordinate, provides a screen coordinate. In 2D view, given a screen coordinate, a coordinate conversion request provides a latitude/longitude coordinate. These conversion functions can be provided in a separate Projection Server library if desired.

Vertical Data Requests

A vertical data request, given a screen coordinate or a latitude/longitude coordinate, provides the applicable vertical data value (elevation if terrain or depth if bathymetry) at that location.

Clear Line-of-Sight (CLOS)

CLOS can be determined in 2D and 3D views. The concept of line-of-sight (LOS) refers to a path connecting an observer and the point being observed (the target). CLOS uses elevation information to determine if the line-of-sight between two points is clear or obstructed. This request returns the latitude, longitude, and terrain elevation of the obstruction point, if it exists.

Point-of-Intercept (POI)

POI can be determined in 2D and 3D views. POI determines the terrain intercept point for a defined line. This request returns the latitude, longitude, and terrain elevation for the first obstruction encountered along the defined line.

Range/Bearing

FliteScene returns range and bearing information via the command interface for any two specified points as described in the FliteScene ICD.

Military Grid Reference System (MGRS)

In 2D and 3D views, FliteScene supports MGRS conversion requests. Requests can be for the MGRS code corresponding to a geo lat/lon or a screen X/Y coordinate. FliteScene can also return the geo lat/lon coordinate corresponding to an MGRS code.

Degrees Minutes Seconds

In 2D and 3D views, FliteScene supports conversion request between degrees minutes seconds and latitude longitude coordinates. FliteScene returns the decimal values along with a formatted string that could be displayed via a textbox.

Data Frame Response

When enabled, FliteScene will provide a response message to each data frame control message with pertinent information about the image, including number of pages (for PDFs), image type, image width and image height.

Acronyms

ACRONYMS

ADRG.....	Arc Digitized Raster Graphics
ACO.....	Access Control Object
AFD.....	Airfield Foundation Data
AGL.....	Above Ground Level
ARINC.....	Aeronautical Radio, Incorporated (standards)
CADRG.....	Compressed Arc Digitized Raster Graphics
CG.....	City Graphics
CHUM.....	Chart Updating Manual
CIB®.....	Controlled Image Base
CLOS.....	Clear Line of Sight
COTS.....	Commercial Off The Shelf
DAFIF.....	Digital Aeronautical Flight Information File
DBDD.....	Database Design Document
DBDB-V.....	Digital Bathymetric Data Base – Variable Resolution
DTED.....	Digital Terrain Elevation Data
DVOF.....	Digital Vertical Obstruction Format
ECHUM.....	Electronic Chart Updating Manual
ECRG.....	Enhanced Compressed Raster Graphics
ESRI.....	Environmental Systems Research Institute, Inc.
FAA.....	Federal Aviation Administration
FARP.....	Forward Area Rearm/Refuel Point
FQT.....	Formal Qualification Test
FV.....	FalconView®
GEO.....	Geographic
GNC.....	Global Navigation Chart
HAT.....	Height Above Terrain
HMI.....	Human Machine Interface
HRTE.....	High Resolution Terrain Elevation
ICD.....	Interface Control Document
ID.....	Identification

Acronyms

JMPS	Joint Mission Planning System
JNC	Jet Navigation Chart
JOG	Joint Operations Graphics
JPEG	Joint Photographic Experts Group
KML	Keyhole Markup Language
KMZ	Keyhole Markup Zipped
LFC	Low-Flying Chart
LOS	Line-of-Sight
LZ	Landing Zone
MGRS	Military Grid Reference System
MrSID	Multiresolution Seamless Image Database
MSL	Mean Sea Level
NGA	National Geospatial-Intelligence Agency
OGC	Open Geospatial Consortium
ONC	Operational Navigation Chart
PDF	Portable Document Format
PNG	Portable Network Graphics
POI	Point of Intercept
PZ	Pick-up Zone
RDTED	RegridDED DTED
SAFIRE	Surface-to-Air Fire
TFADS-O	Table Formatted Aeronautical Data Set-Obstacles
TFC	Transit Flying Chart
TIFF	Tagged Image File Format
TIV	Threat InterVisibility
TLM	Topographic Line Map
TPC	Tactical Pilotage Chart
TTF	True Type Format
UAV	Unmanned Aerial Vehicle
VO	Vertical Obstruction
XML	eXtensible Markup Language

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