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Laser scanner for the architectural and cultural heritage and applications for the dissemination of the 3D model

Vincenzo Barrile[a], Antonino Nunnari[a], Rosa C. Ponterio[b,]*

[a] *Diceam - Universita' Mediterranea di Reggio Calabria Via Graziella Feo di Vito 89124 Reggio Calabria (Italy), vincenzo.barrile@unirc.it*
[b]*CNR - Istituto per i Processi Chimico Fisici Viale Ferdinando Stagno D'Alcontres, 37I-98158 Messina, ponterio@ipcf.cnr.it*

Abstract

The development of new technologies surveying has allowed great strides to acquire spatial data for various applications. Among these, it the scanner technology is one of the methods That Allows for rapid and detailed acquisition of date. Particular and interesting application Concerns The Importance of cultural context as in the surveying of buildings, statues and artifacts and dissemination through Android apps, augmented reality and Webgis thus putting at the disposal of technical and historical information community through the use of new technologies.

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1. Introduction

In recent years Cultural Heritage Studies have attracted an increasing interest by the scientific community, which has found a support in the detection field. In particular, the major agencies and authorities in the field of cultural heritage have focused on digital realization of high accuracy of archaeological site, the historical centre, building complex of historical and archaeological importance and artefacts. From here, the idea that the knowledge of a good is not only made of an artistic nature, but have to include geometrical features, position and shape. For this reason, it was proved that Geomatics was subjected to a deep innovation and a huge evolution. Thanks to the help furnished by

* Corresponding author. Tel./fax: +39 090 39762217.
E-mail address: ponterio@ipcf.cnr.it

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electronics and information technology, it is possible to obtain innovation prospects in every application relating to detection. The Cultural Heritage is the most appropriate filed to this new approach, more than other, due to the interest brought by these new techniques and technologies always in continuous development.
These new techniques and digital technologies give the possibility to configure new products, not only from the relief activities, but also in its representation and visualization, in order to have a clear description of the area, the structures, buildings and finds. They represent a powerful instrument for the analysis of the artefacts, in order to help their reconstruction and restore. Moreover, the process of acquisition and realisation of data have to follow some appropriate methodologies, taking into account the features of every technique in terms of inherent capacity (precision, accuracy and data format) and for the purpose of mutual integration in order to insert all products in a useful database: divulgation, research, structural stability, etc.

2. Practical and operative phase of relief

To make an analysis through the relief laser scanner it is necessary to proceed step by step. At the beginning, it is made an acquisition of the architectural resource by scanning, in order to can obtain as many data as possible. Successively it is made an alignment of the collected scans, by using software furnished by the manufacturer. In particular this study brings to obtain an algorithm to use on Matlab in order to effectuate the alignment. To record the clouds and generate the sames, each time was used the ICP algorithm (Interactive closest Point) [1] implemented in the Matlab environment.
The ICP algorithm iteratively applied a rigid roto-translation in one of the two clouds, considered to be mobile, so that overlap in the best possible way to another cloud, considered fixed.
Given a point cloud V^j and a point cloud V^i to align with each other, for each y_i point of V^j, exists at least one x_i point on the cloud V^i, said corresponding point, which is the closest to y_i compared to all other points in X.
The algorithm is an efficient method to tackle rigid registration between two point sets. Its goal is to find a rigid transformation, with which Y is registered to be in the best alignment with X, that is, let T of Equation:

$$\min_{T,\, j\in\{1,2,\ldots,N_x\}} \left(\sum_{i=1}^{N_y} \left\| T(\vec{y}_i) - \vec{x}_j \right\|_2^2 \right) \tag{1}$$

be rotation and translation transformations, hence the rigid registration between two point sets is

$$\min_{R,\vec{t},\, j\in\{1,2,\ldots,N_x\}} \left(\sum_{i=1}^{N_y} \left\| \left(R\vec{y}_i + \vec{t} \right) - \vec{x}_j \right\|_2^2 \right) \tag{2}$$

s.t. $R^T R = I_x$; $\det(R)=1$

In an iteration, ICP assumes that the closest points correspond, computes the absolute orientation and applies the resulting rigid transformation to V^j. In practice, at step 1 for each point of mobile cloud (V^j set), are sought, within the fixed point cloud, the points (closest point) contained in a sphere of a certain radius (multiple of a parameter introduced by user) belonging to V^i set. The closest of these will be held and considered the corresponding point.

$$C_k(i) = \underset{j\in\{1,2,\ldots,N_x\}}{\arg\min} \left(\left\| \left(R_{k-1}\vec{y}_i + \vec{t}_{k-1} \right) - \vec{x}_j \right\|_2^2 \right) \tag{3}$$

With these matches found, in step 2, the algorithm computes the incremental transformation (rotation matrix $R_{i,j}$ and translation vector T and solving the absolute orientation) by applying it to the elements of V^j; If the mean square error is less than a certain threshold, the iteration terminates otherwise return to step 1;

$$(R_k, \vec{t_k}) = \underset{R^T R = I_m,\, \det(R)=1,\, \vec{t}}{\arg\min} \left(\left\| \left(R\vec{y}_i + \vec{t} \right) - \vec{x}_{c_k(i)} \right\|_2^2 \right) \tag{4}$$

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