Possibilities and Constraints of LIDAR use in Moroccan context

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SUMMARY

LIDAR technology has many applications in Civil engineering, Cartography, Forestry, Geology, Agriculture and Bathymetry. In Morocco this technology is recommended in several fields but is not enough used even if it has a great potential in resolving many problems encountered when using traditional surveying methods.

In Morocco, there is a growing market demand of this new technology. Its main advantage is the very high density and precision of the captured information obtained in a much reduced time. However, to meet the needs of some specific works, much more efforts is demanded to provide high-performance software and qualified stuff.

This article discusses possibilities and constraints of use of LIDAR in Moroccan context and gives some examples.

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1. INTRODUCTION

LIDAR (Light Detection And Ranging) is a technology of optical measure based on the analysis of the properties of a light laser sent back towards its transmitter. Besides the term LIDAR, several other terms are used for this technology: high-density laser surveying, laser-grammetry and 3D laser scanning.

LIDAR allows the determination of the position and the distance of a target with regard to the transmitter. The most known technique consists of the measurement of time propagation between the emitter and the target of pulses emitted by a laser.

The 3D laser scanning leans on new instruments which measure and record a large number of three-dimensional points at much reduced time and with a very good precision (millimeter). This technology allows the acquisition of big and complex scenes in 3 dimensions. The results are digital 3D modeling of zones scanned leading to an important time gain and a better precision in the measures. It also allows exploiting better and valuing the results.

The applications of this technology are in big evolution these last years: topography, infrastructures, 3D modeling, agriculture, forestry and bathymetry.

2. PRINCIPLE

A LIDAR contains a transmitter and a receiver. The source is a laser, generally by impulse, emitting in the field of the visible, typically between 0,3 µm and 10 µm.

The distribution of the laser impulse in the atmosphere is followed by the reception of a fraction of the radiation send back by an obstacle or a target (LIDAR used in surveying) or by back-scattering on the constituents of the atmosphere: molecules, sprays, dusts (atmospheric LIDAR). In this article, it is the first type of LIDAR that will be presented.

The most used method to get measures is based on the laser with impulses. The distance to an object or to a surface is given by the measure of time between the impulse and the detection of the reflected signal.

The data collected by a LIDAR contain position coordinates but can also get the intensity of every point to associate it to digital number corresponding to different spectral bands (red, green, and blue) useful to make a multi-spectral classification of objects.

The LIDAR can be used in a fixed or a mobile position. It can be terrestrial or airborne. Ground 3D laser scanners can be classified in three major categories according to the used principle of telemetry: time-of-flight measure based scanners, scanners that measure the difference of phase and triangulation-based scanners.

3. ADVANTAGES OF THE TECHNIQUE

The market demand development of the LIDAR is mainly due to its multiple advantages compared with the topographic methods of direct surveying and with the photogrammetric methods.

At the moment, and in spite of the revolutionary aspect which certain manufacturers and service providers want to associate to it, the LIDAR cannot totally replace the other methods of acquisition of data but rather complete them.

The advantages of the LIDAR are many, among them:

- The acquisition of data is synonymic of whole surfaces scanning instead of the collection of individual points.

- High-density laser surveying allows a considerable gain of time and precision.

- The 3D laser scanner allows the acquisition of objects without contact with the target objects. The surveying of data is possible even for binding or difficult access sites.

- The density and the richness of points stemming from the survey allow diversified and precise treatments. This also leads to avoid on-site returns.

4. APPLICATIONS IN MOROCCO

In Morocco, the use of 3D laser scanning was helpful to accompany a number of important projects in diverse domains: civil engineering, modeling of the historical and architectural heritage and in the industry.

The possibilities offered in the case of civil engineering projects (roads, bridges, tunnels) are as follows:

- Realization of 2D surveys of the work sites, before, during and after execution.

- Acquisition of 3D cloud points for the follow-up of the works and for the auscultation.

- 3D Modeling and realization of Digital Terrain Models (DTM).

- Establishment of cross sections and longitudinal sections.

LIDAR is particularly useful for projects involving the historical and architectural heritage. The possibilities in this field are:

- Acquisition of 3D points cloud.
- 3D Modelling and realization of Digital Surface Models (DSM).
- Survey and assembly of the frontages building plans.
- Realization of plans for archives, restoration and reconstruction works.
- Establishment of vertical views.

For works requiring cubature calculation (quarries monitoring, stocks of materials, platforms arrangement) the possibilities are:

- Realization of 3D surveys of the sites, before, during and after execution.
- 3D Modelling and realization of Digital Terrain Models (DTM).
- Establishment of cross sections and longitudinal sections.
- Calculation of the quantities of earthworks (cuts and fills) between various levels of the same site.
- Conception of simple and multiple platforms.

5. CONSTRAINTS

In spite of its use in Morocco for several years, LIDAR is not very widely used as it is in several developed countries. Indeed, financial, technological, human and cultural constraints are at the origin of this situation.

In a general way, in the Moroccan context, this technique presents three major inconveniences:

- As any new technique, the hesitation with regard to its use constitutes an obstacle in its development especially when remote sensing and photogrammetry as well as the topographic techniques are very used and profitable.
- The cost of the equipment is still high. Small and medium-sized enterprises are not

capable to sustain these charges. Furthermore, the investment can be profitable only by the availability of high market demands of this technology. This is not yet the case in Morocco.

- With the commercial software, it is possible to do general analysis and calculations. However, for particular applications and for the complex projects (civil engineering works, architectural heritage monitoring, agriculture and forestry applications) a specific development is needed. Besides, LIDAR data analysis requires a high qualified stuff that must be aware of possibilities and errors of the technology.

6. POSSIBILITES OF USE IN MOROCCO

LIDAR technology has many applications in civil engineering, forestry, geology, agriculture, cartography and bathymetry. In Morocco this technology has been used in several projects but is not enough used even if it has a great potential in resolving many problems encountered when using traditional surveying methods. We present here the possibilities of use of LIDAR in some fields not yet developed in Morocco and which have a great impact in the near future.

Morocco's forests, which cover an important rate of its total land area, have substantial commercial value. Morocco satisfies much of its timber needs by harvesting the high-elevation forests in the Middle and High Atlas. In forestry, LIDAR can be used for biomass quantity calculation. It is a robust indicator of plant health. It may be used to check if the environment in which the plant is being grown is proper to its development and growth. In this context, LIDAR is a tool from which trees height can be determined with precision. Height is an indicator of plant's growth directly connected to biomass quantities.

The Green Morocco Plan concerns a sector that plays an important role in the macroeconomic balances of the country. One of the foundations of this plan consists in insuring the development of the Moroccan agriculture in general. In this agricultural context, LIDAR can be incorporated with yield rates on agricultural fields. With LIDAR surveys, Digital Terrain Models and slopes' plans can be established. This can help to classify lands into high, medium, or low-yield zones according to height, slopes and sun exposure. This technology could help to determine which areas of farms to apply fertilizer in order to achieve the highest crop yield.

One advantage of 3D laser scanning is the possibility to get 3D surveys and analysis of complex objects. It offers digital models that are enough fine to perform plan and tridimensional representations with a high precision, even when the shape of the object to be represented is irregular. This characteristic is particularly important in the case of follow-up of civil engineering works like dams and bridges. In this field, many important works are the subject of surveying in order to determine, with a satisfying accuracy, plans, the volume of excavation and embankment and the auscultation works.

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