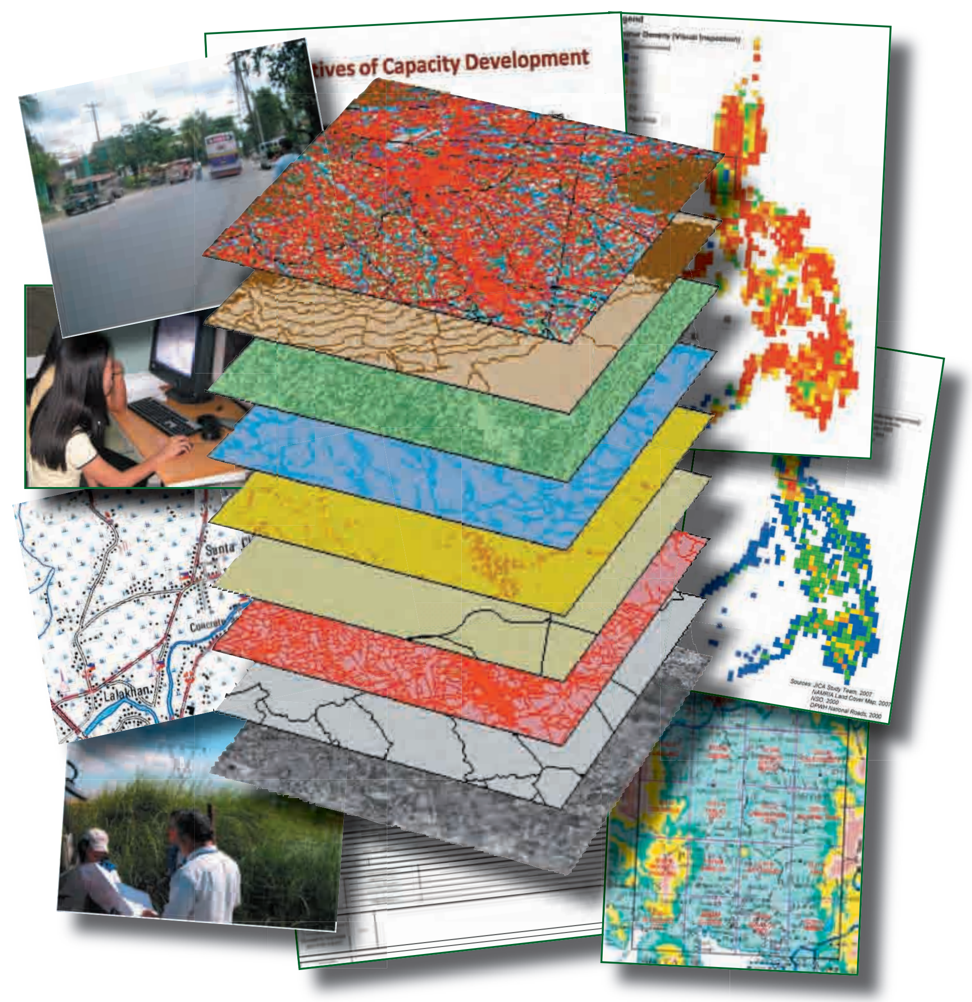
Japan International Cooperation Agency (JICA)

National Mapping and Resources Information Authority (NAMRIA)

No.

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

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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:

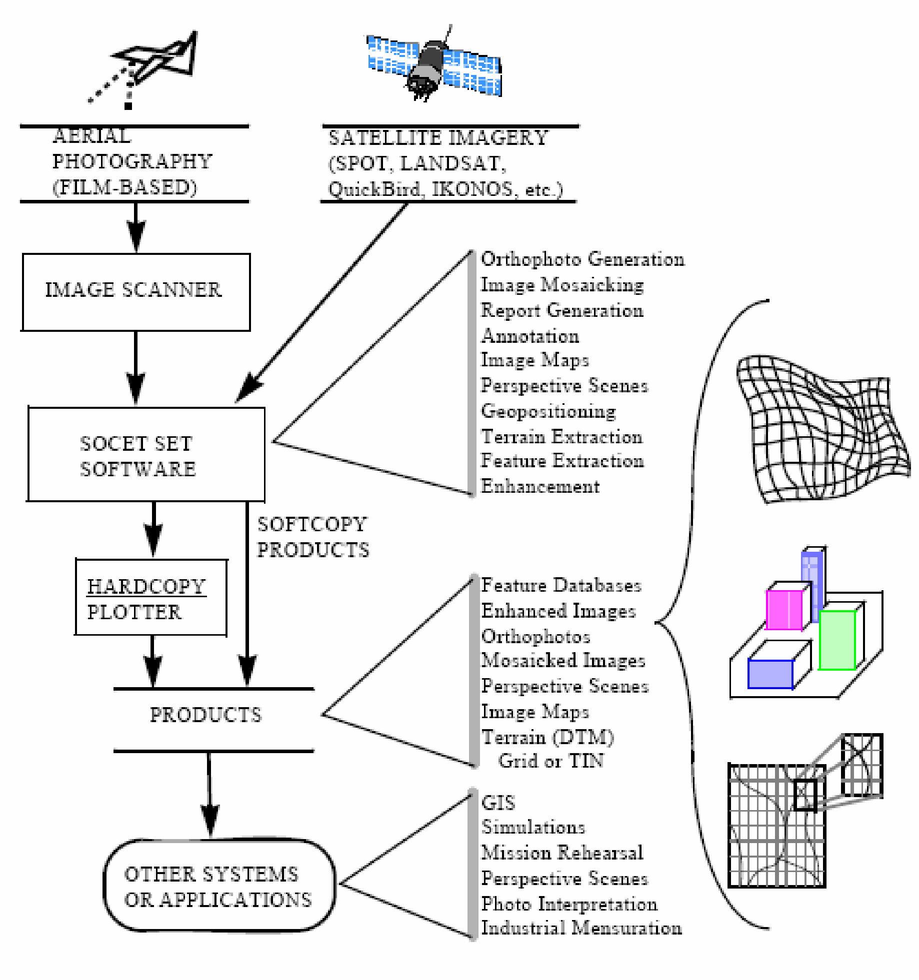
- Populating a GIS database (vector or raster)
- Producing image maps
- Civil engineering
- Mission planning
- Targeting
- Mission rehearsal
- Sensor research and development

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).



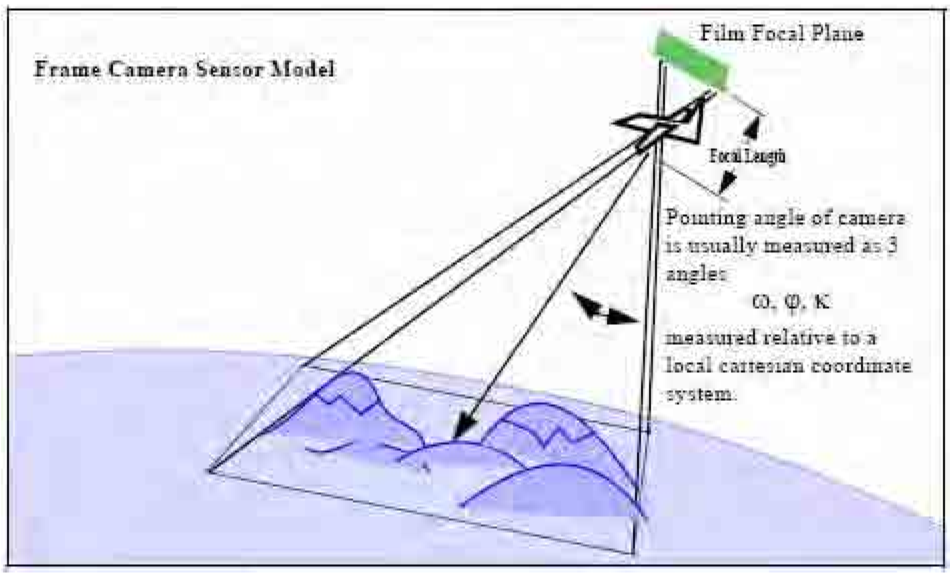
3. Using Aerial Photographs

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:

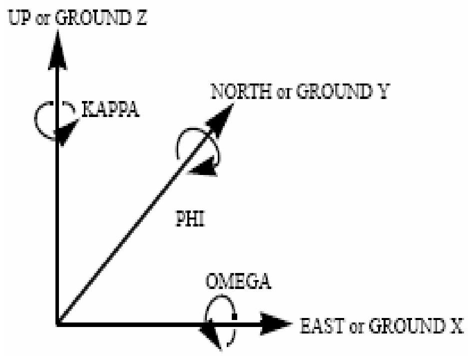
1. You enter Omega, Phi, Kappa in the camera position table. These angles are defined in the "Manual of Photogrammetry" and are the sequential rotations from ground coordinates to image coordinates—more on these later. You may enter Heading, Pitch, Roll in the camera position table. These angles are 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

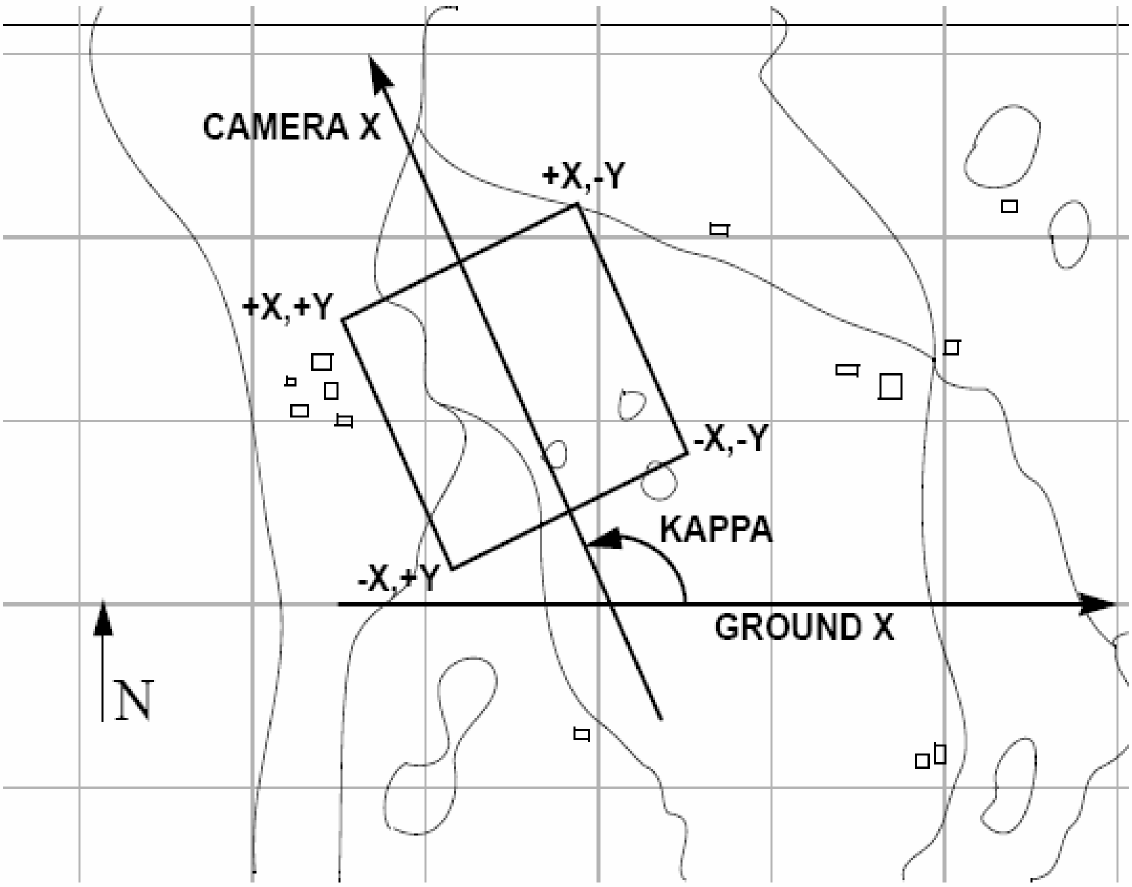
These angles define a transformation from ground space into fiducial (film) space. These angles are not as intuitive as heading, pitch, and roll, so you should avoid using omega, phi, kappa unless you have reason to use them.



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.

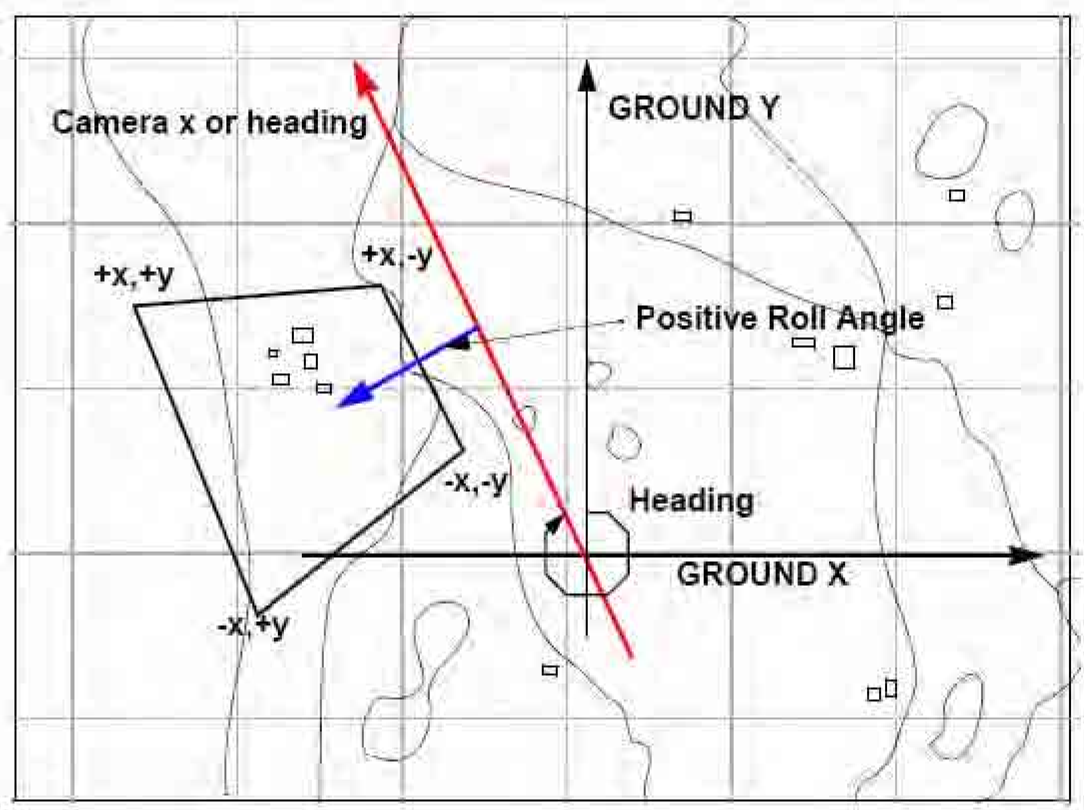
These orientation angles should not be confused with the alternative image-to-ground transformation, which may use the same notation. The following figure shows a Kappa for a vertical image. In this case omega and phi are approximately zero.

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.



EXAMPLE B

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.

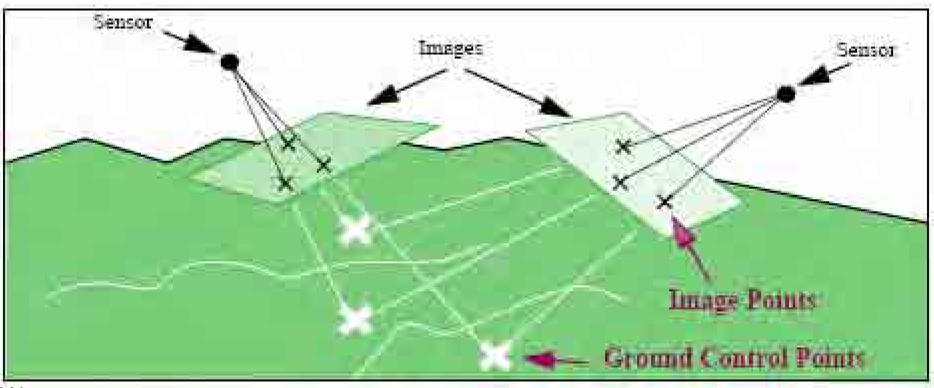
For frame camera imagery, you can start with image coordinates measured outside of SOCET SET. You can import plate coordinates. You can also import camera position and attitude data from programs such as ALBANY, PATB, or by entering this data manually. *See "Frame and Panoramic," Chapter 8* for more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



W

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)
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

Each point takes up one line of text and is represented by eight fields: <point id> <x> <y> <z> <x-accuracy> <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***.

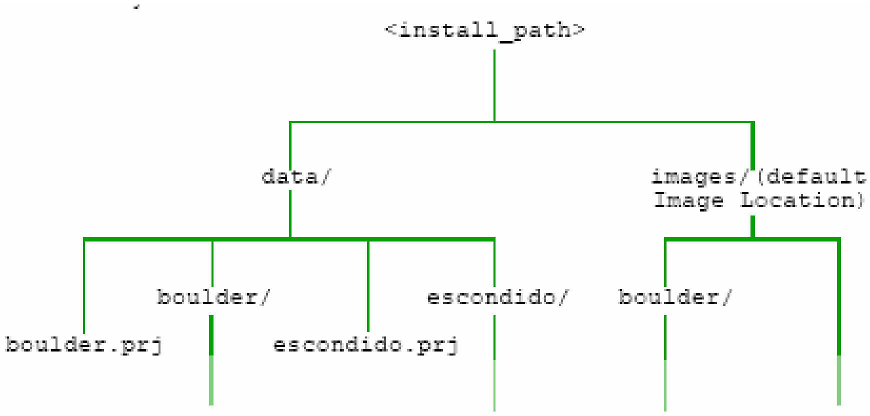
Graphical Attributes (.gra)
Contains values to set the color, font size, font type, line size, and line thickness for each of the graphics types displayed during the triangulation process. These files are stored in the / internal_dbs/HATS directory and may be customized and stored under different names 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.

roj
ect Parameters

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***)

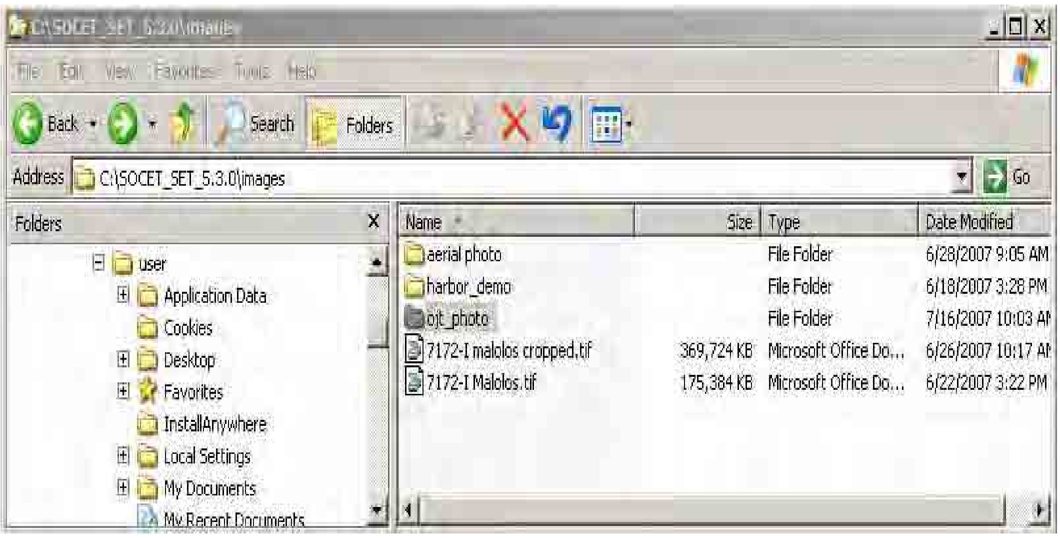
Additional parameters may be required dependent upon various selections. Once the project is created, the parameters you selected are displayed on the Main Menu window.

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.

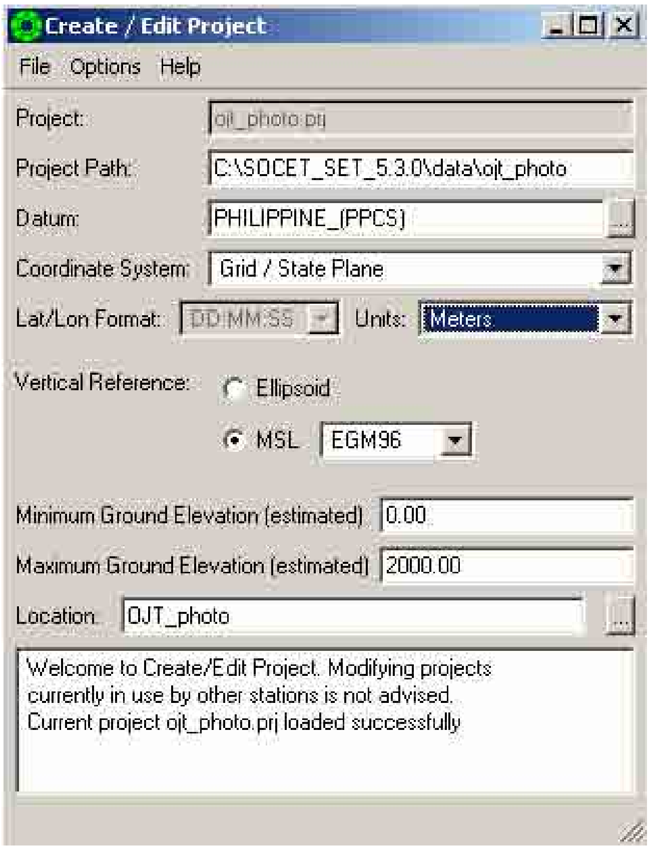
3.1.1.2 Creating folder and path/ directory for the image files

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

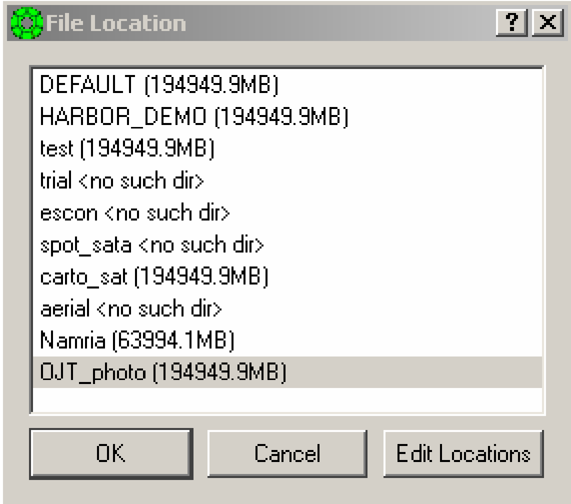


2. Open “SOCET SET 5.3.0” Click ”Project”, select “Create/Edit Project”

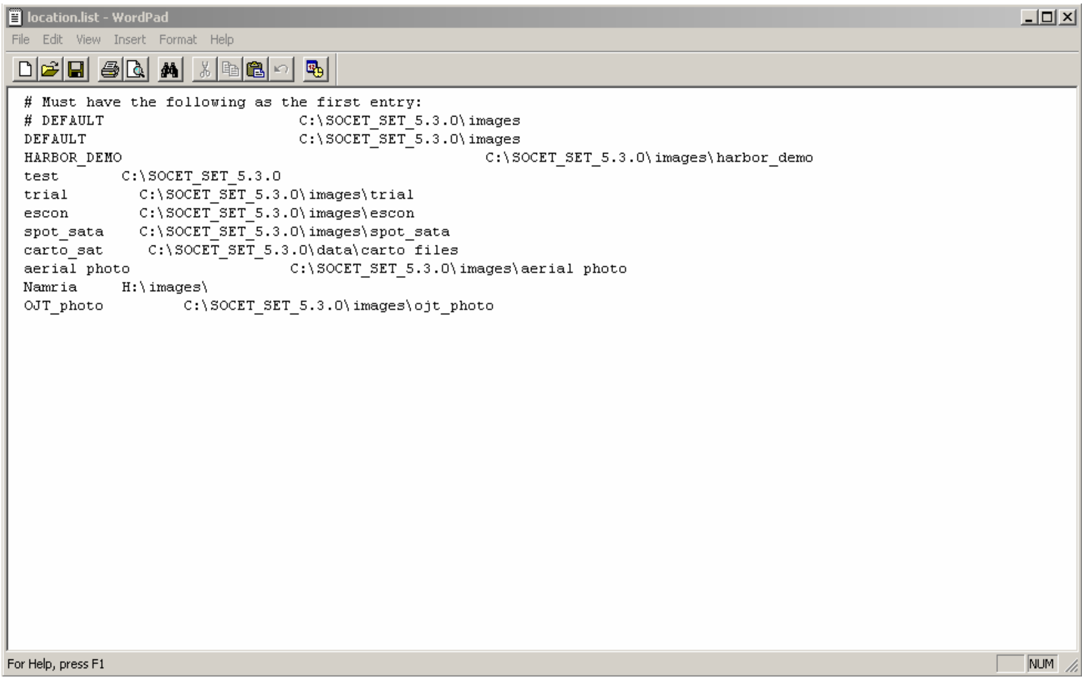
3. A “Create/ Edit Project dialog box will appear. Click the browse button in the “Location “box.



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



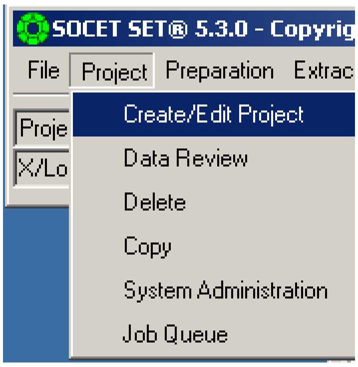
5. A "location.list-WordPad" dialog box will appear. Type the directory (e.g. C:\SOCET_SET_5.3.0\images\ojt_photo). Then click "Save" .



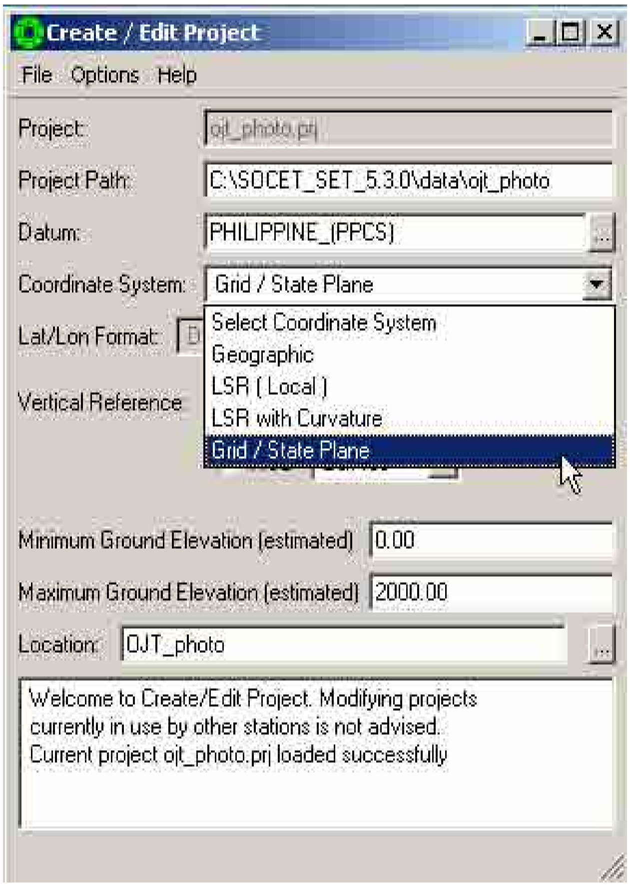
3.1.1.3 Creating Project.

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”.



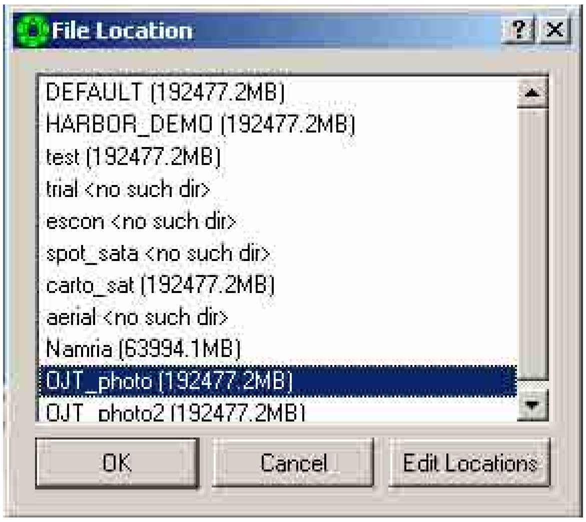
2. Click the down arrow in the “Coordinate System” box and select “Grid / State Plane”.



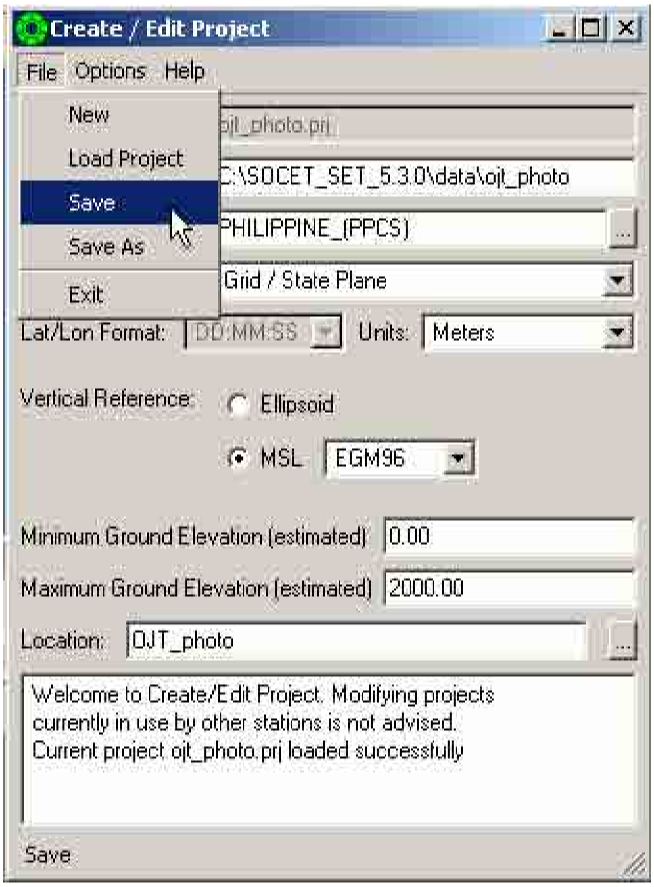
3. A “Select a Coordinate System” dialog box will appear. Scroll down the arrow and select the desired coordinate system (e.g. Philippine_UTM_51N). Then click “OK”.

4. 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".



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" 

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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.

LENS RMKA 15/23 NO : 124253 DATE : 02.04.03

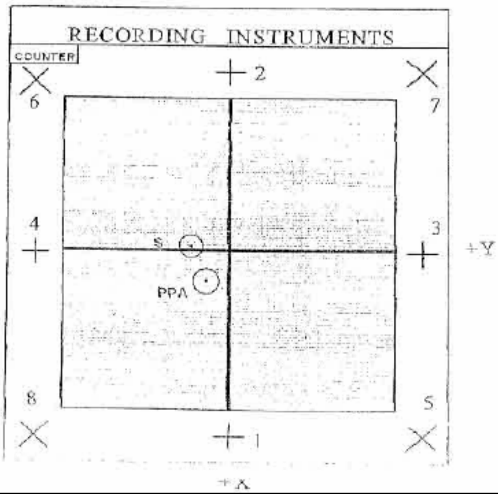
CALIBRATED FOCAL LENGTH : 152.977 mm

FIDUCIAL COORDS

POINT	X MM	Y MM	
FC	0.000	0.000	
S	-0.001	-0.009	Symmetry
PPA	0.010	-0.005	Autocollimatio

FIDUCIAL MARKS REFERRED TO F.C.
ARE ACROSS THE SIDE FIDUCIALS

PPA : PRINCIPAL POINT OF AUTOCOLLIMATION
S : POINT OF BEST SYMMETY



CAMERA : RMKA 15/23 124253

DATE : 02.04.03

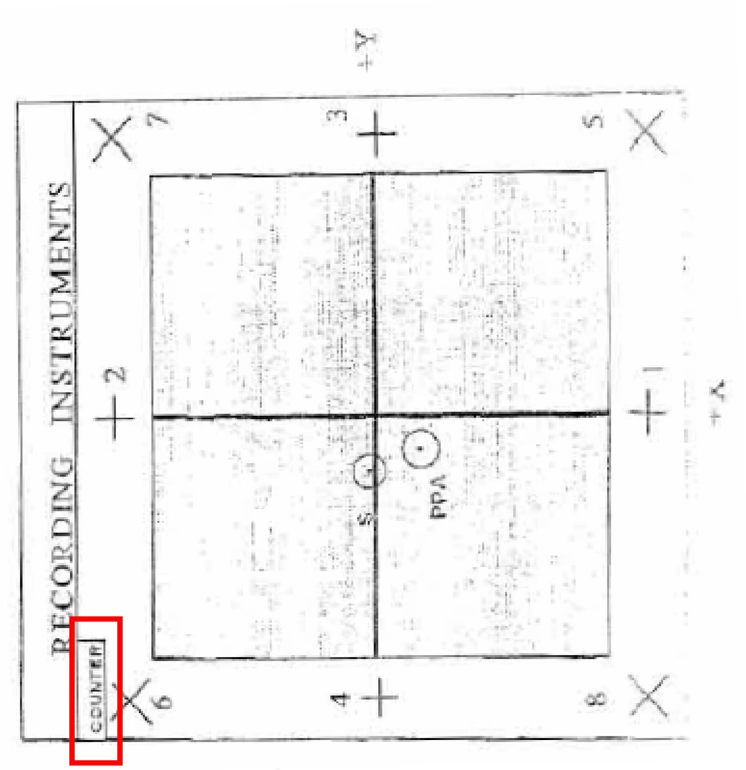
FIDUCIAL COORDINATES (SIDES)

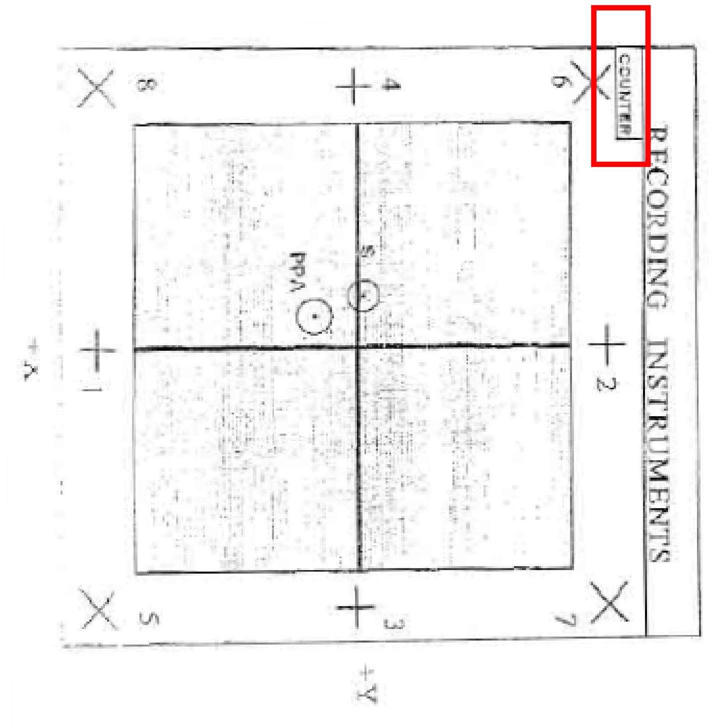
X1= 112.996	X2= -112.995	X3= -0.001	X4= 0.000
Y1= -0.007	Y2= -0.007	Y3= 113.011	Y4= -112.997

DISTANCES 1-2= 225.991 3-4= 226.009

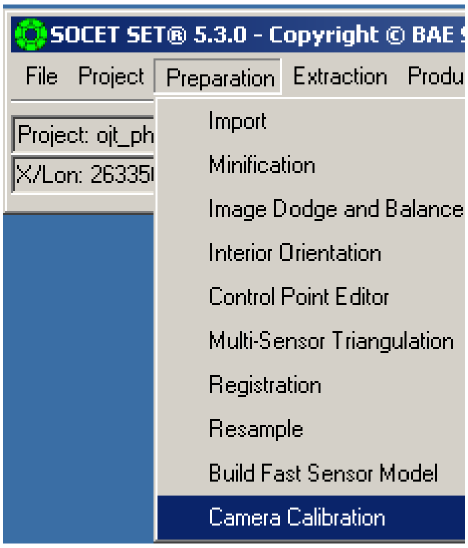
Fiducial position (numbering) depends on the type of camera (e.g. Zeiss RMKA) and location (e.g. Left Bottom, Left Top, Right top) of the aerial photo numbering

a) Left Bottom (LB)

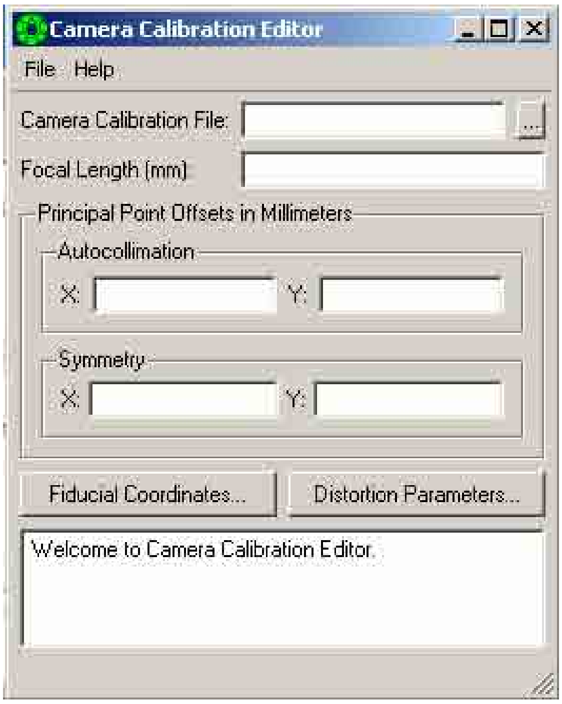




1. Click “Preparation”, select “Camera Calibration”.



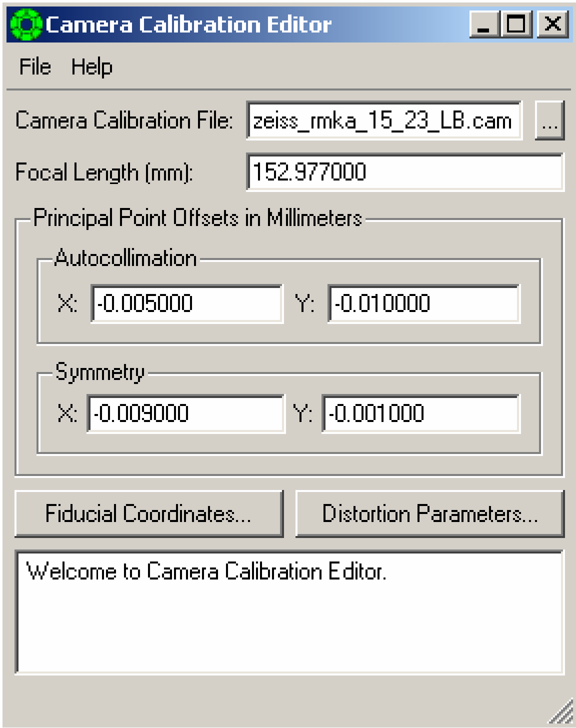
2. A “Camera Calibration Editor” dialog box will appear. Click on the ellipse button  next to Camera Calibration File box.



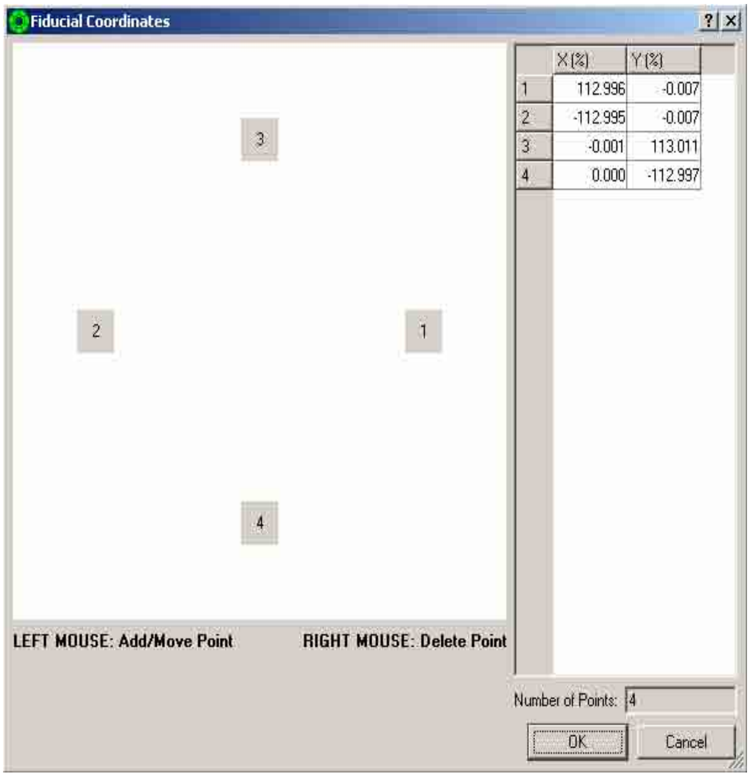
3. Another “Camera Calibration Editor” dialog box will appear. Type the camera calibration setting name (e.g. zeiss_rmka_15_23_LB.cam). Then click “Save”

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.

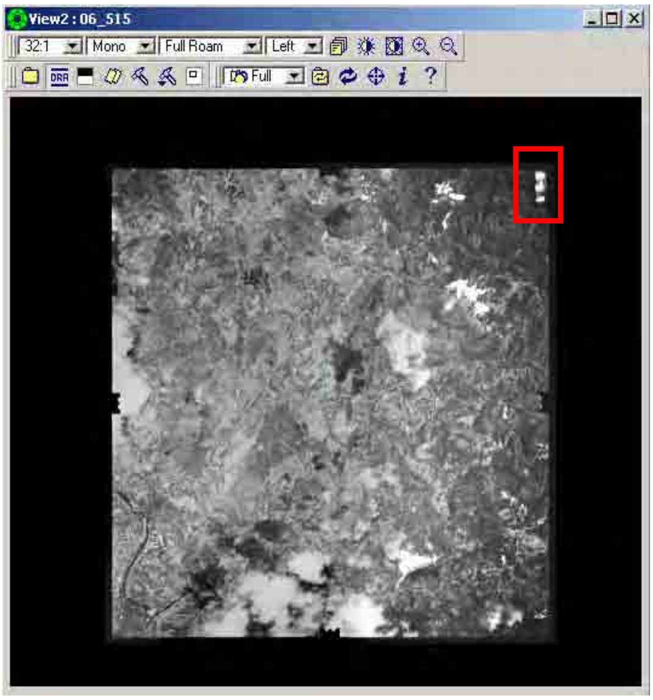


5. A “Fiducial Coordinates” dialog box will appear. This window consists of a large square drawing area and a list of fiducials. To add a fiducial point, position the mouse cursor over the approximate location of the fiducial within the camera frame. A numbered button will appear which represents the 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”.



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. Strip-formatted 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.

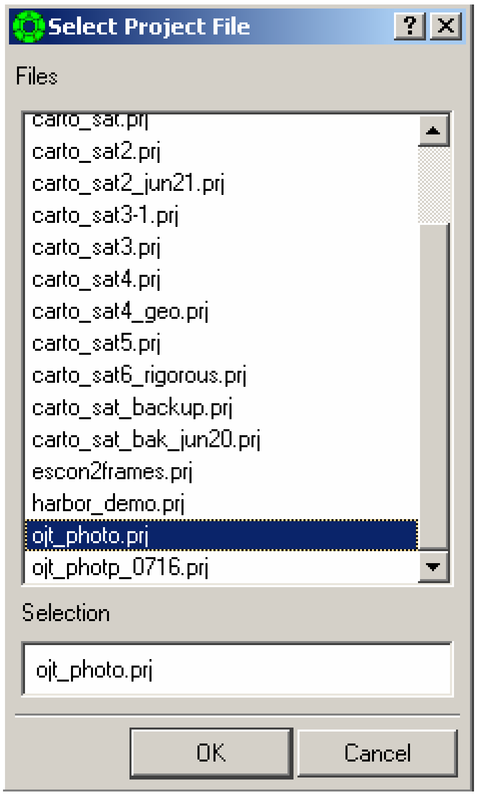
TIFF tiled JPEG compressed (“img_type_tiff_tiled_jpeg”) are created the same as tiled TIFF except tiles are compressed with the JPEG algorithm. The tile size is fixed at 512.

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

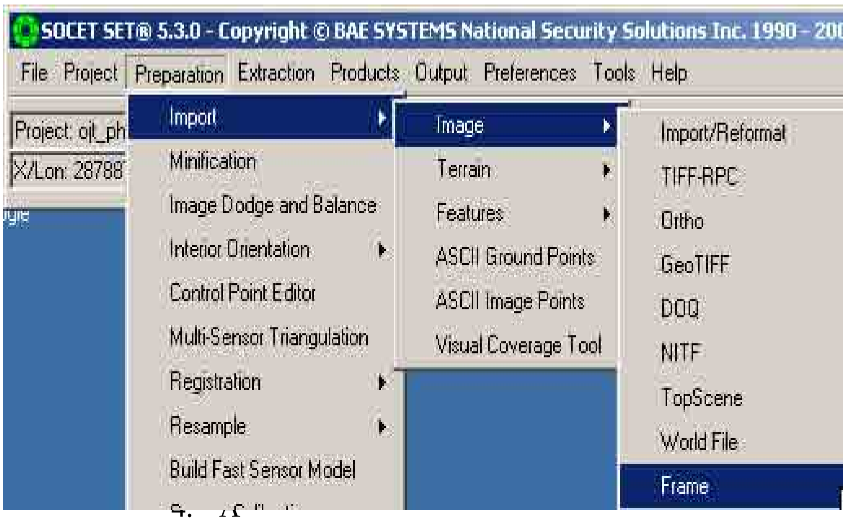
you need to make smaller levels of minification to fill up the pyramid, run the image through Minification.

1. Click “File”, select “Load Project”.

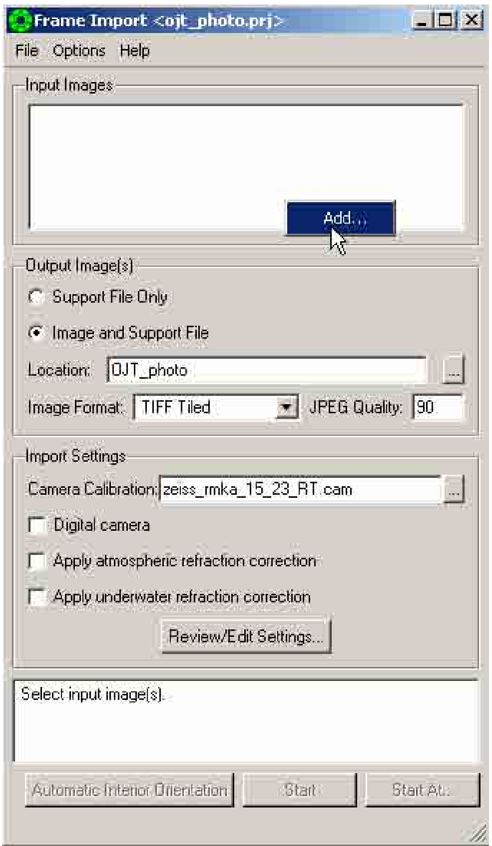
2. A “Select Project File” dialog box will appear. Select the project name (e.g. ojt_photo.prj) that was created. Then click “OK” .



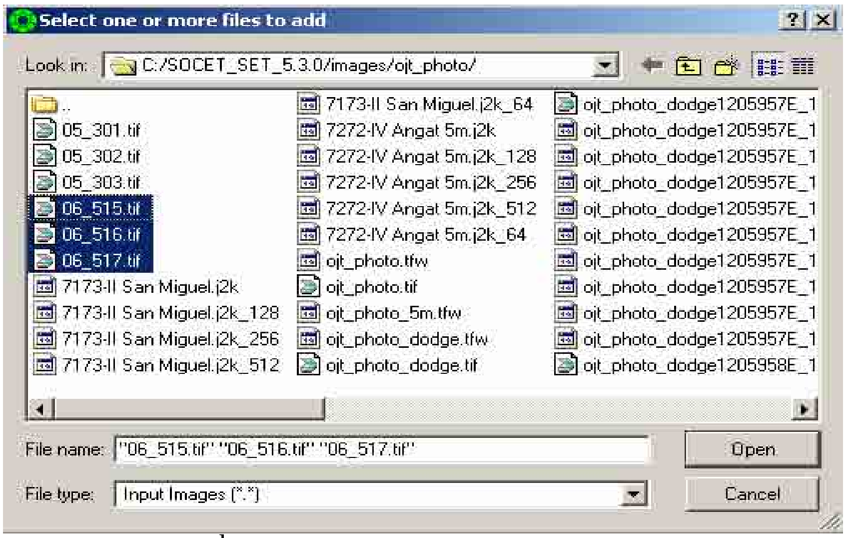
3. Click “Preparation”, select “Import”, select “Image” and then click “Frame”.



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



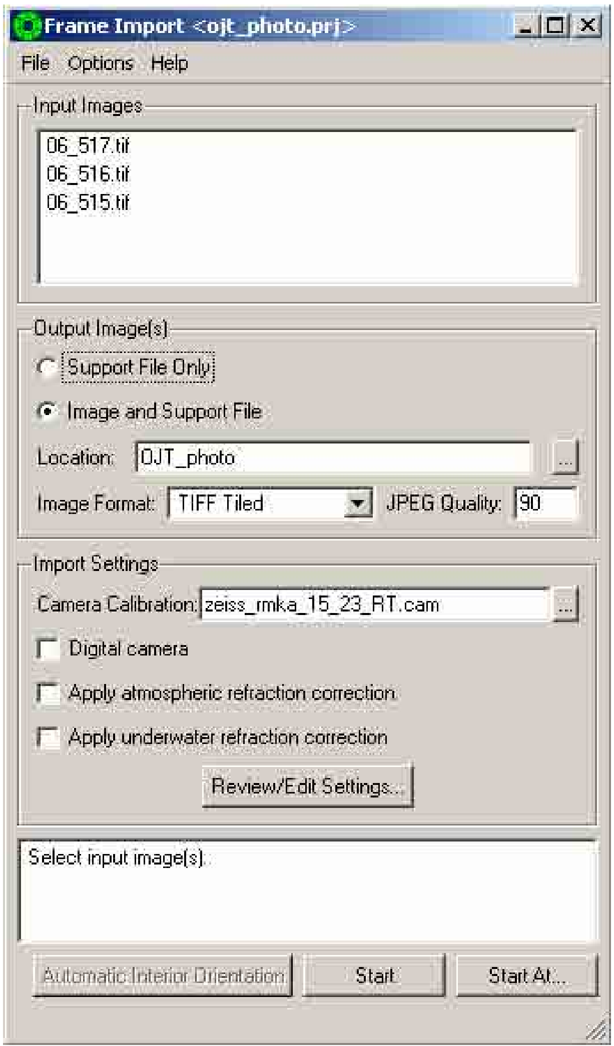
5. A "Select one or more files to add" dialog box will appear. Use the down arrow in the "Look in" box, browse and locate the image file (e.g. 06_517) to add. Then click "Open" .



The 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

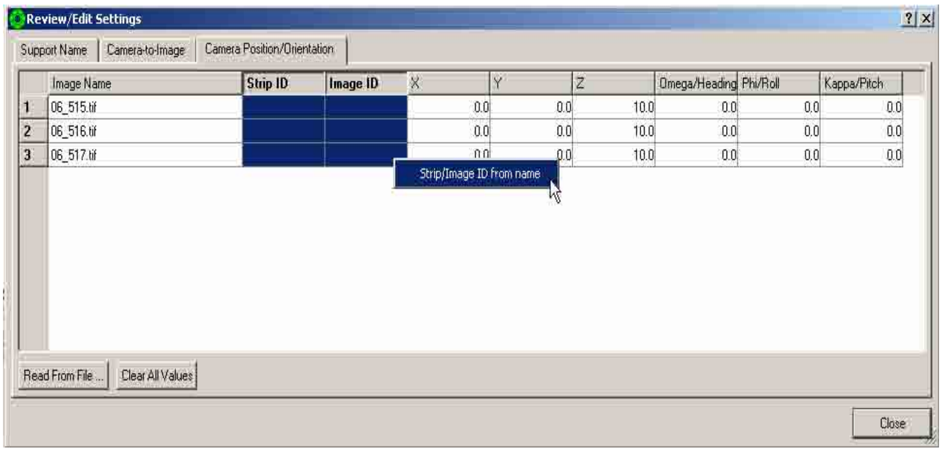
"OJT_photo(192472.4MB) and click "OK". Set Format to TIFF TILED, JPEG Quality to 90. Set Camera Calibration: zeiss_rmka_15_23_RT.cam Then click "Review/EditSettings" 

.



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” 

.



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.

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.

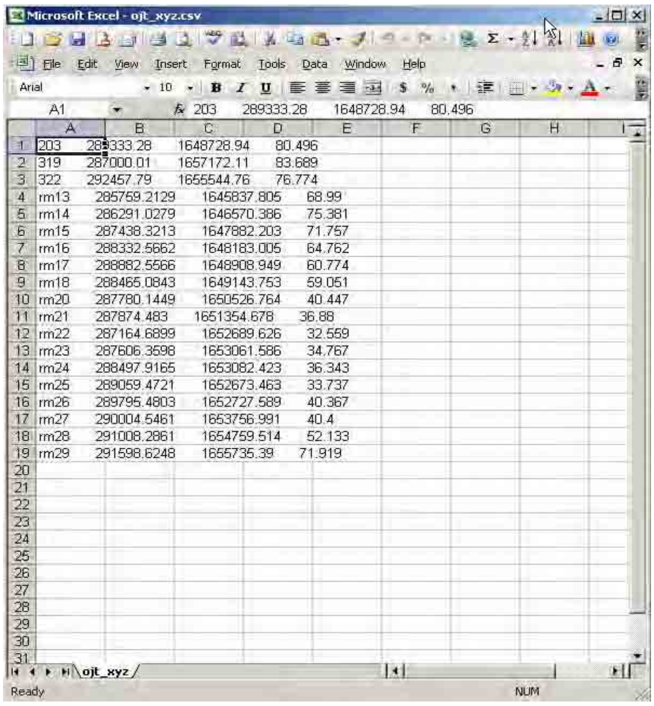
- "Code" has no meaning for ASCII Ground Points.
- "Ignore" is used to ignore any information that may be specified in a field.
- "Illegal" indicates that a field should not contain any information. The entire point is discarded should any information be found in a field marked as "Illegal." The following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

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

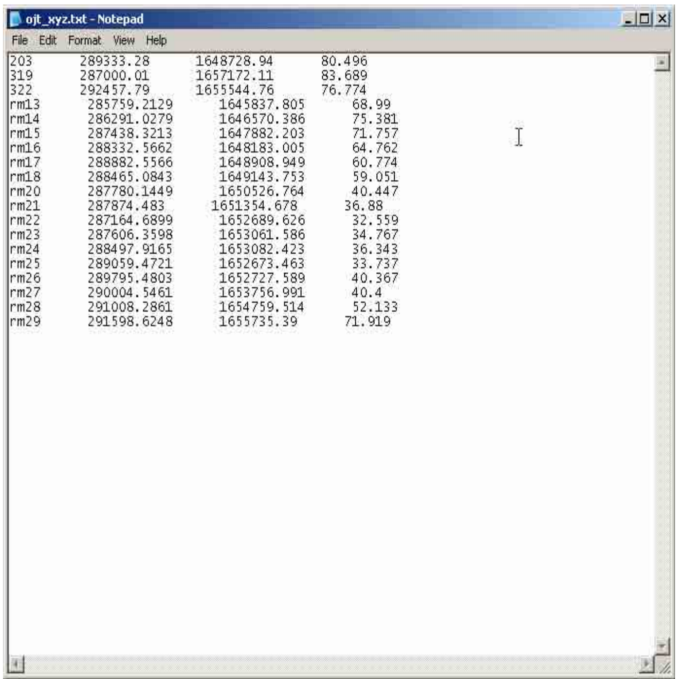
EXAMPLE 1	EXAMPLE 2	EXAMPLE 3
2: X	2: X	2: X
3: Y	3: Z	3: Y
4: Z	4: Illegal	4: Z
5: Ignore	5: Illegal	5: Code
6: Ignore	6: Illegal	6: Ignore

The 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.

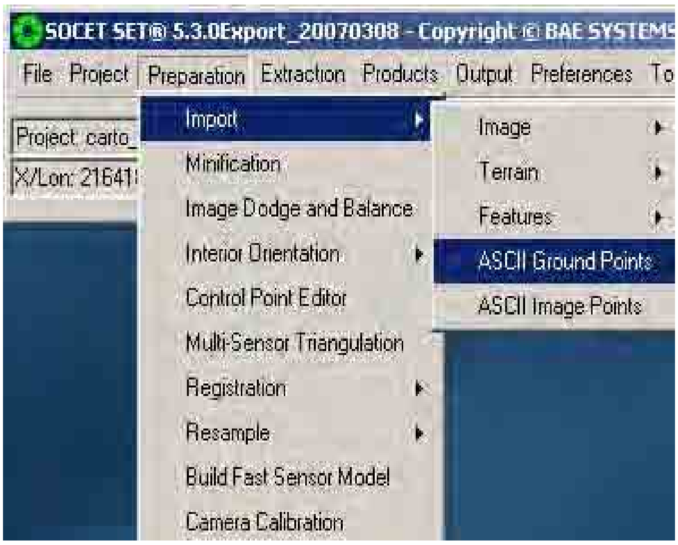
1. Open GPS Ground Control Points text file in Excel. Delete unnecessary field Columns. Then save file to *.csv format.



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



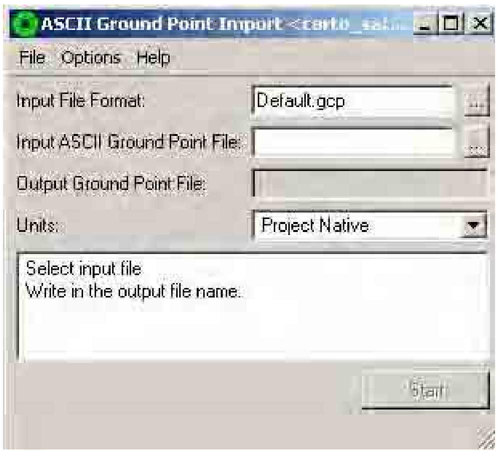
3. Click “Preparation”, select “Import, and click “ASCII Ground Point”.



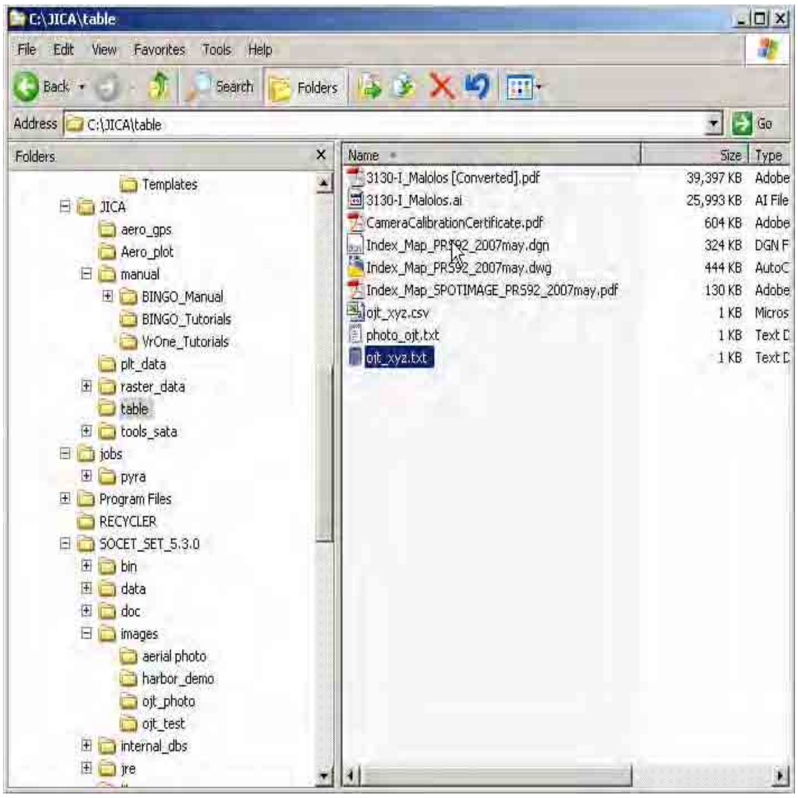
4. An ASCIII Ground Control Point Import dialog box will appear. Click the browse button in the “Input File Format’” box.

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

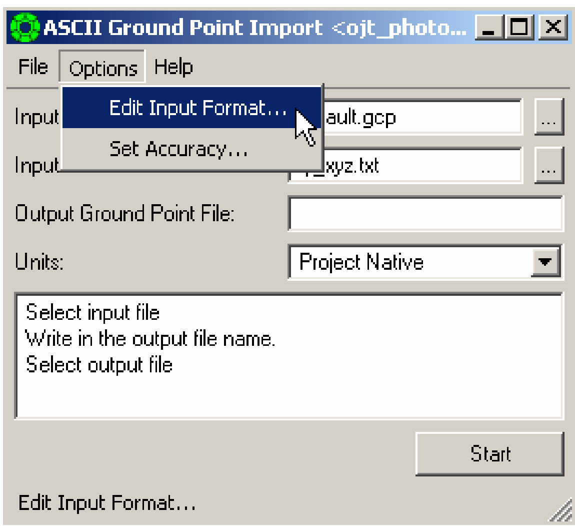
6. Click the browse button in the “Input ASCII Ground Control Point File” box.



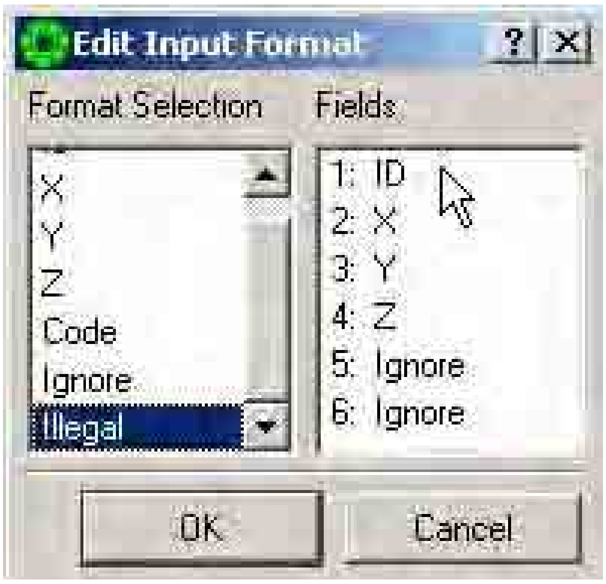
7. An “ASCIII Ground Control Point Import” dialog box will appear. Click the down arrow, browse and locate the directory where the gcp text file is located. Select the file (e.g. “ojt_xyz.txt”). Then click “Open”.



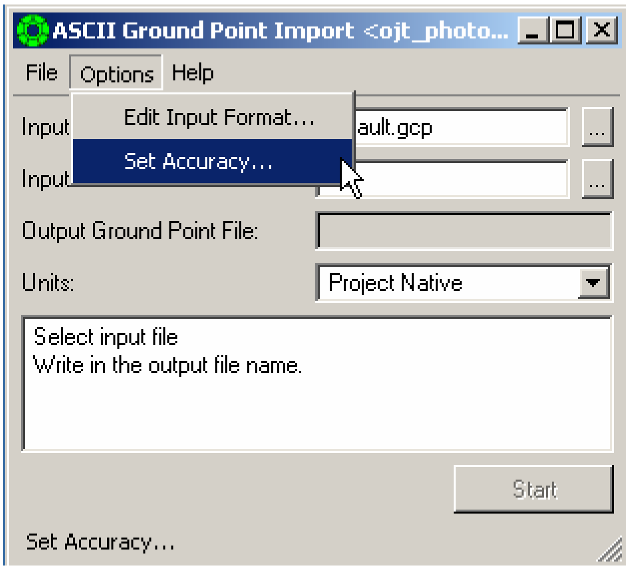
8. Click “Options”, select “Edit Input Format”.



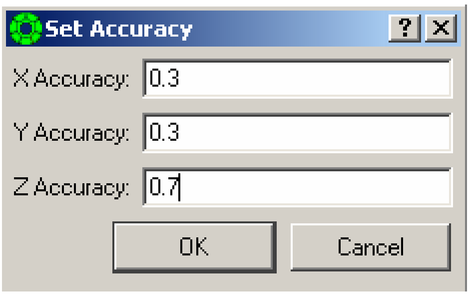
9. An “Edit Input Format” dialog box will appear. Select the settings in the “Format Selection” box the fields (e.g. ID, X, Y, Z) that were used in your gcp text file. Then click “OK”.



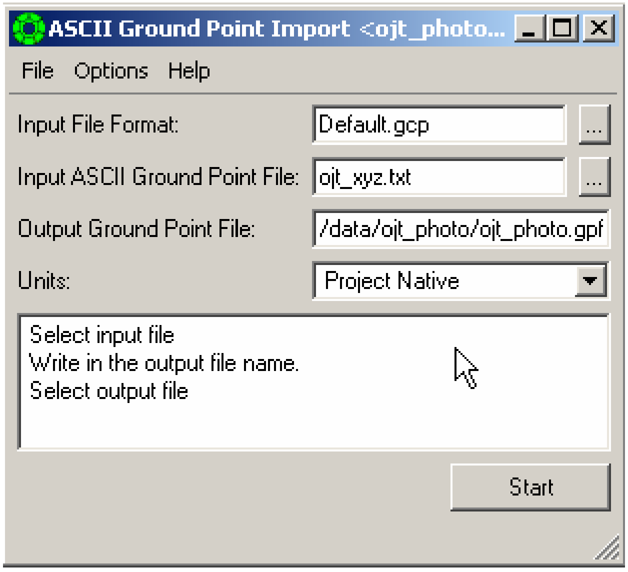
10. Click “Options”, select “Set Accuracy”.



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”.



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.



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.

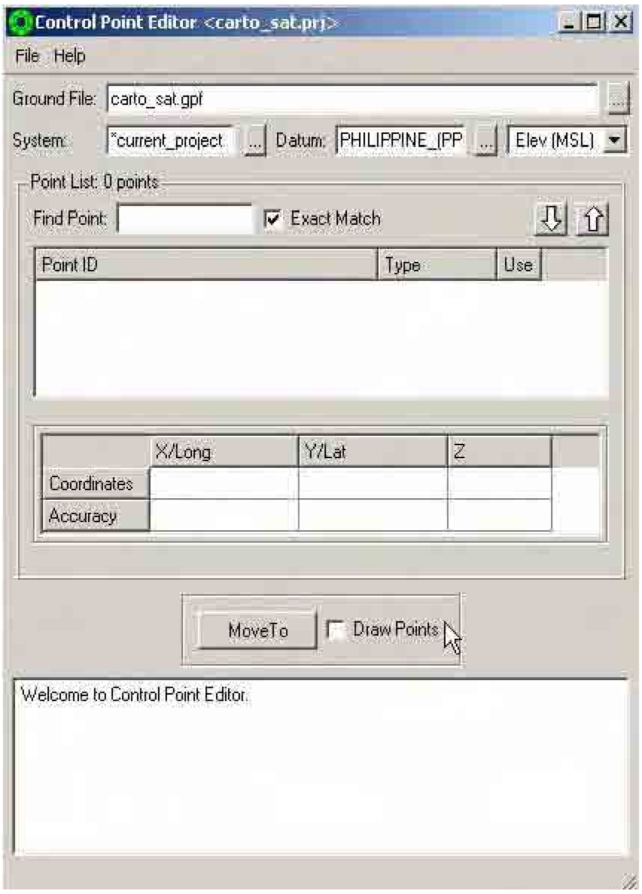
There are four ways to build a file of control points:

- 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 well-controlled imagery (e.g. PPDB) to fabricate control points, you must import the well-controlled images before running Control Point Editor.

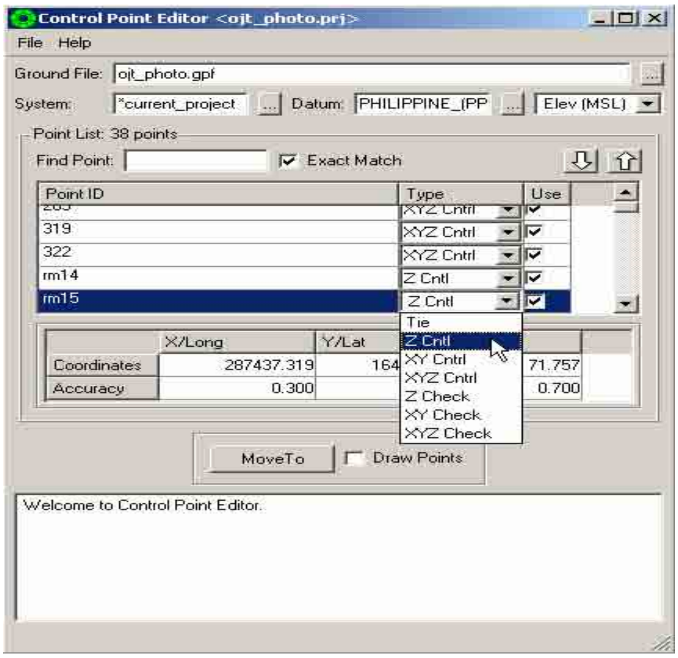
1. Click “Preparation”, select “Control Point Editor”.

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

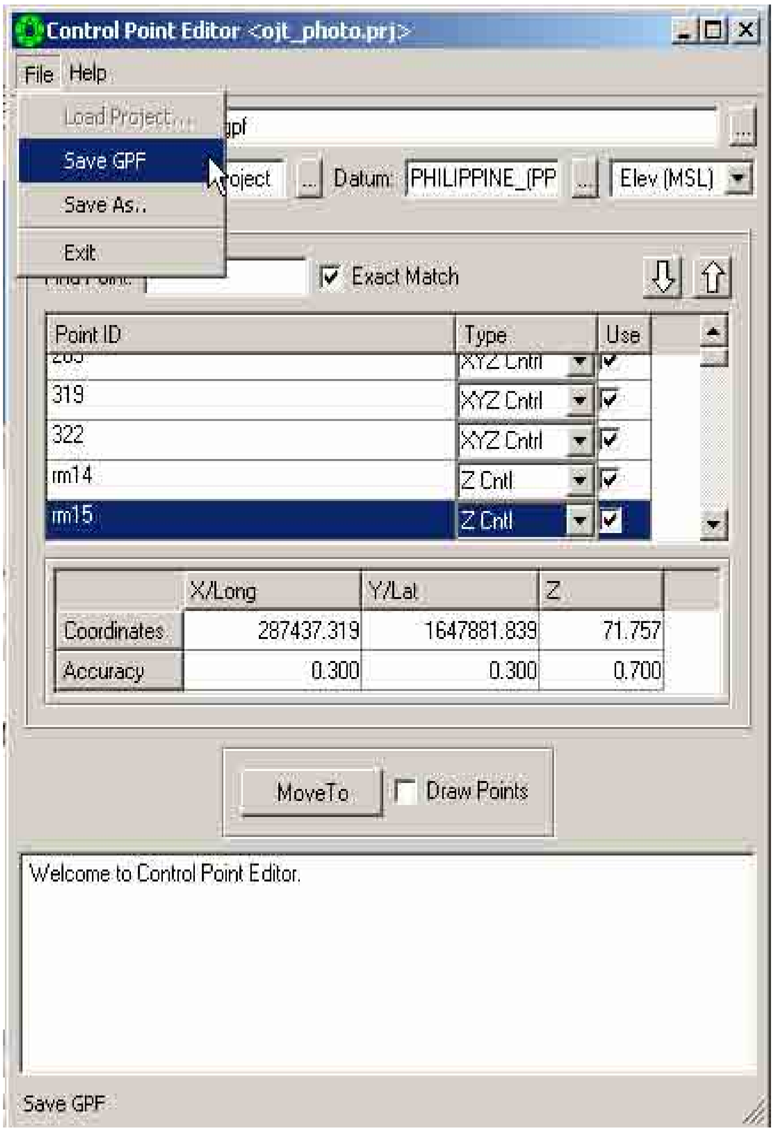


3. A “Select Ground Point File” dialog box will appear. Click the down arrow button in the “Look in” box and locate the folder of the imported ground control point. Then click “Save”.

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”

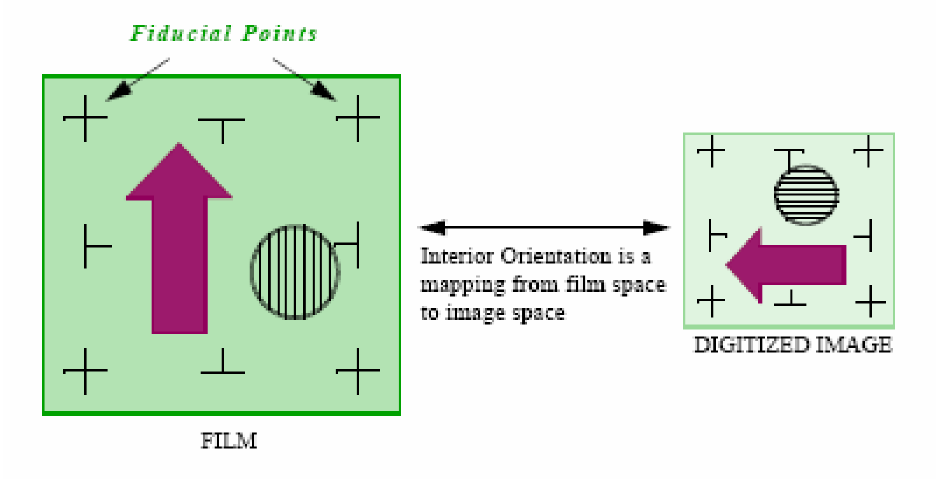


5. Click “File”, select “Save GPF”.



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 user-selected solution type.
- Automatically updates the solution whenever you measure or re-measure 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

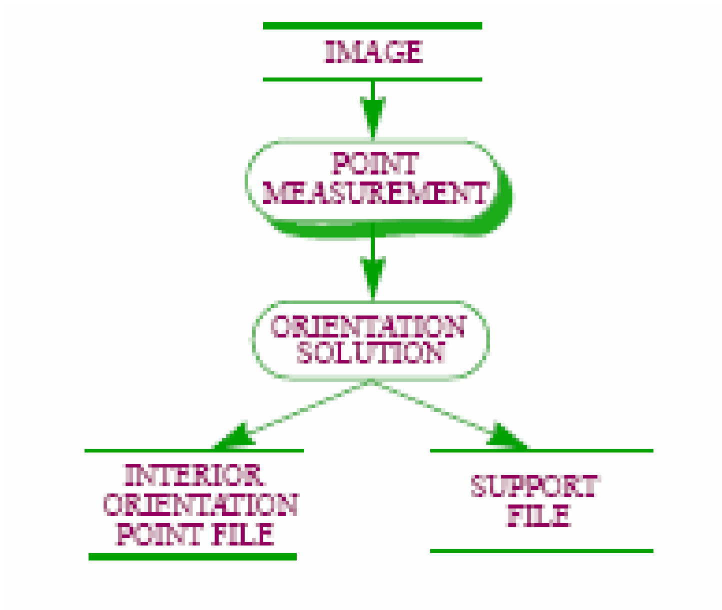
Interior Orientation is required for all images that have been created by scanning film. Interior Orientation is not required for non-film-based imagery such as SPOT or Landsat imagery.

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)

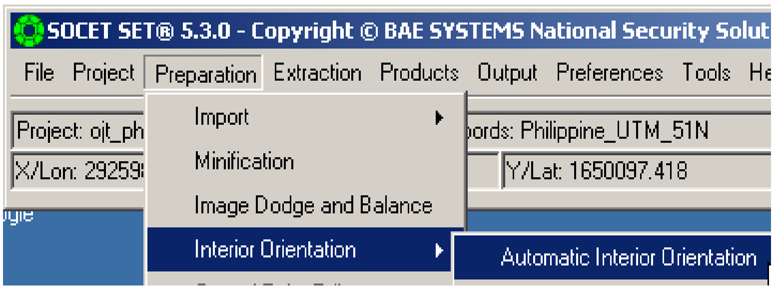
Interior Orientation can either be performed manually or automatically. Automatic Interior Orientation can be performed with multiple images at once either through the SOCET SET menu bar to pop up the AIO window, or in stand-alone batch mode. AIO updates the .iop and .sup with corrected measurements 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:

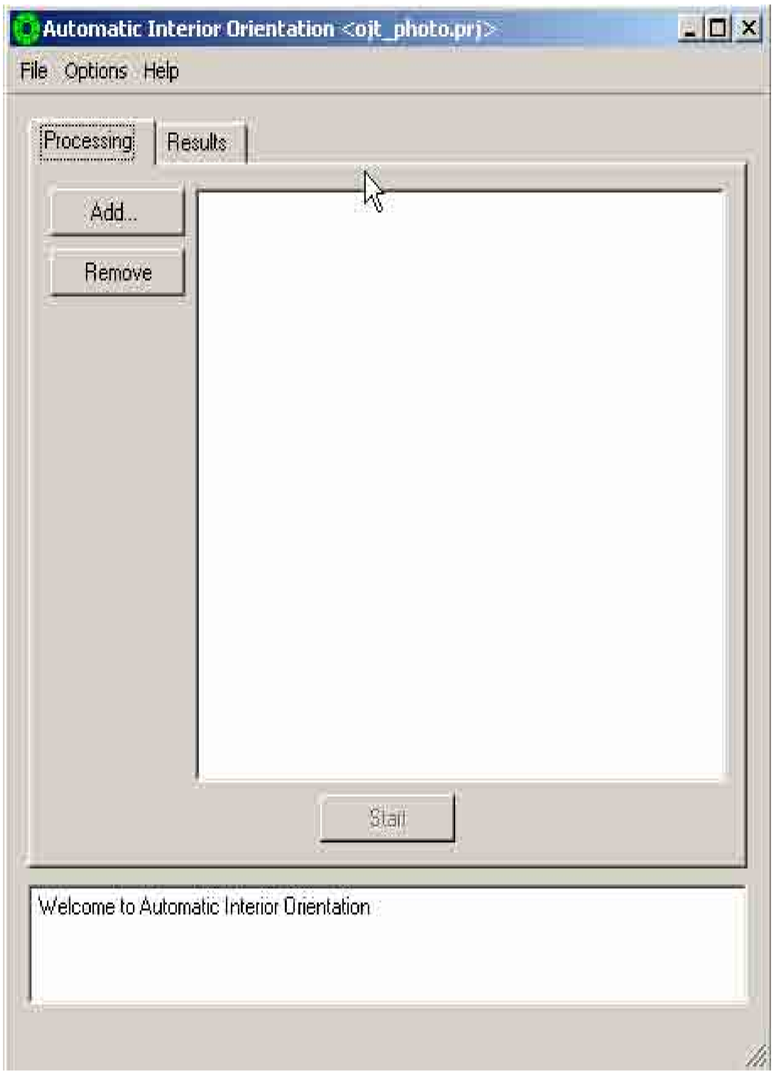
Jena LMK 1000	Jena LMK 2000	Wild RC 10
Wild RC 20	Wild RC 30	Zeiss RMK A
	Zeiss RMK TOP	

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".

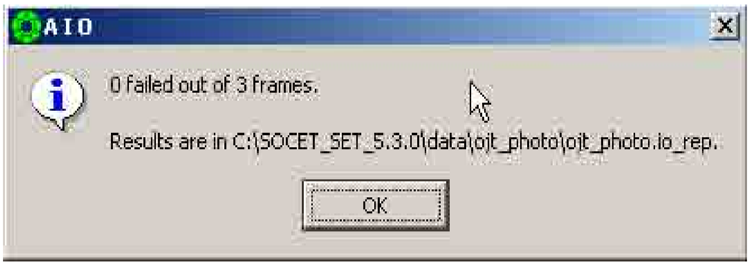


2. An “Automatic Interior Orientation” dialog box will appear. Click “Add” button.

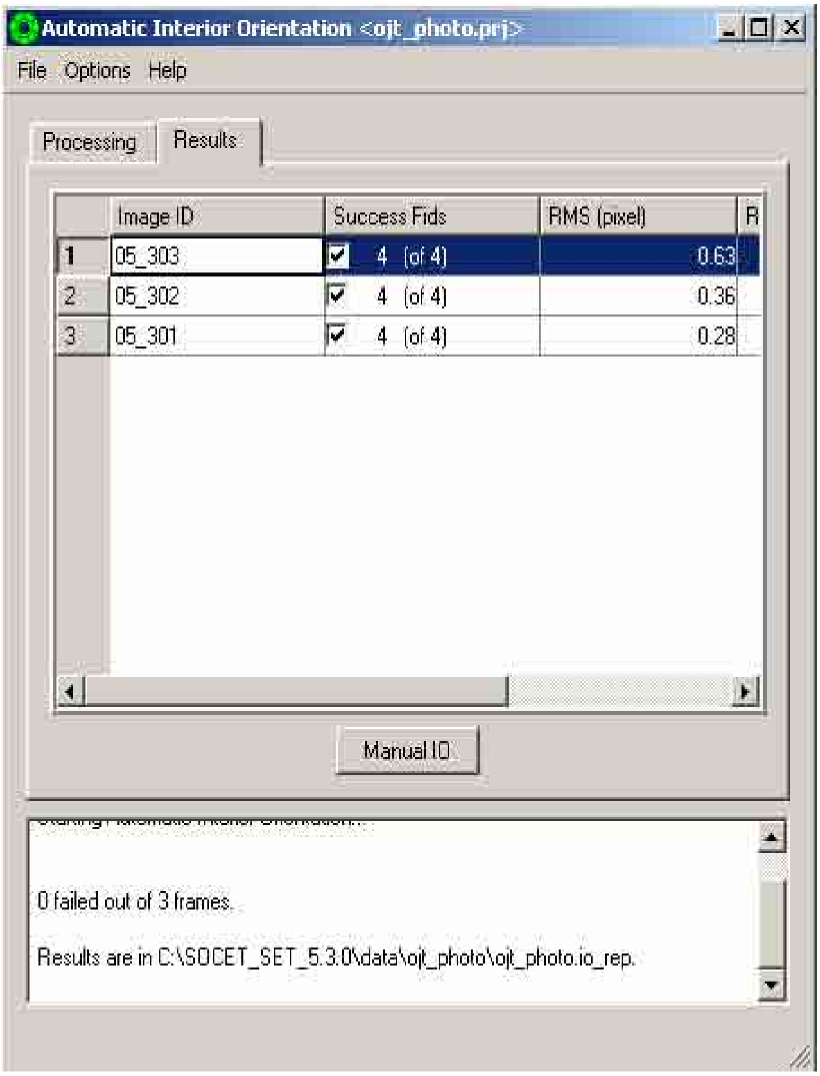


3. A “Select Support File” dialog box will appear. Select all the support file images (e.g. 05_301.sup, 05_302.sup, 05_303.sup) to be used for interior orientation. Click “Open”. Then click “Start”

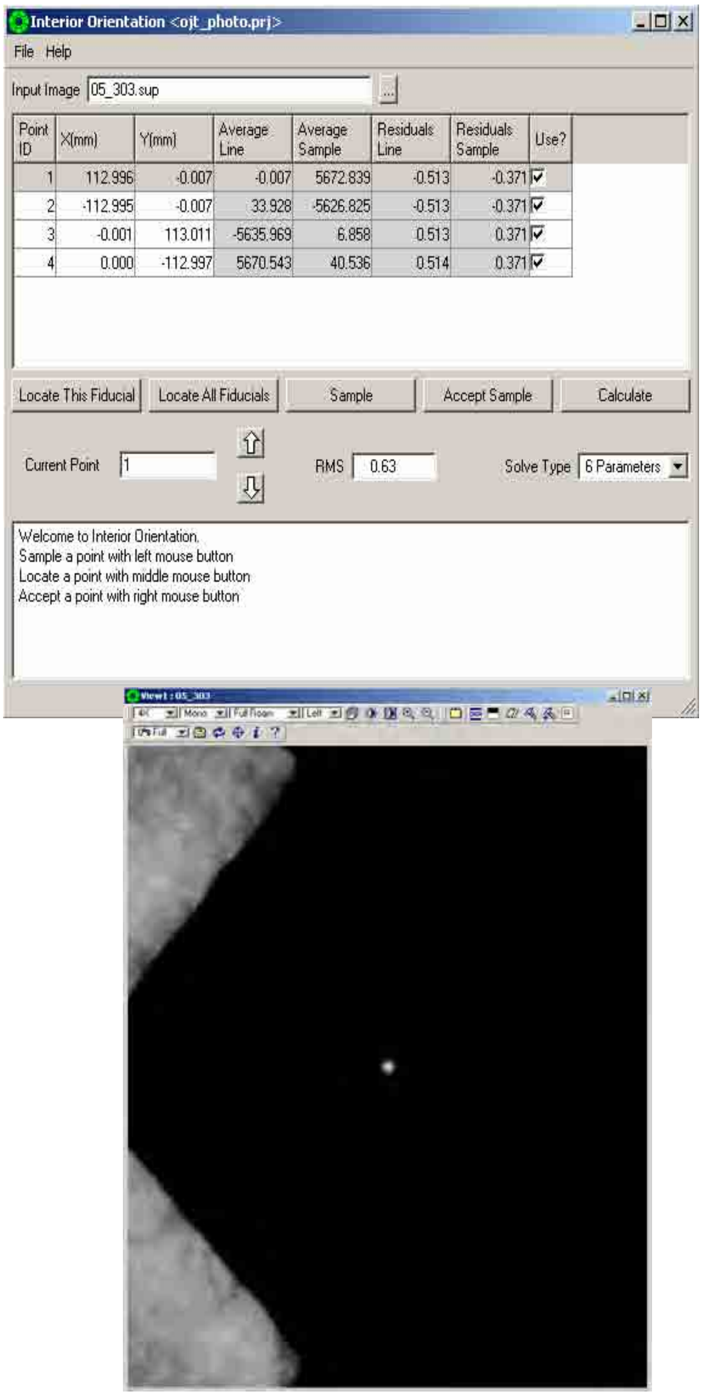
4. An “AIO” info box will appear. Click “OK”.



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".



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.

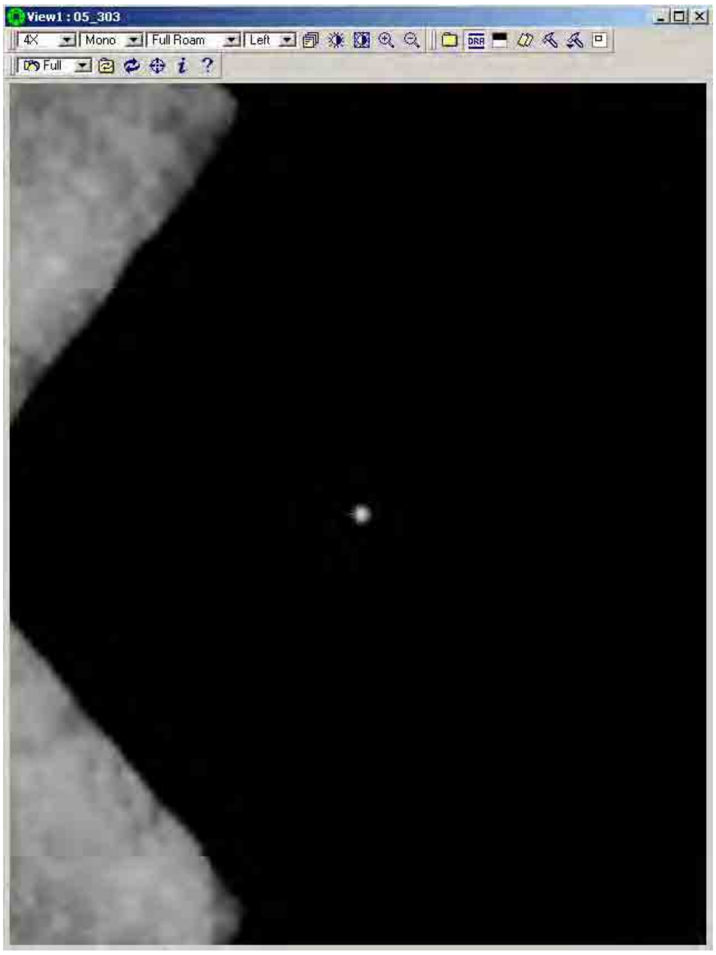


3.1.3.2 Manual Interior Orientation (IO)

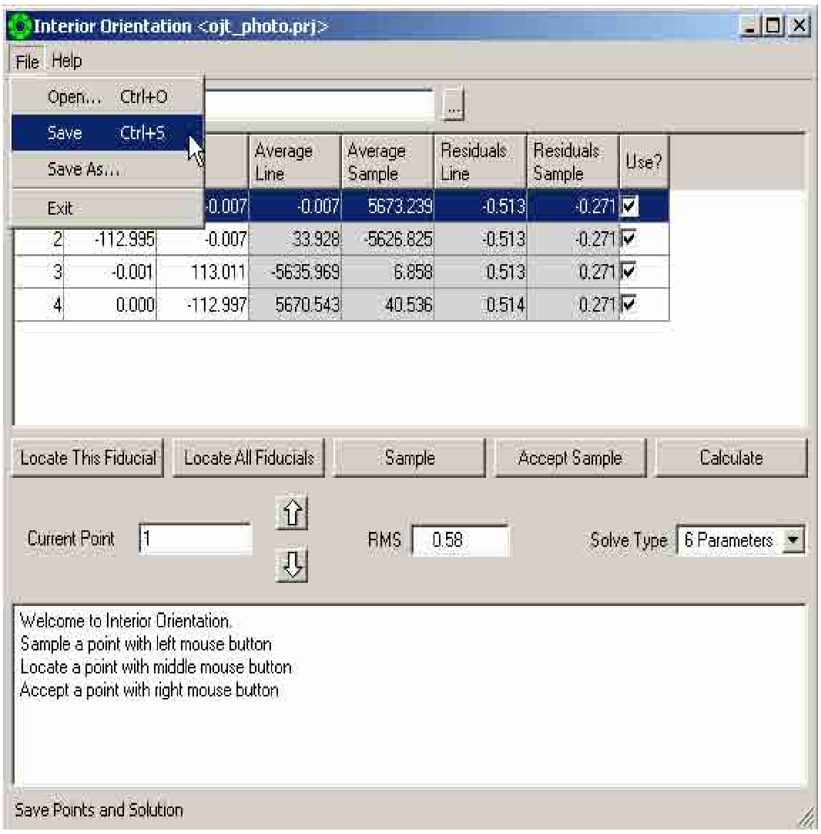
1. Using the 3D stealth mouse, adjust the position of the cross hair near the center fiducial point. Click “Locate This Fiducial” 

. Click “Accept Sample” 

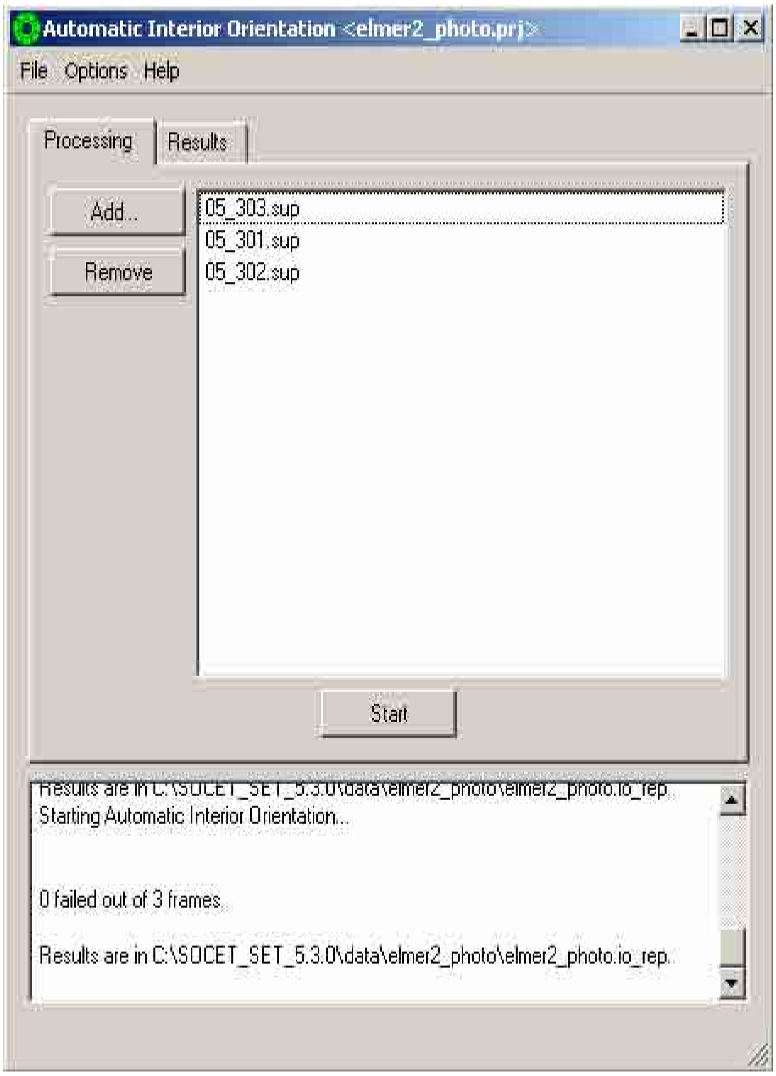
and it will go to the next fiducial point ID. Repeat same procedure until all the fiducial marks have been measured.



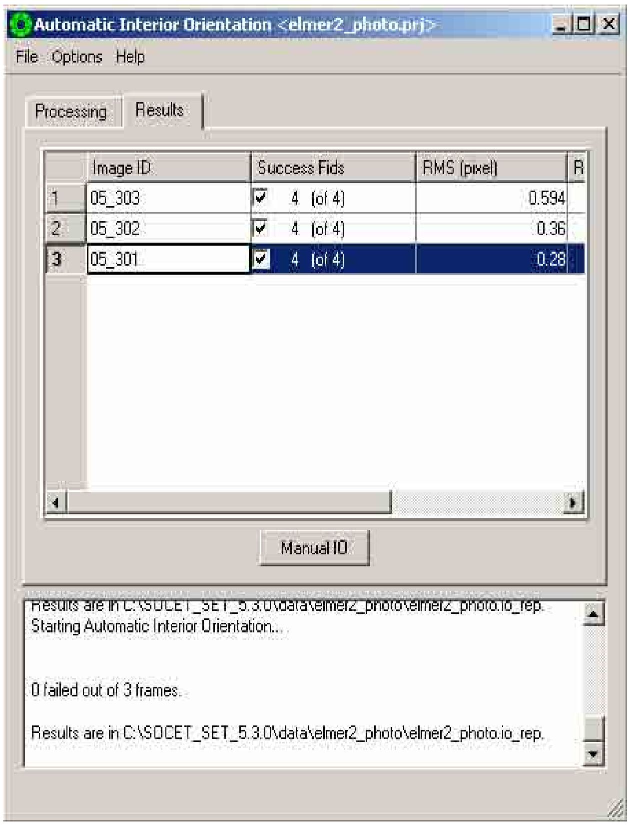
2. Verify RMS if it is approximately 0.35 or better (lower) Click “File”, select “Save”.



3. Click “Start” again.



4. Verify RMS results.



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 table gives some guidance:

WHAT TO RUN	SITUATION
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.

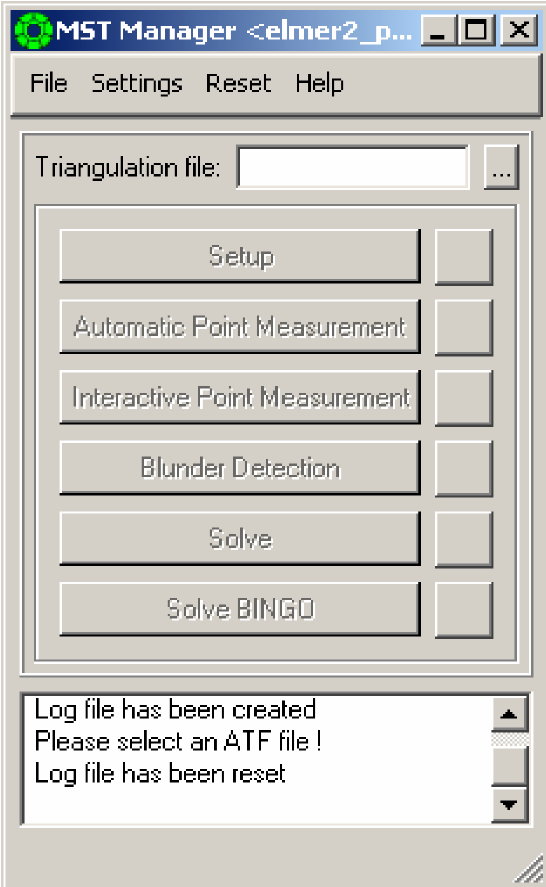
Ground Point Selection
Ground Point consists of two tables containing ground point information. The upper table lists all ground points in the current Ground Point File. Clicking the LMB on any point in the table moves the extraction cursor to that point and loads the measured and unmeasured images.

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.

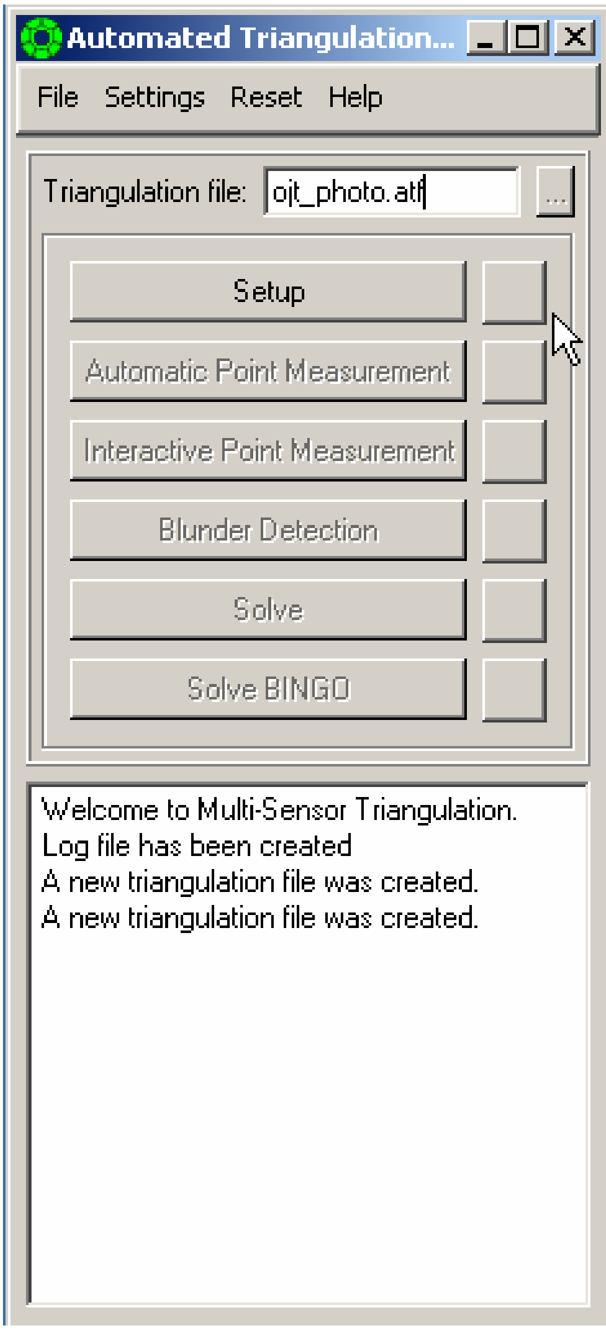
1. Click "Preparation", select "Multi-Sensor Triangulation".

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

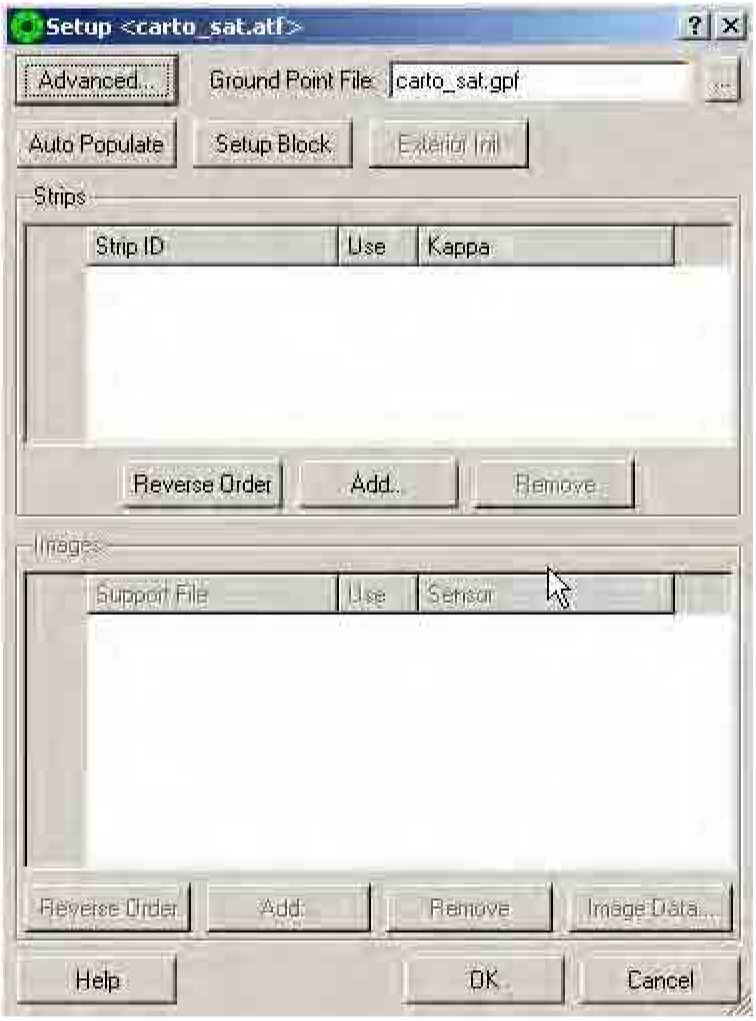


3. A “Save As” dialog box will appear. Type a file name (e.g. ojt_photo) in the file name box. Click the “Save”.

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

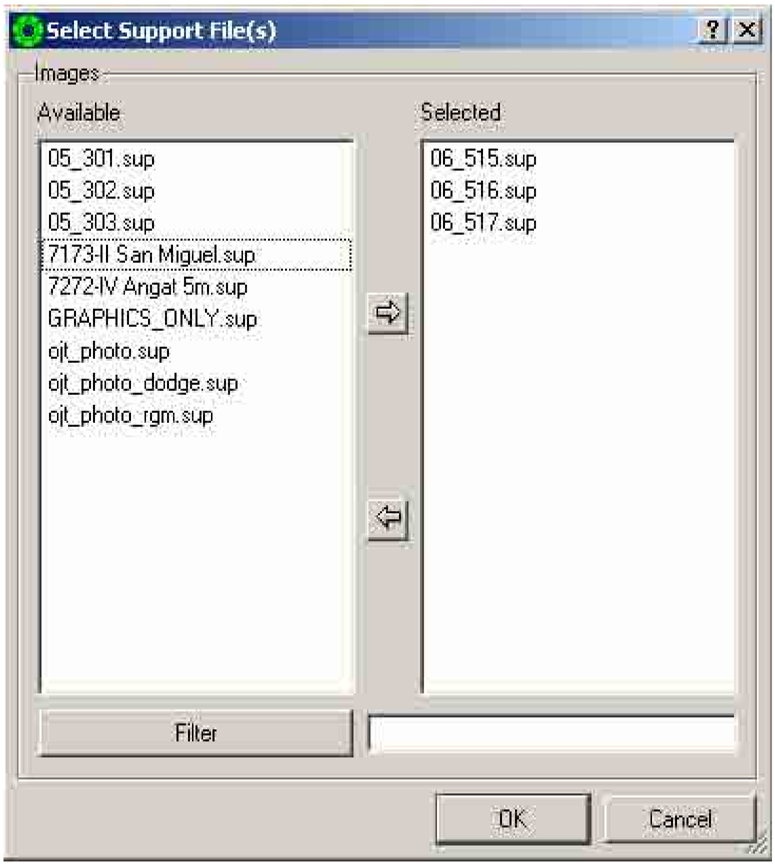


5. A “Setup” dialog box will appear. Click “Add” .

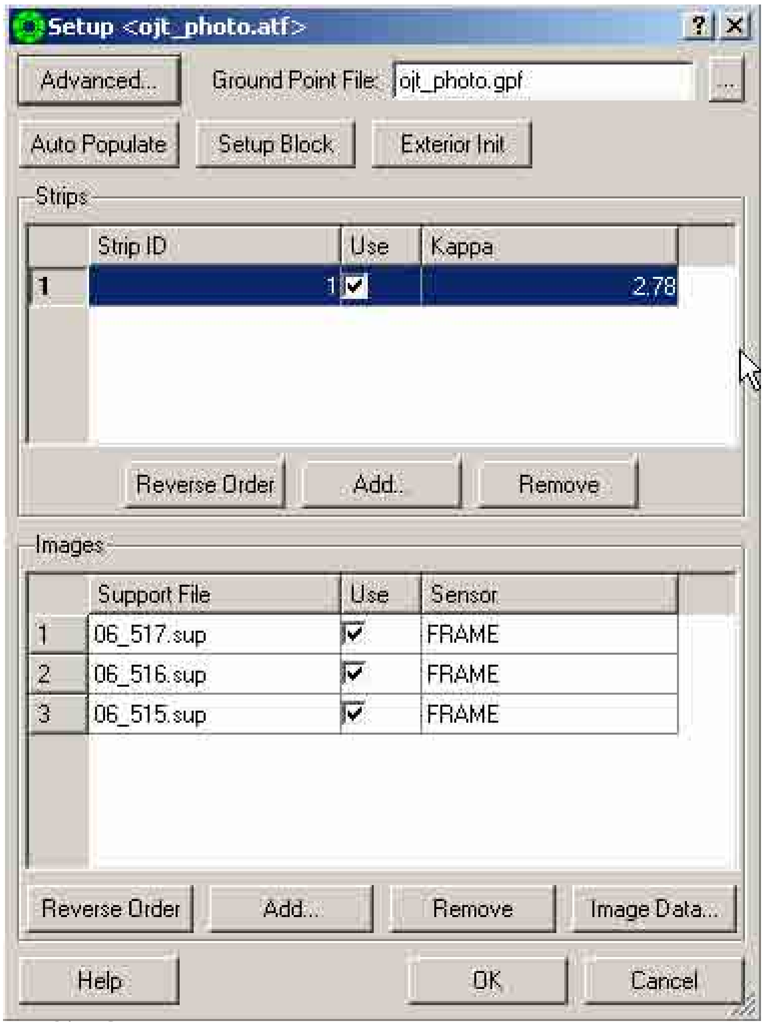


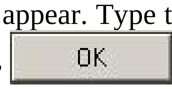
6. A “Strip ID Sequence” box will appear. Type a number (e.g. 1). Then click “OK” .

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” .

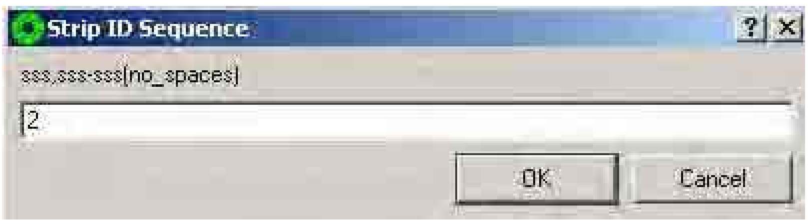


8. The created strip 1 will be reflected in the “Strips” box and the selected image (e.g. 06_515, 06_516, 06_517) will be reflected in the “Images” box. Click “Reverse Order” of the images numbering. Refer to the flight index.



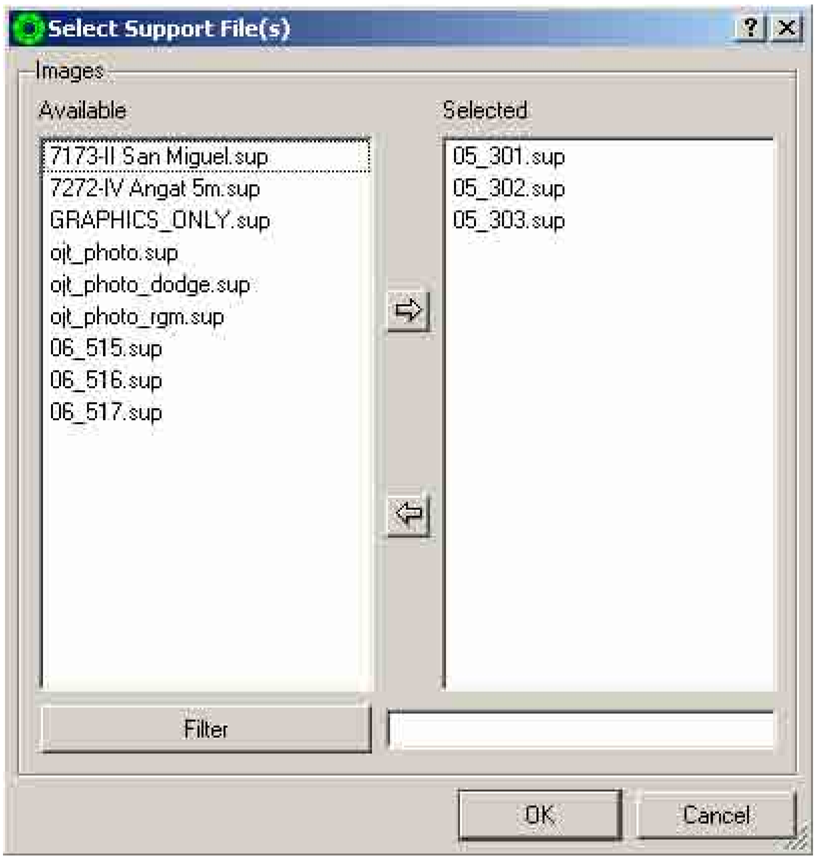
lick “Add” under the “Strips” box. A “Strip ID Sequence” box will appear. Type the next number (e.g. 2). Then click “OK” 

.



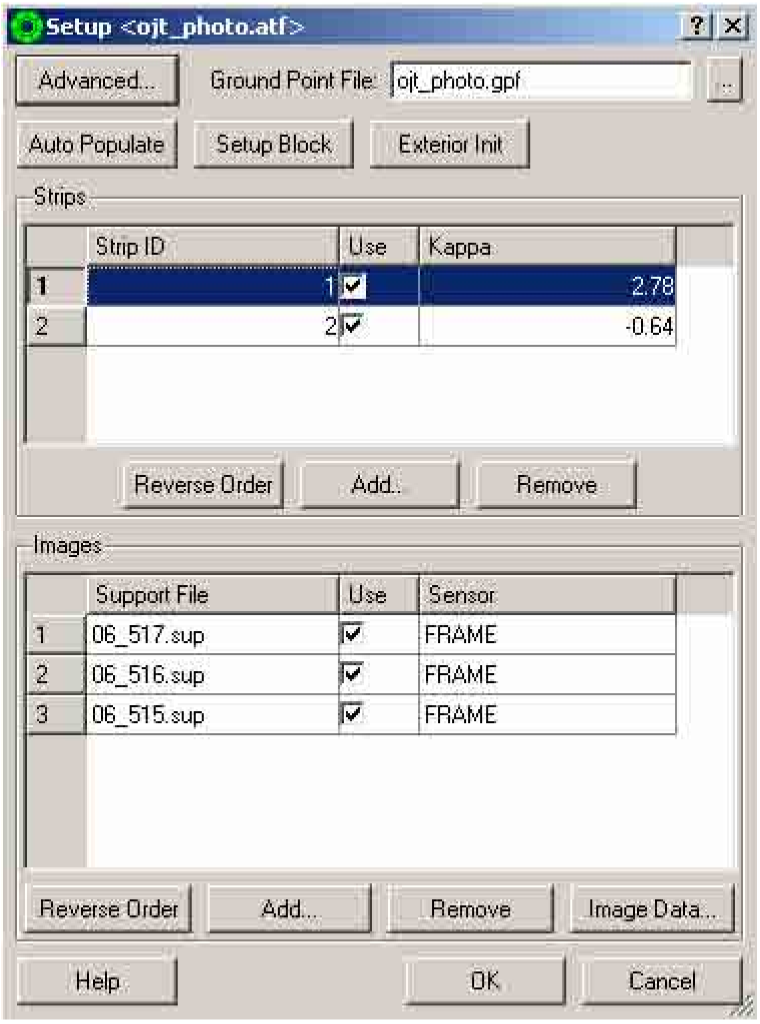
10. Select the next image corresponding to strip number 2. Click the arrow  to move the image to the "Selected" box. Then click "OK" 

.



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

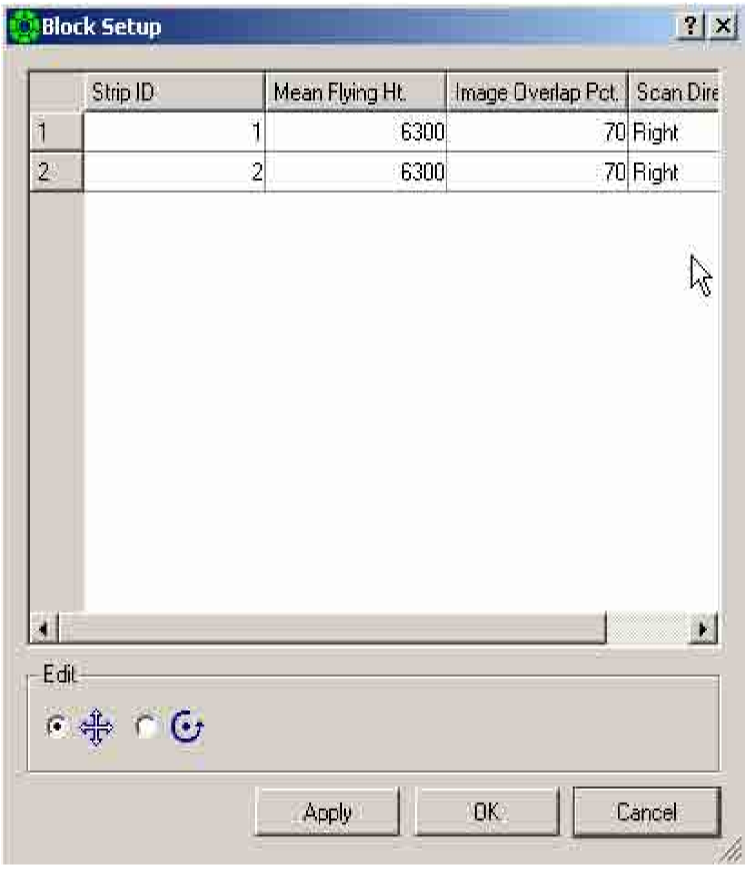
.



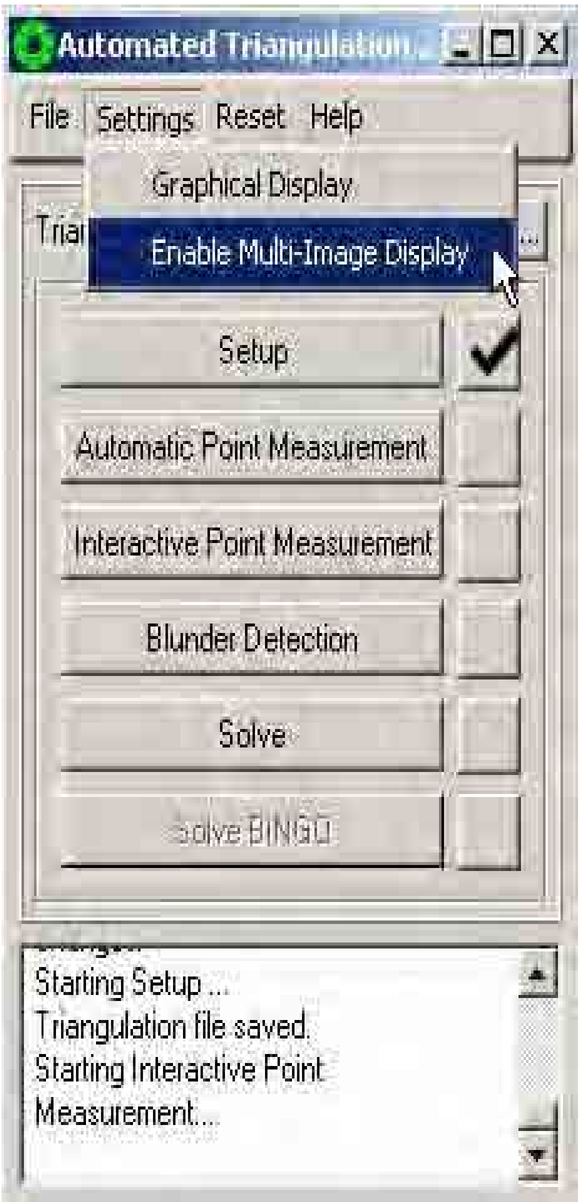
12. A “Setup Block” dialog box will appear. Set “Mean Flying Ht.” to “6300”. And “Image Overlap Pct” to 70. Click “OK” 

. Then click “OK” 

.



13. Click ”Settings” and select “Enable Multi-Image Display.

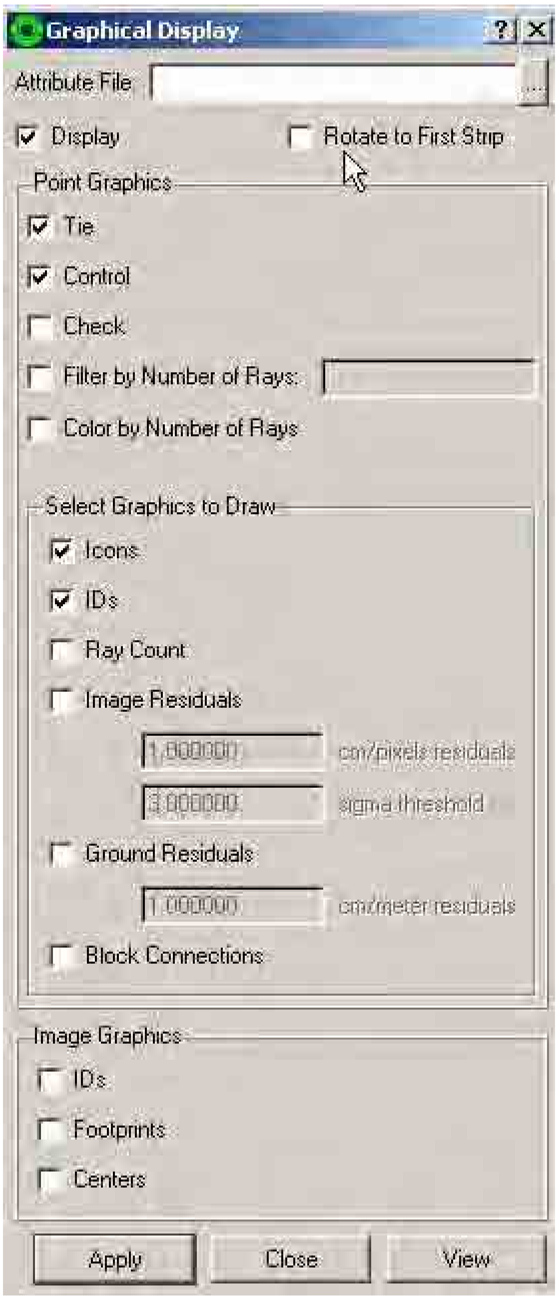


14. Click ”Settings”, select “Graphic Display”.

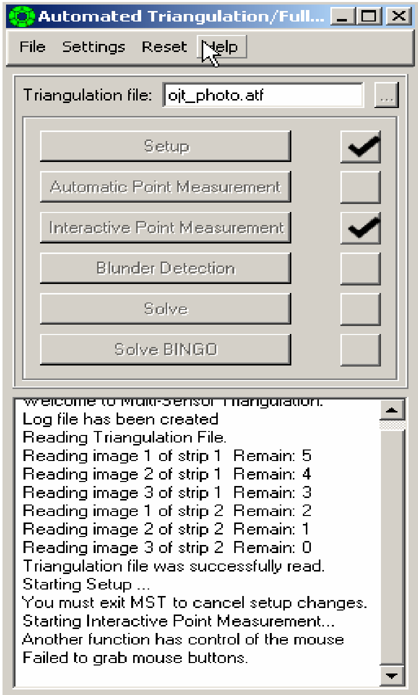
15. A “Graphic Display” dialog box will appear. Check “Tie” box, “Control” box, “Icon” box, and “IDs” box. Click ”Apply” 

. Then click “Close” 

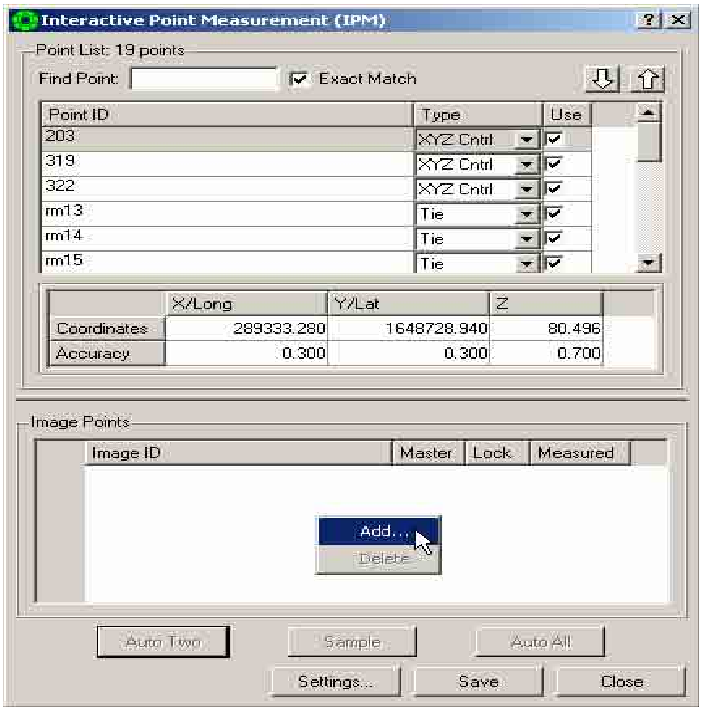
.



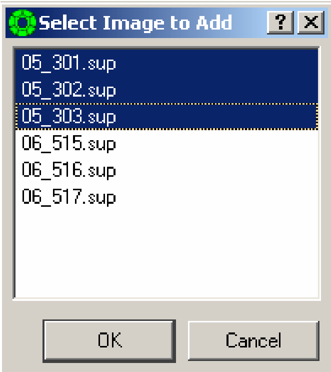
16. Click ”Interactive Point Measurement”.



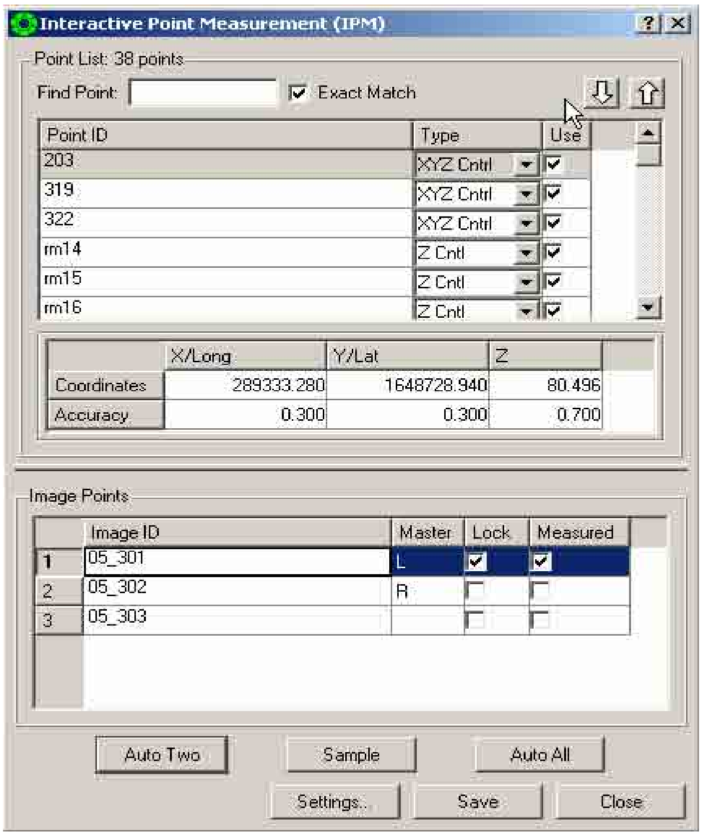
17. An ”Interactive Point Measurement” dialog box will appear. Put arrow inside "Image Points" box, click right mouse button and select “Add”.



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



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.



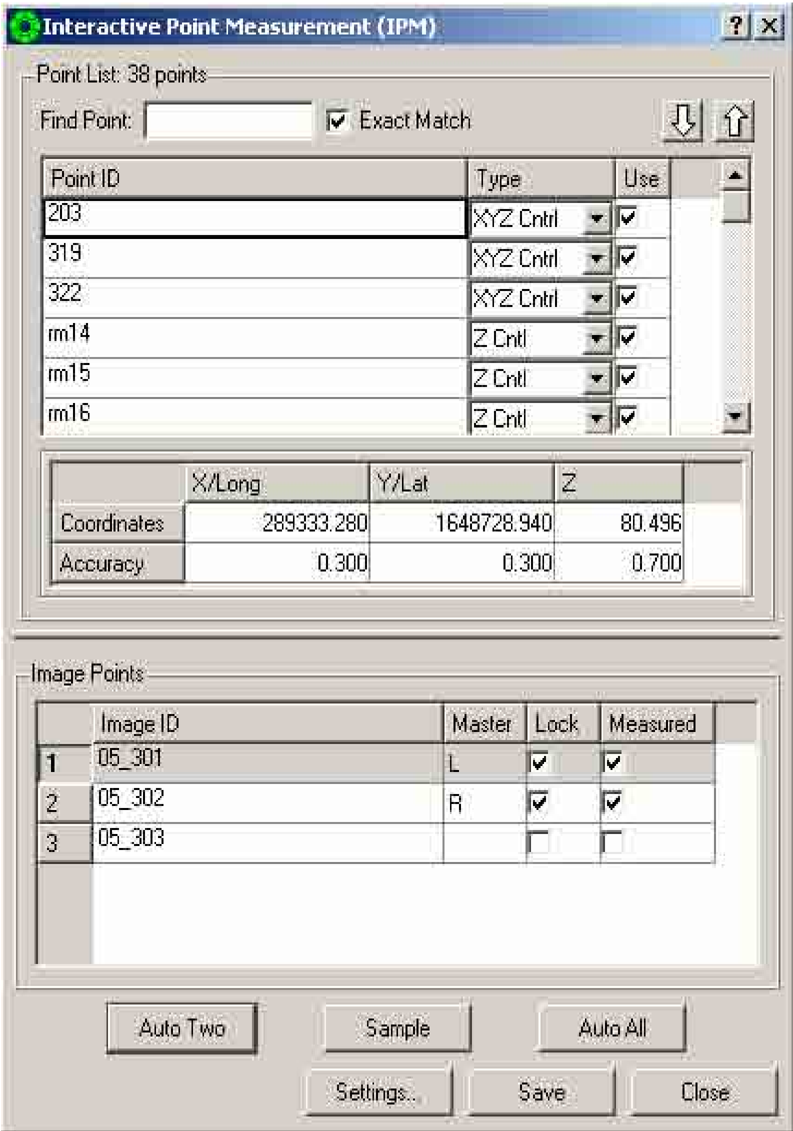
DESCRIPTION OF PHOTO CONTROL

STATION NO.			Operated by	NAMRIA
BLN 03			Checked by	K.USUDA
			Date	
Zone No	UTM 51 N			
	N (m)	E (m)		H
Main Point	1,648,728.94	289,333.28		
ECC				
Supplementary Point				

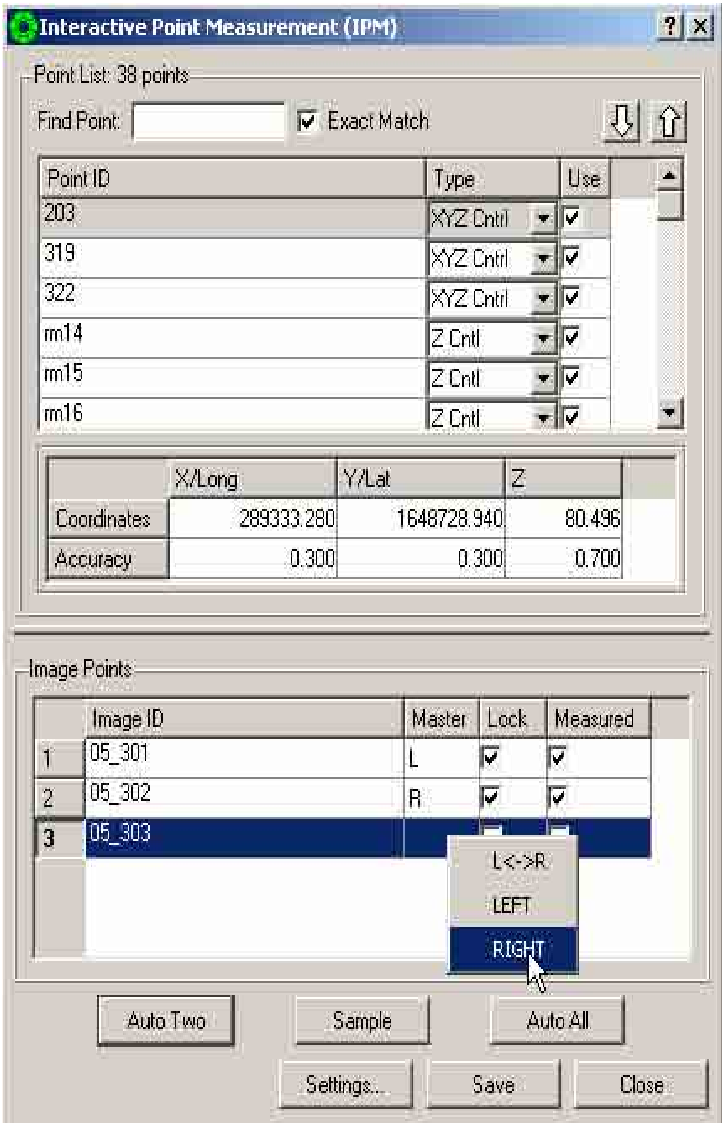
Sketch-Map of Station and Neighborhood	Photograph of Station

Aerial Photograph LEFT LINE-05-301	erial Photograph RIGHT LINE-05-30

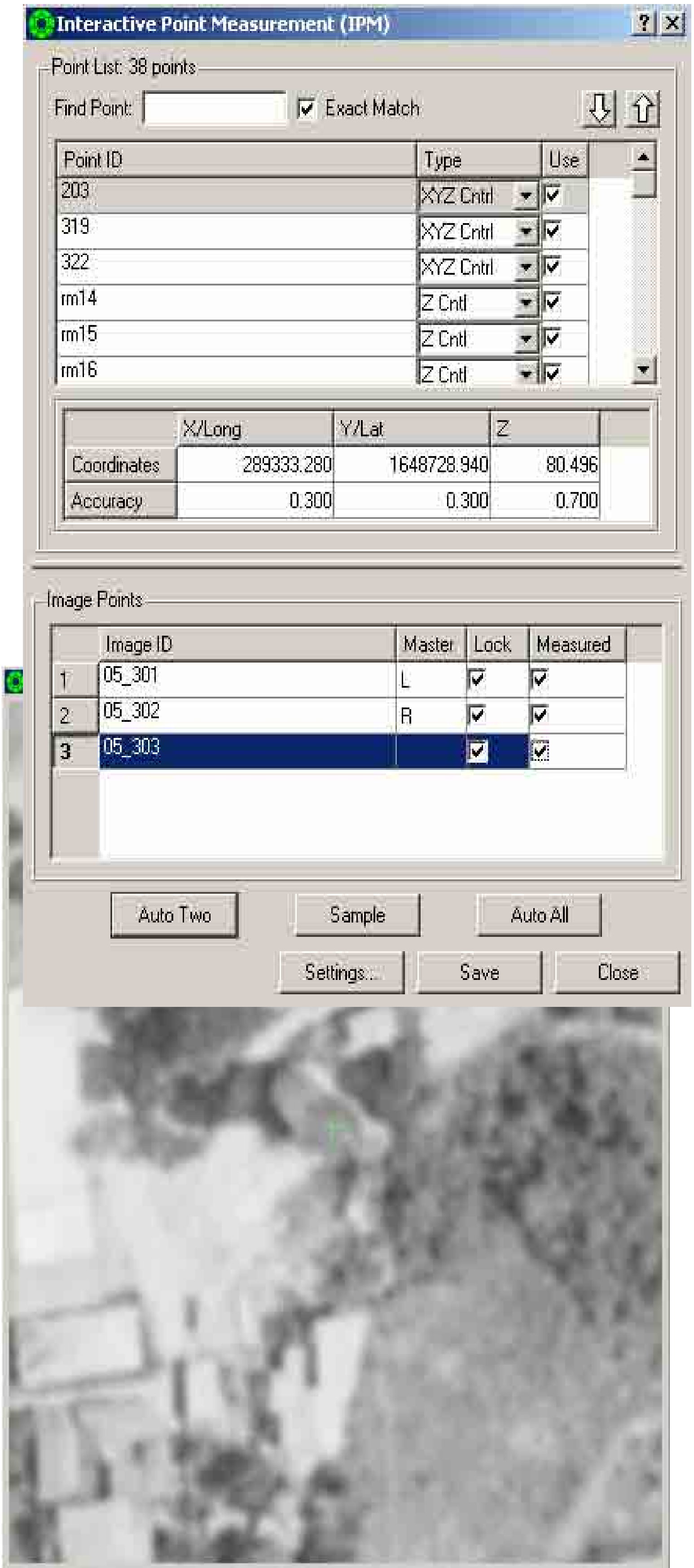
20. Once you have moved the cursor to the exact location, check the “Lock” box of the first Image ID (e.g. 05_301). Click “Auto Two” button if the image point Id is within two or more images. Click “Save”.



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”.



3.1.4.2 Measuring Tie Points.

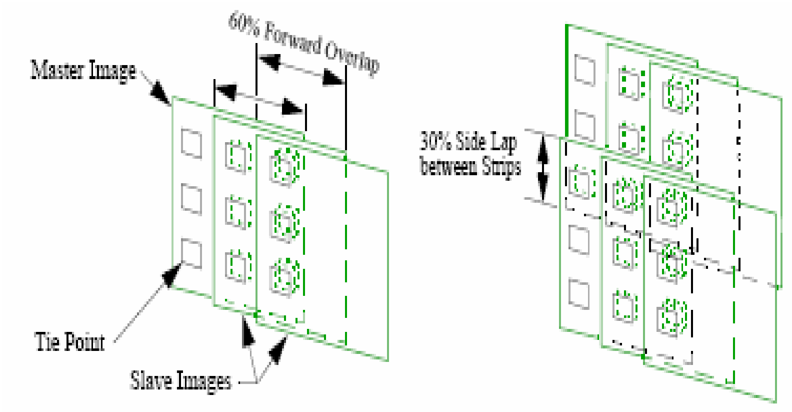
For tie points, the point measurement steps are similar except that the operator add the point ID and identifies the point location.

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.

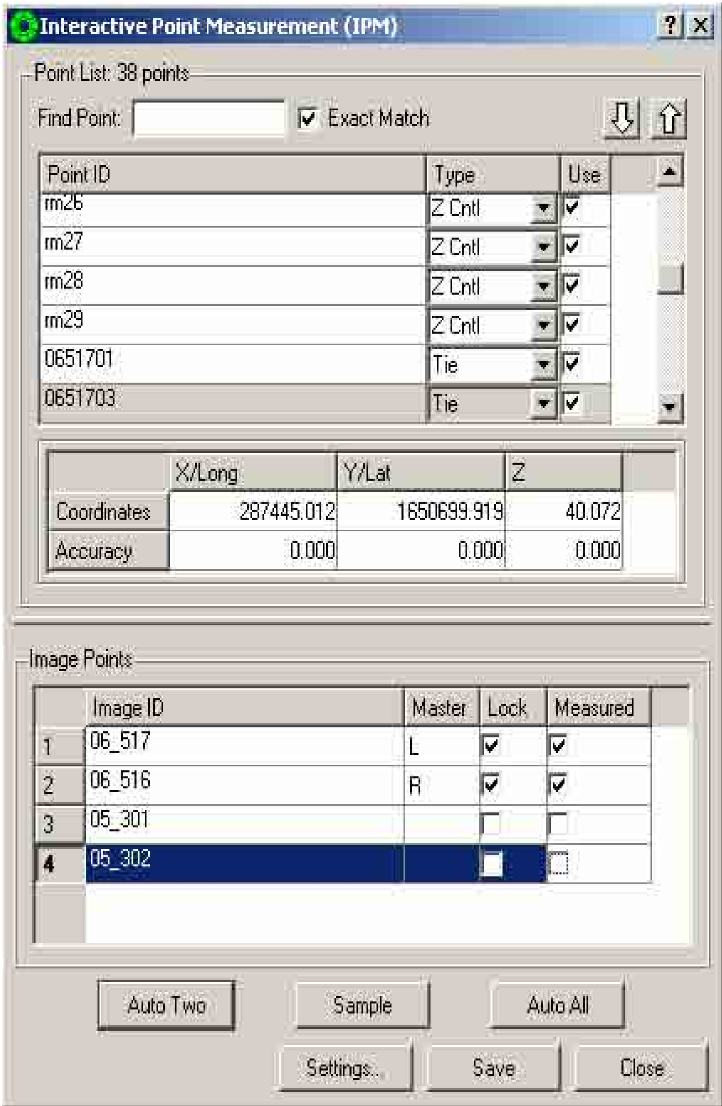
In the simplest case of 60% forward lap and 30% side lap in a rectangular block, the standard 3x3 pattern can be used. This pattern directs APM to find three tie points along any of its sides. With 60% forward overlap the closest image will share six points with the first image, while the next image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

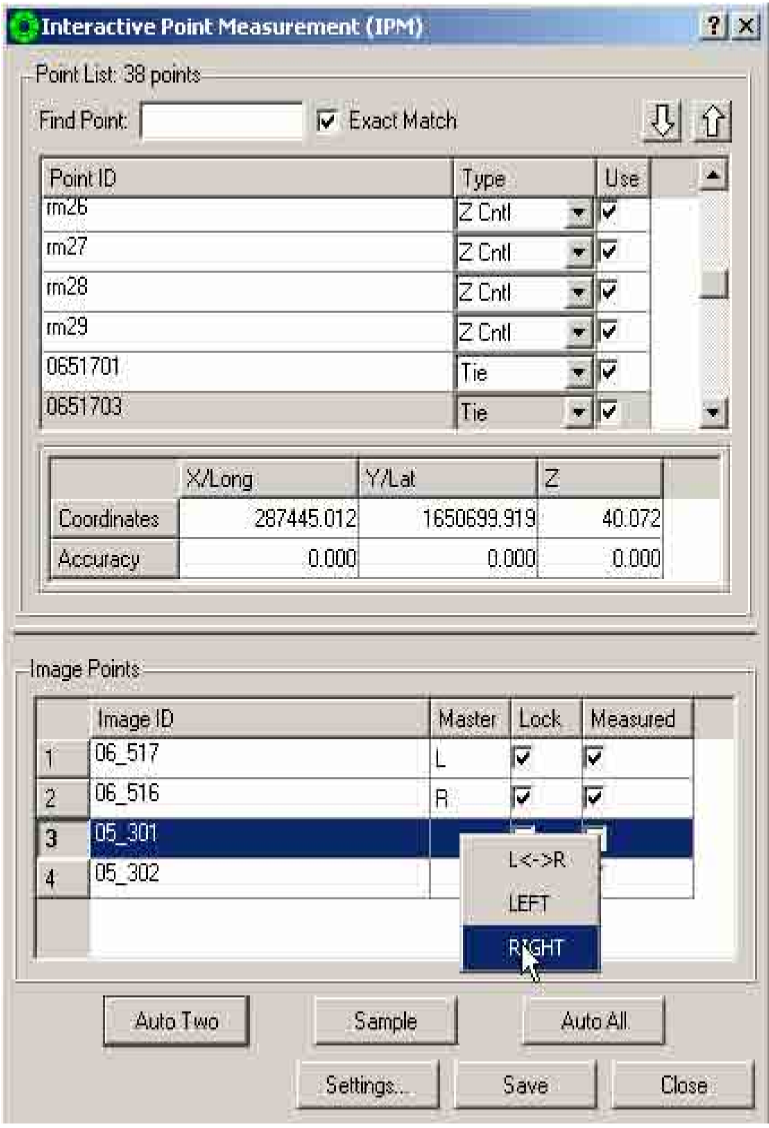
One approach is to add many more tie point candidate locations distributed across each image, and try to measure as many points as possible regardless of the lap percentage and orientation. This results in many redundant points and many failed points. Using this “shotgun” approach trades computer processing 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)

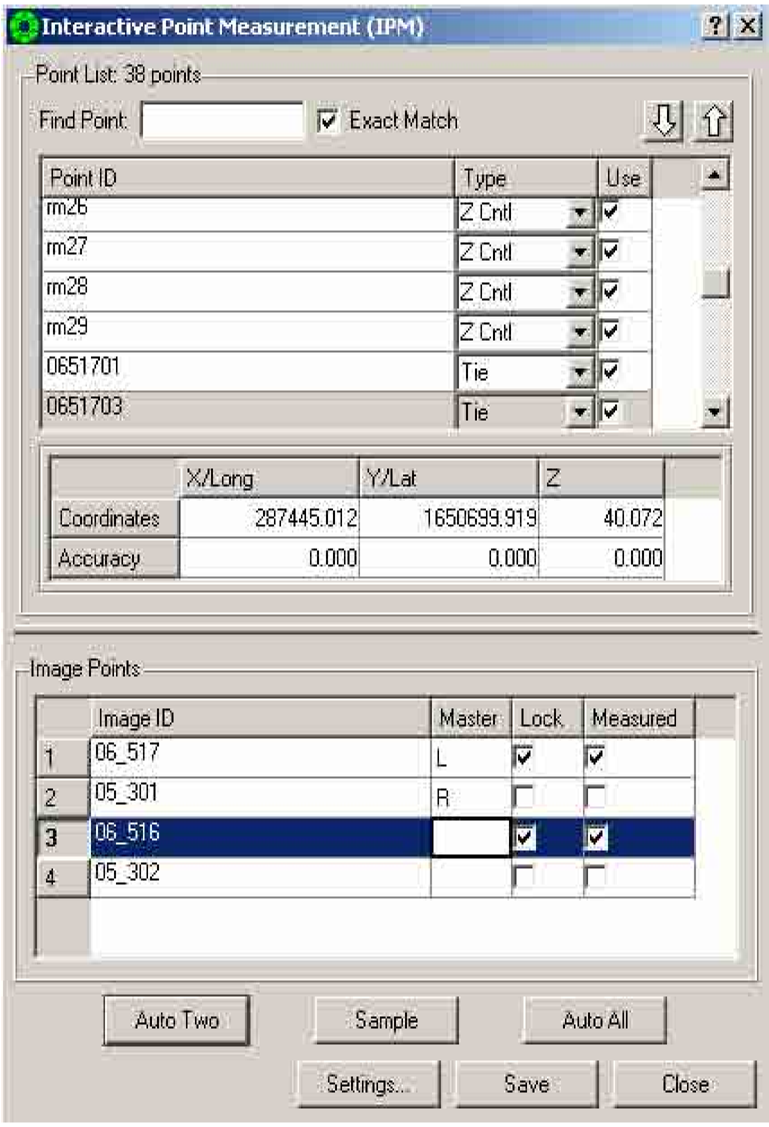


2. Select the created tie point ID (e.g. 0651703), lock the first image ID (e.g. 06_517). Then measure the tie point base on good tie point location. Click "Auto Two". Then click "Save".

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



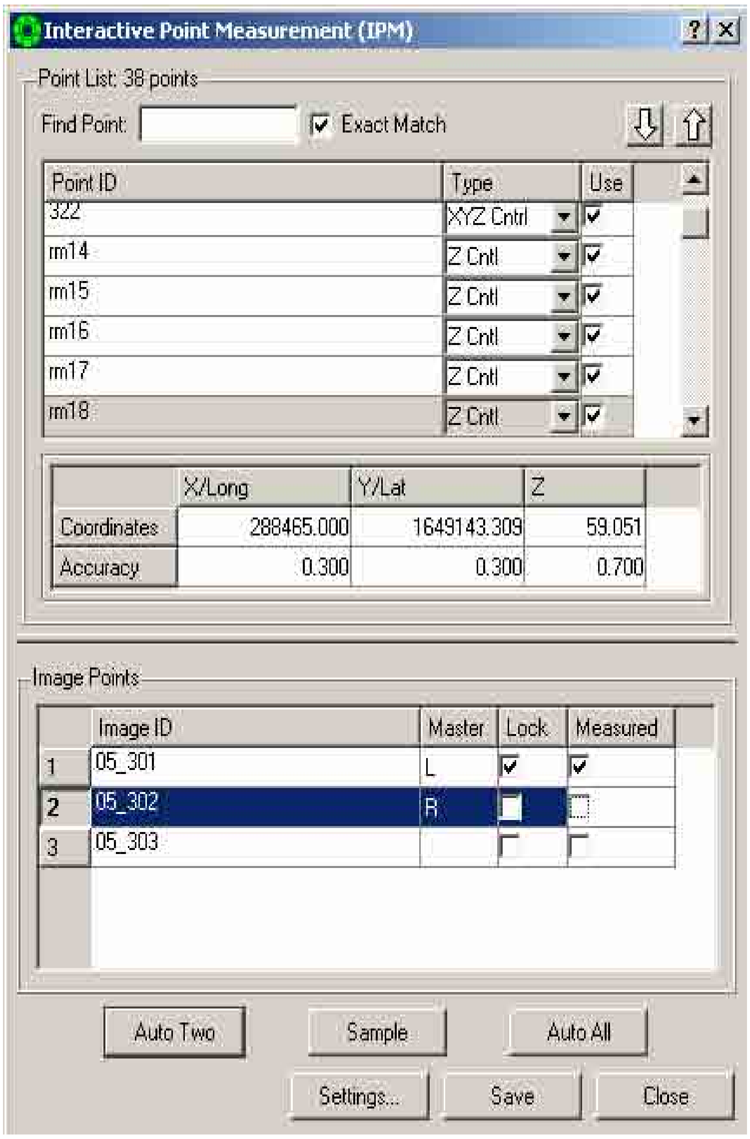
4. The image ID (e.g. 05_301) will be transferred next to first image ID (e.g. 06_517). Then measure the tie point. Click "Auto Two". Then click "Save"



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.



DESCRIPTION OF BENCH MARK

STATION NO.		Operated by	
RM-18		Checked by	
		Date	

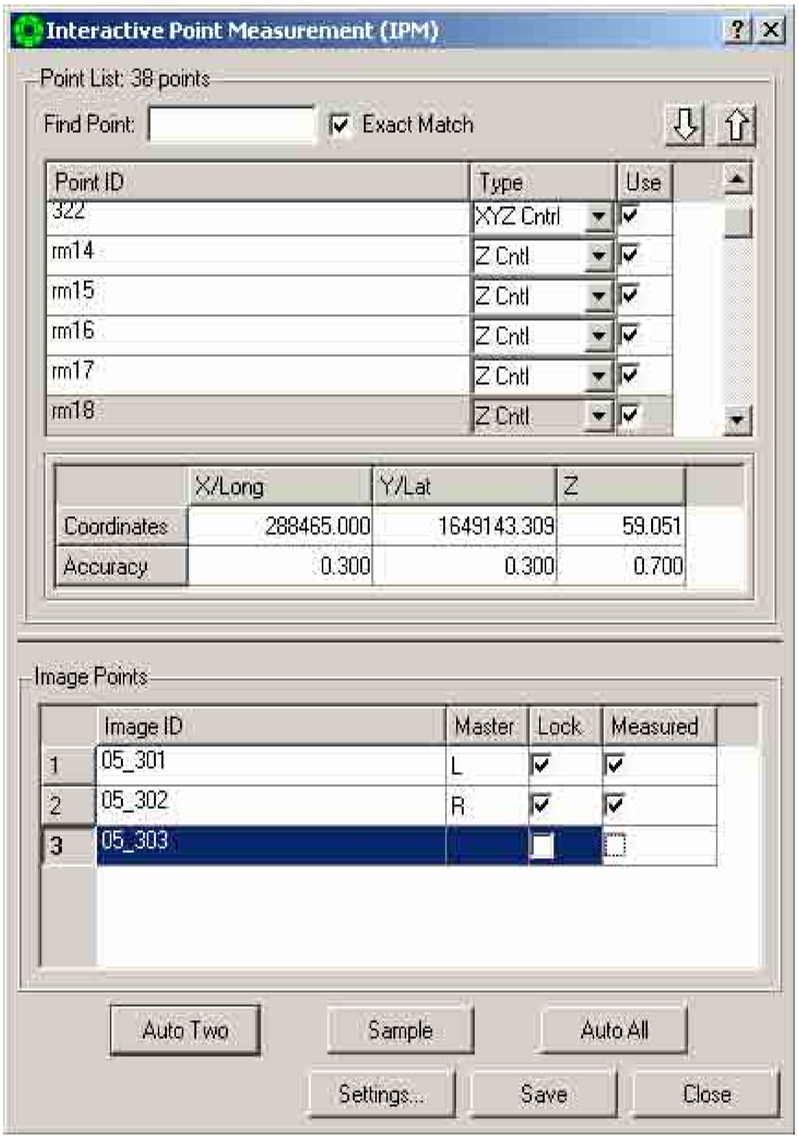
Zone No	UTM 51 N		
	N	E	H
PCP	1,643,154.70	288,481.17	
Supplementary Point			

Sketch-Map of Station and Neighborhood

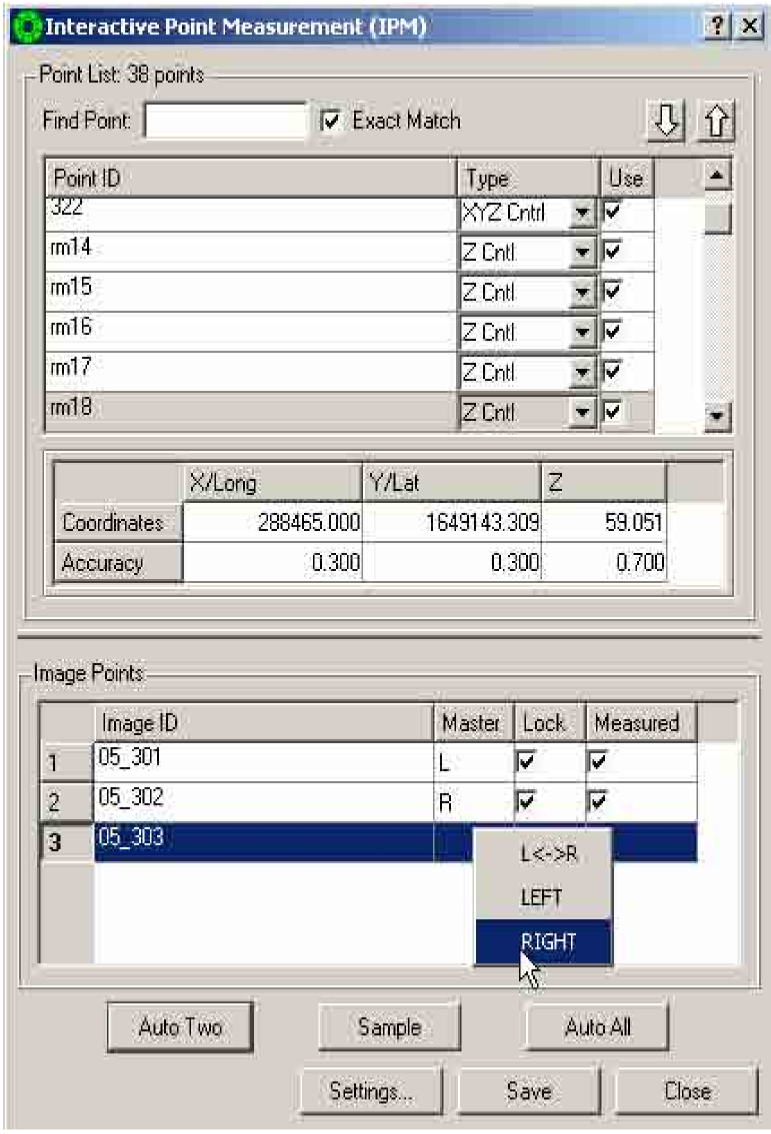
AP# 05300

Photo-Control Point

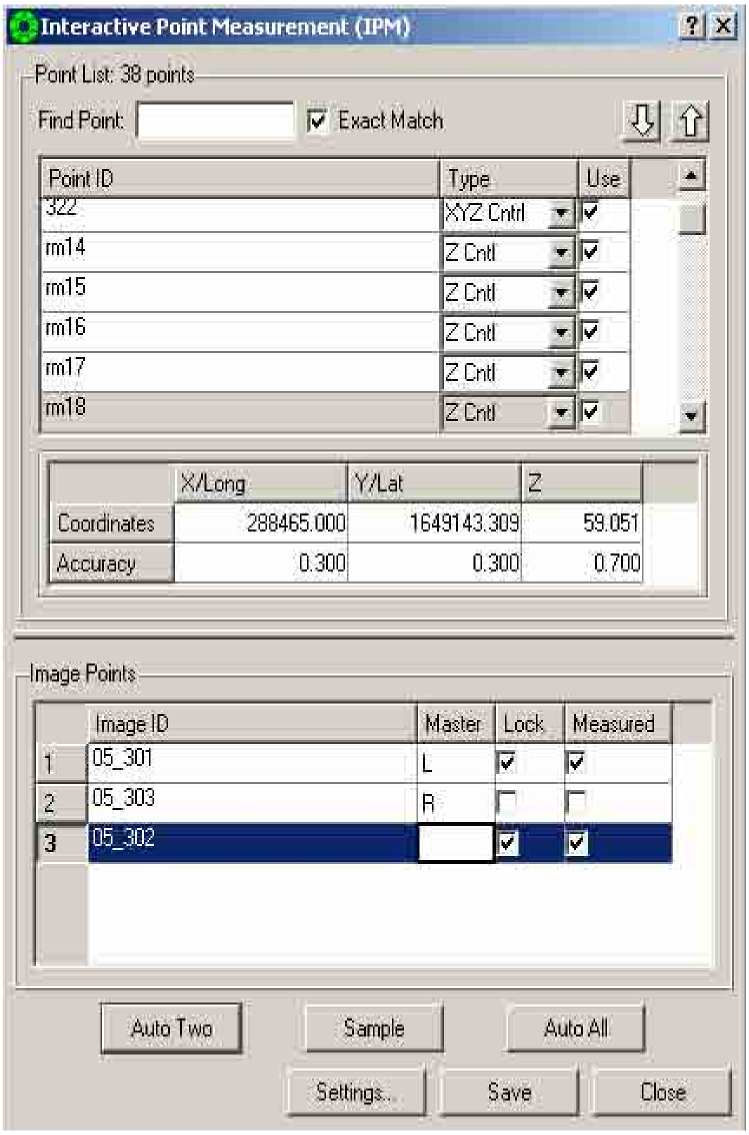
2. Select the created level point ID (e.g. rm18), lock the first image ID (e.g. 06_517). Then measure the tie point base on good tie point location. Click "Auto Two". Then click "Save".



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



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”



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.

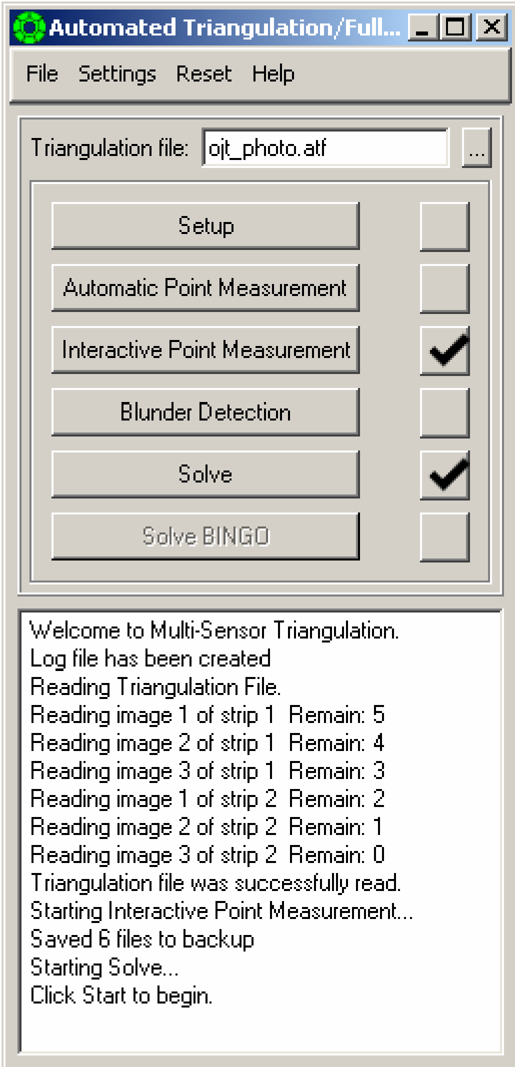
The Display Residuals menu can be selected to view the current image and ground residuals for all the measured points sorted by magnitude. Unfortunately, the largest residual points may or may not be the culprit in skewing the solution.
The first strategy should be to turn off all control points and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



2. A “Simultaneous Solve” dialog box will appear. Click “Start” 

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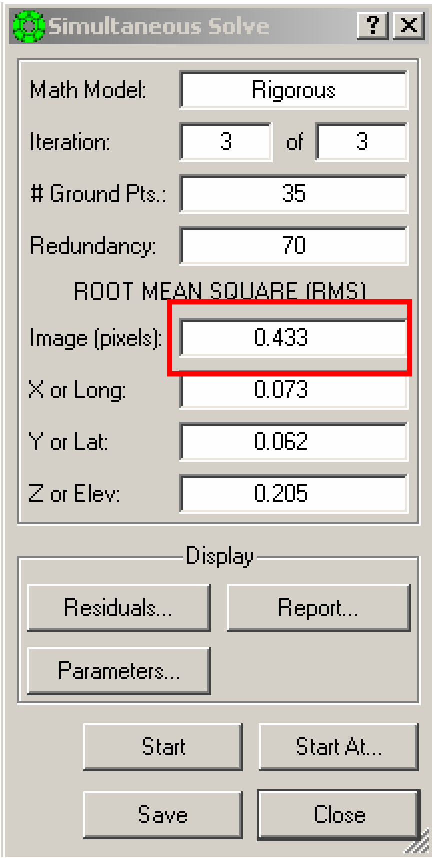

RMS (Image Pixel-0.433) is less than 1.0 pixel.

3.1.6 Product

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