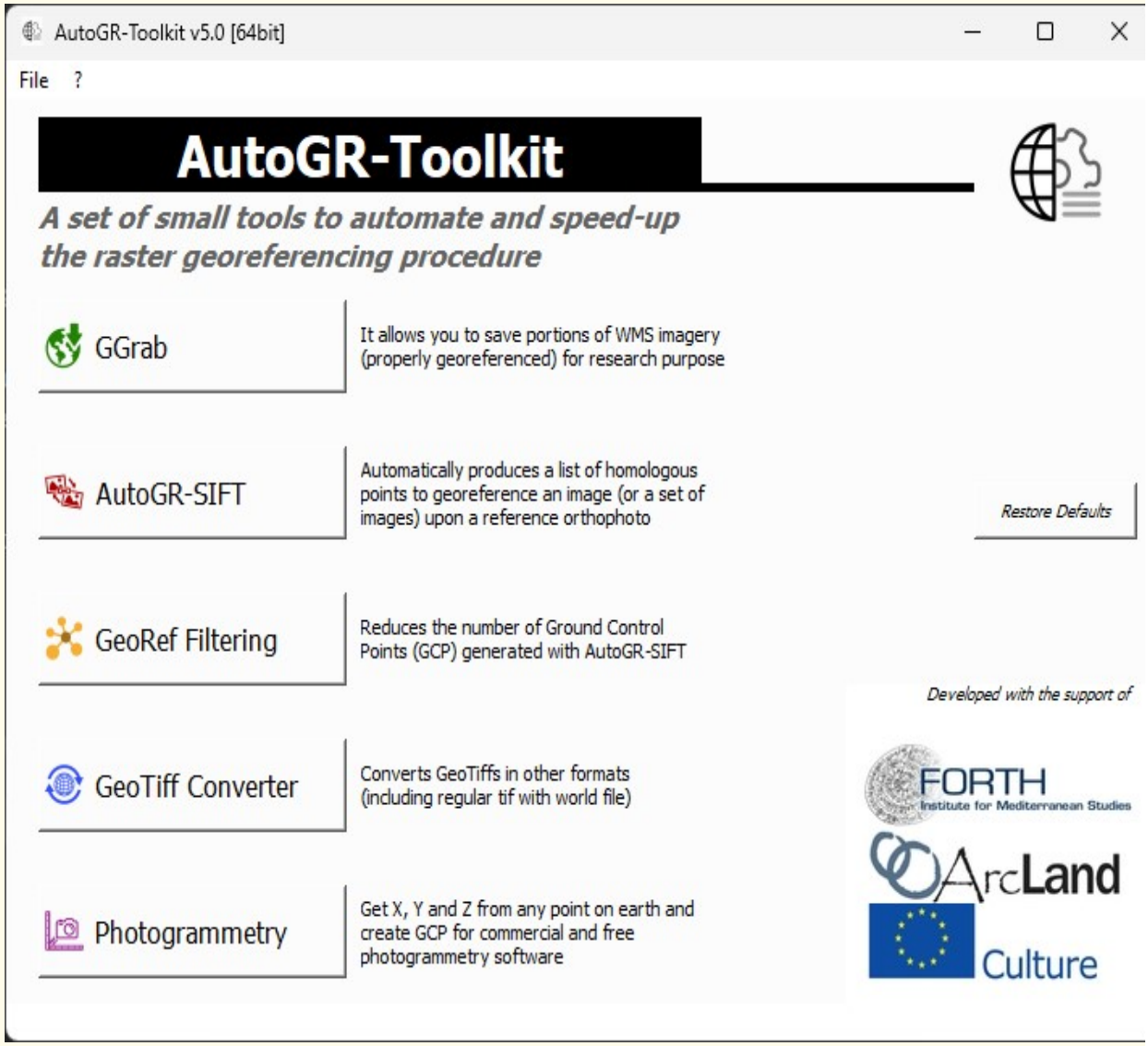
AutoGR Toolkit

AutoGR-Toolkit is a set of tools written in Python and converted to .EXE with py2exe. The purpose of the toolkit is to facilitate and speedup the process of georeferencing images and 3D models.



AutoGR-Toolkit, and the embedded tools (GGrab, AutoGR-SIFT, GeoRef-Filtering, GeoTiff-Converter and the Photogrammetry

package) are distributed for free and can be redistributed (free of charge). It is recommended that users register and download the toolkit directly from the website www.ims.forth.gr/AutoGR which will allow for future contact, notifications, bug-fixes or updates if needed.

Beside the OpenCV source code (compiled against Visual Studio 2015), AutoGR-Toolkit makes use of the following pythonlibraries (both in 32bit and 64bit variants):

- PyQt5 5.15.9
- osr/gdal/osgeo 3.3.3
- pyproj 3.4.1
- Pillow 9.5.0
- dateutils 2.8.2
- numpy 1.24.3
- exifread 3.0.0
- GeoPy 2.3.0
- Pandas 2.0.3
- PyInstaller 5.7.0

A forum is also available at the following address https://groups.google.com/forum/?fromgroups#!forum/gianlucasmallsoftware

It is very important to notice the function "Restore Defaults", since this is going to reset the software to initial settings and avoid possible problems (i.e. due to corrupted settings or problematic files loaded in one of the tools).

GGrab:
Allows you to save orthographic images from Google, Microsoft servers (the download is controlled by the provider who may limit your access or even block your IP!) or other WMS systems.
The area of interest can be easily downloaded (or grabbed) with its

georeferencing information (World and projection files) and converted to any preferred coordinate system.
Specific services in the software are reached with the use of Geospatial Data Abstraction Library
http://www.gdal.org
No responsability can be attributed to the Author of this software for any inappropriate use of WMS images or derived products. This script is intended only for research and personal use.
User is responsible for the respect of the specific wms licenses.

AutoGR-SIFT:
This module automates the image georeferencing process with the use of Computer Vision.
AutoGR-SIFT employs OpenCV (with image matching *'contrib non-free' modules*, optimized and compiled from sources) and GDAL libraries (through python porting). It makes use also of the powerful library SuperGlue for image matching
AutoGR-SIFT automatically produces a list of points to rectify (in real world coordinates, if available) a given pair of images.
It benefits from OpenCV implementation of the David Lowe's SIFT algorithm (http://www.cs.ubc.ca/~lowe/keypoints).
Different algorithms have been added to speed up the image matching and boost the possibility of successful image matching.

GeoRef-Filtering:
AutoGR-SIFT usually produces thousands of points in few seconds and this script lets you reduce this number to a more manageable one.

GeoTiff-Converter:
It extracts geographical information from a geotiff file and it produces a .jpg with its worldfile.

Photogrammetry:
It allows to select X Y and Z coordinates for any point on Earth via the Google API. The same procedure can be automated for the extraction of coordinates for 3D models (supported software: visualsfm; sfm_georef; agisoft photoscan).

If you are running **Windows Vista** or you experience **problems** executing the program, try installing the Microsoft Visual C++ 2015 Redistributable Package and/or the Windows 10 Universal C Runtime.
If the problem persists, feel free to contact the author of the program (see the email below) for assistance.

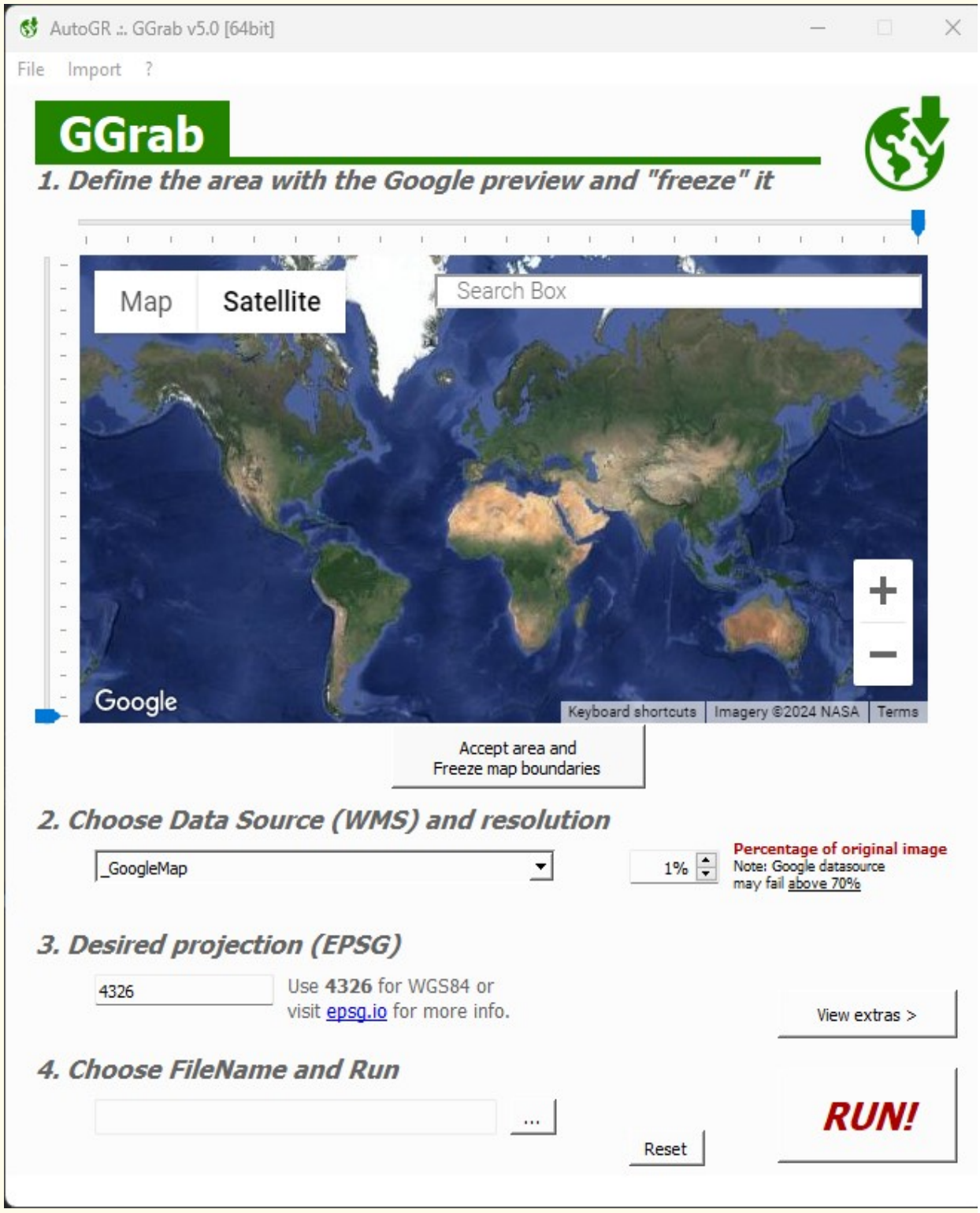
In case of problems, requests/whish list or feedback,
feel free to contact the author of AutoGR-Toolkit:
Gianluca Cantoro // gianluca.cantoro@gmail.com

Contact us

In case of problems, requests/whish-list or feedback,
feel free to contact the author of AutoGR-Toolkit:
Gianluca Cantoro // gianluca.cantoro@gmail.com

GGrab

This module simplifies the download of freely accessible WMS imagery by selecting an area of interest.
GGrab makes use of GDAL and ExifRead libraries through python porting.



GGrab has been largely simplified with the last version. Now it is much easier to select the area of interest: user can search (in the

Search Box) the place name and define the area of interest as combination of zoom and sliding bars. Top and left side bars allows to limit the area of interest to a more specific outline.

In this example a small stripe has been defined by moving the sliding bars.

When the area is defined, user should Accept and Freeze the map. This operation will validate the selected area and store the clipping value in the "view extras" window.

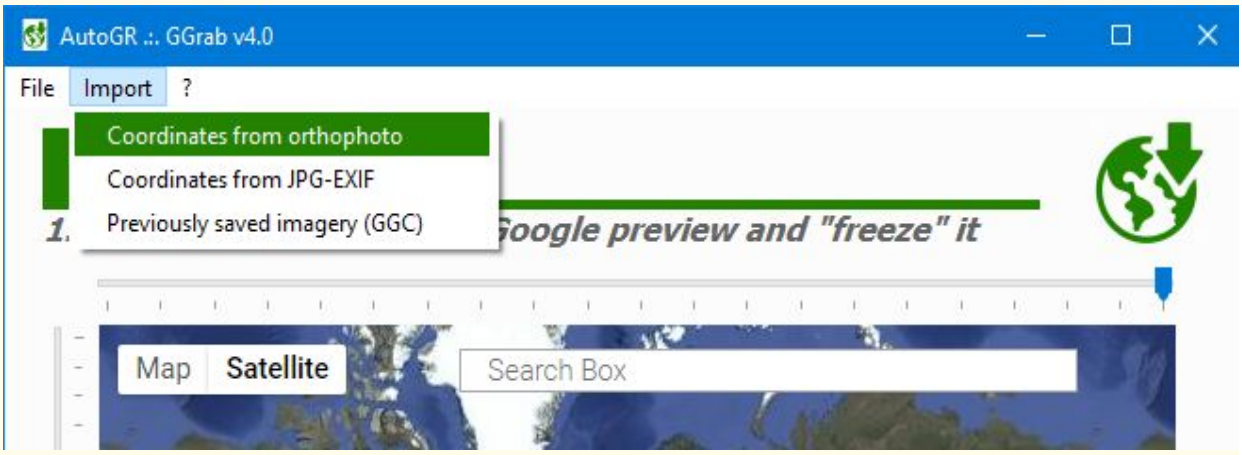
Then it is time to choose the WMS server from the available list (please get in contact if you would like to add other freely accessible servers to the list).

Set now the Percentage of the original image: just keep in mind that 100% may not work with every data source in the list.

If you are working with a small area, you can try to put a higher Zoom level. Consider that every server has a request time-out, which means that if you try to download a large portion of their orthophoto (large size in Megabyte and therefore long downloading time), the server may block the connection... even at 99% of the downloading!!!

Now you can select the EPSG of the desired output image and choose a filename. The same name will be used for the .PRJ and the .TFW files.

At the end of the process, the folder with the produced files will pop-up automatically.



You can also choose different ways to select your area of interest. For example, you can import automatically the coordinates' boundaries from an already available orthophoto. The software will try to emulate the same shape to allow you to perfectly overlay the two images.

In case you have photographs with coordinates embedded in their EXIF, you can try to use them to locate your area of interest.

Finally, you can use a GGC file (created by GGrab at every download) to download again the same area. This is particularly useful with Google provided satellite images, since you have a

chance to download the same area every time a new orthophoto is uploaded and made available to Google users.

Should you experience any problem, please do not hesitate to **contact the author** Gianluca Cantoro.

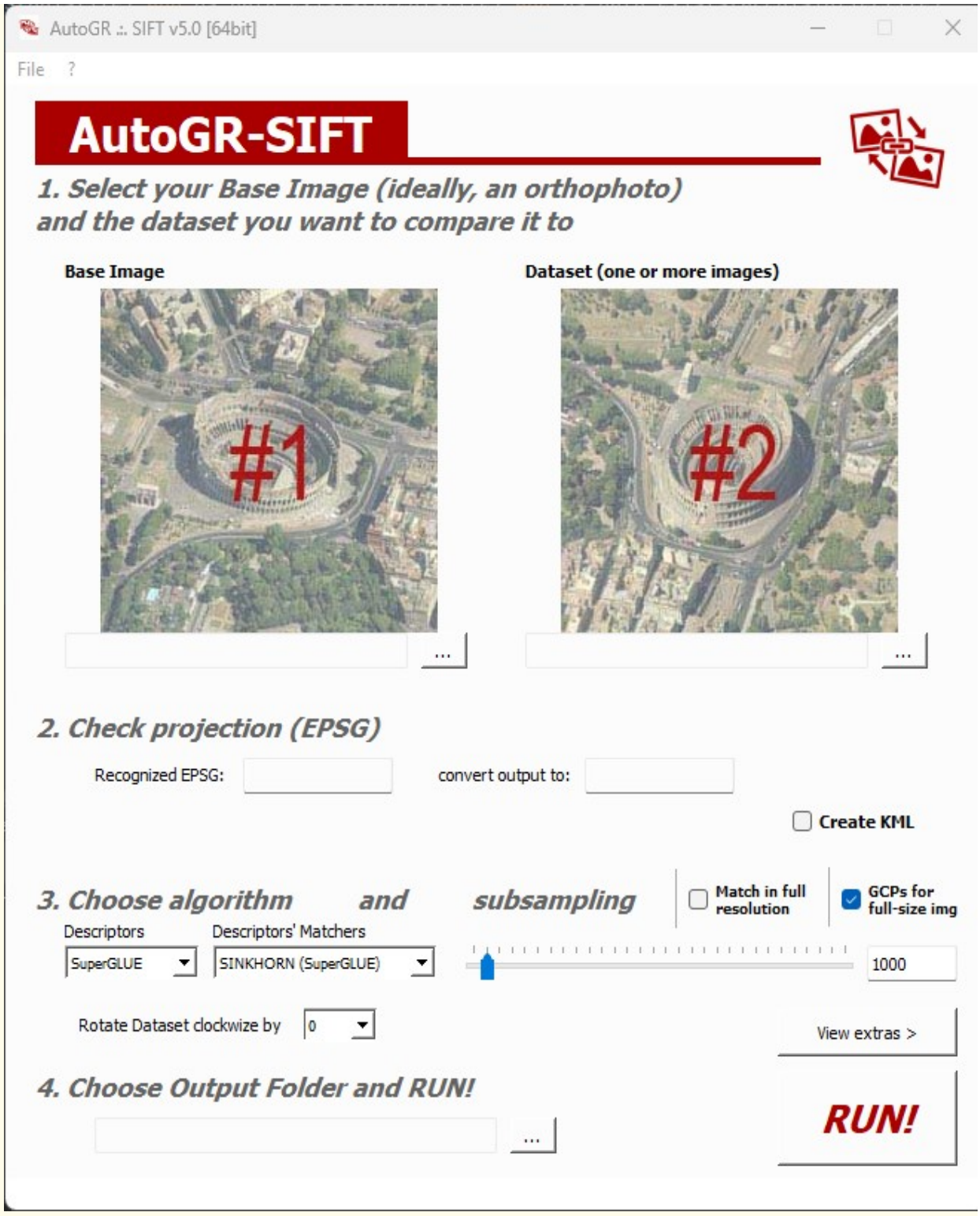
AutoGR-SIFT

AutoGR-SIFT searches for common "features" (homologous points) in a given couple of images using a modified version of the Lowe's Algorithm (c) SIFT (Scale Invariant Feature Transform). The power of the algorithm (and the implemented variants embedded in AutoGR-SIFT) stays in the fact that the two images can depict similar scenes or can be taken from different viewpoint or in different times.

Building on this, AutoGR-SIFT can process for instance a satellite image (such as a Google Map or Microsoft Bing provided Satellite Image, see GGrab) and "compare" it with an oblique photo of approximately the same area taken in another year or season.
If the first selected photo has a WORLDFILE and/or a projection file, the files will be used by AutoGR-SIFT to generate control points in real world coordinate; otherwise a fake world file (with 0,0 as starting coordinate) will be created to allow the reciprocal positioning of both rasters in a GIS environment.
Allowed raster IMAGE FORMATS are Tif, GeoTif, Png and Jpg, together with all files supported by GDAL library.

Lowe algorithm (and its implementation used here) has a RANDOM base, and this makes it possible to repeat the procedure if the first result is not satisfactory or it fails, hoping for better output.

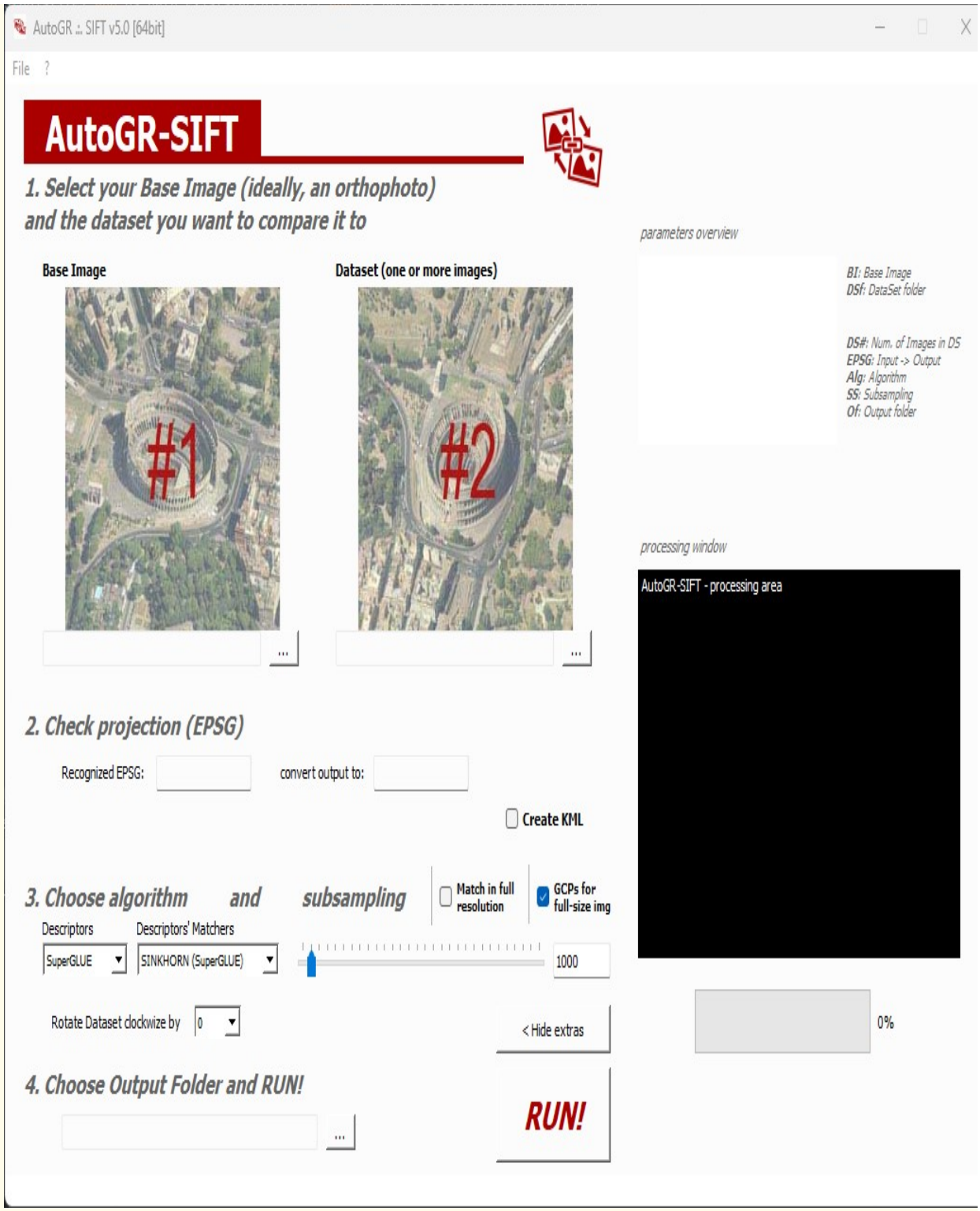
AutoGR-SIFT step-by-step



The ***first step*** of the processing consists in selecting the images to be matched.On the left side (Base image) you select the first image, usually an orthophoto or a satellite image or in general the one that

will **not** be modified during the processing and will be used as base for comparison.On image loading, the software will try to identify the projection type of the raster and convert it in a standard EPSG code. You may also specify a custom EPSG value, different from the recognized one, if there was a problem or if you are sure about the correct input projection. Note that this change will not reproject the output to your desired EPSG. It will just create a prj file with the selected information and will use that EPSG to convert points in WGS84 to be used for KML file generation.

Second step consists in the selection of the dataset to be processed. User can then check the projection EPSG and select whether or not a KML file should be created.



The third step is the selection of the algorithm (descriptor and matcher) and the subsampling value. For an introduction on Feature Detection have a look at the OpenCV tutorial at

https://docs.opencv.org/master/db/d27/tutorial_py_table_of_contents_feature2d.html. In a quick and dirty description, some algorithms are best for reciprocal image rotation or scaling or are more or less sensitive to color/light changes and they are more or less fast in producing the output. The same couple of images can therefore produce different results with different algorithms (and descriptors). The same applies to the subsampling factor: larger or smaller image can produce different results (consider that not always larger image means better results!). The selected subsampling value will produce copies of base and dataset images with the largest side (width or height) reduced to that value (and the other one proportionally adapted). Users have also the option to Keep the full resolution, so that base image and dataset is not going to be resized. This is made possible by the compilation and optimization of OpenCV from source for the purposes of AutoGR. Indeed, in previous versions the software could stack or crash in case of large images. Now the only limit is set by the user's computer: better performing computers can process larger images. In case the processing fails for insufficient memory (see the "view extras" window for details), user can set a decreasing value of subsampling until the upper limit is found (keep in mind also that other running programs reduce the available memory to be used by AutoGR-SIFT).
The last version of AutoGR-Toolkit includes also the powerful SuperGlue algorithm . This is particularly suited and performing with historical and contemporary images matching, thanks to the use of Artificial Intelligence. An important note: given its main application in computer vision, the algorithm may provide better results with low resolution images, differently from the other available algorithms.

Forth step consists in the selection of the Output folder, where all processed and produced files will be saved. We strongly suggest to select an empty folder to avoid data loss or issues with the software.

It is now time to hit RUN. To monitor the progress of the processing, user can click on "view extras": a small appendix window will open with a black box where all the output from the processing will be visible in real time.

When the process is completed, the output window will automatically open up to show you the results. An automatically generated warped image (homography transformation) will be in that folder too for you consideration.

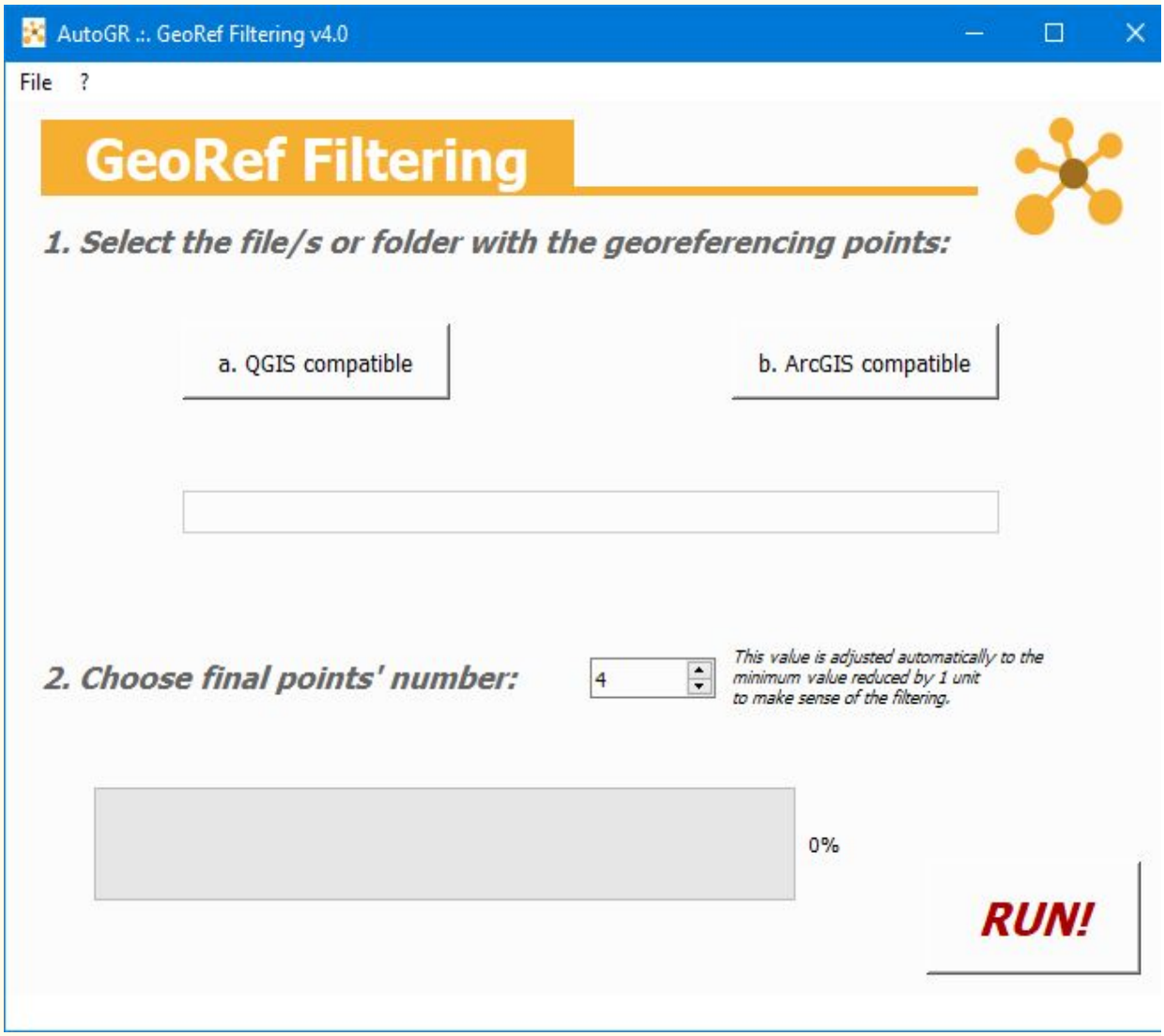
Next steps now will involve the specific GIS platform that you are going to use.Whether you prefer ArcGIS or QGIS, the principles are the same: load the base image and run the georeferencing function to rectify the second image, but instead of choosing manually the common point it will be sufficient to load the matching point list generated by AUTOGR.
From AutoGR version 4.0, a RANSAC filter is applied to the homologous points to identify false matching. This information will be saved in points list both for QGIS (points enabled by default when loading the .qgis file) and ArcGIS (specific file containing only the inliers.

If points are well distributed in the image, it will suffice to accept all of them and apply the GIS second or third polynomial. Otherwise, feel free to delete any mis-matched point or to add some more to improve the result.
When the image have been georeferenced, it can be used as base image for the processing of the next image in the sortie, for instance, or any other image of your area of interest.
If you enabled the specific function, the software will try to produce (assuming that the input has been recognized correctly and that it can be converted to WGS84) an image footprint in KML format (mainly for Google Earth preview).

Should you experience any problem, please do not hesitate to **contact the author** Gianluca Cantoro.

GeoRef Filtering

AutoGR-SIFT usually produces hundreds or thousands of reference points in few seconds. **GeoRef Filtering** lets you reduce this number to a more manageable one. The sampling also helps to simplify the polynomial algorithm to be applied to the image you want to geo-reference.



AutoGR-Toolkit keeps track of the last output folder and it allows here to save time by quickly selecting it for filtering.Otherwise, by choosing

"Select another output folder" the script will let you select a folder from previous processing.
Once the matching file is selected, the window will update the reported information (number of matching points and maximum sampling number). You will notice that the maximum sampling number will be set to the number of available points reduced by one (otherwise the filtering makes no sense).

We suggest you to keep this number within a range of 100 (or less) and 250 points. Higher number may cause the GIS software to stuck or crash, but feel free to experiment...

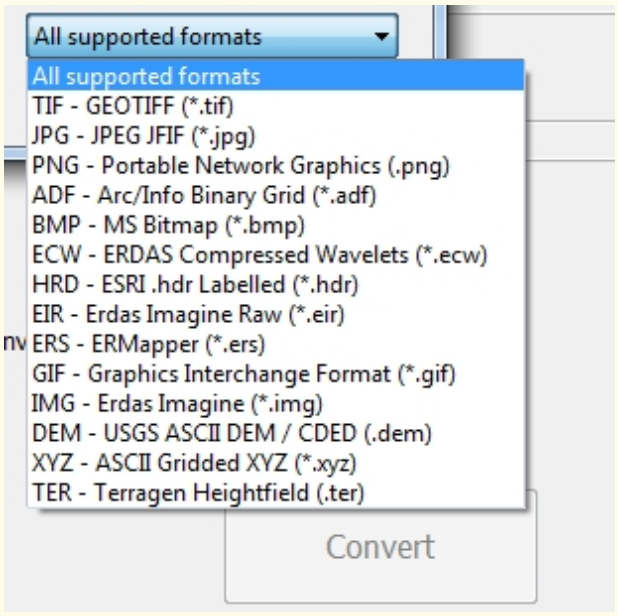
In matter of seconds, the points are filtered and the output folder will popup automatically to show you the resulted files (filtered qgis and arcgis points).
The filtering procedure starts from a random point, which means that if you run this script more times with the same output number of point, you will probably get different sets of points.

Should you experience any problem, please do not hesitate to **contact the author** Gianluca Cantoro.

GeoTiff Converter

Using the GDAL library, GeoTiff Converter transforms a given raster to a regular (non geotiff) tif (and/or jpg and/or png) with its own worldfile.

User will be asked to select the image s/he wants to convert. A larger number of format is supported:



It is sufficient to tick any (or all) of the predefined output format and click on Convert. The output can also be downsampled to desired value (via the "Scale Output to" function).

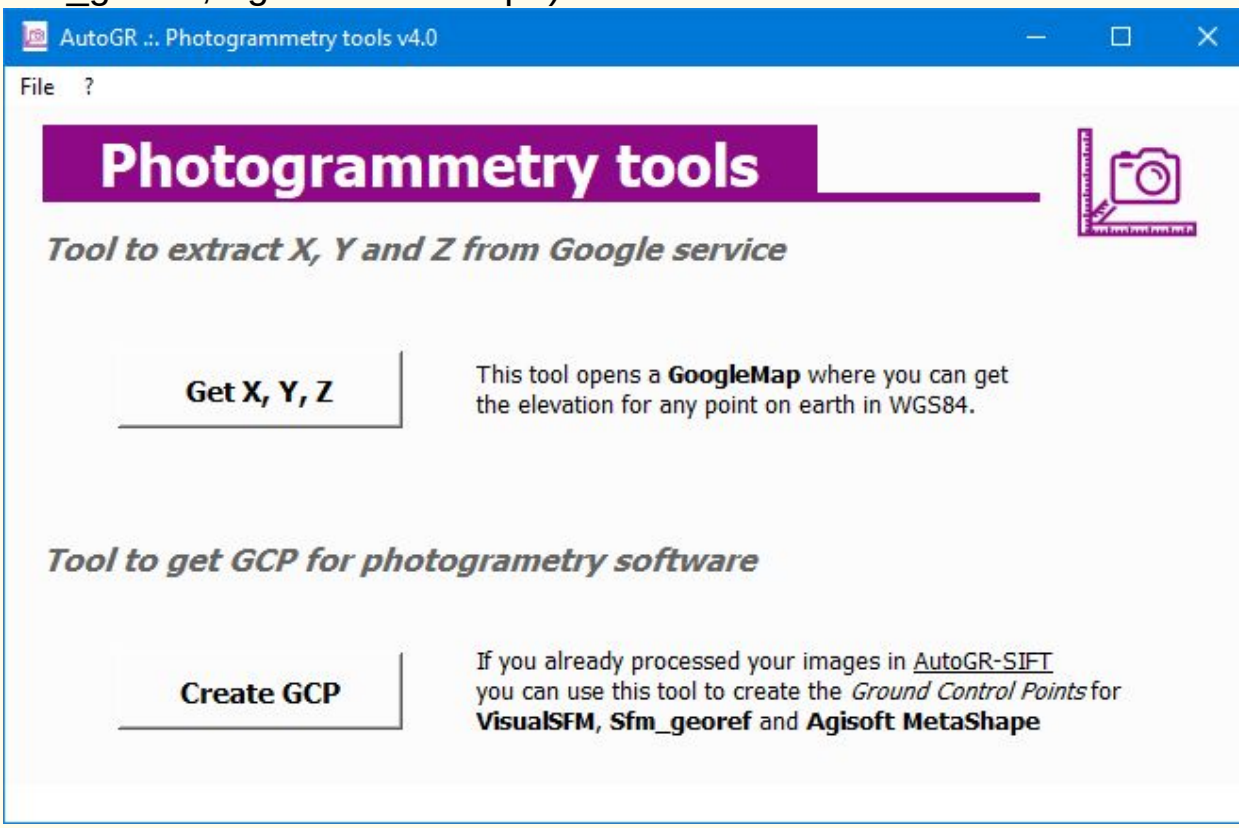
Again, the output folder will popup at the end of the processing. The resulting image/s can then be used to rectify a new raster with geographic coordinate or used as preferred.

Should you experience any problem, please do not hesitate to **contact the author** Gianluca Cantoro.

Photogrammetry

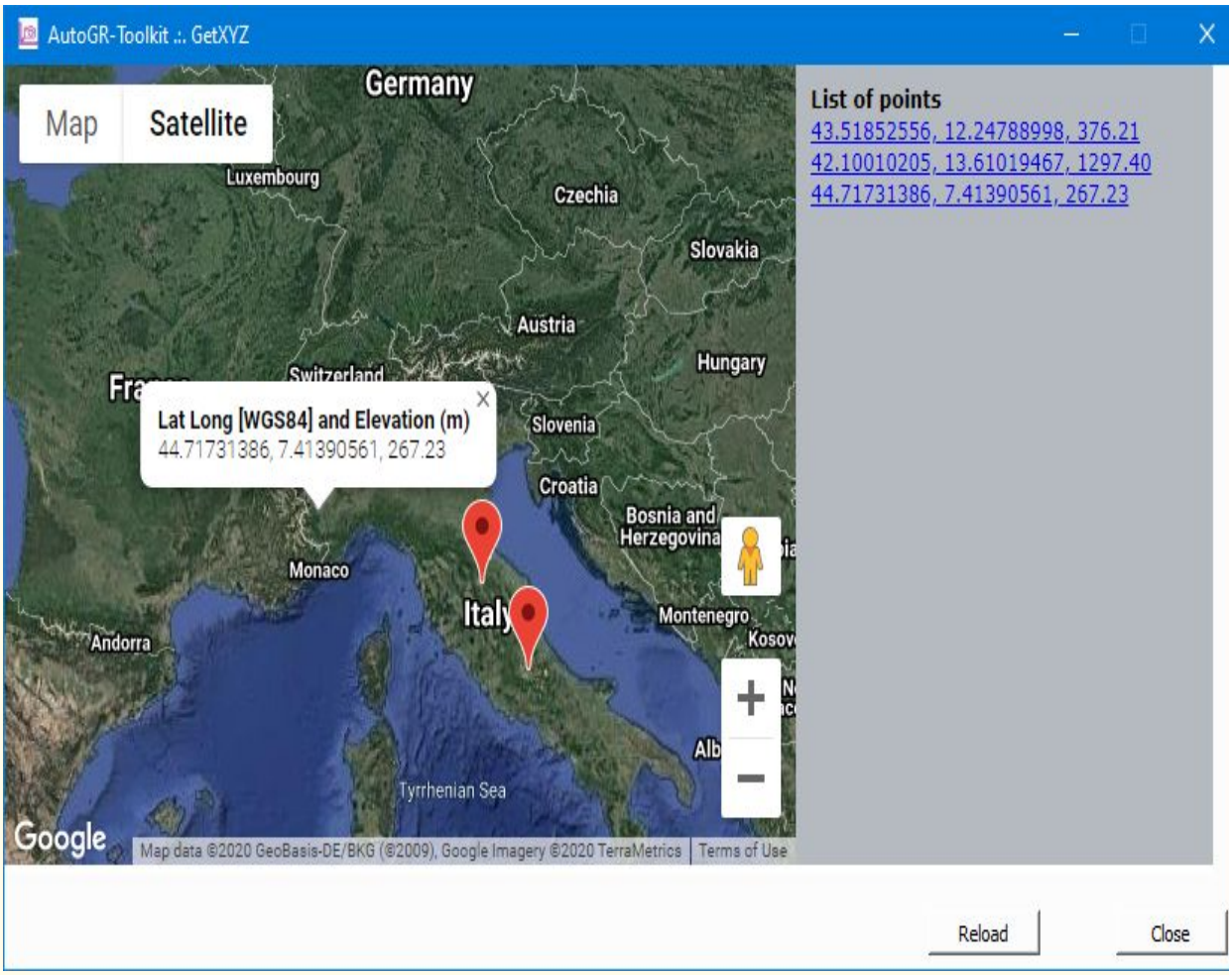
It allows to select X Y and Z coordinates for any point on Earth via the Google API.

The same procedure can be automated for the extraction of coordinates for 3D models (supported software: VisualSFM; sfm_georef; Agisoft Metashape).



From the main screen the user can choose between two options:

- manually select points on a map (Google Altitude API) and get their X, Y (or lat long) and altitude;
- use the Create GCP function to automatically extract Ground Control Points from an AutoGR-SIFT processed folder.



Once the point is selected, its coordinates can be easily copied and pasted into the preferred photogrammetry software for georeferencing.

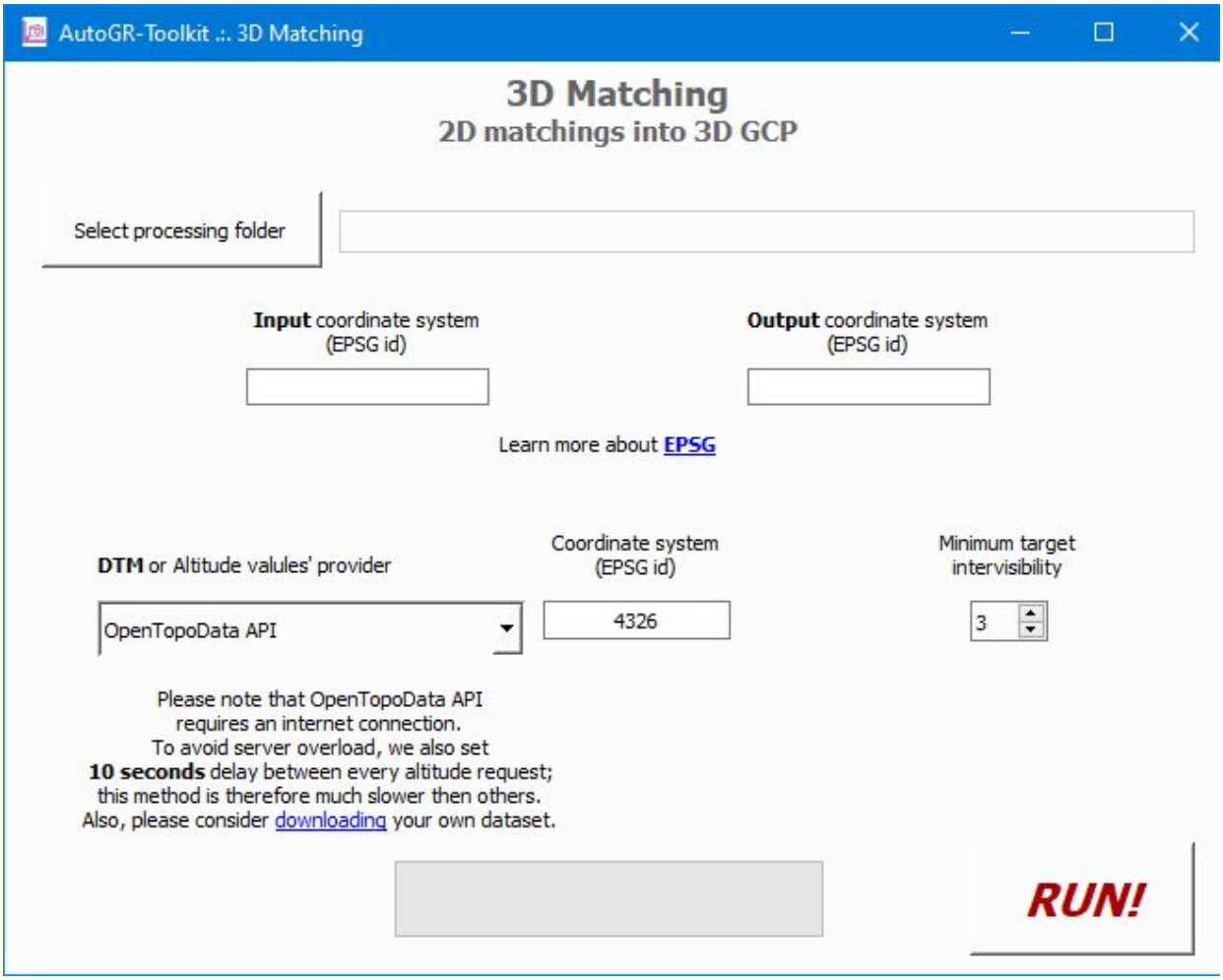
The other function makes a similar process as the above mentioned tool but in an automated way and it operates on photogrammetric matching.

Given a folder were AutoGR-SIFT has been successfully applied, the script:

- recognizes the used projection;
- allows the user to define a preferred output projection (most photogrammetric software works well only with metric coordinates, so

your local UTM may be the best option) and undertakes the necessary coordinate conversion;

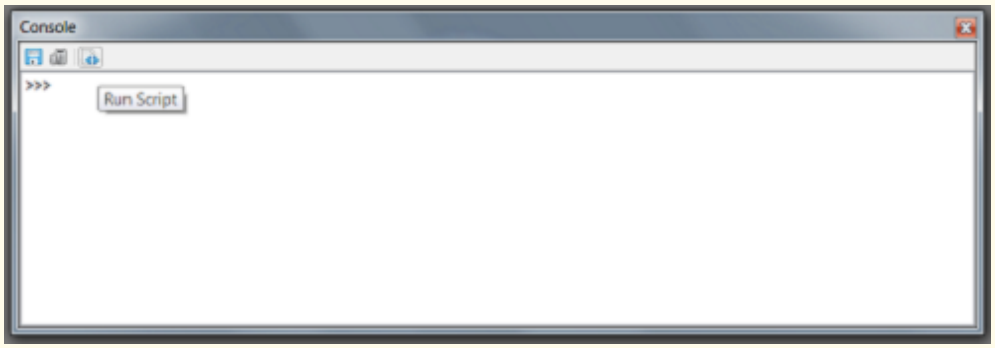
- lets user choose the number of ground control points to be used in photogrammetric software.



At the moment, the only available altitude data provider is OpenTopoData Api. This free service has strict limitations that makes it quite difficult to be employed with large datasets. As alternative, users can load their own DTM (available from other processing source or downloaded from the NASA portal -link provided-).

A subfolder is automatically created with all the required files to be used in VisualSFM, sfm_georef or Agisoft Metashape. In this last

case, the python script has to be loaded into Agisoft PhotoScan via the Run Script function in the console (see below).



Please make sure that you choose the correct project and the Active Chunk is the one where the photos processed by AutoGR-SIFT are loaded.

"Filtered-output_2100.gcp" is the specific file the software created for VisualSFM (in the specific case, the 2100 suffix stands for the EPSG code used to generate the points).
"Sfm_georef-link" and "sfm_georef-observation" are intended to be loaded in sfm_georef, as the filenames suggest.

Note: The altitude accuracy is related to intrinsic accuracy and ground resolution of the chosen provider. If the loaded DTM is not well aligned with the processed images, the derived 3D GCP will not correspond and the process may just add error to the general google accuracy.

Should you experience any problem, please do not hesitate to **contact the author** Gianluca Cantoro.

Acknowledgement

AutoGR Toolkit is a set of tools that have been created to facilitate and speedup the process of images georeferencing.

AutoGR-Toolkit, with related modules (GGrab, AutoGR-SIFT, GeoRef-Filtering, GeoTiff-Converter and AutoGR-Photogrammetry), is distributed for free and can be redistributed (free of charge).

It is recommended that users register and download the toolkit directly from the website www.ims.forth.gr to allow for future contacts, notifications, bug-fixes or updates if needed.

You are kinldy asked to get informed about software and libraries *license policies*, an more particularly about OpenCV, GDAL and Python.

Specific License info files have been stored in the installation folder (License-OpenCV.txt; License-GDAL.txt).

Full credits also to the developers of **OpenCV**, here optimized and recompiled for AutoGR-SIFT.
GGrab, GeoTiff Converter and AutoGR-SIFT use the Geospatial Data Abstraction Library **http://www.gdal.org**.

Thanks to **Christoph Gohlke**, for providing pre-compiled version of some python libraries; his work was very important for my software development.

Thanks to **Gribouillis** and **pyTony** from the *Daniweb's Python Forum* for their immeasurable support for the creation of some special functions in this software.
Thanks to **Irwin Scollar**, **Geert Verhoeven, Rog Palmer, Darja Grosman** , **Giorgio Franco Pocbelli** and **Wlodek Raczkowski** and all other colleagues for their precious revision of my software and for

the solutions they generously suggested me with some specific issues.

The **IT department** (Aris Kidonakis in particular) and all my **colleagues** at IMS-FORTH, for their technical support and help. IMS-FORTH provided the facilities and technical support to develop and finalize this set of applications and it holds, together with the author, the rights of this software.

In case of problems, requests/whishlist or feedback, feel free to contact the author of AutoGR-Toolkit:
Gianluca Cantoro // gianluca.cantoro@gmail.com

Updates

As soon as a new version will be available and uploaded to the server,you will receive an email from the server with the direct link for downloading.
AutoGR-Toolkit 4.0 has also an experimental system for automated update check when internet is available, just in case you don't like to receive emails about further updates.

If for any reason you may require an update or you would like to check if updates are available, you can anytime use the "Update Check" function available in every module's menu.

Institute for Mediterranean Studies - GeoSat ReSeArch Lab

Section: [Download and services]