Digital Photogrammetric System

PHOTOMOD

Version 8.0

USER MANUAL

ScanCorrect program
(Windows x64)

RACURS

Table of Contents

1. About

PHOTOMOD ScanCorrect module is designed for compensation of metric errors occurred when scanning graphical data (analog airborne imagery) on flatbed polygraphic scanners.

2. Purposes of the PHOTOMOD ScanCorrect module

It is necessary to transform scanned image to compensate scanner errors. Information on distribution of scanner errors required for transformation is stored in files with `*.etm` extension. This information is created during the construction of *disturbances field*.

Scanner's *disturbances field* is created using raster data obtained by scanning *calibrated material* (regular grid or regular set of crosses). It is possible also to input and use the table containing coordinates of crosses.

Input and output data of the program are 1, 4, 8 and 24-bit Windows `*.bmp` or `*.TIFF` files. Auxiliary data is stored in `*.etm` (*disturbances fields*) `*.sct` and `*.psp` files.

3. Main conventions and terms

Disturbances field – a set of data, characterizing scanner's metrical errors in some scanned area. It takes into account non-squareness of raster element if calibrated material is regular with enough precision.

Reference point – a point on raster image, correspondent to some characteristic physical point on static object in scanner's working area. The user can use a corner of some object, fastened on scanner's plane, which remained in its position during scanning sequence.

Calibrated material – regular grid or regular set of crosses with small period made on non-deforming material like glass or special film. Based on raster image of this object, obtained via scanning, disturbances field is created by the program.

4. Interface and its elements

To launch the program choose **Rasters › ScanCorrect** in *PHOTOMOD* main window.

Main menu bar contains the following menus:

- **Field**;

- **Table**;

- **Images**;

- **Batch mode**;

- **Help**.

Basic operations are realized in toolbar:

Table 1. The Field menu items and toolbar buttons

Menu items and toolbar buttons	Purpose
Create field (**Ctrl+P**)	to create the disturbances field file for the selected image
View field (**Ctrl+R**)	to view disturbances field
Statistics (**Ctrl+S**)	to view statistics on disturbances field
Manual cross input (**Ctrl+K**)	to edit cross coordinates

Table 2. The Table menu items and toolbar buttons

Menu items and toolbar buttons	Purpose
Create table (**Ctrl+A**)	to create a table containing crosses coordinates
View table (**Ctrl+B**)	to open and view the disturbances field from the table file
Manual cross input (**Ctrl+Shift+K**)	to edit a table containing crosses coordinates

Table 3. The Images menu items and toolbar buttons

Menu items and toolbar buttons	Purpose
View image (**Ctrl+V**)	to open image file located in a folder of *Windows* file system
Transformation (**Ctrl+T**)	to transform single selected image

Table 4. The Batch mode menu items

Menu items and toolbar buttons	Purpose
New project (**Ctrl+Alt+N**)	to create a file with `*.psp` extension and select image files for the batch transformation
Open project (**Ctrl+Alt+O**)	to open the file with `*.psp` extension and perform the batch images transformation

Table 5. The Help menu items

Menu items and toolbar buttons	Purpose
Help	to view the system information and open the current User Manual
About	opens a window indicating the number of system build and serial number of hard lock key, the technical support end date, and also opens the **System Information Panel** window with detailed information about software, hardware configuration, and components of the computer (such as details about the device drivers)

5. Workflow in system

The technique for working with *PHOTOMOD ScanCorrect* consists of the following:

1. include *calibrated material* into sequence of scanning of graphic material (for obtaining *disturbances field*);

2. create scanner's *disturbances field* using raster data from the scanning of calibrated material;

3. transform raster data using *disturbances field*.

> Research on the metric properties of flatbed scanners shows that *disturbances field* is mostly due to systematic scanner errors. This permits the use of *disturbances field* created from one image to transform another.

If the original material (e.g. photomaterial) has calibrated crosses on it, the technique remains the same with the only difference that *disturbances field* is created using the same raster data that is used in transformation.

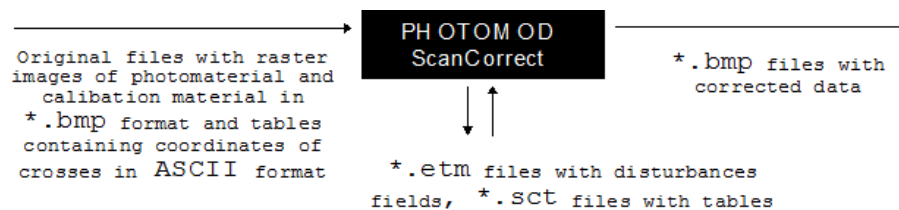The user can consider table values of crosses coordinates for transformation.

Fig. 1. Chart of data flows in the program

The program allows to get metrically correct data on the basis of:

*   scanned raster images of *original photomaterial* and *calibrated material*;

*   scanned raster image of *original photomaterial* with crosses and *calibrated material* with calibrated crosses on it;

*   scanned raster image of *original photomaterial* with calibrated crosses on it taking into account *table with coordinates of crosses*;

*   scanned raster images of *original photomaterial* with crosses and *calibrated material* taking into account *table with coordinates of crosses on photomaterial*;

- scanned raster images of *original photomaterial* and *calibrated material* taking into account *table with coordinates of crosses on calibrated material*.

Order of operations depends upon the task being solved:

- compensation of scanner's systematic errors;

- improvement of metric characteristics of a raster image using calibrated crosses if they have regular coordinates with sufficient precision;

- improvement of metric characteristics of a raster image using calibrated crosses with known coordinates;

- improvement of metric characteristics of a raster image using calibrated crosses with known coordinates (using *calibrated material*);

- compensation of the systematic scanner error using non-ideal *calibrated material* with known coordinates of crosses.

> User can use *disturbances field* of non-ideal *calibrated material* obtained on metric scanner as a table for its crosses coordinates. To do this choose **Import (.etm)** when creating table.

There is a possibility to view and edit the scanner's disturbances field and calculate its statistics. Disturbances field, minimized using least squares method, is visualized in such a way that by the color of its points the user can judge the absolute error in that point.

Efficiency of this technique of metric compensation of systematic scanner's error can be checked in the following way:

1. scan metrically correct grid with a small distance between crosses two times shifting it slightly after first scan;

2. create disturbances field using one of them;

3. transform another image using created field;

4. create field using transformed image;

5. analyze statistics and compare this field with original.

6. Disturbances field

6.1. Creating the disturbances fields

In order to create disturbances field perform the following:

1. Choose **Field › Create field** in the main menu or click the button in toolbar. The **Create field** window opens:
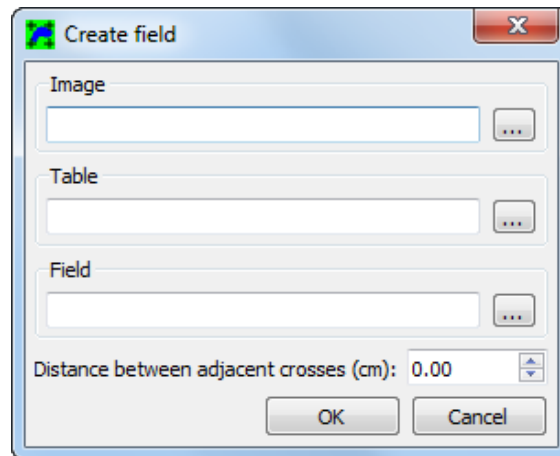

Fig. 2. The Create field window

2. Click the button that corresponds the **Image** field. Select the scanned image with `*.bmp` or `*.TIFF` extension (*calibrated material* or scanned raster image of original photomaterial with calibrated crosses on it). The window with this image and additional panel controlling input of crosses' points (**Select crosses**) appears:

> If the original material (e.g. photomaterial) has calibrated crosses on it, the technique remains the same with the only difference that *disturbances field* is created using the same raster data that is used in transformation (see the "Workflow in system" chapter).
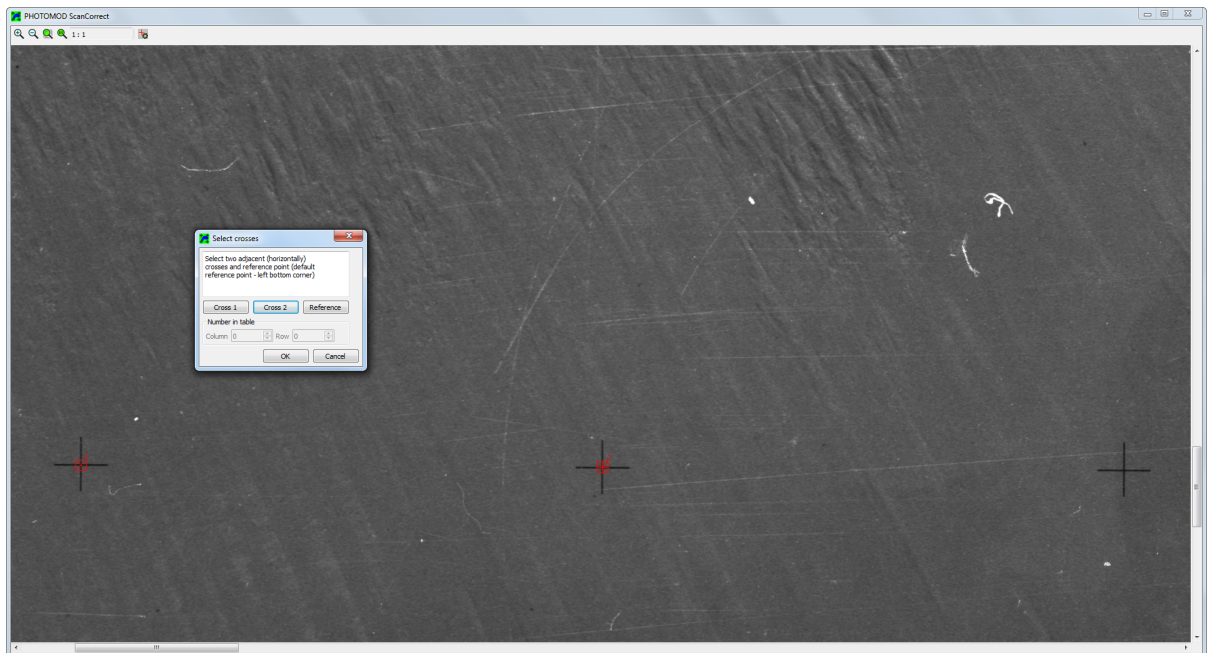

Fig. 3. The Select crosses window

The image window contains a standard toolbar with scaling buttons (🔍, 🔍, 🔍, 🔍) and marker type selection (✛ – see the "General information" User Manual).

To start the automatic search of crosses centers (or nodes of grid) do the following:

1. Select on the image two adjacent (in horizontal direction) well defined crosses (nodes of grid). To do this, place cross-shaped marker on cross center and click the button **Cross 1** in **Select crosses** window, then place marker on an adjacent cross and click the button **Cross 2**.

2. [optional] To transform an image using *disturbances field*, it is needed to link image coordinate system and field coordinate system. It is needed to establish this connection in case of working with disturbances field created from a *calibrated material.*

    If crosses were on original image, there is only one coordinate system and it is not needed to create the link between different systems explicitly. It is done automatically using the beginning of raster image (point with (0, 0) coordinates).

    To create reference between *disturbances field* and scanner's working field do the following:

    Select a *reference point* position of which does not change in the scanner's plane from one scanning to another. For selecting place cross-shaped marker on required image point and click the **Reference** button in **Select crosses** window.

3. Click OK to return to the **Create field** window.

3. [optional] If it is needed to take into account crosses table values perform the following:

    1. Click the [...] button corresponding the **Table** field of the **Create field** window. Choose file with table values (with `*.sct` extension). The window with image and additional panel controlling input of crosses' points (**Select crosses**) appears;
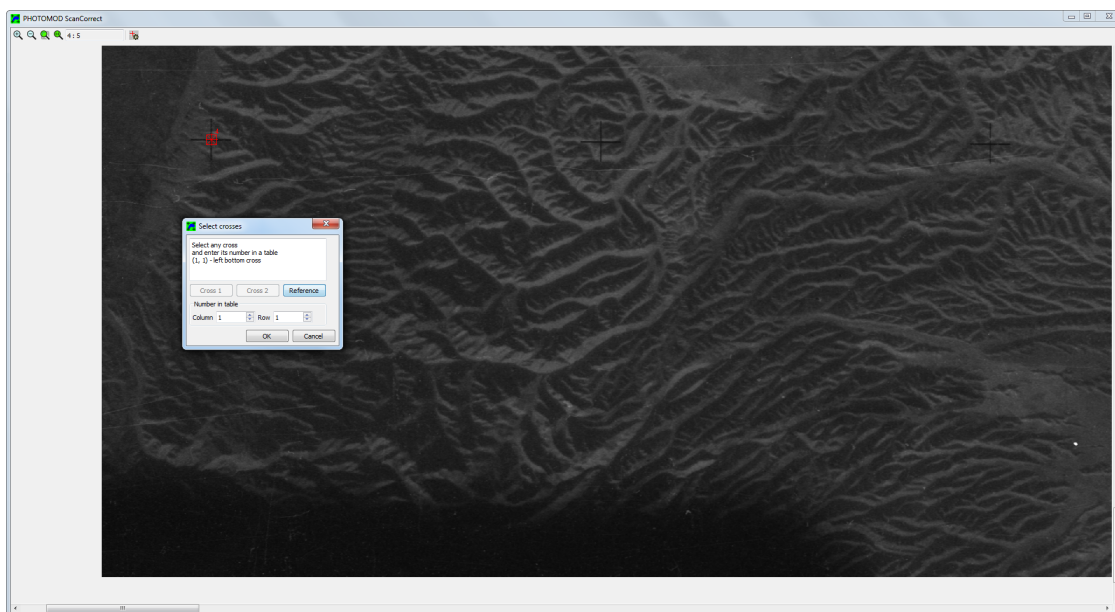
Fig. 4. The Select crosses window

2. To link coordinate system of crosses on raster image and coordinate system of crosses in table select on image well defined cross (node of grid). To do this, place cross-shaped marker on cross's center and press button **Reference** in controlling window;

3. Input table's **row** and **column** of selected cross in **Number in table** section;

4. Click OK to return to the **Create field** window.

4. In the **Field** section of **Create field** window user can edit fields file name. To perform this, click the ⟦...⟧ button corresponding the **Field** section of the **Create field** window.

Fig. 5. The Create field window

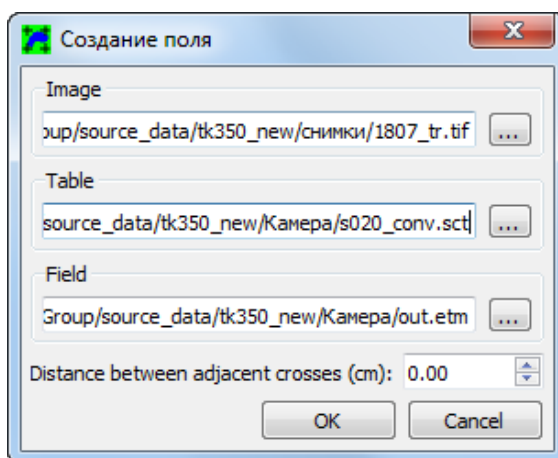5. [optional] Input the **Distance between adjacent crosses (cm)** on the photomaterial;

6. To create disturbances field (taking into account table, if any) click OK button. After successful completion of automatic search procedure the information message will appear.
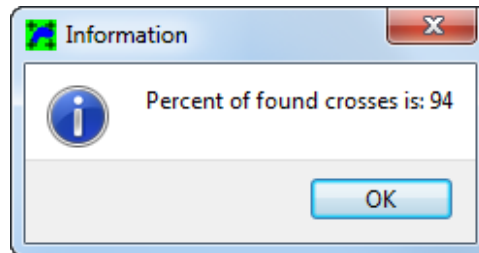
Fig. 6. The information message

7. Click OK, to view disturbances field. Wait until the operation is complete. The **Field view** window appears.

It comprises two color plates each representing disturbances along different axes. Moving mouse cursor above them user can see error in the point and point's coordinates (in plane coordinate system) in lower part of the window. Crosses on plates represent crosses used for field creation.

> Use arrow keys to move the marker between the crosses. To move the marker between crosses, use arrow keys. The selected cross is highlighted with a small yellow circle. To display this tool, press the **Left arrow**, **Right arrow**, **Down arrow**, and **Up arrow** keys several times.
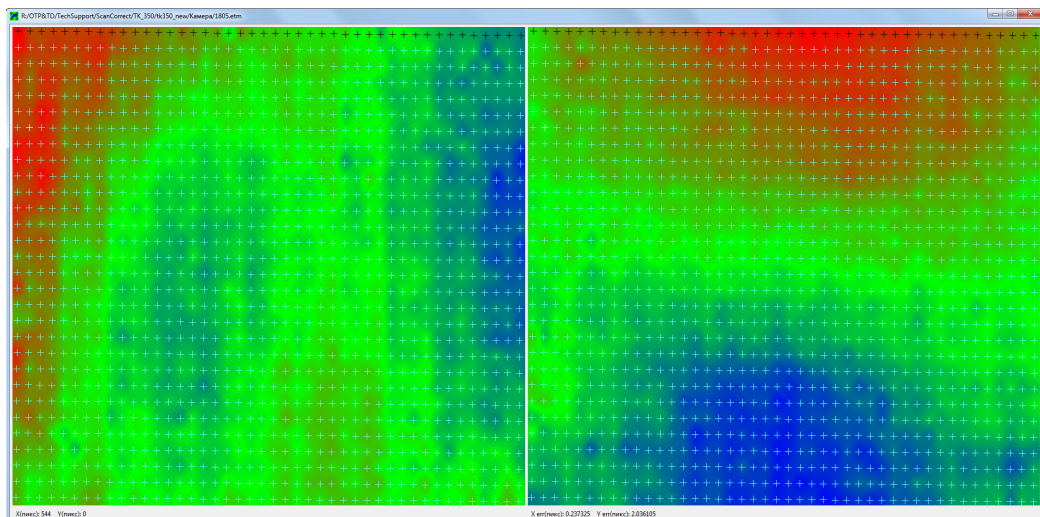
Fig. 7. Disturbances field

6.2. Viewing and editing disturbances fields

To view *disturbances field* choose **Field › View field** or click the button 🔳 in main toolbar. Files with `*.etm` extension filtered for opening by default. Open the needed file. The **Field view** window appears. It comprises two color plates each representing disturbances along different axes. Moving mouse cursor above them the user can see error in the point and point's coordinates (in plane coordinate system) in lower part of the window. Crosses on plates represent crosses used for field creation.

User can edit manually coordinates of crosses. For example it is needed for correcting crosses that were not found automatically. These crosses are painted in dark color.
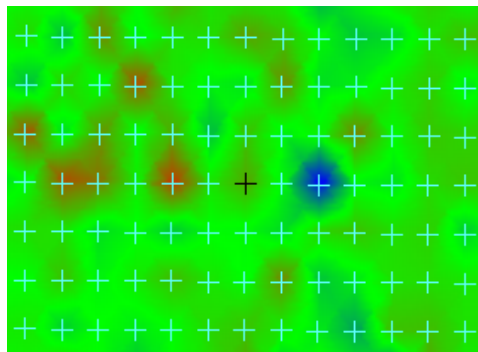
Fig. 8. The "wrong" cross, painted in dark color

To edit coordinates perform the following:

1. Select a cross for editing – place marker on it using arrow keys;

    ☞ The selected cross is highlighted with a small yellow circle. To display this tool, press the **Left arrow**, **Right arrow**, **Down arrow**, and **Up arrow** keys several times.


Fig. 9. The "wrong" cross selection

2. Choose **Field › Manual cross input** (**Ctrl+K**). The **Manual crosses setting** window appears:

⚠ If the program fails to find and open image file for an appropriate disturbances field – the information message **Can't open file** will be displayed.
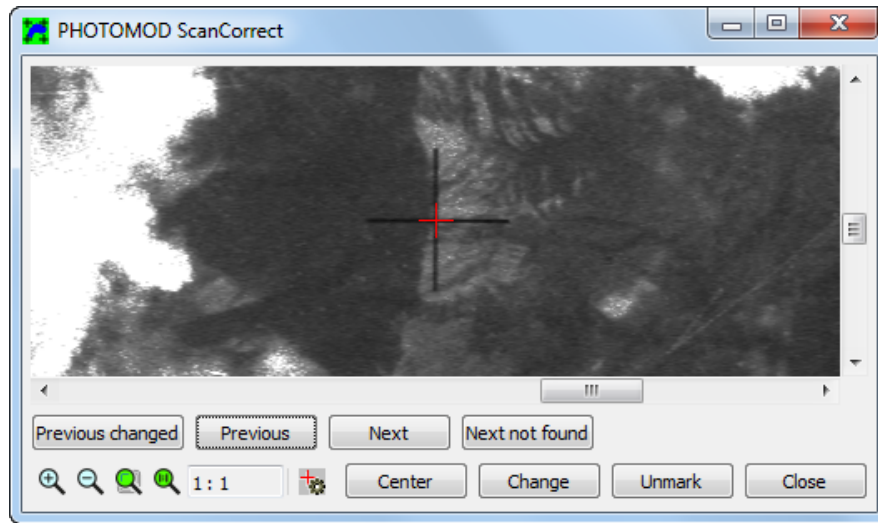
Fig. 10. The Manual crosses setting window

It consists of part of original image around the cross and buttons section. There is cross-shaped marker on image which can be moved by left-clicking or by arrow keys.

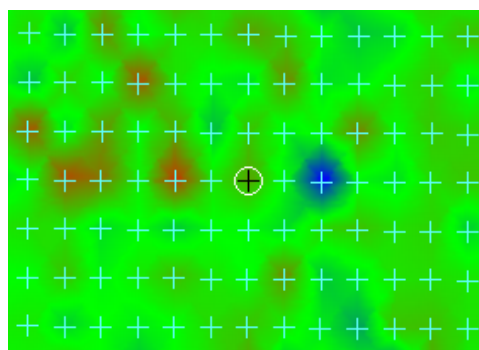The image window contains a standard toolbar with scaling buttons (🔍, 🔍, 🔍, 🔍) and marker type selection (➕ – see the "General information" User Manual).

Buttons below image realize the following commands:

- move to **previous changed** cross;

- move to **previous** cross;

- move to **next** cross;

- move to **next not found** cross;

- scroll window so that cross-shaped marker to be in the window **center**;

- **change** the coordinates of current cross;

- **unmark** cross (mark as unfound), if nonexistent cross was found;

- **close** the window and exit from manual editing.

3. Find the required cross in the cross manual input box. For this, perform the following:

- [optional] Activate the disturbance field viewer by clicking it with the **left mouse button**. Use arrow keys to move between the crosses, tracking the image movement in the manual cross input box;

- [optional] Activate the manual cross input box by clicking it with the **left mouse button**. Move between not-found crosses using the **Next not found** button, tracking the yellow circle in the image viewer.
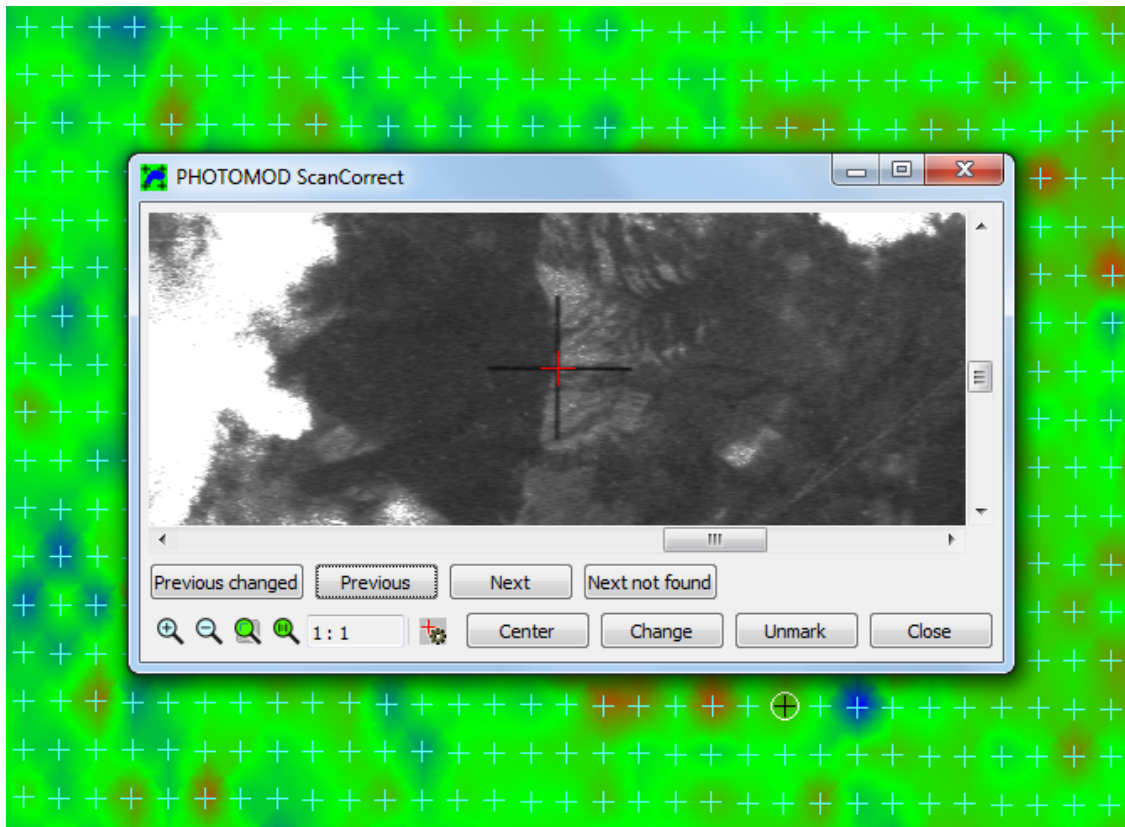
Fig. 11. A search for the "wrong" cross

4. Click the left mouse button to place the marker on the not-found cross;

5. Click **change** to set the new coordinates of the current cross;
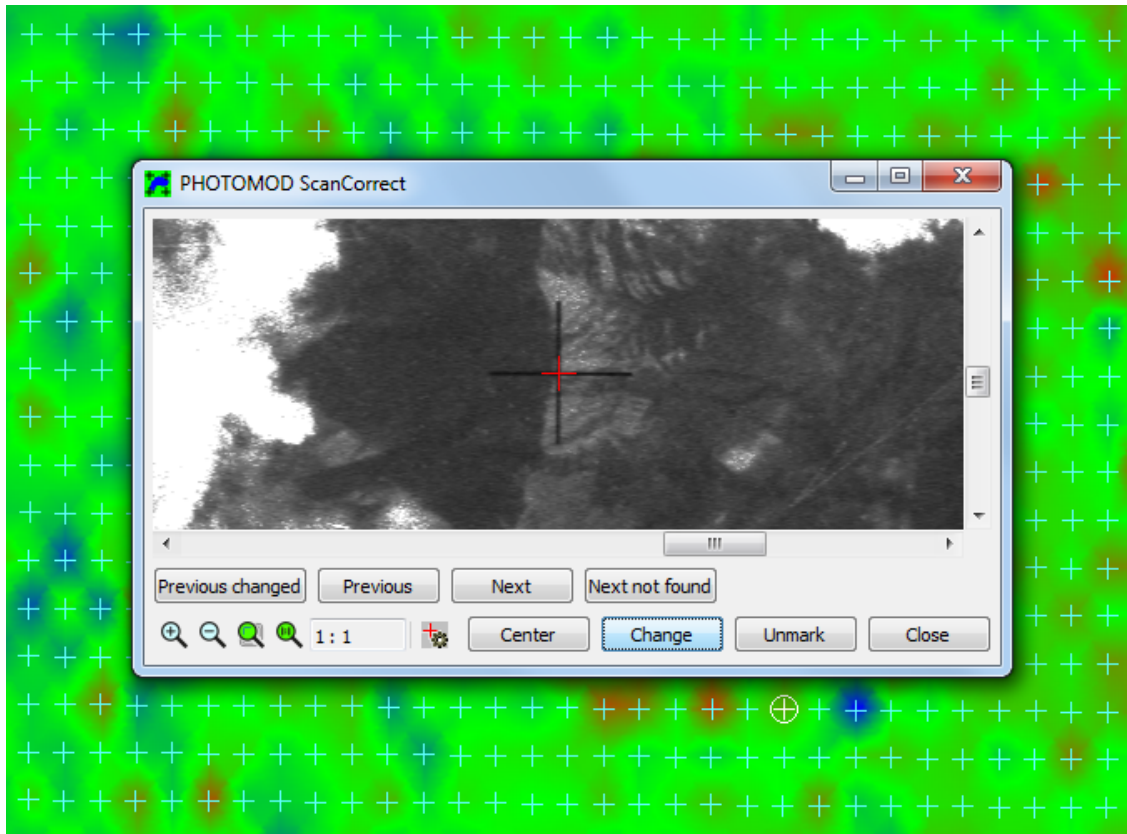
Fig. 12. The "wrong" cross position clarification

6. Repeat the actions from the paragraphs **3**, **4** and **5**, if needed;

7. Click **Close**. Click **Yes** to confirm the changes.
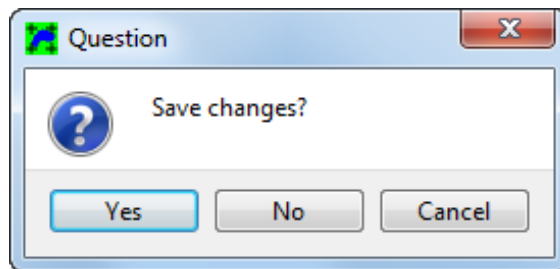
Fig. 13. The dialog window

☞   Corrected crosses are highlighted in yellow in the disturbance field viewer.

6.3. Viewing field's statistics

When viewing *disturbances field* (when the window with it is opened) the user can get statistic information about the field. To do this choose **Field › Statistics** from main menu or click the button 🟩 in toolbar.

The window **Statistics** with two histograms (for X and Y axes) appears.

The window also contains the following statistic data:

• **Crosses along X/Y** – number of crosses along X or Y;

• **Max "+" error** – maximum for "+" error;

• **Min "-" error** – maximum for "-" error;

• **Average error** – average of absolute errors;

• **Dispersion** – average square error.

All data calculated separately for two axes using the whole field.

☞   All deviations in the **Statistics** box are displayed in scan pixels.

Fig. 14. Disturbances field statistics

7. Table with crosses values

Depending upon the source of table data – ASCII file (**Import (.txt)**), `*.etm` file (**Import (.etm)**) or **manual input**, perform the following steps:

7.1. Creating table with crosses values in manual mode

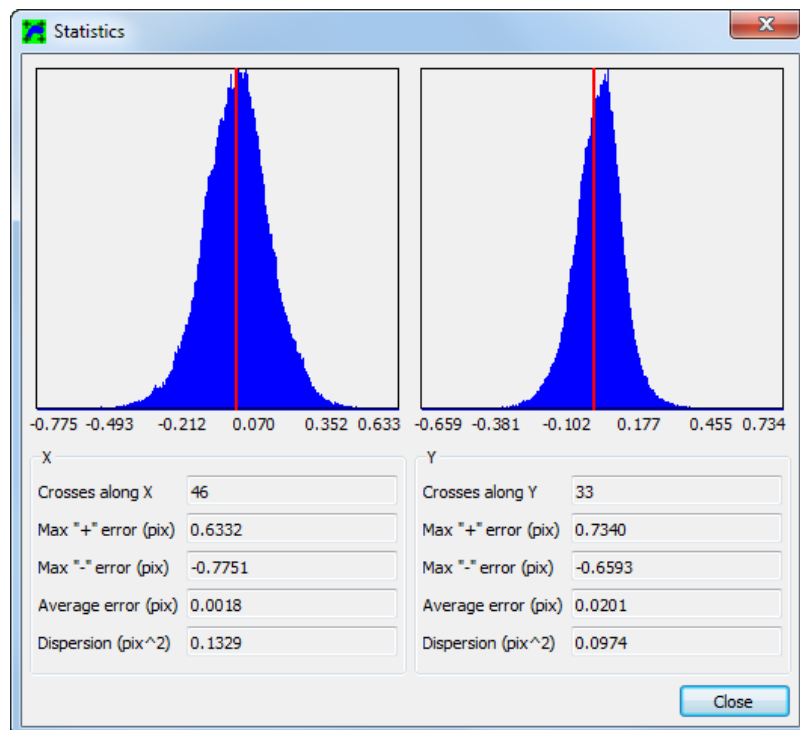To create a table with crosses values in manual mode perform the following:

1. Choose **Table › Create table** (**Ctrl+A**) or click the button 🏓 in the main toolbar. The **Input table** window appears:
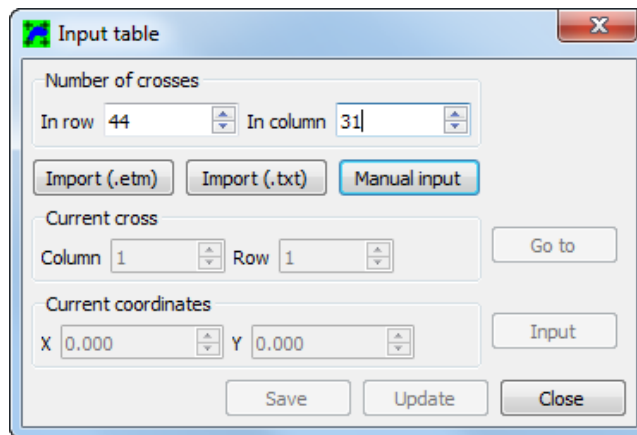
Fig. 15. The Input table window

2. Input table's dimensions in **Number of crosses** section (**in row** and **in column** fields);

> ☞ After the values of the **In Row**s and **In Column**s fields are specified using ▼ and ▲ buttons (and become non-zero), the Manual Input and **Import (.txt)** buttons become available to the user.

3. Click the **manual input** button. Window with **table view** appears. This window looks the same as **field view** window.

   The marker is set to the first cross (red arrow in the picture). The other crosses are not displayed at this moment.

> ☞ The zero point for crosses is the lower left corner of the table.
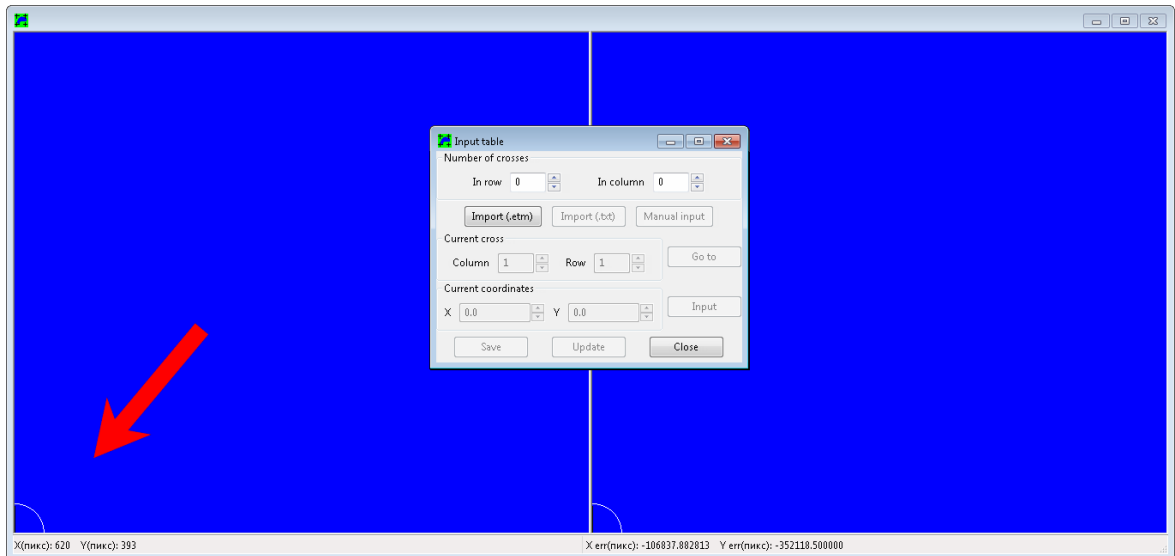
Fig. 16. Creating tables with crosses values in manual mode

4. [optional] to change the current selected cross (**row** – 1, **column** – 1 by default, at the beginning of the operation) – input it's **row** and **column** in **current cross** section of the window and click the **Go to** button;

> When performing this operation, as well as subsequent items **5** and **6**, the appearance of the box remains unchanged.

5. Input current cross's coordinates. To do this input them in **Current coordinates** section (fields **X** and **Y**) and click the **Input** button;

6. Refresh **table view** window so that it corresponds to all updates by clicking the **Update** button. The disturbances field and all the crosses of the table appear. They have different colors depending upon its current state:

   • not significant (on the border) – black;

   • not entered – blue;

   • entered – white.

   The **current cross** is highlighted by the circle.
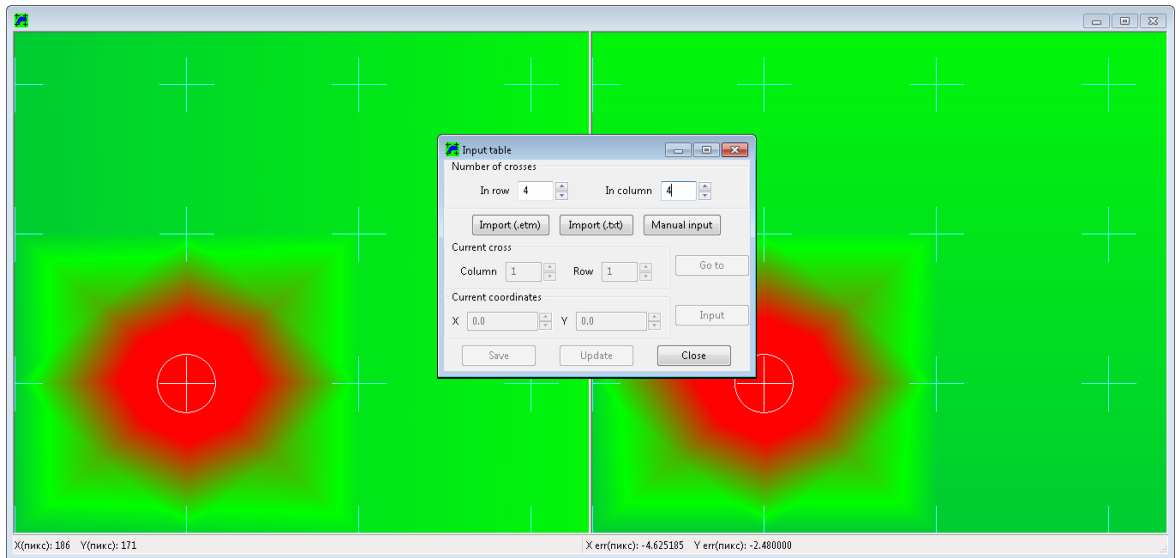
Fig. 17. The disturbance field based on the table of crosses after entering the first cross. The number of crosses is 4 crosses in a row and 4 crosses in a column. In item **4** (optional), the cross located in the second row of the second column (indicated in white and with a circle) was selected as the first cross to enter.

7. Input all the crosses, repeating paragraphs **4**, **5** and **6**;

> Use arrow keys to move the marker between the crosses after the window **Update**.

8. [optional] Refresh **table view** window so that it corresponds to all updates by clicking the **Update** button, when all the crosses are set;

Fig. 18. The window after **Update** (all crosses are set)

9. For future work with table user must save it: click the **Save** button and input in the
    table file name.

> By default, extension `*.sct` is used for files containing tables.

10. **Close** the window.

> To edit crosses coordinates when the **Input crosses** window is closed (while window with
> disturbances field is opened) choose **Table › Manual cross input** (**Ctrl+Shift+K**).

7.2. The table with crosses values import

To import a table with crosses values in perform the following:

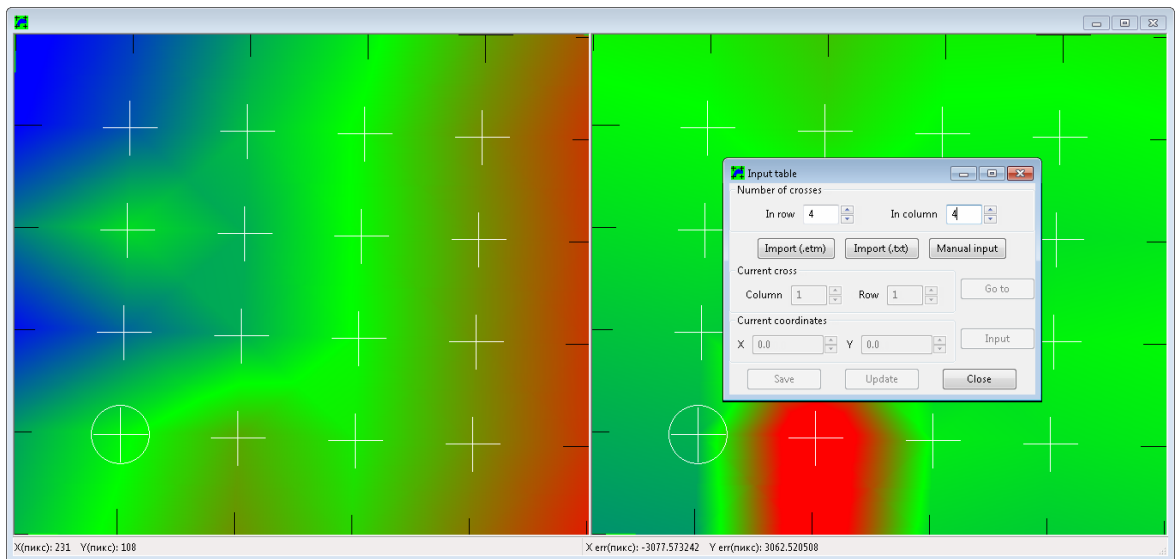1. Choose **Table › Create table** (**Ctrl+A**) or click the button 🟩 in the main toolbar.
    The **Input table** window appears:
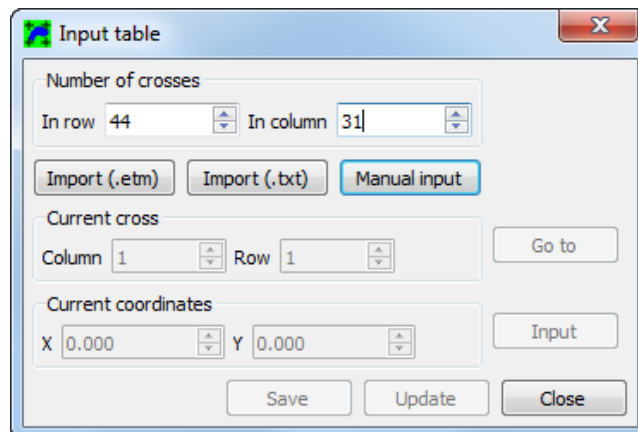
Fig. 19. The Input table window

2. [optional] Input table's dimensions in **Number of crosses** section (**in row** and **in
    column** fields);

> This step is required in cases of **manual input** and import from ASCII file (**Import (.txt)**).

3. [optional] click the **Import (.txt)**, or **Import (.etm)** button, depending upon the source
    of table data;

> Select `*.txt` or `*.etm` file in cases of **Import (.txt)**, or **Import (.etm)**, respectively.

Window with **table view** appears. This window looks the same as **field view** window.

> The manual editing of the crosses coordinates is described in chapter above.

4. [optional] edit crosses coordinates, if needed;

5. For future work with table user must save it: click the **Save** button and input in the table file name.

> By default, extension *.sct is used for files containing tables.

6. **Close** the window.

> To edit crosses coordinates when the **Input crosses** window is closed (while window with disturbances field is opened) choose **Table › Manual cross input** (**Ctrl+Shift+K**).

7.3. Viewing tables

To view a table with a crosses and the *disturbances field* perform the following:

1. Choose **Table › View table** (**Ctrl+B**) from the main menu or click the button 🗔 in the main toolbar. Select file with table. Files with *.sct extension filtered for opening by default. Window with table appears:
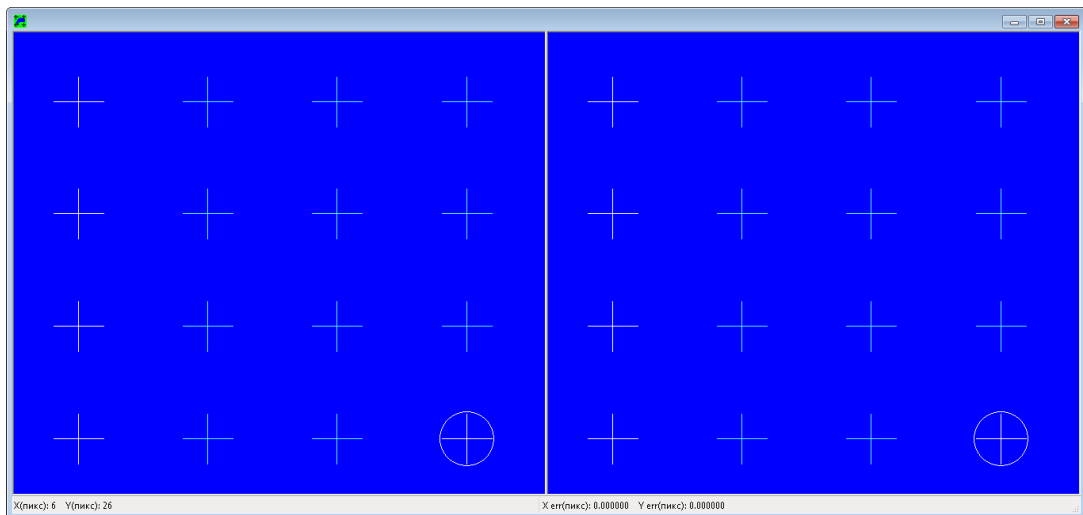
Fig. 20. A table with crosses

2. Choose **Table › Manual cross input** (**Ctrl+Shift+K**). The **Input table** window appears:
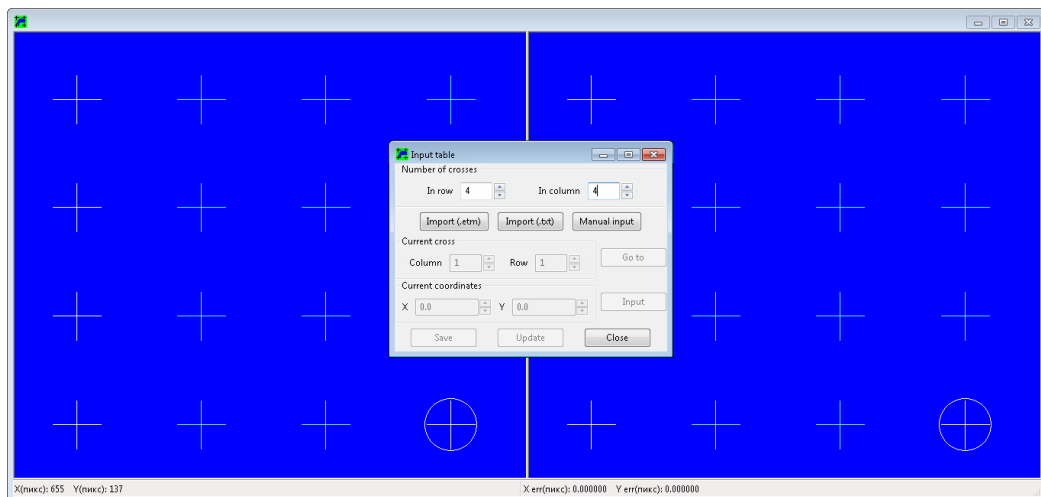
Fig. 21. A table with crosses

3. Refresh the window by clicking the **Update** button. The disturbances field appears.
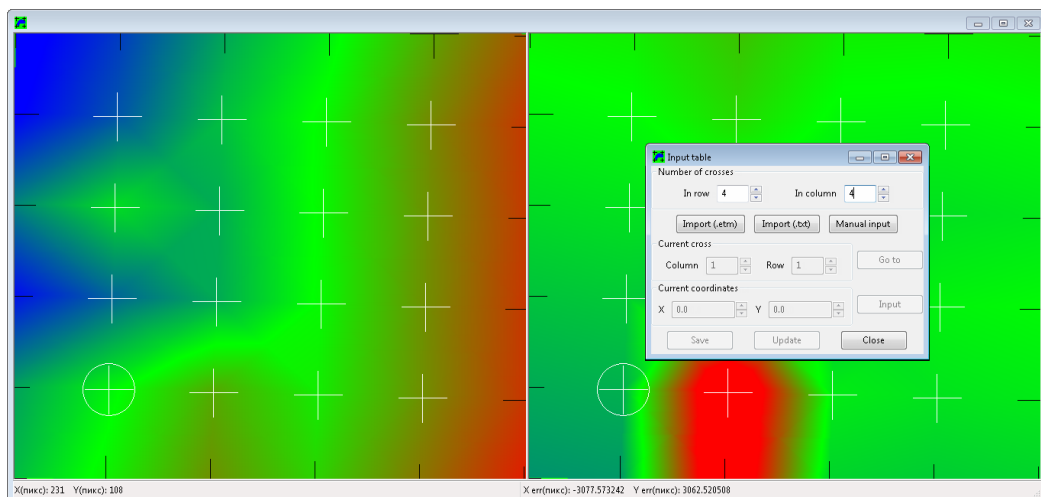
Fig. 22. The window after **Update** (all crosses are set)

The crosses in the table have different colors depending upon its current state:

- not significant (on the border) – black;

- not entered – blue;

- entered – white.

The **current cross** is highlighted by the circle. The manual editing of the crosses coordinates is described in chapter above.

8. Transforming images

8.1. Transforming single image

To transform an image do the following:

1. [optional] include *calibrated material* into sequence of scanning of graphic material (for obtaining *disturbances field*);

    ⚠️ Calibrated material and photomaterial must be scanned with the same resolution.

2. Create disturbances field (taking into account table, if any);

3. Choose **Images › Transformation** (**Ctrl+T**) from the main menu or click the button ▶ in toolbar. The **Transformation** window appears:

    ☞ To view file with raster image choose **Images › View image** from the main menu or click the button 🖼 in toolbar.
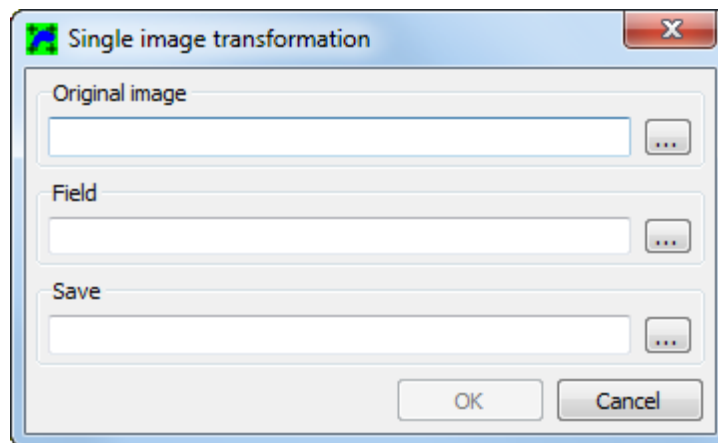
Fig. 23. The Transformation window

4. Click the ⟨...⟩ button near the **Original Image** field. Select file with raster image with *.bmp or *.TIFF extension;

5. Click the ⟨...⟩ button in the **Field** section. Select file with *disturbances field* with *.etm extension;

6. Click the ⟨...⟩ button near the **Transformed image name** field and enter file name for transformed image and its location in the *Windows* file system;

7. Click OK.

8.2. Working in batch mode

Batch mode is very useful feature of *PHOTOMOD ScanCorrect* program since it's a very typical situation when it is needed to transform all images of the big source block by single mouse click.

To do this, perform the following:

1. To start processing in batch mode chosse **Batch mode › New project** from the main menu. The **Project PHOTOMOD ScanCorrect Pro []** window opens:
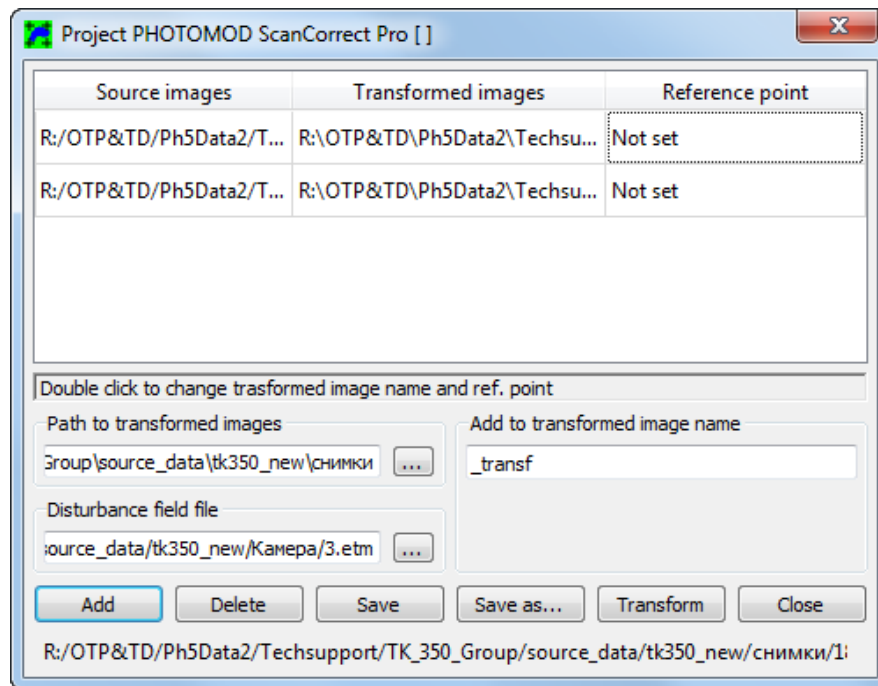
Fig. 24. ScanCorrect batch mode

The window contains the table with the following columns:

- `Input images` – view selected images file names;

- `Transformed images` – view transformed images filenames and output directory;

> Transformed images are saved in the same folder as the original ones; their names differ by the value specified in the **Add to transformed image name** field.

- `Reference point` – contains the reference points coordinates (if they are set).

The **Save** button allows save project settings (file names and other parameters) to the special `*.psp` file, in the current folder with input images, in order to load it later.

The **Save as** button allows save project settings (file names and other parameters) to the special `*.psp` file, in an arbitrary folder in *Windows* filesystem, in order to load it later.

The **Delete** button allows to delete selected source image files from the table.

2. [optional] set the **path to transformed images** –- select the output images folder in the *Windows* filesystem;

   • Click an appropriate button to **add** image files to be transformed to the list;

3. Click the ⌐…⌐ button in the appropriate section to select the **Disturbances field file** (with `*.etm` extension);

4. [optional] input the suffix that will be added to source images file names in the **Add to transformed images file name** field (the default is _TR);

5. [optional] change the position of the **Reference point** (if any) by double mouse click in an appropriate column of the table described above (see the "Creating the disturbances fields" chapter of the current User Manual);

6. Click **Transform** to start the transformation process;

7. Click **Close** to exit the batch mode dialog.

User can save the settings of the batch project to `*.psp` file (**Save** and **Save as** buttons) and start it later by using **Batch mode › Open project** option of the main menu.

Appendix A. Format of text files for importing tables

When importing table of coordinates from text file it is necessary that:

• coordinates of crosses centers were given in pairs: (X,Y);

• orientation of table coincides with orientation of raster image;

• coordinates were given in bottom-up order row by row.

It is not important in what unit's crosses centers are written in file. Type of data is real numbers. Size of table should guaranty more than 50% overlap with raster image.

Below is an example:

There is a raster image of photomaterial (file `image.bmp`) and a table with crosses (on a paper or in some popular table format), we need to get correct text file for importing into system
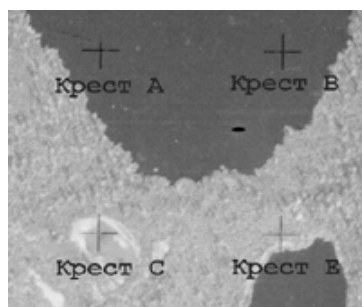
Fig. A.1. Example

Let the part of table looks like

$$\ldots \quad X_A \, Y_A \quad X_B \, Y_B \quad \ldots$$
$$\ldots \quad X_C \, Y_C \quad X_E \, Y_E \quad \ldots$$

Fig. A.2. Table

Table and image already oriented.

The sequence for preparing to write into text file must be.

…C E…A B…

Text file must be like:

… XC YC XE YE … XA YA XB YB …

Appendix B. Examples

B.1. Task 1

We have *calibrated material* and *photomaterial* and we need to compensate systematic metric scanner errors.

> It is required that there should be some fixed (on scanner's plane) object on both raster images, or scanned area should be the same in both scans (in scanner's coordinate system).

> *Calibrated material* and *photomaterial* must be scanned with the same resolution.

Order of operations:

1. scan calibrated material – file with calibrated raster image is created (e.g. `master.bmp`);

2. scan photomaterial – file with raster image is created (e.g. `image.bmp`);

3. using data from `master.bmp` create scanner's *disturbances field*, save it to `master.etm`. Do not forget to select *reference point* – characteristic point correspondent to some fixed point (see note above);

4. transform raster data (file `image.bmp`), using field from file `master.etm` selecting the same *reference point*. File with corrected image (e.g. `newimage.bmp`) is created

> To control the quality of automatic search use **Field › View field** where you can enter coordinates manually.

B.2. Task 2

We have *photomaterial with calibrated crosses on it*, we need to compensate systematic metric scanner errors, assuming that crosses on image are regular with enough precision.

> For typical flatbed scanners errors can be compensated if grid period is no more than **1 cm**.

Order of operations:

1. scan photomaterial – file with raster image is created (e.g. `image.bmp`);

2. using data from `image.bmp` create scanner's *disturbances field* (this field is the sum of scanner and photomaterial errors), save it to `master.etm`;

3. transform raster data (file `image.bmp`), using field from file `master.etm`. File with corrected image (e.g. `newimage.bmp`) is created.

B.3. Task 3

We have *photomaterial with calibrated crosses on it*, we need to compensate systematic metric scanner errors and errors of photomaterial, assuming that *correct coordinate of crosses are known*.

> For typical flatbed scanners errors can be compensated if grid period is no more than **1 cm**.

Order of operations:

1. scan photomaterial – file with raster image is created (e.g. `image.bmp`);

2. input manually (or import) table with correct coordinates of crosses, save it to file (e.g. `image.sct`);

3. using data from `image.bmp` and table from `image.sct` create scanner's disturbances field (this field is the sum of scanner and photomaterial errors), save it to `image.etm`;

4. transform raster data (file `image.bmp`), using field from file `image.etm`. File with corrected image (e.g. `newimage.bmp`) is created.

B.4. Task 4

We have *calibrated material* and *photomaterial with calibrated crosses on it*, we need to compensate systematic metric scanner errors and errors of photomaterial, assuming that *correct coordinates of crosses are known*.

> This task can arise if we have calibrated material with small grid period and photomaterial with large grid period. For typical flatbed scanners errors can be compensated if grid period is no more than **1 cm**. The less the period the better results can be obtained.

> It is required that there should be some fixed (on scanner's plane) object on both raster images, or scanned area should be the same in both scans (in scanner's coordinate system).

> *Calibrated material* and *photomaterial* must be scanned with the same resolution.

Order of operations:

1. scan calibrated material – file with calibrated raster image is created (e.g. `master.bmp`);

2. scan photomaterial – file with raster image is created (e.g. `image.bmp`);

3. using data from `master.bmp` create scanner's *disturbances field*, save it to `master.etm`. Do not forget to select *reference point* – characteristic point correspondent to some fixed point (see. note above);

4. transform raster data (file `image.bmp`), using field from file `master.etm` selecting the same *reference point*. File with corrected scanner errors (e.g. `image_tr.bmp`) is created;

5. input manually (or import) table with correct coordinates of crosses, save it to file (e.g. `image.sct`);

6. using data from file with transformed raster image `image_tr.bmp` create *disturbances field* of photomaterial taking into account table image.sct, save field in file `image_tr.etm`;

7. transform raster data (file `image_tr.bmp`), using field from file `image_tr.etm`. File with corrected errors (e.g. `newimage.bmp`) is created;

B.5. Task 5

We have *non-ideal calibrated material* and *photomaterial*, we need to compensate systematic metric scanner errors, assuming that *correct coordinates of crosses on calibrated material are known*.

To obtain correct coordinates of crosses on non-ideal calibrated material:

1. scan calibrated material on photogrammetric scanner. File with raster image (e.g. `ideal.bmp`) is created;

2. using data from `ideal.bmp` create *disturbances field*, save it to `ideal.etm`;

3. create table with correct coordinates of crosses on calibrated material using import from `.etm` with file `ideal.etm`, save table in a file (e.g. `ideal.sct`);

Calibrated material and photomaterial must be scanned with the same resolution.

Order of operations:

1. scan calibrated material – file with calibrated raster image created (e.g. `master.bmp`);

2. scan photomaterial – file with raster image created (e.g. `image.bmp`);

3. using data from `master.bmp` and table with correct calibrated material coordinates from `ideal.sct` create scanner's *disturbances field*, save it to `master.etm`.

4. transform raster data (file `image.bmp`), using field from file `master.etm`. File with corrected scanner errors (e.g. `newimage.bmp`) is created;

You can scan calibrated material on photogrammetric scanner only once if the material is not subjected to deformation over the time.

Appendix C. Recommendation for scanning

When working with program follow the rules below:

• turn on the scanner 30-40 min. before scanning. This increases stability of scanner's characteristics during scanning;

• to easily position photomaterial fix a frame of required size in the scanner's plane. Image of this frame will help in defining of reference points;

• to allow good contact between photomaterial and scanner's plane material for the frame should be opaque and thin;

• place the frame in such a way so that its inside edges are parallel to the raster axes;

- instead of frame the user can use any other object, image of which can be used to define reference points

- place calibrated material so that its grid lines parallel to the working field of scanner (deviation should be less than 5°);

- select scanned area so that inside edges of the frame are visible and surround the image.