

GigaPan photography as a building inventory tool



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Introduction

This report presents the use of GigaPan photography as a tool for building inventory and it particularly emphasises the opportunities and added value afforded by GigaPan photography. This report describes what building inventory means, what GigaPan photography is and, finally, presents the opportunities afforded by GigaPan photography as a tool of construction stocktaking.

The report is part of the project *Efficient use of natural stone in the Leningrad region and Southeast Finland*. The project is co-funded by the European Union, the Russian Federation and the Republic of Finland.

The report aims to provide everyone working in building inventory new opportunities to implement building inventory particularly in large-scale and challenging targets. The commission has been limited to discuss the facades of buildings, where the opportunities afforded by GigaPan photography can be best utilised.

Building inventory

Maintenance, treasuring and renovation of the built environment require knowledge of buildings, as well as of their condition and state. Building inventory is a fixed part of renovation and restoration projects. Inventory of a site aims to provide a comprehensive picture of the site, its condition and required measures, so that the measures planned and property maintenance can be correctly allocated. (Inventory)

Building inventory is typically included in a building history report. A building history report focuses on a whole building or built entity; the history, various changes and current state of which are studied using archive sources and fieldwork (Sahlberg 2010, 12–13). Inventory aims to systematically gather and store information about, for example, built environment, landscape or relics, while building inventory focuses on an individual building (Sahlberg 2010, 13). In accordance with the original specification of this project, this text discusses building inventory with an emphasis on facades.

The object of building inventory is the building in its current state. The report uses various archive materials, including drawings and other documents not only to verify original information but also to find out about changes and repairs done over the years, throughout the entire construction and change history. Information from various sources is combined and compared to enable an assessment of the preservation of construction parts and the degree of implementation of various plans. The report is the outcome of inventory. Various figures, drawings and charts have a great role in the report (Sahlberg 2010, 9).

The other building renovation project stages include a condition assessment and a survey of the renovation need of a property, building or its part conducted using sensory or experience-based methods. A condition assessment can be used, for example, as initial information for renovation planning. The condition assessment is done without opening the structures. A condition survey is a more detailed study than a condition assessment, which entails also taking samples from within the structures (Sahlberg 2010, 14).



When conducting a building inventory, the first stage is to gather and study various archive data. It is worthwhile to plan the fieldwork in detail, so that all of the necessary information required will be received during the actual field work stage.

The significance of building inventory is emphasised in alteration and renovation of targets with cultural-historical significance. The aim is to store the original look of the renovated or altered target and the "spirit of the place" for future generations.

Facade inventory aims to come up with an overall understanding about the permanence of the external features of the building and about effects caused by any alterations made. Original drawings and drawings of various alteration stages are compared with the current situation. Facades are looked at as a whole but also in terms of various structural parts. Structural parts looked at are:

- foundation walls and foundations
- wall surfaces
- doors and windows
- eaves and water discharge systems
- roof and equipment therein
- open shelters
- balconies and terraces
- stairs and ramps
- equipment and lighting fixtures
- other external structures (Sahlberg 2010, 41).

Inventory makes a record of building materials (e.g. timber), building methods (e.g. type of timber framework) and detailing (e.g. carving, seam padding) (Sahlberg 2010, 43). Simultaneously, all wear, damage, soiling and other relevant issues will be recorded.

Documentation by photography is used extensively in inventory. Photography is a good note-taking method. If old photographs can be found, photography can be used for making parallel images, which can be used for demonstrating and comparing "now and then" pairs of photographs from different periods of time. Photography has been used, for example, in recording damage survey information (Sahlberg 2010, 48).

GigaPan photography

GigaPan technique was developed by Carnegie Mellon University in cooperation with NASA Ames Intelligent Robotics Group, with support from Google in 2008. The system was originally designed for the NASA Mars rovers Spirit and Opportunity. Later it has been developed into a commercial application that is licensed by GigaPan Systems (www.GigaPan.com), a technology company that provides the hardware, software, and services to prepare gigapixel panoramic images.

The GigaPan photographing is done with a normal digital camera attached to a robot frame that moves and operates the camera.





Figure 1. The GigaPan equipment

The GigaPan equipment consists of:

- The GigaPan robot frame and the related equipment
 - Batteries (with its own charger)
 - Control cable to control the camera by the robot
 - DSLR camera that is compatible with the GigaPan hardware (list on the GigaPan website)
- Big enough memory card for the camera, preferably bigger than 16 GB (32 GB , etc.)
- Any other data storage device to save the pictures from the camera since one GigaPan picture can be composed of hundreds or thousands of pictures.

The robot is attached to a standard camera on a tripod, which should be quite robust. The robot has a spirit level that allows it to be set horizontal for shooting.

The robot is attached to the tripod with the tripod's quick release plate so that the quick release plate is attached to the GigaPan robot and then attached to the tripod through that.

The camera is connected to the robot with the mounting plate that is found in the GigaPan robot. The mounting plate is first attached to the camera and then the camera with the plate to the robot. The camera including the lens should be mounted so that the optical center of the lens is in line with the axes of rotation of the robot. In this way the optical center of the camera moves the least with respect to the pivot axis of the robot reducing the parallax error, i.e., the misplacement of the adjacent images.



Preparing the camera

After installation adjust the camera with "manual " settings. Focus the camera manually and set the appropriate value of the ISO, aperture, and shutter speed. This is to avoid too big differences between adjacent pictures that may be caused by automatic changing of the settings of the camera during picture taking. The camera's white balance is set according to the conditions, usually automatic if possible. For outside conditions can generally be used "daylight" setting.

The camera is connected to the robot via a control cable. The robot controls the camera. The robot should be adjusted so as to allow long enough time for the camera to perform all the necessary steps in taking the picture.

- Possible auto-focus
- Take a picture with the selected shutter speed
- To save an image on the memory card

After the robot and the camera gear are ready you can start the GigaPan robot. First you have to go through the Camera setup, which adjusts the robot according to the used lens and camera combination. You must perform this every time you change lenses, camera bodies, or zoom focal length. In this process the robot is told the vertical field of view, which is used in calculating the amount of pictures that needs to be taken for each panorama. In the settings can also be chosen the overlapping percentage of the adjacent pictures. Overlapping helps to prepare a better quality panorama.

Additional settings

There are additional settings of the GigaPan robot that may be useful in adjusting the system for optimal performance.

Exposure Bracketing to Capture HDR Images

- While taking the panorama, the Gigapan robot will take multiple exposures at each location. Your camera will do the necessary adjustments of shutter speed to get the desired exposure levels. If the camera has trouble writing the images to the card before the next image position, increase the Time/Picture in the Options menu.

Mirror Lock-up

- This function is used to flip the mirror up and wait a programmable delay before opening the shutter. Mirror Lock-up is especially important for longer focal length lenses that are larger and heavier and more easily disturbed by movements.

Shutter Teach

- With shutter teach you can set the timing for exposure bracketing or multiple pictures. The GigaPan robot enters a teaching mode where you press the left directional button at each point in time you want it to take a photograph. After this you can tell the robot how long time to wait until moving into next position.





Timelapse/Series

- You can use the 'Timelapse/Series' function to take a series of panoramas over a period of time. You can use either the external trigger and a remote control or a timer to tell the GigaPan robot when to start the next successive panorama.

New panorama

To start making a panorama you can choose between 'New Panorama', '360 panorama' or 'Previous' under 'Panorama Memory' if you have saved a previous set-up. Remember that you will need to repeat the camera set-up instructions if you change lenses or focal lengths.

After starting the equipment and choosing to make a new panorama you have to go through the following steps.

- Use the directional keys in the GigaPan frame to point the camera to the top left corner and the bottom right corner of your scene. GigaPan will calculate how many pictures, horizontally and vertically, are needed for the panorama
- The GigaPan prompts "Show Panorama?" in case you want to check the area still before starting the panorama. It moves to the upper left corner and lower right corner respectively.

After confirming the previous steps the GigaPan robot starts to take pictures for the panorama. It starts from left side and goes to right and down of the panorama.

It would be important that the field of view of the panorama was free of interference like people walking into the view so that unnecessary disturbance does not come to the final panorama. It might also happen that there might be missing pictures for some reason. If someone steps into your frame, or if your camera misses a picture, press X to pause the panorama, use the directional keys to go back to an earlier camera position and retake the photo.

Preparing the panorama (Stitching)

The taken pictures are put in the right locations and connected together into a single panorama in stitching software. There might be hundreds or thousands of pictures both in vertical and horizontal lines that make the final picture. The adjacent pictures overlap each other to some extent, usually at least 30%.

- The pictures from the camera are loaded into a mass storage device for stitching. It has to be noticed that depending on the size of the original pictures that amount of data for a single panorama can be several gigabytes.
- The pictures from the storage are imported to the stitching program (e.g. Stitch Efx 2.0 by GigaPan or Autopano by Kolor), where they are put in the same order as they were taken in. The choices can be column by column or row by row. The setting of the panorama can be then viewed and checked that the pictures are in right order and that there are not missing pictures.



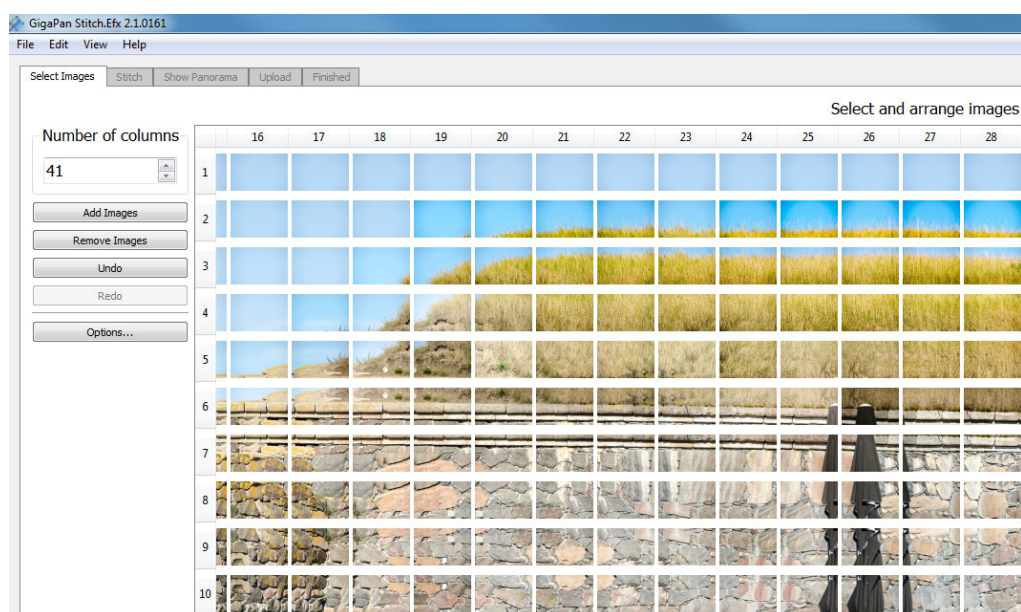


Figure 2. Single pictures ordered for stitching. The panorama consists of 656 pictures. Each picture is about 7 MB in size.

After stitching the pictures together the panorama looks a single picture as in the figure 3.



Figure 3. The completed panorama picture. The size of the panorama is 3.63 gigapixels. Picture by Joonas Toivanen, GTK.

Uploading the panorama to GigaPan site

From the GigaPan Stitch program the finished panorama can be uploaded to GigaPan site from the program itself. Before uploading there has to be an activated account in the GigaPan.com.

If you want to edit the panorama picture before uploading it to the GigaPan site the panorama can be exported from the stitching program as TIFF or RAW image. The size of the picture can be very large, which has to be taken into account. After editing the panorama outside the stitching program you can upload it to GigaPan site with GigaPan Uploader program.



In uploading process general information about the panorama are asked. This includes title (description), tags (words that describe what you've photographed), location of the view, photographer, photo machine etc.

After uploading the picture it can be viewed through an URL link unless the viewing is restricted. If you want only selected people to see your panorama, check the box for 'Private'. This way, only people you give the panorama's URL to can view it. The URL link of the example in this paper is:

<http://www.GigaPan.com/GigaPans/139173>

Examples of GigPan photos



Figure 4. The facade of the Nylands Nation house in Helsinki (Kasarmikatu 40).



Figure 5. The Finlandia hall, Helsinki.



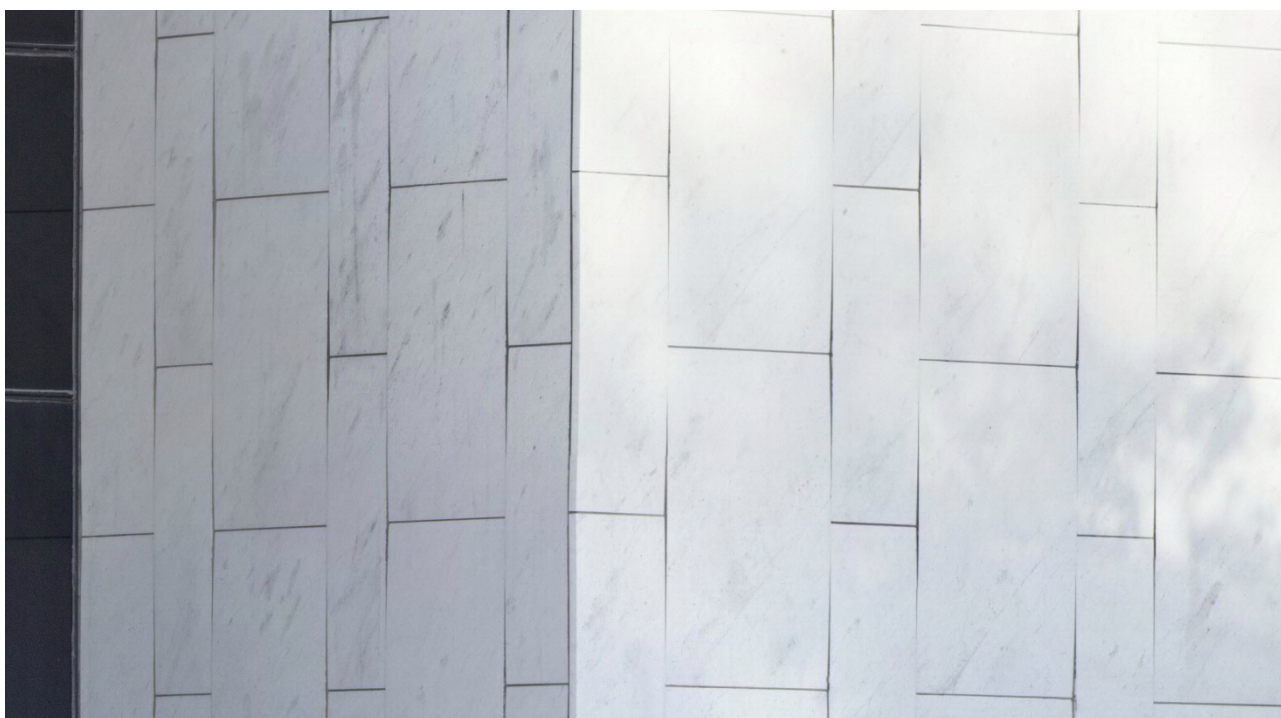


Figure 6. Magnification of the wall of Finlandia Hall (Figure 5).



Figure 7. The National museum in Helsinki.

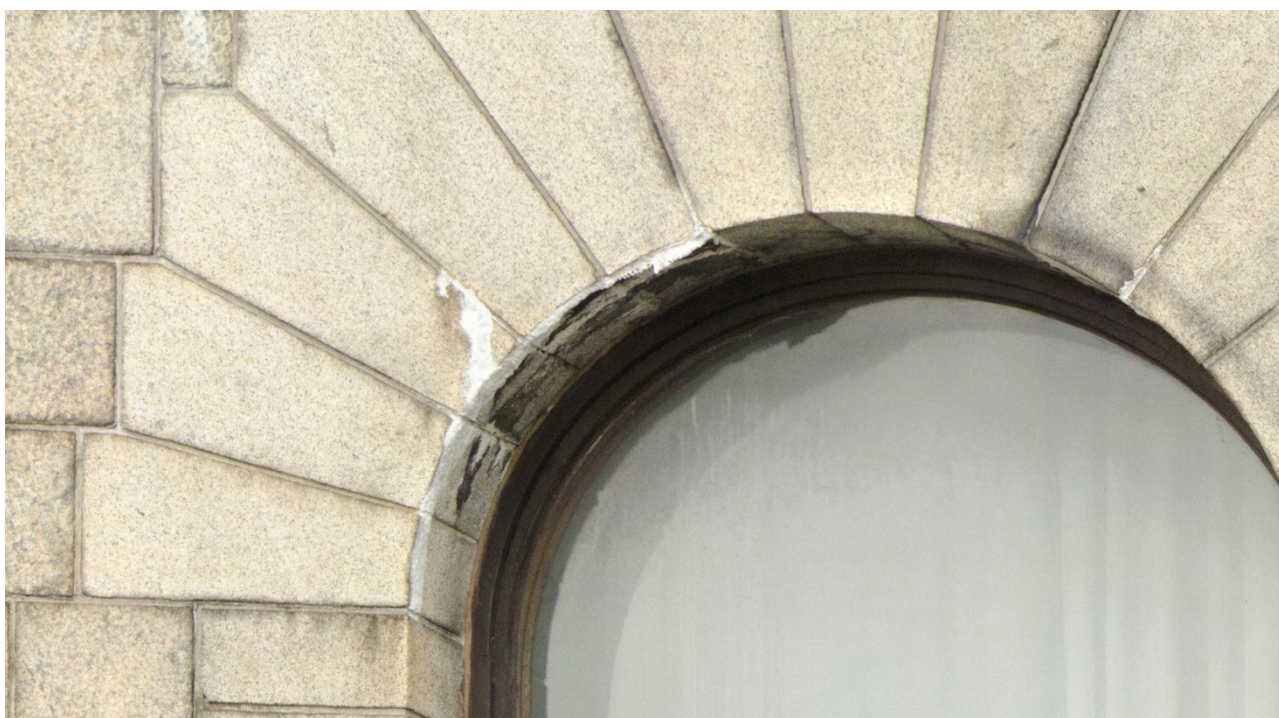


Figure8. A detail of a window frame in the National museum. Mortar used for renovation has been leaking from the seams leaving white marks.

The use of GigaPan photography as a building inventory tool

Photography has been used extensively as a tool for building inventory. The following details are the added value provided by GigaPan photography for building inventory.

GigaPan photography enables coming up with a very accurate overall picture of even a large-scale facade without great technical challenges. When photographing large-scale objects, it is usually necessary to use scaffolding and hoists to reach the suitable distance to photograph the facade or parts thereof. The larger the object and the more demanding the terrain around the building the more difficult it is to use scaffolding or hoists. GigaPan photography eliminates this difficulty. Time and money are saved.

Traditional photography has required taking of an overall picture and separate pictures of the details. GigaPan photography records the entire object: a one large-scale overall picture, which can be focused to get detail-level views of various structural details. This speeds up the process and makes process management easier. Simultaneously, it will be easier to compare materials, when all of the material from one facade is in one file in uniform format. Various damages, such as cracks and soiling, trickle traces and their degrees are easy to detect and record.

All in all, GigaPan photography offers an easy way to visualise large entities and their details.



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Sources

GigaPan Systems 2012. EPIC Pro User Guide.

Inventory. <http://www.nba.fi/fi/kulttuuriymparisto/rakennusperinto/inventointi>. Extracted 02/04/2014.

Sahlberg, M. 2010 (ed.). Talon tarinat - Rakennushistorian selvitysopas ('Stories of the house – A construction history survey guide'). The National Board of Antiquities .
<http://www.nba.fi/fi/File/1112/talon-tarinat-opas.pdf>. Extracted 28 March 2014.



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