Japan International Cooperation Agency (JICA) National Mapping and Resources Information Authority (NAMRIA)

The Study for Mapping Policy and Topographic Mapping for Integrated National Development Plan in the Republic of the Philippines



The Study for Mapping Policy and Topographic Mapping for Integrated National Development Plan in the Republic of the Philippines

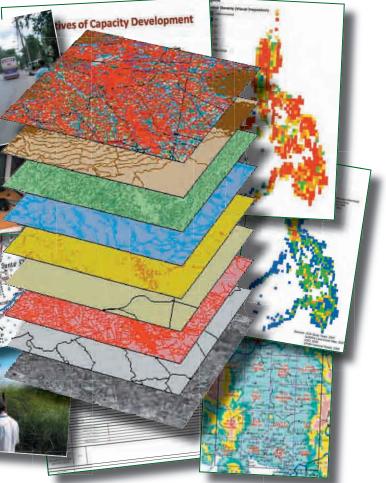
Final Report Volume 4 Manuals March 2008

SD JR 08-011



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Final Report Volume 4 Manuals



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Pasco Corporation Nomura Research Institute, Ltd.

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Final Report

Volume IV

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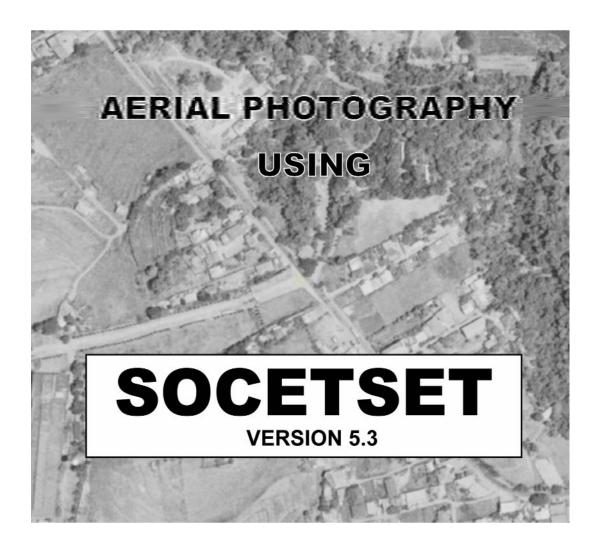
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Exchange Rates US\$1.00=PHP2.638=¥106.18

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THE STUDY ON MAPPING POLICY AND TOPOGRAPHIC MAPPING FOR THE INTEGRATED NATIONAL DEVELOPMENT PLAN OF THE PHILIPPINES



EDITION 1

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1. Introduction

The purpose of the Softcopy Exploitation Tool (SOCET SET®) software is to support imagebased softcopy applications such as map-making, mission rehearsal, and photo-interpretation.

SOCET SETgenerates databases and products such as Digital Terrain Models (DTM), reports, vector databases, orthophotos, image maps, and image mosaics. SOCET SET supports a wide variety of applications, including:

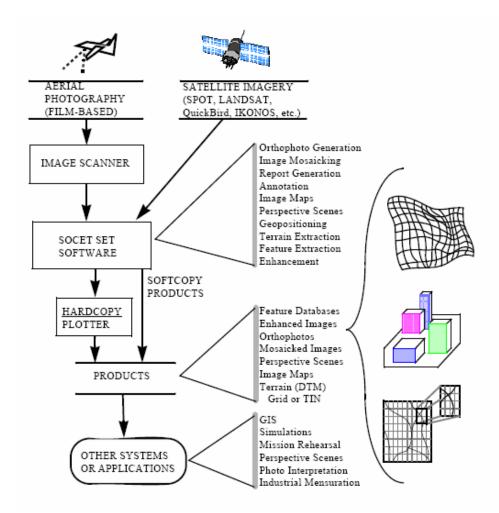
- Populating a GIS database (vector or raster)
- Producing image maps
- Civil engineering
- Mission planning
- Targeting
- Mission rehearsal
- Sensor research and development

The SOCET SET software consists of over sixty application functions that can be chained together to form a processing flow that inputs imagery, performs the requisite analysis, and produces the final hardcopy or softcopy products. This User's Manual describes the application functions in detail, including the following:

- Data import capabilities for imagery, feature, and terrain data
- Automatic extraction of Digital Terrain Model (DTM) elevation data
- Interactive graphical editing of DTM data
- Interactive two and three-dimensional feature data extraction
- Orthophoto generation
- Perspective scene generation
- Point positioning, three-dimensional mensuration, and targeting
- Image mosaicking
- Image enhancement
- Data export functions for softcopy databases (imagery, feature, and terrain data), and hardcopy products (image maps)

2. Typical Product System Flow

Imagery is input to SOCET SET from either a digital softcopy source, such as SPOT or Landsat, or by scanning film-based imagery. The workstation products are in either softcopy format (such as DTMs, vector databases, orthophotos, etc.) or hardcopy format (such as image maps or photorealistic perspective scenes).

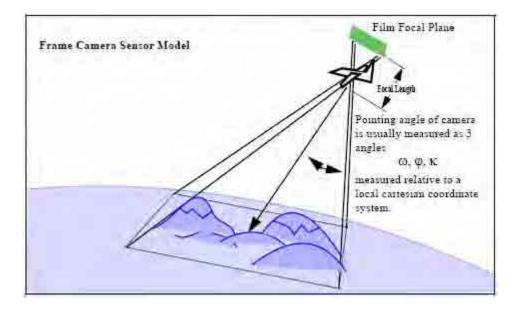


3. Using Aerial Photographs

Frame and Panoramic Frame and Panoramic Import allow you to use digitized camera images in SOCET SET.

Overview

Frame Import reads a digitized frame camera image or a panoramic into SOCET SET. A frame image is a digitized version of a photograph taken by a frame or panoramic camera. A frame camera is a conventional camera with simple projective geometry. Most cameras, including surveying cameras and reconnaissance cameras, are frame cameras. A panoramic camera can be imported and is modeled as a cylinder. If the image you want to import is not a frame or panoramic image, you should use one of the other import modules: SPOT Import (for SPOT imagery), Landsat Import (for Landsat imagery), or Image Import/Reformat (for imagery with an unknown *Math Model*).



When to Use Frame or Panoramic

Frame Import

Importing imagery is usually the first thing you do after creating a project.

After importing a frame image, you typically perform Interior Orientation (if it was not done during the scanning process) and then control the image using Triangulation. After the image is controlled, you can utilize any extraction application, such as Feature Extraction or Terrain Extraction. If you have corrupted or lost your frame support file, you can recover it by importing the same way as you originally did and click **Reuse** when prompted that the image file exists. If you used "Image and Support" when you originally imported, use "Image and Support" again to re-create the support file. Frame Import can do several things for you, some of which are:

a Reformat or copy the input image to the standard SOCET SET directory or format (to improve image access time)

- b Creates a support file containing the frame math model parameters; and
- c Places the image into a Project file structure so it is known to SOCET SET and is available for subsequent tasks.
- d Minify the image to create the reduced resolution images.

To use Frame Import, you must have the input image stored as a disk file available to SOCET SET. The input image format may be any sort of raster image; however, if you are importing a plain-raster image, you must select the *Image and Support* option of Frame Import if you wish it to be minified or displayed on Main Workstation Windows.

- If the input image file is on tape, you must copy it from tape to disk before running Frame Import.
- If the input image is on film, you must digitize or scan the image before running Frame Import.

Panoramic Imagery

If your frame image is a panoramic aerial photograph, you should use Panoramic Import. Panoramic Import creates a model with compensation for sensor movement.

User Interface

The inputs to Frame Import include raster image files and image support data. The input image can be of any SOCET SET supported type (*See "Data Import and Export," Chapter 15* for types) including types from the LHS Scanner. If the format is plain raster, the first N bytes correspond to the N pixels in the first line of the image, from upper-left to upper-right corners; the next N bytes are the pixels in the second line, and so forth.

The image support data can consist of triangulation data (camera position, attitude, focal length), scanned photo data (image dimensions and photo to image transformation data), camera calibration data (camera fiducial coordinates, lens distortion data, principal point offset), and PATB, ALBANY or BINGO triangulation results data. These may come in file formats for certain supported input types, or may be entered by keyboard.

You should supply the name of a camera calibration file. Creating a camera calibration file is described fully in the Utilities chapter. *See "Camera Calibration Editor" on page 54-5*.

If you are importing JPEG compressed images, move the images and support files (if any) to the directory you will be keeping them in permanently before running Frame Import. Then import them using the "Support Only" option. Otherwise the images will be written to the new location as un-compressed images.

Orientation Angles

One of the key inputs to the frame import process is camera orientation. This is generally expressed as three angles such as omega, phi, and kappa but may be expressed in many ways.

Frame Import allows the orientation to be imported in the following ways:

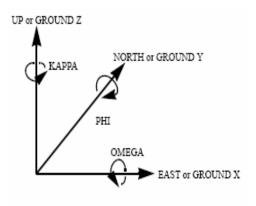
1. You enter Omega, Phi, Kappa in the camera position table. These angles are defined in the "Manual of Photogrammetry" and are the sequential rotations from ground coordinates to image coordinates—more on these later. You may enter Heading, Pitch, Roll in the camera position table. These angles are sequential rotations from ground coordinates to image. The orientation angles may be provided in the documentation accompanying the photo. In this case you must enter the data in the Frame Import window. If the orientation angles are not in one of the supported formats, you must convert them.

- 2. The orientation angles may be included in triangulation file such as from ALBANY, BINGO, PATB, or a plain text file. See below for the format of a text file.
- 3. If the orientation angles are not provided with the photo, you can have SOCET SET compute the orientation for you automatically during the Triangulation process. To do this, leave all entries in the Camera Position table at their default values.
- 4. If the orientation angles are not provided with the photo, you can estimate the camera azimuth and obliquity by simply looking at the photo, then enter the heading and roll angles as described below. *See "Estimating the Orientation Angles" on page 8-5*.

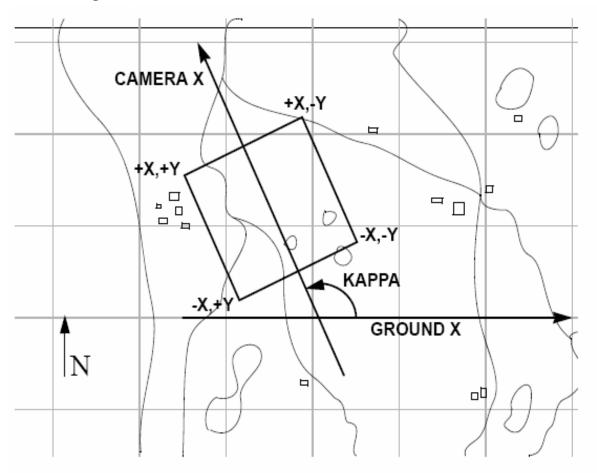
Omega, Phi, Kappa

These angles define a transformation from ground space into fiducial (film) space. These angles are not as intuitive as heading, pitch, and roll, so you should avoid using omega, phi, kappa unless you have reason to use them.

The three rotations are applied in the order omega, phi, kappa. Positive values are right-hand rotations. Omega is a rotation about the X (East) axis. Phi is a rotation about the once rotated ground Y axis. Kappa is a rotation about the twice rotated ground Z axis.



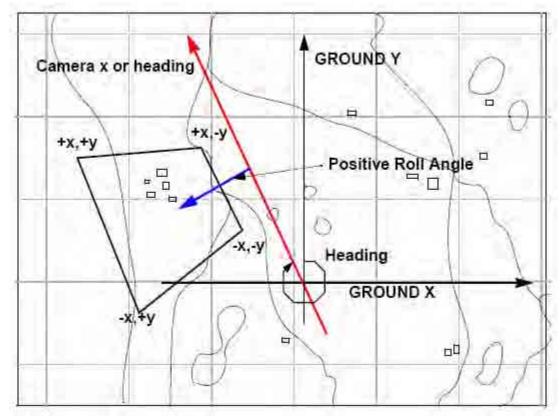
These orientation angles should not be confused with the alternative image-to-ground transformation, which may use the same notation. The following figure shows a Kappa for a vertical image. In this case omega and phi are approximately zero.



Heading, Roll, Pitch

EXAMPLE A: You have a photo taken straight down, and the fiducial X axis is toward the North-West. The omega and phi are near zero (vertical photo) and Kappa is about 120 degrees.

These angles define a transformation from ground space to image space (fiducial or film). The three rotations are applied in the order heading, roll, then pitch. Heading is the azimuth angle from ground axis Y to film axis X normally the heading of the plane). It is positive clockwise from Y ground axis. The roll angle is about the once-rotated ground X axis (typically parallel to the fiducial X axis) and positive values are right-hand rotations. Pitch is positive (right-hand rule) about the twice-rotated ground Y axis.



Consider the situation when you have a digitized frame photo and you are preparing to run the Frame Import module. If you have the orientation angles and camera positions, then you should enter them during Frame import in the omega, phi, kappa format, or the heading roll, pitch format. Alternatively, you can select Unknown and solve for the angles during triangulation. As a last resort, you can estimate the orientation angles using the following steps.

Heading - Looking at the photo camera X axis (fiducial X), estimate the heading (Red) from your ground Y axis. The ground Y axis is normally North (000). The heading angle should be between 0-360 degrees and is estimated from North clockwise to your assumed heading. The above diagram shows a heading of about 320°, the direction of flight.

Roll - Estimate the roll angle. Picture the photo and plane aligned in fiducial x direction. If the plane were rolled to the right (as shown above), you have a positive roll angle. If you picture the plane rolled to the left, you have a negative roll angle. (Roll right is with the right wing down.)

Pitch - The pitch is very hard to visualize and is usually set to zero. Pitch is again pictured as if the plane is pitching nose down (positive) or nose up (negative).

Examples

EXAMPLE A: You have a photo taken straight down, and the top of the photo is towards the NW. The roll and pitch are 0, and the heading is 45 degrees.

EXAMPLE B: You have a photo obliquely taken toward the south-west. The fiducial x axis is toward the direction of flight (north-west). The photo appears to have a heading of 320 degrees and a roll of about 30 degrees. Pitch is zero.

Camera Mounting Angle (Panoramic only)

Mounting omega, phi, and kappa are the angles of the sensor relative to the vehicle's direction of flight. If all three angles are zero, the view is straight down at the center of the scan with the X coordinate (image samples direction) of the scan oriented along the line of flight. Omega is the left or right deflection. A sensor pointing to the left of the vehicle has a positive omega. Phi is the forward or backward deflection. A sensor pointing behind the vehicle has a positive phi. Kappa is the rotation in the vehicle's horizontal plane. A sensor rotated counterclockwise has a positive kappa.

Start and End Scan Angle (Panoramic only)

Panoramic Import requires you to enter a start and end of scan angle. These angles are used to initialize the internal timing of the sensor model. By default, the scan direction is perpendicular to the direction of flight, with a positive angle to the left of the platform. The values are closely related to the interior orientation coordinates. The interior orientation must match the scan angles; i.e. if you enter non-symmetrical scan angles, then your IO coordinates must be non-symmetrical. For example if your start and end scan angles were 10 and 20 degrees, the interior orientation Y coordinates would be 100 and 200. (The exact values for interior orientation depend on the camera parameters and scan rate.)

Camera Position

You have a choice of either entering a camera position during Frame and Panoramic Import or leaving the camera position as "unknown." If you leave the images as unknown, you must run Multisensor Triangulation (MST) to control the images with ground control points. To make an image unknown with Frame Import, leave the X and Y boxes on the Camera Position / Orientation interface at 0.0. For Panoramic Import, the default is unknown and the position will remain unknown unless you select and fill out one of the camera position options under File > Camera Location pulldown. You can store position values in a text file (see below) and load them into the interface directly.

Text File Input

You can provide camera position and orientation angles for several images by creating a text file with one line of information in it for each image. The general format for each line is:

ID X Y Z Omega Phi Kappa

ID is the name of the image file or "dsup" file with the extensions stripped off. An alternate form is to put the strip and image number on each line:

Strip_Number Image_Number X Y Z Omega Phi Kappa

You may also omit IDs, strip and image numbers, or omega, phi, and kappa, for example:

Strip_Number Image_Number X Y Z

X Y Z Omega Phi Kappa

ID X Y Z

Values may be separated by spaces, tabs, or commas. Frame Import compares the values in the highlighted rows of the table with the values in the file. When it finds a match, the values are transferred from the file into the table. Be sure to highlight the rows you want to fill before importing the text file. If IDs, strip numbers and image numbers are omitted in the text file, the values from the file are placed in the highlighted rows in the order they appear in the text file.

Load your orientation text files into the application from the Frame Import window:

- 1 Select the *Review/Edit Settings* button from the Frame Import window.
- 2 In the Review/Edit Settings window, select the Camera Position/Orientation tab.
- 3 Highlight rows of imagery files listed.
- 4 Press the *Read From File...* button, and open your file. The x, y, z, Omega/Heading, Phi/ Roll, Kappa/Pitch columns in the Review/Edit Settings window will auto-populate with data.
- 5 Press *Close* to accept.
- 6 Continue with frame import in the Frame Import window.

PAT-B File Input

Frame Import can read exterior orientation from PAT-B files. Make sure your frame images (without file extension) are named the same as one of the items in the PAT-B file. For example if your image is named "6840154.tif", the PAT-B file must contain an item such as:

6840154	0.00000000	330560.51973	3056293.28534	1348.79095
0.7797929077	0.626034537	0.001944019	0.62515213071	0.778851362241
0.050748093	0.0332841618	0.0383576955	0.998709593319	

Applanix File Input

If you have an Applanix file which specifies your camera positions, you should select it with the "Read From File..." option. If your data is from a DSS system, use the "Applanix DSS EO data" option; otherwise use the "Applanix EO data" option. The Applanix file is required to contain "POS/AV Computed Data at Camera Perspective Centre", and each line of camera data must have exactly 11 columns. The name of each image file, without extension, must match the first column exactly. For example, if the image name is "12345.tif", then the first column must be "12345". If you choose to run Triangulation on the images, be sure to select the Applanix file in the Setup > Advanced > Airborne GPS option.

ISAT File Input

ISAT (Intergraph's ImageStation Automation Triangulation) can be imported into SOCET SET. With SOCET SET project file information, the application uses the data from ISAT photo and camera files to generate support (.sup) files. The project file used for this triangulation import option should be in the LSR coordinate system.

The following are steps to import ISAT data into SOCET SET:

- 1 Select *Preparation > Import > Image > Frame* (the Frame Import window opens).
- 2 RMB at Input Images and *add...* images to import.
- 3 Set Camera Calibration to isat.cam.
- 4 Make sure Digital Camera is checked.
- 5 Click *Review/Edit Settings...* button.
- 6 At Review/Edit Settings, select images to import.

- 7 Select Camera Position/Orientation tab.
- 8 Click on Read From File and select *ISAT file* option.
- 9 Select ISAT photo file.
- 10 Close the Review/Edit Settings window.
- 11 At Frame Import window, click *Start*.

BINGO Frame Import

BINGO Frame uses the interface as Frame Import. BINGO software is ideally suited for the adjustment of large blocks of Frame images.

If the final desired mapping coordinate system is Geographic, it is recommended to first perform image import and triangulation under an interim Project using a coordinate system such as UTM. Then a new Project with Geographic coordinate system is created after and the contents of the interim project are then copied into the new project using the Project Copy functionality in SOCET SET.

Another difference exists in the use of the attitude data ingested during image import. Although the BINGO Frame import module behaves in exactly the same manner as the Frame Import module, the input attitude values are applied in the sequence phi-omega-kappa in the BINGO Frame sensor model instead of the usual omega-phi-kappa sequence in the Frame sensor model. Provided the attitude data are appropriate for the target sensor type, how the data is input into the two import modules should be the same from the point of view of the user.

3.1 Aerial Triangulation (SOCETSET-VR1-Bingo)

Triangulation updates the Sensor Models of the images and uses a mathematical formula which models the relationship between Ground Space and Image Space.

Overview

Triangulation is a highly automated system for performing triangulation on a wide variety of image sources:

- Large blocks of Frame Images
- Satellite imagery (single or overlapped)
- Stereo Image Pair
- Combinations of Frame and non-Frame imagery
- Imagery with or without initial support data

Triangulation automates the tedious procedure of selecting and measuring the image coordinates of *Pass Points*, *Tie Points*, and *Control Points*. Triangulation automatically flags unacceptable tie points and displays the required images for remeasurement without your intervention. It also has the ability to automatically remove unacceptable tie points during the solve process.

Triangulation executes the following major steps:

- Setup
 - Tells Triangulation which images you wish to orient
 - The type of adjustment you wish to perform
 - The name of the ground point file you wish to use
 - The general layout of the image block
- Automatic Point Measurement
 - Automatically or semi-automatically measure existing points as well as add new points to your chosen layout
 - Automatically measure points for relative orientation of strips or blocks of images
 - Measure across different scales and sensor types
 - Provides for automatically driving the extraction cursor to those points which require interactive measurement
- Interactive Point Measurement
 - Measure control and tie points in any of the images participating in the triangulation.
- Initialize/Solve
 - Provides blunder checking, relative, absolute, simultaneous, polynomial, and Direct Linear Transform (*DLT*) adjustments.
 - Initializes blocks of images that you imported without a priori camera model support data. After you solve the images, you must re-load them into the main image display.

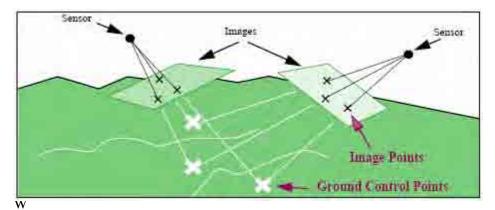
For frame camera imagery, you can start with image coordinates measured outside of SOCET SET. You can import plate coordinates. You can also import camera position and attitude data from programs such as ALBANY, PATB, or by entering this data manually. *See "Frame and Panoramic," Chapter 8* for more details.

Triangulation can also export data for use outside of SOCET SET. For example, you can export plate coordinates or model coordinates after measuring them with Triangulation.

Triangulation registers images to the ground and to other images. Generally, most images need to be triangulated before you can perform accurate ground space measurements with the imagery. Triangulation is sometimes known by other names such as image registration, geopositioning, aerial triangulation, orientation, exterior orientation, and resection.

The primary inputs to Triangulation are ground points and tie points.

- Ground control points are identifiable objects in the image for which you have the precise ground space location (lat/long/elevation).
- Tie points are points found in the overlap region of two or more images for which you do not have the ground space location.



hen triangulating more than one image simultaneously, the images can come from a variety of sensors. For example, Triangulation can orient a SPOT image simultaneously with a frame camera image. After triangulation, images are said to be *triangulated*. Other words used for this are *controlled*, *registered*, *solved*, *oriented*, and *georeferenced*

When to Use Triangulation

Triangulation may not operate properly if images are rectified. For best results, perform Triangulation before $Rec \ t \ i \ f \ i \ c \ a \ t \ ion$. You should also run Triangulation before you can accurately perform image mensuration and data extraction.

- For digital satellite-based imagery, you should run Triangulation immediately after importing your images.
- For digitized film-based images, run Triangulation immediately after Interior Orientation.
- If there is no support data available when you import the image(s), then you must run Triangulation before you can use the image for geopositioning.

You can skip Triangulation if the sensor model support parameters provided at import time are sufficiently accurate. However, the support data provided with imagery is usually a mere estimate so if you skip Triangulation, poor stereo visualization and inaccurate geopositioning may result. Thus it is recommended that you run Triangulation even for images that have support data provided during the Import process. If you import an image with an unknown sensor model, you should run Triangulation in the polynomial mode to create a sensor model for the image. *See "Image Import/Reformat" on page 7-9* for importing images with unknown sensor models.

After Triangulation, you can run the tools that require controlled imagery, such as Rectification, Automatic Terrain Extraction, Feature Extraction, Orthophoto, Mosaicking, and Coordinate Measurement. *See "Workflow," Chapter 3* for more details. You can run a few applications on uncontrolled imagery, such as Annotation (for making annotated screen dumps), Minification, and Image Export Reformatting.

What to Name Images When Importing

If you are going to triangulate a large block of imagery, you should use the Triangulation naming convention: *ssss_iiii.sup*, where *ssss* is the strip number and *iiii* is the image number.

If you are working with a small number of images (a single image pair, for instance) you may use any names for the images.

Triangulation uses the name of the support file to create names for automatically creating tie points. It does this by appending a decimal number to the support file name. If the support file name does not have an underscore in it, the decimal number is added without an intervening underscore. For example, if the support file name is "123.sup" a typical tie point name will be "1235". If the support file name does have an underscore, another underscore will precede the decimal number. For example if the support file name is "1_1.sup", a typical tie point name will be "1_1_7". This allows you to control the tie point name to some extent and generate IDs which are all decimal numbers.

Triangulation creates, updates, manipulates and uses the following files. Triangulation File (.atf)

This file contains a list of images that will participate in the triangulation. It also contains the necessary information to compute the initial estimates of the Triangulation parameters. Setup creates and populates this file.

Ground Point File (.gpf)

This file contains the information about all ground coordinates of points involved in Triangulation such as control and tie points. This file is updated by Automatic Point Measurement (for tie points) and Interactive Point Measurement (for control points and tie points). You can create a Ground Point File containing just control points by running Interactive Point Measurement before you import any imagery. The residuals of each point are stored in the Ground Point File; the residuals are updated by Blunder Detection and Simultaneous Solve.

Normally, you will use a single Ground Point File (.gpf) to control all images in your project. Each point in the file has a unique identifier called the *Point ID* for use throughout Triangulation.

There are several ways to create the Ground Point File for your project:

- Interactive Point Measurement provides a Review/Edit mode in which you can enter the ground control points regardless of whether you have imagery available.
- Run Automatic Point Measurement
- You can convert ASCII-formatted ground point files into the format that Triangulation expects by using ASCII Ground Point Import, as described in the Data Import/Export chapter. *See "ASCII Image Point Import" on page 15-5* for details.

Image Point Files (.ipf)

Triangulation creates an Image Point File for each of the images participating in the triangulation. Each Image Point File has the same base name as the corresponding image file, but with a suffix of .ipf. The image point file contains the image point measurements and the point ID of the corresponding ground point from the Ground Point File. Automatic Point Measurement initially creates tie point data; Interactive Point Measurement creates and edits the ground control point data as well as tie points. This file is updated by Blunder Detect and Simultaneous Solve. If you somehow have points in IPF files which are not reflected in the GPF file, transfer them using the *Reset > Transfer* Image Points menu selection.

Image Support Files (.sup)

A single Support File exists for every image that participates in Triangulation. The ultimate goal of Triangulation is to build a support file that has accurate sensor model parameters. This file contains information for relating ground and image points via the sensor's math model. This file is created during Image Import and updated by Exterior Initialize, Blunder Detection, and Simultaneous Solve.

Image Files

A single Image File exists for every image that participates in Triangulation. The file contains the pixel information for each image. This file is created during Image Import.

Constraint Files (.cns)

When images share common exposure parameters these must be treated together and not adjusted as if they were independent. The constraint file defines which image parameters are shared between which images and allows the solution to adjust them in all shared images at once rather than independently for each image. GPS uses a constraint file.

Automatic Point Measurement Strategy Files (.apm_strat)

This file is used by Automatic Point Measurement (triangulation only) to guide the hierarchical matching algorithm. You must select one of the existing Automatic Point Measurement Strategy Files in the internal database. For Automatic point generation but manual point measurement, you can use the manual.apm_strat file.

Solve Strategy Files (.solve)

Contains flag values and parameter limits used by the Solve bundle adjustment operation.

Tie Point Pattern File (.tpp)

Automatic Point Measurement uses this file to control the placement and number of tie points. You can edit this file at will at the beginning of Automatic Point Measurement.

Input File Bundle Measurement (images.meas)

Contains image coordinate measurements. This file is used for Close Range Solve input. The file is generated from the File Export function.

Object Coordinates (object.ini)

Initial object coordinates, usually control points, used for Close Range Solve. The file is generated from the File Export function.

GPS File (.gps)

Contains accurate camera location data for each image at the moment of exposure and is used to define the support file math model.

ASCII Ground Points (.agp)

Each point takes up one represented by eight

<y> <z> <x-accuracy>

Contains the same information as the .gpf file of the same name. It also includes accuracy information for each point. The file is generated from the File Export function, and is designed specifically for use by Terrain Import.

POINT TYPE	DESCRIPTION
0	Tie Point
1	Vertical Control Point
2	Horizontal Control Point
3	3-D Control Point
4	Vertical Check Point
5	Horizontal Check Point
6	3-D Check Point

line of text and is fields: <point id> <x> <y-accuracy> <z-

accuracy> <point type>. The point id is an alphanumeric identifier that is unique to the point. x, y, and z are the point's coordinates. The accuracy fields give the

standard deviation or error along the corresponding axis. The point type distinguishes among a *Tie Points*, *Control Points*, and *Check Point*.

Graphical Attributes (.gra)

Contains values to set the color, font size, font type, line size, and line thickness for each of the graphics types displayed during the triangulation process. These files are stored in the / internal_dbs/HATS directory and may be customized and stored under different names based on the user's preferences. **ocov file**

The .ocov file is a binary file containing the posteriori (after adjustment) variance of adjusted sensor model parameters and all types of ground points. It also contains the covariance between any pair of there parameters and ground points. Of course it contains the ID of these parameters and points as well. The specific parameters and points included in the .ocov file can be controlled by the user through the .cns file.

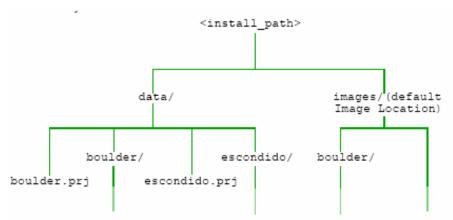
Exporting Triangulation Information

Triangulation can export information to several formats. Refer to the descriptions under the File menu for details. Some of these formats use the strip and image numbers created in Setup. If you have images in the *sss_iii.sup* naming convention and wish to preserve the strip and image numbers, be sure to use Auto Populate in Setup. This will make the strip and image numbers in the exported file match the support file names.

3.1.1 Preparation

Before you can import or display imagery with the software, you must create a project. You can think of a project as a container holding the data for a set of images you are going to utilize. The data you extract from a set of imagery will be stored in the project directory that contains that set of imagery. When you create a project, you specify the coordinate system and datum to use for the project. You also will specify the disk directories of where the project and imagery data will be stored. Most importantly, you give your project a name. The name of the project file is the name you assigned to the project with the extension.prj when it was created. The software stores the definition of a project in a special project file.

SOCET SET uses the computer file system to store its project data. The following figure depicts the directory tree the software uses to store its data.



ost software applications require that you first load a project. Once you have loaded a project, you can then operate on the imagery and other data contained therein. You can import images into the project, triangulate the images, perform feature and terrain extraction, and create image products to export. The locations of the image files are defined by entities called Image Locations.

You create a project by running Create/Edit Project, Initially, the project is empty; you populate it with imagery and other files when you run any of the Import applications (Image Import, Feature Import, etc.). After importing data, you will typically execute one or more extraction applications (Automatic Terrain Extraction, Feature Extraction, etc.). Next, build the products you desire (using applications such as Orthophoto or Image Map). Finally, you should archive the project using Backup and then delete the project with Delete.



ect Parameters

roj

The key constraint imposed by projects is that all data stored in a given project must conform to that project's parameters. This means that all data entry, data display, and imported data must conform to the project parameters.

For example, if you create project XYZ and select the Geographic (lat/long) coordinate system with feet units, then you must enter all data (such as ground control points) as lat/long values, and all Z-units must be specified in feet. If you have any data in another coordinate system (e.g. UTM) you must convert it to lat/long before entering it into project XYZ.

Every software project is characterized by the following parameters:

- Coordinate System (Geographic or UTM or LSR or Grid/State Plane)
- Horizontal Datum (WGS 84, NAD 27, etc.)
- Units (feet vs. meters)
- Vertical Reference (*Ellipsoid* vs. *MSL*)

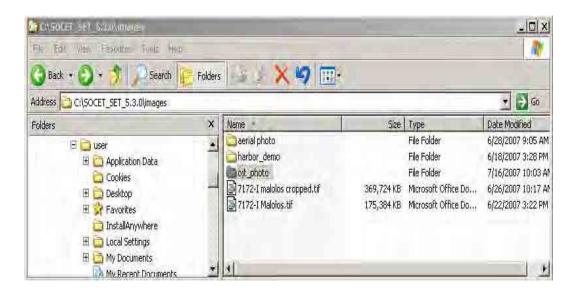
Additional parameters may be required dependent upon various selections. Once the project is created, the parameters you selected are displayed on the Main Menu window.

Parameter Exceptions

There are a few exceptions to this rule. For example, Coordinate Measurement allows you to display the extraction cursor location in several coordinate systems. Also, *Triangulation* allows you to enter ground control points in any datum. After you create a project, you may need to convert some of the project data to other coordinate systems or other units. To do this, use the Project Copy or Project Save As operations described later in this chapter.

3.1.1.2 Creating folder and path/ directory for the image files

1. Open Windows explorer and create new folder (e.g. ojt_photo) for the image files (e.g. 05_301).



2. Open "SOCET SET 5.3.0" Click "Project", select "Create/Edit Project"



3. A "Create/ Edit Project dialog box will appear. Click the browse — button in the "Location "box.

😳 Create / Edil	Project	- 10 ×
File Options He	elp	
Project:	oil_photo.ptj	Ÿ
Project Path:	C:\SOCET_SET_5.3.0\data\ojt_pł	noto
Datum:	PHILIPPINE_(PPCS)	
Coordinate System	n: Grid / State Plane	*
Lat/Lon Format:	DDIMMISS - Units: Meters	•
	Elevation (estimated)	1
Maximum Ground	Elevation (estimated) 2000.00	- î
Location OJT_	photo	
currently in use b	ate/Edit Project. Modifying projects y other stations is not advised. (t_photo.prj loaded successfully	
		7.

4. A "File Location" dialog box will appear. Click "Edit Locations" Edit Locations button

Ş	File Location
	DEFAULT (194949.9MB) HARBOR_DEMO (194949.9MB) test (194949.9MB) trial <no dir="" such=""> escon <no dir="" such=""> spot_sata <no dir="" such=""> carto_sat (194949.9MB) aerial <no dir="" such=""> Namria (63994.1MB) OJT_photo (194949.9MB)</no></no></no></no>
	OK Cancel Edit Locations

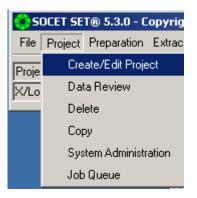
5. A "location.list-WordPad" dialog box will appear. Type the directory (e.g. C:\SOCET_SET_5.3.0\images\ojt_photo). Then click "Save"

E location.list - WordPad	- 🗆 🗵
File Edit View Insert Format Help	
<pre># Must have the following as the first entry: # DEFAULT C:\SOCET_SET_5.3.0\images DEFAULT C:\SOCET_SET_5.3.0\images HARBOR_DEMO C:\SOCET_SET_5.3.0\images\trial escon C:\SOCET_SET_5.3.0\images\trial escon C:\SOCET_SET_5.3.0\images\trial escon C:\SOCET_SET_5.3.0\images\trial earial photo C:\SOCET_SET_5.3.0\images\appt_sata carto_sat C:\SOCET_SET_5.3.0\images\appt_sata aerial photo C:\SOCET_SET_5.3.0\images\appt_sata OJT_photo C:\SOCET_SET_5.3.0\images\ojt_photo</pre>	
For Help, press F1	NUM //

3.1.1.3 Creating Project.

You use Create/Edit Project to create your project. Since most SOCET SET applications require a project to be loaded, you must create a project before you can proceed with importing and extracting data.

1. Click "File", select "New".



2. Click the down arrow in the "Coordinate System" box and select "Grid / State Plane".

Project	of_photo.pq
Project Path:	C:\SOCET_SET_5.3.0\data\ojt_photo
Datum:	PHILIPPINE_(PPCS)
Coordinate System:	Grid / State Plane
Lat/Lon Format 🗍 Vertical Reference	Select Coordinate System Geographic LSR (Local) LSR with Curvature
u::	Grid / State Plane
	levation (estimated) 2000.00
Location: OJT_pl	1010
currently in use by	e/Edit Project. Modifying projects other stations is not advised. .photo.prj loaded successfully

3. A "Select a Coordinate System" dialog box will appear. Scroll down the arrow and select the desired coordinate system (e.g. Philippine_UTM_51N). Then click "OK".

Gauss_Boaga British_Nationa	_Italia_Fuso_Ovest	-
PTM_zone_1(A CALCULATION OF A CALC	
PTM_zone_2[
PTM_zone_3(
PTM_zone_4(- 13 - 24 - 27 - 17	
PTM_zone_5((25)	-
Philippine_UTM	4_51N	
		1070 M.
ection:		

Click the browse button in the location box. A "File Location" dialog box will appear. Select the image file location [e.g. OJT_photo(192477)] Then click "OK"



5. Type 0 in the "Minimum Ground Elevation (estimated) box and 2000 in the Maximum Ground Elevation (estimated) depending on the highest elevation of the project area. Click "File", then click "Save".

💽 Create / Edit P	roject	_ 0 ×
File Options Help	N.,	
New	bil_phota.prj	
Load Project	C:\SOCET_SET_5.3.0\data\ojt_p	hoto
Save	PHILIPPINE_(PPCS)	
Save As	Grid / State Plane	-
Exit	dia / state / lane	<u></u>
Minimum Ground Ele	vation (estimated) 0.00	
Maximum Ground El	evation (estimated) 2000.00	
Location: OJT_ph		T.
currently in use by	/Edit Project, Modifying projects other stations is not advised. photo.prj loaded successfully	
Save		2

6. A "Project Name Selection" dialog box will appear. Type the desired project name (e.g. ojt_photo) in the "Enter Project Name" box. Then click "OK"

Project Name Selection		? ×
Enter Project Name		
ojt_photo		
	OK	Cancel

3.1.1.4 Camera Calibration

The Camera Calibration Editor provides the means by which you enter and save frame camera calibration data. Calibration

data includes focal length, lens distortion, and principal point offset.

It is also used for Triangulation using BINGO Frame images is the same as those for other types of images except that towards the end of the process the Solve Bingo button is activated for the block adjustment instead of the usual Solve button. *See "BINGO Frame Import" on page 8-16* for details.

Although this is true in general, there exist some subtle differences between these two processes. One involves the creation of the Camera Calibration file. For triangulation of BINGO Frame images, the Radius Unit must always be in millimeters, the Radius interval must be uniform, the Radius must be input in increasing order, and the Zero Radius must be included in the input Distortion table.

You can edit an existing camera calibration file, or you can create a new one. The editor provides two ways for you to enter data:

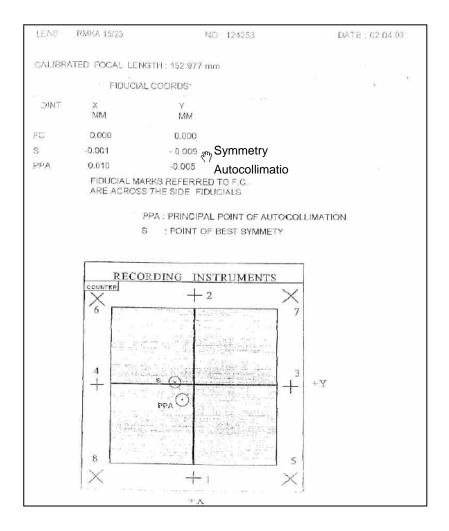
- A graphical drawing area that you click the mouse in.
- Labelled text fields that you type data into with the keyboard.

Your calibration data is saved in a camera calibration file with the .cam extension in the

<install_path>/internal_dbs/CAM directory.

To edit fiducial coordinates and distortion parameters, you have to bring up the Fiducial Coordinates and Distortion Parameters sub-windows, respectively. These sub-windows aredirectly accessible from the Camera Calibration Editor.

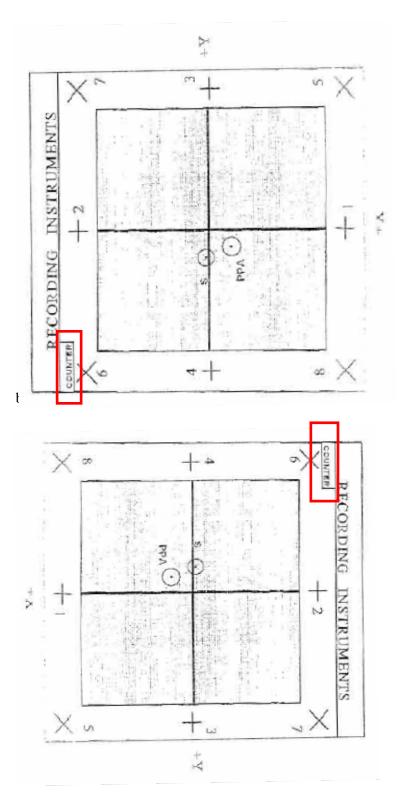
The following steps are used to create a new camera file from the information contained in typical camera Calibration Report.



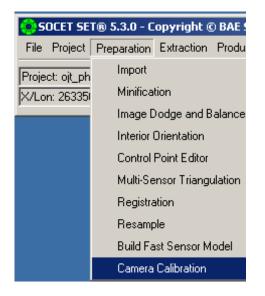
CAMERA: RMKA 1 DATE: 02.04.03	5/23 124253			
FIDUCIAL COORDIN	ATES (SIDES)			
X1= 112.996 Y1= -0.007	X2= -112.995 Y2= -0.007	X3= -0.001 Y3= 113.011	X4= 0.000 Y4= -112.997	
L.STANCES	1-2= 225,991	3-4= 226.009		

Fiducial position (numbering) depends on the type of camera (e.g. Zeiss RMKA) and location (e.g. Left Bottom, Left Top, Right top) of the aerial photo numbering

a) Left Bottom (LB)



1. Click "Preparation", select "Camera Calibration".



2. A "Camera Calibration Editor" dialog box will appear. Click on the ellipse button in next to Camera Calibration File box.

amera Calibration File:	
ocal Length (mm) Principal Point Offsets in M	illimeters
Autocollimation	×
Symmetry X	Y:
Fiducial Coordinates	Distortion Parameters.

3. Another "Camera Calibration Editor" dialog box will appear. Type the camera calibration setting name (e.g. zeiss_rmka_15_23_LB.cam). Then click "Save"

era Calibrati	on Editor				?
Save in:	CAM		2	- 🖻 🗗	
Au Pracent ocumente Desk kap Documente v Composer	default.cam dmc.cam gen_cam.can gen_pan.can gen_pan.can link.cam ninek.cam rc10-20.cam rrs0.cam mrk111111.c mrk-a.cam mrk-top.cam test_rmk-a.cam	cam am h am am	zeiss_rmka_15_23 zeiss_rmka_15_23		
Iv Network	File name:	zeiss_rmka_15_2	23_LB.cam		Save
Places	Save as type:	Camera Calibratio	on Files (*.cam) *.ca	m 🔹	Cancel

Location (e.g. Left Bottom) of the Photo Number



4. Based on the camera setting parameters fill up all the boxes, Focal Length (152.977000), Autocollimation x (-0.005000) and y (-0.01000), Symmetry x (-0.009000) and y (-0.001000). Then click "Fiducial Coordinates" button.

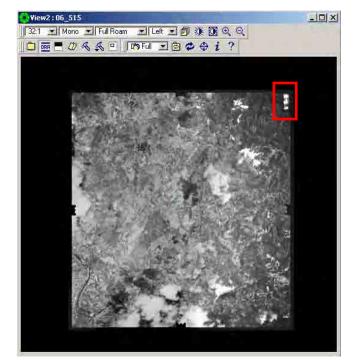
🥮 Camera Calibratio	n Editor	
File Help		
Camera Calibration File:	zeiss_rmka_15_23_L	B.cam
Focal Length (mm):	152.977000	
Principal Point Offsets	in Millimeters	
-Autocollimation		
X: -0.005000	Y: -0.010000	
Symmetry		
X: -0.009000	Y: -0.001000	
-		
Fiducial Coordinates	. Distortion Para	ameters
Welcome to Camera Ca	alibration Editor.	
		1
		111

5. A "Fiducial Coordinates" dialog box will appear. This window consists of a large square drawing area and a list of fiducials. To add a fiducial point, position the mouse cursor over the approximate location of the fiducial within the camera frame. A numbered button will appear which represents the fiducial. At the same time, a corresponding entry (consisting of the ID number and coordinates) will appear in the fiducial list on the right side of the window. Note that the coordinate system origin is in the center of the drawing area. The units are in millimeters. Type the corresponding coordinates of each fiducial point. Click "OK". Then click "Save".

Fiducial Coordinates				?	×
			X(%)	Y [%]	
		1	112.996	-0.007	
		2	-112.995	-0.007	
3		3	-0.001	113.011	
		4	0.000	-112.997	
2 4 LEFT MOUSE: Add/Move Point RIGHT MOUSE: D	elete Point				
		J			
		Numb	er of Points:	4	
			OK	Cancel	

Note: Create another camera calibration setting if the project has more than one aerial photo numbering position.

Right Top Numbering



3.1.2 Importing the Data

3.1.2.1 Aerial Photo (TIFF file).

SOCET SET can read strip, tiled, grayscale, palette color, or RGB TIFF images. Multiple band tiled TIFF is importable in either "chunky" or "planar" planar configuration. Stripformatted images must have uniformly sized and sequentially stored strips. Tiled JPEG, LZW, and Packbits compression are supported.

If you create a one band TIFF image ("img_type_tiff"), it will have grayscale format (Photometric Interpretation = 0), except for creation by Image Map or Terrain Shaded Relief. When you select a pseudocolor output with Image Map or Terrain Shaded Relief, the TIFF image will have palette color (Photometric Interpretation = 3). If you create a multiple band image it will have RGB format (Photometric Interpretation = 2) and contiguous planar configuration (Planar Configuration = 1). All TIFF files you create will have big endian format.

Tiled TIFF images ("img_type_tiff_tiled") are created the same as regular TIFF, except tiling will be enabled. The tile size for output is fixed at 128. Multiple band images will be in "planar" format (PlanarConfiguration = 2). "Planar" format tiled images will read and display the fastest in SOCET SET. The PlanarConfiguration is irrelevant for single band images.

Chunky tiled TIFF ("img_type_tiff_tiled_chunky") are created the same as Tiled TIFF except they will have "chunky" planar configuration (PlanarConfiguration = 1) if they have multiple bands. This format is more common throughout image processing software packages for color imagery.

TIFF tiled JPEG compressed ("img_type_tiff_tiled_jpeg") are created the same as tiled TIFF except tiles are compressed with the JPEG algorithm. The tile size is fixed at 512.

SOCET SET can also read and write from 8 to 16 bit per sample (two-byte) TIFF images. For reading, the bit depth is determined from the MaxSampleValue TIFF tag, if present. If this tag is not present, the BitsPerSample TIFF tag is used. To create two-byte data. select TIFF or TIFF Tiled format on any of the SOCET SET applications which write two-byte data as shown above.

You can utilize TIFF files with multiple image pyramid levels within one file. In this case it is not necessary to minify the image, just perform an import and select the Support Only option. When the image is loaded into any application, the pyramid levels will be loaded automatically. To confirm which pyramid levels are in your image, import and load it into the Main Workstation Window and click on the minification level button. The pyramid levels available will be reflected there. If you need to make smaller levels of minification to fill up the pyramid, run the image through Minification.

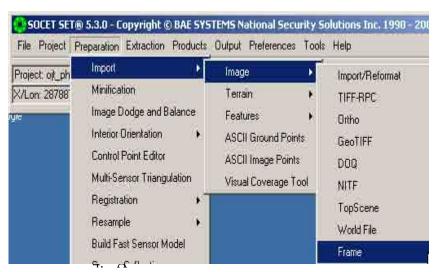
1. Click "File", select "Load Project".



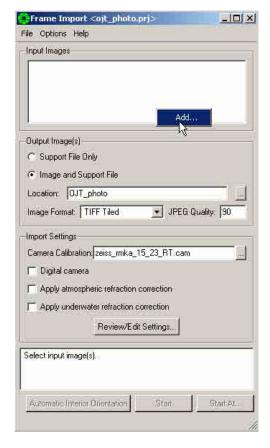
A "Select Project File" dialog box will appear. Select the project name (e.g. ojt_photo.prj) that was created. Then click "OK"

😟 Select Project File	<u>? ×</u>
Files	
carto_sat.prj	_
carto_sat2.prj	
carto_sat2_jun21.prj	
carto_sat3-1.prj	
carto_sat3.prj	
carto_sat4.prj	
carto_sat4_geo.prj	
carto_sat5.prj	
carto_sat6_rigorous.prj	
carto_sat_backup.prj	
carto_sat_bak_jun20.prj	
escon2frames.prj	
harbor_demo.prj	
ojt_photo.prj	
ojt_photp_0716.prj	-
Selection	
ojt_photo.prj	
ОК	Cancel

3. Click "Preparation", select "Import", select "Image" and then click "Frame".



"Frame Import" dialog box will appear. Put mouse arrow inside the Input Images box and click right mouse button. Click the "Add" button.



5. A

"Select one or more files to add" dialog box will appear. Use the down arrow \checkmark in the "Look in" box, browse and locate the image file (e.g. 06_517) to add. Then click "Open"

<u> </u>	🛅 7173-II San Miguel.j2k_64	jojt_photo_dodge1205957E_
🔊 05_301.tif	📾 7272-IV Angat 5m.j2k	👼 ojt_photo_dodge1205957E_
🔊 05_302.tif	國 7272-IV Angat 5m.j2k_128	is_ojt_photo_dodge1205957E_
🔊 05_303.tif	👼 7272-IV Angat 5m.j2k_256	it_photo_dodge1205957E_
🗃 06_515.tif	📅 7272-IV Angat 5m.j2k_512	it_photo_dodge1205957E_
🗃 06_516.uf	📾 7272-IV Angat 5m.j2k_64	ig ojt_photo_dodge1205957E_
🔿 06_517.tif	🔟 ojt_photo.tfw	ig_ojt_photo_dodge1205957E_
💼 7173-II San Miguel.j2k	ojt_photo.tif	💼 ojt_photo_dodge1205957E_
💼 7173-II San Miguel.j2k_128	💼 ojt_photo_5m.tfw	is_ojt_photo_dodge1205957E_
📷 7173-II San Miguel.j2k_256	📾 ojt_photo_dodge.tfw	🔄 ojt_photo_dodge1205957E_
💼 7173-II San Miguel.j2k_512	🔊 ojt_photo_dodge.tif	ojt_photo_dodge1205958E_
۹]	Ĵ	b
ile name: 1"06_515.tif" "06_516	tif" "06-517.tif"	Üpen

e selected image file will be reflected in the "Input Images" box. Check "Image and Support File". Click the ellipse button next to "Location" box, a "File Location" dialog box will appear. Select

h

🖲 Frame Import <ojt_photo.prj></ojt_photo.prj>	×
File Options Help	
-Input Images	
06_517.tif	
06_516.tif	
06_515.tif	
Output Image(s)	1
C Support File Only	
Image and Support File	
Location: 0JT_photo	
Image Format: TIFF Tiled JPEG Quality: 90	
- Import Settings	
Camera Calibration: zeiss_rmka_15_23_RT.cam	
🖵 Digital camera	
F Apply atmospheric refraction correction	
Apply underwater refraction correction	
Review/Edit Settings	
Heview/Eult Settings	
Select input image(s)	
Automatic Interior Drientation Start Start At	1
	L

7. A "Review/ Edit Settings" dialog box will appear. Click the "Camera Position/ Orientation" tab, select the all the rows under the "Strip ID" column and Image ID Column, click right mouse button and click the "Strip/Image ID from name" button. Click "Close". Then Click "Start" Start.

	Image Name	Strip ID	Image ID	×	Ŷ	Z	Omega/Heading	Phi/Roll	Kappa/Pitch
	06_515.tif			0.0	0.0	10.0	0.0	0.0	0.0
Ş	06_516.tif			0.0	0.0	10.0	.0.0	0.0	0.0
1	06_517.tif			nn	0.0	10.0	0.0	0.0	0.0
					14				

3.1.2.2 Ground Control Points (ASCII).

Ground Point Import reads ground point data in an ASCII format into the internal Ground Point File Format. The input ASCII file is restricted to one ground point per line. Each ground point contains a point ID along with an (X,Y,Z) coordinate. This information can be in any order, butit must all be on one line.Obtaining this window is as simple as clicking *Preparation* > *Import* >*ASCII Ground Point* Import on the main workstation.

Ele Optime Help		
(rpul File Formel:	1	1.6
Input ASCII Ground Point Elec-	1	10
Dapat Ground Paint File:		
Uais	Pigent Native	
Chanse payed ite Select input lie		HIL.

Ground point control types of horizontal, 3-dimensional, and vertical are used within SOCET SET. Ground points which have a value of 0.0 exactly will cause the control point type setting to change. If your data has a control point of 0.0 0.0 3.2, the point type will be set to vertical (Z only). If your data has a value of 2456.8 23778.9 0.0, the point type will be set to horizontal (X and Y only).

You use ASCII Ground Point Import to translate and import ground point data from an external source into the native SOCET SET ground point file format. The units of the data can be either decimal for UTM, grid, LSR, or Geographic projects (see below), or degrees minutes seconds for any project. Degrees minutes seconds must be entered as "+-DD:MM:SS.SSS". The presence of two colons is mandatory. When you create a Geographic project, you specify a preference for coordinate display. If you import a file with decimal numbers into a Geographic project whose display preference is "dd.dddd" the numbers will be interpreted as decimal degrees. For all other Geographic projects, decimal numbers will be interpreted as radians.

Edit Input Format Option

This window provides you with a way to specify the order of the information in the input file. Click *Options > Edit Input Format* on the ASCII Ground Point Import window. You can save this ordering in an input format file for later use with other ground point files.

The Fields column on the right of the ASCII Ground Point Import window (above), indicates the current order. To change a field setting, select the desired format from Format Selection on the left. Then click on the appropriate field on the right.

There are seven format settings from which to select: ID, X, Y, Z, Code, Ignore, and Illegal.

- "Code" has no meaning for ASCII Ground Points.
- "Ignore" is used to ignore any information that may be specified in a field.
- "Illegal" indicates that a field should not contain any information. The entire point is discarded should any information be found in a field marked as "Illegal." The following are some examples of legal settings for the input fields.

Trimat Selection	1.94.72
X.	122
4	18 2
2	34. Ignuis
Code	5 Ignnie
ignare	G Ignore
illegal 🔤	

EXAMPLE 1	EXAMPLE 2	EXAMPLE 3
l: ID	1: Y	1: Ignore
EXAMPLE 1	EXAMPLE 2	EXAMPLE 3

EXAMPLE 1	EXAMPLE 2	EXAMPLE 3
2: X	2: X	2: X
3: Y	3: Z	3: Y
4: Z	4: Illegal	4: Z
5: Ignore	5: Illegal	5: Code
6: Ignore	6: Illegal	6: Ignore

Т

he GPS Ground Control Points file has several Field columns that need to be edited based on the seven Field column format settings (ID, X, Y, Z, Code, Ignore, and Illegal) being used in SOCETSET. 1. Open GPS Ground Control Points text file in Excel. Delete unnecessary field Columns. Then save file to *.csv format.

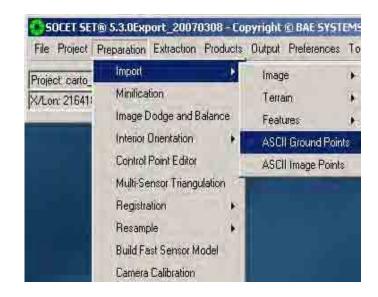
Ari	al	+ 10	BIU		H \$ %) 達山田 	- 3	Α.
	A1	the second s	203 28933	and the second second		496		
	A		C D	E	F	G	Ĥ	-
1	203			0.496				
2	319			3.689				
3	322		and the second	6.774				
4	rm13	285759.2129	1645837.805					_
5	rm14	286291.0279	1646570.386	75.381				
6	rm15	287438.3213	1647882.203	71.757				1
7	rm16	288332.5662	1648183.005	64.762				
	rm17	288882.5566	1648908.949	60.774				
	rm18	288465.0843	1649143.753	59.051				
	rm20	287780.1449	1650526.764	40.447	1			
	rm21	287874.483	1651354.678	36.88				
	rm22	287164.6899	1652689.626	32.559	Y		_	
	rm23	287606.3598	1653061.586	34,767				
14	rm24	288497.9165	1653082.423	36.343				
15	rm25	289059.4721	1652673.463	33.737				
16	rm26	289795.4803	1652727.589	40.367				
17	rm27	290004.5461	1653756.991	40.4				
18	rm28	291008.2861	1654759.514	52.133				
19	rm29	291598.6248	1655735.39	71.919				
20								
21								
22								
23								1.0
24								
25								
26								
27								
28								
29								1.1
30								
31					1.0.0			1
• •	FERE	ojt_xyz/			14			98H

2.

Open csv file in notepad, edit format and save as text file.

and the first of the later	z.txt - Notepad Format View Help			_	
2003 322 m13 m13 m15 m17 m16 m17 m18 m21 m23 m23 m23 m23 m23 m23 m23 m29	28933.28 287000.01 292457.79 285759.2129 286291.0279 286291.0279 28832.5662 288465.0843 287780.1449 287874.483 287780.1449 287874.483 287760.5843 287760.5843 287760.449 287874.483 287760.4546 289059.4721 289755.4803 290004.5461 291598.6248	1648728.94 1657172.11 1655544.76 1645570.386 1647882.203 164808.949 164908.949 164908.949 16526.764 1652689.626 1653061.586 1652689.626 1653062.423 1652673.463 165277.589 1653756.991 1653775.39	80.496 83.689 76.774 84.99 75.381 71.757 64.772 60.774 99.051 40.447 36.48 32.559 34.767 36.343 33.737 40.367 40.4 71.919	Ĩ	

3. Click "Preparation", select "Import, and click "ASCII Ground Point".



4. An ASCIII Ground Control Point Import dialog box will appear. Click the browse button in the "Input File Format" box.

oject Native 📃 💌
Star)

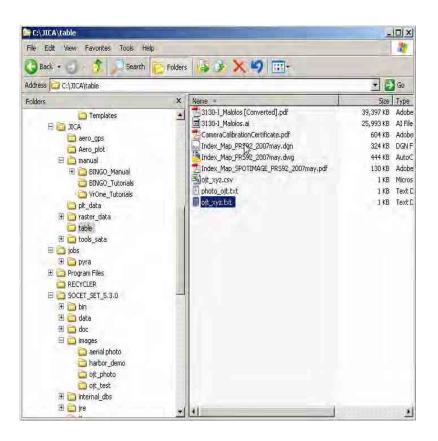
5. Another ASCIII Ground Control Point Import dialog box will appear. Select "Default.gcp". Then click "Save".

ASCII Ground Po	int Impo r t				? ×
Save in	MISC		1	* 🖻 🗗 💷 +	
My Recent Documents	Default.gcp				
Deskton My Documents					
My Computer					
My Network Places	File name:	Default.gcp			Save
11050	Save as type:	ASCII Ground Po	bint Files (*.gcp)	*	Cancel

6. Click the browse button in the "Input ASCII Ground Control Point File" box.

ASCII Ground Point Im	port <cert0_sata< th=""><th>- 0 ×</th></cert0_sata<>	- 0 ×
File Options Help		
Input File Format:	Default.gcp	-
Input ASCII Ground Point File:	ſ	
Output Ground Point File:		
Units:	Project Native	
Select input file Write in the output file name.		
		itart
		1

7. An "ASCIII Ground Control Point Import" dialog box will appear. Click the down arrow, browse and locate the directory where the gcp text file is located. Select the file (e.g. "ojt_xyz.txt"). Then click "Open".



8. Click "Options", select "Edit Input Format".

() A	SCII Ground Point Im	port <ojt_ph< th=""><th>oto 💶 🗙</th></ojt_ph<>	oto 💶 🗙
File	Options Help		
Input	Edit Input Format	' 🔪 ault.gcp	
Input	Set Accuracy	xyz.txt	
Outp	ut Ground Point File:		
Units	:	Project Nativ	e 💌
Writ	ect input file e in the output file name. ect output file		
			Start
Edit	Input Format		1.

9. An "Edit Input Format" dialog box will appear. Select the settings in the "Format Selection" box the fields (e.g. ID, X, Y, Z) that were used in your gcp text file. Then click "OK".

X Y Z Code Ignore	 1: ID 2: X 3: Y 4: Z 5: Ignore 6: Ignore
-------------------------------	---

10. Click "Options", select "Set Accuracy".



11. A "Set Accuracy" dialog box will appear. Type ".3" in "X Accuracy" box, type ".3" in "Y" Accuracy" box, and type ".7" in "Z Accuracy" box. The values are the handheld GPS accuracy level in XYZ. Then click "OK".

😟 Set Accu	iracy	? ×
× Accuracy:	0.3	
Y Accuracy:	0.3	
Z Accuracy:	0.7	
	OK	Cancel

12. Type output ground point file name (e.g. ojt_photo.gpf) in the "Output Ground Point File" box. Hit "Enter" in the keyboard. Then click "Start.

😟 ASCII Ground Point Im	port <ojt_photo th="" 💶="" 🗖="" 🗙<=""></ojt_photo>		
File Options Help			
Input File Format:	Default.gcp		
Input ASCII Ground Point File:	ojt_xyz.txt		
Output Ground Point File:	/data/ojt_photo/ojt_photo.gpf		
Units:	Project Native		
Select input file Write in the output file name. Select output file	k ₽		
	Start		

3.1.2.3 Using Control Point Editor

Control Point Editor creates a file of control points, which are used by Triangulation. Use the Control Point Editor to create, view, edit, or change a file of control points.

One of the important features of the Control Point Editor is that it lets you input the control point data in one coordinate system, and save the file in a different coordinate system. Selecting an alternative datum changes the display and input values. These are converted to/from the underlying project datum for storage in the .gpf file. This could be used, for example, when you have a pair of well-controlled images in a UTM project, but you want to collect control points for a State Plane project.

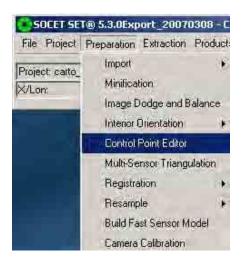
The major capabilities of the Control Point Editor are as follows:

- Creates a new ground point file or modifies an existing ground point file.
- Saves the ground control points to the current project or a different project.
- Converts the list of points to any project's coordinate system and datum.
- Measures (in three-dimensional space) ground points from controlled imagery.
- Drives the extraction cursor to a three-dimensional ground point location for any point in the list.
- Displays and accepts control point data in the current project's coordinate system or an arbitrary coordinate system and datum.

There are four ways to build a file of control points:

- The Control Point Editor,
- The Interactive Point Measurement window of Triangulation,
- Ground Point Import, and
- Coordinate Measurement Log.

If you decide to use Control Point Editor for inputting your control points, you should run it after you create a project, but before running Triangulation. If you are going to use wellcontrolled imagery (e.g. PPDB) to fabricate control points, you must import the well-controlled images before running Control Point Editor. 1. Click "Preparation", select "Control Point Editor".



2. A "Control Point Editor" dialog box will appear. Click the browse button in the "Ground File" box.

ound File: cart	o_sat.gpf			1
stem: *cur	rent_project	Datum: PHILIPP		Elev (MSL)
Point List: 0 poir	nts			2441-0
Find Point:		Exact Match		卫①
Point ID		T	ype L	lse
Date	Programme and the	04.5	z	1
1	X/Long	L T /L at		
Coordinates	X/Long	Y/Lat		
The second secon	X/Long	T/Lat		
Coordinates Accuracy	X/Long	T/Lat		
Contraction and the second second	X/Long		5	
Contraction and the second second				
Contraction and the second second			Points	
Accuracy	Mo			
Accuracy				
Accuracy	Mo			
Accuracy	Mo			

3. A "Select Ground Point File" dialog box will appear. Click the down arrow button in the "Look in" box and locate the folder of the imported ground control point. Then click "Save".

	le la company
- +	• • • •
	_
	Save
	2

4. The GCP point ID will be reflected in the Point ID box. Select one point ID (e.g. 319), the coordinates XY and elevation Z will be shown in the "Coordinates" box. Select the Leveling point ID (e.g. rm 14), click down arrow and select "Z Cntrl". Change all "XYZ Cntrl" type of leveling point id to "Z Cntrl"

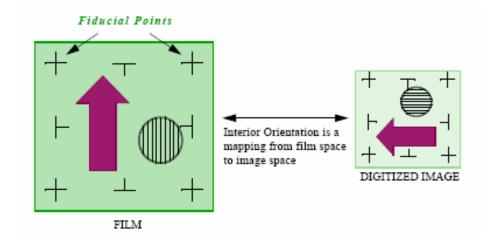
	nt_project Da	tum: PHIL	IPPINE_(PP	Elev (MSL) _
Point List: 38 poin Find Point:		xact Match	i	IJ	一仓
Point ID			Туре	Use	-
203					_
319			and the second se		
322			1.01.000 0000000	N.	
rm14			Z Cntl		
rm15			Z Cntl 👱		-1
	X/Long	Y/Lat	Tie Z Cntl		
Coordinates	287437.319	1/Lat	XY Cntrl	71.757	_
	267437.319	1.	XYZ Cntrl	0,700	
Accuracy	0.300		Z Check	0.700	
			XY Check XYZ Check	1	
	Later Section	1 m pu	w Points	1	
	MoveTo		iw Foints		
Velcome to Contro	Point Editor.				

Load Project.	or ppf				
Save GPF	oject Da	tum: PHIL	IPPINE_(PP	Elev (N	(ISL)
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322			XYZ Cntrl	<u>v</u>	
rm14			Z Cntl	V	
m15			Z Cntl	-	
	-	1			
122310-02449-02649	X/Long	Y/Lat	Z		_
Coordinates	287437.319	1000	47881.839	71.757	
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			-		
	MoveTo	I = pe	aw Points		
	MOVELO				
elcome to Cont	rol Point Editor.				
	torr one cator.				

5. Click "File", select "Save GPF".

3.1.3 Interior Orientation

Interior Orientation is a critical part of various import models. The units in film space are millimeters; the units in digitized image space are pixels. This transformation is a key part of the Frame and Panoramic sensor models.



The transformation created by Interior Orientation accounts for:

- Resolution used by the scanner (dots per inch).
- Film shrinkage or warping.
- Orientation of the film when it was scanned.
- The portion of the film that was scanned.
- The position (offset) of the film on the scanner.

Interior Orientation performs the following processing:

- Provides you with the means by which you measure fiducial points or reseau marks.
- Calculates Interior Orientation coefficients according to the userselected solution type.
- Automatically updates the solution whenever you measure or remeasure a point.
- Stores the measured point data in the Interior Orientation point data file.
- Stores the Interior Orientation coefficients in the image support file.

When to Use Interior Orientation

You normally perform Interior Orientation:

- After importing your imagery with Frame or Panoramic Import
- Before you perform Triangulation
- Before the image is rectified
- Before Automatic Point Measurement process

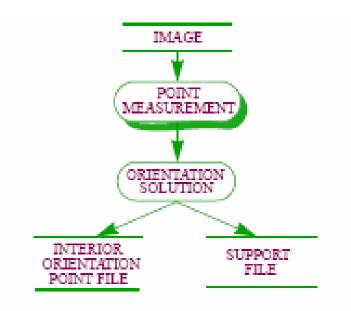
Interior Orientation is required for all images that have been created by scanning film. Interior Orientation is not required for non-film-based imagery such as SPOT or Landsat imagery.

You may skip Interior Orientation if the Interior Orientation transformation is provided with the digitized image, in which case the system obtains the Interior Orientation information when you import your image. The Interior Orientation may also be skipped when employing special math models (for S2 and S3) since the .sup file is generated by using Topographic Engineering Center (TEC) translators on data block raster images prior to the orientation process.

If Fiducials are Not Present

If fiducial marks are not visible in the scanned imagery (because only a portion of the film was scanned, or because the film never had fiducial marks) then you should skip Interior Orientation. In this case, proceed directly to Triangulation and use a polynomial solution.

Interior Orientation Data Flow



3.1.3.1 Automatic Interior Orientation (AIO)

Interior Orientation can either be performed manually or automatically. Automatic Interior Orientation can be performed with multiple images at once either through the SOCET SET menu bar to pop up the AIO window, or in stand-alone batch mode. AIO updates the .iop and .sup with corrected measurements and generates a report file and a log file. If AIO fails, you can call Manual Interior Orientation by click the Manual IO button to measure fiducials.

AIO supports the following camera types:

Jena LMK 1000	Jena LMK 2000	Wild RC 10
Wild RC 20	Wild RC 30	Zeiss RMK A
	Zeiss RMK TOP	

To access AIO from within SOCET SET, click *Preparation* > *Interior Orientation* > *Automatic Interior Orientation* on the main workstation window

1. Click "Preparation", select "Interior Orientation" and click "Automatic Interior Orientation".

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	ion		Y/L	at: 1650097.41	8	
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Interior (Drientation	\	Auto	matic Interior O	Irientatio	on .
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2. An "Automatic Interior Orientation" dialog box will appear. Click "Add" button.

Automatic Interior Orientation <ojt_photo.prj></ojt_photo.prj>	_ 🗆 ×
File Options Help	
Processing Results	
<u> </u>	
Add	
Remove	
Stat	
Welcome to Automatic Interior Orientation	
	10
	11

3. A "Select Support File" dialog box will appear. Select all the support file images (e.g. 05_301.sup, 05_302.sup, 05_303.sup) to be used for interior orientation. Click "Open". Then click "Start"

Select Support Fi	ie(s)			? X
Look in:	🔁 ojt_photo		+ 🖬 💣 🗐+	
My Repent Documents Desktop My Documents My Documents	hats_backup ojt_photo ojt_photo_RGM ojt_photo_seams ojt_photo_test temporary_dir 05_300.sup 05_303.sup 06_515.sup 06_516.sup 06_517.sup 06_517.sup 07173-II San Miguel.sup 7272-IV Angat 5m.sup 07272-IV Angat 5m.sup	置 ojt_photo.sup 回 ojt_photo_dodge.sup 國 ojt_photo_rgm.sup		
My Network	File name: ["05_3	03.sup" "05_301.sup" "05_3	02.sup"	Open
Placer	Files of type: Suppo	nt File (*.sup)	2	Cancel

4. An "AIO" info box will appear. Click "OK".



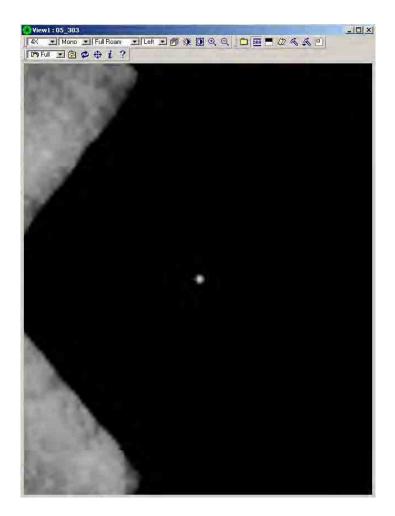
5. The RMS (pixel) result will be reflected in the "Result" tab. Check the RMS of those Image ID which has a value more than 0.35. Click "Manual IO".

			ess Fids	RMS (pixel)	R
1	05_303	Z 4	(of 4)		0.63
2	05_302	V 4	4 (of 4)		0.36
3	05_301	V V	4 (of 4)		0.28
•					•
		M	anual IO		

6. An "Interior Orientation" dialog box will appear. The fiducial point id 1 will be shown in the view window. Click "Locate All Fiducials and check the position of cross hair if it is in the center of the fiducial point. if yes, accept the RMS result, if not re-measure by performing manual IO.

	nage 05_303	sup						
oint)	X(mm)	Y(mm)	Average Line	Average Sample	Residuals Line	Residuals Sample	Use?	
1	112.996	-0.007	-0.007		-0.513	-0.371	2	
2		-0.007	33.928	-5626.825	-0.513	-0.371	2	
3	-0.001	113.011	-5635,969	6.858	0.513	0.371	ম	
4	0.000	-112.997	5670.543	40.536	0514	0.371		
ocate	e This Fiducial	Locate Al	l Fiducials	Sample		ccept Sampl	e	Calculate
ùne	nt Point 1		ी ए	RMS 🕅	0.63	Sol	ve Type	6 Parameters
			1					

- 3.1.3.2 Manual Interior Orientation (IO)
 - Using the 3D stealth mouse, adjust the position of the cross hair near the center fiducial point. Click "Locate This Fiducial" Locate This Fiducial . Click "Accept Sample" Accept Sample and it will go to the next fiducial point ID. Repeat same procedure until all the fiducial marks have been measured.



2. Verify RMS if it is approximately 0.35 or better (lower) Click "File", select "Save".

100000000	Ctrl+O							
Save Save	Ctrl+5 As	k	Average Line	Average Sample	Residuals Line	Residuals Sample	Use?	
Exit		0.007	-0.007	5673.239	-0.513	-0.271		
2	-112.995	-0.007	33.928	-5626.825	-0.513	-0.271	7	
3	-0.001	113.011	-5635,969	6.858	0.513	0.271	V	
4	0.000	-112.997	5670.543	40,536	0.514	0.271	7	
ate Tł	nis Fiducial	Locate Al		Sample	. A	ccept Sample		Calculate
ate Tł	. ا	Locate All	Fiducials	A	9 A			Calculate

3. Click "Start" again.

Automatic Inte	rior Orientation <elmer2_photo.prj></elmer2_photo.prj>	<u>_ ×</u>
- 11 - 12 - 11	esults 05_303.sup 05_301.sup 05_302.sup	
Starting Automatic	Start SUCE 1_SE 1_5.3.0\data\elmer2_photo\elmer2_photo Interior Orientation ames. SOCE 1_SE 1_5.3.0\data\elmer2_photo\elmer2_photo	

4. Verify RMS results.

I

	Image ID	Success Fids		RMS (pixel)	B
1	05_303	✓ 4 (of 4)		0.594	-
2	05_302	✓ 4 (of 4)		0.36	
3	05_301	🗹 4 (of 4)	H	0.28	8
গাঁ			1		
1					<u>.</u>
<u>+ </u>		Manual ID			<u>)</u>
	are in CASULE I	at 1_0.3.0\data\eimer.		.eimerz_pnoto.io_rep.	<u>) </u>

3.1.4 Observation of Photo-Coordinates (GCP, Pass Points, Tie Points, & Leveling Points)

Measurement of Image Coordinates (Points)

There are four ways to measure ground points in imagery:

- Automatic Point Measurement (APM) (in Triangulation)
- Interactive Point Measurement for APM
- Interactive Point Measurement (IPM) for Blunder Detection
- Interactive Point Measurement for Simultaneous Solve The decision of whether to run IPM before of after APM depends on the kind of ground points you have. The following

WHAT TO RUN SITUATION

table gives some guidance:

- **APM before IPM** You have a few control points; and you want to Solve (after APM) before running IPM so that it is easier to find the control points in IPM.
- **IPM before APM** You measure some control points and some tie points in IPM (in one image only), then you run. APM to transfer these points to other images and to measure additional tie points.
- **IPM only** You have just one image. Or, you have lots of control points and you don't need tie points.
- APM only You have no control points. To interactively review the tie points measured by APM, you use IPM. Neither APM or IPM You have measured the image points on an analytical plotter, and imported them with ASCII Image Point Import, and are using Triangulation only for the Solve process.

Control Points are points with known ground coordinates (XYZ, or XY, or Z). You must enter the location into the IPM window. Triangulation stores this data in the project Ground Point File. You must also use the extraction cursor to identify the control point in all the images in which the point is located. The image space positions are stored in the Image Point Files (IPF).

Tie Points are points on the ground that you can identify in two or more overlapping images, but you don't know the ground coordinate. You use the extraction cursor to identify the point in all the overlapping images. The image locations are stored in the Image Point Files (IPF). An entry is created in the Ground Point File (GPF) for each tie point. APM will create tie points automatically.

Check Points are points with known ground location (XYZ) that are not used in the solution, but are provided to help the operator perform a quality control check after the solution is complete. Check points are also called diagnostic points.

Ground Point is an umbrella term that includes Control Points, Tie Points, and Check Points.

Image points are the image space locations (in lines and sample coordinates) of Ground Points. A single image point is stored for every instance of a ground point in an image. For example, if a tie point is located in 4 overlapping images, and you measure it in 3 of the images, then 3 image points are stored. Image points are stored in the IPF files. An image point must be associated with some ground point. If you somehow have points in IPF files which are not reflected in the GPF file, transfer them using the *Reset* > *Transfer* Image Points menu selection.

Ground Point Selection

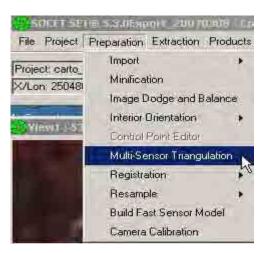
Ground Point consists of two tables containing ground point information. The upper table lists all ground points in the current Ground Point File. Clicking the LMB on any point in the table moves the extraction cursor to that point and loads the measured and unmeasured images.

Image Point Section

This area contains the image status list which displays all images containing the selected ground point. The point status is either locked or unlocked, measured or unmeasured. An X in the appropriate field indicates locked or measured. The Master field indicates which images are loaded left or right. The left master image is always used as the master when Auto Two or Auto All is selected.

3.1.4.1 Measuring GCP.

1. Click "Preparation", select Triangulation".



"Multi-Sensor

2. An "Automated Triangulation" dialog box will appear. Click the ellipse button.

😟 MST Manager <elmer2_p th="" 💶="" 🗖="" 🗙<=""></elmer2_p>
File Settings Reset Help
Triangulation file:
Setup
Automatic Point Measurement
Interactive Point Measurement
Blunder Detection
Solve
Solve BINGO
Log file has been created Please select an ATF file ! Log file has been reset
//

3. A "Save As" dialog box will appear. Type a file name (e.g. ojt_photo) in the file name box. Click the "Save".

re As		States of Lot			?
Save in	elmer2_pho	ito	•		5.00
My Recent Documents	ahats_backup				
Elesktop					
ly Documents					
My Computer					
My Network Places	File name:	ojt_photo		-	Save
Tiles	The section of the se	a transfer to sail			

4. The file name (e.g. ojt_photo) will be reflected in the triangulation file box. Click "Setup".

0	Automated Triangulation 💶 🗖 🗙
File	: Settings Reset Help
Tri	angulation file: ojt_photo.atf
	Setup
	Automatic Point Measurement
	Interactive Point Measurement
	Blunder Detection
	Solve
	Solve BINGO
Lo: A r	elcome to Multi-Sensor Triangulation. g file has been created new triangulation file was created. new triangulation file was created.

5. A "Setup" dialog box will appear. Click "Add" Add...

Setup <cart< th=""><th>o_sat.atf></th><th>? ×</th></cart<>	o_sat.atf>	? ×
Advanced	Ground Point File.]carto_sat.gpf	
Auto Populate	Setup Block Exterior Init	
Strips		
Strip ID	Use Kappa	
Reve Inages	rse Order Add. Remove	1
Fleverse Order Help		Data

6. A "Strip ID Sequence" box will appear. Type a number (e.g. 1). Then click "OK"

Strip ID Sequence	and the second second	? ×
sss,sss-sss(no_spaces)		
1	- Andrews	
	OK	Cancel

7. A "Select Support File(s)" dialog box will appear. Select the images (e.g. 06_515, 06_516, 06_517) in the "Available" box. Click the arrow ➡ to copy the selected image to the "Selected" box. Then click "OK" OK.

mages Available	Select	ed	
05_301.sup 05_302.sup 05_303.sup 71734I San Miguel.sup 72724V Angat 5m.sup GRAPHICS_ONLY.sup ojt_photo.sup ojt_photo_dodge.sup ojt_photo_rgm.sup	06_5 06_5	15.sup 16.sup 17.sup	
Filter			

8. The created strip 1 will be reflected in the "Strips" box and the selected image (e.g. 06_515, 06_516, 06_517) will be reflected in the "Images" box. Click "Reverse Order" of the images numbering. Refer to the flight index.

١d	vanced Ground	Point File	ojt_photo.gpf	
uto	Populate Setup	Block	Exterior Init	
trip	25			
	Strip ID	Use	Карра	
	1	1		2,78
		Contra Contra		
		r		-1
	Reverse Order	Add.	Remove	
	ges			-
na		-	Wenner.	-
	Support File	Use	Sensor	
	06_517.sup	7	FRAME	
_	06_516.sup	<u>र</u>	FRAME	
i	06_515.sup	V	FRAME	
le'	verse Order A	dd	Remove	age Data
4	Help		ок,	Cancel
	lick "Add" m	dor the	"Strips" box. A	"Strip
			ar. Type the next n	
	_	25	ок	
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? X			uence	Strip ID Se
			paces)	ss,sss-sss(no_
				2
el	Ca	OK		
iC.	Ca	ØK		

10. Select the next image corresponding to strip number 2. Click the arrow → to move the image to the "Selected" box. Then click "OK" OK.

Available	Selected	
7173-II San Miguel.sup 7272-IV Angat 5m.sup GRAPHICS_ONLY.sup oit_photo.sup oit_photo_dodge.sup oit_photo_rgm.sup 06_515.sup 06_516.sup 06_517.sup	05_301.sup 05_302.sup 05_303.sup	
Filter		

11. Repeat steps 7and 8 until all the needed images have been selected. Click "Setup Block" Setup Block

) Se	etup <ojt_photo.< th=""><th>atf></th><th></th><th>? ×</th></ojt_photo.<>	atf>		? ×
Ad	vanced Grou	nd Point File:	ojt_photo.gpf	
Auto	o Populate Setu	ip Block	Exterior Init	
Strip	ps			
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1		1 🗹		2.78
2		217		-0.64
lma	iges	- Norman	Heren	
	Support File	Use	Sensor	·
1	06_517.sup	2	FRAME	
-	06_516.sup	<u>v</u>	FRAME	
2	06_515.sup	V	FRAME	
Re	werse Order	Add	Bemove	Image Data
				18-

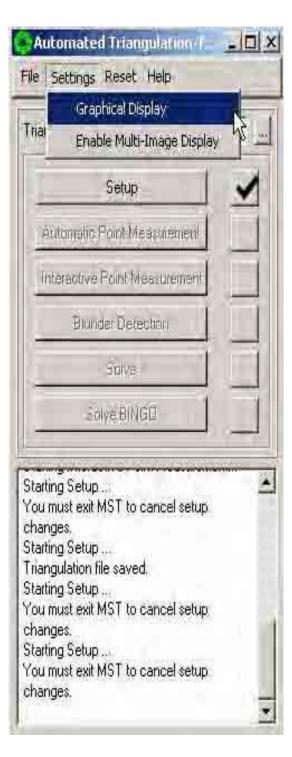
12. A "Setup Block" dialog box will appear. Set "Mean Flying Ht." to "6300". And "Image Overlap Pct" to 70. Click "OK" OK . Then click "OK"

	Strip ID	Mean Flying Ht.	Image Overlap Pct.	Scan Dir
1	্রা	6300	70	Right
2	2	6300	70	Right
				43
4				<u>.</u>

13. Click "Settings" and select "Enable Multi-Image Display.



14. Click "Settings", select "Graphic Display".



15. A "Graphic Display" dialog box will appear. Check "Tie" box, "Control" box, "Icon" box, and "IDs" box. Click "Apply" Apply . Then click "Close" Close

💌 Graphical Display	? ×
Attribute File	
🔽 Display	Rotate to First Strip
Point Graphics	- 13
🔽 Tie	
Control	
F Check	
Filter by Number of Ra	ys:
Color by Number of Ra	ays
Select Graphics to Draw I Icons I IDs Ray Count I Image Residuals I.600000 G 000000 G 000000 G 000000 G 000000	con/pixels residuals signet threshold
1.000000	
T Block Connections	
Image Graphics	
Apply 0	Close View

16. Click "Interactive Point Measurement".

😟 Automated Triangulation/Full	<u>- 🗆 ×</u>
File Settings Reset Nelp	
Triangulation file: oit_photo.atf	
Setup	
Automatic Point Measurement	
Interactive Point Measurement	
Blunder Detection	
Solve	
Solve BINGD	
Weicome to Watt-Sensor Mangulation. Log file has been created Reading Triangulation File. Reading image 1 of strip 1 Remain: 5 Reading image 2 of strip 1 Remain: 4 Reading image 2 of strip 1 Remain: 3 Reading image 2 of strip 2 Remain: 1 Reading image 2 of strip 2 Remain: 0 Triangulation file was successfully read. Starting Setup You must exit MST to cancel setup char Starting Interactive Point Measurement Another function has control of the mous Failed to grab mouse buttons.	

17. An "Interactive Point Measurement" dialog box will appear. Put arrow inside "Image Points" box, click right mouse button and select "Add".

Point ID		Type	Usi	e 🔺
203		XYZG	ntri 👻 🔽	
319		XYZ G	ntrl 🔻 🔽	
322		XYZ Ci	ntri 👻 🔽	
rm13		Tie	- 17	-
rm14		Tie		
rm15		Tie		
r	X/Long	Y/Lat	Z	
Coordinates	289333.280	1648728.94		496
Accuracy	0.300	and the second s		700
nage Points Image ID		Master	Lock Mea	sured [
	1	Add		

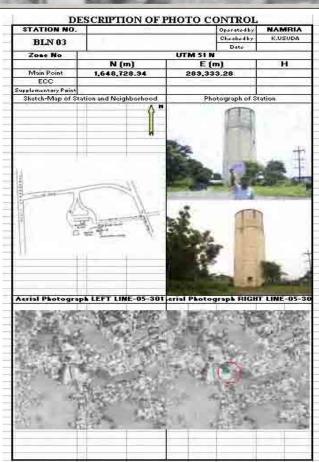
 A "Select Image to Add" dialog box will appear. Select the needed images (e.g. 05_301, 05_302, 05_303). Then click "OK".

🧿 Select Image t	o Add 🤶 🗙
05_301.sup 05_302.sup 05_303.sup 06_515.sup 06_516.sup 06_517.sup	
ОК	Cancel

19. Select a point ID (e.g. 203) in the "Interactive Point Measurement" dialog box. The position of the selected point ID will be identified on the image. Move the cursor if necessary to adjust the location of gcp on the position described from the description data sheet.

	Point ID		Тур	a	Use	
322 Y/Z Cntil V/Z m14 Z Cntil V m15 Z Cntil V m16 Z Cntil V X/Long Y/Lat Z Coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700	203		XYZ	Cntrl		-
Image ID Master Lock Measured			XYZ	Cntrl	- 1	
X/Long Y/Lat Z coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700	1 199 am /		XYZ	Cntrl	- V	
X/Long Y/Lat Z Coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700	작품값		ZCr	ntl 🔄	- 1-	
X/Long Y/Lat Z Coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700 age Points Image ID Master Lock Measured 05_301 L Z Z Z			and the second se	212		
Coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700 age Points Image ID Master Lock Measured 05_301 L Image ID Image	m16		ZCr	ntl	- II-	-
Coordinates 289333.280 1648728.940 80.496 Accuracy 0.300 0.300 0.700 age Points Image ID Master Lock Measured 05_301 L V V		×/l ong	Y/Lat	7	1	
age Points Image ID Master Lock Measured 05_301 L V	Coordinates	A REAL PROPERTY AND A REAL	1150.075.212		80.496	
age Points Image ID Master Lock Measured 05_301 L V					0.700	
	err.201.0503.00			4	4	
	Image ID		A CONTRACTOR	NAME OF COLUMN	March 1	
			_			
	05_301			1	1	_
3 002000	05_301			1	-	- 1





20. Once you have moved the cursor to the exact location, check the "Lock" box of the first Image ID (e.g. 05_301). Click "Auto Two" button if the image point Id is within two or more images. Click "Save".

171-222	nt ID				Туре	_	Use	^
203 319	W				XYZ			-
313	1. 1.				XYZ	-		e .
	1 ⁻¹				XYZ		- V - V	
rm1	10				Z Cni Z Cni		-	9
rm1					ZCh		- 17	
	š	_			∥∠ Uni		Z.H.A.	
		X/Long		Y/Lat		Z		
Co	Coordinates 289333.280				48728.	940	80.49	16
A	couracy		0.300		0.	300	0.70	00
nage	e Points Image ID	i		1	Master	Lock	Measu	red [
1	05_301	·		i		V		
2	05_302			F	<u>(</u>	V	V	
3	05_303							

- ? X Interactive Point Measurement (IPM) Point List: 38 points ① ① Find Point: ▼ Exact Match Point ID Use Type 203 - -XYZ Cntil 319 XYZ Cntrl - -322 XYZ Cntrl - rm14 - 17 Z Cntl rm15 Z Cntl rm16 Z Cntl • - -Y/Lat Ζ X/Long 289333.280 Coordinates 1648728.940 80.496 0.700 0.300 0.300 Accuracy Image Points Master Lock Measured Image ID 05_301 5 7 L 1 05_302 R 5 2 7 3 05_303 L<->R LEFT RIGHT 45 Auto Two Sample Auto All Settings... Save Close
- 21. Click the "Master" column of the next Image ID. Click right mouse button, select "Right".

22. The selected image ID (e.g. 05_303) will move next to the first image ID (e.g. 05_301) Move the cursor if necessary to adjust the location of gcp on the position described from the description data sheet. Click "Auto Two" button if the image point Id is within two or more images. Click "Save".

ind Point:	E V	Exact Matel	r	\overline{v}
Point ID			Туре	Use
203			XYZ Cntrl	- 17
319			XYZ Cntrl	- I
322			XYZ Cntrl	- V
m14			Z Cntl	- v
m15			Z Cntl	- V
m16			Z Cntl	- T
	X/Long	Y/Lat	Z	
Coordinates	289333.280	164	18728.940	80.496
Accuracy	0.300		0.300	0.700
2 05_302 3 05_303		B		ব
Auto	Two	Sample		Auto All
Auto		Sample tings	Save	Auto All

3.1.4.2 Measuring Tie Points.

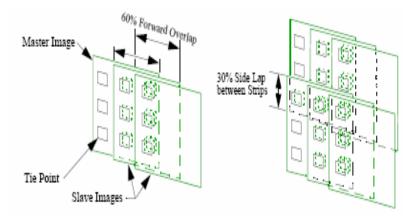
For tie points, the point measurement steps are similar except that the operator add the point ID and identifies the point location.

Good tie point locations:

- Flat Ground
- No Vertical Obstacle
- No Moving Cars
- Good Image Contrast

The tie point pattern represents an initial set of search locations that will be tested between each pair of overlapping images as APM proceeds. It is intended to give APM a hint on where to look for tie points, but does not indicate the final arrangement of points that APM will produce. The determining factors for selecting the arrangement of tie points are the amount and orientation of the overlap regions between images.

In the simplest case of 60% forward lap and 30% side lap in a rectangular block, the standard 3x3 pattern can be used. This pattern directs APM to find three tie points along any of its sides. With 60% forward overlap the closest image will share six points with the first image, while the next image over will share three with the first.



Assuming the approximate math models are reasonable, APM should be able to find a sufficient number of points in this minimum case to allow a relative solution. However, in reality the approximate data may be inaccurate especially if the images were imported as "Unknown." The effect of this is that the overlap areas will contain areas outside the pixel data and points will fail to correlate. In other cases, the overlap areas may be widely varied across or between strips—for some sensors these areas may be irregular polygons or just barely clip the edge of an overlapping image making correlation, which requires a 15 to 128 pixel "window," impossible.

One approach is to add many more tie point candidate locations distributed across each image, and try to measure as many points as possible regardless of the lap percentage and orientation. This results in many redundant points and many failed points. Using this "shotgun" approach trades computer processing time for manual editing and remeasurement time. Even if many points fail to measure, if enough have been measured to reach a solution, the failures can just be ignored without remeasurement. Care should be taken to insure that a "reasonable" distribution of successful points is achieved. Even if a large number of points fail, the remaining number are usually more than sufficient to allow reaching a solution. All points do not need to be measured before a solution can be executed. Unmeasured points are ignored by the solution algorithm. 1. In the "Interactive Point Measurement" dialog box, select the last point Id number, click right mouse button and select "Add". Type the number of the tie point (e.g. 0651703)

	nt ID				Туре	S.	Use	
m2					Z Cn	1		
m2					Z Cn	1	- V	
m2	8				Z Cn	1	v	_
m2					Z Cn		- V	
	1701				Tie		- I7	
065	1703				Tie	1	* IV	¥
-		X/Long		Y/Lat		z	ľ	_
C.	oordinates	The second second	87445.012	1.1.1.1.1.1.1.1.1	650699.	125	40.072	
	ccuracy		0.000			000	0.000	
1985	0.000.004		08/19/78		5.5	5.63P	198955717	
-								
age	e Points —					00		
	lmage ID				Master	Lock	Measured	
ĺ.	06_517				Ľ	N	N	
į	06_516				R	2	v	
3	05_301							
<u> </u>	05_302							
: } 								
)	10							

2. Select the created tie point ID (e.g. 0651703), lock the first image ID (e.g. 06_517). Then measure the tie point base on good tie point location. Click "Auto Two". Then click "Save".

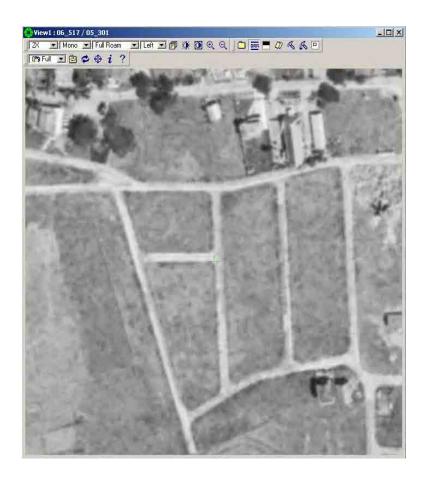


3. Click the "Master" column of the next Image ID (e.g.05_301) Click right mouse button, select "Right".

Point ID			Type	8	Use	
m26			Z Cnt			
m27			Z Cnt	1	- 1-	
m28			Z Cnt	1	-	
m29			Z Cnt	[]	- 17	
651701			Tie		- 17	
651703			Tie	j.		
		alaman wa		T-		
	X/Long	Y/Lat		Z		
Coordinates	287445.012		50699.		40.07	-
Coordinates Accuracy	287445.012			919	40.07 0.00	-
	0.000					0
Accuracy age Points Image ID 06_517	0.000		0.1	000	0.00	0
Accuracy age Points Image ID 06_517	0.000		0. Master	000	0.00	0
Accuracy age Points Image ID 06_517	0.000		0. Master	D00	0.00 Measu	0
Accuracy age Points Image ID 06_517 06_516	0.000		0.1 Master L R	Lock Lock L<->R	0.00 Measu	0
Accuracy age Points Image ID 06_517 06_516 05_301	0.000		0.1 Master L R	D00	0.00 Measu	0

4. The image ID (e.g. 05_301) will be transferred next to first image ID (e.g. 06_517). Then measure the tie point. Click "Auto Two". Then click "Save"

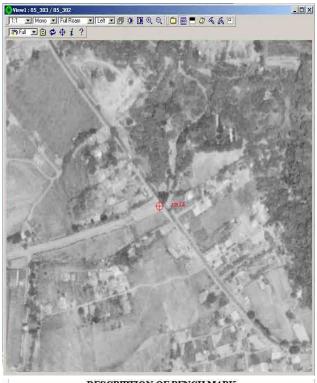
Poi	int ID				Туре	ų.	Use	
rm2	6				Z Cnt		- 17	
rm2	7				Z Cnt	()		
rm2	8				Z Cnt	6 8	- 17	
rm2					Z Cnt	1	- v	
3.111	51701				Tie		<u> </u>	
065	51703				Tie	j		
-		X/Long		Y/Lat		Z		<u> </u>
Co	oordinates		445.012		650699.1		40.07	2
A	ceuracy		0.000		0.1	000	0.00	-
age	e Points Image ID				Master	Lock	Measu	red
t	06_517				L	7	V	MS
2	05_301				B		F	
3	06_516					~		
4	05_302			t,	· ·	_	F	
								1.

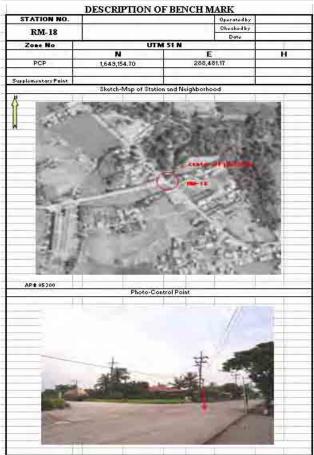


5. Select the next tie point in the point ID box and repeat steps 1-4 until all the needed tie points have been measured.

- 3.1.4.3 Measuring Leveling Points.
 - 1. In the "Interactive Point Measurement" dialog box, select the level point Id number (e.g. rm14). The position of the selected point ID will be identified on the image. Move the cursor if necessary to adjust the location of gcp on the position described from the description data sheet.

	rt ID			Type	S.	Use	. 5
322				XYZ			
m14	2			Z Cn	1	- IV	-
m15	;			Z Cn		- 17	
m16				Z Cnl	1	- IT	
m17				Z Cn		- I	
m18	li.			ZCn	()	• IV	
-		Q31 and	Y/Lat		z	- T	_
Cá	ordinates	X/Long 288465.000	COLUMN .	649143.	-	59.051	
Coordinates Accuracy		0.300			300	0.700	
						1.	
ane	Points						
oye	Image ID	6		Master	Lock	Measured	1
oye				L	7	1	
	05_301			R		0	
aye	A REAL PROPERTY AND A REAL					E .	
2	05_301					-	
	05_301 05_302				Π	-	
2	05_301 05_302				Γ		-1





2. Select the created level point ID (e.g. rm18), lock the first image ID (e.g. 06_517). Then measure the tie point base on good tie point location. Click "Auto Two". Then click "Save".

	int ID			Туре	8	Use	1
322				XYZ	Cntrl	- 1-	
rm1				Z Cnl	ti j	- T	
rm1				Z Cn	ti _	<u>v</u>	
rm1				Z Cnl	ti j	- T	
rm1	U			Z Cn	t		
mī	8			ZCn	Z Cntl		-
Ē		X/Long	Y/La	ส์	z		-
C	oordinates	288465.0	No. 181	1649143.	-	59.051	
-	ocuracy		0.300 0.300			0.700	
nage	e Points Image ID	v		Master	Lock	Measure	ग
1	05_301	10 10		Master	V LOCK	Measure	9/1
2	05_302			B	V	V	-
~ 3	05_303						

3. Click the "Master" column of the next Image ID (e.g.05_301) Click right mouse button, select "Right".

	int ID			13	Гуре		Use	
322					YZ Cnt	rl 💌	5	
rm1	4			Z	Cntl	۲	V	
rm1	56			Z	2 Cntl		ম	
rm1				Z	2 Cntl	×	1	
rm1				Ē	2 Cntl	Z	ম	
rm1	8			Z	2 Cntl			
ŕ		CONCUST:	To	'Lat		z		r—
E	oordinates	X/Long	65.000	4101	143.309	122	59.051	-
-	ccuracy	2004	0.300	1043	0.300	-	0.700	
		-						
nage	e Points —							
_	Image ID	e.		Ma	ster L	ock	Measure	ed
	05_301			És:	v		7	
1	05_302			R	V		V	
1 2	05_303			j, j	Ŀ	<->R		
	00_305				LE	FT		
2	03_303							
2	03_303				R	IGHT		

4. The image ID (e.g. 05_303) will be transferred next to first image ID (e.g. 5_301). Then measure the level point. Click "Auto Two". Then click "Save"

Po	int ID				Type	8	Use	
322					XYZI		- 17	
rm14					Z Cnt	1		
rm1	5				Z Cnt	t i	- 17	
rm1	6				Z Cnt	Í I		
rm1	7				Z Cnt	t i	- 17	
rm1	8				Z Cnt	Ê J		
-		Down		a a an i co		Ť-		- P
		X/Long		Y/Lat		Z		-
Coordinates		288465.000			1649143.309		59.051	
Accuracy		0.300			0.300 0.70		/00	
_								
nagi	e Points —							
	Image ID			Master	Lock	Meas	ured	
î	05_301				L	7	V	
2	05_303				R		1	
3	05_302			-	N .	7	2	
							1.2	-



5. Select the next level point in the point ID box and repeat Steps 1-4 until all the needed level points have been measured.

3.1.5 Calculation/ Inspection

Simultaneous Solve.

Simultaneous Solve performs a rigorous triangulation adjustment of a block of images to refine the estimates of their Triangulation parameters. Simultaneous Solve uses the weighted least squares method of adjustment in an iterative manner. It is capable of simultaneous adjustment of blocks of images taken by different sensors such as frame, panoramic, etc. It is also capable of recovering the interior geometry of the sensors via added parameters.

Simultaneous Solve requires the following input: image coordinates of control and tie points and their accuracies (image point files), ground coordinates of control points and their accuracies (ground point file), estimates of Triangulation parameters and their accuracies (support files and Triangulation file), and the interior geometry of the sensors (support files). All these data are automatically accessed by Simultaneous Solve without your intervention.

Simultaneous Solve uses a method known as "bundle adjustment" to determine the set of individual image parameter coefficients that minimizes the relative line/sample differences between points measured in overlapping images. The goal is to adjust the image parameters so that the position of a point in one image corresponds to the same point position in the other. If ground control is included, the parameters are adjusted so that the same image point corresponds to the same absolute position on all the overlapping images.

The method constructs a matrix of the linear equations and iteratively adjusts each of the independent image parameters until the solution converges below a pre-defined acceptance threshold. There are generally two problems that can happen with Simultaneous Solve: failure to converge, and excessive RMS residual error.

When you accept the solution, Simultaneous Solve will:

- Update the residual fields in the Ground Point File.
- Update the residual fields in each of the Image Point Files.
- Update the sensor model parameters in each of the Image Support Files.
- Write a Solution Accuracy Quality Report file (with extension .rep) in the project directory summarizing the image points, residuals, and solution quality.
- Write a second, more detailed Accuracy Summary Data report <atffilename>.atf.utri_rep. This contains information on QA statistics not available under the regular solve bundle adjustment method.

Excessive RMS residual error

The RMS of all the image residuals for the block is reported once convergence has been achieved. The acceptability of the RMS residual error depends on the sensor type and GSD but should be less than 1.0 pixel in most cases. Values greater than this indicate that one or more points is mismeasured and is skewing the solution excessively.

The Display Residuals menu can be selected to view the current image and ground residuals for all the measured points sorted by magnitude. Unfortunately, the largest residual points may or may not be the culprit in skewing the solution.

The first strategy should be to turn off all control points and attempt a relative solution first, unless the bad tie point is obvious.

If you examine a point with a high residual and it looks like it was well measured, you can skip it and try other points until you find one that is mismeasured. Examine points with even numbers of image overlaps over 2 (4, 6) and check the points between the first, third, fifth, etc. images to make sure that the point is measured at the same location.

Also, move and remeasure points which are on rooftops or in trees. Trees tend to move somewhat in windy conditions, or are difficult to measure accurately and distort the solution when used for tie point locations.

It is recommended that solutions with excessive RMS error should be discarded and not Saved. It is likely that the resulting math models are degenerate, or at least worse than the existing approximate math model. If the relative solution (control points OFF) shows good RMS error results, the math model can be Saved and the control points can be later remeasured. Usually the problem is not the measurement but the absolute ground position specified for the point. You should confirm from the original hardcopy control database, or other sources, that you have the right coordinates for the right image point, and that the elevation data is consistent with the project units (feet vs. meters, MSL vs. Ellipsoid) as specified.

1. After measuring all the needed control points, click "Solve" in the "Automated Triangulation" dialog box.

💌 Automated Triangulation/Full 💻							
File Settings Reset Help							
Triangulation file: oit_photo.atf							
Setup							
Automatic Point Measurement							
Interactive Point Measurement							
Blunder Detection							
Solve							
Solve BINGO							
Welcome to Multi-Sensor Triangulation. Log file has been created Reading Triangulation File. Reading image 1 of strip 1 Remain: 5 Reading image 2 of strip 1 Remain: 4 Reading image 3 of strip 1 Remain: 3 Reading image 1 of strip 2 Remain: 2 Reading image 2 of strip 2 Remain: 1 Reading image 3 of strip 2 Remain: 0 Triangulation file was successfully read. Starting Interactive Point Measurement Saved 6 files to backup Starting Solve Click Start to begin.							

2. A "Simultaneous Solve" dialog box will appear. Click "Start" Start.

	S in	hultaneou	us Solv	/e	<u>? x</u>				
	Math	Model:							
	Iterati	Iteration:		of	3				
	# Gro	# Ground Pts.:		35					
	Redu	ndancy:	70						
	ROOT MEAN SQUARE (RMS)								
	Image	e (pixels):	0.433						
	X or L	.ong:	0.073						
	Y or L	.at:	0.062						
	Z or E	lev:	0.205						
Display									
	B	esiduals		Report					
Parameters									
		Start		Star	At				
		Save	•	Close					

RMS (Image Pixel-0.433) is less than 1.0 pixel.

3.1.6 Product

Stereo model with all the measured photo control points (GCP, Tie Point, Level Point)

