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ADAMS FUNCTIONAL DESCRIPTION

FOR THE

CORONA 350 II

FLIR SYSTEMS POLYTECH AB

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Introduction

Overview

The FLIR Systems Polytech AB's Corona 350 II is dedicated to the aerial survey and inspection of transmission towers, lines and asset infrastructure.

The Airborne Data Acquisition and Management Software or ADAMS is easy to use mission software that provides operational efficiencies and user-friendly methods for identifying faults and defects in existing transmission assets.

From initial planning and sensor management, to fault detection and data recording, all mission data captured by ADAMS is retained for post-mission analysis. This includes all video and high-resolution still images captured in the visible, thermal, and ultraviolet spectrums.

ADAMS features include:

- User-customizable asset database import and database management tools
- User-customizable Moving Map Display (MMD)
- Display geo-spatial asset data on the digital MMD
- Effective sensor management and data recording capabilities
- Gimbal off-sets to reduce operator fatigue
- Continuous recording of aircraft and camera boresight positions
- Post-mission analysis & review of captured mission data
- Export still images, video, and metadata for post-mission reporting/ archive
- PDF report generation (using FLIR Reporter Pro software)

Purpose

This document describes functional asset inspection, sensor management, and mission management features of the mission system software for the Corona 350 II system.

ADAMS Functional Description

The mission system software is used for mission planning, inspection flight definition, and operator control and the airborne recording for fault/ maintenance management of transmission assets.

The main features of the mission software are detailed below.

Setup & Configuration

Corona 350 II Camera Integration

The Corona II gimbal contains 3 video cameras and one still image camera. Inspections require an easy way to view and control individual video cameras and quick access to the still camera.

The display can be configured with the 3 video cameras as illustrated in the figure below. Toolbar buttons are provided for the user to choose which video they want to view and control in the main panel.

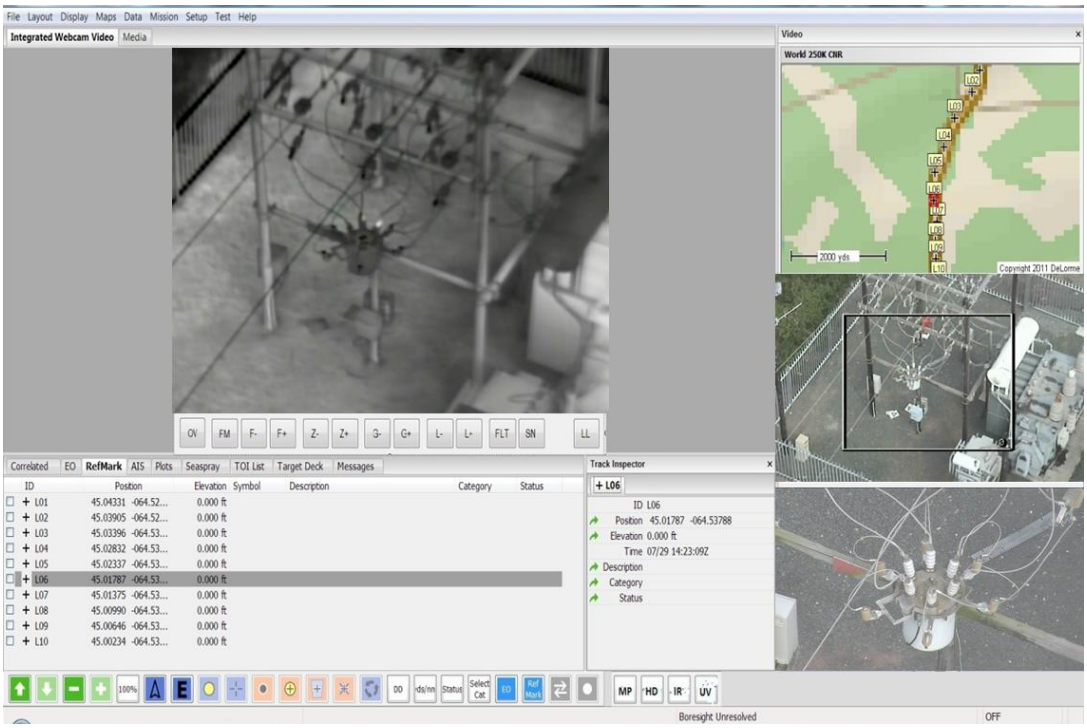


Figure 1 – Output from the FLIR IR Imager in the View-in Main configuration

All sensor controls for the following sensors are issued by the ADAMS software:

- Thermal radiometric infrared video camera (Figure 2)
- Corona discharge video camera (Figure 3)
- High Definition color TV video camera (Figure 4)
- High Resolution photo camera (Figure 5)

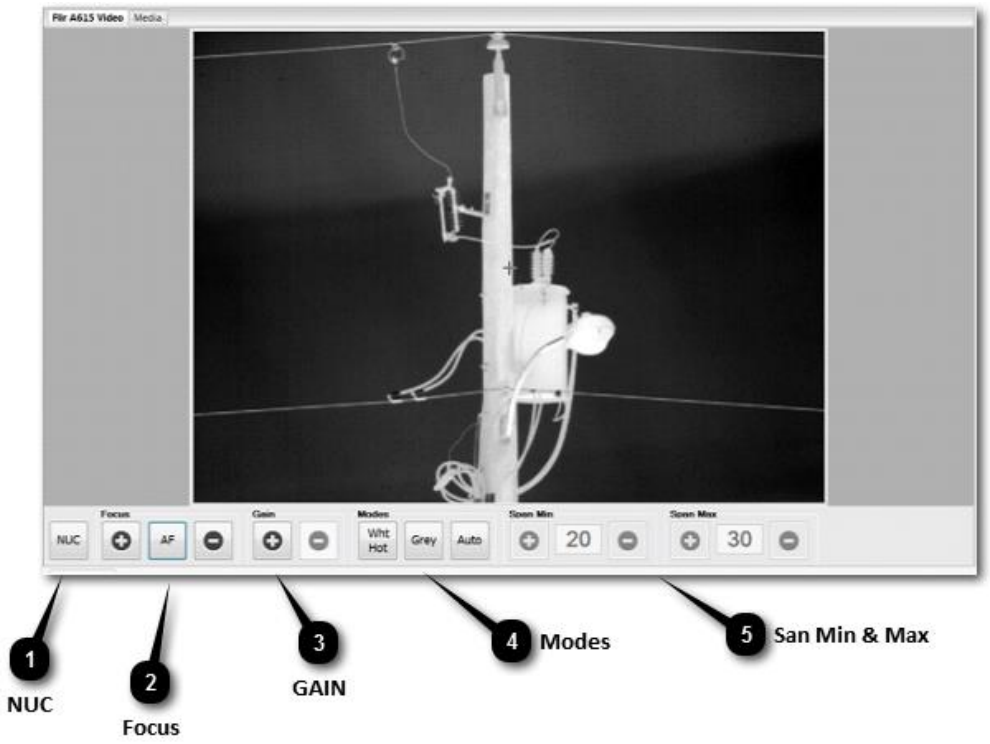


Figure 2 – Infrared Camera Controls in the View-in Main configuration

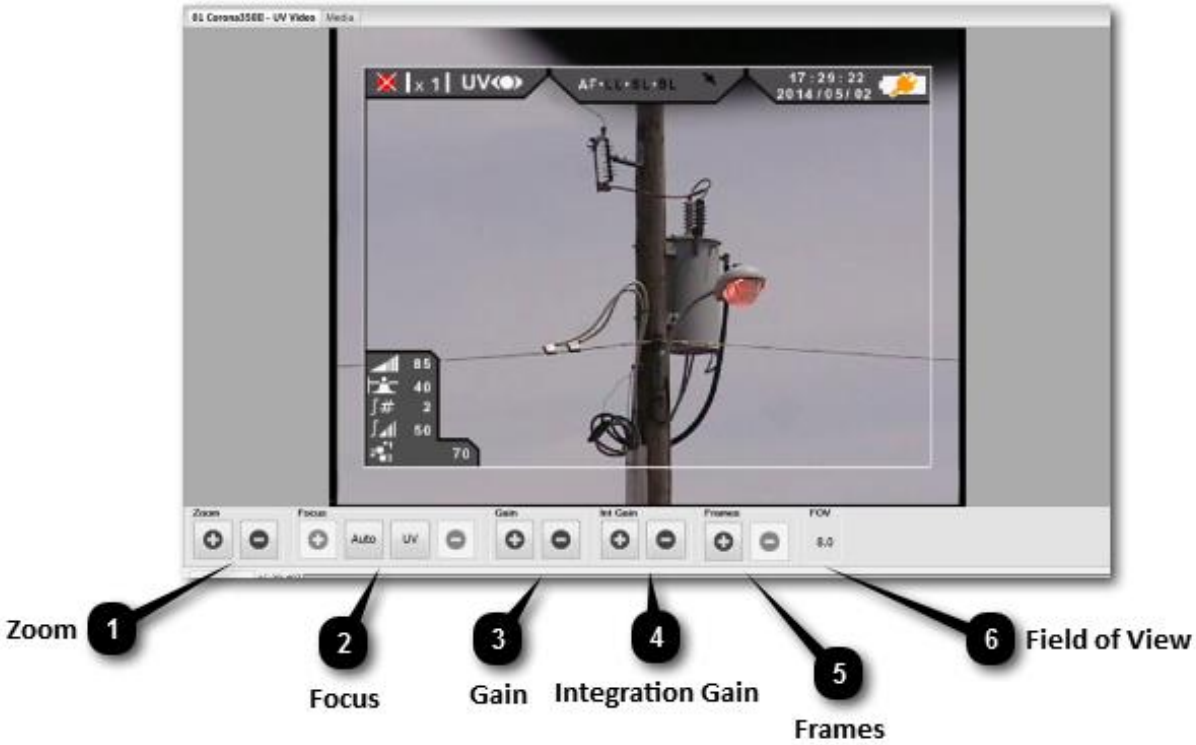


Figure 3 – UV Camera Controls in the View-in Main configuration

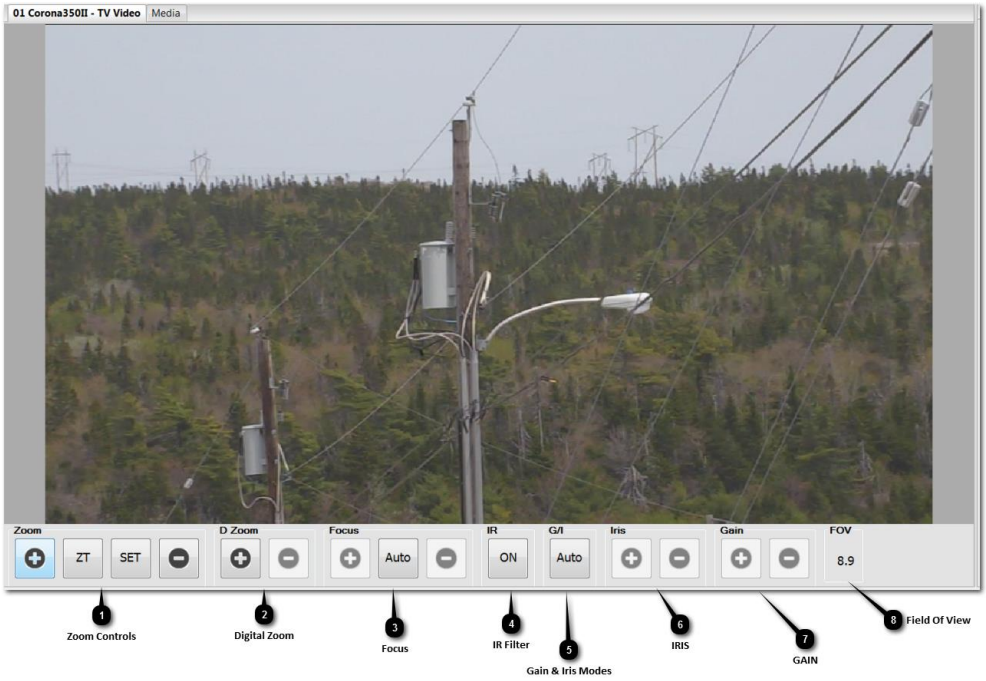


Figure 4 – HD TV Camera Controls in the View-in Main configuration

The digital photo camera provides limited video through a "Live Video" mode where the user can adjust the camera controls prior to taking a snap shot. This camera and associated controls will be available as a model dialog as illustrated below.

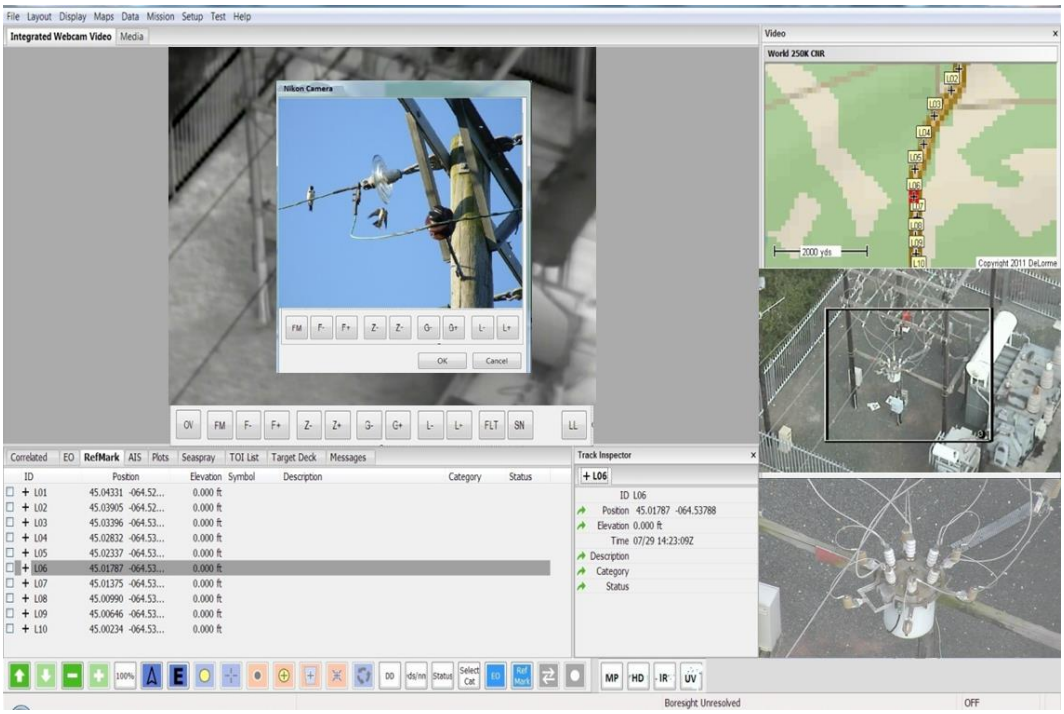


Figure 5 – Digital Photo Image Dialog

A toolbar button provides quick access to the dialog when the end user needs to take high-resolution pictures. Any position (latitude, longitude, elevation) displayed, including imported transmission assets, may be used as a 'slew-to-cue' reference for the camera system.

Data Import (customer's asset database)

The ADAMS asset database contains asset tables that can be tailored to meet different customer asset attribute lists, and is capable of holding in excess of 500,000 individual assets.

The customer will be required to export their asset data in ESRI Shapefile format so that custom-asset data can be imported by ADAMS. Shapefile was selected to ensure ADAMS supports a specific but flexible format to accommodate a wide range of customer asset databases.

When exporting custom asset data, customers should ensure each point has a unique numeric ID, a position specified as WGS84 latitude and longitude and attribute data specified using name, value and type.

During the import process into ADAMS, the points will be spatially indexed and stored in a read only database containing the complete data set. This data set may be further processed into a map layer for efficient drawing on the map panel in ADAMS.

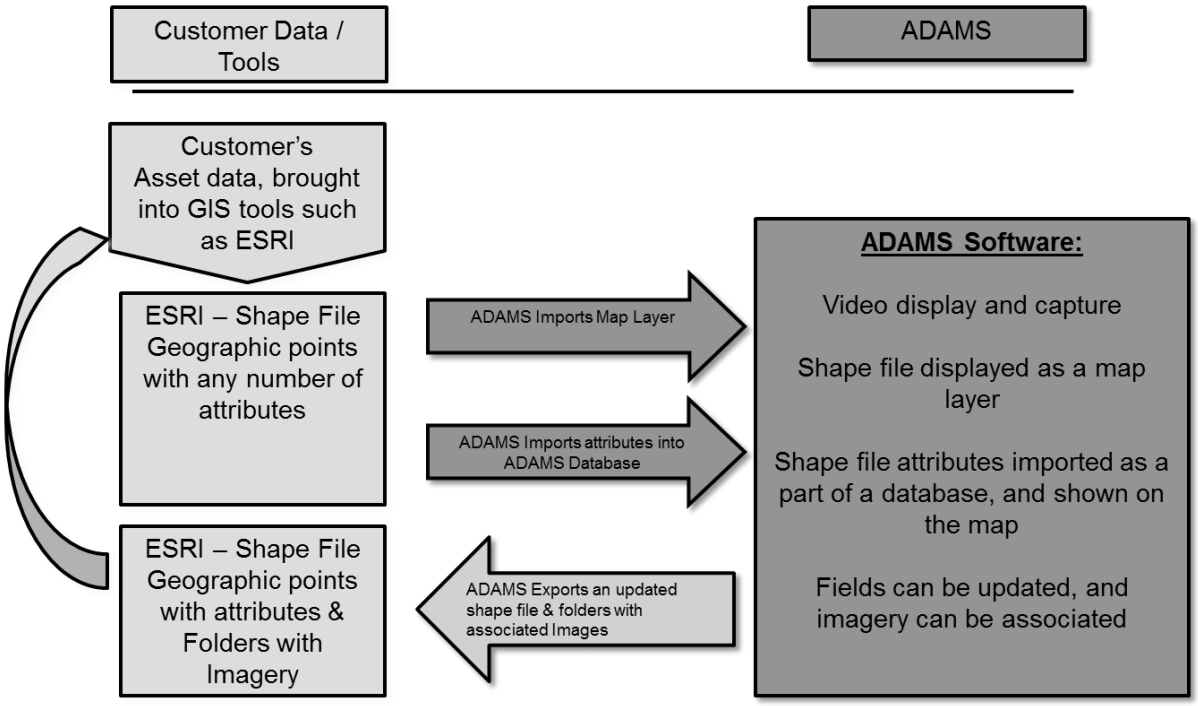
During the import process, the user will also have an opportunity to select and order which attributes will be included in ADAMS and to assign properties including editable/non-editable and hidden/shown.

For example, attributes may include, but are not limited to:

- Asset ID Number
- Asset Line Designation
- Asset Position
- Asset Elevation
- Asset Defect Data
- Asset Data Modified/ Update
- Additional customer specific data attributes

On import of the initial asset database in Shapefile format, a read only ADAMS database is created to hold the complete set of values. The asset data is shown in an optimized version of the track list, which can query the asset database and buffer a subset of the data.

Editing of the asset data is done through a modified version of the track inspector which uses the asset attribute values and types to configure the interface for efficient editing of the values by the end user. For example, a drop down list may be provided for an attribute that has a fixed range of values determined during import.



Pre-Mission Preparation

Map Converter

ADAMS supports industry standard raster and vector map formats, and provides a standalone map converter application to enable the user to import custom map sets and elevation data.

Digital map formats may be grouped into three generic categories:

- Raster Format.
- Vector Format.
- Gridded Elevation Data Formats.

Raster Map Formats

Raster map data is simply a graphical representation of the Earth's surface that has been geographically referenced. The popularity of raster map data stems from its convenience and relative availability. Raster maps can include anything from geo-referenced EO/IR imagery, satellite imagery, and aerial photographs to ad-hoc scans of topographical paper maps.

Common raster map formats include:

- GeoTIFF
- CADRG
- CIB

The level of detail available in a raster map is defined by the number of geographical degrees per pixel in the source imagery. Therefore, the inherent disadvantage of raster maps is that the resolution is fixed. In other words, as the map is magnified (zoomed-in), the imagery is stretched and can become very pixelated. Depending on the size and resolution of imported raster maps, rendering performance can be degraded when large raster maps are viewed at low zoom levels.

Vector Map Formats

Unlike raster data that contains map images, vector data is comprised of points, lines and symbols representing geographical features. For example, the outline of a land mass may be represented by a series of points, connected by lines and filled with a specific colour. The advantage of this is that, as a vector map is magnified, all features are scaled to the new zoom level and redrawn. Therefore, regardless of zoom level, there will be no pixelation of the map.

Common vector formats include:

- S-57 Digital Chart Files
- S-63 Encrypted Digital Chart Files

When vector maps are imported, the Map Converter converts all vector map data to the CarteNav Map Format (CNV). CNV is a proprietary format developed by CarteNav Solutions Inc. to take advantage of modern computer graphics cards and greatly improve the rendering speed of vector maps imported into AIMS.

Elevation Data Formats

Digital Elevation Data (DEM) formats (also known as Gridded Elevation Format) could easily be described as 'collections of geo-referenced elevation values divided into rows and columns'. The density and detail of the elevation data in DEM products will vary depending on the data set used.

There are four types of DEM data suitable for use in ADAMS:

- Digital Terrain Elevation Data (DTED) Format
- USGS Digital Elevation Model (DEM) Format
- USGS Digital Elevation Model, (GeoTIFF) Format.

There are various levels of DTED:

•**DTED Level 0 (or 30 arc second post spacing)** - Allows for general modeling and assessment activities.

•**DTED Level 1 (or 3 arc second post spacing)** - Allows for military activity and systems that require medium resolution digital landform, slope and elevation data.

•**DTED Level 2 (or 1 arc second post spacing)** - Allows for military activity and systems that require high-resolution digital landform, slope and elevation data.

WGS-84 Map Projection

World Geodetic System (WGS) is the standard projection used in cartography and navigation. The coordinate origin of WGS-84 is located at the Earth's theoretical center of mass. Most importantly for AIMS, WGS-84 is the reference coordinate system used by the U.S.-based Global Positioning System (GPS). As the U.S. Global Positioning System (GPS) is the most commonly used source of navigation data, ensure the projections used for all geo-referenced map sets imported into AIMS use WGS projection, WGS-84.

Mission Planning (asset sub-set definition)

ADAMS is capable of holding asset tables in a searchable asset database. When correctly configured, any asset selected by the operator may be used as a geographic reference for steering the camera system.

After import of the complete asset data set, the user may limit the data shown for a mission to a manageable sub-set. Asset data sets can be in the range of hundreds of thousands of points and the working set will likely be in range of hundreds of points.

A mechanism is provided for the user to select a "work set" from the full data set and these points will be saved to a writable asset database for editing during the mission. Selection of the working set will be accomplished using geographic regions defined on the map using ADAMS Vector Graphic (AVG) shapes as shown in the Figure below.

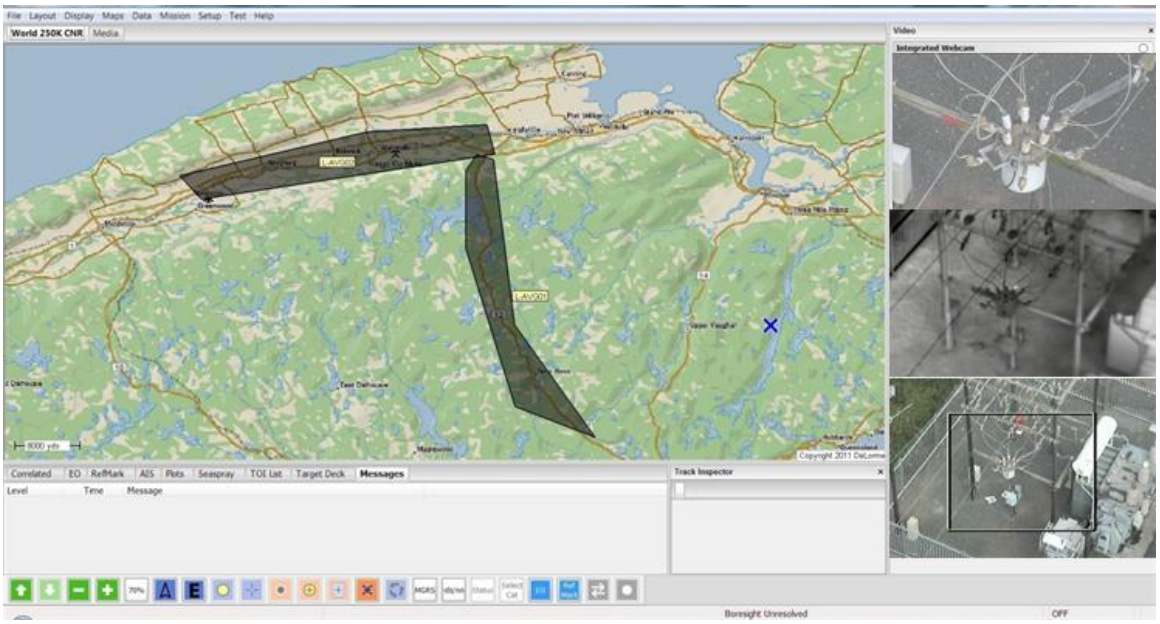


Figure 6 - Work-set Creation

Using the full data set as a guide (which is rendered on the Map panel in ADAMS), the user creates AVG shapes covering the areas to be included in the current mission. The user can then right click on a shape and choose "Add to work set" or "Remove from work set".

In-flight Operation and Control

User Interface

The mission management computer (MMC) for the ADAMS system is the Getac X500 Ultra-rugged Notebook. The X500 features a 15.6-inch full HD 1080p, sunlight readable, widescreen display with touchscreen capability, delivering crystal-clear display of sensor output in all operating environments.

The graphical User Interface (UI) provides all necessary human-machine interactive features required to record, display, edit, sort, and delete all attributes associated with individual assets.

Moving Map Display

ADAMS uses the built-in GPS receiver to display aircraft position, course, and speed on the MMD.

The WGS-84 geographic datum is used with map data projected in a variety of user-selected position formats, including Decimal Degrees (DD), Degrees Minutes Seconds (DMS), Universal Transverse Mercator (UTM), and more…

Built-in attitude heading reference system is combined with the aircraft's GPS position and the ADAMS mission system software's accurate global digital terrain elevation data model, to calculate the camera boresight line.

The camera boresight line is dynamically displayed relative to the aircraft position, deriving critical target information such as the direction the camera is looking, the geographic boresight position and elevation, and the off-set angle with respect to the aircraft's heading[1].

[1] Not the Track Made Good (TMG).

Local Operating Picture

Work Sets created by the operator during pre-mission preparation are listed in the Track Inspector Panel, and are digitally rendered over the MMD. This is called the Local Operating Picture (LOP).

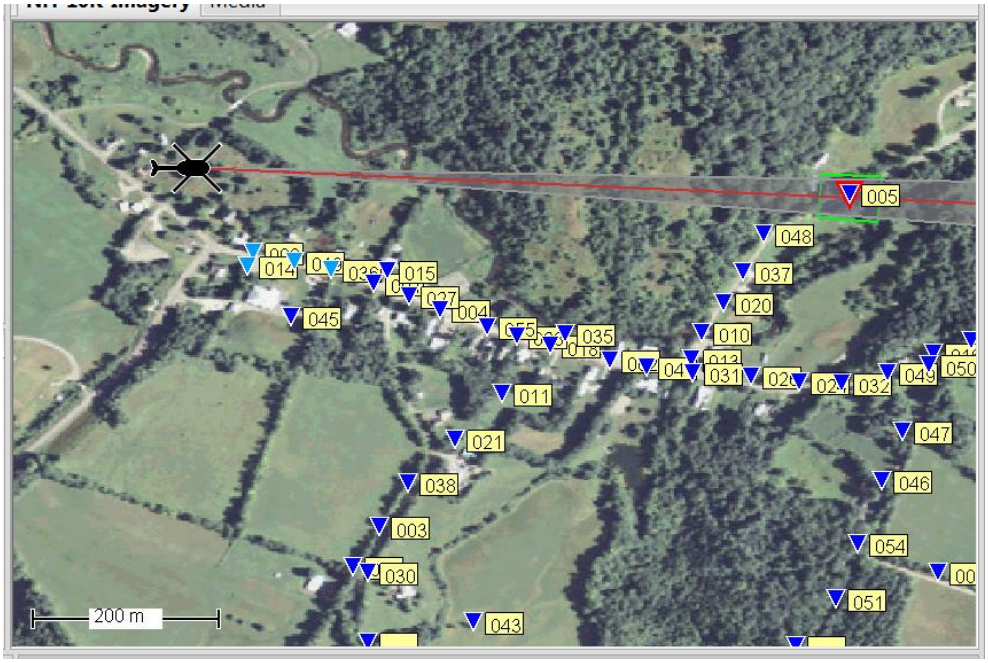


Figure 7 - Example of the Local Operating Picture (LOP)

In addition to rendering transmission assets earmarked for inspection, ADAMS enables the Operator to create polylines, polygons, circles, rectangles, and routes over the MMD.

This can be achieved either by clicking in the Maps Pane to generate the desired ADAMS Vector Graphic (AVG), or by graphically recording the boresight position of the camera system—rendering the recorded boresight track history on the MMD.

At any time, the LOP may be oriented with reference to the aircraft position, boresight position, or any asset or point rendered on the MMD.

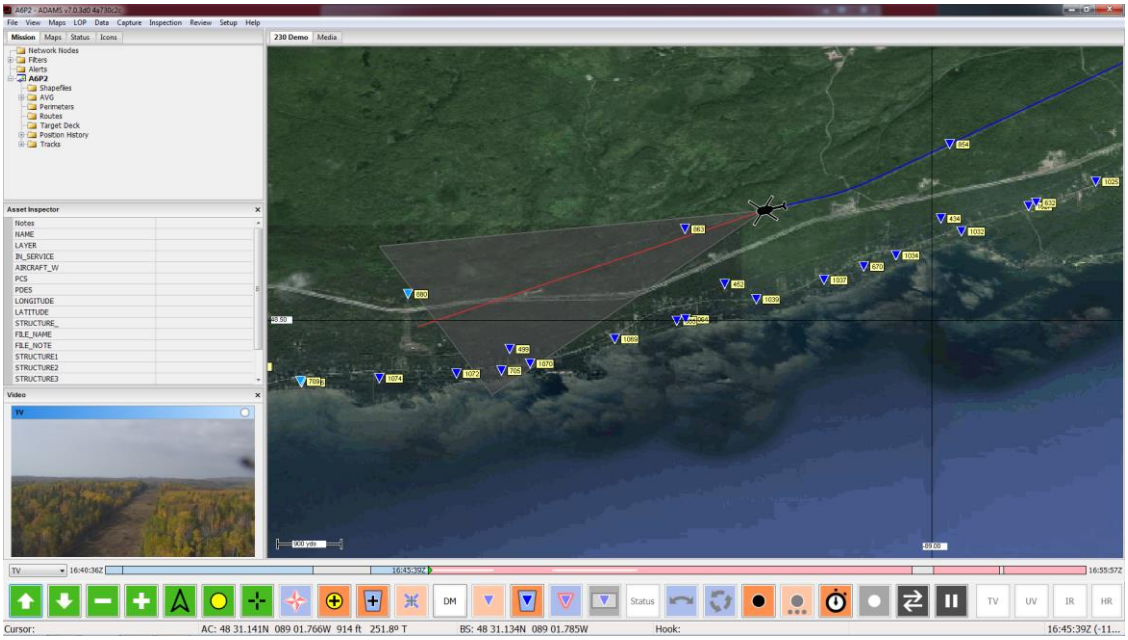


Figure 8 - Aircraft, Boresight Positions and Boresight Line displayed in the LOP

Camera Display & Control

Sensor Display & Management

The intuitive user interface enables the Operator to display and adjust a variety of different Layout Options with live sensor video output simultaneously next to the moving map display. Options can include picture-by-picture and view map or video in main (full screen).

Additionally, any individual pane or panel displayed in the ADAMS mission system software may be hidden or shown at any time without affecting what imagery or mission data is recorded to the hard drive.

Similarly, a number of Display Options allow the Operator to de-clutter the tactical display to ensure only the most relevant information is readily available, but that any information may be recalled at anytime throughout the mission.

Gimbal Control

ADAMS provides a number of manual and on-line methods for steering the camera system:

- Manual control via the MMC hand controller
- Slew-to-cue commands issued by the mission system software
- Fixed-offset with reference to the aircraft heading, or
- Geo-lock controls for holding the boresight position at any nominated latitude-longitude.

Data Capture

Video Recording

ADAMS is capable of recording one, or all, available video outputs from the IR, UV and HD TV cameras.

Still Image Capture

During inspection operations, the Operator will collect images and edit the data for existing assets. ADAMS mission system software may be used to capture high-resolution still images from any of the four sensors, in particular, the high resolution digital photo camera.

Still images associated with selected assets may be viewed at any time throughout the mission.

Metadata Capture

Aircraft navigation data, such as aircraft and boresight position, is appended to all captured imagery products by way of the image metadata. All captured video clips and still images are time-stamped, and may be synchronized with the associated geo-spatial mission data.

To provide immediate operational context to the imagery collected, all video clips and still images are associated with the applicable asset, selected in the active work set.

Note – All still images and video clips are stored separately on the MMC hard disk drive with the associated metadata files.

Vector Overlays

ADAMS mission system software records both the aircraft position and boresight position track histories for the duration of a mission. Track history overlays may be divided into portions and displayed as separate elements during post-mission analysis and review. Track history overlays may be exported any time during a mission in Shapefile format.

Screen Captures

Sometimes it is simpler to show someone what is on your screen than it is to try and explain it. ADAMS is a Windows© based application capable of grabbing screen captures of the current UI configuration. Screen captures may be saved anywhere on the hard disk drive in the .jpg image format.

The following data is captured from the Corona 350 II Camera System:

CORONA 350 II	Video Recording		Still Image Capture	Metadata	Notes
	Continuous	Clips			
HD TV Video Camera	Yes	Yes	Yes	Yes	
UV Camera	Yes	Yes	Yes	Yes	Video clips aid in the post-mission capture of intermittent Corona bursts.
Thermal Camera	Yes	Yes	Yes	Yes	Still Images captured in FLIR IMG Format for temperature readings taken post-mission.
Digital Photo Camera	-	-	Yes	Yes	

Table 1 - Imagery Products captured from Corona 350 II Sensor Systems

Asset Database Management

The asset database management tools of the ADAMS enable operators to search for, identify, edit, update, and annotate a variety of selected user-defined attributes associated with individual assets; whether they are operating from the map to the ground or from the ground to the map.

This includes the ability to quickly sort asset data in the active work set to identify individual assets that are subject to obstructions, defects, and hazards that require preventative, or reactive maintenance attention. These assets with specific attributes applied (i.e. open work orders associated with the asset) can be rendered differently on the LOP.

The active asset database rendered on the LOP, will have as a minimum, but not limited to the following features:

- Display the underlying reference map set
- Display all assets in the active work set, when extracted from the master asset database
- Provide suitable display options (asset colour, hide/ show, etc.) to easily distinguish individual assets with user-defined attributes, (for example, inspected poles, un-inspected poles, fault/ defects detected, no faults/ defects not present etc.)

At any time during the mission, operators can select any individual asset either from the LOP display or the active work set in the Tracks Pane, and edit the values of the user-nominated attributes.

Similarly, can create, modify, or delete information associated with individual assets imported into ADAMS in the active work set, indicating new and missing assets as required by the mission.

Upon completion of the mission, the writable asset database contains the updated asset information, which is associated with the collected image and video data. An export mechanism is provided to produce edited work sets in Shapefile format.

Mission Analysis & Review

ADAMS records all critical mission parameters at all times (when Capture Mode is enabled), removing the requirement to perform a 'save' operation.

Post-mission, the mission analysis & review capabilities allow the User to specify start/ stop times, and review mission attributes such as aircraft position and track, camera boresight position and track, and all still imagery, video, vector overlays, and metadata captured during the mission.

Data Export

Video (incl. metadata)

The ADAMS records all captured video clips to the MMC hard disk drive in TS format for the HD TV, MPEG4 format for the UV camera and AVI format for the infrared camera.

Still Images (incl. metadata)

Still images may be captured from the available video sources in JPEG digital image formats, including the FLIR IR IMG format captured from the infrared camera.

ADAMS Vector Graphics (AVG)

AVG may be exported from ADAMS as an industry standard Shapefile (.shp).

ESRI shape files (.shp) are geospatial vector data formats used by most third-party GIS software applications. Shape files typically contain information required for creating polypoints, polylines, and polygons capable of retaining colour information and re-drawing themselves to scale proportional to any zoom level set for the map. Files should be Geographic (LAT/LONG) & WGS84.

The mandatory elements are:

- **.shp** – The primary shape format that contains feature geometry.
- **.shx** – Shape index format that contains feature index reference to improve seeking.
- **.dbf** – A format which contains associated attribute information stored in dBase III format.

Shape files are therefore useful for representing various geographic features and are produced using an external GIS application. To work in ADAMS, source files must use the decimal degrees (DD) position format. Shape files consist of individual elements, some of which are mandatory. In addition, a shape file may optionally include additional files, which can contain information such as coordinate and projection information, geo-coding indexes and additional metadata. ADAMS supports ESRI shape files for import as a database using asset management. ADAMS supports capturing imagery using .JPEG as the default format.

Database Sub-sets

The writable work set is a sub-set of the complete customer asset database. The work set contains edited data and new assets created during the mission. The work set can then be exported in Shapefile format for import back into the customer's GIS application and master database as required.

Post-Mission Reporting

All data captured into ADAMS, may be exported to the computer hard disk drive (HDD) for use in third-party report generation software.

While PDF reports are not generated within the ADAMS mission system software, report generation software FLIR Reporter Professional is included.

Third party applications may also be hosted along side the ADAMS mission system software on the Getac X500 MMC.

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