DSM from TLS: a 3D planning verification tool

GIS integration for terrestrial laser scanner data for Lloret de Mar Historical Centre planning

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Introduction

This contribution presents the use of a terrestrial laser scanner (TLS) model and its integration into a GIS platform as a 3D planning verification tool. The image of Lloret de Mar, located in the Costa Brava in Catalonia, is strongly rooted in a reality based on the intensive use produced by mass tourism (29.443 hotel rooms, 7.164 secondary residences), strong urban growth beyond the historical centre boundary and a strong transformation process of the historical centre; high differences in urban volumetric shapes, streets types, facade colours, urban densities and commercial uses at building ground floor. These two realities between the centre and its surrounding areas appears to coexist in different levels defined by three main axes: the Marlin and Vilarrodona Fair Avenue, the Villa de Tossa Avenue and the Pau Casals Avenue. In itself, the old town of Lloret de Mar is a very diverse district, which has changed its strongly Mediterranean initial appearance due to pressure generated by mass tourism (in 2010 only 43% residences,7.418 corresponded to local inhabitants). This paper describes in detail the developed methodology in order to integrate the information captured from the TLS sensor into a high density digital surface model (DSM) valid for a GIS application. Validation for different planning attributes are checked; such as existing attics, heights validation and allowed terraces. This model has been chosen for its volumetric complexity and its continuous building pressure on the historical centre.

Methodology

The complexity of the volumes in Lloret de Mar and its surrounding (Fig 1), the absence of any previous survey and the need to reconstruct the 3D geometry in a brief period of time, suggested the use and combination of two different techniques: laser scanner for surveying the Historical Centre and GIS data for creating a DSM of its surroundings. In this chapter the workflow used to perform the 3D reconstruction of the place from laser scanner data, is described and discussed analyzing each step (Fig.2)

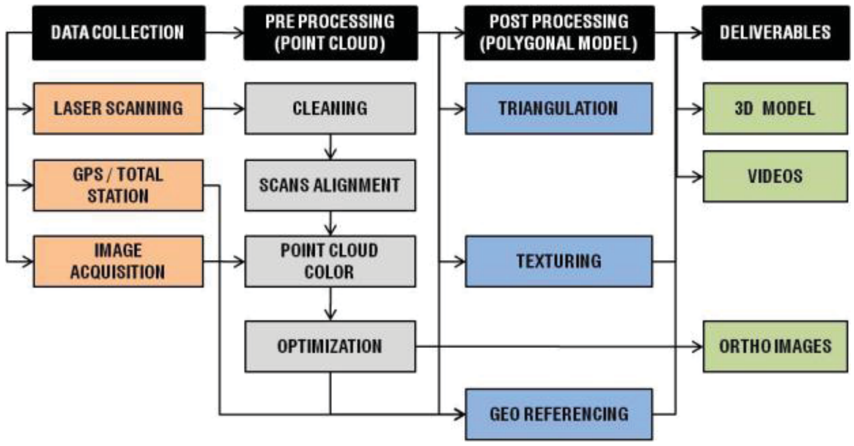

Figure 2: Laser scanner Workflow

Data Collection and Pre-Processing

The measurement system used for the project is a RIEGL LMS Z420i Laser-Scanner [4] equipped with a calibrated Nikon D100 6 Mega Pixel digital camera mounted solidly on top of the scanner. Recording was made in only one field day. A total of 6 scan positions where taken, each scan position was made at a 0.04º resolution with a 80º by 180º field of view, in order to have 6 million points per scan. 60 calibrated images where taken in order to add color to the point cloud model. No registration targets where used, because all scan positions alignment were calculated via software. Reducing data collecting time simplifies post processing noticeably; especially on sites where there are work in progress and climate conditions vary considerably.

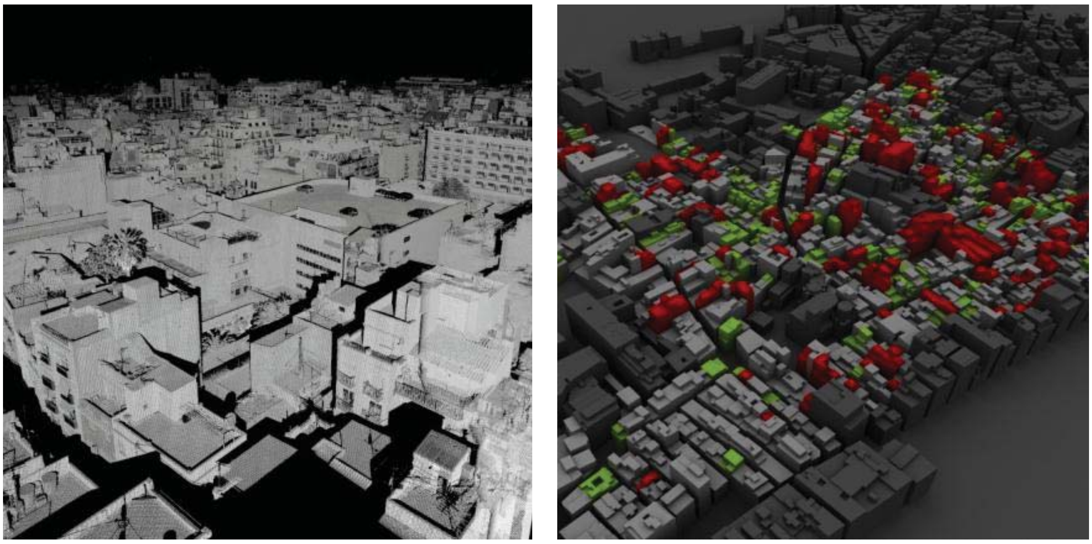

Figure 1: TLS raw data and GIS attic planning verification

Laser scanning pre-processing was made in three days: one day for cleaning unwanted data and aligning scan positions, another for fixing colour of the images, and the third for optimizing the resolution of the point cloud model [1]. The raw point cloud model, contained 46,3 millions points (X,Y,Z,i,R,G,B) with a 790Mb file size. The final point cloud model was optimized to a 1cm resolution, and was reduced to 22,6 million points and a 198Mb file size only. Three software were used to perform these operations: Riegl Riscan Pro for cleaning and colouring the point clouds, Innovmetric Polyworks for aligning scan positions without topographic references points (an algorithm permits a best-fit alignment of the point clouds) [2], and Raindrop Geomagic for global point cloud optimization (for reducing the number of points to a specified density).

Viewshed, slope, or hillshade analysis can be added to the model with the same process, thus allowing different levels of information, for intelligent and interactive data interpretation [3].

Results

Terrstrial laser scanning offers different advantages in the 3d modeling of complex surfaces, appropriate point density is needed for different level of detail and scales:

- Laser scanning is a valid alternative where traditional survey techniques doesn´t give enough information for complex 3d models environments, even if accessibility from all aspects is needed to scan it fully. Data collection is fast and accurate.
- Free target scanning using software for alignment, allows data collection in desirable periods of time.
- Large number of points found in a point cloud consist a valuable archive file.

Current Attics			**Attics and rules of law applied**		
with attics	347	32%	Attics with regulations	186	54%
without attics	689	63%	Attics out rules	161	46%
Property protected	57	5%			
TOTAL	1.093		TOTAL	347	

Table 1: Attics and Planning

GIS technology enriches the 3d virtual environment, allowing different standard analysis to work interactively with the virtual model.

References

[1] **Bryan P et al.** (2007), 3D Laser Scanning for Heritage. Advice and guidance to users scanning in archaeology and architecture, UK.

[2] **Remondino F.** (2005), From point cloud to surface: the modeling and visualization problem" Commission V – WG 6 International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XXXIV-5/W10

[3] **Mills J., Barber D**. (2005), An Addendum to the Metric Survey Specifications for English Heritage - The Collection and Archiving of Point Cloud Data obtained by Terrestrial Laser Scanning or other methods. Newcastle, U.K

[4] **Riegl** (2011), Terrestrial Scanner Overview, http://www.riegl.com/nc/products/terrestrial-scanning/produktdetail/product/scanner/4 (accessed 10 February, 2011).