

**TITLE: Education and training resources for digital photogrammetry**

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**Education and training resources on digital photogrammetry**

*State of the art*

The project entitled “Education and training resources on digital photogrammetry” started with a research on the already existing innovative methodologies for education and training in photogrammetry and for preparing educational resources and support.

The most significant bibliography on the various training systems used for teaching geomatics in general and photogrammetry in particular, have been researched. In particular, the systems of distance learning, online courses, MOOC, etc. were examined. In addition, online sites, tutorials, videos about the following have been researched:

1. Universities and academic websites:
  - 1.1. courses for academic credit;
  - 1.2. single modules and classes;
  - 1.3. tutorials on specific topics, aimed mostly at their own students.
2. Commercial websites, which in turn can be divided into several categories:
  - 2.1. tutorials by photogrammetry software manufacturers on their own products;
  - 2.2. tutorials by other technologies manufacturers (UAVs, game engines, etc.) on workflows including photogrammetric third-party products;
  - 2.3. online courses including photogrammetry contents by commercial (non-academic/institutional) training centres.
3. Freelance producers (non-profit organisations, youtubers, amateur websites and blogs, user forums, etc.).

Overall, there is a strong lack of consistency in quality and detail. Most of the materials consist of tutorials on the use of software, while, there are few materials even among those produced in universities regarding the acquisition of data, the network design, and how to take images for producing the requested results and verify the metric quality of outcomes.

A summary of the investigations has been published in [1].

*Data produced during courses at University of Florence*

During the courses conducted by Prof. Tucci at the University of Florence, a dataset on a significant historical building, the Spedale di Sant'Antonio in Lastra a Signa, near Florence, was collected. The same case study has been the object of study during several courses during the year e.g. two courses, one entitled “Geomatics for the conservation of cultural heritage” (one in Italian and one in English) at the school of Architecture, and one entitled "Topography and geographic information systems" at the school of Engineering. Therefore, materials have been tested with most challenging students from different cultural backgrounds and coming from different countries. The dataset includes terrestrial photogrammetric imagery, measurements of ground control points and relative documentation, laser scanner acquisitions for comparing and verifying the quality of the results, as well as photographic and video recordings of the survey operations.



*Some of the students of the University courses during the GNNS acquisitions in Lastra a Signa*

Moreover, students have been requested to make short videos for illustrating the acquisition of photogrammetric data and their process as a feedback for understanding which aspects they considered more challenging and significant.

#### *Dehradun, India tutorial*

During the first phase of the ISPRS TC V Mid Term Symposium 2018, which took place from 17 to 19 November, the Ground based 3D Modeling (Close Range Photogrammetry & TLS) pre-symposium tutorial was held. Participants included 15 students from several countries. The students were master students, PhD students, researchers and teachers with different backgrounds and skills.

For this reason, the participants provided an interesting opportunity to evaluate the effectiveness of the proposed teaching materials, as they are scholars who know the overall problems of remote sensing but not specialized in cultural heritage and without specific training in the use of photogrammetry and terrestrial laser scanner.

Although the learning-by-doing teaching method was used, the first day has been dedicated to introducing the topics of the tutorial, to provide everyone with the essential information to deal with the practical part. The topics examined concerned photography for photogrammetry, Structure-from-Motion close-range photogrammetry and terrestrial laser scanning.

The field work has been carried out in one of Dehradun's most representative historic buildings, the headquarters of the Forest Research Institute.

During the tutorial, after a careful analysis of the location, the participants, supported by the tutors, started planning a survey project. Since students were not familiar with working on cultural heritage projects, the requirements of a photogrammetric project useful for this purpose were first indicated, identifying a proper Ground Sample Distance and the most appropriate network design. The focal length, distance from the object and baseline were chosen taking into account the site characteristics and the available equipment. All exposure parameters were selected according to lighting conditions. The target positions were then chosen, considering that the object would have been acquired simultaneously with laser scanner, with the aim of both training in laser scanning and

comparing the results. The field experience was focused to document the facades of the central court, with a special attention to the left wing, where the vaulted portico at the ground floor has been surveyed.



*The participants of the pre-symposium tutorial Ground based 3D Modeling (Close Range Photogrammetry & TLS) in Dehradun, India*

In order to show other possible applications of terrestrial photogrammetry, for example to the human body acquisition, 3D models of the faces of some students were also performed.



*3D models of two tutorial's participants faces in Dehradun, India*

During the last day of the tutorial there was an introduction to data processing, and the results were presented and discussed. Photogrammetric data were compared with laser scanner results for

assessing their quality. Moreover, even if the peculiarities and differences between the two methods had already been explained from a theoretical point of view, it was much more effective to see their consequences on a project personally carried out by the participants.

As requested by the participants, some their previous close-range photogrammetry projects in other fields were also presented for comparing and discussing the results together.

The experience was positive. The students learned how geomatic techniques are used to carry out cultural heritage documentation projects and acquired (or deepened) basic skills in close-range photogrammetry. Knowledge about the image acquisition can be deepened or adapted to other areas of their activity. In addition, a new dataset has been created documenting an interesting built heritage case study and obtaining data on structural assessment that will be published soon in the papers [2,3], which will be presented at the Conference Geores2019.

### *San Vivaldo workshop*

The didactic paradigm of Dehradun's tutorial was tested again in a workshop held from 23 to 26 March 2019, acquiring part of the so-called New Jerusalem of San Vivaldo, (Montaione, Italy). In this case the participants, coming from Cuba and Greece, were already trained on laser scanning and photogrammetry and the workshop aimed to improve their practical skills. With regard to the didactic materials, this was another test to assess their clarity and effectiveness in front of an audience with already acquired skills. During the workshop, data acquisitions and processing were carried out.



*An aerial image of the participants from Cuba, Italy and Greece at the S. Vivaldo workshop*

### *Participated photogrammetry in Cuba*

The training model will be proposed in a different context also in Havana (Cuba) during the next step of InnovaCuba project. The project foresees the realization of a participatory photogrammetry event, as reported in [4]. In this case, the aim will be to introduce photogrammetry to a non-professional public with no knowledge, using the same material and guidelines created for this purpose, together with a basic assistance for explaining how to take photographs useful for a photogrammetric process (carried out later by professional operators).

## Conclusions

In summary, the experiences carried out show the effectiveness of an educational method based on the use of didactic materials and tutorials and based on the learning-by-doing method. This method allows students, especially if they already have basic skills in the same or related fields, to acquire new practical skills on the implementation of photogrammetry projects and together to understand the principles of photogrammetry. The availability of data sets also allows learners to practice autonomously on many different topics, comparing results with data coming from different techniques (as laser scanning) or different software. On the other hand, it must be clear that these didactic materials only deal with the image acquisition step and therefore for a complete training (under an academic and professional point of view) other learning methods are also required, as well as gaining personal experience to completely master this technique.

## List of publications

- [1] Tucci, G., Conti, A., Fiorini, L., Panighini, F., Parisi, E. I., 2018. Education and training resources on digital photogrammetry. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLII-5, 45-50, <https://doi.org/10.5194/isprs-archives-XLII-5-45-2018>
- [2] Tucci, G., Rihal, S., Betti, M., Conti, A., Fiorini, L., Kovacevic, V., Bartoli, G., 2019. Ground based 3D modelling (photogrammetry and TLS) – Survey, documentation and structural assessment of XX Century cultural heritage in India – A case study of the masonry vaults in Dehradun. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, publication in progress
- [3] Tucci, G., Parisi, E.I., Conti, A., Corongiu, M., Fiorini, L., Panighini, F., 2019. Educational and training experiences in geomatics: tailored approaches for different audience. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, publication in progress
- [4] Tucci, G., Conti, A., Fiorini, L., Mei, F., and Parisi, E. I., 2018. Digital photogrammetry as a resource for Cuban Cultural Heritage: educational experiences and community engagement within the INNOVA CUBA project. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLII-5, 37-44, <https://doi.org/10.5194/isprs-archives-XLII-5-37-2018>

## Financial report

The financial report presents a list of the costs incurred during the project. In particular, the expenses mainly refer to the participation at the ISPRS TCV Mid Term Symposium and at the pre-symposium tutorial Ground based 3D Modeling (Close Range Photogrammetry & TLS) in Dehradun, India (November 2018) of four members of the Prof. Tucci's research group.

The funds were thus used for:

- Insurance policy to transport the instrument laser scanner to India
- Documentation CARNET ATA to transport the instrument laser scanner to India
- Travel costs (10%) to collect the VISAs at the Indian Embassy in Rome
- Registration fees for the Conference (x4)
- Collaboration contract with a drone pilot (Filippo Fiaschi) to collect the aerial dataset of Lastra a Signa