

Product Version: 3.0.1

# ScanIMAGER

Professional



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## 1. Overview

**ScanIMAGER** enables processing of 3D laser scan data. The software includes tools for processing point clouds obtained using various 3D laser scanning systems. The unique feature of the software is the capability to visualize a large amount of measurements as well as display the color of a measured point, which enables you to work with discrete data as a 3D model.

Main features of the software are:

- Upload scans containing billions of points (the number of files being uploaded simultaneously is restricted by the PC computing capacity)
- Align (register) scans in a single coordinate system
- Color point clouds using a set of digital images
- Generate orthophotomaps reproduced on defined planes
- Create planar views of convoluted surfaces
- Take measurements using scans
- Obtain object sections
- Obtain part sections
- Cut out fragments
- Calculate areas and volumes
- Export data to various formats (PTX, DXF, TXT)

**ScanIMAGER** has been developed by **Photogrammetria**, a Russian research and production company based in St. Petersburg, since 2006 and is undergoing dynamic advancement now. The software has multiple editions. This manual describes **Professional** edition, which includes the widest set of features. Features that are unavailable in lower-level editions are marked with comments in brackets. For more information on **ScanIMAGER** and Photogrammetria, please visit our websites: [www.scanimager.ru](http://www.scanimager.ru) and [www.photogrammetria.ru](http://www.photogrammetria.ru).

## 2. Installation and Setup

The software can be installed by running the installation file setup.exe that can be found on the installation CD or in the downloaded copy in the directory with the same name. Follow Installation Wizard instructions during installation. Please note: The software logs file operation history when working with scan data. Therefore, sufficient available disk space is required on the drive where the software is installed.

## 3. PC Requirements

Recommended configuration for working with the software is as follows:

- Processor: Pentium Intel Core 2 Duo 2GHz or higher
- RAM: 2 GB or more
- Video card: based on mid-level nVidia or ATI Radeon chipsets
- Additional requirements: network board (for network version)

## 4. Operational Systems

**ScanIMAGER** works in systems running Microsoft Windows XP, Microsoft Windows Vista, Windows 7, and Windows 8. Separate copies are available for 32-bit and 64-bit versions.

## 5. Definitions

**Point cloud (scan)** is a graphic representation of a set of geometric objects each of which is represented by three space coordinates (X, Y, Z) and optical density.

**Orthophotomap** is a raster image obtained by means of orthogonal projection of scan points onto the defined plane. Besides horizontal coordinates, an orthophotomap also contains data on the inner distance for each point.

**Planar view of a scan** is a raster image obtained by projecting scan points onto the cylinder surface taking into account coordinates of the scan point.

**Project** is a file containing a working set of scans.

**Scan registration** is a process of aligning all scans into a single coordinate and height system selected by the user.

## 6. Working with ScanIMAGER

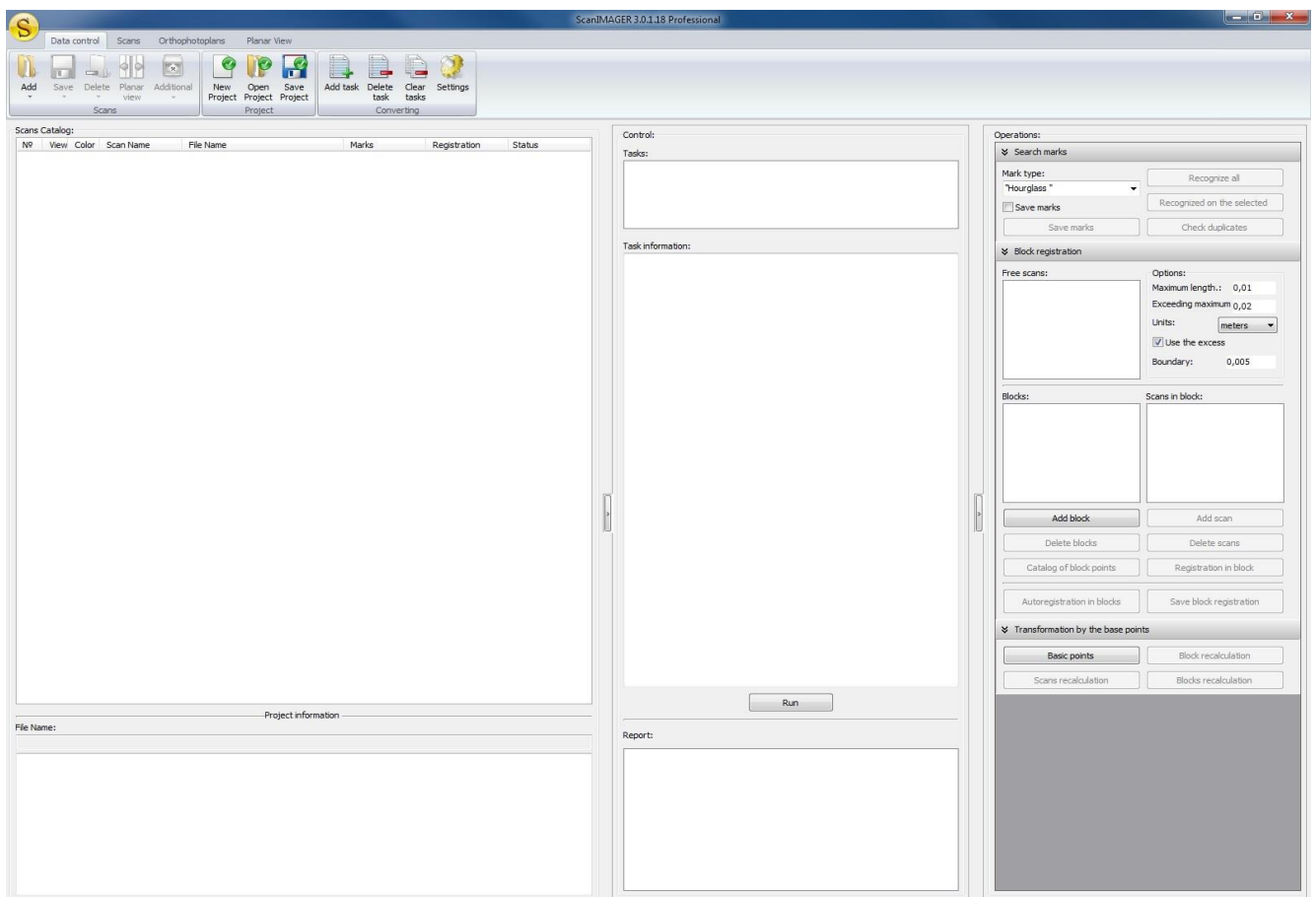
### 6.1. General

The software structure allows to work with data of different types (scans, orthophotomaps, planar views) in different modules within a single coordinate space. Each module's functionality deals with a specific type of data and is represented in separate software tabs.

### 6.2. Data Control Tab

Data Control tab contains three modules:

- [Scan Manager module](#)
- [Converting module](#)
- [Registration module](#)



### 6.3. Data Control Tab Ribbon

#### 6.3.1. Scans

**Add** — Adds scan files to the catalog.

**Save** — Saves changes to the current scan.

**Save All** — Saves changes to all scans.

[Planar view](#) — Creates a planar view of scans.

**Additional > Reset Registration** — Deletes registration of the selected scans.

### 6.3.2. *Project*

**New Project** — Creates a new project file.

**Open Project** — Opens a saved project.

**Save Project** — Saves changes to a project.

### 6.3.3. *Converting*

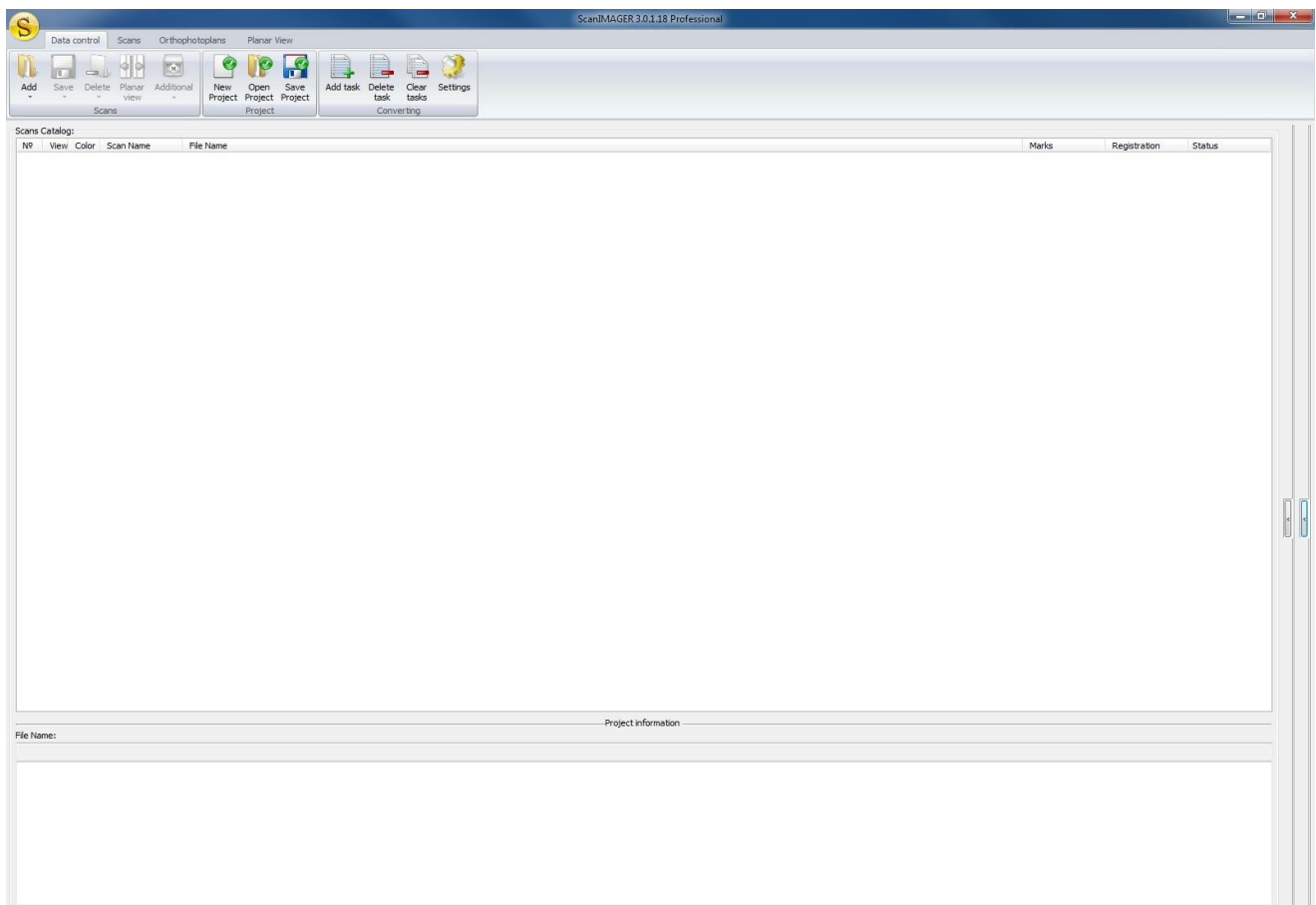
**Add task** — Adds a conversion task.

**Delete task** — Deletes a selected task.

**Clear tasks** — Deletes all tasks.

[Settings](#) — Opens Settings window for conversion.


## 6.4. Scan Manager module





Scans Catalog section displays the list of uploaded SPF files. Information on the number or marks measured, registration and status is displayed for each scan.

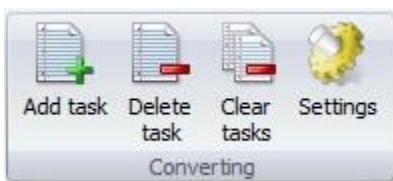
To show/hide a scan, click  in the **View** column.

To set the color for scan points, click  in the **Color** column. Choose black to reset the selected color.

**Project information** section displays information on the project. A software project is a working set of scans. It is not necessary to create a project before starting the work, you can create and save it after forming the scan set as well.

## 6.5. Converting Module

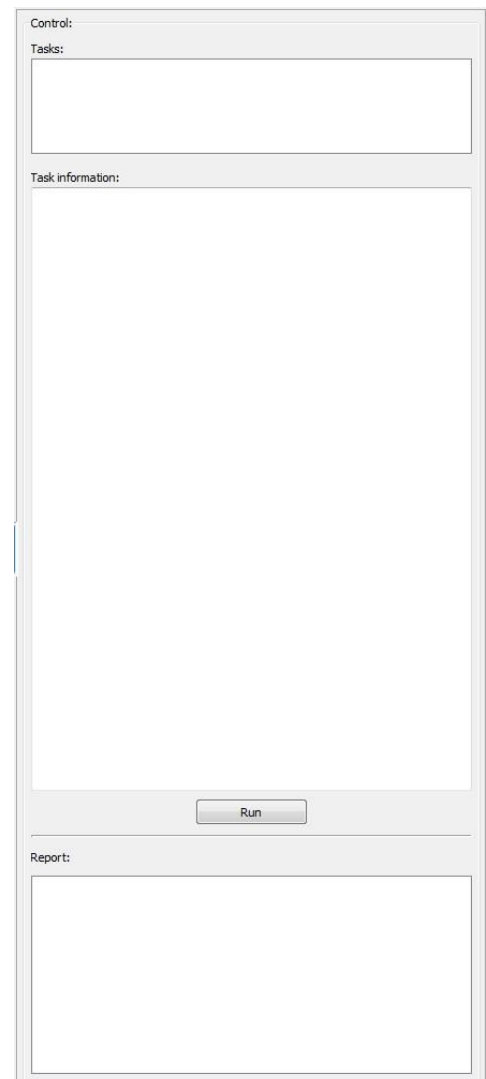
Converting module allows to convert point catalog files from exchange formats into the internal SPF format. To begin the converting, you need to create a converting task. Converting tasks are managed from **Converting** ribbon section.

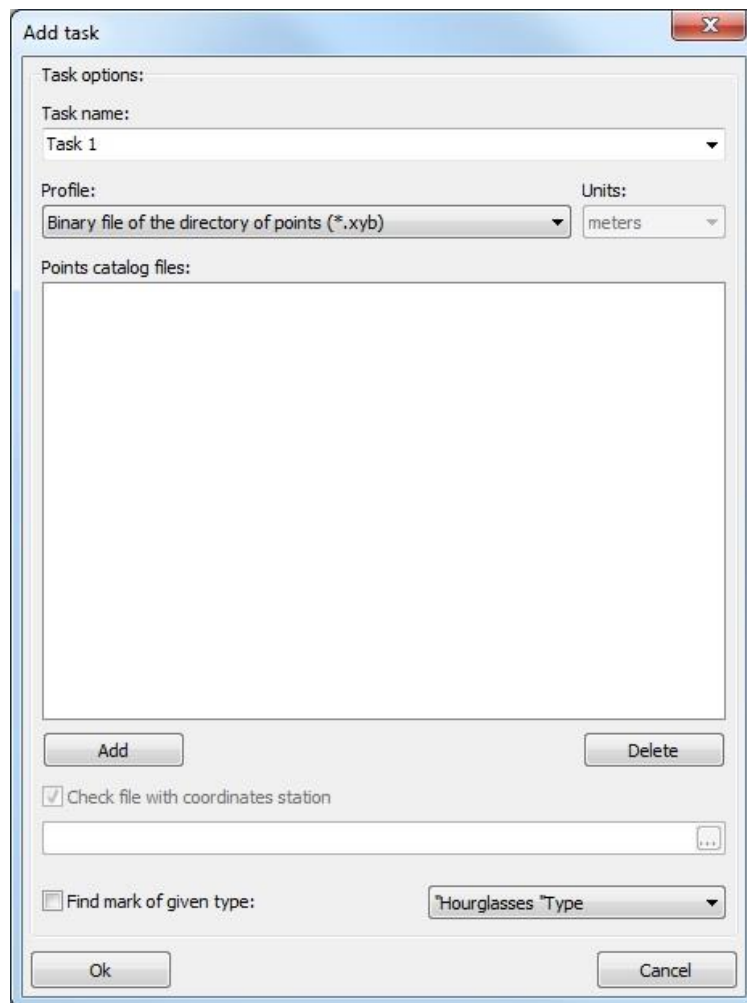


### 6.5.1. Creating a New Task

**Add task** button opens **Add task** dialog box.

Name for the task is entered in the **Task name** field. You can set a profile corresponding to the file format that needs to be converted in the **Profile** field. **Units** field allows to set units of measure for the file data. Click **Add** and select the necessary files to add files containing a set of points to the package. File must have the same format and correspond to the profile selected. In order to delete the files, select them in the list (multiple choice is allowed) and click **Delete** (or press the **Delete** key).

The image shows a control panel for the converting module. It has a 'Control:' section with a 'Tasks:' list box. Below that is a 'Task information:' section with a large text area. At the bottom of the 'Task information' section is a 'Run' button. Below the 'Task information' section is a 'Report:' section with a text area.



If the file being converted only contains points from one station and the station coordinates are known, these can be written in a **.pos** file with the same name in order **X, Y, Z**. During converting, the station coordinates will be read automatically from the created file and saved in **SPF** format for future use by some functions. If there is no file with station coordinates, clear the **Check file with coordinates station** checkbox. If the work was done using Faro Focus 3D scanner, you can use the registration report file instead of .pos files. Registration report file can be uploaded by clicking "...".

**NOTE:** In case of working with Faro Focus 3D using the **Binary file of the directory of points (\*.xyb)** profile provides the best technological benefits.

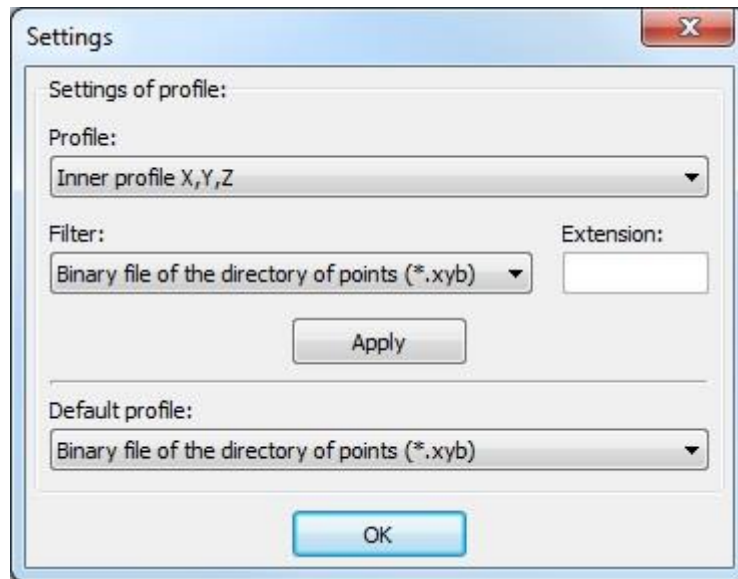
Hourglasses type marks can be recognized automatically during converting. To do this, you should enable the **Find mark of given type** option.

### 6.5.2. Editing a Task

To edit a task, double-click it in the **Tasks** list of the **Converting** module. The **Edit Task** dialog box will open which is similar to the **Add task** dialog box.

### 6.5.3. Converting Settings

The **Settings** button in the **Converting** section opens the **Settings** dialog box.



In this window you can specify one of existing file extensions or create a custom extension for each profile. The default profile that will be used for newly created tasks can be set in the **Default profile** field.

Click **Run** to start the converting process.

## 6.6. Registration Module

Registration module is used for registering (aligning) scans into a single coordinate system both manually and automatically. Recognized common marks or measured points are necessary for registration. Scans being registered must have at least three common marks/points for successful registration.

### 6.6.1. Searching for Marks

If marks were not recognized during converting, they can be measured manually on a flat view of a scan or automatically.

For automatic recognition of marks on all scans click **Recognize all** in the **Search marks** section. To recognize marks on a single scan, you need to select the desired scan in the **Scans Catalog** section and click **Recognized on the selected**.

Check **Save marks** to save marks to the hard drive automatically. The **Check duplicates** button is used to check whether the same mark is recognized twice.

Operations:

Search marks

Mark type: "Hourglass"

Recognize all

Recognized on the selected

Save marks

Check duplicates

Block registration

Free scans:

Options:

Maximum length.: 0,01

Exceeding maximum 0,02

Units: meters

Use the excess

Boundary: 0,005

Blocks:

Scans in block:

Add block

Add scan

Delete blocks

Delete scans

Catalog of block points

Registration in block

Autoregistration in blocks

Save block registration

Transformation by the base points

Basic points

Block recalculation

Scans recalculation

Blocks recalculation

### 6.6.2. Block Registration

Registering scans in a block allows for precise scan alignment into a local coordinate system of the first scan.

Prior to registration, you must set tolerances for distance and relative altitude in the **Options** section so that corresponding marks are automatically defined in the desired units. The **Boundary** field contains the precision boundary. Values that are out of the boundary will be marked red.

To register scans in a block, click **Add block** and enter the block name in the appearing dialog box. Then click **Add scan** and select the first scan from the appearing list to form a preliminary catalog for block points. The **Catalog of block points** dialog box will appear with block mark coordinates identical to mark coordinates of the first scan.

Select scan

Scan list:

Et\_0\_028

Et\_0\_029

Et\_0\_030

Et\_0\_031

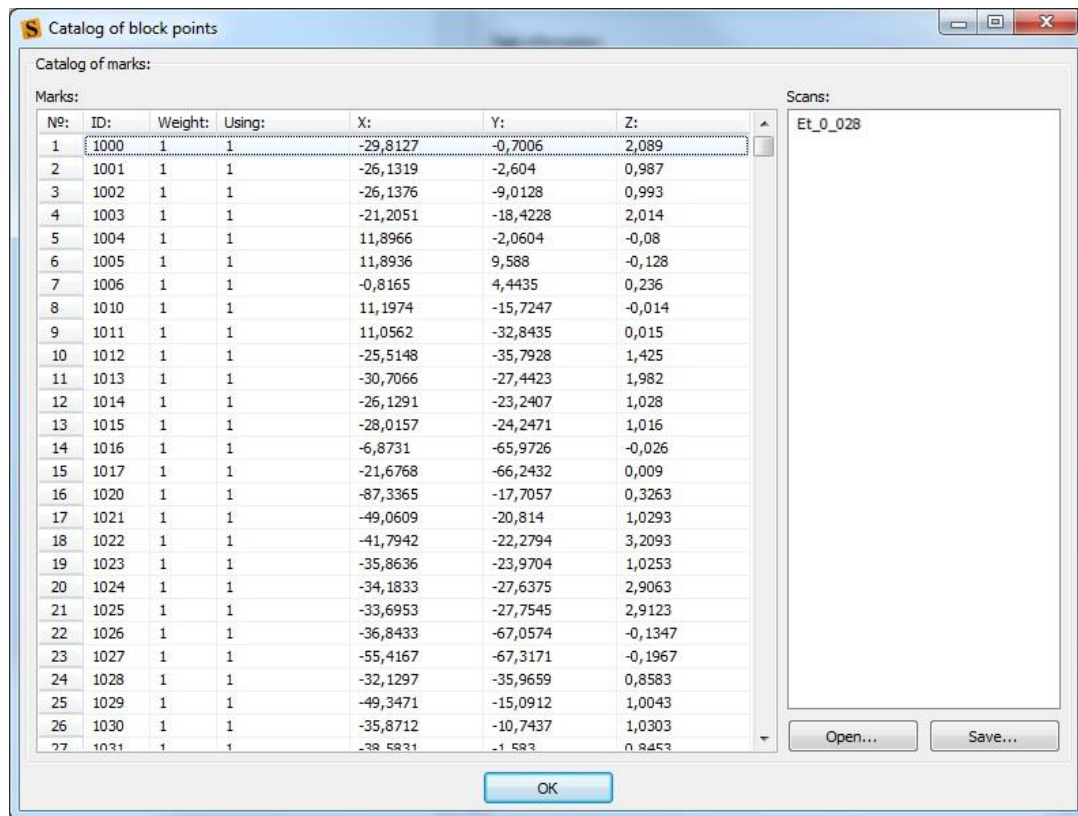
Et\_0\_032

Et\_0\_033

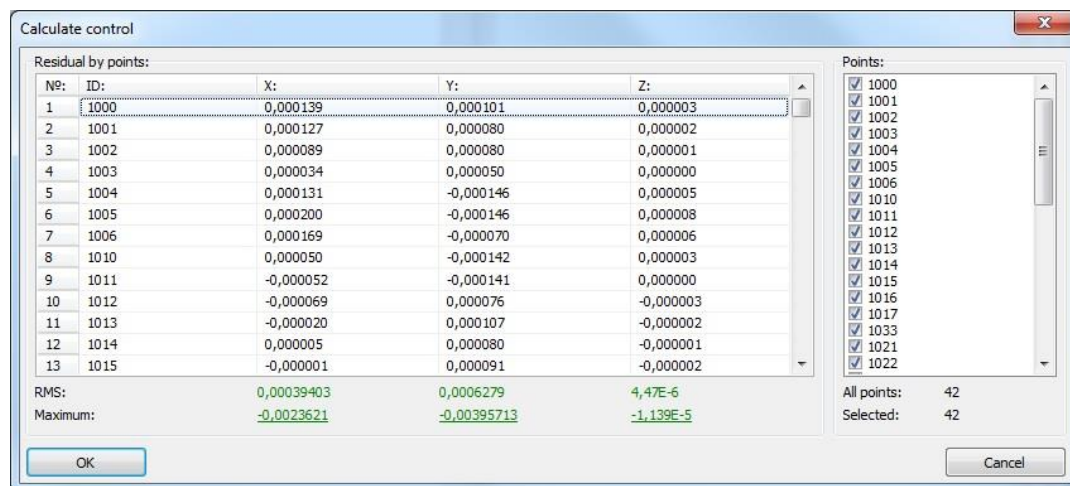
Et\_0\_034

Et\_0\_035

OK



Then add scans as you go. After adding a new scan, the **Calculate control** dialog box will open.



The **Residual by points** section contains residual errors for each point in units specified in the **Options** section of the **Block registration** scroll. If RMS and Maximum values fall within the tolerance, they appear in green, otherwise in red. Click the maximum value to move to the point with the maximum value in a coordinate. You can uncheck the point in the **Points** section to exclude it from calculation.

If the **Calculate control** window is not displayed after adding a scan, it means that the software has not found three or more common marks between the block point catalog and the scan being added.

After adding all scans to the block, click **Registration in block**. The **Registration** dialog box will appear with a table of data for each point in the block with residual error for each scan and maximum values.

**S Registration**

Georeference information

Nr:	ID:	Block1	Block2	Block3
1	1000	0,000172	0,000172	0,000172
2	1001	0,00015	0,00015	0,00015
3	1002	0,00012	0,00012	0,00012
4	1003	6E-5	6E-5	6E-5
5	1004	0,000196	0,000196	0,000196
6	1005	0,000247	0,000247	0,000247
7	1006	0,000183	0,000183	0,000183
8	1010	0,00015	0,00015	0,00015
9	1011	0,00015	0,00015	0,00015
10	1012	0,000103	0,000103	0,000103
11	1013	0,000109	0,000109	0,000109
12	1014	8E-5	8E-5	8E-5
13	1015	9,1E-5	9,1E-5	9,1E-5
14	1016	0,000251	0,000251	0,000251
15	1017	0,000256	0,000256	0,000256
16	1020	-	-	-
17	1021	0,000217	0,000217	0,000217
18	1022	0,000173	0,000173	0,000173
19	1023	0,000137	0,000137	0,000137
20	1024	0,000129	0,000129	0,000129
21	1025	0,000126	0,000126	0,000126
22	1026	0,000293	0,000293	0,000293
23	1027	0,000361	0,000361	0,000361
24	1028	0,000135	0,000135	0,000135
25	1029	0,000224	0,000224	0,000224
26	1030	0,000159	0,000159	0,000159
27	1031	0,000203	0,000203	0,000203
28	1032	0,000411	0,000411	0,000411

Admission:

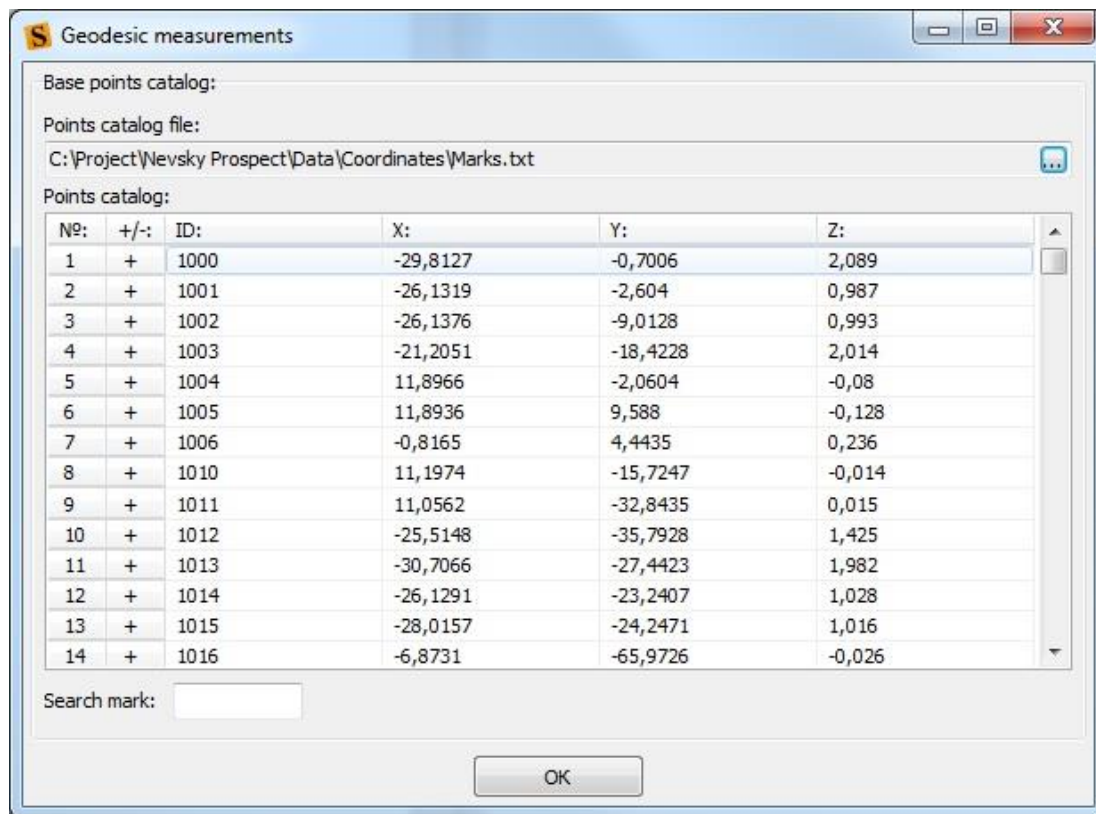
To delete a scan from the block, select the scan in the **Scans in block** list and press the **Delete** key. To delete a block, select the block in the **Blocks** list and press the **Delete** key.

**IMPORTANT!** All the block registration operations listed above can be automated. For automated registration simply click **Autoregistration in blocks**, after which all scans will be displayed in the **Registration** window with residual errors and maximum values. If the result of automated registration is unsatisfactory in terms of precision, registration should be done manually. For linking a scan block into the desired coordinate system, please refer to the next section.

### 6.6.3. Transformation by the Base Points



In order to position separate scans or blocks in a geodesic coordinate system, a base point catalog must be uploaded (in the right coordinate system). To do this, click **Basic points** in the **Transformation by the Base Points** scroll. The **Base points catalog** section of the **Geodesic measurements** dialog box will display base points with their IDs. To exclude a point from calculation, click the rectangle with “+” symbol in the “+/-:” column. The excluded point will be marked with “-”. To find a mark in the catalog, enter the name in the **Search mark** field and press **Enter**.



After uploading the points click one of the three buttons depending on the operation you want to perform:

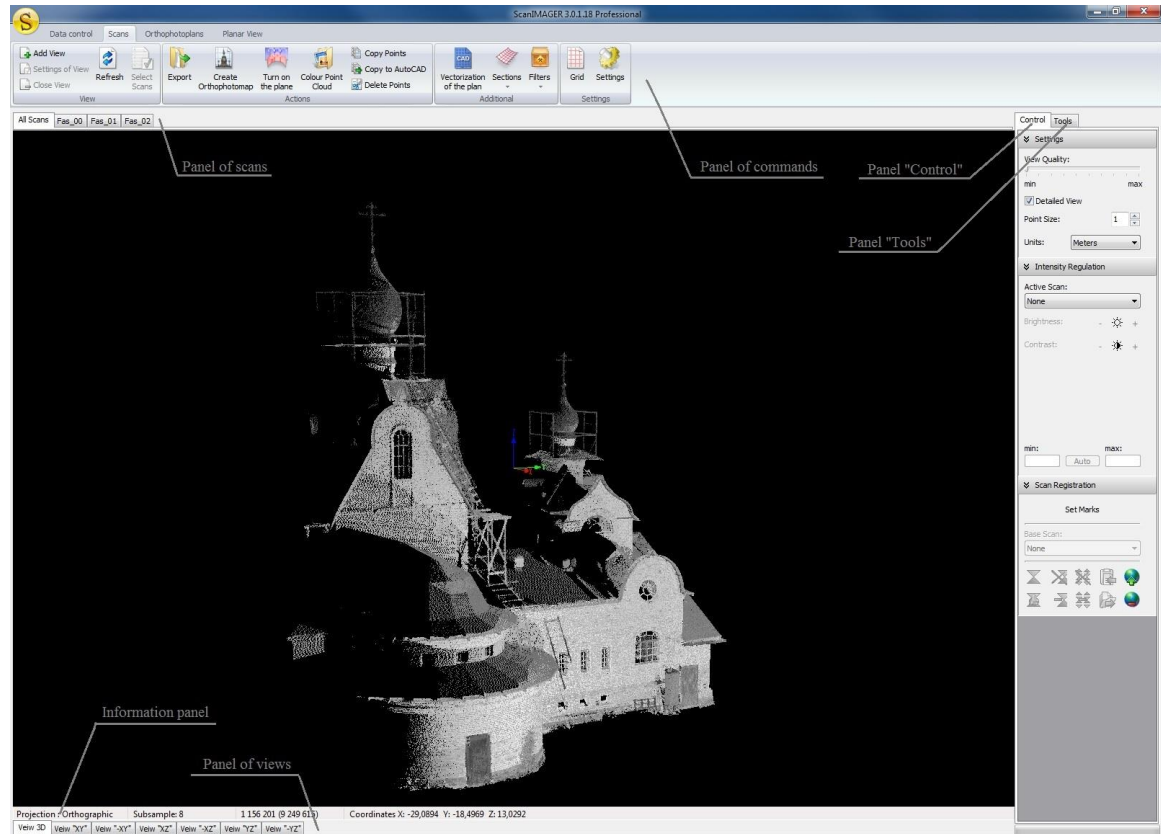
**Block recalculation** — Positions the current block selected in the **Blocks** list.

**Scans recalculation** — Positions all scans without forming blocks in a geodesic coordinate system. For this operation, each scan should contain at least 3 geodesically measured base points.

**Blocks recalculation** — Positions all formed blocks in a geodesic coordinate system.

## 6.7. Scans Tab

The Scans tab is used to visualize and process laser scanning data represented in a point cloud. Features are listed in a ribbon and in the **Control** and **Tools** panels.



## 6.8. Scans Tab Ribbon

### 6.8.1. View Section

**Add View** — Creates a new view.

**Settings of View** — Configures current view (this feature is not available for standard views created by default, except for 3D view).

**Close View** — Closes current view (this feature is not available for standard views created by default).

**Refresh** — enforces screen redraw (the same can be done by pressing F5).

### 6.8.2. Actions Section

**Export** — Allows to export data to different exchange formats. **Create Orthophotomap** — Creates an orthophotomap and opens the ORTHO module.



[Turn on the plane](#) — Creates a planar view of convoluted objects (available in **Standard** and **Professional** editions).

[Colour Point Cloud](#) — Colors the point cloud based on a set of aligned digital images (available in **Professional** edition).

**Copy Points** — Creates a separate virtual scan and copies points within the selected region to it.

**Copy to AutoCAD** — Copies points within a [3D limit box](#) to AutoCAD system.

**Delete Points** — Deletes points within the [selected polygon](#).

### 6.8.3. Additional Section

[Create Sections](#) — Sets section parameters and starts the vectorization process (available in **Standard** and **Professional** editions).

[Correct Sections](#) — Corrects the created sections (available in **Standard** and **Professional** editions).

**Delete Sections** — Deletes the created sections.

[Filters > Scan Filtration](#) — Starts the process of scan filtering in order to reduce the noise (available in **Standard** and **Professional** editions).

### 6.8.4. Settings Section

[Grid](#) — Displays and sets the grid parameters in XY plane.

[Settings](#) — Opens the Settings window.

## 6.9. Control Panel

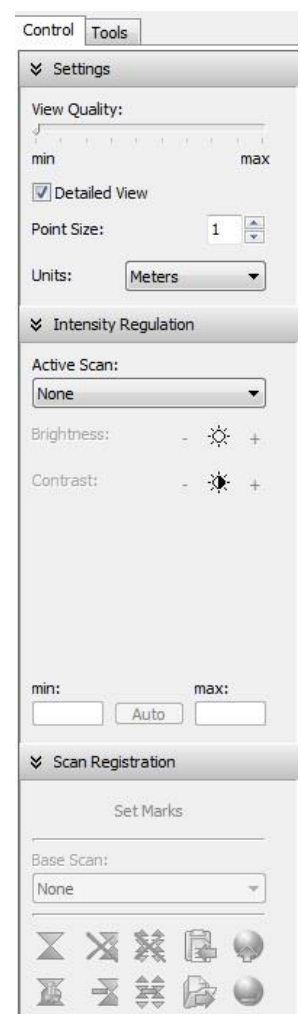
### 6.9.1. Settings

**View Quality** — This setting corresponds to the number of points displayed on the screen. The higher the quality, the more points will be displayed.

**Detailed View** — If this option is enabled, the display is redrawn after each action on the point cloud. If you work with a large amount of data, we recommend you to disable this option and use forced redraw by clicking **Refresh** in the **View** panel or pressing **F5**.

**Point Size** — The size of point in pixels.

**Units** — Units of measure in which point coordinates in the information panel are displayed. **These are also units in which points are exported!**



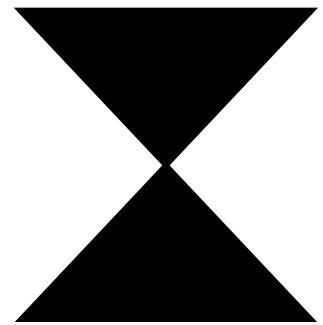
### 6.9.2. Intensity Regulation

Tools in this panel allow to adjust screen brightness and contrast (only for points that have reflected signal intensity rather than a real color obtained by coloration based on aligned images). Select the scan to which the settings will apply in the **Active Scan** field. The **Min** and **Max** fields are used for lower and upper limits of intensity range (0 to 10,000) respectively. Intensity within these limits is converted to grayscale (55 to 255). Increasing or decreasing brightness with “+” and “-” buttons shifts the range limits. Increasing or decreasing contrast with “+” and “-” buttons narrows or broadens the limits respectively. You can also set range limits explicitly.

### 6.9.3. Scan Registration

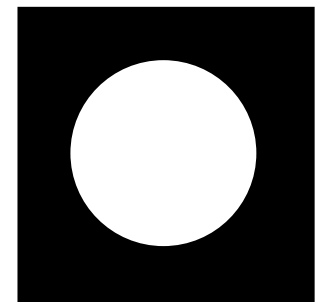
ScanIMAGER provides several scan registration methods: based on tacheometric survey data, relative to another scan and based on set parameters. The first two methods of scan alignment can be applied both to special marks and arbitrary points of the object being scanned.

Hourglass marks (ZF marks) are the most common in the field of laser scanning. This type of mark provides high precision both when determining its coordinates using a scan and during targeting in the process of tacheometric survey.



ZF mark

Photogrammetric marks are used for special tasks that require the algorithm developed by Photogrammetria experts. This type of mark provides high precision of measurements based both on scans and on digital images.




Photogrammetric mark

Spot point is an arbitrary mark, its coordinates are determined by averaging measurements that fall within the given area. This type of mark is useful to calculate projection rotation angle when creating an orthophotomap in case the object is not parallel to any of the standard views. It can also be used for scan alignment based on distinctive points of the object, i.e. window angles, but this way is less precise and more time-consuming and thus rarely used in practice.

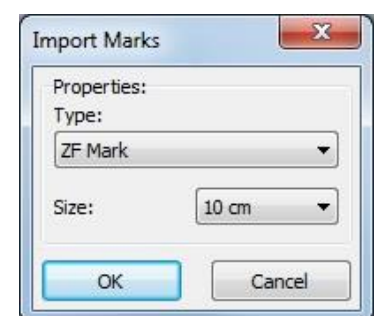
#### 6.9.3.1. Scan Registration Based on Tacheometric Survey Data

To register scans using tacheometric survey data:

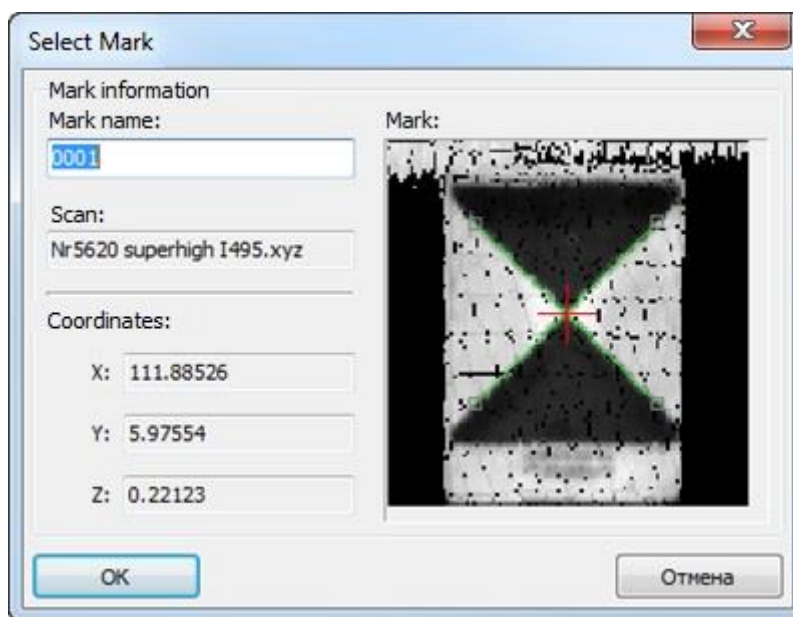
- Open the scans you want to register.

• Click  (**Import Mark Catalog**) in the **Scan Registration** panel. Select a file with mark coordinates in the appearing dialog box. This should be a TXT file consisting of four columns, the first column being the mark number and the second, the third and the fourth columns containing X, Y, and Z coordinates respectively.


- Select mark type and size in the **Import Marks** window.

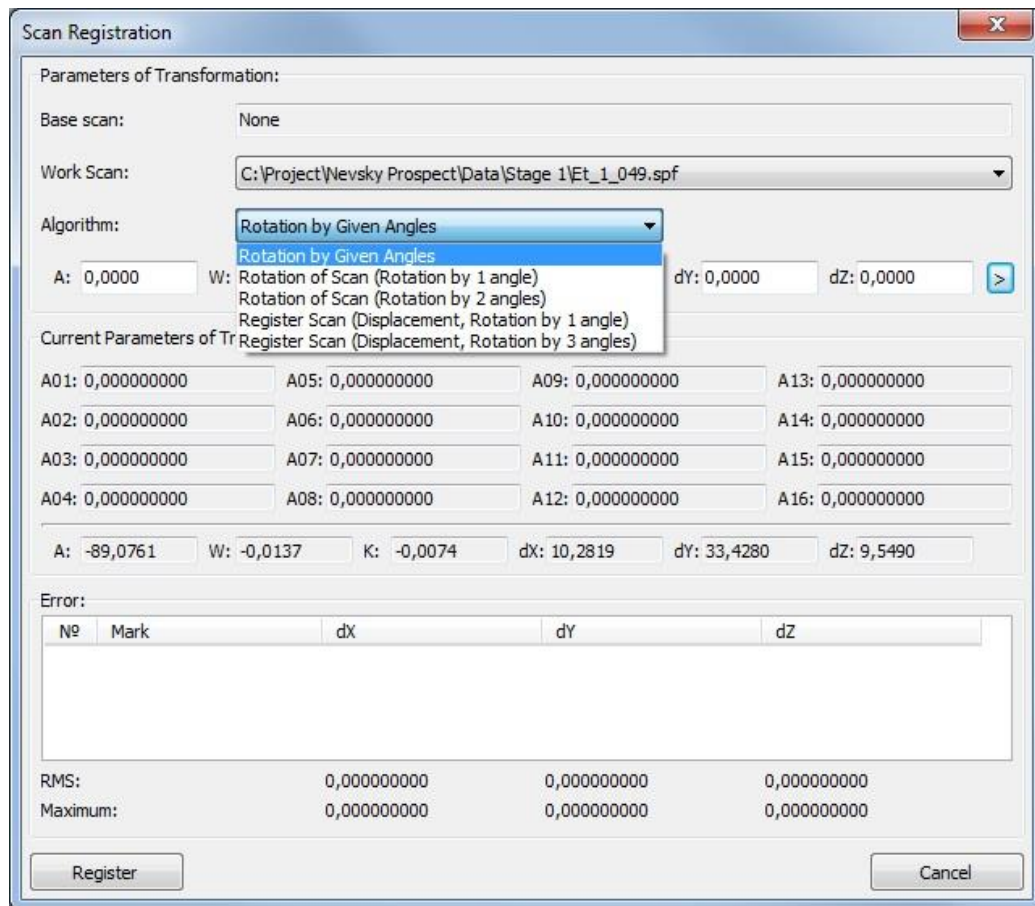


- Imported marks and their coordinates will be displayed in the **Catalog of Points**, and the **Geodata** status will change to **Measured**.
- Then specify the marks on the scan being registered. To do this:
  - Select the tab with the corresponding scan number in the **panel of scans**.
  - Select the mark being determined in the **Catalog of Points** and point it on the scan.
  - The **Select Mark** dialog box will appear. It will display mark number and coordinates as well as the name of the scan to which it belongs, and a graphic representation of the mark to control rough inaccuracies during measurements.



After confirming the measurement in the **Mark Catalog** in the column of the selected scan, the mark status will change to **Measured**. Follow the same procedure to point all other marks on each scan, after which registration can be performed.



- To register a scan, click  (**Scan Registration...**) in the **Scan Registration** panel. The **Scan Registration** dialog box will appear. Select the scan to register and specify the transformations to be performed during the registration. If the registration is related to a coordinate file, select **None** for Base scan.





Calculation RMS will be displayed at the bottom of the **Scan Registration** window. After you click **Register**, the main view will be refreshed and the status of the registered scan in the **Scan Manager** module will change to **CHANGED**. Click **Save changes** to save the registration.

#### 6.9.3.2. *Registration Relative to Another Scan*

To register a scan in relation to another (base) scan:

- Open the base scan and the scan to register.
- Select the base scan in the panel of scans and point marks on it. To do this, click  (Create mark) in the Tools panel. Specify the number, type and size of the mark in the dialog box. Then point the mark on the scan. Follow the same procedure to measure the other marks.
- After pointing all marks on the base scan, select the scan you want to register in the panel of scans.
- Point the created marks on the scan being registered.
- Select the base scan in the Scan Registration panel and click  (Scan Registration...). The rest of the procedure is identical to registration based on tacheometric survey data.

#### 6.9.3.3. Registration Based on Set Parameters

Registration based on set parameters is performed without using marks. This method is used in case transformation parameters are known. After clicking  (Scan Registration...) select Rotation By Given Angles in the appearing dialog box and enter their values manually. Then click  to calculate the transformation matrix. The rest of the procedure is identical to registration based on tacheometric survey data.

#### 6.9.3.4. Additional Tools



— **Delete Mark** — Deletes the selected mark.



— **Delete All Marks** — Deletes the whole mark catalog.



— **Delete Mark Measurement** — Only deletes the measured coordinates of the selected mark.



— **Delete Measurements of All Marks** — Only deletes the measured coordinates of all marks.



— **Default Mark Setting** — Opens the window for setting the parameters of the default mark.



— **Export Mark Catalog** — Exports the coordinates of the marks measured on the scan into a text file.








— **Reset Registration** — Deletes all registration data from the scan.

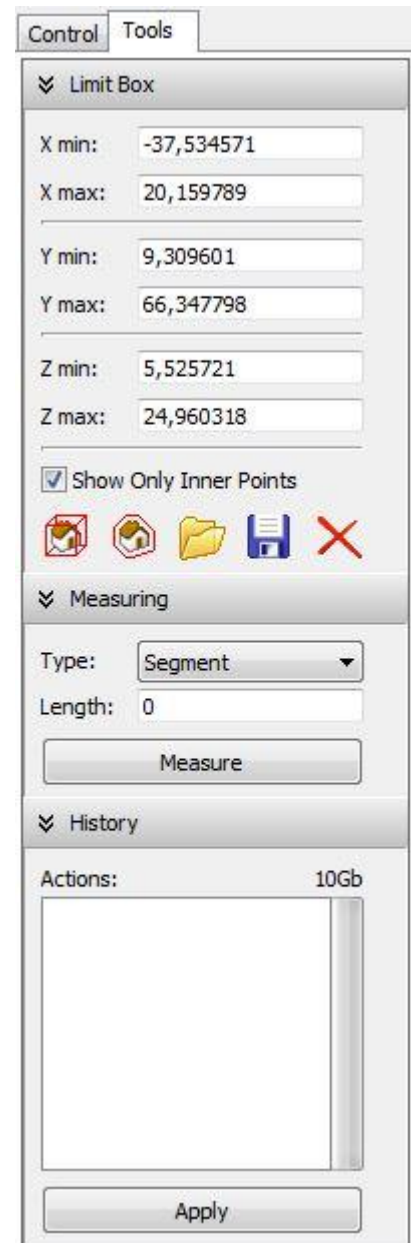
## 6.10. Tools Panel

### 6.10.1. Limit boxes

Tools in this panel allow to create 3D limit boxes and flat regions.

A **3D limit box** is used for limiting the scan to a desired 3D area. These restrictions affect point display (if **Show Only Inner Points** is enabled) and how points participate in different processes (cutting, export, creation of an orthophotomap, etc.). To create a 3D limit box, Click  (**Create Limit Box**) (limit box borders correspond to the scan borders by default). A 3D limit box can be set by entering direct values into the corresponding fields (**X min**, **X max**, **Y min**, **Y max**, **Z min**, **Z max**) or by moving the borders using the mouse in standard views (except for 3D view). You can save or upload a previously created limit box using the  (**Save Limit Box**) and  (**Open Limit Box**) buttons. Click  (**Delete Limit Box**) to delete the limit box.

A **region** allows to set an area (in the screen plane) of points that will be used for deletion and copying. To create a region, click  (**Create Region**) and draw it on the screen by adding vertices by means of left-clicking (if the **Projection** parameter of the current view was set to **Perspective**, it will change to **Orthographic**). Press **Escape** to cancel further vertex addition. Click Create Region again to delete a previously created region. Press **Escape** to cancel drawing of the region.



### 6.10.2. Measuring

The **Measuring** panel is used for measuring segments or paths between scan points. To measure a distance, select the **Type** of measurement (**Segment** or **Path**), click **Measure** and specify the scan points between which the distance needs to be measured. The result is displayed in the **Length** field.

### 6.10.3. History

**ScanIMAGER** includes a tool for registering and saving changes made to scans in an action history. The following actions on scans are logged:

- Point deletion

- Coloration
- Filtering
- Conversion (registration)

Each of the actions listed above is logged in the **Actions** list. To cancel one or more actions and return to a previous state, select the action you want to return to in the list and click **Apply**.

## 6.11. Main Features of Scans Tab

### 6.11.1. Add view

The **Add view** button in the **View** panel opens the **View** dialog box. To create a new view, enter the necessary parameters (see Section 6.11.2) and click **OK**.

### 6.11.2. Settings of View

To configure the current view (except for standard views parallel to the corresponding planes), click **Settings of View** in the **View** panel (or click **Settings of View...** in the context menu that can be opened by right-clicking **Coordinate Space Field**). Set the necessary parameters in the **View** dialog box that will open and click **OK**.

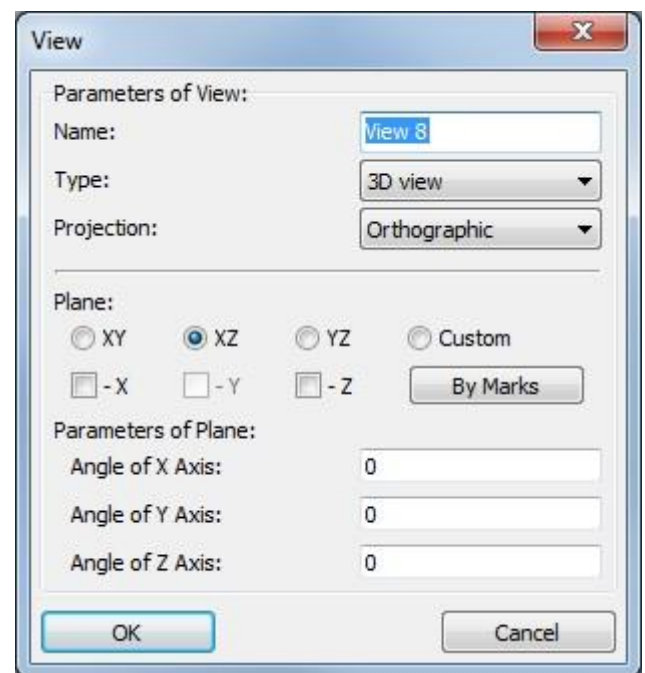
There are the following view settings:

- View name
- View type (2D view or 3D view).

Rotation is not allowed for 2D views.

- View projection (orthographic or perspective). It is possible to create an orthophotomap from the current view in case of orthographic projection only.

- View orientation. A view can be oriented perpendicular to one of the standard planes, or orientation angles can be set arbitrarily. You can also orient a view perpendicular to an arbitrary plane. To do this, specify at least 3 spot point type marks on an arbitrary plane (see Section 6.9.3), and plane parameters and orientation angles will be calculated after you click **By Marks**.

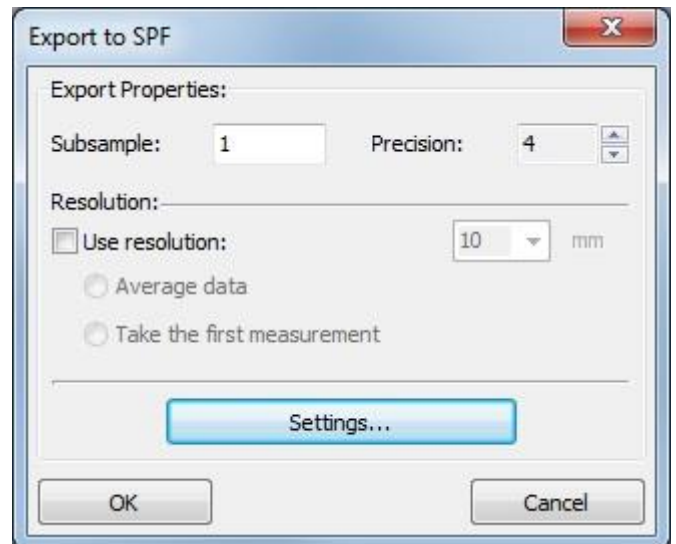




### 6.11.3. Export

The **Export** button in the **Actions** panel opens **Save As** dialog box where you can select the output file format. After you specify the file name, the **Export** dialog box will open with various settings depending on the format:

- **Subsample** — Sets the interval for writing points to the file (“1” means every point is written).
- **Precision** — Number of decimal places.
- **Use resolution** — Writes points to the file with the specified resolution (allows to obtain a more uniform subsampling), blocks the **Subsample** setting.
  - **Average data** — Averages the data by all points that fall within the cell with the given resolution.
  - **Take the first measurement** — Uses the first measurement that falls within the cell with the given resolution; other values within the cell are ignored.
- **Settings...** — Allows to select the type of representation for color information:
  - RGB color
  - Intensity ranging from 0 to 1.0
  - Intensity ranging from 0 to 255



### 6.11.4. Create Orthophotomap

Before creating an orthophotomap:

- Limit the points that will be used for creating an orthophotomap using a 3D limit box (see Section 6.10.1) if necessary.
- Select the projection plane. To do this, choose one of the standard views or create a new one by setting the required plane parameters (see Section 6.11.2).

Click **Create Orthophotomap** in the **Actions** panel to create an orthophotomap.



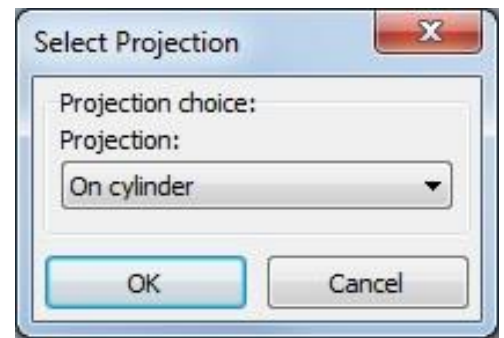
The **Projection** dialog box will open. Set the following parameters:

- **Range** — Sets the range for projection (**Limit Box** or **Scan**). Limit Box is selected automatically in case a 3D limit box is specified.
- **Scale** — Sets the resolution for the projected orthophotomap (mm per pixel).
- You can correct the projection borders in the corresponding fields. Information on the size of the resulting orthophotomap is given below.
- **Use Actual Size** — Enables the field for setting actual scale (mm per pixel). If the resolution of the orthophotomap being created is higher than scan resolution, it may result in back points showing through the front ones. In this case enabling this option and setting actual scan resolution can solve the problem.
- **Intensity Correction** — Enables reflected signal intensity levelling (based on the set polynom) when multiple scans are used for the same area. This reduces the color noise effect.
- **By scan position** — Divides the orthophotomap into areas around scanner position points, and these areas are filled with points from the nearest scan only. This increases the image quality due to absence of noise from other scans. This option is used for almost flat objects.

Click **Create** to start the point projection process. After completing the projection, further actions are performed on the [Orthophotomaps](#) tab (see Section 7).

#### 6.11.5. Turn on the plane

In order to create a development of a convoluted object, first you need to specify spot point type marks on the object one by one (see Section 6.9.3). Mark size is chosen depending on the scan resolution and noise level (mark size should be approximately 2 or 3 times greater than scanning pitch). The beginning of the development is formed by the coordinates of the first mark, and the coordinates of the last mark are the end. Marks should be specified sequentially, a new mark cannot be added between the two previously specified marks! After that, click **Turn on the plane** in the **Actions** panel and specify the projection in the **Select Projection** window that will open.



##### 6.11.5.1. Projection on the cylinder

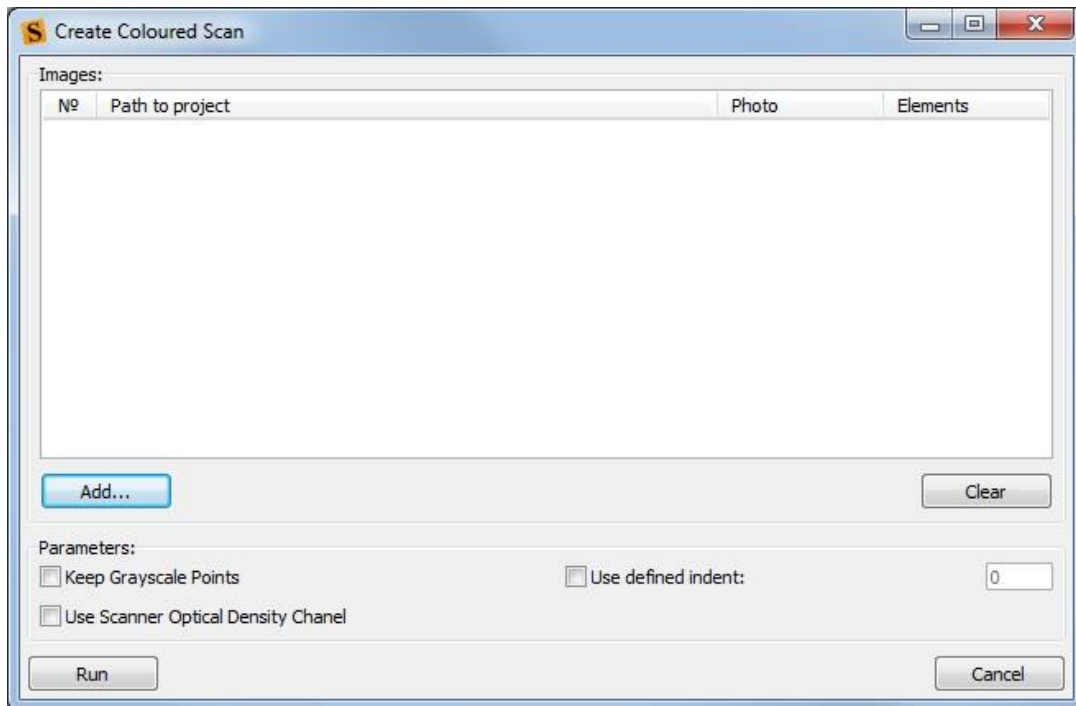
The **Projection on the cylinder** dialog box will open. You can set the range (Limit Box or Scan), choose the scale, the projection plane (XY, XZ, YZ) and the acceptable deviation in the **Projection Parameters** section. The lower the acceptable deviations from the circle, the more circles are used for approximation of the given curve. The **Circle is closed** option closes the set of the specified marks with the first mark. If you change the above mentioned settings, the size of the resulting orthophotomap is recalculated automatically. Specify the number of circles used for approximation of the curve formed by the specified points, in the **Quantity of circles** field. The calculated length is displayed in the **Planar view length** field. The **Residual** section displays deviations from the circle for each point as well as average and maximum values for the selected point. The resulting development is displayed in the [Orthophotomaps](#) tab.

Nº:	Name:	Residual:
1	1	0,000000
2	2	0,000000
3	3	0,000000
4	4	0,000000

Average: 0,000000  
Maximum: point: 2 residual: 0,000000

#### 6.11.6. Colour Point Cloud

To color a point cloud using oriented digital images, click **Colour Point Cloud** in the **Actions** panel.

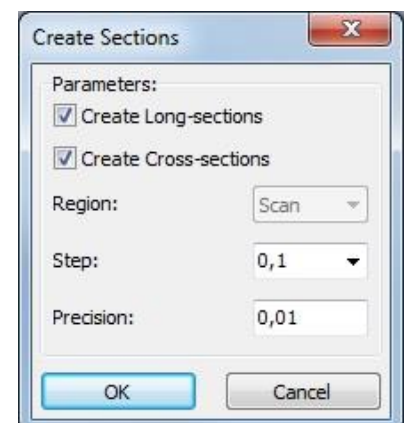


Make a list of processed images and enable corresponding options in the **Create Coloured Scan** dialog box that will open. To add images to the list as projects created in the **Orthophotomaps** tab or in **PhotoTransformer** software (<http://www.photogrammetria.ru/6-phototransformator.html>), click **Add** and select the necessary folders where project with images are located. For the correct scan coloration, the images must be taken from the scan point. Simultaneous coloration of point clouds obtained from different scan points is not allowed. The **Keep Grayscale Points** option prohibits deletion of uncolored points during coloration. The **Use Scanner Optical Density Channel** option allows to color the scan using YCbCr color space (brightness, red-difference and blue-difference chroma components) which uses scanner brightness channel instead of image brightness channel and thus maintains the sharpness of the initial scan. The **Use defined indent** option allows to reduce the area of the image that is used for scan coloration by setting a fixed offset from the image edges (in pixels). Black (RGB 0/0/0) on the images is ignored during coloration.

#### 6.11.7. Create Sections

To create long- and cross-sections of an object, click **Sections > Create Sections**.

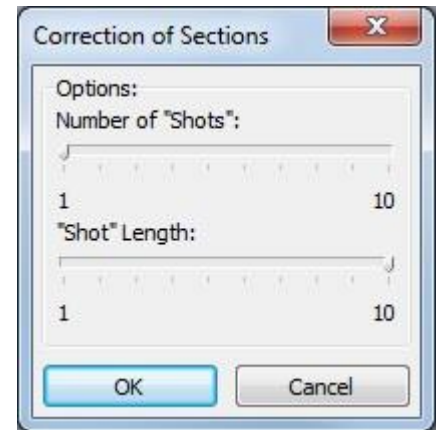
In the opened dialog box, specify which sections you want to create, set the region (**Limit Box** is selected automatically in case a 3D limit box was created), **Step** (in meters) and precision (calculated automatically based on the previous setting). The most successfully drawn up sections are ones where the object is mostly located in **XY** plane without dramatic differences in height and curves (banks, open pits, roofs etc.).



#### 6.11.8. Correction of Sections

To correct “shots” in the created sections, click **Sections > Correct Sections**.

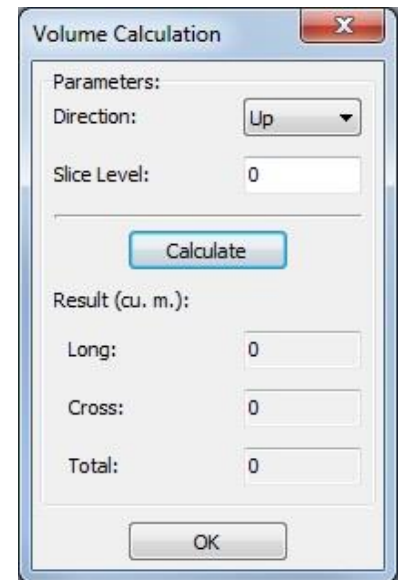
Set the following parameters in the opened dialog box: Number of “Shots” — corresponds to the number of vertices involved in the “shot”, and “Shot” Length — corresponds to the acuteness of the “shot” angle (the lower the value, the more obtuse angles between two vertices are considered a “shot”). Changes in parameters lead to automatic redraw.



#### 6.11.9. Volume by Sections

To calculate the volume based on sections, click **Sections > Volume by Sections**.

In the opened dialog box, set **Direction** (**Up** means positive volume, e.g. bank, **Down** means negative volume, e.g. an open pit), and enter the height point from which the volume will be calculated in the specified direction in the **Slice Level** field. Calculation result will be displayed in the corresponding fields after clicking **Calculate**.



#### 6.11.10. Scan Filtration

To start the scan filtering process, click **Filters > Scan Filtration**.

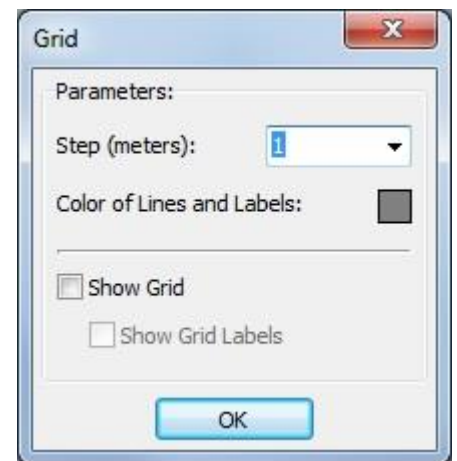
Enter the following parameters in the opened dialog box:

- **Cell size** — corresponds to the size of the cube facet (cell) into which the scan is divided.
- **Filter Threshold** — corresponds to the minimum amount of points in a cell. If the number of points that fall within a cell is lower than the specified threshold, all points in the cell are deleted.



#### 6.11.11. Grid

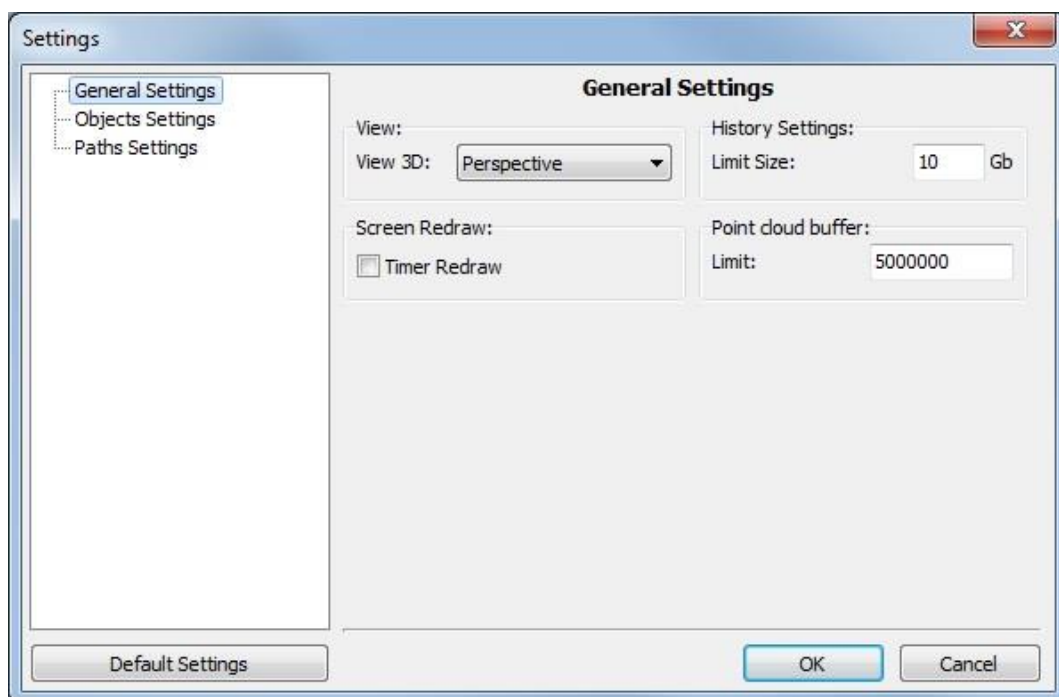
When you click **Grid** in the **Actions** panel, the **Grid** dialog box will open where you can enable or disable displaying the grid as well as set its color and step (in meters). The grid is displayed in **XY** plane at the lower border of the point cloud.



#### 6.11.12. Settings

Click **Settings** in the main menu to open the software settings. The left part of the **Settings** window contains sections and the right part displays the corresponding settings.

##### 6.11.12.1. General Settings Section

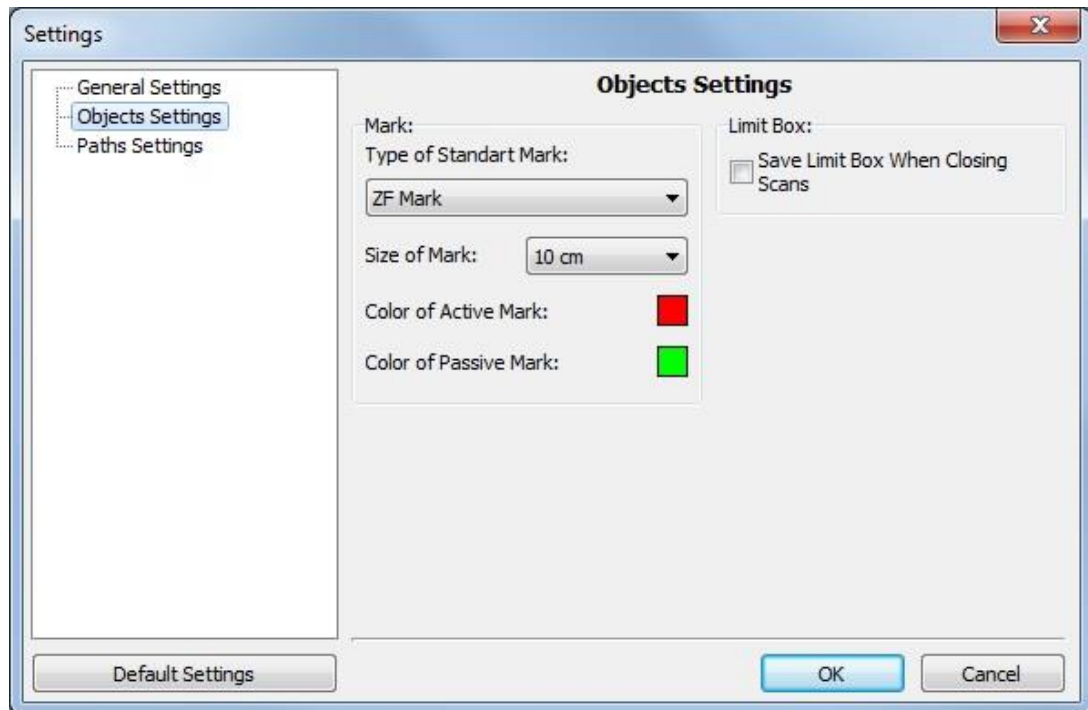


6.11.12.1.1. *View Settings.* You can set the type for the default 3D view that will be assigned to the view at the software start.

6.11.12.1.2. *History settings.* Maximum size of the action buffer is set here.

6.11.12.1.3. *Screen Redraw.* Enables constant refreshing of the screen. **ATTENTION:** The image may blink if this option is enabled on computers with video boards not supporting double buffering. In this case disable the option.

#### 6.11.12.2. **Object Settings Section**



6.11.12.2.1. **Mark.** Sets the type and size for the default mark as well as colors for active and passive marks.

6.11.12.2.2. **Limit Box.** This option enables saving the specified [3D limit box](#) after closing all scans.

#### 6.11.12.3. **Path Settings Section**

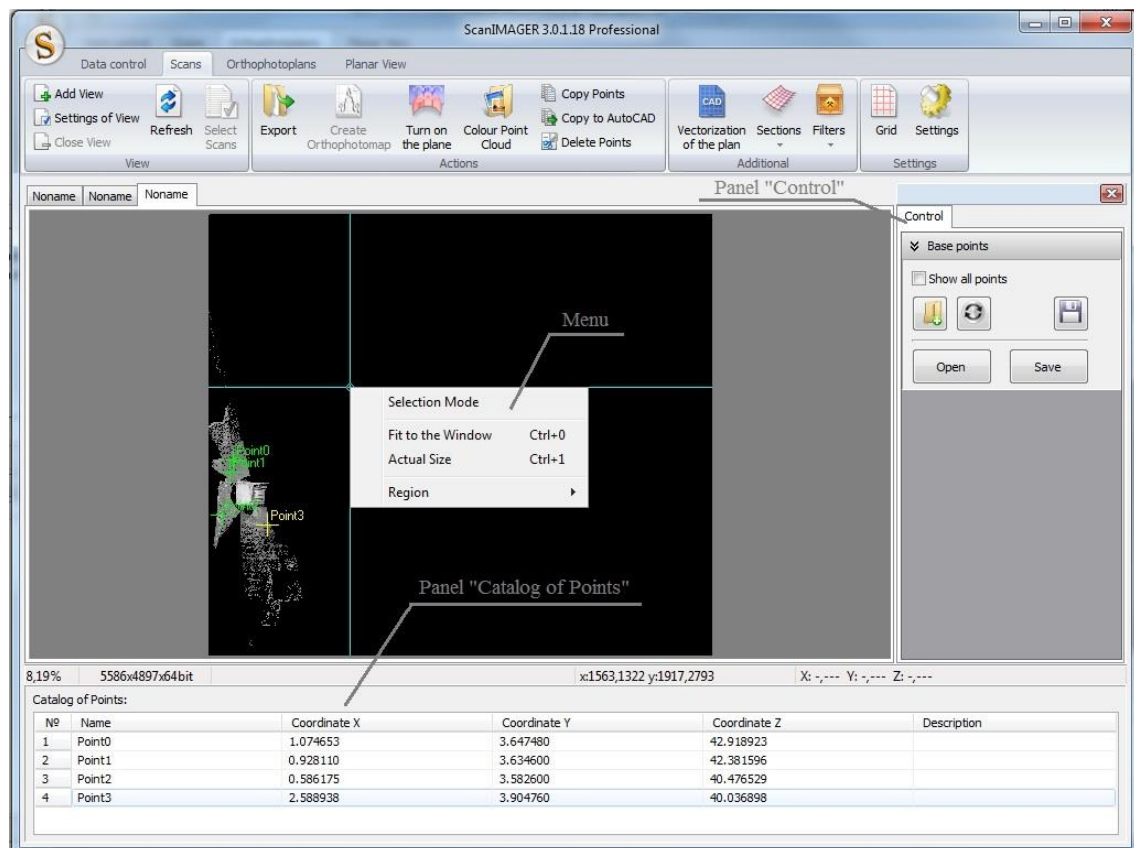
This section allows to set the path for oriented images used for coloration of scans created in the [Orthophotomaps](#) tab or PhotoTransformer software (<http://www.photogrammetria.ru/6-phototransformator.html>).

## 7. ScanIMAGER Ortho Module

### 7.1. General

**ScanIMAGER Ortho Module** is designed to work with orthophotomaps projected on a specified plane. You can work with multiple orthophotomaps in this software and switch between them using tabs in the main panel. You can also upload multiple orthophotomaps simultaneously in the same tab (they need to have the same size and recalculation parameters for the coordinate system), and they will be combined into one during upload. The software uses internal \*.spo format to store orthophotomaps. Besides plan coordinates and information on color, this format also contains data on the third coordinate making it a 3D orthophotomap.

### 7.2. The Main Window



### 7.3. Main Menu

#### 7.3.1. File

**Open Ortho** — Uploads one or more selected orthophotomaps (each in a separate tab).

**Open and Combine** — Uploads multiple orthophotomaps with the same parameters and combines them into one.

**Save Ortho** — Saves the current orthophotomap.

**Close Current** — Closes the current orthophotomap.



**Close All** — Closes all uploaded orthophotomaps.

**Converting** — Converts orthophotomaps from old \*.spo format to new.

[Control of images](#) — Opens the **Control of images** dialog box that allows to work with a list of image projects.

**Export Image** — Exports the orthophotomap into graphic formats (\*.tiff, \*.jpg, \*.bmp) or a point cloud.

**Export to AutoCAD** — Exports the current orthophotomap into a \*.dwg file as a raster image with recalculation for the working coordinate system.

### 7.3.2. Actions

[Delete Points](#) — Deletes points inside the [specified region](#).

[Crop](#) — Cuts the orthophotomap by the [given border](#).

[Interpolation](#) — Starts the interpolation process which eliminates blanks in the orthophotomap.

[Create Coloured Orthophotomap](#) — Colors the orthophotomap using a set of oriented digital images (available in Professional edition).

[Calculate square](#) — A tool for calculating the surface area by an orthophotomap.

**Specify Base Points** — Opens the panel for specifying base points to calculate external orientation elements.

[Highlight Images](#) — Enables highlight mode for a part of colored orthophotomap.

[Grid](#) — Displays and sets the coordinate grid parameters in the orthophotomap plane.

### 7.3.3. Filters

[Noise Correction](#) — Starts orthophotomap correction process in order to eliminate isolated points and local “shots”.

[Smooth/Blur](#) — Starts smoothing the current orthophotomap by reflection intensity and inner distance in each point.

[Pseudocolouring](#) — Used for clearer contour definition.

[Segmentation](#) — Used for clearer contour definition.

[Subtraction](#) — Subtracts one orthophotomap from another using the inner distance coordinate.

[Negative Image](#) — Reverses the reflection intensity parameter.

[Change Channels](#) — Swaps RGB channels for pseudocolored and colored orthophotomaps.

### 7.3.4. Settings

Opens the setting window.

### 7.3.5. About



opens a window with information on the software and license.

#### **7.4. Context Menu**

Can be opened by right-clicking the image panel.

**Fit to the Window** — Scales the orthophotomap so that the whole image fits within the window.

**Actual Size** — Scales the orthophotomap so that each pixel of an orthophotomap corresponds to one pixel of the display.

[Region](#) — Contains commands used for creating and deleting regions.

## 7.5. Main Features

### 7.5.1. Delete Points

To delete points, set the region (see Section 7.5.8) and click **Actions > Delete Points**.

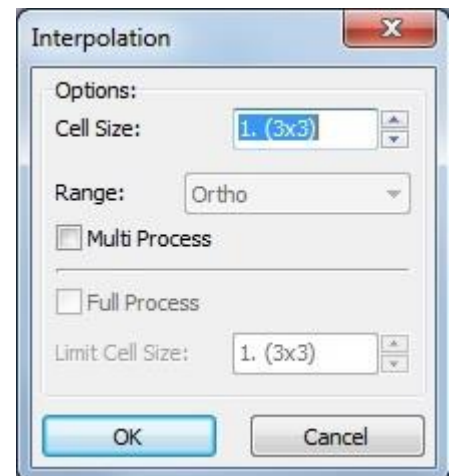
### 7.5.2. Crop

To crop (cut) an orthophotomap, set the required region (see Section 7.5.8) and click **Actions > Crop**.

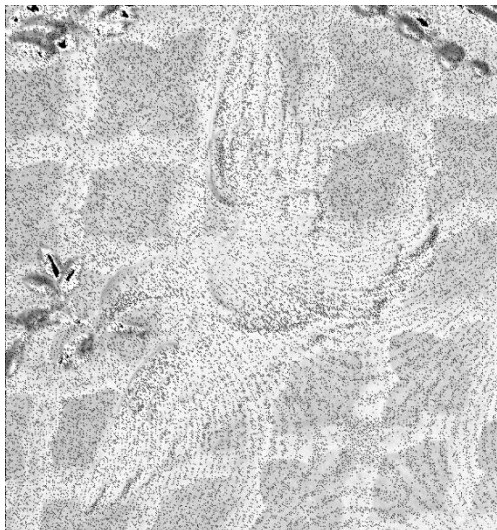
### 7.5.3. Interpolation

To start the interpolation process, click **Actions > Interpolation**.

In the opened dialog box, set the filter cell size and interpolation range (**Ortho** or **Region**). The **Multi Process** option enables continuous interpolation until there is no point to interpolate in the specified cell size. The **Full Process** option enables continuous sequential interpolation within the cell sizes specified in the **Cell Size** and **Limit Cell Size** fields respectively.

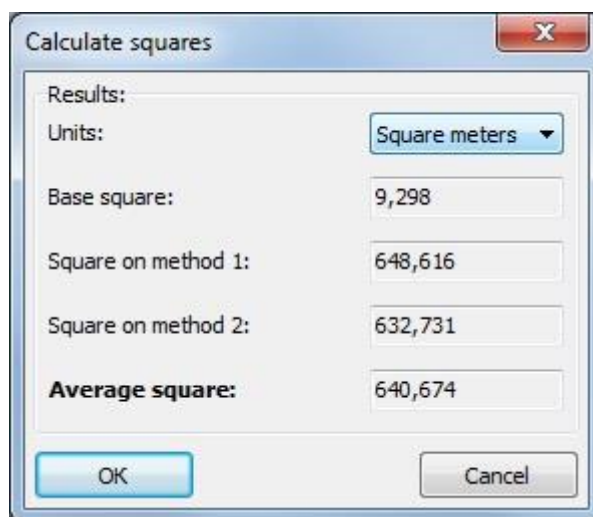


Filtering results:



#### 7.5.4. Calculate Square

To calculate the surface area by an orthophotomap, points within the selected region or all orthophotomap points (in case there is no orthophotomap) are used. After the calculation process is complete, a reporting window is displayed with the following calculation results: surface base area, surface areas calculated with two methods and arithmetic mean of these two results. You can select the units of measure in which the results will be displayed.



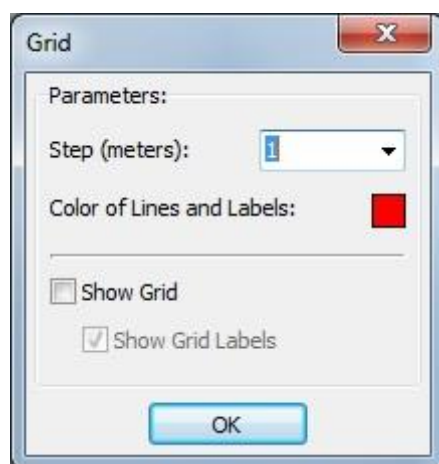
The 'Calculate squares' dialog box displays the following results:

Results:	Units:
Base square:	9,298
Square on method 1:	648,616
Square on method 2:	632,731
<b>Average square:</b>	<b>640,674</b>

Buttons: OK, Cancel

#### 7.5.5. Grid

When you click **Actions > Grid**, the **Grid** dialog box will open where you can enable or disable displaying the grid as well as set its color and step (in meters).



The 'Grid' dialog box displays the following parameters:

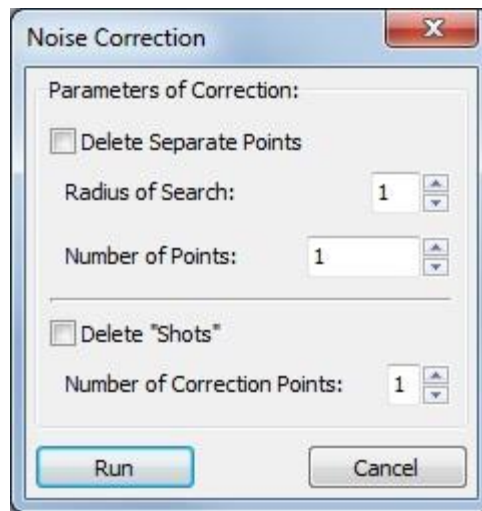
Parameters:
Step (meters):
Color of Lines and Labels:
<input type="checkbox"/> Show Grid
<input checked="" type="checkbox"/> Show Grid Labels

Buttons: OK

#### 7.5.6. Filters

##### 7.5.6.1. Noise Correction

To start the noise elimination process, click **Actions > Noise Correction**. The filter eliminates both isolated points and local “shots” on the orthophotomap.



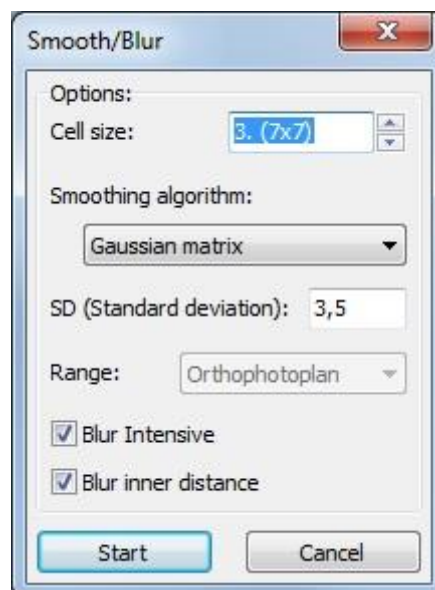
To eliminate isolated points, enable **Delete Separate Points** and set the following filter parameters:

- **Radius of Search** — Corresponds to the size of the region (in pixels) where points are counted.
- **Number of Points** — Corresponds to the minimum number of points in the region. If the number of points in the area around the “suspicious” point with the specified radius is lower than allowed, the “suspicious” point is deleted.

To eliminate local “shots” (orthophotomap points with Z coordinate significantly different from the neighboring points), enable **Delete “Shots”**. Set the number of sequential points that will be interpreted as a local “shot” in the **Number of Correction Points** field.

#### 7.5.6.2. Smooth/Blur

Smooths the inner distance coordinate (perpendicular to the screen plane) and reflection intensity. Set smooth factor and application range (Orthophotomap or [Region](#)) in the Inner **Distance Smooth** window.



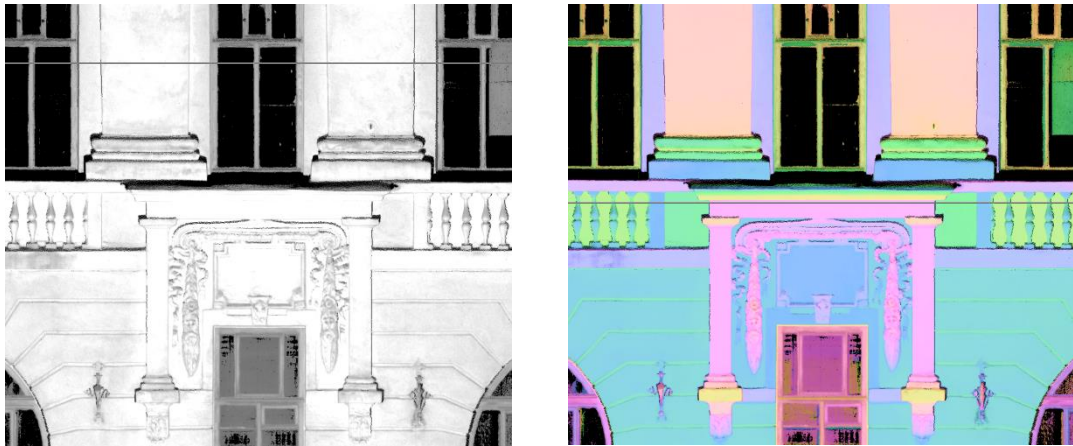
#### 7.5.6.3. Pseudocolouring

To pseudo-color an orthophotomap for clearer contour definition, click **Filters > Pseudocolouring**.



Set the application scale of the color space in the opened **Pseudocolouring** dialog box. If the scale is set to 1.0, the color space is used without repetition within 1 meter of inner distance. It is recommended to increase the scale if there are small differences, and decrease the scale if differences are significant.

Example of the feature use:

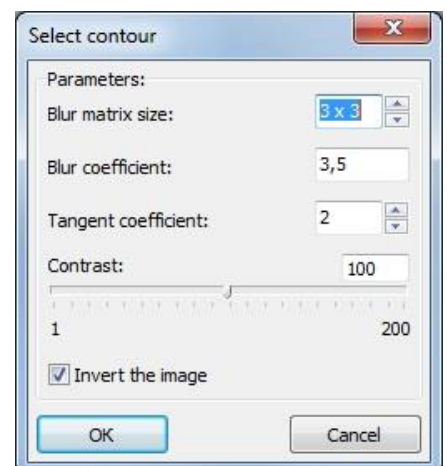


Brightness channel of the orthophotomap is used in pseudocolouring by default. To obtain a colored image without brightness channel, enable **Define General Brightness** and specify the value from 0 to 255 in the corresponding field.

#### 7.5.6.4. Segmentation

Segmentation is used to highlight contours on the orthophotomap. To segment the image, click **Filters > Segmentation**.

Set **Blur matrix size**, **Blur coefficient** and **Tangent coefficient** in the **Select contour** dialog box. The values depend on the orthophotomap resolution and source data quality. Applying this filter results in a black-and-white image with clear contours. Inner distance coordinate is used to generate this image while reflection intensity in each orthophotomap point is ignored. If **Invert the image** is disabled, the result will be a negative image (with black background).



An example of image segmentation:



#### 7.5.6.5. Subtraction

Subtracts an orthophotomap selected in a file from the current orthophotomap. To perform this operation, the sizes of orthophotomaps must be identical.

#### 7.5.6.6. Negative Image

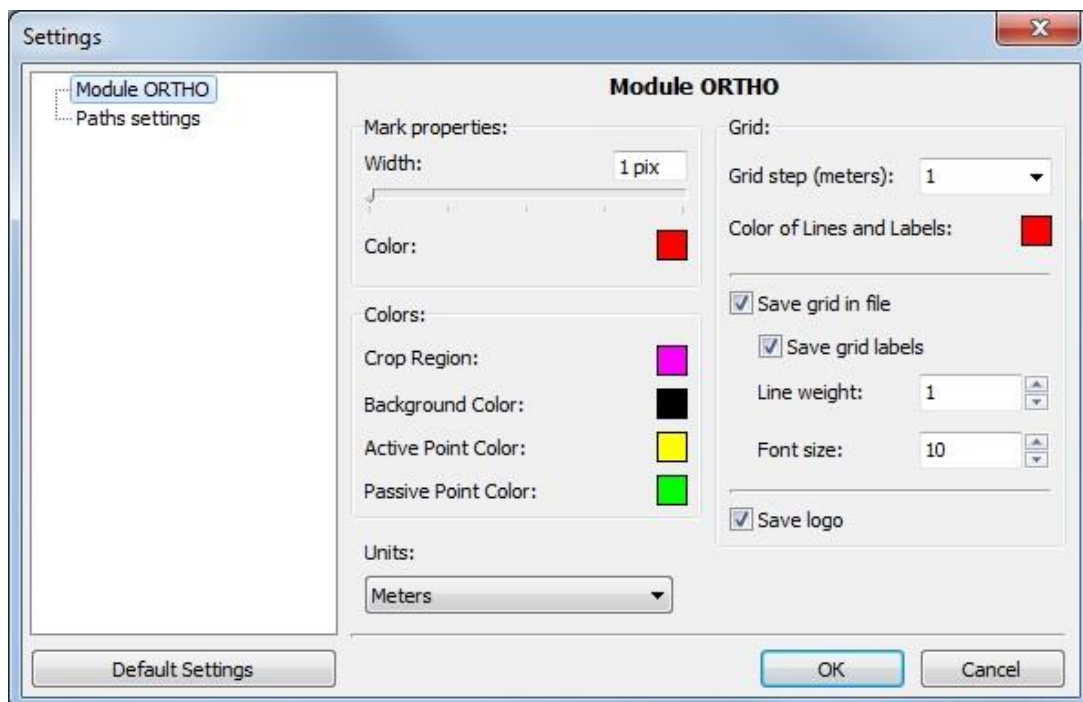
Inverts the colors of the active orthophotomap.

#### 7.5.6.7. Change Channels

Swaps the **R** and **B** channels in the **RGB** color space.

### 7.5.7. Settings

Click **Settings** in the main menu to open the module settings.



7.5.7.1. Mark properties: Sets the width and color of the mouse pointer.

7.5.7.2. Colors: Sets colors for various objects and areas of the module.

7.5.7.3. Grid: Sets the step and (default) color of the grid, as well as parameters for size, color and labels of the grid in the exported image. To save the grid to a file (when exporting to a raster image), enable **Save grid in file** and set the required parameters.

7.5.7.4. Camera Directory Path In the **Path settings** section, set the path to the folder with files containing information on camera calibration (internal image orientation elements for orthophotomap coloration).

### **7.5.8. Region Control**

To create a rectangular area, open the context menu (right-click the image panel), click **Region > Create Rectangle**, and point the upper left and bottom right corners of the area on the image.

To create a polygonal area, open the context menu (right-click the image panel), click **Region > Create Polygon**, and point the vertices of the polygon on the image. To cancel the command and finish region creation, press **Escape**.

To delete the region, click **Region > Delete Region**.

### **7.5.9. Create Coloured Orthophotomap**

A colored orthophotomap results from coloring a black-and-white orthophotomap by mapping each orthophotomap point to a corresponding point of a digital image.

Creating a colored orthophotomap consists of the following main steps:

- Creating a black-and-white orthophotomap
- Forming an image catalog
- Calculating internal elements for image orientation
- Coloring the orthophotomap
- Highlighting the images

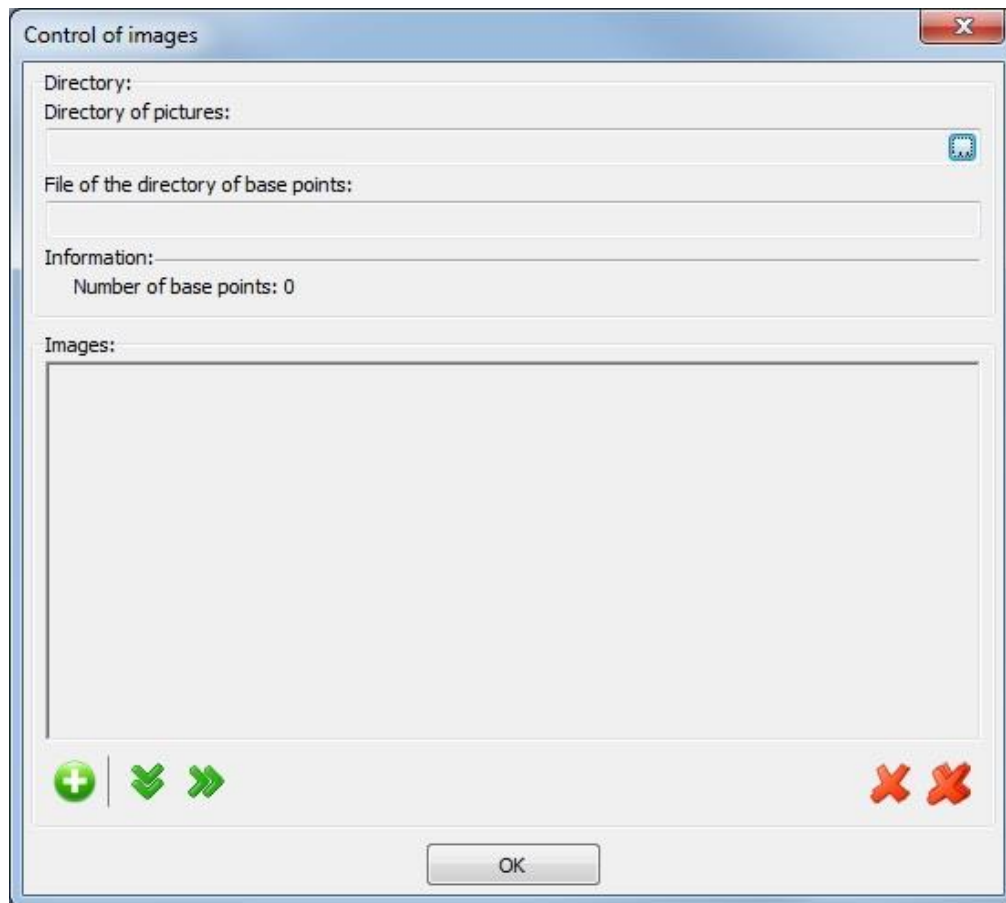
#### **7.5.9.1. Creating a black-and-white orthophotomap**


A black-and-white orthophotomap is created in the ScanIMAGER module, followed by processing and filtering in the ScanIMAGER Ortho module (see subsections 6.7.6, 7.5.1 – 7.5.9).

#### **7.5.9.2. Forming an image catalog**

To create an image catalog, click **File > Control of images** or press **Ctrl + M**.






In the **Control of images** dialog box, specify the path to the directory containing image projects. The directory can contain projects created in **PhotoTransformator**. If there are no projects, specify an empty directory and create projects using the project creation button . File of the catalog of base points can be specified manually, otherwise it is created automatically.


To create a project, specify the path to the .JPG, .BMP or .TIF image file in the **Creation of the project of an image** dialog box. Enter the project name in the corresponding field. The project name corresponds to the digital image file name by default.

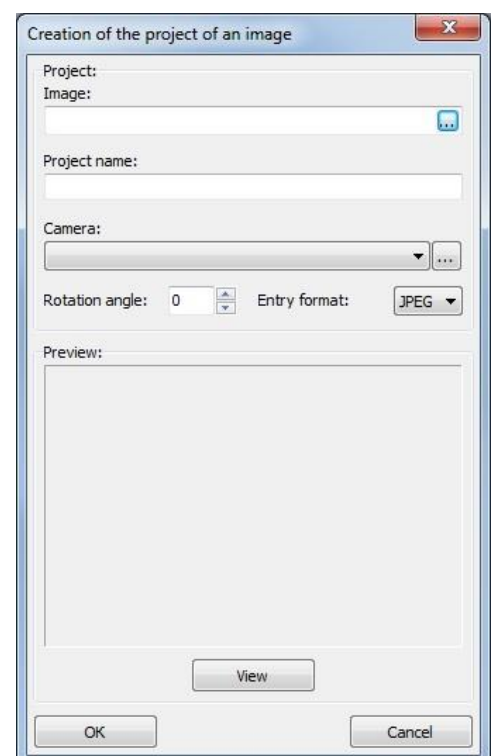
Then select the camera and the assembly used for photographic work from the camera catalog. You can also turn the image by a multiple of 90° to simplify future processing. The **View** button allows to preview the image as it would be uploaded to the new project.

After creating an image project it will appear in the image list. The image line color represents its status: grey — an active image, red — an image with no external orientation elements calculated, green — an image with external orientation elements calculated.

External orientation elements of the image must be calculated for orthophotomap to be colored.

Use  buttons to expand and minimize the image list.

Use  buttons to delete one or all images in the list.





Click **OK** or close the dialog box to finish image list creation. You can continue to form the image list any time by clicking the corresponding command in the **File** menu.

### 7.5.9.3. Calculating External Image Orientation Elements

To calculate external orientation elements for images, click **Actions > Specify Base Points**. Image panel, base point catalog and control panel will open in the main window of the module.

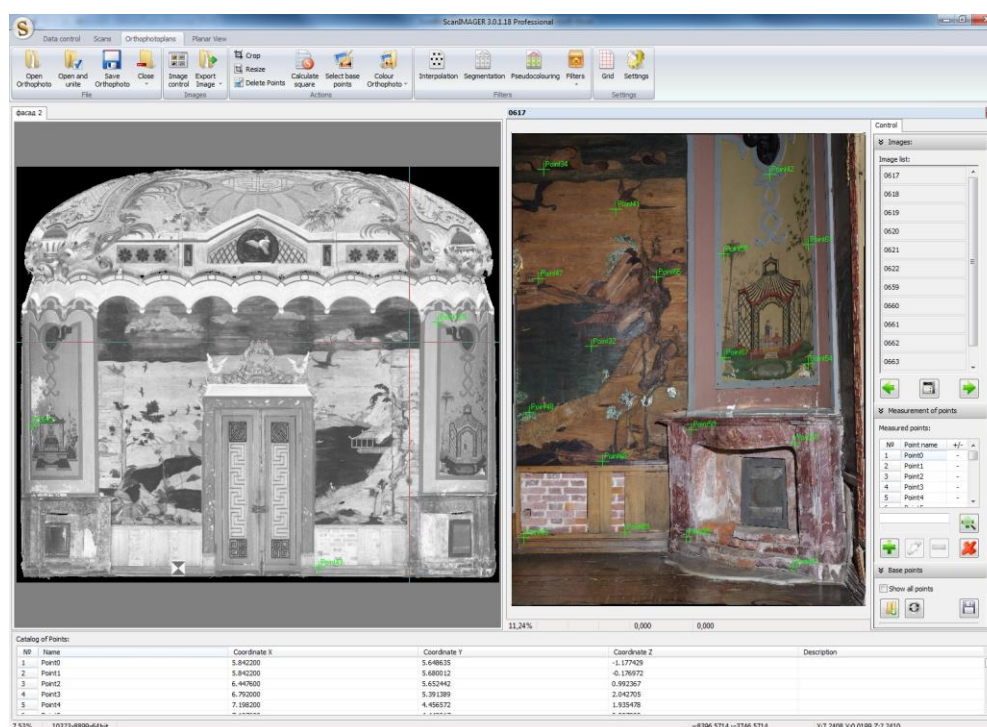
The **Control** panel displays the list of images. The active image is displayed in the image panel.

Calculation of external orientation elements consists of the following steps:

- Forming the base point catalog
- Measuring and adjusting base point positions on the image
- Calculating the orientation elements


To calculate external orientation elements, we recommend to measure at least five points on the image with at least one base point per each quarter.


### Forming the Base Point Catalog




To add a point to the base point catalog, point it on the orthophotomap and enter its name in the opened dialog box. The point with coordinates in the orthophotomap coordinate system will be displayed in the base point catalog at the bottom of the screen.



### Point measurement


To measure the coordinates of an image point, select the point in the **Measured points** list, place the mouse pointer at the corresponding place on the image and click  (**Measure**).

To change the point coordinates, select the point in the **Measured points** list or double-click a measured point on the image, place the mouse pointer to the new place in the image and click  (**Move**).

To delete the point measurement, select the point in the list and click  (**Delete Measurement**).

You can also delete all base points measurements by clicking  (**Delete All Measurements**).

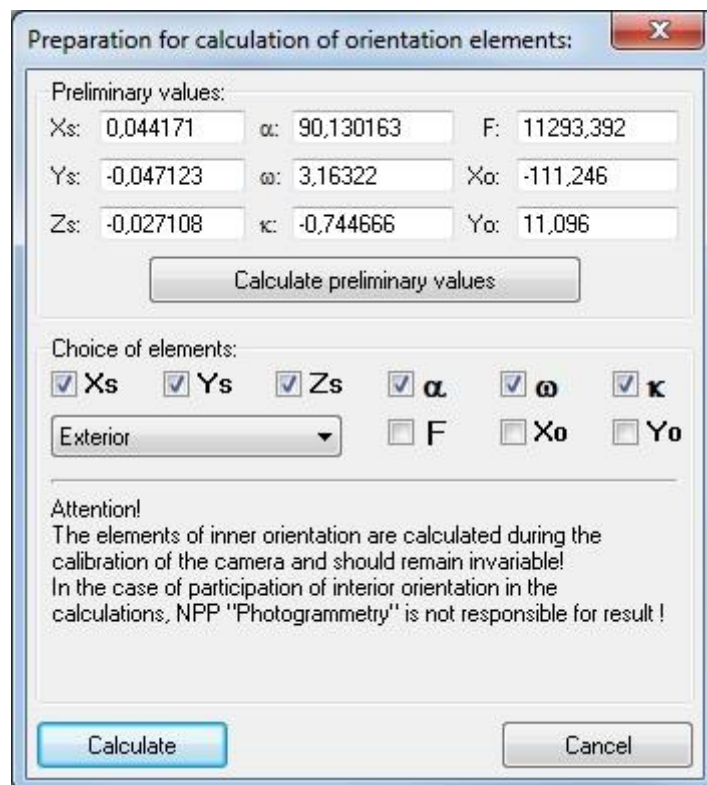
You can also upload base points from a text file using the  (**Open Catalog**) button in the **Base points** tab of the **Control** panel. There is also a button for saving base points in a text file —  (**Save Catalog**).

In case projects for orthophotomap coloration were created in PhotoTransformator, they are uploaded to the ScanIMAGER Ortho module with pre-calculated external orientation elements and point catalog. ScanIMAGER Orthomodule has a feature for automatic creation of the base point catalog which can be applied by clicking  (**Synchronize**). The software reads the points from project files and writes them to a single file with new unique names.

### Orientation Element Calculation

To calculate external point orientation elements, click  (**Orientation Elements**) of the **Images** panel.

Preliminary values for orientation elements are calculated in the **Preparation for calculation of orientation elements** dialog box. Here you can also select elements to define.




The dialog box titled "Preparation for calculation of orientation elements:" contains the following fields and controls:

- Preliminary values:**
  - Xs: 0,044171     $\alpha$ : 90,130163    F: 11293,392
  - Ys: -0,047123     $\omega$ : 3,16322    Xo: -111,246
  - Zs: -0,027108     $\kappa$ : -0,744666    Yo: 11,096
- Calculate preliminary values** button
- Choice of elements:**
  - ☒ Xs    ☒ Ys    ☒ Zs    ☒  $\alpha$     ☒  $\omega$     ☒  $\kappa$
  - Exterior dropdown menu    ☐ F    ☐ Xo    ☐ Yo
- Attention!**

The elements of inner orientation are calculated during the calibration of the camera and should remain invariable!  
In the case of participation of interior orientation in the calculations, NPP "Photogrammetry" is not responsible for result !
- Calculate** and **Cancel** buttons at the bottom.

Inner image orientation elements (focal distance and zero distortion point coordinates) are uploaded automatically according to the camera selected during project creation.

To begin the process of levelling and orientation element definition, click **Calculate**.

Click the **Start** button in the **Calculation of elements** dialog box to begin the levelling process, upon completion save the results by clicking **Save**. The **Information on points** field will display data on residual errors on X and Y. If the elements were calculated successfully, you can evaluate the precision after saving by clicking  (**Precision**).

**Calculation of elements**

Orientation elements:

Value:	Corrections:
Xs: 0,044171	$\delta X_s$ : 0
Ys: -0,047123	$\delta Y_s$ : 0
Zs: -0,027108	$\delta Z_s$ : 0
$\alpha$ : 90,130163	$\delta \alpha$ : 0
$\omega$ : 3,16322	$\delta \omega$ : 0
$\kappa$ : -0,744666	$\delta \kappa$ : 0
F: 11293,392	$\delta F$ : 0
Xo: -111,246	$\delta X_o$ : 0
Yo: 11,096	$\delta Y_o$ : 0

Output of values:

Value output accuracy:  Residuals:

Iterations:

Quantity of iteration:  Number of iteration:

Information on points:

Nº:	Name:	Residual on X:	Residual on Y:
1	Point61	0	0
2	Point32	0	0
3	Point34	0	0
4	Point41	0	0
5	Point42	0	0
6	Point47	0	0
7	Point48	0	0
8	Point49	0	0
9	Point50	0	0
10	Point52	0	0
11	Point53	0	0
12	Point54	0	0
13	Point55	0	0
14	Point65	0	0
15	Point66	0	0
16	Point67	0	0

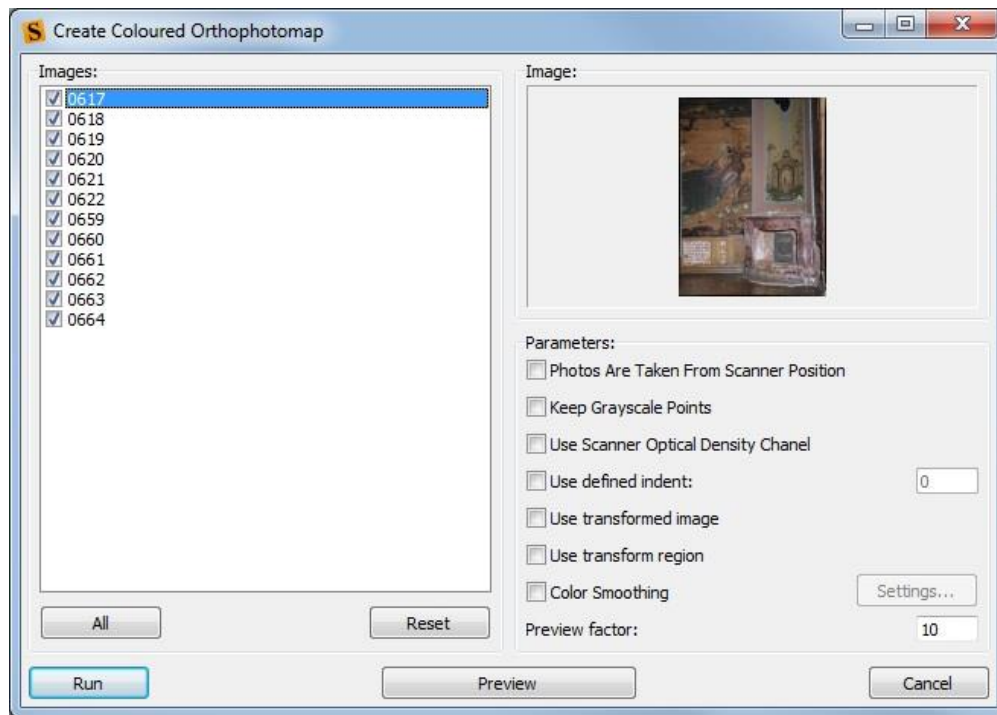
Max:

#### 7.5.9.4. *Coloring the orthophotomap*

Click **Actions > Create Coloured Orthophotomap** to open the **Create Coloured Orthophotomap** dialog box.

To the left of the opened dialog box the image list is displayed, and the right part contains image preview and coloration options.

In the image list, tick the images you want to use for coloration of the current orthophotomap.

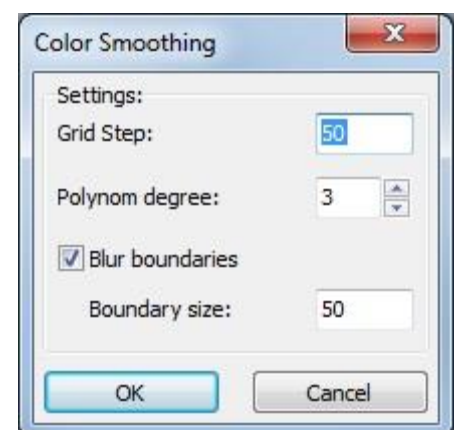


The following options are available for creating a colored orthophotomap:

- **Photos Are Taken From Scanner Position** — Used in case scanner position point coordinates match shooting point coordinates
- **Keep Grayscale Points** — When using this option, points not covered by images are included in the result as grayscale points
- **Use Scanner Optical Density Chanel** — Allows to color the orthophotomap using YCbCr color space (brightness, red-difference and blue-difference chroma components) which uses scanner brightness channel instead of image brightness channel and thus maintains the sharpness of the source scan
- **Use defined indent** — Allows to reduce the area of the image that is used for scan coloration by setting a fixed offset from the image edges (in pixels)
- **Use transformed image** — Is used for projects calculated in PhotoTransformator in case the project contains a transformed image (a digital image with eliminated perspective distortion)
- **Use transform region** — Only points within special areas defined in PhotoTransformator are used for coloration
- **Color Smoothing** — Allows to smooth major color differences at image edges when coloring an orthophotomap using multiple images. Black (RGB 0/0/0) on the images is ignored during coloration.

By clicking the **Settings** button you can:

- select grid step (the size of smoothing matrix in pixels)
- select the polynom degree
- apply edge smoothing option
- set border size (offset from each edge of the image limiting the area that will be used for edge smoothing)



ScanIMAGER Ortho Module provides preview during coloration, which allows to evaluate the quality of coloration with selected settings. Preview factor is set in the Create coloured orthophotomap dialog box and affects how much the preview will be reduced in size relative to the original orthophotomap (the higher the factor, the lower the preview resolution).

Full-size orthophotomap coloration is performed by clicking **Run**. Coloration result is displayed in the main window of the application.

#### 7.5.9.5. Highlighting the Images

After coloration you can use **Actions > Highlight Images** to evaluate the result. The software will display the colored orthophotomap and the **Image Highlighting** panel containing the image list. The area colored using the image selected in the list is highlighted, which allows to evaluate image borders, stitching quality and color levelling.