Digital Photogrammetric System

PHOTOMOD

Version 6.0.2

USER MANUAL

Orthorectification

RACURS

Table of Contents

1. Purpose of the document

This document contains detailed information about orthorectification images and orthoimages creation in the *PHOTOMOD* system.

2. General information

Orthoimage is a georeferenced image prepared from a perspective photograph or other remotely-sensed data in which displacement of objects due to sensor orientation and terrain relief have been removed.

The system provides possibility of creating orthoimages by source images block. This step allows to prepare images for further processing and creating mosaic in the*Geomosaic program*program.

В процессе *ортотрансформирования* исправляются искажения, связанные с рельефом местности, наклоном оптической оси фотокамеры, дисторсии фотокамеры и так далее. При построении ортофотоплана необходимо задать размер пиксела ортофотоплана, выбрать систему координат и масштаб ортофотоплана, установить формат выходного файла и тип геопривязки.

Prior to create orthoimages it is necessary to adjust images block (see “Block adjustment” User Manual).

3. The “Orthorectification” toolbar

The **Orthorectification** toolbar is used for creating orthoimages.

In order to display the toolbar, choose the **Rasters › Orthorectification** (**Ctrl+Alt+M**) or click the  button on the main toolbar.

Table 1. The ’Orthorectification’ toolbar

Buttons	Function
	allows to create the new orthorectification project
	allows to open an orthorectification project from active profile resources
	allows to save an orthorectification project
	allows to save an orthorectification project with a new name
	allows to set the orthorectification parameters
	allows to set the percent of trim image edges during orthorectification
	allows to perform the accuracy control of orthorectification
	allows to start of orthoimages building and creation of output file for selected sheet
	allows to start orthoimages creation for specified active sheets considering user settings and parameters in distributed processing mode
	allows to start of orthoimages building in the MegaTIFF format using the distributed processing mode

Buttons	Function
	allows to create a separate layer with orthoimage for each of selected images (see Section 4)
	allows to show general information about project (number of images channels, byte per channel, number of images and output size of mosaic)
	allows to move to previous image in a block scheme. The first image of the first strip opens if the block scheme 2D-window is active
	allows to open selected in 2D-window of a block scheme image in a separate window
	allows to move to next image in a block scheme. The last image of the last strip opens if the block scheme 2D-window is active

4. “FastOrtho” displaying

The system provides possibility to quick display and create of orthoimages *“FastOrtho”* separately for each of selected images.

FastOrtho is used to display orthoimage, created “on fly” by adjustment results. At that the pyramid level of image is used, depending on current zoom. These orthoimages allows to preliminary (rough) estimate data quality.

FastOrtho could be created only on a block with adjustment in geodetic coordinate system.

Orthorectification images “in fly” is used to display orthoimage in 2D-window for any selected image of project.

Perform the following actions to create orthoimages “on fly”:

1. Perform the block adjustment in a geodetic coordinates (see the “Block adjustent” User Manual).

2. [optional] Select images for *FastOrtho* in 2D-window (more details see in the *Vector objects selection* chapter in the “*Vectorization*” User Manual).

3. Click the  button of the **Orthorectification** toolbar. Separate raster *FastOrtho* layer creates for each of selected images. Orthoimage displays in 2D-window.

5. Orthoimages creation

Perform the following actions to create orthoimages:

1. Adjust the source images block (see the “Block adjustment” User Manual).

2. [optional] Select images for orthorectification in 2D-window (more details see in the *Vector objects selection* chapter in the “Vectorization” User Manual).

3. Choose the **Rasters › Orthorectification**. The **Orthorectification** toolbar opens.

4. Click the button. The **Orthoimages parameters** window opens.

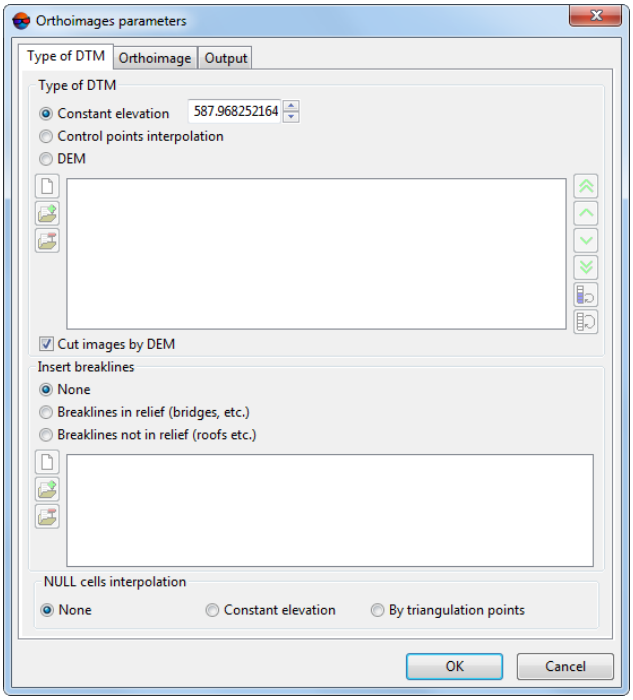

Fig. 1. The Orthorectification parameters

5. Set the orthorectification parameters.

6. Click OK to save parameters.

7. Click the of the **Orthorectification** toolbar to save the orthoimages project.

8. Click the button of the **Orthorectification** toolbar. The **Output** window opens.

For orthorectification in distributed processing mode, click the button. For orthorectification in MegaTIFF format in distributed processing mode , click the button.

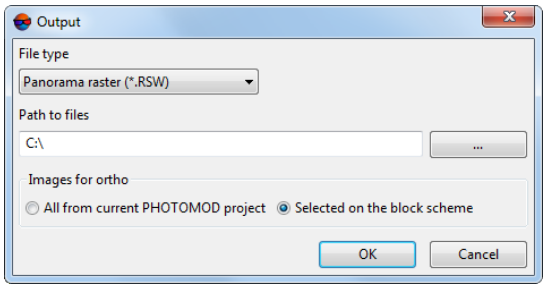

Fig. 2. Output parameters

9. Choose **File type** for output files and define path for files.

10. [optional] If some images are selected on a block scheme, choose **Images for ortho**:

    - **All from current PHOTOMOD project**:
    - **Selected on the block scheme**.

11. [optional] If in the **File type** list chosen the **Panorama raster (*.RSW)** type, the **Panorama map selection** window opens.

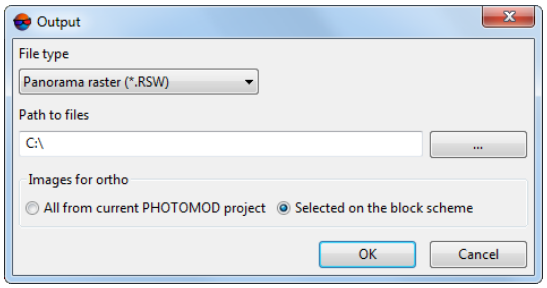

Fig. 3. Parameters of Panorama map export

Set name and path for the map file with one of the following ways:

- click the ... button to export the map `*.sit`-file;
- click the **Create** button to create a new Panorama map (`*.sit`), input filename and click the **Save** button.
- to export DEM that is used in orthomap creation, set on the **Export DEM to Panorama map** checkbox.

12. Click OK to start process of orthorectification.

    The orthoimage and georeference files are created in the project's folder in chosen formats.

6. Settings of ortoretrification parameters

6.1. Type of DTM

The **Type of DTM** tab allows to choose method of using DTM and breaklines during the orthoimages creating.

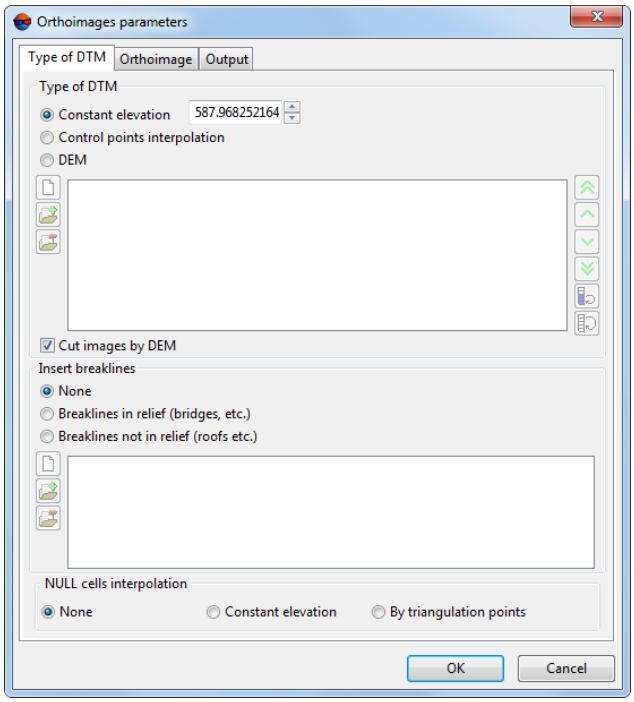

Fig. 4. The ortoretrification parameters on the 'Type of DTM' tab

The **Type of DTM** section allows to set the following parameters of DTM using:

- **Constant elevation** – allows to use constant relief elevation during the orthoinages creating and fit elevation in one value from the input field;

  Default value is mean elevation value calculated from all source images block.

- **Control points interpolation** – smooth polynomial model calculated by ground control and tie points is used in orthorectification process (see the "Block adjustment" User Manual);

- **DEM** – allows to use information from DEM (see the "DTM" User Manual).

  To form the list of DEM there is a toolbox, which contains the following buttons:

  - – allows to clear the DEM list;
  - – allows to add DEM in the list;
  - – allows to remove DEM from the list;
  - – allows to move selected DEM at the head of the list;
  - – allows to move selected DEM up the list;

- ○ – allows to move selected DEM down the list;
- ○ – allows to move selected DEM at the end of the list;
- ○ – allows to inverts selected DEM in the list;
- ○ – allows to reverse the DEM order.

The **Cut images by DEM** checkbox allows to create orthoimages by rectangle border considering using DEM and without considering the rest area of image.

The **NULL cells interpolation** allows to define area out of DEM:

- **None** – NULL cells are not used in orthorectification process;
- **Constant elevation** – allows to use constant elevation out of DEM during the orthoimages creating and fit elevation in one value from the input field;
- **By triangulation points** – smooth polynomial model calculated by triangulation points is used in orthorectification process (see the “Block adjustment” User Manual).

The **Insert breaklines** allows to set the following parameters of using vector objects:

- **None** – orthoimages are creating without using vector objectsl
- **Breaklines in relief (bridges, etc.)** – orthoimages are creating with breaklines, which allows to define typycal relief forms;
- **Breaklines not in relief (roofs, etc.)** – orthoimages are creating with breaklines out of relief.

To form the list of vector files there is a toolbox, which contains the following buttons:

- – allows to clear the file list;
- – allows to add vector file in the list;
- – allows to remove vector file file from the list.

6.2. General orthoimages creation parameters

The **Orthoimage** tab of the **Orthoimages parameters** window purposes to setup main options of orthoimages creating.

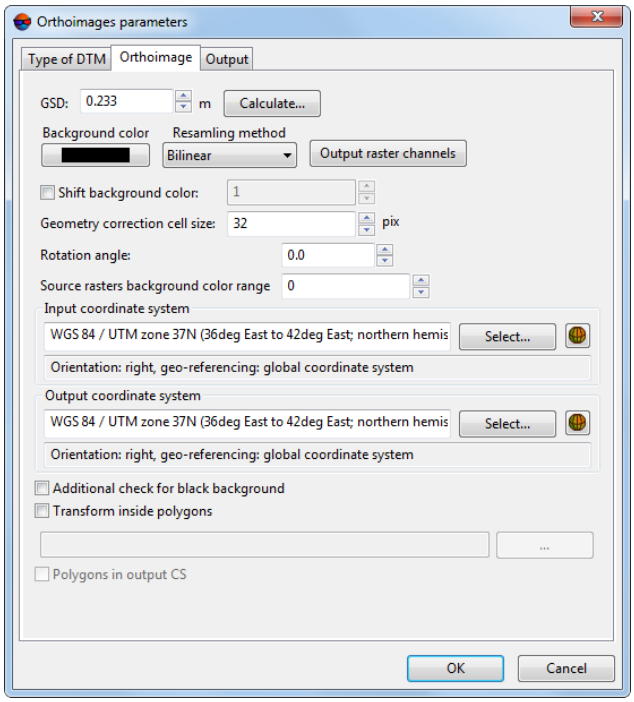

Fig. 5. General orthoimages parameters

The **Orthoimage** tab is used for setting the following parameters of output orthoimages:

- **Cell size** – allows to specify the size of output orthoimage cell on the terrain. The cell size by default is equal to the cell size of the first image of project.

The cell size is set in measurement units equal to units of ground control points in the adjustment step (see the “Block adjustment” User Manual).

The **Compute** button allows to set general size of orthoimage in pixels and recalculate the cell size according to set parameters.

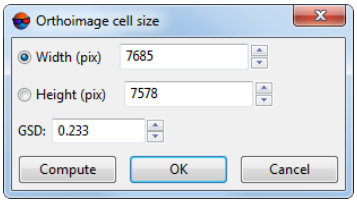

Fig. 6. Orthoimage cell size

- **Background color** – allows to set a colour for orthoimages background, since output orthoimages always inscribes into a rectangular of this color.
- **Resampling method** – allows to choose the brightness interpolation mode during orthomosaic creation: **bilinear**, **cubic** or **nearest neighbour**;

- **Shift background color** – allows to specify a shift of colour on the image if this colour coincides with defined colour of orthoimages background.

- **Geometry correction cell size** – allows to setup a fragment size (in pixels) when creating orthoimages using fragments with projective dependence.

  The larger the fragment, the faster the mosaic building and the lower the accuracy of output orthoimages. The value of 32 pixels is optimal for “speed-accuracy” ratio.

- **Output raster channels** – opens the window **Output image parameters**, used for specifying the following parameters:

  By default quantity and structure of channels are defined by first added image.

  - **Use radiometric form RMC-files** – is used when create orthoimages if in the *Raster Converter* module was preliminary performed the radiometric correction (see the “General information about system” User Manual);

  - **Channels list** – contains list of source (left) and selected for using in orthorectification channels (right);

    Quantity and structure of channels are forming with buttons of the **Channels list** section.

  - **Data format** – allows to choose the format of image: **8 bit** or **16 bit**;

  - **Monochrome output** – allows to create output file with one grayscale channel.

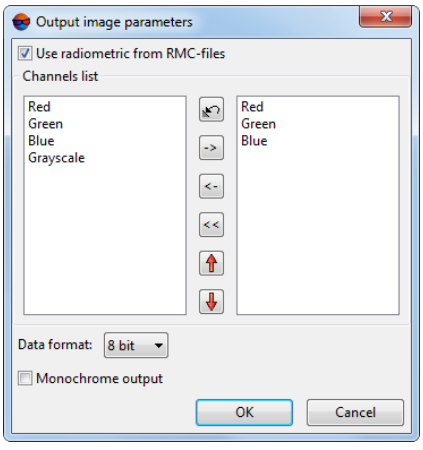

Fig. 7. Output channels parameters

- **Rotation angle** – allows to setup a rotation angle (in degrees) of orthoimages.

This option is used if a block of initial images has elongated shape and it is necessary to remove over background area in rectangular window of created orthoimages.

- **Source rasters background color range** – allows to set a deviation from background color: to specify a range of color, that consider as background in initial images (see the “Orthomaps creation” User Manual);
- **Additional check for black background** – for areas out of DEM is used a black background in orthoimages creation;
- **Transform inside polygons** – area of orthorectification is set by arbitrary polygons from a vector file. Choose a file with polygons in active profile resources.

Also the **Orthoimage** tab allows to choose **Input** and **Output coordinate systems**.

6.3. Output orthoimages parameters

The **Output** tab of the **Orthoimages parameters** window purposes to setup output options of orthoimages creating.

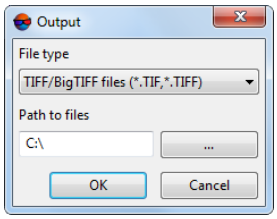

Fig. 8. Output orthoimages parameters

The **Map scale** field allows to set the scale of output orthoimages.

The **Calculate map scale** button allows to calculate a scale and map sheet size (in meters) and print resolution (in dpi).

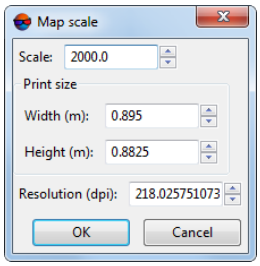

Fig. 9. Map scale

With orthomap in chosen format also could be created the following additional files (depending on output format):

- **Create MS TIFF** – [only TIFF/BigTIFF output format support] output images creates in MS TIFF format with pyramid that helps to redraw images more quickly on a screen;
- **Create Geo TIFF** – [only TIFF/BigTIFF output format support] output orthoimages create in Geo TIFF format with pyramid;
- **Create pyramids** – allows to create pyramids for output orthoimages in files of internal format;
- **Create KML** – allows to create additional file in KML format, e.g. to show results in the *Google Earth*;

It is necessary to choose global coordinate system as output to create file in KML format.

KML-files are creating both for all block and each image individually.

The **Output images compression** allows to set up the compression parameters of output orthoimages files:

- **None** – files are creates without compression;
- **JPEG with quality .. %** – files are creates with set quality of JPEG-compression;

Default compression level is 75 %, that provides the 5-7 times compression of initial image volume.

- **LZW** – files are creates with LZW-compression.

Also the **Output** tab allows to set the following parameters of saving files during orthorectification:

- **Georeferenced file** – allows to select the format of the additional file created;
- **Swap X, Y** – allows to swap X,Y coordinates to obtain output orthoimages;
- **Create georeference only** – allows to create just georeference files of orthoimages without orthorefication (i. e. without files creation);
- **Set background color as "transparent"** – allows to set the output background color which is shown in MapInfo system, as transparent when saving the resulting orthoimage in *MapInfo* or *"GIS Map 2011"*, chosen in the **Georeference file** list;
- **Save georeference as "NonEarth"** – allows you to save georeference In NonEarth coordinate system, when saving the resulting orthoimages in *MapInfo TAB* program;

Used if*MapInfo* system does not support coordinate system of mosaic project.

- **Save metadata** – allows to save images metadata in the `*.x-feat`-file: background colour, number of channels and its settings;
- **Save datum parameters** – allows to save seven parameters of coordinate system to meta data of TIFF-file;
- **Save DEM** – allows to save the DEM file to the output path.

The **Output data** button allows to choose output format of orthoimage and set path to files.

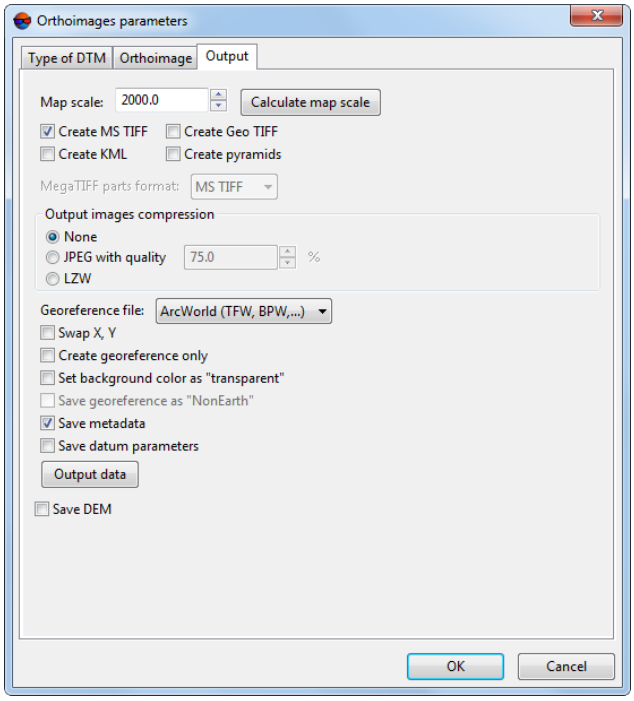

Fig. 10. Map scale

7. Orthoimages creating in distributed processing mode

The system provides possibility of creating orthoimages in distributed processing mode and also to use distributed processing of MegaTIFF.

To create orthoimages in distributed processing mode, perform the following actions:

1. Change settings and run the distributed processing server/client (see the "*Distributed processing*" chapter in the "General information about system" User Manual).

2. Change settings and run the distributed processing server/client (see the "*Distributed processing*" chapter in the "General information about system" User Manual).

3. Set up parameters of orthorectification (see Section 6).

4. Click the button of the **Orthorectification** toolbar. The **Mosaic distributed processing** window opens.

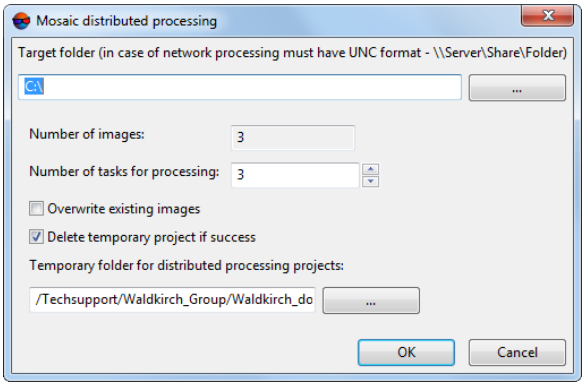

Fig. 11. Mosaic's distributed processing parameters

5. Define **Target folder** for output orthoimage.

In case of network processing path mast have `\\Server\Share\Folder` format.

6. The **Number of sheets** displays in the window. Set the **Number of tasks for processing** based on one kernel for one task.

7. Setup the following parameters:

   - **Overwrite existing images** – allows to rewrite previously created orthoimages sheets;

   - **Delete temporary project if success** – allows to remove the folder with temporary project if success; Is used by default.

8. Set path to a **temporary folder for a distributed processing project**.

9. Click OK. Distributed processing tasks are created and the system shows a message about number of created tasks.

To create orthoimages in distributed processing of MegaTIFF mode, perform the following actions:

1. Change settings and run the distributed processing server/client (see the "*Distributed processing*" chapter in the "General information about system" User Manual).

2. Change settings and run the distributed processing server/client (see the "*Distributed processing*" chapter in the "General information about system" User Manual).

3. Set up parameters of orthorectification (see Section 6).

4. Click the button of the **Orthorectification** toolbar. The **Distributed processing** window opens.

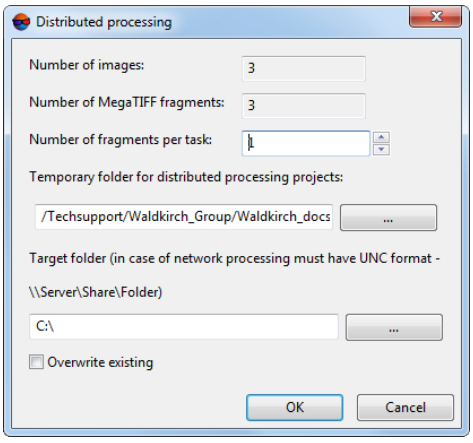

Fig. 12. Mosaic's distributed processing of MegaTIFF paramters

The total **Number of sheets** and **Number of MegaTIFF fragments** are displays in the window.

5. Set the **number of fragments per task**.

   It is recommended to estimate number of tasks based on network capacity and speed of hard drives.

6. Define path for temporary files of distributed processing.

7. Define **Target folder** for output orthoimages.

   In case of network processing path mast have `\\Server\Share\Folder` format.

8. [optional] To rewrite previously created orthoimages sheets, set on the **Overwrite existing** checkbox.

9. Click OK. Distributed processing tasks are created and the system shows a message about number of created tasks.

8. Accuracy control

The system allows to perform accuracy control of orthoimages creation.

Visual displaying of residuals vectors is used for that. Residuals vector on point is a difference of the same point position, calculated from different images for used DEM.

To display residuals on a block scheme, click the button of the **Orthorectification** toolbar. The **Display options** and **Triangulation points** windows open. Residuals are displayed in a 2D-window considering to a specified parameters.

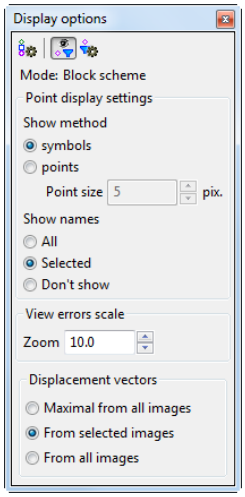

Fig. 13. Parameters of triangulation points display

The **Display options** window contains the toolbar with buttons used to perform the following operations:

- – allows to display list of symbols of point on a block scheme (see the “Block adjustment” User Manual);
- – allows to set on/off the filter of triangulation points display;
- – allows to set filter of triangulation points display (see the “Block adjustment” User Manual).

In the `Mode` field is displayed chosen mode of block scheme, It depends on active 2D-window – `Block scheme` or `Image`.

Triangulation points are not displayed in the stereopair 2D-window.

The **Point display settings** section allows to setup the following parameters:

- The **Show method** of points:

- **symbols** – points are displayed by selected symbols;
- **points** – **point size** is specified in pixels.

- **Show names** the following points in 2D-window:
  - **All** points;
  - **Selected** points;
  - **Don't show** points names on a block scheme.

The **View error scale** section allows to define scale of residuals on a block scheme. **Zoom** of scale – size of residual vector is equal to a scheme scale. At that vectors are zoom in/out during zooming in/out of block scheme.

Error vector creates in regard to a point's position on each image with point's coordinates.

The **Displacement vectors** section allows to choose what quantity of vectors for what type of points are displayed on a block scheme:

- **Maximal from all images** – maximal error vector for each point displays;
- **From selected images** – all error vectors for points on selected image display;
- **From all images** – all error vectors for all points display.

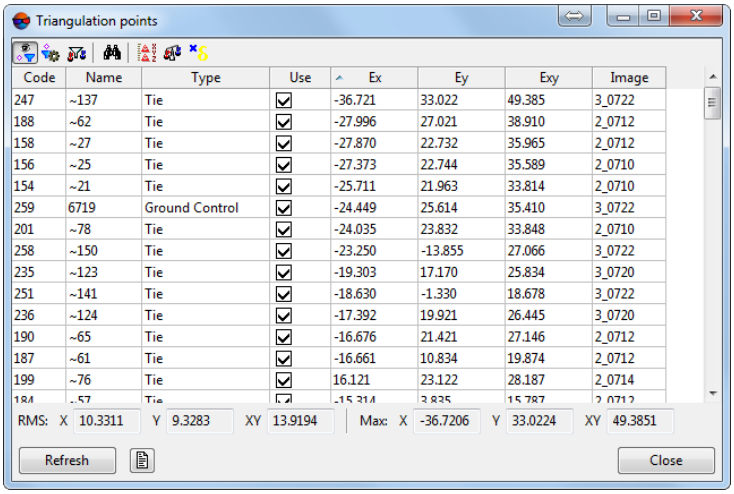

Fig. 14. The "Triangulation points" window

Table 2. Toolbar of the "Triangulation points" window

Buttons	Function
	allows to set on/off the filter of triangulation points display
	allows to setup the filter of triangulation points display

Buttons	Function
	allows to display all/selected points in the table
	is used to search for an image by name (part of name)
	allows to display GC/tie points with initial coordinates (see the 'Aerial triangulation" User Manual);
	allows to set the percent of trim image edges during orthorectification
	allows to display triangulation points with coordinates obtained after adjustment
	allows to display only errors

For refreshing data in the list and on a block scheme about project state after changes the **Refresh** button is used.

The  button allows to display accuracy control report of orthoimages creation in a print forms, and also to save the report as text, export or print it.

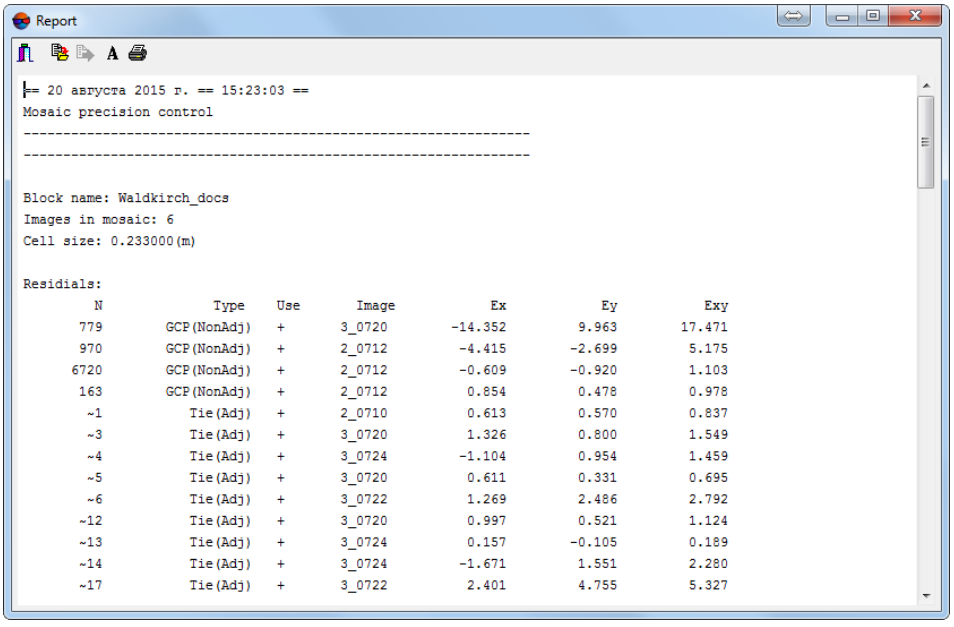

Fig. 15. Accuracy control of orthoimages creation

The list of triangulation points is a table with the following columns:

- Code of the point;
- Image name;
- Type – tie, GCP, check, excluded;
- Use – data about point use for calculating of DEM deviation by Z-coordinate:
  - ☑ – the triangulation point was used;

  - ☐ – the triangulation point was not used;
  - ⛔ – the triangulation point cannot be used, since it was not used for adjustment.

- Ex – coordinate discrepancy on X;
- Ey – coordinate discrepancy on Y;
- Exy – error of plane point position (the square root of X and Y errors sum).
- Image – name of image for which is calculated error value on selected point.

In the status bar is displayed the **RMS** value and maximum error (**Max**) as points position and coordinate discrepancy on X and Y.

The **Triangulation points** window is synchronized with 2D-window: when point selecting in 2D-window it is also selects in the table.

Double-click on point's name in the table allows to open the **Points measurement** module for edit point's position.