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accuracy analyst ™

Brief and Demo:

Automating Accuracy Verification with Accuracy Analyst Version 2.0 (AAV2)

JACIE 2010

March 16, 2010

Chuck O'Hara (cgohara@spatialis.com)
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Starkville, MS 39759
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MSU Research

Invention to Innovation

Research with map industry partners:

- Map Accuracy (Modernization)
- Map Content (Maintenance)

Technology Gaps & Identified Needs:

- Map accuracy and content needs
- Lack of commercial tools
- Software technologies needed
- Customer-centric solutions needed

Outcome: New & Useful Software Tools

The Spin-Out of SIS from MSU!

Problem

Base map photos must be verified to meet map accuracy needs and specifications

Solution

Identifies accuracy and errors in base map photos

Benefit

Reduces a lengthy, multi-day project to less than 30 minutes and eliminates uncertainty

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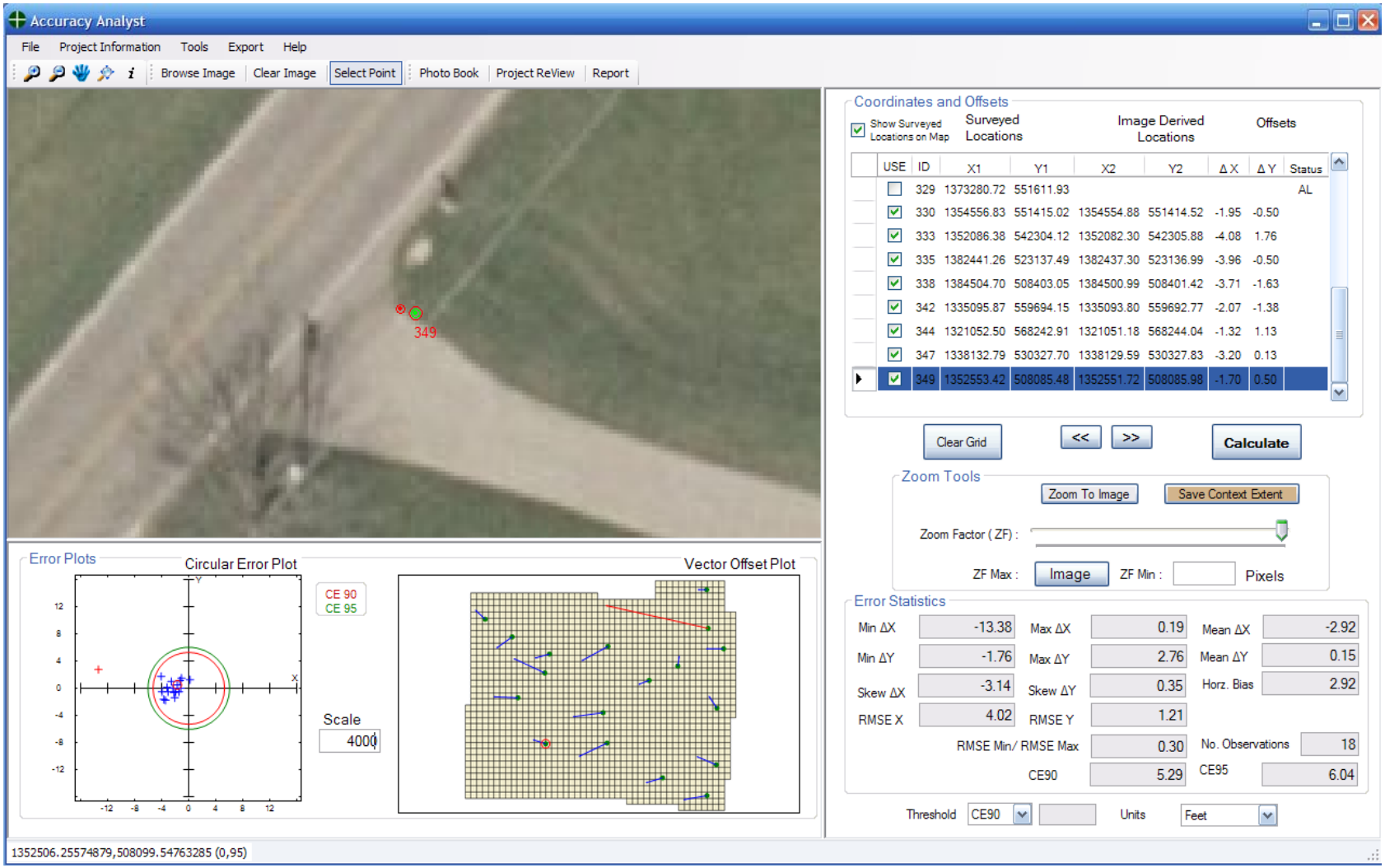
Accuracy Analyst™

NSSDA CE95 Testing

Full Analytics and Reporting



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Accuracy Analyst™

Reviews & Whitepapers

PRODUCT REVIEW

ACCURACY ANALYST

Compute Horizontal Accuracy Assessment Metrics for Orthoimagery Products

Reprinted from
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July/August 2009

By R. Brian Caldwell, a GIS specialist at the Center for Advanced Spatial Technologies (www.case.uark.edu), University of Arkansas, Fayetteville, Ark.

Accuracy Analyst is a standalone software product that provides a standardized assessment methodology for calculating the horizontal accuracy of orthorectified imagery. The product simplifies the horizontal accuracy assessment process so many desktop geographic information system (GIS) users will be able to compute their own horizontal accuracy assessments, regardless of their imagery contractor or data provider. This is important because often horizontal accuracy assessments are compiled and delivered by imagery vendors to prove they've met or exceeded the accuracy specified within a contract. Because high-resolution imagery projects typically cost thousands of dollars, many imagery consumers acquire the data and then use the imagery without independently confirming its stated accuracy. Such accuracy assessments are critical when imagery is leveraged for base mapping and feature extraction by GIS technicians.

The product's output indicates the off-set error calculated by RMSE, CE90 and CE95 (see "Useful Definitions" at right) within the image tile(s) as compared to on-the-ground, Global Positioning System (GPS)-based ground control point (GCP) observations. With Accuracy Analyst, imagery consumers can conduct a defensible horizontal accuracy assessment and possibly spend less money by doing the work themselves.

In addition, imagery vendors may use Accuracy Analyst to provide an easily understood, comprehensive assessment of data accuracy to enhance customer acceptance of purchased data. Also, any service company that conducts imagery data validation will find Accuracy Analyst a useful tool for enabling efficient and standardized assessment workflows.

Practical Applications

Orthoimagery typically is acquired for use in mapping, planimetric measurement and/or feature extraction (e.g., digitizing). Imagery consumers juggle several variables related to acquisition and delivery options related to orthoimagery instruments and collection procedures, including color selection, delivery formats, cloud cover and leaf-on conditions. However, the resulting horizontal accuracy—and ground resolution—usually tops the list of import criteria. Often the horizontal accuracy is written into contracting specifications and may determine final acceptance and/or rejection of final product delivery and payment. Therefore, the ability for clients to independently confirm the horizontal accuracy of delivered imagery products is an important aspect of the transaction and aids in the accuracy assessment of any map features derived from the base imagery product.

With Accuracy Analyst, users can compile in-house accuracy assessments of base mapping image products and make better decisions regarding the use of existing orthoimagery products. Collecting high-precision, survey-grade GPS or traditionally surveyed control points are a required input into any Accuracy Analyst assessment, and those surveyed GCP locations must be clearly visible within the images being tested. The Federal Geographic Data Committee's National Standards for Spatial Data Accuracy (NSSDA) recommend users collect at least 20 photo-identifiable control points per accuracy assessment that are "well distributed" across the entire study area. The cost of collecting the control points is an additional expense Accuracy Analyst users should anticipate.

Software Use and Documentation

Accuracy Analyst automates much of the work required for a horizontal accuracy assessment, but users should be familiar with the process. New users should be familiar with the NSSDA guidelines and the U.S. National Map Accuracy Standards. Although these national mapping and data accuracy standards have been around for years, Accuracy Analyst is the first software product that compiles horizontal accuracy assessments for orthoimagery. The user documentation and downloadable example datasets provided for Accuracy Analyst are geared toward new users, providing useful information on proper procedures for conducting a horizontal accuracy assessment.

In short, Accuracy Analyst generates a complete accuracy assessment report with a click of a button.

Accuracy Analyst provides quick access to each GCP location with simple point-and-click navigation between GCPs and easy image point digitization. Instant feedback is provided via the dynamic Cluster Error and Vector Offset plots.

Accuracy Analyst:
A Horizontal Accuracy Assessment Tool

Dr. Charles G. O'Hara and Anil Chariyadat

***Abstract*—Spatial error analysis and estimation is an important task pertaining to geospatial imaging and mapping that can enable the user to establish the accuracy of information obtained from georeferenced images. Spatial error analysis techniques allow the user to quantify and understand spatial uncertainty and discrepancies in data. The objective of this work is to develop a set of software tools that may be used to analyze and estimate the spatial inaccuracies and quantify findings using industry standard terms for georeferenced image data accuracy specifications. Accuracy Analyst is a software tool that can be used to analyze the horizontal accuracies pertaining to the spatial coordinates surveyed for certain well-defined survey checkpoint locations and the locations of those photo-identifiable points extracted from georeferenced orthorectified image data**

Keywords – Image Horizontal Accuracy, CE_{90} , CE_{95}

I. Introduction

Mechanical limitations of instrument, sensor position and orientation, curvature of the earth and unforeseen human errors are some of the sources for mapping inaccuracies that are usually encountered in geospatial mapping or imaging processes. One such spatial discrepancy is the horizontal positional inaccuracy of the remotely acquired image. Due to the aforementioned sources of errors, the horizontal positional information of an object obtained from a remotely acquired image may deviate from its true real world surveyed or measured location. Although some of the potential causes for spatial errors can be eliminated or reduced, estimation of horizontal inaccuracies is still an important task that needs to be undertaken to assess the reliability of the information retrieved from the image. In this paper, authors explain the Accuracy Analyst toolkit, which has been developed to provide a user friendly graphical user interface, implementing the circular error distribution analysis procedures described by Greenwalt and Shultz [1] for analyzing and estimating the horizontal accuracy.

II. Fundamentals of CE90/CE95

The horizontal positional error of an object can be represented by a random variable pair, (x, y). The random variables x and y correspond to the error encountered in the X (longitude) and Y (latitude) directions respectively. The error can be considered as the deviation of the measured values from the true values. The two random variables can be assumed to be independent, with a Gaussian distribution and zero mean. The joint probability density distribution for these random variables (x, y) is given by equation (1). Rearranging equation (1) results in (2).

$$p(x,y) = \frac{1}{2\pi\sigma_x\sigma_y} e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right)} \quad (1)$$

$$-2\ln[p(x,y)2\pi\sigma_x\sigma_y] = \left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right) \quad (2)$$

As it can be observed from equation (2) for a given value (x, y) the probability density function represents the square of the radius of circle assuming that variances (σ_x and σ_y) in both the dimensions are equal. The probability for an error random variable pair (x, y) to be contained within a circle of radius R can be defined by the circular error probability function $P(R)$. The circular error probability function can be derived from equation (2) and is detailed in [1]. A condensed form for $P(R)$ for the case when σ_x and σ_y are equal is given by equation (3)

$$P(R) = 1 - e^{-\frac{R^2}{2\sigma^2}} \quad (3)$$

where R is the radial distance.

For CE90, the National Map Accuracy Standard (NMAS) specifies that 90% of well-defined points in an image or map should fall within a certain radial distance R. For CE95, the National Map Accuracy Standard (NMAS) specifies that 95% of well-defined points in an image or map should fall within a certain radial distance R. Therefore substituting the left hand side of (3) with 0.90 will yield the horizontal accuracy standard as specified by NMAS which is given by equation (4).

$$CE_{90} = 2.1460\sigma_x \quad (4)$$

where $\sigma_x = \sigma_y = \sigma_x$.

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Positive Industry Reviews

PRODUCT REVIEW

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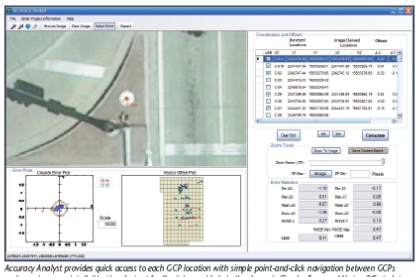

Accuracy Analyst provides quick access to each GCP location with simple point-and-click navigation between GCPs and easy image point digitization. Instant feedback is provided via the dynamic Circular Error and Vector Offset plots.

User Input Requirements

Accuracy Analyst requires a modest amount of setup and user input to get started. New users can refer to a general checklist of data requirements to serve as a guide for their first accuracy assessment project. Accuracy Analyst requires users to have a polygon index file of their imagery—sometimes referred to as an "image catalog" by GIS users. Image catalogs often are supplied by imagery vendors when they deliver their products. Accuracy Analyst requires the index to be provided as an ESRI Shapefile, so users should request this index file as a contract deliverable for their image acquisitions.

In addition, users must know their data coordinate system, as the aforementioned GCP coordinates must be within the same mapping unit and projection/coordinate system as the delivered imagery. This is typically a State Plane Coordinate System for local government mapping applications in the United States, but many statewide acquisitions are delivered in the Universal Transverse Mercator (UTM) projection/coordinate system. Regardless of the coordinate system of the delivered imagery, be sure the surveyed GCP coordinates are precisely located upon easily photo-identified points within the delivered imagery and that the x, y coordinates are delivered within the same projection/coordinate/datum/unit as the delivered imagery.

These GCP or "real-world" coordinate locations should be collected as much as three times the accuracy of the specified accuracy of the final imagery products and recorded with the appropriate coordinate precision to support such accuracy. Accuracy Analyst expects each GCP location to be identified with a user-defined unique "ID" and include the x, y coordinates, as well as any field notes that may help Accuracy Analyst users "heads-up" digitize the corresponding position on the imagery.

Useful Definitions

CE90 (Circular Error of 90 percent): A CE90 value is the minimum diameter of the horizontal circle that can be centered on all photo-identifiable ground control points (GCPs) and also contain 90 percent of their respective twin counterparts acquired in an independent geodetic survey. CE95 (Circular Error of 95 percent) is more rigorous and allows for only 1 GCP outlier for every 20 GCP sets.

RMSE (Root Mean Squared Error): An RMSE value is a single summary statistic that describes the square root of the mean horizontal distance between all photo-identifiable GCPs and their respective twin counterparts acquired in an independent geodetic survey.

Accuracy Analyst users can load these control points into the software by typing them individually or in bulk as a comma separated file (.csv) in which the left-hand column represents a unique ID for each GCP, followed by the x, y coordinates.

After an imagery index file (.shp) and GCP file (.csv) are acquired, the next step is to open the Accuracy Analyst application and create a new Project file (.aap). After providing a project file name and brief metadata, users import the imagery index file (.shp) and load the GCPs (may be typed individually or imported via a .csv file) for the accuracy assessment. The imagery index files must contain an attribute with the name of each image or else your individual images can't be located. Accuracy Analyst reads the most common raster image formats, including .tiff, .img, .sid, .jpeg and jg2. For better performance, users should store the imagery on the same computer. Including the .rrd and/or the .ovr files for each image will improve the imagery's display performance, but they aren't required.

Accuracy Analyst Workflow

The product's usefulness and efficiency quickly becomes apparent after a project is set up and the two required datasets are imported (.shp and .csv files). Notice that I haven't mentioned anything about the imagery, because Accuracy Analyst will load only the area of each image that intersects a control point. This means Accuracy Analyst's image display is fast, and users will save hours of work by eliminating the need to wait for an entire high-resolution image to load before they locate and digitize the corresponding GCP point on corresponding images. The time savings alone is reason enough to justify Accuracy Analyst's purchase.

Accuracy Analyst's software layout streamlines the coordinate acquisition workflow, too, so users can quickly move through their list of surveyed GCP locations (see upper right corner of accompanying product screen shot) and locate, then heads-up digitize, the appropriate "on image" location that corresponds to its twin GCP position. After all of the image control positions are digitized for each of the GCPs, the user "calculates" the error results, which are quantified by the RMSE, CE90 and CE95 accuracy assessment statistics for the project imagery. Additionally, a circular error and offset vector error plot are generated and presented within the application. These error plots are interactive and provide color-coded graphics that depict the error distribution, as well as the direction of image offset from each control point. The points are color coded based on whether they're within the CE90 or CE95 specifications.

After the accuracy statistics are calculated, Accuracy Analyst users can review their collection of GCP positions and use the graphic display of the error plots to help decide if they should remove "outliers" from their assessment or add additional GCPs to refine their accuracy assessment. As these changes are made, Accuracy Analyst recalculates RMSE, CE90 and CE95 to provide instant results.

Finally, when users have completed their work, they can select "Generate Report," and a snap-shot, multipage report of their accuracy assessment data, input, output and results is produced in a single portable document format (.pdf) file. The reports are time/date stamped and contain all relevant information regarding the accuracy assessment. The report includes snapshots of each control point's location and corresponding digitized image location.

In short, Accuracy Analyst generates a complete accuracy assessment report with a click of a button. The time-stamped reports can be re-generated at any time, and each report run reflects the current status and result computed at that moment within the Accuracy Analyst project. The product's report generator will save users hours of project documentation time and should easily justify the product's purchase.

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Customer Feedback

Steve Kasten, VP
SURDEX Corporation

1st Use --"*Just finished the accuracy evaluation on my Corps of Engineers project. Took about 10 minutes - the first time. This is really nice."*

2 Weeks Later -- *"Accuracy Analyst will be our standard tool for product accuracy reporting from now on. What took 4 to 5 days manually can now be done in minutes – concisely, and with a great report!"*

2 Months After Adopting -- *"We will not do another project without Accuracy Analyst!"*

SURDEX wants to offer Accuracy Analyst software to their customers!

Version 1.0 Product Highlights

Standalone Software – Windows Platform
Rapid Development – Builds on Open Source
Interactive Analysis – Maps, Stats, & Charts
Rapid Image Handling – No Delays
Lightweight Application – Streamlined Workflow
Comprehensive Reporting
Shared “Analytics”
Positive Industry Reviews and Press

Customer Feedback – “New Features Release”

Accuracy Analyst™ Release 2.0

Customers Needed “Extended” Workflow Support
Survey Planning Tool: **Control / CheckPoint Planner**
Integrated Checkpoint Photo Viewer: **PhotoBook**
End-to-End Image Data QA: **ReViewer**
Analytics and Report Export Options
Enhanced Controls and Large Data Handling
Systematic Data Review & Acceptance Workflow

Extends Workflow Supports

Planning – Production – Review – Acceptance

CheckPoint Libraries are vital to ensuring the accuracy of digital map data. Use existing image data and CheckPoint Planner to –

- ID points easily seen in aerial photos for on the ground survey.
- Create detailed plans for efficient survey work.
- Create nav files so crews can easily get on site.
- Plan and build CheckPoint Library data.
- Reuse checkpoints for verifying all digital map data.

CheckPoint Planner

Take the Guess Work Out of Field Work!

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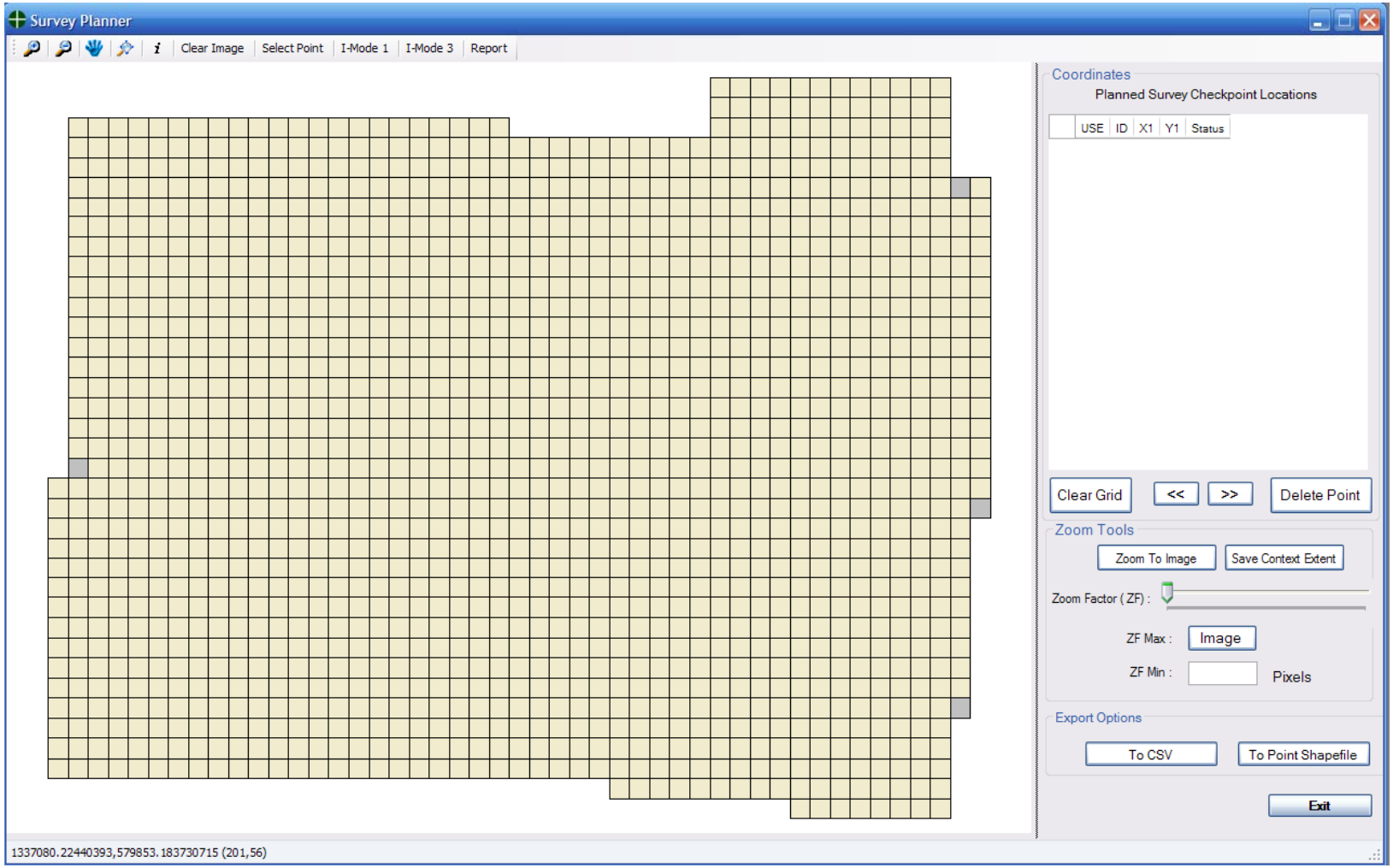
Accuracy Analyst™

New Feature: CheckPoint Planner

Projectwide CheckPoint Planning

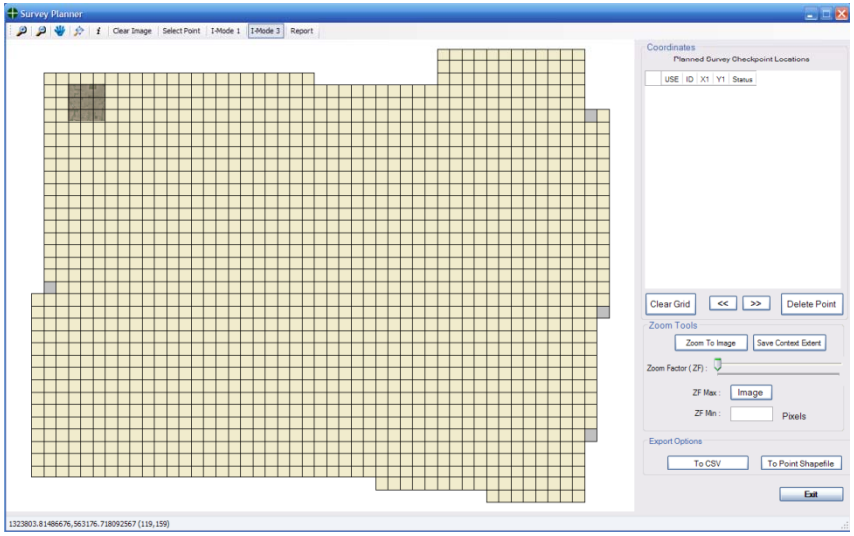


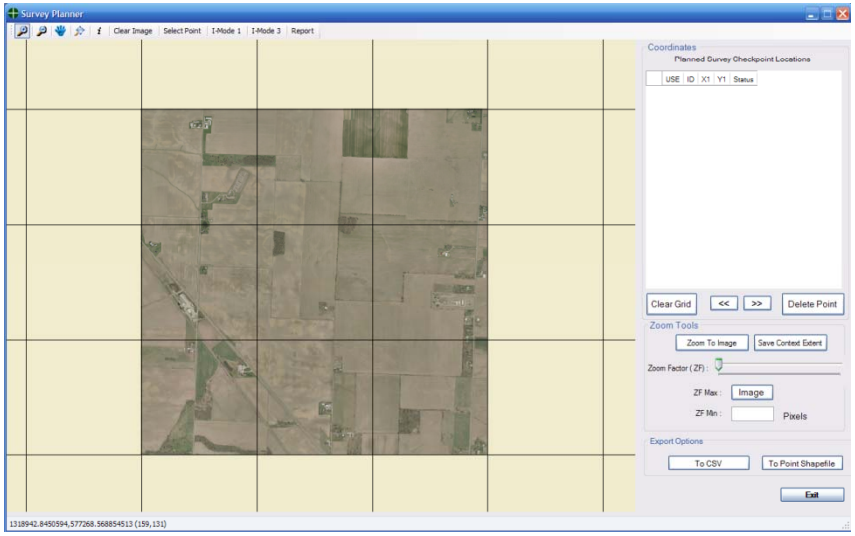
spatial information solutions

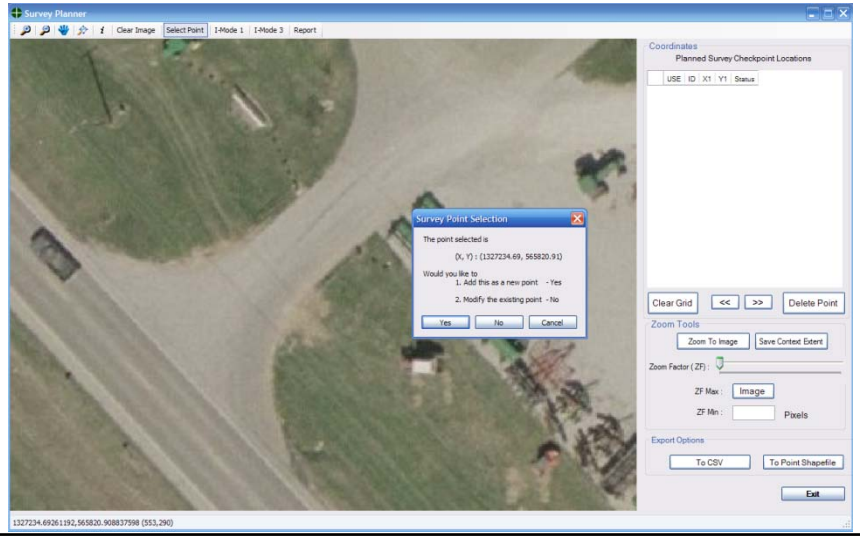
Accuracy Analyst™

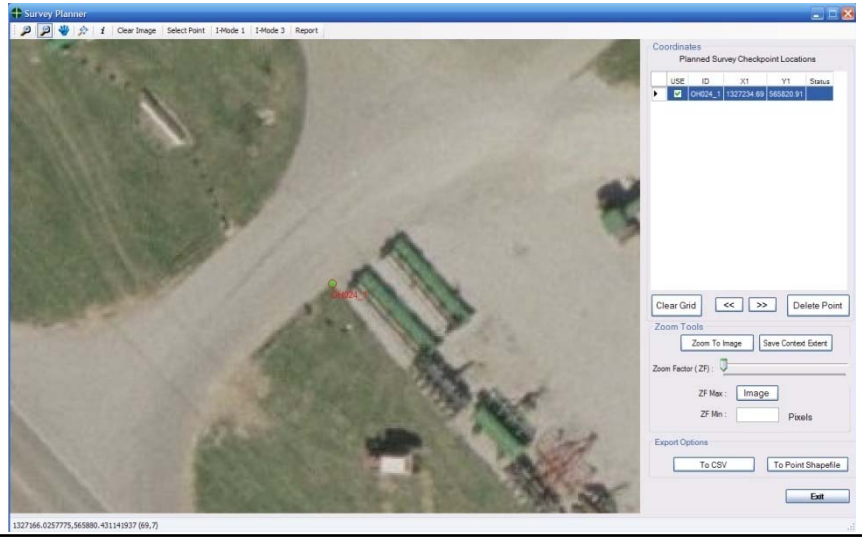
New Feature: CheckPoint Planner

Zoom & Select CheckPoints









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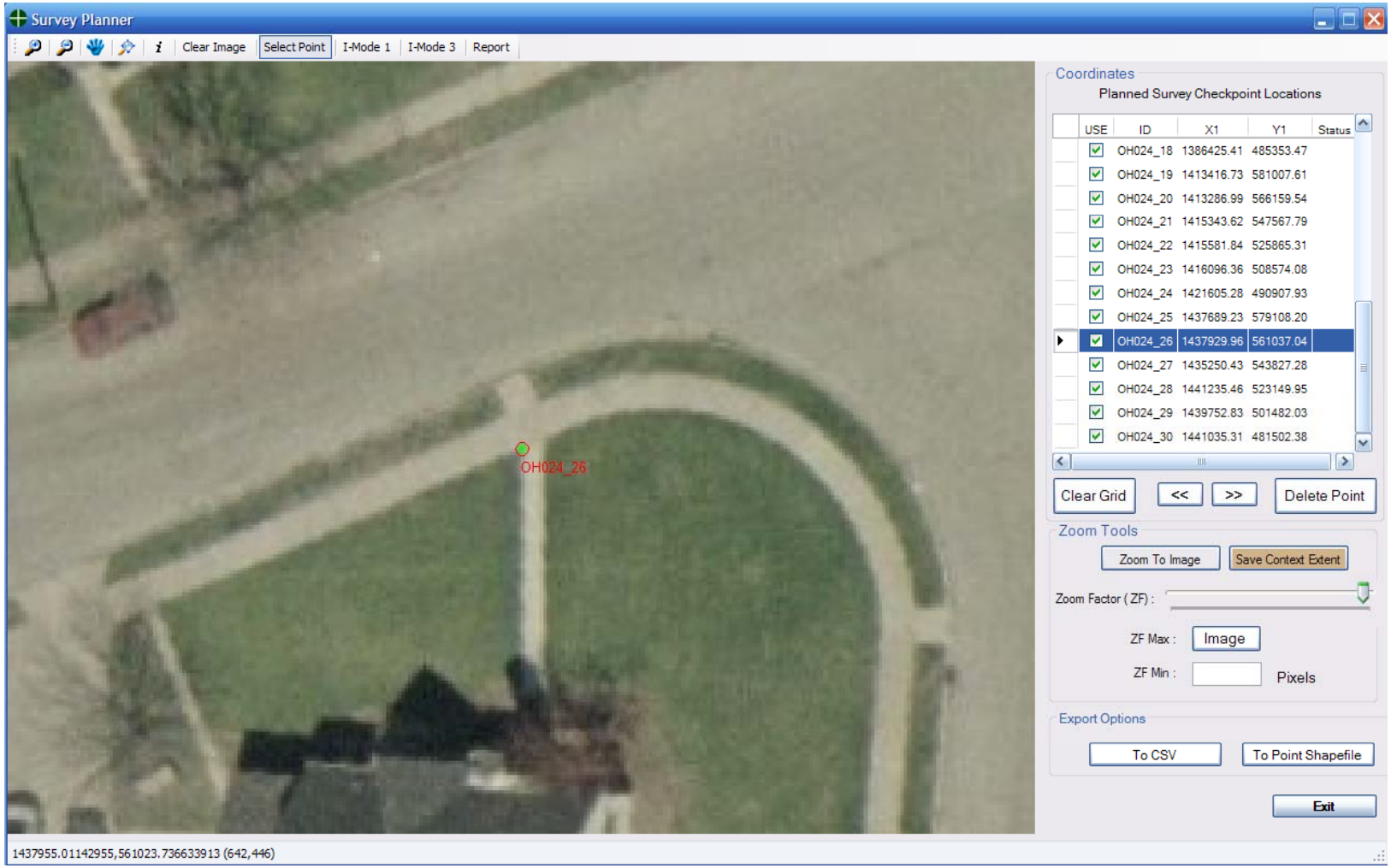
Accuracy Analyst™

New Feature: CheckPoint Planner

Review / Refine CheckPoint Plan



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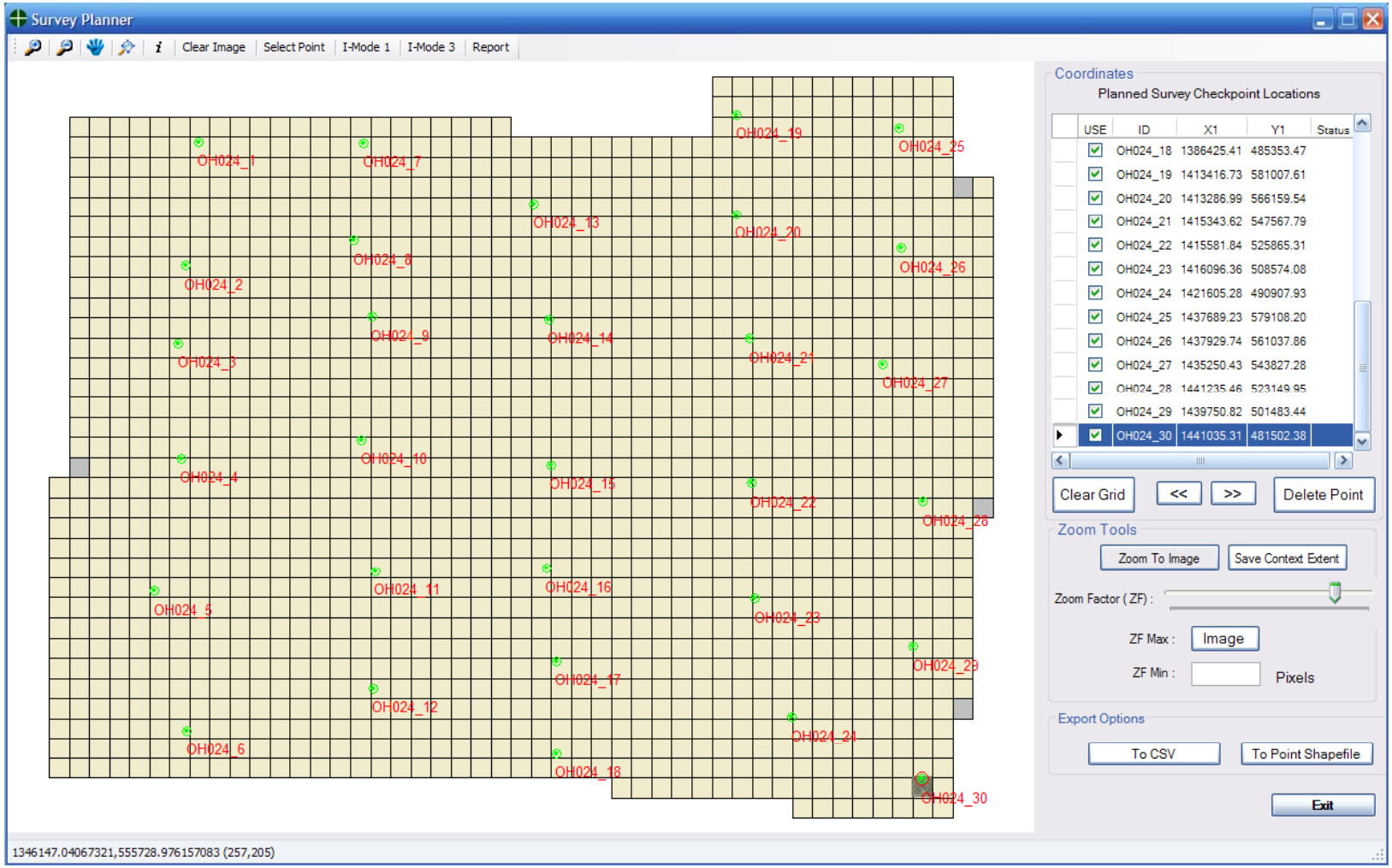
Accuracy Analyst™

New Feature: CheckPoint Planner

Optimize CheckPoint Coverage



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Accuracy Analyst™

New Feature: CheckPoint Planner

Document CheckPoint Plan

SURDEX CORPORATION

accuracy analyst™
http://www.spatialis.com

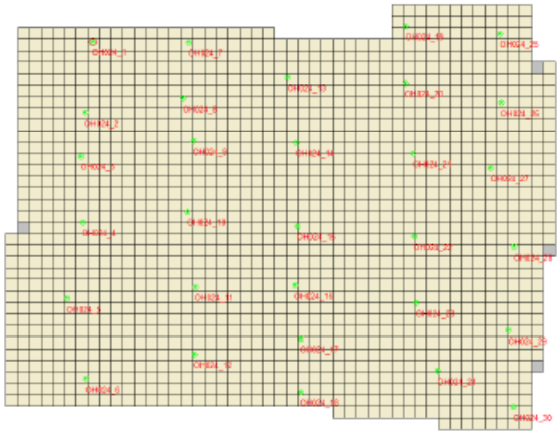
Survey Location Planning Project

Prepared By: Chuck O'Hara
Project Name: SIS MATAA V2.0 Demo
Sensor Info: Z/I DMC
Sensor Resolution: 0.5
Vendor Name: SURDEX
Date of Aquisition: 12/16/2009

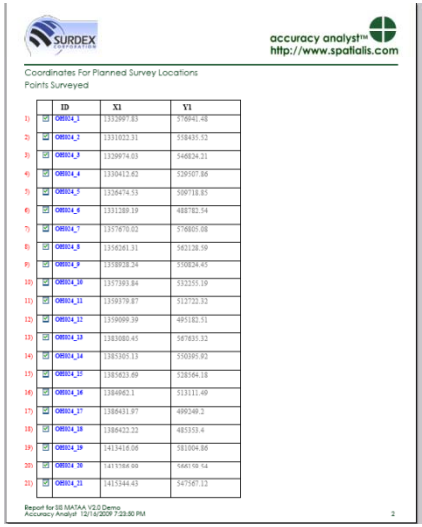
Metadata Information

Index File Name: tiles.shp
# of Polygons: 1550
# of Matching Images: 1546
Polygon ID: ID
Units: Feet
Image Folder Path: H:\Schuckman\Orthophotos\FinalOrthos

Tiled-Image Area



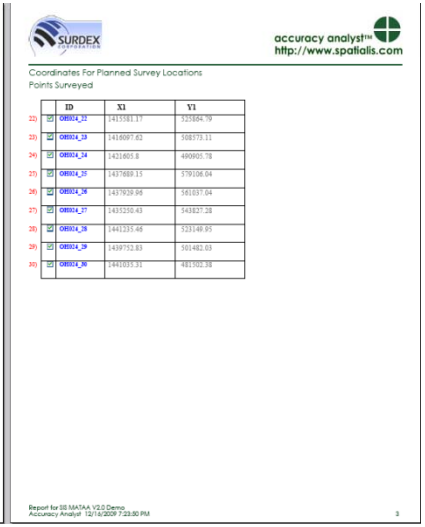
Report for SIS MATAA V2.0 Demo
Accuracy Analyst 12/16/2009 7:23:50 PM 1



SURDEX CORPORATION
accuracy analyst™ http://www.spatialis.com
Coordinates For Planned Survey Locations
Points Surveyed

	ID	X1	Y1
1)	OH024_1	1332997.83	576941.48
2)	OH024_2	1331022.31	559435.52
3)	OH024_3	1329974.03	546824.21
4)	OH024_4	1330412.62	529507.86
5)	OH024_5	1328474.53	509718.85
6)	OH024_6	1331289.19	488782.54
7)	OH024_7	1357670.02	576805.08
8)	OH024_8	1356361.31	560238.59
9)	OH024_9	1358928.24	550824.45
10)	OH024_10	1357393.84	532555.19
11)	OH024_11	1359379.87	512722.32
12)	OH024_12	1359099.39	495182.51
13)	OH024_13	1383080.45	567635.32
14)	OH024_14	1385305.13	550395.92
15)	OH024_15	1385623.69	528564.18
16)	OH024_16	1384985.1	513111.49
17)	OH024_17	1386431.97	499249.2
18)	OH024_18	1386422.22	485353.4
19)	OH024_19	1413416.06	581004.86
20)	OH024_20	1413566.66	566150.54
21)	OH024_21	1415344.43	547567.12

Report for SIS MATAA V2.0 Demo
Accuracy Analyst 12/16/2009 7:23:50 PM 2



SURDEX CORPORATION
accuracy analyst™ http://www.spatialis.com
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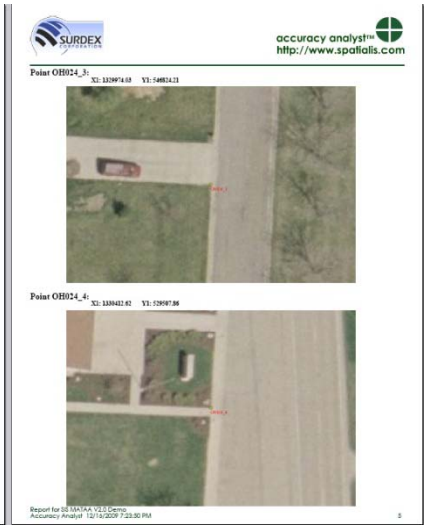
Points Surveyed

	ID	X1	Y1
22)	OH024_22	1415581.17	525864.99
23)	OH024_23	1416097.62	508573.11
24)	OH024_24	1421605.8	490905.78
25)	OH024_25	1437889.15	579106.04
26)	OH024_26	1437920.96	561037.04
27)	OH024_27	1435250.43	543827.28
28)	OH024_28	1441235.46	523148.95
29)	OH024_29	1439752.83	501482.63
30)	OH024_30	1441055.31	481502.38

Report for SIS MATAA V2.0 Demo
Accuracy Analyst 12/16/2009 7:23:50 PM 3

SURDEX CORPORATION
accuracy analyst™ http://www.spatialis.com
Point OH024_1: X1: 1332997.83 Y1: 576941.48
Point OH024_2: X1: 1331022.31 Y1: 559435.52

Report for SIS MATAA V2.0 Demo
Accuracy Analyst 12/16/2009 7:23:50 PM 4



SURDEX CORPORATION
accuracy analyst™ http://www.spatialis.com
Point OH024_3: X1: 1329974.03 Y1: 546824.21
Point OH024_4: X1: 1330412.62 Y1: 529507.86

Report for SIS MATAA V2.0 Demo
Accuracy Analyst 12/16/2009 7:23:50 PM 5

spatial information solutions

Accuracy Analyst™

New Feature: CheckPoint Planner

1st End-to-End Statewide Project

Accuracy Analyst™ will be used in a North Carolina statewide 6” image collection, $12 M Emergency 911 map update project.

Accuracy Analyst™

Integrated Use

3000 Checkpoints

- 30 Per County
- 100 Counties

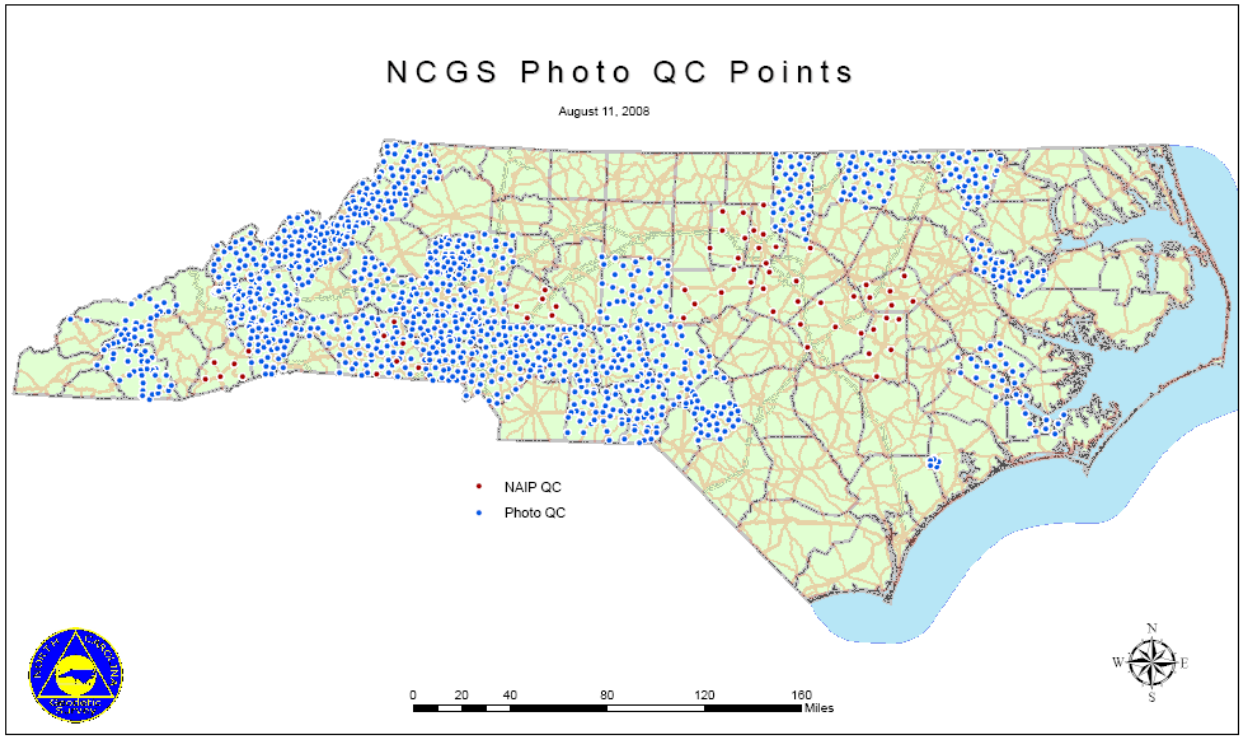
Statewide PhotoBook

Statewide 6” Images

Shared Analytics

Agencies, Vendors & QA

- **NCGS & NCDENR**
- **SURDEX**
- **URS CORP**



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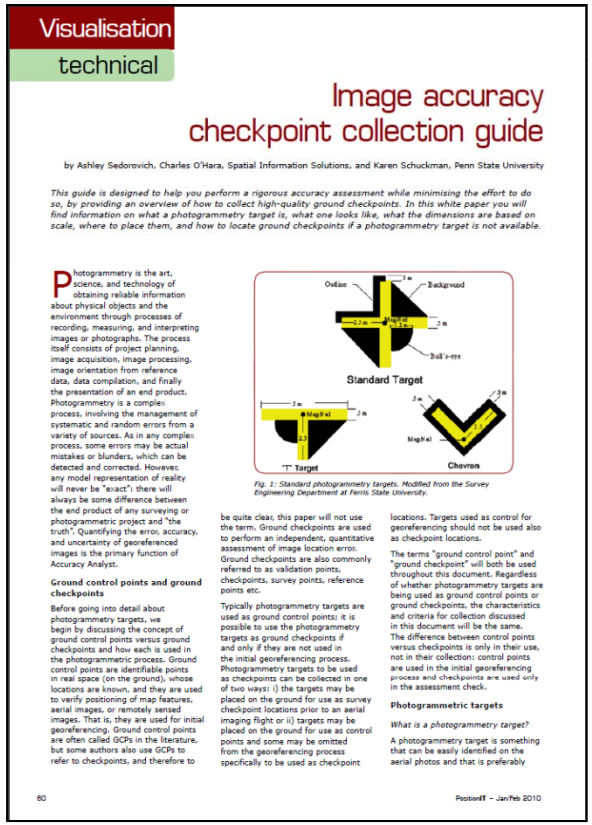
Industry Trade Magazine Publishes SIS CheckPoint Paper

Digital map data accuracy is an area of emerging importance. SIS technology and white paper on "CheckPoint Libraries" raised industry interest resulting in the publication of an SIS White Paper!



Visualisation technical

Image accuracy checkpoint collection guide

by Ashley Sedorovich, Charles O'Hara, Spatial Information Solutions, and Karen Schuckman, Penn State University

This guide is designed to help you perform a rigorous accuracy assessment while minimising the effort to do so, by providing an overview of how to collect high-quality ground checkpoints. In this white paper you will find information on what a photogrammetry target is, what one looks like, what the dimensions are based on scale, where to place them, and how to locate ground checkpoints if a photogrammetry target is not available.

Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting images or photographs. The process itself consists of project planning, image acquisition, image processing, image orientation from reference data, data compilation, and finally the presentation of an end product. Photogrammetry is a complex process, involving the management of systematic and random errors from a variety of sources. As in any complex process, some errors may be actual mistakes or blunders, which can be detected and corrected. However, any model representation of reality will never be "exact"; there will always be some difference between the end product of any surveying or photogrammetric project and "the truth". Quantifying the error, accuracy, and uncertainty of georeferenced images is the primary function of Accuracy Analyst.

Ground control points and ground checkpoints

Before going into detail about photogrammetry targets, we begin by discussing the concept of ground control points versus ground checkpoints and how each is used in the photogrammetric process. Ground control points are identifiable points in real space (on the ground), whose locations are known, and they are used to verify positioning of map features, aerial images, or remotely sensed images. That is, they are used for initial georeferencing. Ground control points are often called GCPs in the literature, but some authors also use GCPs to refer to checkpoints, and therefore to be quite clear, this paper will not use the term. Ground checkpoints are used to perform an independent, quantitative assessment of image location error. Ground checkpoints are also commonly referred to as validation points, checkpoints, survey points, reference points etc.

Fig. 1: Standard photogrammetry targets. Modified from the Survey Engineering Department at Ferris State University.

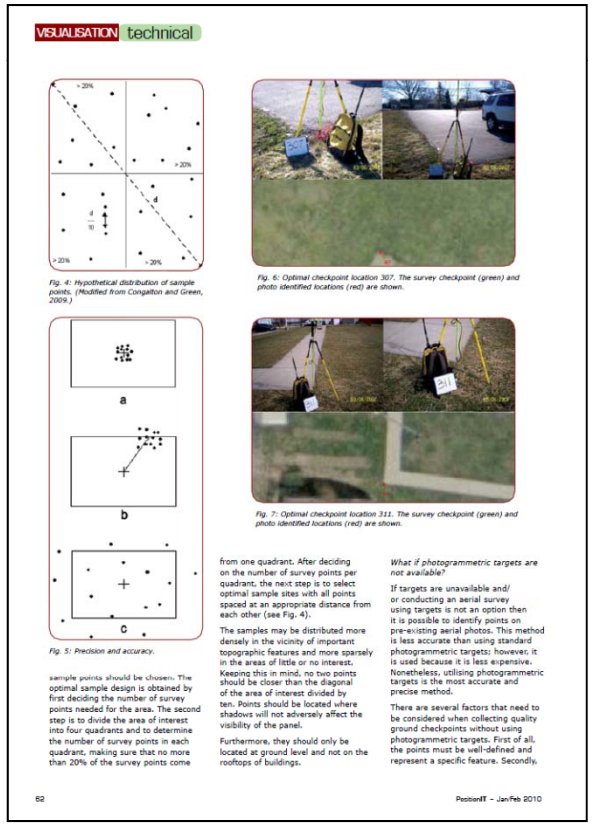
Typically photogrammetry targets are used as ground control points: it is possible to use the photogrammetry targets as ground checkpoints if and only if they are not used in the initial georeferencing process. Photogrammetry targets to be used as checkpoints can be collected in one of two ways: i) the targets may be placed on the ground for use as survey checkpoint locations prior to an aerial imaging flight or ii) targets may be placed on the ground for use as control points and some may be omitted from the georeferencing process specifically to be used as checkpoint locations. Targets used as control for georeferencing should not be used also as checkpoint locations.

The terms "ground control point" and "ground checkpoint" will both be used throughout this document. Regardless of whether photogrammetry targets are being used as ground control points or ground checkpoints, the characteristics and criteria for collection discussed in this document will be the same. The difference between control points versus checkpoints is only in their use, not in their collection: control points are used in the initial georeferencing process and checkpoints are used only in the assessment check.

Photogrammetric targets

What is a photogrammetry target?

A photogrammetry target is something that can be easily identified on the aerial photos and that is preferably



VISUALISATION technical

Fig. 4: Hypothetical distribution of sample points. (Modified from Congalton and Green, 2009.)

Fig. 6: Optimal checkpoint location 307. The survey checkpoint (green) and photo identified locations (red) are shown.

Fig. 5: Precision and accuracy.

Fig. 7: Optimal checkpoint location 311. The survey checkpoint (green) and photo identified locations (red) are shown.

sample points should be chosen. The optimal sample design is obtained by first deciding the number of survey points needed for the area. The second step is to divide the area of interest into four quadrants and to determine the number of survey points in each quadrant, making sure that no more than 20% of the survey points come from one quadrant. After deciding on the number of survey points per quadrant, the next step is to select optimal sample sites with all points spaced at an appropriate distance from each other (see Fig. 4).

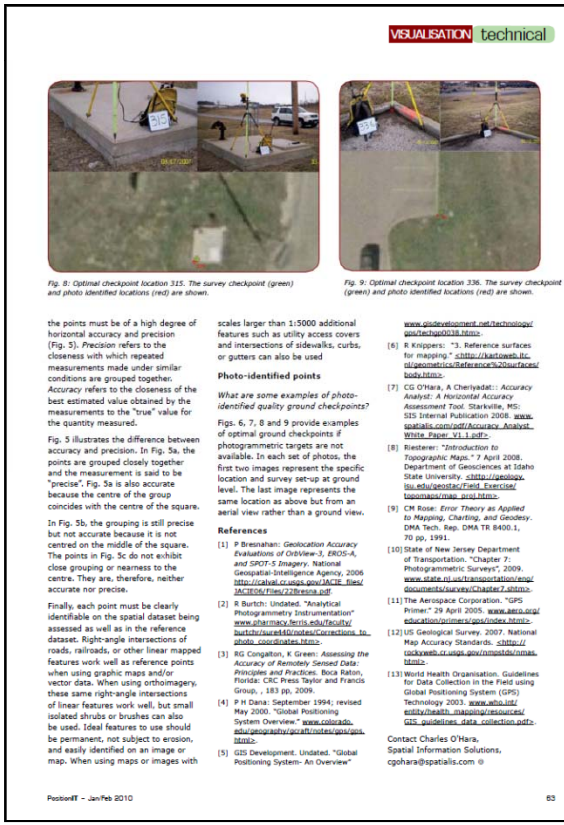
The samples may be distributed more densely in the vicinity of important topographic features and more sparsely in the areas of little or no interest. Keeping this in mind, no two points should be closer than the diagonal of the area of interest divided by ten. Points should be located where shadows will not adversely affect the visibility of the panel.

Furthermore, they should only be located at ground level and not on the rooftops of buildings.

What if photogrammetric targets are not available?

If targets are unavailable and/ or conducting an aerial survey using targets is not an option then it is possible to identify points on pre-existing aerial photos. This method is less accurate than using standard photogrammetric targets; however, it is used because it is less expensive. Nonetheless, utilising photogrammetric targets is the most accurate and precise method.

There are several factors that need to be considered when collecting quality ground checkpoints without using photogrammetric targets. First of all, the points must be well-defined and represent a specific feature. Secondly,



VISUALISATION technical

Fig. 8: Optimal checkpoint location 315. The survey checkpoint (green) and photo identified locations (red) are shown.

Fig. 9: Optimal checkpoint location 336. The survey checkpoint (green) and photo identified locations (red) are shown.

the points must be of a high degree of horizontal accuracy and precision (Fig. 5). *Precision* refers to the closeness with which repeated measurements made under similar conditions are grouped together. *Accuracy* refers to the closeness of the best estimated value obtained by the measurements to the "true" value for the quantity measured.

Fig. 5 illustrates the difference between accuracy and precision. In Fig. 5a, the points are grouped closely together and the measurement is said to be "precise". Fig. 5a is also accurate because the centre of the group coincides with the centre of the square.

In Fig. 5b, the grouping is still precise but not accurate because it is not centred on the middle of the square. The points in Fig. 5c do not exhibit close grouping or nearness to the centre. They are, therefore, neither accurate nor precise.

Finally, each point must be clearly identifiable on the spatial dataset being assessed as well as in the reference dataset. Right-angle intersections of roads, railroads, or other linear mapped features work well as reference points when using graphic maps and/or vector data. When using orthoimagery, these same right-angle intersections of linear features work well, but small isolated shrubs or brushes can also be used. Ideal features to use should be permanent, not subject to erosion, and easily identified on an image or map. When using maps or images with scales larger than 1:5000 additional features such as utility access covers and intersections of sidewalks, curbs, or gutters can also be used

Photo-identified points

What are some examples of photo-identified quality ground checkpoints?

Figs. 6, 7, 8 and 9 provide examples of optimal ground checkpoints if photogrammetric targets are not available. In each set of photos, the first two images represent the specific location and survey set-up at ground level. The last image represents the same location as above but from an aerial view rather than a ground view.

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PhotoBook allows rapid and assured ID of photo locations that match checkpoints.

- Automatically load photos and sketches for checkpoints.
- Improve analysis efficiency and eliminate doubts.
- Incorporate PhotoBook contents in report output.
- Deliver validated results that eliminate uncertainty.

PhotoBook

Guides the Analyst!

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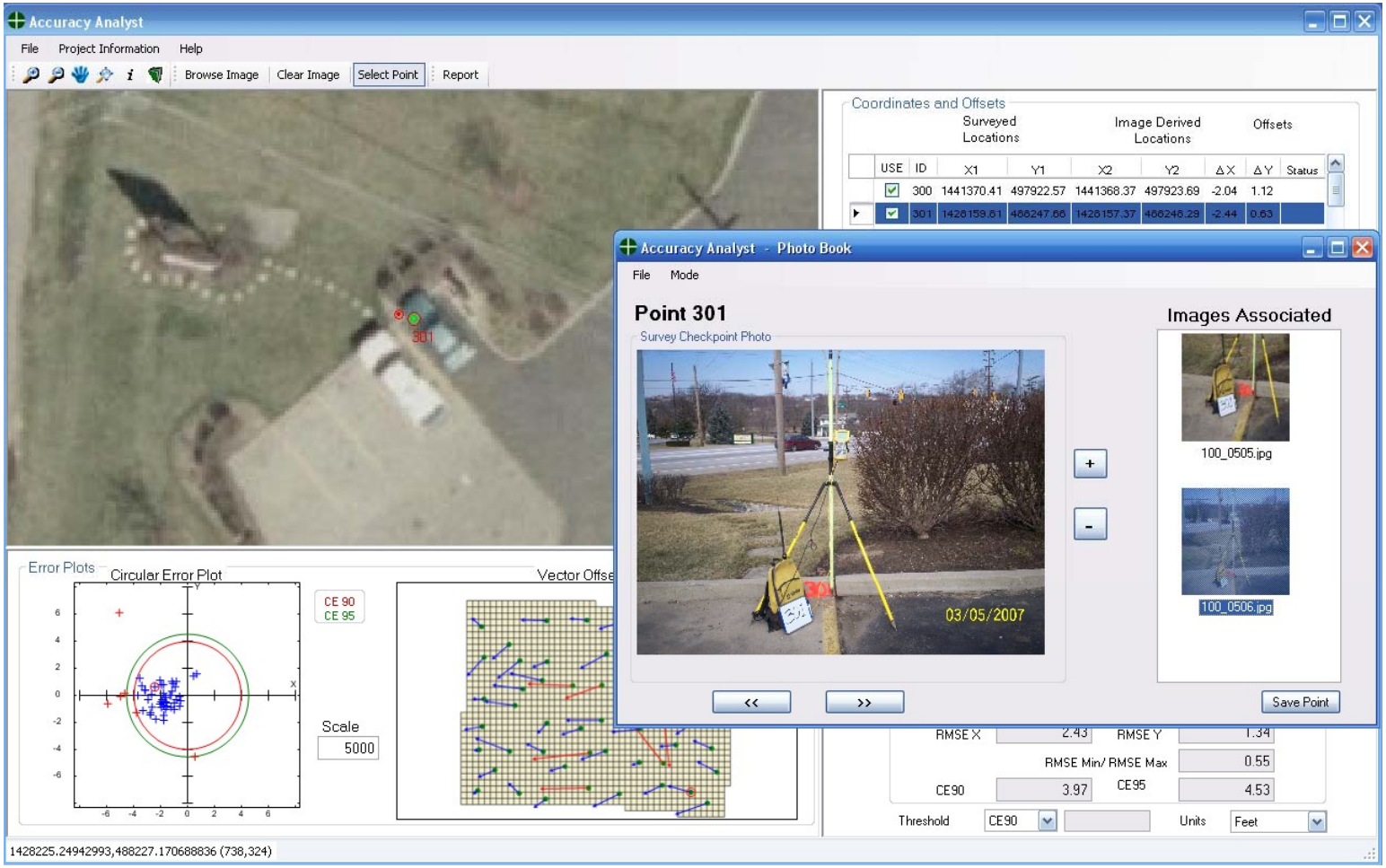
Accuracy Analyst™

New Feature: PhotoBook Guides the Analyst



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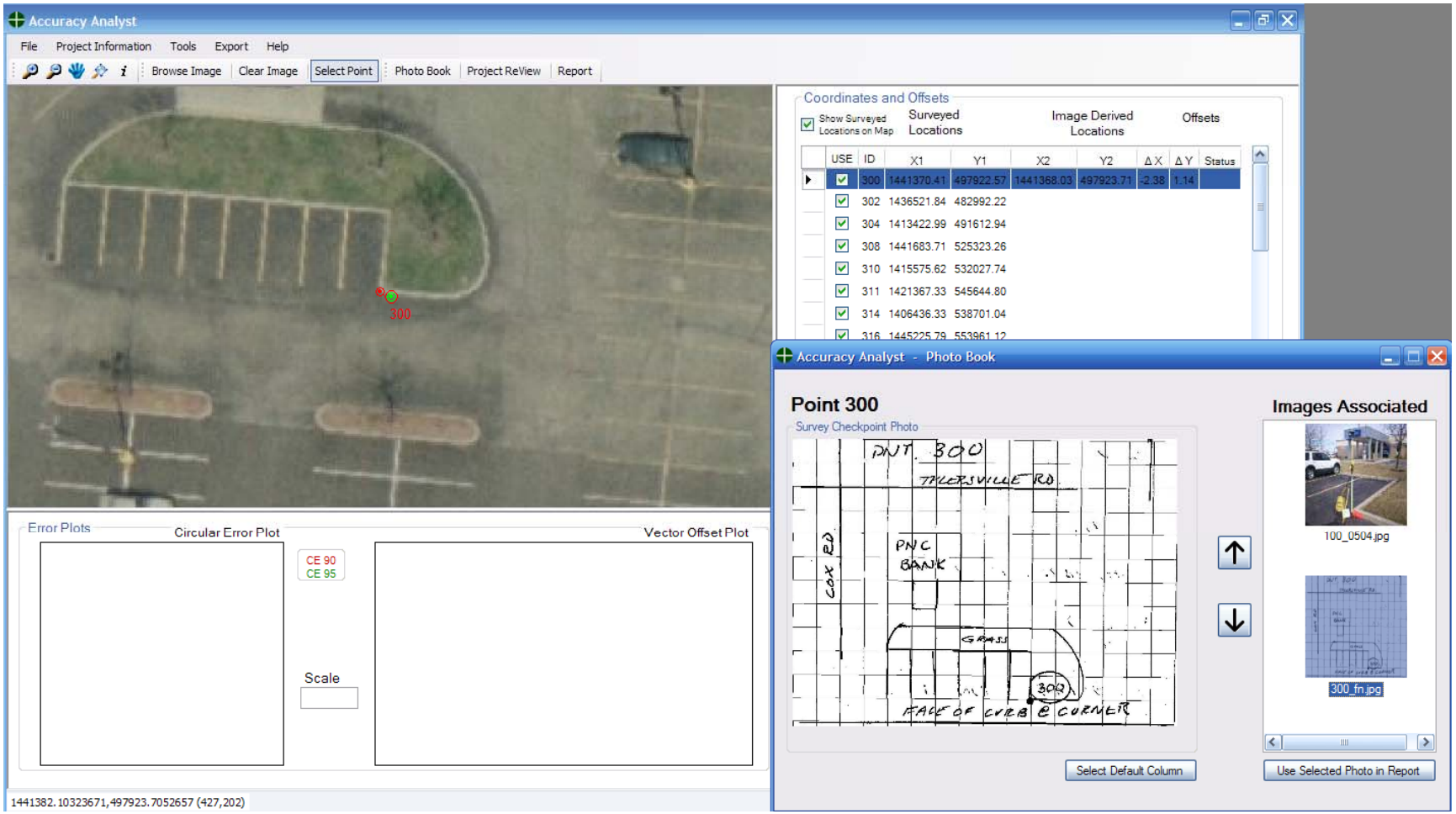
New Feature: PhotoBook

Multiple Photos & Sketches



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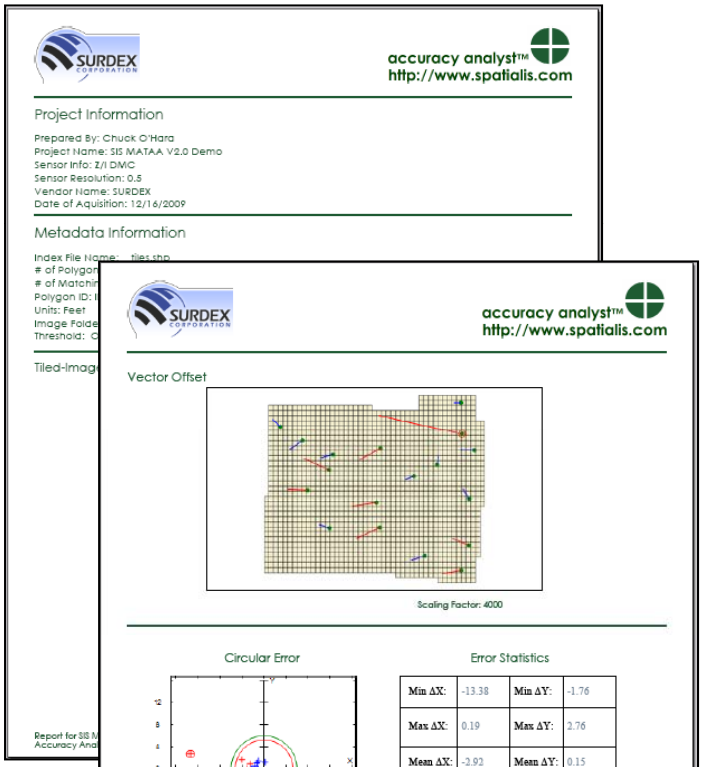
New Feature: PhotoBook

Enhances Reports w/ Photos



Producing, delivering, and reviewing image data is complex and lacks tools and methods.

- Review production data and identify problems.
- Documentation data product QA.
- Provide tools and methods for full accuracy review.
- Provide standard methods for image review and markup.
- Ensure easy data review, feedback, and acceptance.
- Readily differentiate the quality of data products.

ReViewer

Easy Methods to Deliver, Review, and Accept Data!

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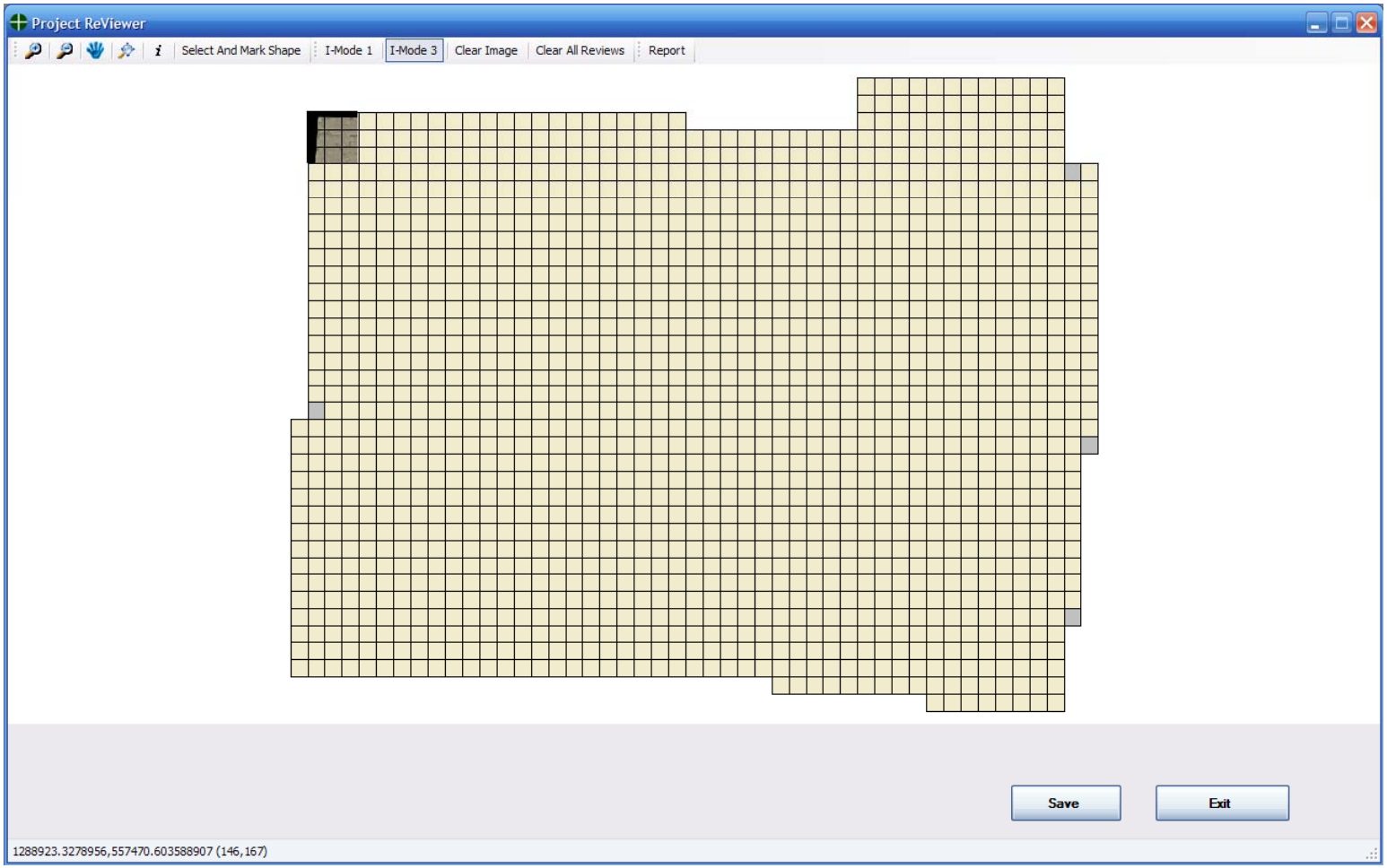
New Feature: ReViewer

Easy Image Viewing Modes



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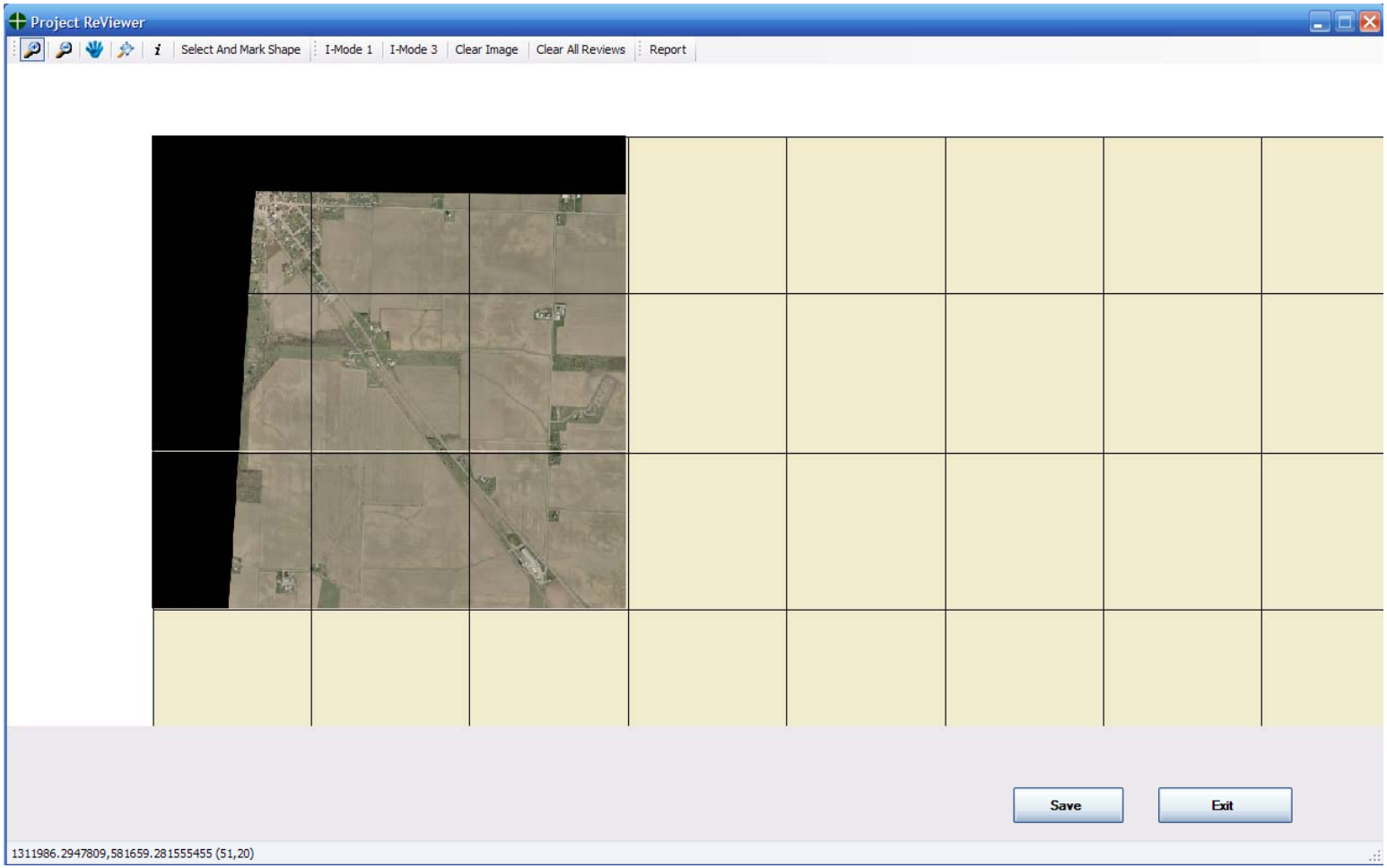
New Feature: ReViewer

Fast Image Handling



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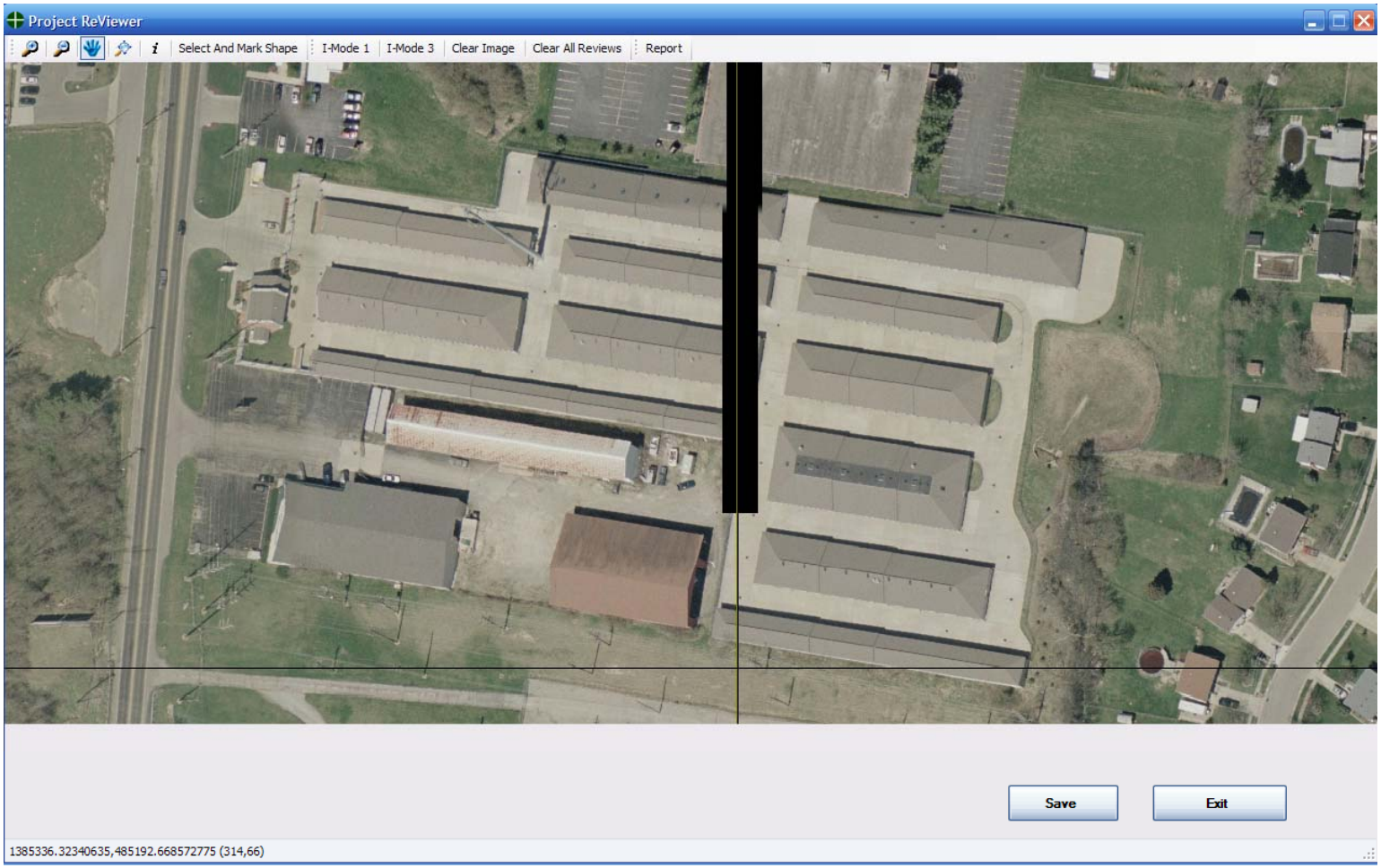
New Feature: ReViewer

Identify Image Problems



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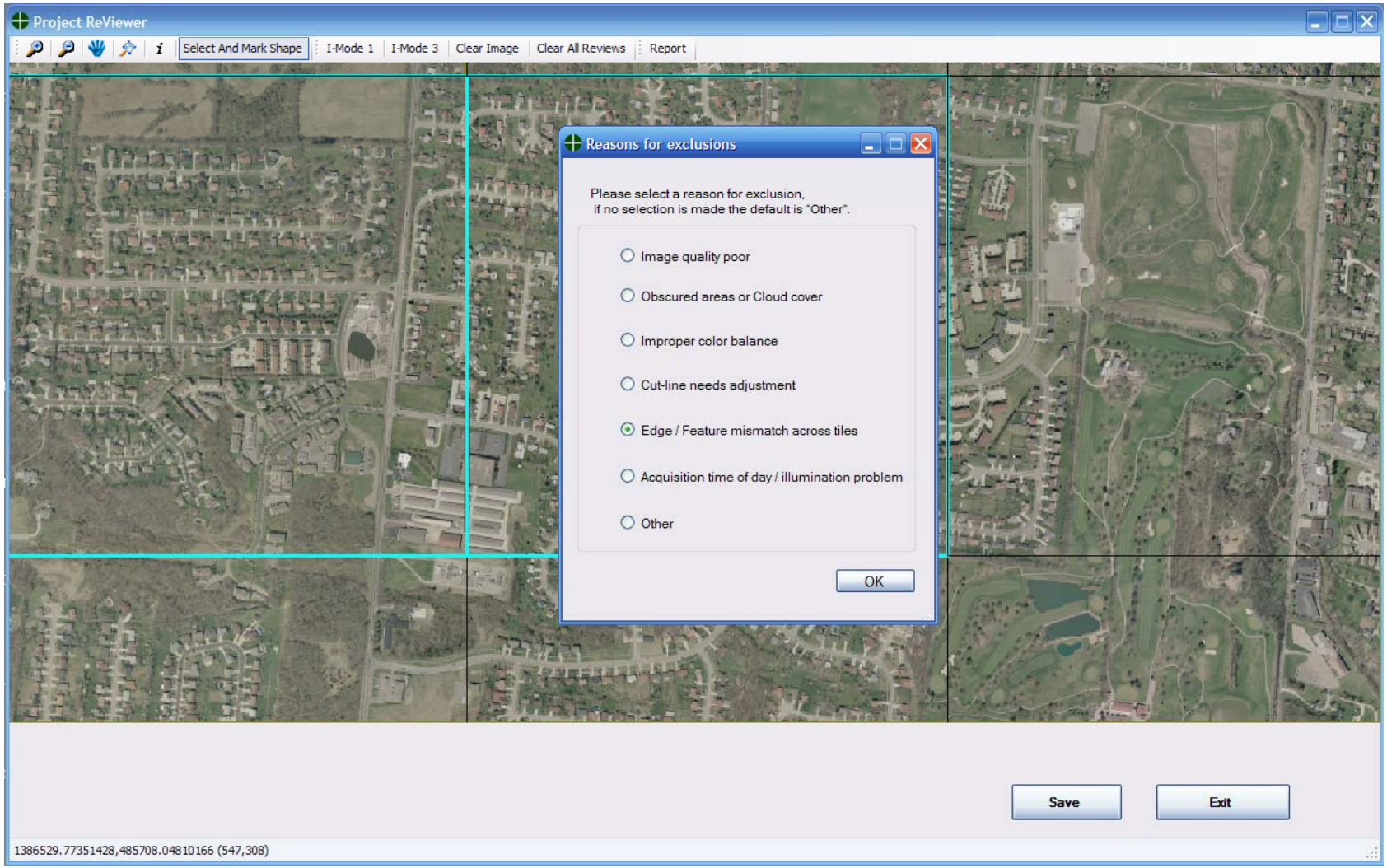
New Feature: ReViewer

Select and Mark-Up Data



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New Feature: ReViewer

Easy Feedback Reporting

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ReViewer Report

Prepared By: Chuck O'Hara
Project Name: SIS MATAA V2.0 Demo
Sensor Info: Z/I DMC
Sensor Resolution: 0.5
Vendor Name: SURDEX
Date of Aquisition: 12/16/2009

Metadata Information

Index File Name: tiles_rev.shp
# of Polygons: 1550
# of Accepted Images: 1517
# of UnReviewed Images: 0
# of For Review Images: 29
# of Absent Images: 4

Tiled-Image Area

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Image Review: Images Up For Review

	Shape Index	Image Name	Reason For Review
1)	94	13824847.tif	Edge / Feature mismatch across tiles
2)	95	13854847.tif	Edge / Feature mismatch across tiles
3)	618	14425177.tif	Cut-line needs adjustment
4)	619	14455177.tif	Cut-line needs adjustment
5)	664	14425207.tif	Cut-line needs adjustment
6)	665	14455207.tif	Cut-line needs adjustment
7)	711	14425237.tif	Cut-line needs adjustment
8)	712	14455237.tif	Cut-line needs adjustment
9)	713	14485237.tif	Cut-line needs adjustment
10)	715	13165267.tif	Cut-line needs adjustment
11)	760	13135297.tif	Cut-line needs adjustment
12)	761	13165297.tif	Cut-line needs adjustment
13)	806	13135327.tif	Cut-line needs adjustment
14)	852	13135357.tif	Cut-line needs adjustment
15)	898	13135387.tif	Cut-line needs adjustment
16)	944	13135417.tif	Cut-line needs adjustment
17)	990	13135447.tif	Cut-line needs adjustment
18)	1036	13135477.tif	Cut-line needs adjustment
19)	1082	13135507.tif	Cut-line needs adjustment
20)	1128	13135537.tif	Cut-line needs adjustment
21)	1174	13135567.tif	Cut-line needs adjustment

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Extends Workflow Support

- Efficiently plan, verify, deliver, and review large data sets.
- Standards-based absolute geolocational accuracy evaluations (NSSDA CE95).
- Self-documenting accuracy verification and quality assurance.
- Shared analytics - workflow and results for accuracy and QA.
- Plan checkpoint collections with **CheckPoint Planner**.
- Integrate use of field collected photos in **PhotoBook**.
- Enhance production, delivery, and acceptance with **ReViewer**.

Accuracy Analyst™ 2.0

Digital Map Data – Delivered and Used with Confidence!

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DEMO

Ohio – Disputed 6” Data Set
USGS Sioux Falls, Z/I DMC 3” Data Set

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