Digital Photogrammetric System

PHOTOMOD AutoUAS

USER MANUAL

AutoUAS program (Windows x64)

RACURS

Table of Contents

1. About

1.1. Purpose of the document

This document contains detailed information about features of the *PHOTOMOD AutoUAS* system (hereinafter referred to as *program*).

1.2. Brief description of program features

The *PHOTOMOD AutoUAS* program is purposed to process data from unmanned aircraft system (UAS). There is a limit on using of the source data when working with program. Only central projection images with size not more than 100 Mpix could be used a source data.

The *PHOTOMOD AutoUAS* program is a stand-alone software, which does not require the *PHOTOMOD* system installation. The program allows for **automatic** (without manual editing) performance of the following stages of UAS data processing:

- Selection of the project coordinate system zone and output data;
- Creating interim projects on the base of input UAS survey data;
- Image adding;
- Aerial triangulation;
- Triangulation network adjustment;
- Output products creation: (dense DSM, TrueOrtho, LAS point clouds and 3D models).

The functioning of the *PHOTOMOD AutoUAS* software is provided in the distributed processing mode only, using standard distributed processing tools of the *PHOTOMOD* software.

Operator's control of processing results is available in the *PHOTOMOD AutoUAS* **3D-window**.

Additional installation of *PHOTOMOD* or *PHOTOMOD UAS* software on a workstation allows to expand the capabilities of operator control and analysis of the obtained results (and also provides for their further manual processing).

1.3. Technical Support

The Racurs company technical support provides the actual information about system functionality, characteristics, price and services.

For technical support use one of the following ways:

- e-mail: support@racurs.ru;

- phone: +7 (495) 720-51-27;
- mail: RACURS Co., Ul. Yaroslavskaya, 13-A, office 15, Moscow, Russia.

1.4. Distribution kit

License software distribute in a branded box. The company name is place on the front. On the reverse side are placed address, technical support service phone and e-mail, web-site of company.

The system distribution kit includes:

- CD-ROM containing the system setup files and the documentation files in PDF format;
- System installation and configuration Manual;
- Unique hardware lock key (see Appendix F).

1.5. Main conventions and terms, abbreviations and acronyms

Through this User Manual the following abbreviations and acronyms are used:

DEM – Digital Elevation Model;

GSD (Ground Sample Distance) – a pixel size on ground for satellite digital images;

IP-address (Internet Protocol Address) – is a numerical label assigned to each device participating in a computer network that uses the Internet Protocol for communication;

LZW compression (Lempel-Ziv-Welch) – lossless data compression algorithm;

SGM – Semi-global matching method;

TIN – Triangulation Irregular Network;

DTM / **DSM** – Digital Terrain Model / Digital Surface Model.

Through this User Manual various conventions and terms are used to describe processes and objects, which are used in the system.

- *Distributed tasks processing* – a capability of parallel task execution with multiple processor cores or multiple computers in local network;
- *Server* – the control center of the distributed processing, responsible for distribution of tasks and synchronization of *Client* computers;
- *Client* – a computer, which receives tasks to process from the *Server*;

- *Network node* – a part of the distributed processing system having its own network address;
- *Monitor for distributed processing* – the window used to monitor task execution by clients.

2. About program

The purpose of the software package is prompt full-automatic processing of materials acquired by unmanned cameras that carried out using a workstation or a portable device (laptop) and obtaining spatial products: digital terrain models (DTM), TrueOrtho and 3D models of two types (DSM + TrueOrtho or LAS + Textures), as well as *PHOTOMOD AutoUAS* final product visualizations.

This software is intended for organizations that need to promptly receive monitoring metric 3D information about objects of their interest (security agencies, EMERCOM, organizations operating linear objects, pipelines, and etc.).

Available data processing methods (**Precise**, **Optimal** and **Fast**) allows to obtain products having the resolution depending on acceptable software running tine:

- The **precise** method is for producing output products with the resolution that matches the pixel size of the source data (approximate data processing speed – from 5 sq. km per hour)
- The **optimal** method - with 2 pixel resolution (from 10 sq. km per hour);
- The **fast** method - with 4 pixel resolution (from 34 sq. km per hour).

Here we imply the theoretical speed of typical data processing that cover territories with the abovementioned areas and having averaged parameters that are typical for the materials collected in normal conditions by UAS equipped with standard instruments (GSD – 0.1 m).

The accuracy of output products corresponds the accuracy of source data. The software allows for processing source raster imagery (`*.jpeg` or `*.tiff`) obtained by cameras with central projection and exterior and interior orientation data.

Interior and exterior orientation import is carried out automatically from EXIF metadata of source imagery (or separate file) and does not require operator customization.

Selection of a coordinate system is automatic with the selection of the zone of the cartographic coordinate system with minimal distortion for the processed area.

The following coordinate system family is supported (National State Standard GOST 32453-2017): **PZ-90.11**, **GSK-2011**, **SK-42**, **SK-95**; **WGS-84/UTM** (full compatibility with *Panorama* products).

Photogrammetric processing in order to obtain output products is full automatic and does not require operator customization.

When creating dense regular DSMs, the state-of-the-art methods of semi-global image identification (SGM) are used that do not require customization. Output DSM are represented as rasters (`*.tiff`).

True ortho images represent metric raster data without distortions caused by technogenic objects (buildings, fences, utility poles, and trees) and imaging angles (building side walls) what facilitates determination of object location and decreases the area of invisible zones.

Processing results are saved into the output folder and supplemented with report files about image block adjustment and project processing.

Minimum specifications: 4 core RAM 16 Gb and greater (there are no mandatory requirements for using specific video cards).

3. Program installation

Prior to the system installation it is desirable to insert *Sentinel HL* security key into the USB-socket of the workstation.

The system required 2 GB of free hard disk space.

To start the system installation, launch the `setup.exe` file or input the installation software and launch the `autorun.exe` file.

The **PHOTOMOD** window opens.

Fig. 1. PHOTOMOD installation window

Click **Install › PHOTOMOD AutoUAS**. The **Installation PHOTOMOD 7 AutoUAS** window opens.

The system initial installation process consists of a sequence of steps with instructions.

In case of cancel at any step, installed program files and data are not removed. To complete the system installation, restart the `autorun.exe` or `setup.exe` file and go through all steps again.

To start installation manually, run the `PH_N_CCCC_AutoUAS_x64.exe` file, where N is the version number, CCCC is the build number.

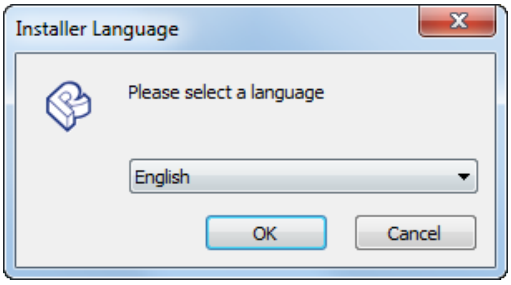
The *PHOTOMOD AutoUAS* program requires 64 bit operating system.

It is strongly not recommended to install the system in folder with name, which contains letters, different from Latin.

If the program is to be installed on a workstation with a network profile and with preinstalled *PHOTOMOD*, *PHOTOMOD UAS* or *PHOTOMOD Conveyor* system (hereinafter referred to as the *system*), close all system's modules on each workstation before installation.

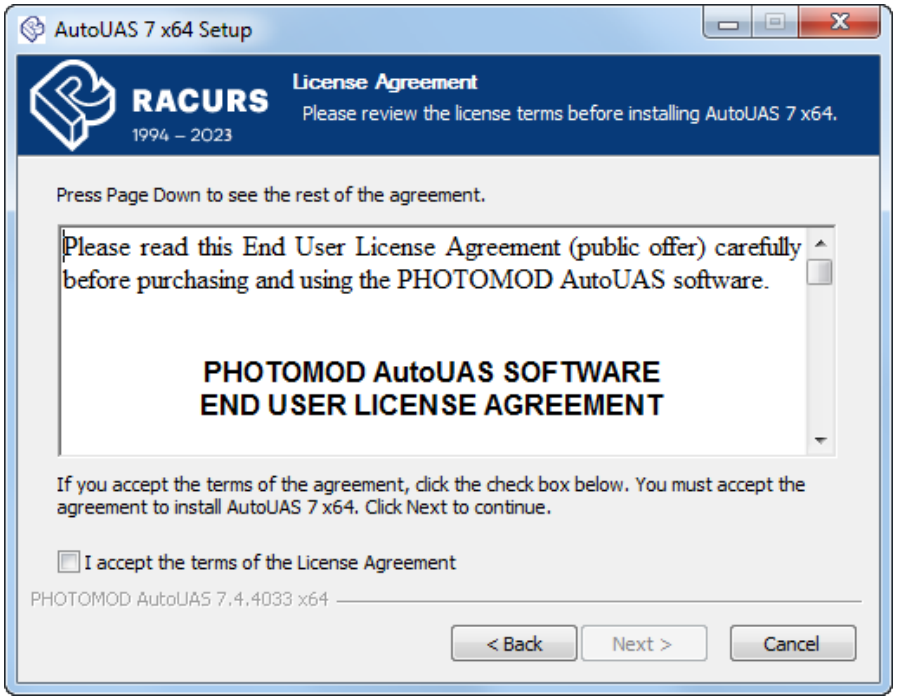
3.1. Preparation step

1. Choose the installation language. Click OK;

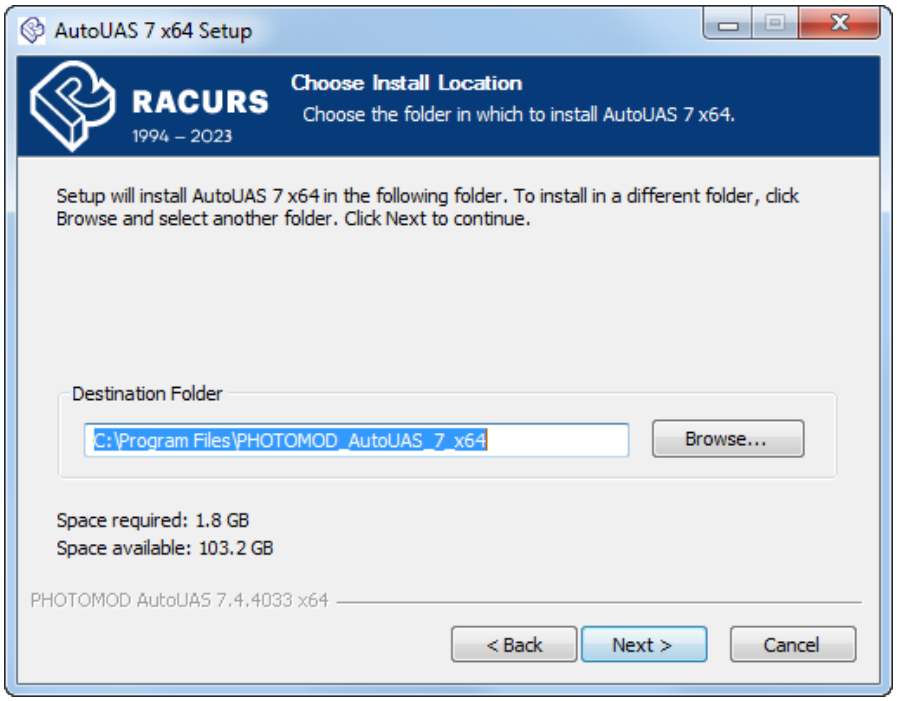


2. Read the welcome and warning messages. Click the **Next** button;

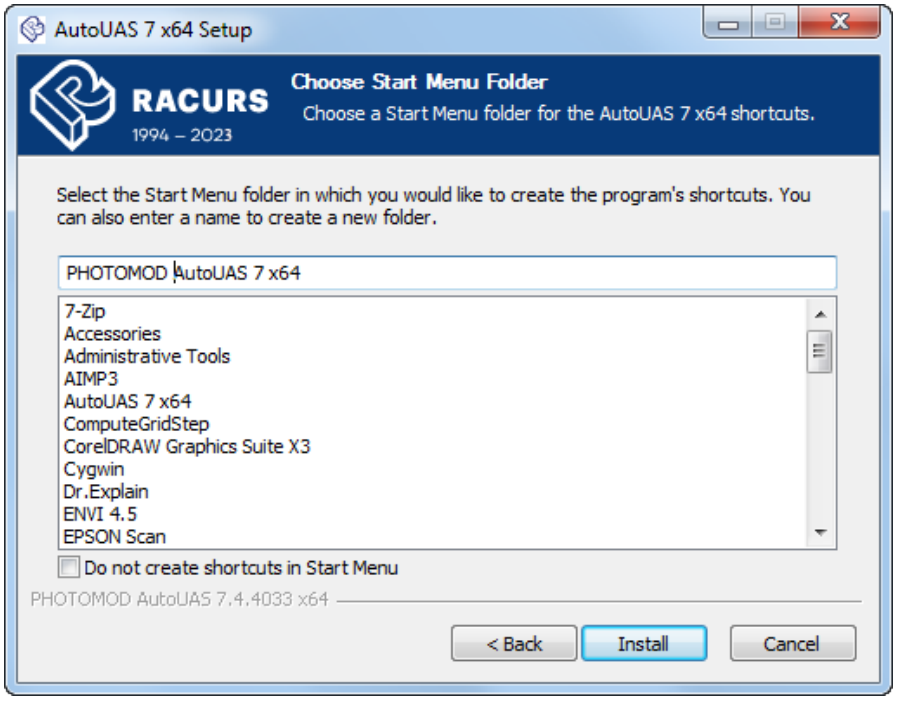
3. Read the license agreement. If you agree with it, set the **I accept the terms in the License Agreement** checkbox on and click the **Next** button;



4. Define the folder to install the program files of the system. By default the *C:\Program Files\PHOTOMOD_AutoUAS_7_x64* folder is used. Click the **Next** button (or click the **Back** button to change installation parameters);

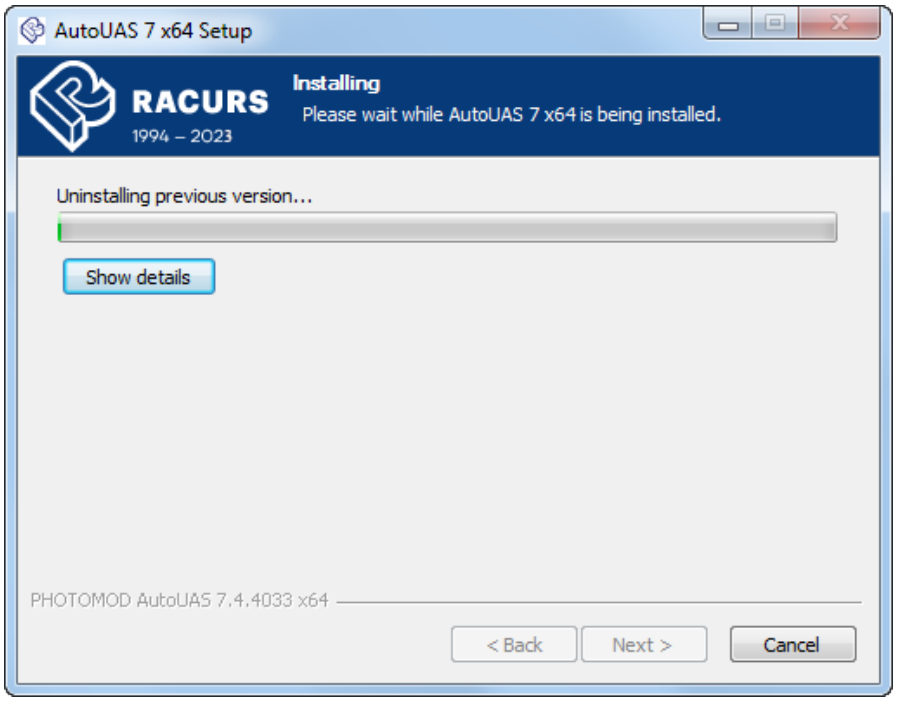


5. Enter a folder name for the *PHOTOMOD AutoUAS* program and modules in the *Windows* **Start** menu. In order not to create shorcuts in *Windows* **Start** menu set the appropriate checkbox. Click the **Install** button.



3.2. File copy stage

1. Wait until the installation is complete;



2. When installation complete perform one of the following actions:

3. • [optional] clear the **Run PHOTOMOD AutoUAS x64** checkbox and click the **Finish** button to complete the installation process without program launch;

   • [optional] leave the **Run PHOTOMOD AutoUAS x64** checkbox set and click the **Finish** button to proceed to the system configuration stage.

If the **Run PHOTOMOD AutoUAS x64** checkbox is set, the *PHOTOMOD AutoUAS* program will launch automatically.

If the security key or security key drivers (they must be installed automatically during the program installation) were not found, the error message displays.

Make sure that the *Sentinel HL* security key is inserted into the USB-socket of the workstation. Install the security key drivers manually and restart the system. In case of problems contact the Racurs company technical support service (see Section 1.3).

In order to **create shortcuts on Windows desktop** set an appropriate checkbox.

3.3. System configuration stage

During the first launch of the system, the message about the required detailed configuration appears. The initial setup of the program can be performed in various ways, depending on the circumstances of the system installation on a particular workstation. The most common situations are the following:

- The system was installed on this workstation for the first time. The user needs to create a folder for storing settings, a resource system, and profiles for organizing local work. This procedure will be discussed in detail below in this chapter.

- If other *Racurs* software products (*PHOTOMOD*, *PHOTOMOD Conveyor* or *PHOTOMOD UAS*) are already installed and configured on the workstation, the user can quickly connect the installed program to existing profiles and resource systems.

  If the connection did not occur automatically during the first launch of the installed program, then in the **Initial setup** window that opens (see below), an already existing **settings folder** used by previously installed software products is indicated.

PHOTOMOD AutoUAS is an independent software package intended, first of all, for work on a separate workstation in its own local profile. Network profile management is not provided for this product.

However, if other *Racurs* software products (*PHOTOMOD*, *PHOTOMOD Conveyor* or *PHOTOMOD UAS*) are already installed and configured on the workstation, the user can quickly connect the installed program to existing profiles and resource systems.

3.3.1. Fast system configuration

During the first launch of the system the *PHOTOMOD AutoUAS* initial (fast) setup windows are opened.

To stop the process of the program quick setup and go to the **PHOTOMOD initial setup** window (as part of the standard setup of the program), close the quick setup window (or click **Cancel**).

1. Click the ... button to select a physical folder on a local PC to store resources (an intermediate data) of the *PHOTOMOD AutoUAS* projects. Click OK.

It's impossible to use logical disk root folder.

Resources can take up a significant amount of free space on hard drive.

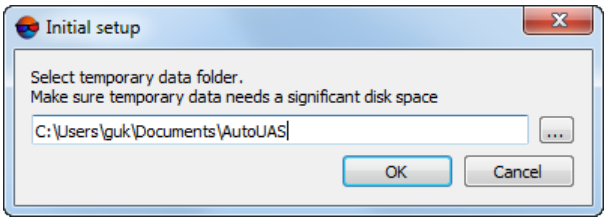


Fig. 2. Choosing a folder to store the projects (an intermediate data)

2. In the **Settings folder** field is displayed path to the *PHOTOMODAutoUAS7.VAR* folder, that is used to store configuration files. Click the ... button to change path

to configuration folder or click OK to finish fast system configuration, create the *local profile* automatically and run *PHOTOMOD AutoUAS* program.

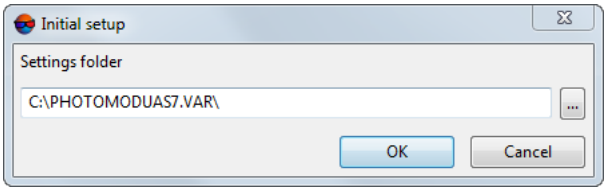


Fig. 3. Choosing a folder to store the configuration files

3.3.2. Advanced system configuration

If the existing folder for data storage (or configuration files folder) are not specified during the fast system setup, the message about the required detailed configuration appears.

To do this, perform the following:

1. Click OK, close the **Warning** window.

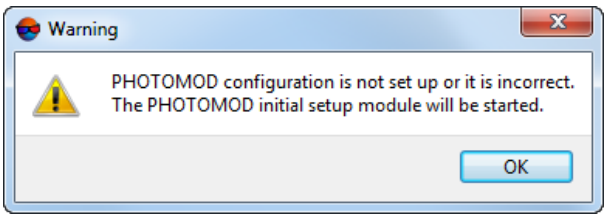


Fig. 4. Information message

2. The **Initial setup** window opens:

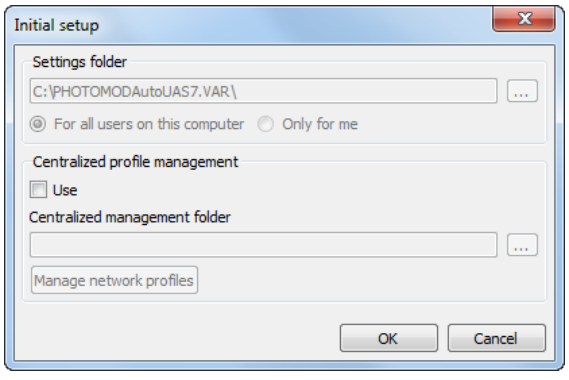


Fig. 5. The “Initial setup” window

In **Settings folder** section is displayed path to the *PHOTOMODAutoUAS7.VAR* folder, that is used to store configuration and temp files.

If other *Racurs* software products (*PHOTOMOD*, *PHOTOMOD Conveyor* or *PHOTOMOD UAS*) are already installed and configured on the workstation, the system provides for connecting the program to existing profiles and resource systems.

For this, the **settings folder** is to be specified which is used by these software products. In this case, the user will not be required to perform the steps described below to create a new local profile.

[optional] To **Use** the **centralized profile management** set the appropriate checkbox and define the **centralized management folder**. Click OK.

Creation of a *local profile* is described in this Chapter. Network profiles management is described below in Appendices.

3. The *Control Panel* module opens. An info message that at least one *local profile* is to be created appears. Click OK.

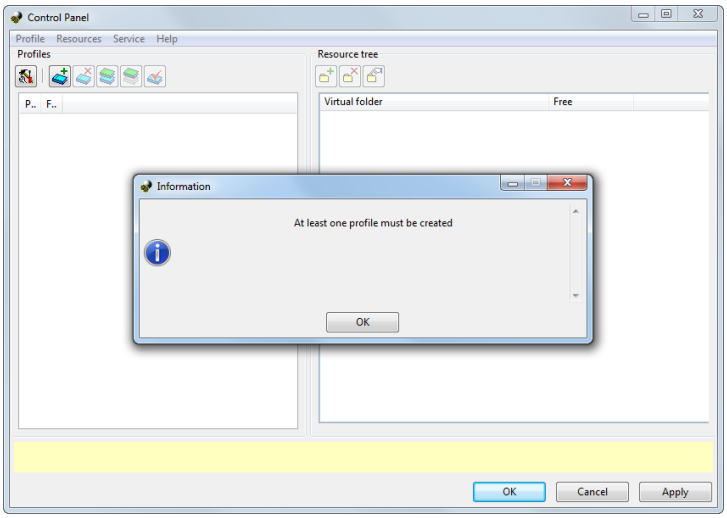


Fig. 6. Information message

The *Control Panel* module is used to configure detailed system settings during the further work.

4. Specify a *local profile* name in the **New profile** window and click OK.

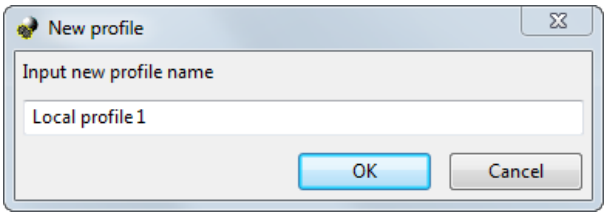


Fig. 7. Local profile name setup

5. The window allowing to **connect virtual folder** opens:

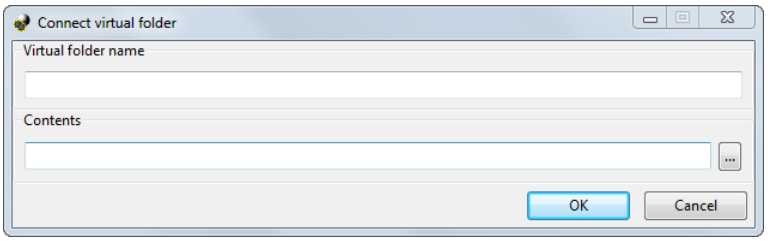


Fig. 8. The “Connect virtual folder” window

Input a **virtual folder name** – arbitrary text used to identify data in folder. In **Contents** field click the ... button to choose a physical space for connecting as a virtual folder. Click OK to close the **connect virtual folder** window.

It’s impossible to use logical disk root folder.

To connect folder only read access for this folder is required. The `AutoUAS_IntermData` catalog will be created in the selected folder.

Local profile folder could be placed both on a workstation, where the system runs, and on any workstation of the network.

6. Click OK in the **Control panel** window to finish system configuration. An info message that the system should be restarted appears. Click OK to restart *PHOTOMOD AutoUAS* program.

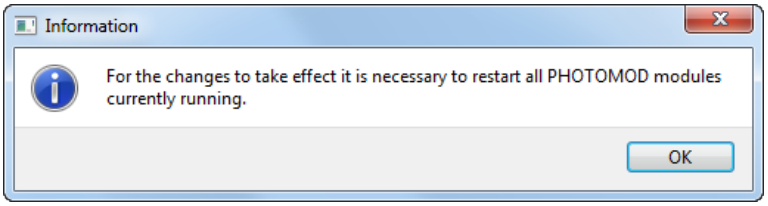


Fig. 9. Information message

3.4. System deinstallation

To remove the system from computer, close all modules of the system and choose **Start › Programs › PHOTOMOD 7 AutoUAS x64 › Uninstall PHOTOMOD AutoUAS 7 x64** or use standard tools in **Control panel** of *Windows file system*.

4. Getting started with PHOTOMOD AutoUAS

During the first launch, the initial system configuration will be performed.

The system provides an opportunity only to use local computer for distributed processing tasks with using several cores of one computer, i.e. using computer as a *Server* and *Client* at the same time.

The *distributed tasks processing* parameters will be configured automatically and do not require user participation.

1. Choose **Start › Programs › PHOTOMOD AutoUAS 7 x64 › PHOTOMOD AutoUAS 7 x64** (or run the `AutoUAS.exe` file in *PHOTOMOD_AutoUAS_7_x64* folder manually).
   - wait, until the *System Monitor* module starts. The icon in the *Windows* system tray appears;
   - wait, until the **Distributed processing control center** completely starts. The **Distributed processing control center** is launched with properties of previous working session of program. The icon in the *Windows* system tray appears;

     Tooltip to the distributed processing center displays the version of the system from what **distributed processing center** was launched, the port number and information about server/client status.

   - wait, until *PHOTOMOD AutoUAS* main window opens.
2. [optional] If it is needed to recreate the distributed processing database, the appropriate dialog window appears (and the icon in the *Windows* system tray appears):

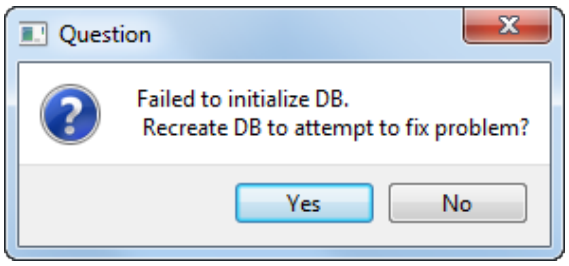


Fig. 10. The dialog window

Click **Yes** to recreate **DB**. Wait, until the distributed processing database will be created. The icon in the *Windows* system tray appears.

5. Data processing sequence

To create a new project, perform the following:

1. Insert *Sentinel HL* unique security key into the USB-socket of the workstation. The security key drivers should be installed on the workstation;
2. Run *PHOTOMOD AutoUAS*;
3. Set the project processing parameters in the main program window;
4. Click the **Start processing** button;
5. [optional] If the **project folder** contains some data, the appropriate warning message appears. Click OK to clean the output data folder and start the processing.

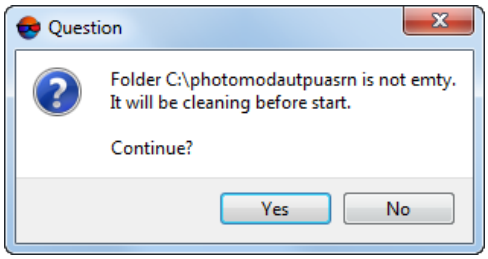


Fig. 11. Information message

6. The information window with the progress bars appears:

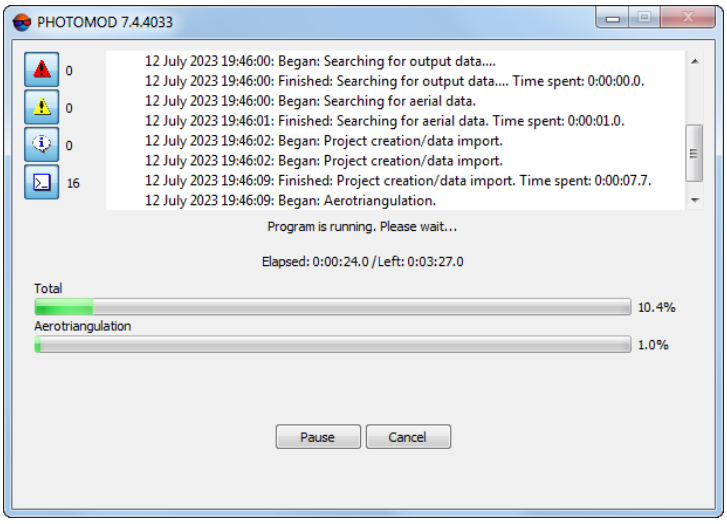


Fig. 12. The information window with the progress bars

7. If the project processing is successfully complete, the project processing report opens and appropriate info message appears:

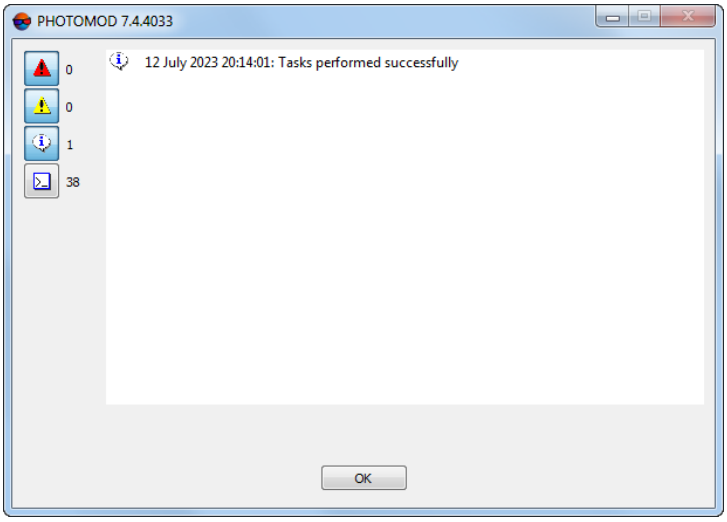


Fig. 13. Information message

8. Click OK to proceed to the output data viewing and analysis;

9. To shut down *PHOTOMOD AutoUAS* program, do the following:

   - Close *PHOTOMOD AutoUAS* main window;
   - **Exit** from the *System Monitor* module using the appropriate item in the drop-down menu (right-click on the icon the *Windows* system tray);
   - **Exit** from the **Distributed processing control center** using the appropriate item in the drop-down menu (right-click on the icon the *Windows* system tray). The appropriate warning message appears. Click OK to shut down **Distributed processing control center**.

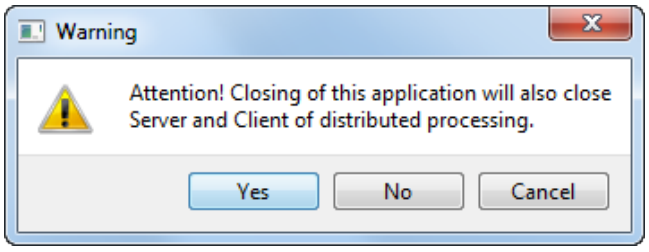


Fig. 14. Information message

6. PHOTOMOD AutoUAS interface and its elements

6.1. PHOTOMOD AutoUAS main window

The main *PHOTOMOD AutoUAS* window allows to set the new project processing parameters and start the distributed processing, as well as to view the previously created projects output data (if available). For the processing parameters configuration, the **General** and **Settings** tabs are provided.

The **Start processing** button clears an intermediate data (in case of reprocessing an existing project) and runs the distributed processing. The **Help** button allows to open Help documents.

6.1.1. The “General” tab

The **General** tab allows to create a new project or to select a previously created project from the list to view it’s output data (if available).

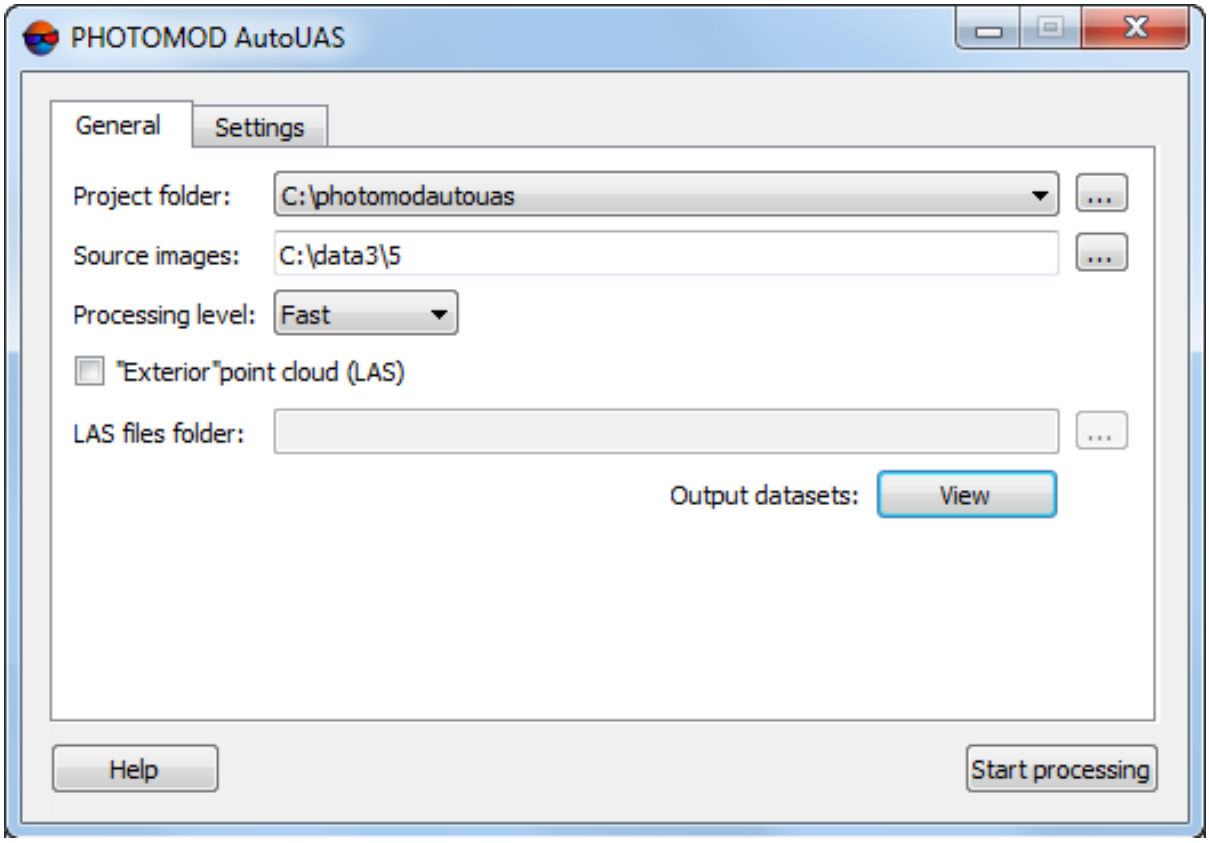


Fig. 15. The “General” tab

The **General** tab contains the following elements:

- The drop-down list **project folder**, allowing to select the folder containing the output data of previously processed project, for the further analysis.

  See output data format and placement in Appendix A.

  The ... button allows to specify the path to the **project folder** in *Windows* file system while creating a new project.

- The field, allowing to input (...) the path to the **Source images** folder in *Windows* filesystem.

  The *PHOTOMOD AutoUAS* program is purposed to process data from unmanned aircraft system (UAS). There is a limit on using of the source data when working with program. Only central projection images with size not more than 100 Mpix could be used a source data.

  The software allows for processing source raster imagery (`*.jpeg` or `*.tiff`) obtained by cameras with central projection and exterior and interior orientation (EXIF), 8 bit, RGB formats.

  Interior and exterior orientation import is carried out automatically from EXIF metadata of source imagery and does not require operator customization.

- The drop-down list, allowing to select the processing method:

  - **Precise** – for producing output products with the resolution that matches the pixel size of the source data (approximate data processing speed – from 5 sq. km per hour);
  - **Optimal** – for producing output products with 2 pixel resolution (approximate data processing speed – from 10 sq. km per hour);
  - **Fast** – for producing output products with 4 pixel resolution (approximate data processing speed – from 34 sq. km per hour).

    Here we imply the theoretical speed of typical data processing that cover territories with the abovementioned areas and having averaged parameters that are typical for the materials collected in normal conditions by UAS equipped with standard instruments (GSD – 0.1 m).

- The **view** button allowing to open 3D-window, to view the project output data.

To use an **"Exterior" point cloud (LAS)** as input data to build dense DSM, set the appropriate checkbox. In this case, the source of data used when creating the abovementioned photogrammetcric products is the user-defined **LAS files folder** in the *Windows* file system. Otherwise, a dense DSM to be used for further creation of a TrueOrtho is created using the SGM method directly during data processing by the *PHOTOMOD AutoUAS* program.

An **“exterior” point cloud (LAS)** can only be used if it spatially intersects with the territory displayed in the images of the project being processed. When processing a project, the system runs an appropriate check (see Appendix A for detailed information).

6.1.2. The “Settings” tab

The **Settings** tab is used to set output data formats.

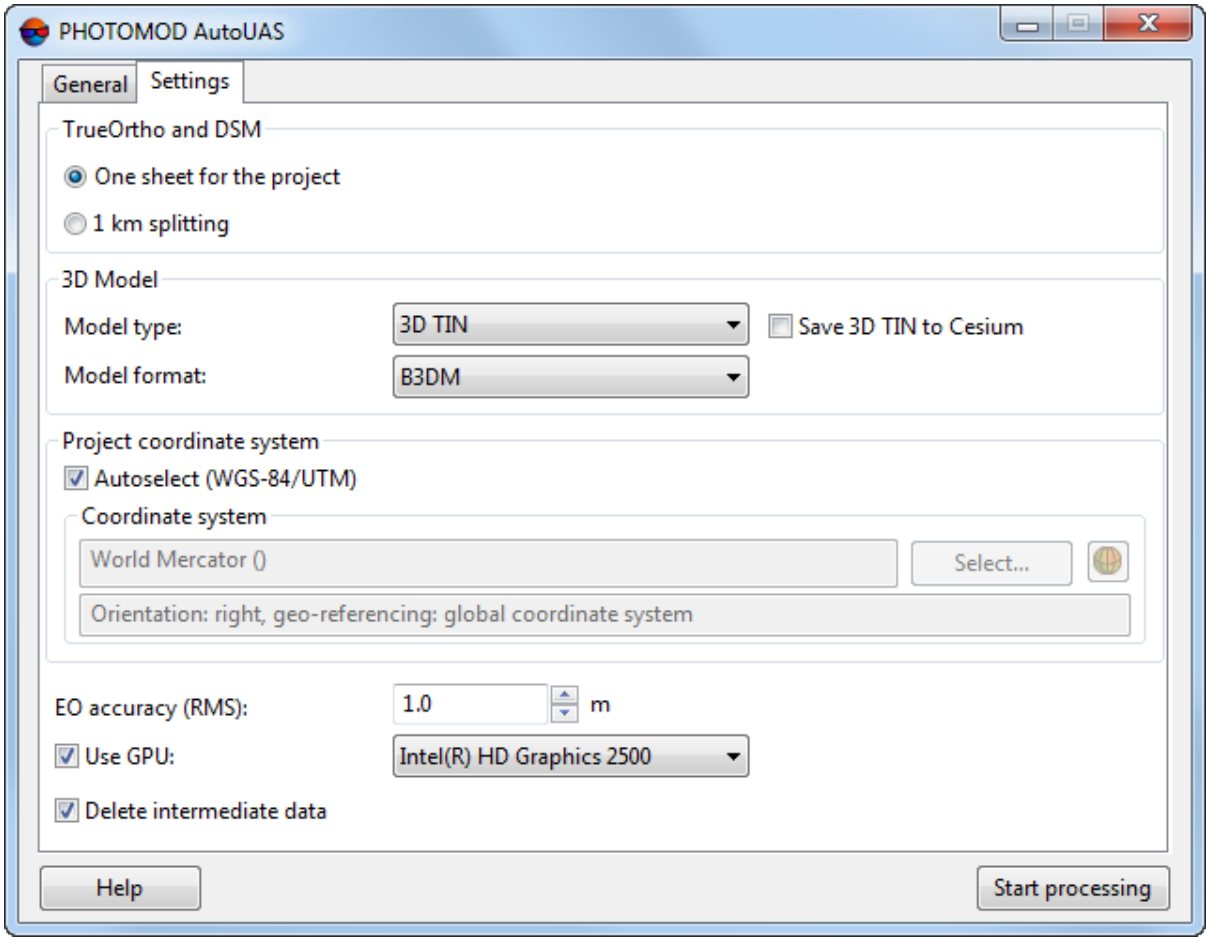


Fig. 16. The “Settings” tab

The **Settings** tab contains the following elements:

- The **TrueOrtho and DSM** section allowing to set one of the following ways of splitting into sheets an output orthomosaic:
  - **One sheet for the project**;
  - **1 km splitting** – in this case, the output mosaic is splitted into similar 1000 m x 1000 m sheets. Each sheet has X-Y name, where X and Y are the coordinates of the left lower sheet corner in kilometers. It is used when creating orthophotomaps larger than 1:2000 scale.

- The drop-down list, allowing to select the **model type** for the output data:

  The main output products (digital surface model (DSM) and true ortho) will also be created in both following cases.

  - **3D-model** – 3D-model based on the digital surface model (DSM). The *PHOTOMOD AutoUAS* **3D-window** is used to view the processing results;
  - **3D-TIN** – the textured 3D-TIN surface in **B3DM** format (and also LAS point cloud) is created. The *PHOTOMOD AutoUAS* **3D-window** is used to view the processing results.

    The separate *PHOTOMOD 3D-Mod* software can also be used to work with **3D-TIN** surface (see the "Three-dimensional modeling" User Manual from the *PHOTOMOD* documentation).

    - To view and edit the textured 3D-TIN surface in *Panorama* software, select the **COLLADA DAE model format** from the appropriate drop-down list.
    - Set the **Save 3D-TIN to Cesium** checkbox to select the appropriate coordinate system.

      For CESIUM 1.38 version, the coordinate system does not matches the geocentric reference one. It is rotated by -90 degrees around the X axis. CESIUM 1.70 coordinate system matches the classic geocentric reference system with WGS84 ellipsoid and orientation.

- The **Project coordinate system** section is used to **select** the geodetic **Coordinate system** where the project will be processed.

  1. Clear the **Autoselect (WGS84/UTM)** checkbox;

     If the **Autoselect (WGS84/UTM)** checkbox is set, the coordinate system to map a territory of interest is selected automatically, taking into exterior orientation data. WGS84 is used as the geodetic datum, then the UTM projection for the appropriate zone is used. Interior and exterior orientation import is carried out automatically from EXIF metadata of source imagery and does not require operator customization.

  2. Click the **Select...** button to specify initial coordinate system.

     Coordinate system is specified using one of the following ways:

     - **From DB** – from international or other coordinate system database;
     - **From file** – allows to select coordinate system from files with `*.x-ref-system`, extension located out of active profile resources;

- **From resource** – from files with `*.x-ref-system` extension located in active profile resources, for example, to select coordinate system from another active profile project.

The system also allows to select coordinate system from a list of recently used coordinate systems.

3. [optional] When choosing coordinate system from database the **Coordinate system database** opens, which contains the list of coordinate systems.

To perform fast search for coordinate system, input the whole coordinate system name or its part to the **Find** input filed.

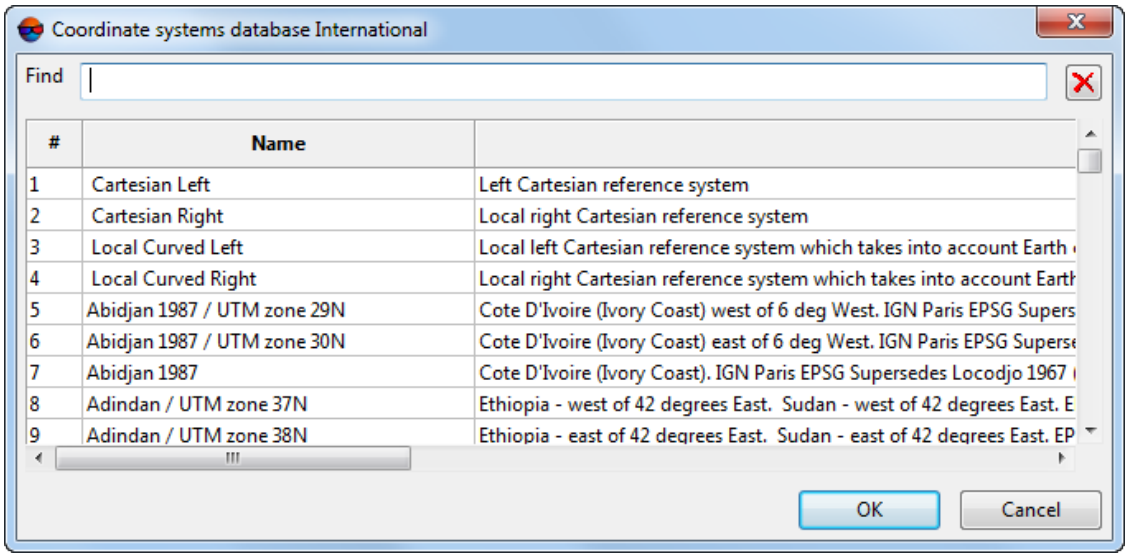


Fig. 17. Window used to select coordinate system from coordinate system database

4. [optional] To choose geoid to be used, click the  button. Select proper type of geoid usage:

- **No geoid**;
- **EGM 96**.

The system allows to use the EGM2008 geoid. See more details in the “Installation EGM2008 Geoid” User Manual from the *PHOTOMOD* documentation. After installation the geoid is displayed in the list.

- Set the **EO accuracy (RMS)** in meters. It is recommended to enter following values of **EO accuracy (RMS)**:
  - Navigation projection centers (frequency L1) – 10 meters;

- Precise projection centers (frequencies L1, L2) without postprocessing – 1 meters;
- Fixed projection centers (RTK, PPK postprocessing) – 0.1 meter.

Postprocessing accuracy data could be taken from the corresponding report.

- [optional] To increase the system performance through graphic processing unit resources, set the **Use GPU** checkbox and select the desired device from the drop-down list.
- [optional] To **delete intermediate data** data if success, set the appropriate checkbox.

Unlike output project data that are placed in the chosen folder in the *Windows* file system and are available for view and analysis in *PHOTOMOD AutoUAS*, intermediate project data are placed in the active profile resources (see the description of the *Control Panel* service module).

Viewing and analysis of the intermediate project saved in the active profile resources can be useful for advanced users and is available if *PHOTOMOD* and/or *PHOTOMOD UAS* are also installed on the workstation. It is recommended to save intermediate data when you need contacting the technical support.

The work with resources is described in detail in ???.

When the **Delete temporary data** checkbox is set, the system also clears the task list step by step in the distributed processing monitor (tasks are removed from the list as they are successfully completed). Clearing the task list makes it possible to limit the increasing size of the distributed processing database, what can significantly affect system performance.

It is strongly suggested to clear the task list when processing large amounts of data on workstations with limited disk space. Full display of the task list (for further analysis of their logs) may be feasible when restarting calculations, if the previous data processing session failed.

7. Output data viewing and analysis

If the project processing is successfully complete, the project processing report opens and appropriate info message appears:

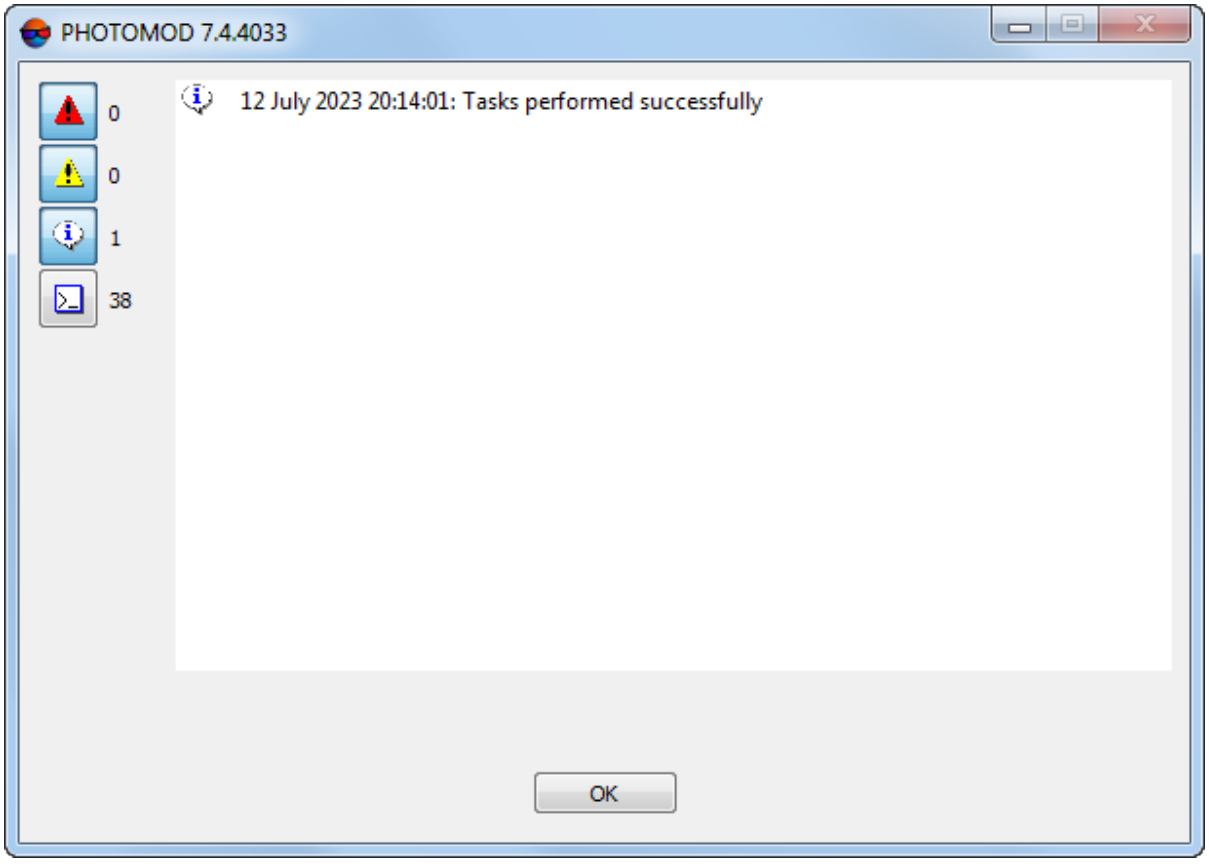


Fig. 18. Information message

When the user click OK the **3D-window** opens:

To view output data of previously processed projects, perform the following:

1. Open the program main window;
2. In **General** tab, in the **project folder** drop-down list, select the folder containing the output data of previously processed project.

   The ... button allows to specify the path select to the **project folder** in *Windows* file system.

3. Click the **View** button:
   - [optional] the **3D-window** opens;
   - [optional] If output data is not found, the appropriate error message appears:

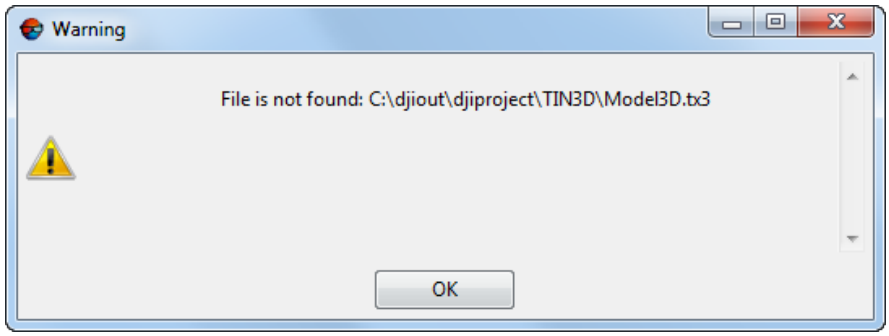


Fig. 19. Warning of absent required output data

Check the selection accuracy in the **project folder** drop-down list, as well as the content of this folder in the *Windows* file system. Make sure that the files containing output data from the projects performed before have not been moved or damaged. Otherwise their successful identification is not possible.

7.1. 3D-window

PHOTOMOD AutoUAS **3D-window** is intended for operator control of processing results.

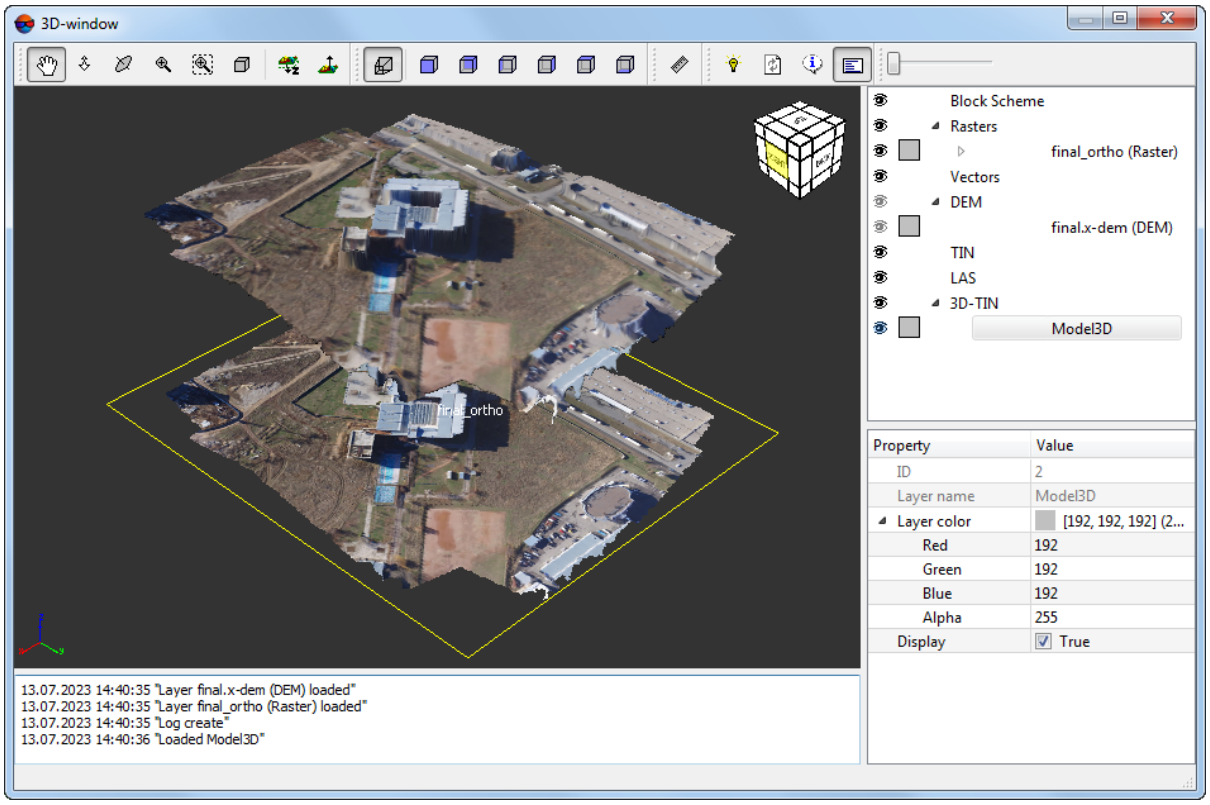


Fig. 20. 3D-window

The **3D-window** GUI contains the following elements:

- toolbar;
- the work area, used for viewing loaded data. The work area contains the following elements:
  - project output data;
  - indicator of the axes direction of loaded data coordinate system;
  - projective cube.
- *layer manager* allowing to manage loaded data layers;
- [optional] system message logs;
- the table, containing the selected layer properties.

7.1.1. 3D-window toolbar

The toolbar of **3D-window** contains the following buttons:

Table 1. Brief description of main toolbar

Buttons	Function
	allows to refresh **3D-window**
	allows to display **3D-window** system info
	allows to display system message logs
	allows to move view area of 3D-scene in any direction
	allows to move view area of 3D-scene perpendicular to the screen plane
	allows to set rotation mode on. The point rotation is performed around is set by clicking the **left mouse button** and displayed as a blue sphere
	allows to zoom in/zoom out view area
	allows to zoom in of 3D-scene view area selected by rectangle
	allows to implement a comprehensive display of all objects of 3D-scene
	allows to move center scene with press and hold down mouse button and moving cursor
	allows to scaling along 3D-objects Z axis (**+/-**) with press and hold mouse button, and also displays the **scale** and **origin** input fields
	allows to turn the perspective mode on, i.e. to display 3D space in 2D plane
	allows to rotate loaded layers

Buttons	Function
	allows to open the **Measurement** window

7.1.2. Layer manager

The *PHOTOMOD AutoUAS* program provides possibility to manage layers, loaded in the **3D-window**. *Layer manager* is used for that. The **3D-window** supports the following types of layers:

- **Rasters** – layer contains loaded output orthoimages (see the "Orthophotomaps creation" User Manual from the *PHOTOMOD* documentation);
- **Vectors** – layer contains vector objects (see the "Vectorization" User Manual from the *PHOTOMOD* documentation);
- **DEM** – layer contains digital surface model (see the "DTM generation" User Manual from the *PHOTOMOD* documentation);
- **TIN** – layer contains triangulation irregular network (see the "DTM generation" User Manual from the *PHOTOMOD* documentation);
- **LAS** – layer contains LAS points cloud (see the "LIDAR Data processing" User Manual from the *PHOTOMOD* documentation);
- **3D-TIN** – layer contains textured 3D-TIN surfaces (see the "DTM generation" User Manual from the *PHOTOMOD* documentation);

In the *Layer manager* is displayed the list of all opened layers and the following elements of layer management:

- – layer is visible in 2D-window;
- – layer is invisible;
- – displays the layer color in layer *Layer manager*;

  To change the layer color perform the following:

  1. Double-click on layer objects color button ( ) in a *Layer manager*. The **Select color** window opens:

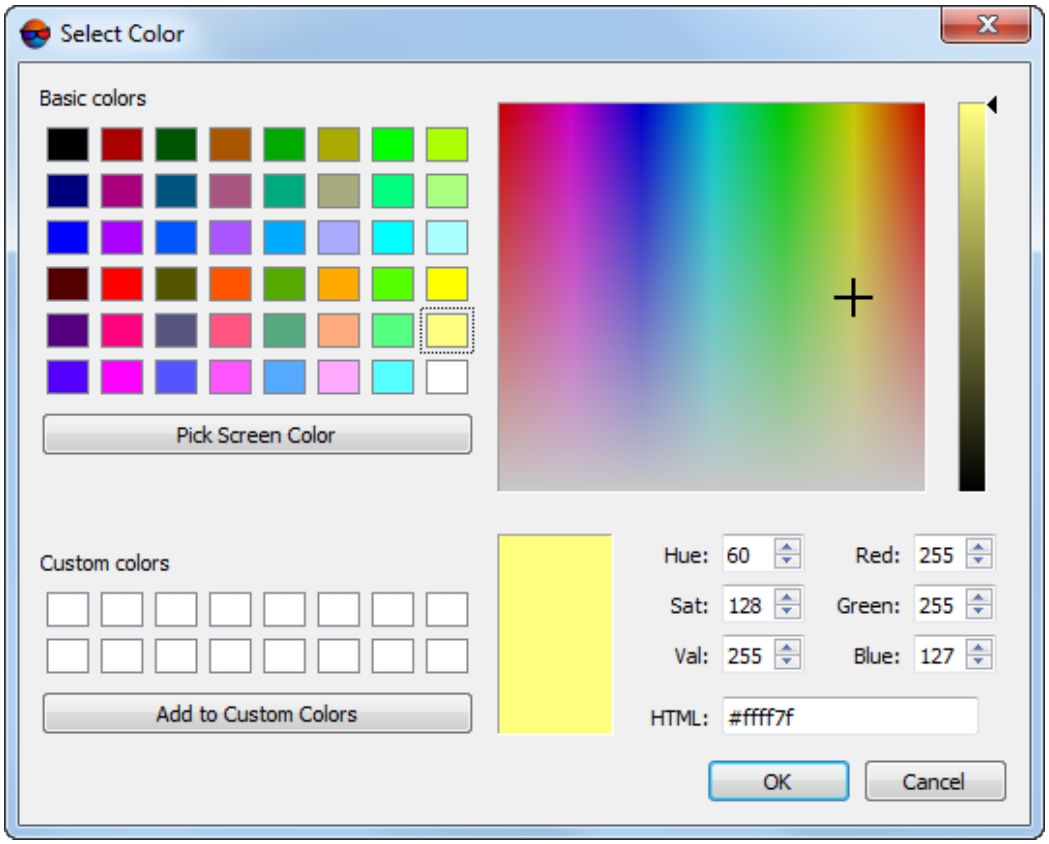


Fig. 21. The “Select color” window

2. Set the layer color;
3. Click OK to save parameters.

Right-click menu is used to manage the layer. Right-click on the name of layer in the *Layer manager* to open it. Right-click menu of selected layer contains the following menu items:

- **Zoom to fit** – allows to show the entire layer in **3D-window**;
- **Close** – allows to close selected layer;
- **Close all of this type** – allows to close all the layers of the selected type.

7.1.3. Layer properties

The table, containing the selected layer properties is used to obtain the information about the layer. Left-click on the name of layer in the *Layer manager* to open it. The table can contain the following data, depending of the layer type:

- **ID**;

- **Layer name**;
- **Layer color** ( ) in layer *Layer manager* (RGBA). To change the layer color input the appropriate values in **Red**, **Green**, **Blue** and **Alpha** fields;
- **Display**. To hide the layer – clear the appropriate checkbox;
- **Height** (for rasters only). To change the layer height input the needed value in appropriated field. The output orthoimages are located on zero level by default;
- **DEM view** – is chosen in an appropriate drop-down list:
  - **Hypsometry** – as hypsometry model;
  - **Color fill** – allows to display DEM with color filling layer-by-layer corresponding to altitude relief scale;
  - **Texture**.
- **DEM details** – allows to set the detail degree of displayed DEM (is set in an appropriate input field);
- **MAP details** – allows to set the detail degree of **Raster layer** which is used as a **DEM texture** (is set in an appropriate input field);
- **Raster layer** which is used as a **DEM texture** – is chosen in an appropriate drop-down list.

7.1.4. The “Measurement” window

The program provides possibility to perform measurements on view area of 3D-scene. To do so use the **Measurements** window.

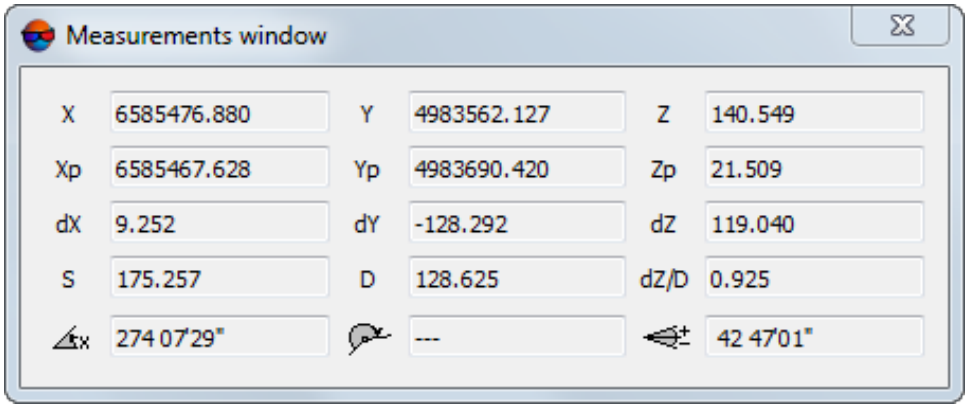


Fig. 22. The “Measurements” window

The window contains fields with marker coordinates values:

- *X* – marker X geodetic coordinate;
- *Y* – marker Y geodetic coordinate;
- *Z* – marker Z geodetic coordinate;
- *Xp* – marker Xp geodetic coordinate;
- *Yp* – marker Yp geodetic coordinate;
- *Zp* – marker Zp geodetic coordinate;
- *dX* – current segment incrementation by X;
- *dY* – current segment incrementation by Y;
- *dZ* – current segment incrementation by Z;

Besides, the **Measurements** window contains fields with values of the following parameters of segment:

- *S* – a length of segment;
- *D* – a length of horizontal distance (projection on a plane) of segment by Z;
- *dZ/D* – a value of segment slope (Z increment ratio to the horizontal distance);
- – direction of current segment relative to X axis;
- – vertical angle of current segment.

Do the following actions to perform measurements:

1. Click the button of the main toolbar to turn on the measurements mode. The **Measurements** window opens.
2. Place marker to start point of measurement and click **left mouse button**.

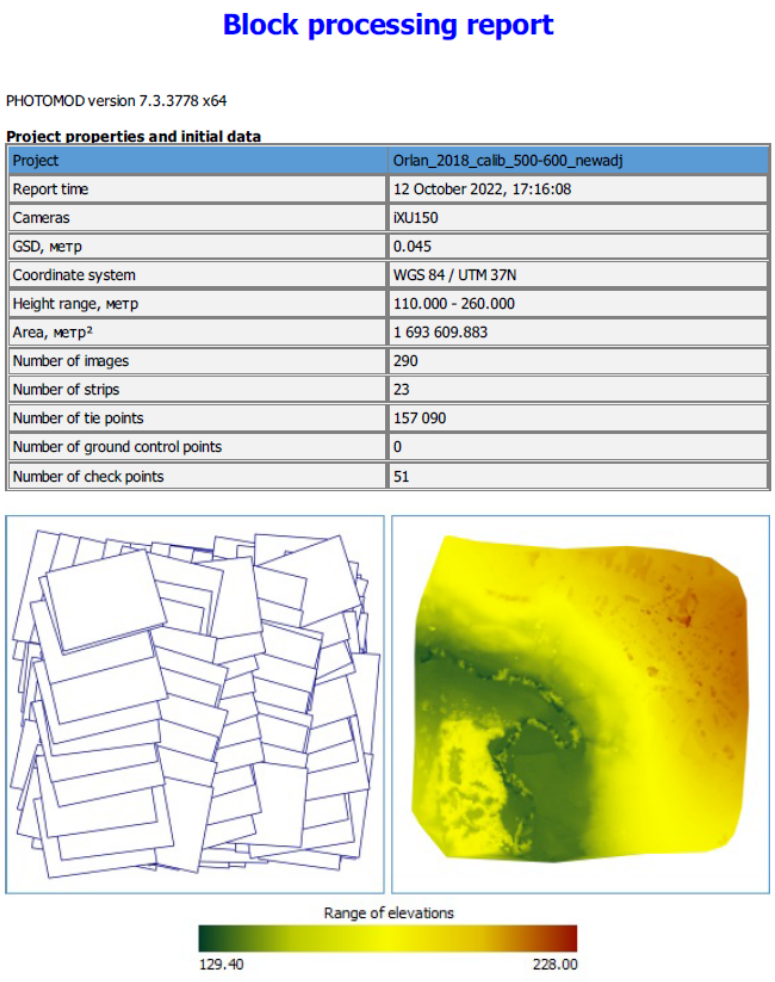
   During measuring the system creates temporary line (“rubber line”), that disappears after exit from measurements mode.

3. Place marker to next point of measurement and click **left mouse button**. Parameters of created segment are displayed in the **Measurements** window.
4. To complete measurements, close the **Measurements** window.

7.2. Project processing report

Project processing report contains data on the project's properties, parameters of automatic tie point measurement and adjustment, lens calibration, and summary on block errors. The report file is saved in output folder in `AeroReport.pdf` file. After the processing is complete, the processing report file opens in standard viewer. Processing report contains the following main elements and sections:

- the **Project properties and initial data** section of a report used to view general statistics and contains the following information:



Block processing report

PHOTOMOD version 7.3.3778 x64

Project properties and initial data

Project	Orlan_2018_calib_500-600_newadj
Report time	12 October 2022, 17:16:08
Cameras	iXU150
GSD, метр	0.045
Coordinate system	WGS 84 / UTM 37N
Height range, метр	110.000 - 260.000
Area, метр²	1 693 609.883
Number of images	290
Number of strips	23
Number of tie points	157 090
Number of ground control points	0
Number of check points	51

Fig. 23. Processing report

  - a project name;
  - report generating date;
  - camera data;

- GSD (Ground Sample Distance) – a pixel size on ground for digital images;
- project coordinate system;
- project heights range in meters;
- area of the in m^2;
- a total number of project strips/images;
- a number of tie/check/groud control points;
- a block scheme and visual display of project heights range.

- the **Processing parameters** section of a report used to view the parameters of automatic tie point measurement and block adjustment;

Параметры обработки

Параметры обработки	Значение
Тип отчета	----
Конфигурация коррелятора	----
Калибровать камеру	Вкл
Выполнить уравнивание	Вкл
Априорная точность измерений на снимках, пикс	0.700
Присвоить камеру после калибровки	Вкл
Удалять промежуточные данные	Вкл
Параметры уравнивания	
Метод начального приближения:	Независимых маршрутов
Метод уравнивания:	Связок
Учет систематических ошибок:	Общие на маршрут
Тип калибровки:	Физическая
Время обработки	----

Fig. 24. The “Processing parameters” section

- **Results of camera calibration** (see the “Project cameras management” chapter of the “Aerial triangulation” User Manual of the main *PHOTOMOD* documentation).

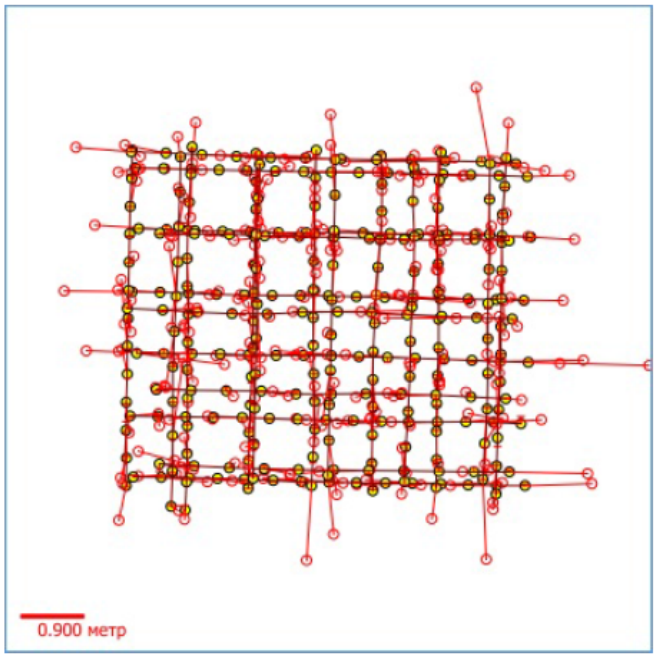
Results of camera calibration

	Initial data	Optimized data
Camera	iXU150	iXU150 [selfcal]
Focal length, mm	55.000	55.094
Principal point (X/Y), mm	0.000 / 0.000	-0.036 / 1.829
Pixel size (X/Y), mm	0.005 / 0.005	0.005 / 0.005
Type of distortion, mm	----	Formula
Point of symmetry (X/Y), mm	0.000 / 0.000	-0.036 / 1.829
K1	0.000000	-0.000024
K2	0.000000	9.301558e-09
K3	0.000000	1.830551e-12
K4	0.000000	0.000000
K5	0.000000	0.000000
P1	0.000000	-4.543816e-06
P2	0.000000	-1.024945e-06
P3	0.000000	0.000000
P4	0.000000	0.000000
b1	0.000000	0.000054
b2	0.000000	2.158602e-06

Fig. 25. The “Processing results” section

- the **Exterior orientation parameters accuracy** section of a report used to view residuals on linear and angle exterior orientation parameters (see the “The “Report” tab” chapter of the “Block adjustment” User Manual of the main *PHOTOMOD* documentation). Contains the following tables:
  - **Control exterior orientation parameters**;
  - **Check exterior orientation parameters**;
  - **Systematic errors**.

Exterior orientation parameters accuracy



Control exterior orientation parameters

Error type	X, метр	Y, метр	Z, метр	Omega, °	Phi, °	Kappa, °
RMS	0.533	0.445	0.034	0.000	0.000	0.000
Mean absolute value	0.334	0.283	0.026	0.000	0.000	0.000
Maximum	1.739	1.429	0.124	0.000	0.000	0.000

Check exterior orientation parameters

Error type	X, метр	Y, метр	Z, метр	Omega, °	Phi, °	Kappa, °
No check exterior orientations						

Systematic errors

Strip	X, метр	Y, метр	Z, метр
Global per block	-0.000	0.000	-0.000

Fig. 26. The “Exterior orientation parameters accuracy” section

- the **Points residuals** section of a report used to view and analyse the block adjustment results (see the “Brief residuals report” chapter of the “Block adjustment” User Manual of the main *PHOTOMOD* documentation) and contains the following tables:
  - **Stereopairs residuals** – a table containing tie point measurement difference between stereopairs (see “Brief residuals report” in the “Block adjustment” User Manual of the main *PHOTOMOD* documentation);
  - **Errors in images**.

Points residuals

Stereopair residuals

Error type	Ex, метр	Ey, метр	Exy, метр
From mean			
RMS	0.000	0.000	0.000
Mean	0.000	0.000	0.000
Max	0.000	0.000	0.000
Mutual			
RMS	0.000	0.000	0.000
Mean	0.000	0.000	0.000
Max	0.000	0.000	0.000

Errors in images

Error type	Ex, pix	Ey, pix	Exy, pix
RMS	0.000	0.000	0.000
Mean	0.000	0.000	0.000
Max	0.000	0.000	0.000

Fig. 27. The “Points residuals” section

- the **Ground control and check points accuracy** section of a report used to view and analyse the block adjustment results (see the “Brief residuals report” chapter of the “Block adjustment” User Manual) and contains the following tables:
  - **Ground control point residuals** – adjustment residuals on GC points;
  - **Check point residuals** – adjustment residuals on check points.

Ground control and check points accuracy

Ground control point residuals

N	Apriori X/Y/Z accuracy	Ex, метр	Ey, метр	Ez, метр	Exy, метр
No control points					

Check point residuals

N	Apriori X/Y/Z accuracy	Ex, метр	Ey, метр	Ez, метр	Exy, метр
DF03	0.020/0.020/0.030	-0.031	0.102	0.223	0.107
DF04	0.020/0.020/0.030	-0.029	0.095	0.137	0.100
DF05	0.020/0.020/0.030	-0.062	0.116	0.122	0.132
DF06	0.020/0.020/0.030	-0.088	0.173	0.104	0.194
DF07	0.020/0.020/0.030	-0.106	0.159	0.146	0.191
DF08	0.020/0.020/0.030	-0.097	0.187	0.138	0.211
DF09	0.020/0.020/0.030	-0.145	0.159	0.129	0.215
DF10	0.020/0.020/0.030	-0.168	0.149	0.274	0.225
DF11	0.020/0.020/0.030	-0.171	0.171	0.201	0.242
GT08	0.020/0.020/0.030	-0.104	0.230	0.109	0.253
GT09	0.020/0.020/0.030	-0.186	0.166	0.185	0.249
GT10	0.020/0.020/0.030	-0.013	0.131	0.075	0.131

Fig. 28. The “Ground control and check points accuracy” section

- brief description of output data (DSM, True Ortho).

Appendix A. Input and output data

A.1. Input data

The software allows for processing source raster imagery (`*.jpeg` or `*.tiff`) obtained by cameras with central projection and exterior and interior orientation (EXIF), 8 bit, RGB formats.

Interior and exterior orientation import is carried out automatically from EXIF metadata of source imagery (or separate file) and does not require operator customization.

The camera description is carried out automatically from EXIF metadata of source imagery (or from the separate file).

A.1.1. Interior and exterior orientation import from separate file

Interior and exterior orientation import is carried out automatically from EXIF metadata of source imagery (or separate file) and does not require operator customization.

If both sources of interior and exterior orientation parameters are available, priority is given to a separate file delivered with imagery.

This file must meet the following requirements:

- The file must be located strictly in the root of the **Source images** folder in the *Windows* file system;

  It is allowed to place source images both in the root of the **Source images** folder, together with the `eo.csv` file, and in child subfolders.

- The file must have strictly defined name and extension, `eo.csv`;
- The file must have the following `*.csv` format parameter settings:
  - The field delimiter is a comma;
  - The decimal delimiter is a dot.
- The coordinate system for data imported from the file is geodetic, WGS-84, lat./lon.;
- The file coding is UTF-8;

- In its first line, the file must contain the following column names: `Name`, `Lat`, `Lon`, `Alt`, in the above order. Additional columns with other data (if they are located after the four abovementioned) is acceptable;

  Data import, therefore, is performed starting from the second line of the `eo.csv` file

- Names of image files in the `Name` column must not contain an extension. Otherwise, proper data import from `eo.csv` is not possible.

  In case of impossible data import from the detected `eo.csv` file, the appropriate error message appears.

The following is an example of correct `eo.csv` file content (note that image names have no extensions):

```
Name,Lat,Lon,Alt,column5,column6

20TUZ_DJI_f1_19,56.8444136,80.60971671,336.226,data5,data6

20TUZ_DJI_f1_20,56.84418296,80.60976516,335.766,data5,data6

20TUZ_DJI_f1_21,56.84395433,80.60980611,335.551,data5,data6

20TUZ_DJI_f1_22,56.84390058,80.60982994,335.882,data5,data6

20TUZ_DJI_f1_23,56.84393753,80.61012121,336.117,data5,data6

20TUZ_DJI_f1_24,56.84396039,80.61046207,336.55,data5,data6

20TUZ_DJI_f1_25,56.84399618,80.61048636,336.622,data5,data6

20TUZ_DJI_f1_26,56.8441402,80.61041766,336.654,data5,data6

20TUZ_DJI_f1_27,56.84434981,80.61036323,336.126,data5,data6

20TUZ_DJI_f1_28,56.84457253,80.61031856,335.649,data5,data6

20TUZ_DJI_f1_29,56.84479721,80.61026833,335.417,data5,data6
```

A.1.2. Camera description import from separate file

The camera description is carried out automatically from EXIF metadata of source imagery (or from the separate file).

If both sources of camera description are available, priority is given to a separate file delivered with imagery.

This file must meet the following requirements:

- The file must be located strictly in the root of the **Source images** folder in the *Windows* file system;

  It is allowed to place source images both in the root of the **Source images** folder, together with the `camera.x-cam` file, and in child subfolders.

- The file must have strictly defined name and extension, `camera.x-cam`.

A.1.3. “Exterior” point cloud (LAS)

An **“exterior” point cloud (LAS)** can only be used if it spatially intersects with the territory displayed in the images of the project being processed. When processing a project, the system runs an appropriate check.

Some point clouds (depending on data formats and providers) can contain metadata carrying information on the point cloud coordinate system (PCS). If these metadata are not found, the program attempts to automatically determine the coordinate system of the external point cloud.

In case of the lack of reliable information on the availability of abovementioned metadata, use external point clouds saved in the coordinate system identical to the output project coordinate system (WGS84 UTM point cloud is also acceptable).

The *PHOTOMOD* software provides for converting LAS-files into another coordinate system (see the “Transformation of point cloud coordinate system” in the “LIDAR Data processing” User Manual of the main *PHOTOMOD* documentation).

In case of complete absence of spatial intersection of the point cloud with the territory displayed in the images of the project under processing (or in case of inability to determine the coordinate system of the external point cloud reliably), the system generates appropriate information messages.

A.2. Output data

Output data formats:

- Digital orthophotos are presented in TIFF formats with `*.tfw` or GeoTIFF, 8 bit, RGB binding files;
- Digital terrain models are presented in one band GeoTIFF format, floating-point numbers, 64 bits;
- 3D textured terrain models are presented in `*.b3dm` format.

An output data of the each processed project is stored in **Output folder** in *Windows* file system, in a separate folder with definite structure for output files.

It is not recommended to change output files or folders using standard OS *Windows tools*.

The name of this folder is taken from the **Project name** field, and it contains the following files and folders:

- *DSM* folder – is used to store output DSM files with `*.tif` extension;
- *Interm* folder – is used to store intermediate DSM files and orthoimages;
- *Reports* folder contains processing report (`AeroReport.pdf`) and block adjustment report (`adjust_report.txt`);
- *TIN3D* folder contains output textured 3D models;
- *LAS* folder contains output LAS point clouds;
- *TrueOrtho* folder – is used to store output orthoimages;
- `AutoUASProject.x-ini` file, containing project processing parameters;
- `CoordSystem.x-ref-system` file, containing data about project coordinate system.

Appendix B. Progress bar

The progress bar window is displayed during *PHOTOMOD AutoUAS* data processing. The window displays the overall progress of data processing, the progress of the current task, elapsed and estimated time of data processing, as well as a log of performed actions.

The progress bar window blocks the user's work with the *PHOTOMOD AutoUAS* interface. The progress bar window is intended to monitor the *overall* progress of data processing, if user's action is not required.

To monitor the progress of each individual task execution and manage the progress of data processing, the **monitor for distributed processing** is used (opened manually using the relevant item of the context menu that opens by right-clicking on the  icon on *Windows* system notification panel).

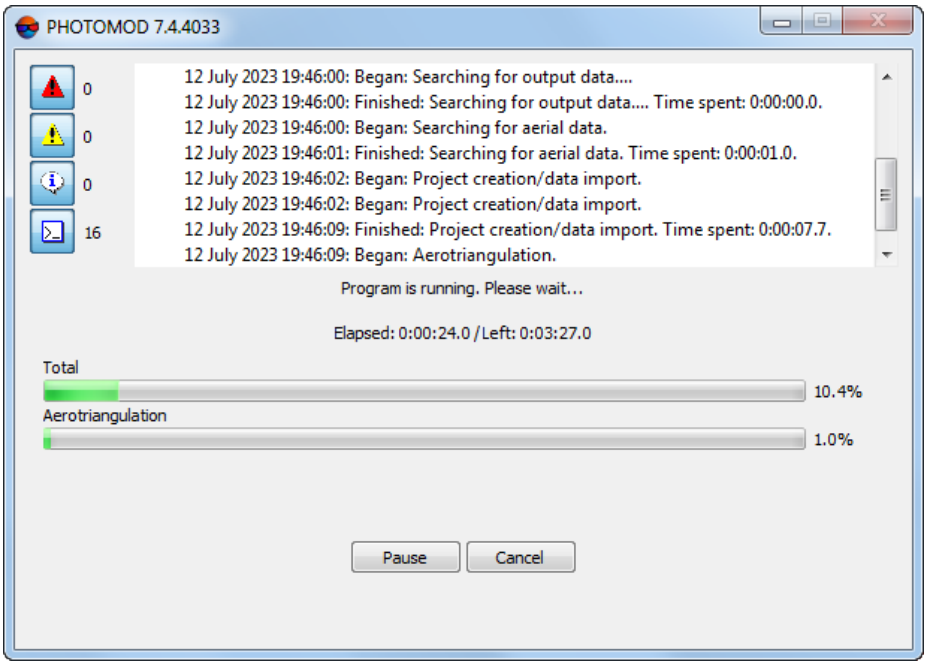


Fig. B.1. The loading progress window

The progress bar window contains the following buttons

- **Pause** – allows the user to pause the display of data processing progress in the progress bar window (data processing itself will continue and will be displayed in the **monitor for distributed processing**);
  - **Resume** – allows the user to continue displaying the progress of data processing.
- **Cancel** – stops data processing.

The buttons of the window toolbar allows to enable/disable the visibility of an appropriate messages categories. The number of messages in the each category is displayed to the right of the corresponding button.

Table B.1. The loading progress window toolbar

Buttons	Function
	allows to enable/disable the visibility of the error messages
	allows to enable/disable the visibility of the warnings
	allows to enable/disable the visibility of the information messages
	allows to enable/disable the visibility of all the messages

Appendix C. Distributed processing

During the first launch of the system, the *distributed tasks processing* parameters will be configured automatically and do not require user participation. The information below is intended for advanced users.

C.1. General Information

The functioning of the *PHOTOMOD AutoUAS* software is provided in the distributed processing mode only, using standard distributed processing tools of the *PHOTOMOD* software. This helps achieve maximum utilization of hardware resources for carrying out large projects.

Distributed tasks processing is a capability of parallel task execution with multiple processor cores or multiple computers in local network.

Computers participating in the distributed processing are assigned the two following modes:

- *Server* is the control center of the distributed processing, responsible for distribution of tasks and synchronization of *Client* computers;

  Server is also could has *Client* status.

- *Client* is a computer, which receives tasks to process from the *Server*;

  Each *Client* must be connected to the *Server.*

  It is possible to temporary exclude *Client* from distributed processing.

There could be several computer groups in one local network to process project in distributed mode independently of each other.

The **Distributed processing control center** opens automatically when the *PHOTOMOD AutoUAS* launches (the  icon in the *Windows* system tray appears). To launch the **Distributed processing control center** manually choose the appropriate item in right-click menu of *System Monitor module* (the  icon in the *Windows* system tray).

If both *PHOTOMOD AutoUAS* and full version of *PHOTOMOD* system (*PHOTOMOD UAS*, *PHOTOMOD Conveyor*) are installed on a computer, it is required to install the same *PHOTOMOD AutoUAS* and *PHOTOMOD* (*PHOTOMOD UAS*, *PHOTOMOD Conveyor*) system's version (pg. 8) on all computers of group, to guarantee correct distributed processing.

Tooltip to the distributed processing center displays the version of the system from what **distributed processing center** was launched, the port number and information about server/client status.

The distributed processing icon in the *Windows* system tray is different depending on using computer in the distributed processing mode:

-  – *Server* and *Client* are not launched (computer is not used in distributed processing);
-  – *Server* connection fault;
-  – only *Server* is launched;
-  – *Server* and *Client* are launched;
-  – only *Client* is launched, connection to *Server*.

To use distributed processing in a local network requires the following:

- the same Centralized management folder should be connected to each workstation, involved in distributed processing;

   Active profile is not important for *Client* computers.

- read and write public access and defined full path is required for all folders with data;

   Full path is not required for local folders.

- at least one computer should be in *Server* mode and all *Clients* should be connected to one *Server*.

Distributed processing control center right-click menu contains the following menu items:

- **Monitor for distributed processing**;
- **Configuration**;
- **Recreate DB** – the *database* contains the distributed processing parameter settings, the lists of tasks and logs of their execution. The database files are saved in the *PHOTOMODAutoUAS7.VAR* folder at the *Server* by default;
- **About** – opens a window indicating the number of system build and serial number of hard lock key, the technical support end date, and also allows to open the **System Information Panel** window with detailed information about software, hardware configuration, and components of the computer (such as details about the device drivers);
- **Exit** – allows to close **distributed processing center**.

C.2. Workflow of distributed processing

The following workflow is used to distributed tasks processing:

1. Make sure that the **Distributed processing control center** is launched on all involved computers.

2. Configure the required distributed processing settings:

   - Define one of computers as a *Server* and input free **Port for incoming connections**.

     Ports in the range 0-1023 are reserved by the operating system, so the minimum value of the port is set to 1024.

   - Define all the rest involved computers as a *Clients*, choose server name and **Port for connecting to server**, specified on step 2.

     Server is also could be use as a *Client* at the same time.

     The system also provides an opportunity only to use local computer for distributed processing tasks with using several cores of one computer, i.e. using computer as a *Server* and *Client* at the same time.

3. Open the main *PHOTOMOD AutoUAS* window;

4. Setup the processing parameters in this window and click the **Start processing** button. The list of distributed processing tasks is created and displayed in the **Tasks** table.

   As the output folders and folders for intermediate data, specify only folders which are available for all involved computers.

   Distributed processing is impossible if the server is not available. The appropriate message appears in this case.

Fig. C.1. An information message

5. Open the **Monitor for distributed processing** to view the progress of tasks performance;

Click the button to perform all distributed processing tasks automatically.

The **Monitor for distributed processing** window also allows to manage distributed processing tasks performance.

C.3. Distributed processing parameters setup

The **Distributed processing setup** window is used to setup distributed processing parameters. Parameters are setup depending on computer's mode.

To open the **Distributed processing setup** window the menu item **Configuration...** of right-click menu of the distributed processing icon is used. The **Distributed processing setup** also opens after the first launch of the **Distributed processing control center**.

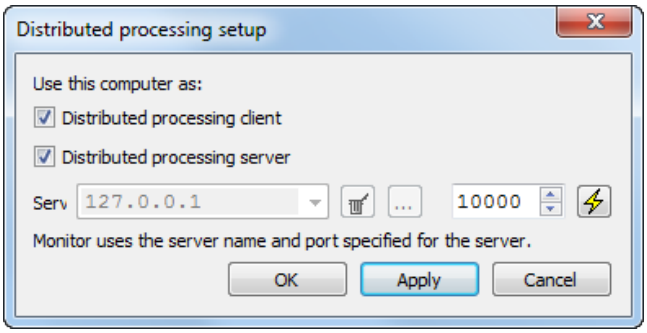


Fig. C.2. Distributed processing parameters setup

To use computer as a *Client* of distributed processing, perform the following actions:

The system upgrade may require to delete the existing database and create a new one (when the **Distributed processing setup** window opens, the appropriate informational message appears).

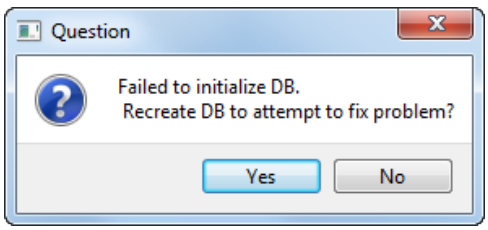


Fig. C.3. The dialog window

The *database* contains the distributed processing parameter settings, the lists of tasks and logs of their execution. The database files are saved in the *PHOTOMODAutoUAS7.VAR* folder at the *Server* by default.

The ⚡ button allows to check the availability of the database (at the specified server IP address and port for connecting to the server) for the current network node.

1. Set on the **Distributed processing server** checkbox.
2. Set the **Distributed processing client** checkbox off.
3. Set free port in the **Port for incoming connections** field.

   Ports in the range 0-1023 are reserved by the operating system, so the minimum value of the port is set to 1024.

   If not possible to connect with chosen port, choose another one.

4. Click OK.

   It is necessary to restart the distributed processing control center if parameters were changed.

To use computer as a *Client* of distributed processing, perform the following actions:

1. Set the **Distributed processing server** checkbox off.
2. Set on the **Distributed processing client** checkbox.
3. Input in the **Server name or IP address** or click the ... button and choose computer name or IP-address from the list used as a *Server*.

   The list of last computers, used as a Server, are kept in the system. The 🗑 button allows to clear the file list;

4. Input port number which was specified during the **Server** adjustment in the **Port for incoming connections** field.
5. Click OK.

   It is necessary to restart the distributed processing control center if parameters were changed.

The system also provides an opportunity only to use local computer for distributed processing tasks with using several cores of one computer, i.e. using computer as a *Server* and *Client* at the same time. Perform the following actions to do this:

1. Set on the **Distributed processing server** checkbox.
2. Set free port in the **Port for incoming connections** field.

If not possible to connect with chosen port, choose another one.

3. Set on the **Distributed processing client** checkbox. Server name and port number are set automatically.

Ports in the range 0-1023 are reserved by the operating system, so the minimum value of the port is set to 1024.

If not possible to connect with chosen port, choose another one.

4. Click OK.

It is necessary to restart the distributed processing control center if parameters were changed.

C.4. Distributed processing management

The **Monitor for distributed processing** window is used for condition monitoring of distributed processing. The menu item **Start monitor** of right-click menu of the distributed processing icon allows to open this window.

Tasks could be created both by *Server* and *Client*.

If the *Server* (and *database*) are disconnected for any reason, the further distributed processing management is not available (when trying to run the **Monitor for distributed processing** window at the *Client* workstation, the appropriate informational message appears).

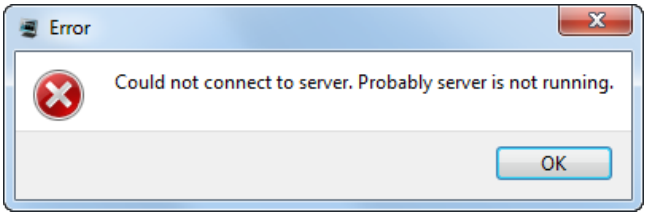


Fig. C.4. The informational message

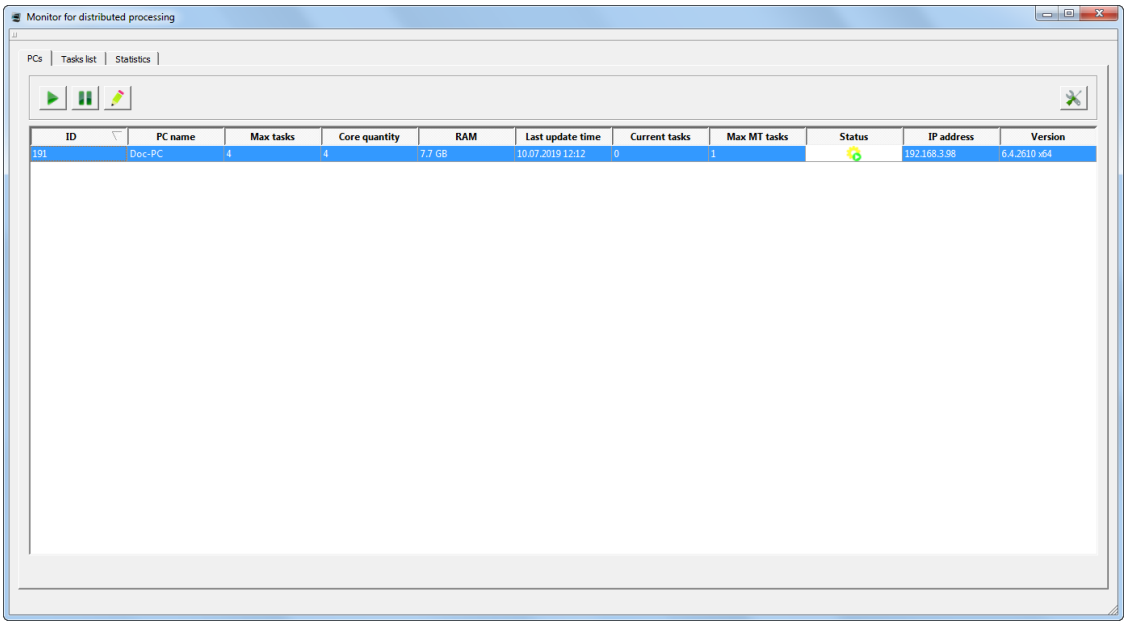


Fig. C.5. Monitor for distributed processing

The **Monitor for distributed processing** window contains the following tabs: **PCs**, **Tasks list** and **Statistics**.

In the **Monitor for distributed processing** window displays information about tasks queue and *Clients* computers using. The window also allows to manage tasks processing.

The window refresh automatically each several seconds.

C.4.1. Computers

The **PCs** tab contains toolbar and table of computers, which are currently in the network and configured with the same *Server*.

The *Server* is displayed in this list only in if it also takes part in the processing being also a *Client*.

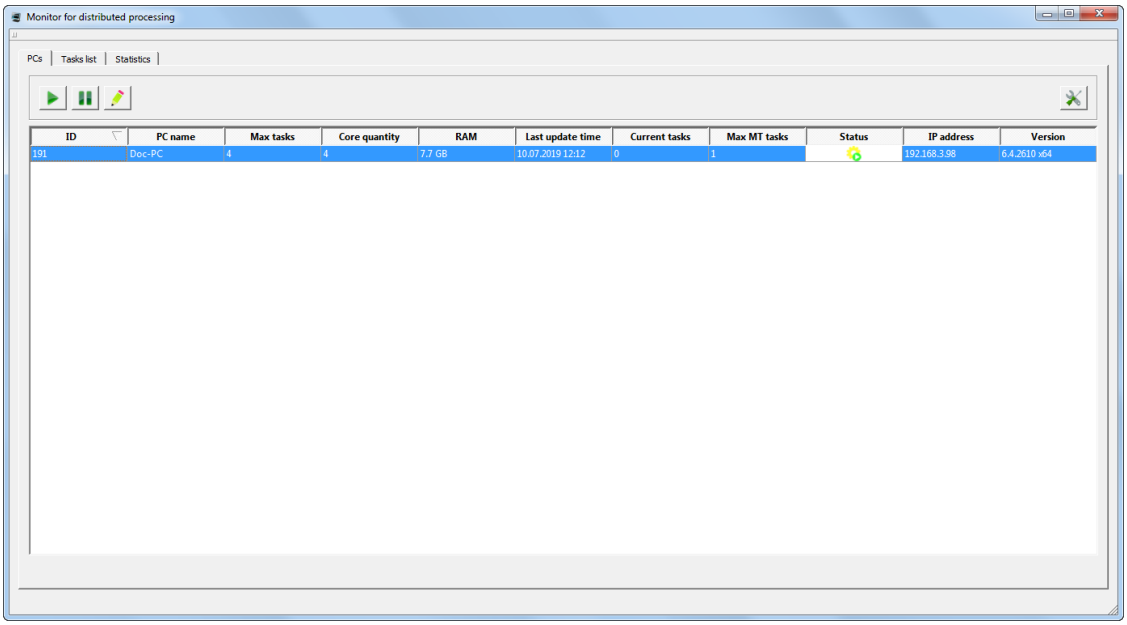


Fig. C.6. The “PCs” tab

The table contains following parameters for each computer:

Points sorting in columns of the list is performed by mouse click on the column header.

The button allows to set columns visibility.

- The Computer **ID**;
- **PC Name** – shows network computer name;
- **Max tasks** – the maximum quantity of simultaneously running tasks on *Client*;

The **Max tasks** number by default is equal to the number of CPU’s cores of a workstation (but doesn’t exceed the number available according to the license).

If the capacity of the network connecting workstations equipped with hard disk drives (HDD) does not exceed 1 Gb/s, the recommended total **Max tasks** for all workstations is no more than 16.

- **Core quantity** – the total quantity of Client CPU’s cores;
- The Client’s **RAM**;
- **Last update time** – the time of the last connection between *Server* and *Client*;
- **Current tasks** – tasks number of distributed processing, which currently performed by Client;

- **Max MT tasks** – the maximum quantity of simultaneously running tasks on *Client* in *MultiThreading* mode;

  MultiThreading – in computer architecture, multithreading is the ability of a central processing unit (CPU) (or a single core in a multi-core processor) to provide multiple threads of execution concurrently, supported by the operating system.

  This approach differs from multiprocessing. In a multithreaded application, the threads share the resources of a single or multiple cores, which include the computing units, the CPU caches, and the translation lookaside buffer (TLB).

  Where multiprocessing systems include multiple complete processing units in one or more cores, multithreading aims to increase utilization of a single core by using thread-level parallelism, as well as instruction-level parallelism. As the two techniques are complementary, they are sometimes combined in systems with multiple multithreading CPUs and with CPUs with multiple multithreading cores.

  When setting this option, it is needed to take into account the *Client's* specifications i.e. **RAM** and the number of processor cores. In most cases, the recommended **Max MT tasks** value for a workstation having a multicore processor and 8 GB **RAM** is 1. The recommended **Max MT tasks** value for a workstation with 16 GB **RAM** is 2, etc.

- The permission **Status** for the selected computers to execute new tasks;
  - – allowed;
  - – forbidden.

    When current task complete, *Client* go to sleep mode and doesn't start new tasks temporary.

- **IP-address** – IP-address of the computer;
- **Version** – the PHOTOMOD build number for control of compatibility.

  It is recommended to use the same RHOTOMOD build on all computers working with the same Synchronization folder.

To perform actions with multiple computers, select them in the table using **Shift** and **Ctrl** keys.

Table C.1. The "PC" tab toolbar

Buttons	Function
	allow selected computers to execute new tasks (if forbidden)
	forbid selected computer to execute new tasks When current task complete, *Client* go to sleep mode and doesn't start new tasks temporary

Buttons	Function
	allows to open the **Num tasks entry** window to set **Max tasks** and **Max MT tasks** quantity (see below)
	allows to open the **Display options** window to set the visibility of the columns in the table of computers (see below)

To set **Max tasks** and **Max MT tasks** quantity for the selected workstation, select this computer in the table of computers and click the  button of the **PCs** tab toolbar. The **Num tasks entry** window opens:

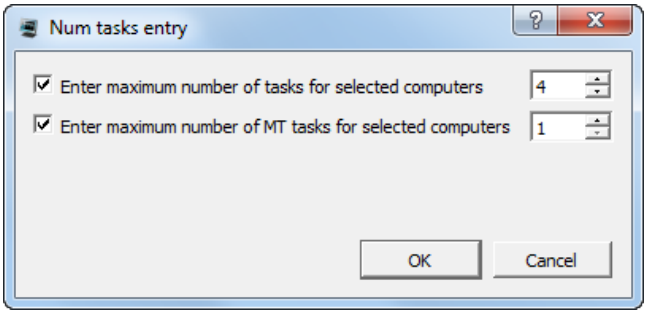


Fig. C.7. The “Num tasks entry” window

- [optional] **Enter maximum number of tasks for selected computers** or clear an appropriate checkbox, if this parameter does not need to be changed;
- [optional] **Enter maximum number of MT tasks for selected computers** or clear an appropriate checkbox, if this parameter does not need to be changed;

Click OK. If no workstations were selected above, changes will be applied to all of them.

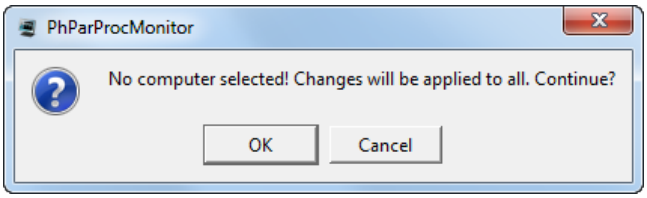


Fig. C.8. The question window

The system allows to set visibility of the columns in the table of computers. To do this click the  button of the **PCs** tab toolbar. The **Display options** window opens. Clear an appropriate checkboxes if needed, and click OK.

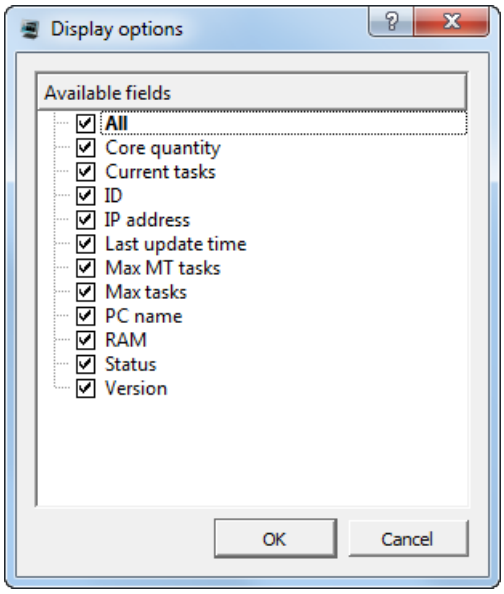


Fig. C.9. The “Display options” window

C.4.2. Tasks list

The **Tasks list** tab contains toolbar and table with information about tasks.

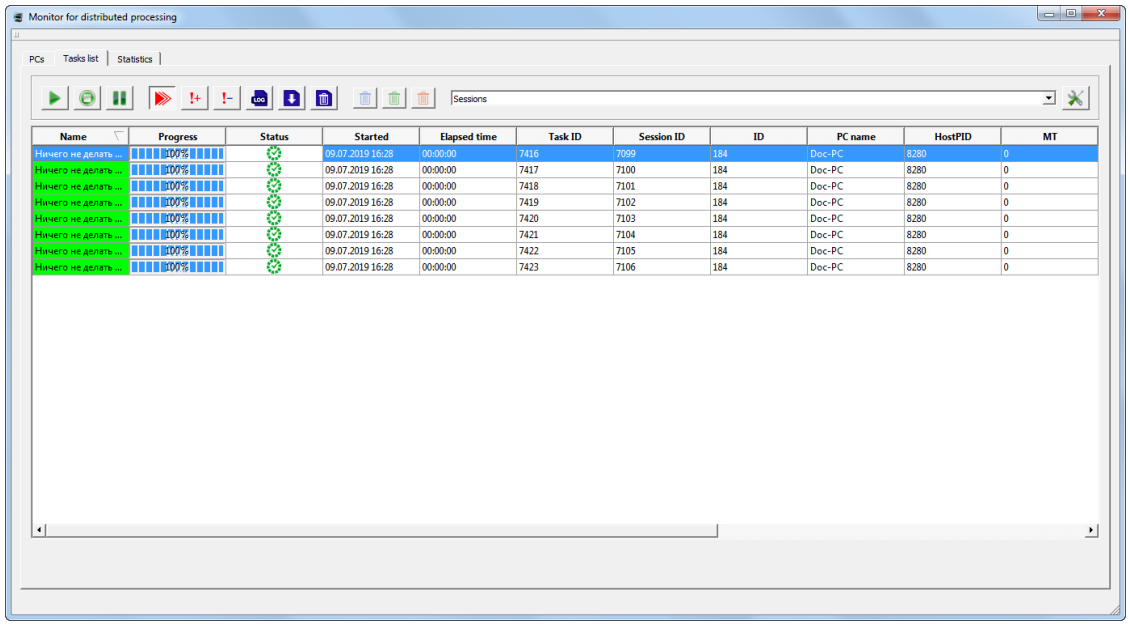


Fig. C.10. The “Tasks list” tab

The table consists of columns with following information:

Points sorting in columns of the list is performed by mouse click on the column header.

The button allows to set columns visibility.

- The task **name**;
- The task **progress**;
- The **Status** of the task:
  -  – `waiting`;
  -  – `unknown error`;
  -  – `stopped`;
  -  – `paused`;
  -  – `performed`;
  -  – `restarted`;
  -  – `complete`;
  -  – `failed` – displayed in case of complete part or resource connection error;
  -  – `not complete` – displayed in case of tasks didn't complete because of *Client* was disconnected during the task processing, *Server* was disconnected or task was canceled.
- **Started** – the data and time are displayed for started task;
- **Elapsed time**;
- **Task ID** – unique identifier for each task;
- **Session ID** – unique identifier for each communication session between the *Server* and the *Client*;
- Computer **ID**;
- **Maker** – shows network computer name;
- **Maker ID** – is a unique *PHOTOMOD* session ID;
- **MT** – this parameter estimates if this task is processed in the MultiThreading mode;

  1– this task is processed in the MultiThreading mode, 0 – this task is not processed in the MultiThreading mode.

- **Update time** is the time of the latest log entry creation;

- **Priority** – priority of the tasks (integer, the larger the number, the higher the priority, the tasks of higher priority are performed in the first place);

To change the **Priority** of the performed task, double click the appropriate cell of this column.

To sort out performed tasks by priority, click the icon to the right of the **Priority** column name.

- **Executor** – for started task – the name of *Client* computer, which executes it;
- **Created at** – the date and time of posting task;
- **Profile** – active Client profile at the time of posting of tasks. This profile must be network and connected to other Clients in order that they have been able to execute the tasks;
- The task **description**.

If during the task execution an error occurs on any of network computers, it's highlighted in red in the list. In this case attempts will be made to perform the same tasks on other computers. The task will remain in the queue with a `failed` state until it is deleted manually, if no computer in network is able to execute this task.

Table C.2. The "Tasks list" tab toolbar

Buttons	Function
	allows to start selected tasks sequentially
	allows to pause selected tasks
	allows to stop selected tasks
	allows to set on the auto run tasks – automatic distribution of tasks in the queue (according to priority) between the Clients and launch of the tasks
	allows to increase priority of selected tasks by 1
	allows to decrease priority of selected tasks by 1
	allows to show logs for selected tasks (see below)
	allows to perform logs export (see below)
	allows to enable/disable logs saving mode while deleting tasks
	allows to remove selected tasks from the queue
	allows to remove complete tasks from the queue
	allows to clear the queue of tasks
	allows to open the **Display options** window to set the visibility of the columns in the table with information about tasks (see below)

The system allows to set visibility of the columns in the table with information about tasks. To do this click the button of the **Tasks list** tab toolbar. The **Display options** window opens. Clear an appropriate checkboxes if needed, and click OK.

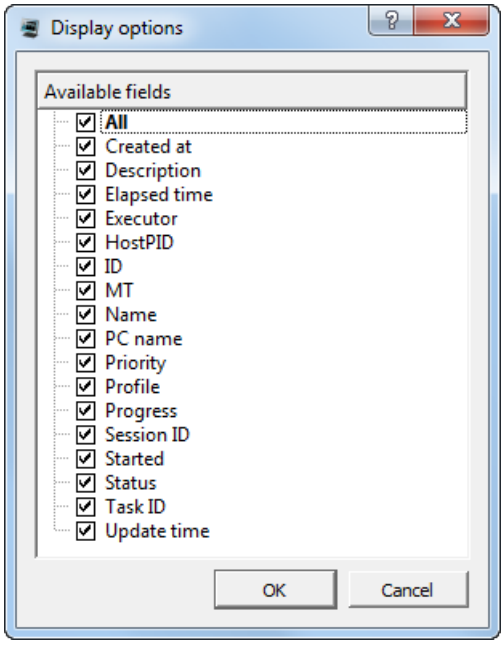


Fig. C.11. The “Display options” window

To show logs for selected tasks, select this tasks in the table above and click the button of the **Tasks list** tab toolbar. The **Session logs** window opens:

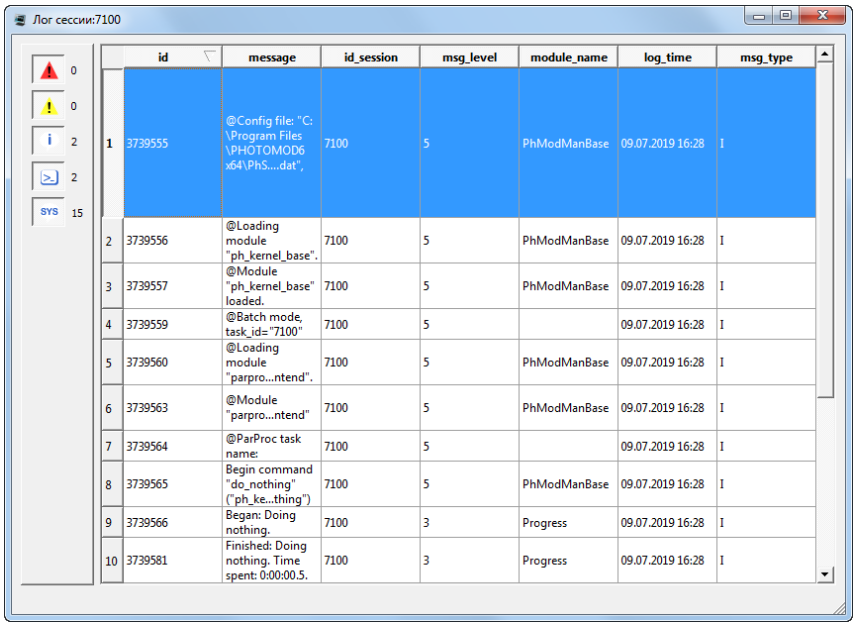


Fig. C.12. The “Session logs” window

The **Session logs** window contains the table with messages about tasks performance and the toolbar, allowing to enable/disable the visibility of the messages categories.

The table consists of columns with following information:

Points sorting in columns of the list is performed by mouse click on the column header.

- **ID** – unique identifier for each message;
- the **message** text;
- **Session ID** – unique identifier for each session;
- **Msg level** – message significance level;
- **Module name** – the used module of the *PHOTOMOD* system;
- **Log time** – the time of message creation;
- **Msg type** – message category.

The buttons of the **Session logs** window toolbar allows to enable/disable the visibility of an appropriate messages categories. The number of messages in the each category is displayed to the right of the corresponding button.

Table C.3. The “Session logs” window toolbar

Buttons	Function
	allows to enable/disable the visibility of the error messages
	allows to enable/disable the visibility of the warnings
	allows to enable/disable the visibility of the information messages
	allows to enable/disable the visibility of all the messages
	allows to show all records (detailed log)

To export the logs of the selected tasks perform the following:

1. [optional] select necessary tasks in the table together with task info (otherwise, logs of all the tasks from this table will be exported);
2. click the  button of the **Tasks list** tab toolbar. The **Log export** window opens;

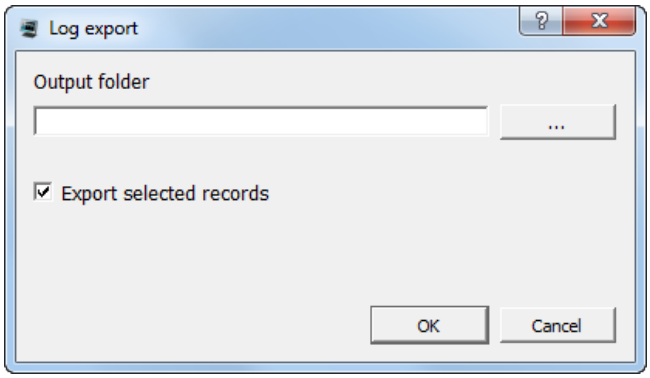


Fig. C.13. The “Log export” window

3. press the ... button to specify the **Output folder**;

4. [optional] clear the **Export selected records** checkbox to export logs of all the tasks from the table in the **Tasks list** tab;

5. To save logs in the chosen folder, click OK. Task logs are text files with `*.log` extensions. If it is needed to export logs for more than one task, an archive of logs with `*.tar.gz` extensions will be saved in the chosen folder.

C.4.3. Statistics

The **Statistics** tab contains the table with statistics of the current task session.

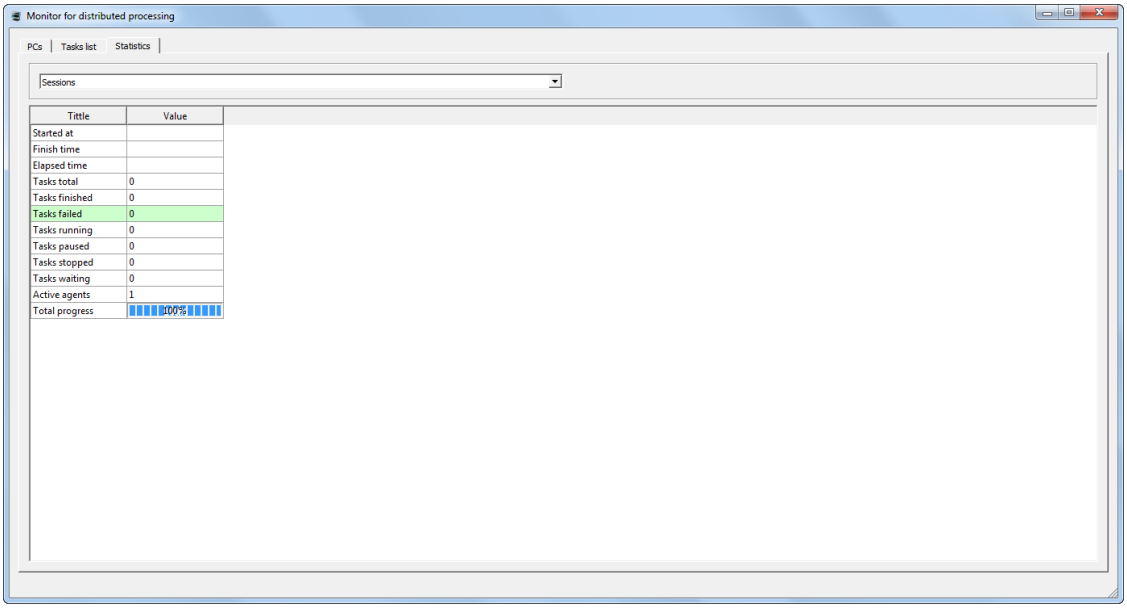


Fig. C.14. The “Statistics” tab

The table consists of strings with following information:

- **Start time**;
- **Finish time**;
- **Elapsed time**;
- **Tasks total**;
- **Tasks finished** ();
- **Tasks failed** ();
- **Tasks runned** ();
- **Tasks paused** ();
- **Tasks stopped** ();
- **Tasks waiting** ();
- **Active agents** – the number of *Clients* in the **PCs** tab;
- **Total progress**.

Appendix D. Intermediate data

The information below is intended for advanced users.

D.1. Data storing

D.1.1. Main definitions of resources system

Resources system of *PHOTOMOD* software is a way to store data with possibility of network distributed project processing. Operator has access for an unified system with all available profiles, nod depends on PC using for storing data and processing. Data could be stored in optimal way for processing a current task.

The following main definitions are used in the resources system:

- *Profile* – independent group of projects relative to one or several projects;
- *Virtual folders* is a virtual names of real local/network folders (hard disks) or group of folders, chosen by user to store profile resources;

One profile could use data placed on several computers.

D.1.2. Profiles and virtual folders

Configuration of resources depends on profile settings. Profile has a virtual name and do not equal to real file system. This name is a common root of the resources tree that connects all branches (resources) profile.

Profile resources could be placed on any workstations and hard disks in a local network.

It is recommended to create one profile for one project or group of projects.

The profile resources system contains all subfolders and files (except `meta`-files) of real folder, defined as virtual.

Configuration files that describe a set of local profiles and its structure are stored in the *PHOTOMODAutoUAS7.VAR folder.*

The Control Panel module is used to create and manage profiles. The *Control Panel module* is used to create and edit profiles, connect virtual folders, create/connect network profiles folder, change active profile and so on.

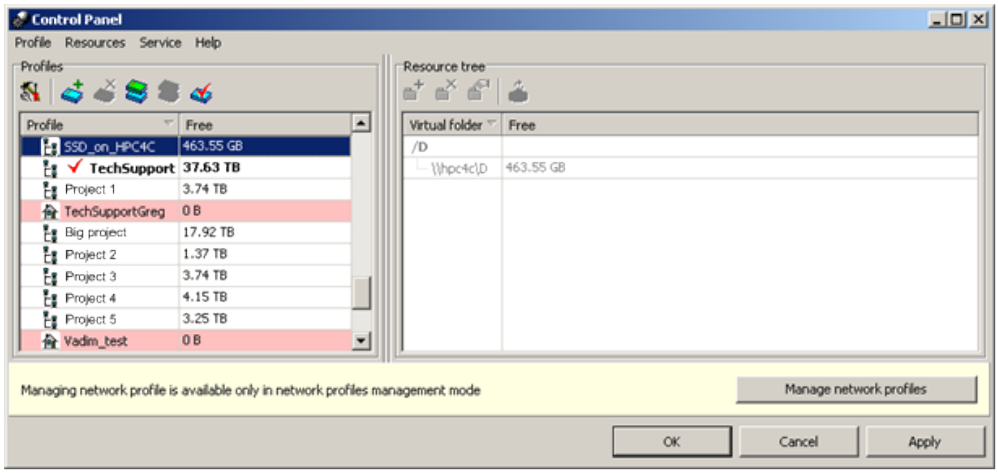


Fig. D.1. Control Panel window

The system provides possibility to create and manage local and network profiles.

Profile, available to use only on one PC, is called *local* profile. Local profile is marked with leftward to profile name.

Network profile is available on all workstations in the system to process project at the same time. Network profile is marked with leftward to profile name. When selecting a network profile, its configuration is copied automatically to a local PC to provide independent work if storage is unavailable.

In one session could be used only one active profile. Any local or network profile available profile could be chosen as active.

D.1.3. Storages

Storage folders are a special type of virtual folder.

Resources are automatically placed in storage folders by the system on the basis of free space analysis. Thus, storage folders allow optimization of multiple disk usage for storage resources, which is advantageous when network processing large projects (see ???).

It is not recommended to place more than one storage on the same hard disk.

Both one and several storages could be connected to a profile as a virtual folder.

It is available to create not more than 16 storages for one virtual folder.

If you create a folder in virtual folder with several storages, it creates in all storages in the */content* folder. Thus, all storages have equal structure. Besides content of these folders is different, because one resource could be used only in one storage of group.

In the root folder of storage are placed *$PhStorage.list* file with information about all resources in storage, *$PhStorage.x-ini* file with information about storage and temporary files to block *$PhStorage.list* file during its reading/saving. The *$PhStorage.x-ini* file contains storage ID and ID list of all other storage in a group. These information is checked during initialization of virtual folder.

These way of data storing allows to reallocate data between storages. To reallocate data, move files and delete table of storages. At the next using of the virtual folder, new *$PhStorage.list* files create automatically.

Metadata of each resource is stored in `*.meta`-files. Metadata files always place in the same storage as resource.

D.2. Profiles

D.2.1. Control Panel Profiles management

The *Control Panel module* is used to manage profile structures to work in the system.

To launch the system at least *one* profile is required. Creation of profile is performed in the *Control Panel module*.

During the first launch of the system, the **PHOTOMOD initial setup** windows opens that allows to define settings folder and create profile.

Profile separate place for project files. It is a resources tree with the following structure:

- *Root* – profile virtual name.
- *Top level branches* – profile virtual folders – virtual names of physical local or network folders/disks.

One physical folder could be specified as a virtual folder.

- *Resources* – the whole content of selected folder of a profile – all subfolders and files. Only images source files from active profile resources could be matched with images of current project.

In the Lite-version of the system it is possible to create *only local* profiles and to process project only by *one operator* in one time. In the full version could be created any local or network profiles and organized network processing of project with a lot of operators. In both versions project data could be stored on any computers of the net (including servers).

To launch the *Control Panel module* choose **Control Panel** in the right-click menu of the *System Monitor module* (the  icon in the*Windows*system tray):

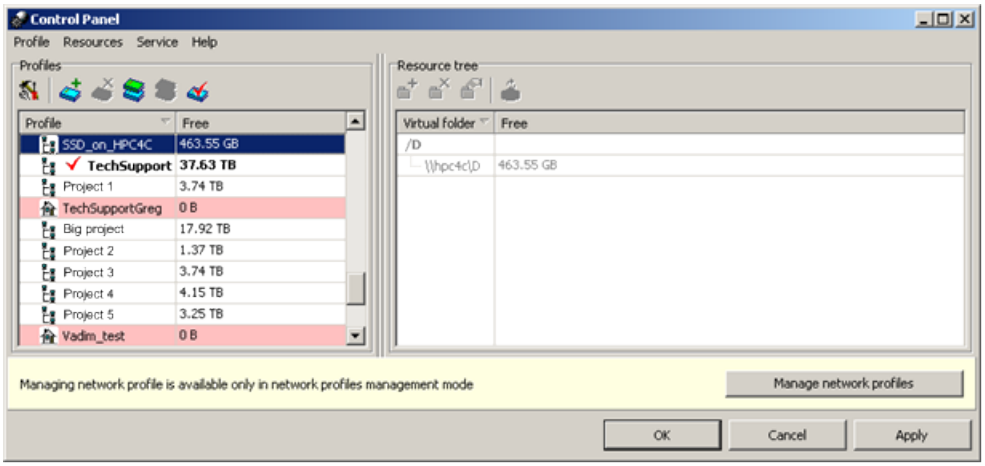


Fig. D.2. Control Panel window

Loading progress with a log-file are displayed while module is launching.

If module launches too slowly, remove all incorrect profiles, because delay is due to attempts to access a non-existent folders.

Loading progress window is displayed while processing any time-consuming operation. Progress of loading, spent and estimates time and log are displayed in the window.

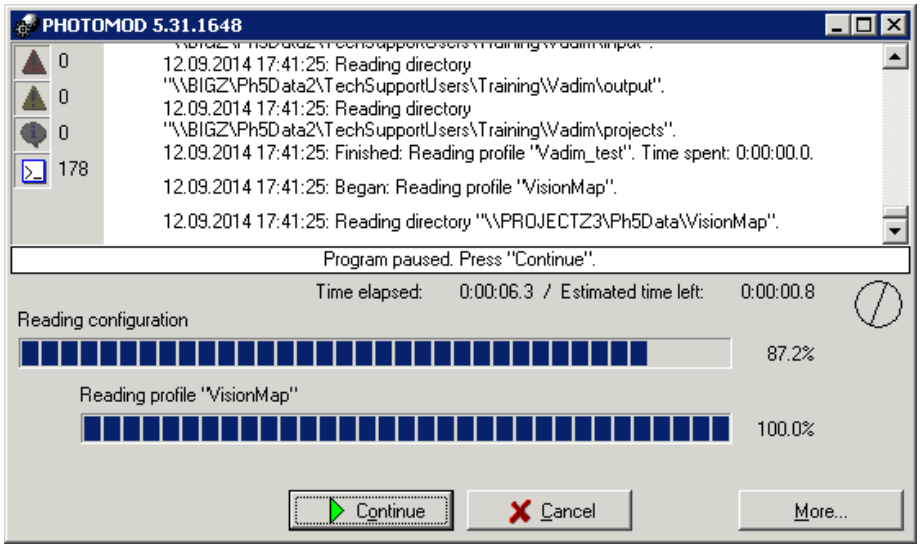


Fig. D.3. Control panel module loading

In the *Control Panel module* window the resources system, allowed to work in the system, is displayed. Each profile has resource structure – list of virtual folder compared to real folders on hard disks of different computers in the network used to store system's data.

Only one chosen *'active'* profile could be used at the same time.

Unavailable profiles and profiles with unavailable resources or virtual folders are marked by red color in the table. To remove these profiles from the table choose **Profile › Delete uncorrect profiles**.

Table of profiles with size of common free space of each profile is displayed in the **Profiles** section. Common free space of profile is a sum of free places on all hard disks with connected folders. Profiles could be local or network and marked by different icons in the table. For detailed information see the Creating and connecting profiles chapter.

Table of virtual folders is displayed in the **Resource**. It contains list of real folders, corresponding to virtual folders and information about free space on all involved hard disks.

Points sorting in columns of the list is performed by mouse click on the column header.

The system provides possibility of additional placement of project folder in subfolder (e.g. *Projects/InfoMap/InfoMap_copy*). For example, to place project folder in the *InfoMap_copy* folder, create a new folder in the *InfoMap_copy* with ***project.tag*** name. It is possible to place projects in the *projects.tag* folder.

Table D.1. Brief description of Control Panel window toolbar and menu items

Buttons and menu items	Function
Service › Initial setup	allows to specify initial settings of access and management of network profiles, which configurations are stored in the centralized management folder
Profile › Create	is used to create the new local profile
Profile › Delete	allows to remove from the table local profile and its resources structure; at fact files and folders *do not delete* and could be used again in new or existed profiles
Profile › Delete uncorrect profiles	allows to remove from the table all profiles (local or network) that are linked to unavailable of nonexistent profiles
Profile › Copy	allows to copy selected profile with its its resources structure and save it with a new name
Profile › Rename	allows to to rename selected profile
Profile › Activate	allows to make selected profile active and use it in the next system's launch
Resources › Connect folder	allows to create virtual folder and connect it to a selected profile
Resources › Disconnect folder	allows to disconnect folder selected in the list from profile; real folder does not changes
Resources › Modify folder	allows to rename virtual folder or change path to its real folder on a hard drive

D.2.2. Creating active profile

Profile, available to use only on one PC, is called *local* profile. This profile is not displayed in the list of profiles on other PCs in the network. Local profile is marked with leftward to profile name.

Perform the following actions to create a local profile:

1. Choose the **Profile › Create** or click the button. The **New profile** window opens.

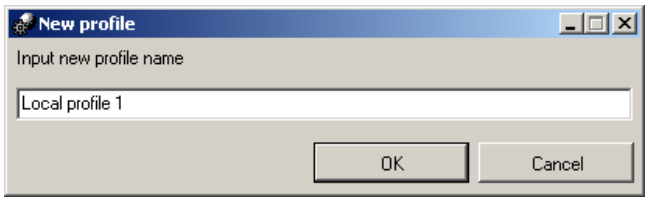


Fig. D.4. Creating profile

2. Input a name of new local profile.
3. Click OK. The **Connect virtual folder** window opens.

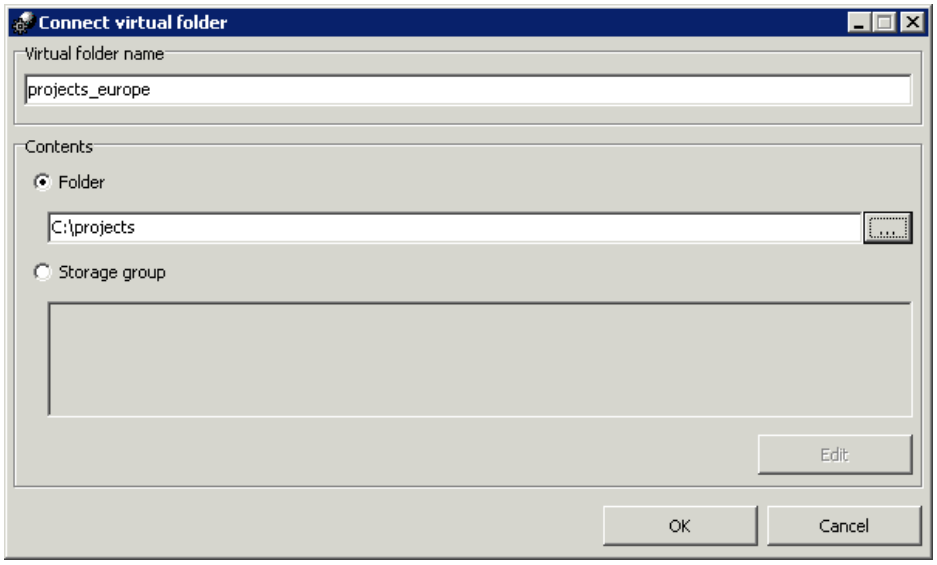


Fig. D.5. Connecting new folder

4. Define name and path to virtual folder.

5. Click OK. Local profile creates and also defined virtual folder connects to this profile.

Local profile is marked with leftward to profile name.

6. Make profile active by double-clicking on its name. Leftward to profile name is shown the red mark. It marks an active profile.

Restart all opened modules of the system to apply changes.

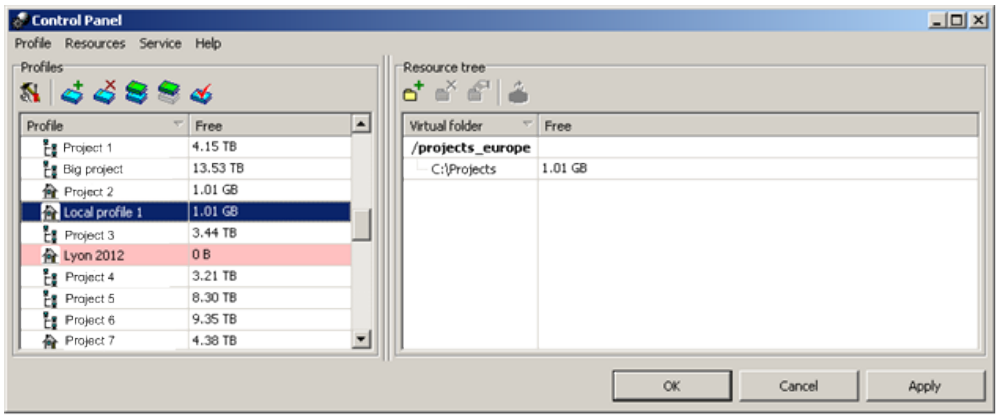


Fig. D.6. Control Panel window

7. Click OK.

8. Run the system. All space in active network profile resources is available in the system on a current workstation. The **Project management** window opens allows to choose active or create, copy, remove, import and backup profiles (see the Project creation User Manual of the main *PHOTOMOD* documentation)

D.2.3. Connect virtual folder

To connect virtual folder to selected profile perform the following:

1. In the Control panel window choose the **Resources › Connect folder** or click the button. The **Connect virtual folder** window opens.

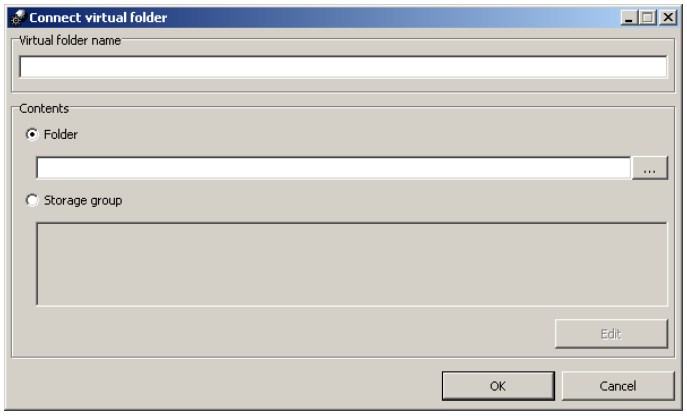


Fig. D.7. Connect virtual folder

2. Input a **virtual folder name** – arbitrary text used to identify data in folder.

3. In **Contents** field click the ... button to choose a physical space for connecting as a virtual folder. Click OK to close the **connect virtual folder** window.

It's impossible to use logical disk root folder.

To connect folder only read access for this folder is required. The `AutoUAS_IntermData` catalog will be created in the selected folder.

Local profile folder could be placed both on a workstation, where the system runs, and on any workstation of the network.

4. Click OK. Folder connects to the active profile.

To disconnect virtual folder form a local profile, choose **Resources › Disconnect folder** or click the button. At that, physical folder *is not deleted*, only the *virtual folder name* is remove (cleared the path to this folder).

To disconnect virtual folder form a network profile, choose **Resources › Disconnect folder** or click the button in the Network profiles **management**.

When disconnecting the *network* profile it is converted to *local*. *This local* profile is available on all workstation of the network.

D.3. System Monitor service module

After the system installation *System Monitor* module is launched and in the system tray of *Windows* the icon displays.

The **Start › Programs › PHOTOMOD AutoUAS 7 x64 › PHOTOMOD System Monitor** menu item is used to start the module.

It is also possible to start module from a command line. Use *--profile='*profile_name' key when launch the run the module from command line to run profile with active profile, defined in a key. Last active profile is used if module runs without key.

It is not possible to change active profile when module is launched from a command line.

Module right-click menu contains the following menu items:

- **PHOTOMOD AutoUAS** – is used to launch the program (also double-click on the icon);
- **Control Panel** – allows to run module for resources system management;
- **Distributed processing control center** – allows to setup options and to control distributed processing;
- **Start automatically** – with start of *System Monitor module* **Distributed processing control center** starts automatically ( );
- **Profile** – allows to select an active profile in the list of local (h) and network (R) profiles;
- **Language** – allows to change the interface language;

  Language changes at restart modules. To change the *System Monitor* language also restart the module.

- **About** – opens a window indicating the number of system build and serial number of hard lock key, the technical support end date, and also allows to open the **System Information Panel** window with detailed information about software, hardware configuration, and components of the computer (such as details about the device drivers);
- **Licence info** – opens a window with information on system's modules configuration and hard lock key ID;

- **News** – opens the embedded browser window for quick link to www.racurs.ru news;
- **Automatic download for news** – allows for enabling () or disabling automatic download data on unread news on the www.racurs.ru website;
- **Exit** – allows to close the *System Monitor module* and close the system.

Appendix E. The PHOTOMODAutoUAS7.VAR configuration folder

The information below is intended for advanced users.

At the stage of system first configuration is automatically created the *PHOTOMODAutoUAS7.VAR* folder. This folder is used to store configuration, temporary and other system files.

Only one *PHOTOMODAutoUAS7.VAR* folder creates, even for several installed copies of the system.

It is not recommended to place the configuration folder in the net, because it leads to slowing of system's work.

PHOTOMODAutoUAS7.VAR folder contains the following files and folders:

- *AutoSave* folder – is used to store autosaved data:
- *Config* folder – is used to store files of general parameters of all profiles;

It is possible to return to default parameters in case of changing configuration file. To do this, remove a configuration file in the *PHOTOMODAutoUAS7.VAR* folder and restart the system. Default configuration file are copied from the *PHOTOMODAutoUAS7.VAR\Config* system files folder.

Both global settings and settings for the local profile is loaded at startup of the system and saved when you exit. Local project settings is loaded when loading a project and saved when project closing. In case of working without projects, settings are stored in the *PHOTOMODAutoUAS7.Var\Profiles\[profile_name]\VoidProjOptions.x-ini* file.

- *Logs* folder – is used to store log-files for all profiles;
- *Profiles* folder – is used to store all parameters for each profile separately. The list of local and network profiles is also stored in the folder. It is the same list as in the **Control Panel** module. Configuration file with resource structure and path to local/network folder is also stored in folder of each profile;

New subfolder creates for each profile.

- *Tmp* folder – is used to store temporary files;
- *UserData* folder – is used to store data out of resources system;
- *policy.x-ini* file – contains general information about configuration parameters (active profile name, name and path to centralized management folder and so on).

Appendix F. Sentinel hard lock key

The distribution kit includes the unique hard lock key from *Sentinel HL* (previous called *HASP*), to protect the system and data from software piracy and unauthorized dissemination. Prior to work in the program, it is needed to insert *Sentinel HL* unique security key into the USB-socket of the workstation. The security key drivers should be installed on the workstation too. If the *Sentinel HL* hard lock key or security key drivers (they must be installed automatically during the program installation) are not found, the error message of protection system displays. Contact the Racurs company technical support service (see *Section 1.3*) to for the consultation.

In case of problems with installation of security key drivers, install it manually. To do this open the *Hasp\Sentinel_HASP_Run-time_setup* folder from the installation CD and launch the `HASPUserSetup.exe` file. Install security key drivers with default parameters. You can also download the last version of security key drivers on this link.

To check congruity of hard lock key perform the following:

1. Choose **License info** in the right-click menu of the *System Monitor module* (the icon in the *Windows* system tray). Process of licences checking starts. After checking, the **PHOTOMOD Distribution info** windows opens.

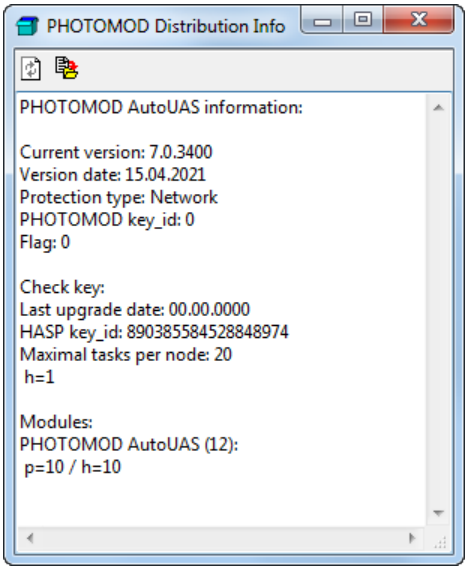


Fig. F.1. Distribution Info

2. Compare the unique number of security key in the `Serial number` line with the number on hard lock key.

3. Compare quantity of license for modules in each line below the name of module. Quantity of licence in the hard lock key and in certificate should be equal.

'h' is quantity of licence in the hard lock key, *'p'* is quantity of licence in certificate.

4. If number are not equal contact the RACURS company technical support service.

If there is not enough RAM or resource-intensive tasks are performed on workstation with the secure key, The protection system failure or loss of data are possible.