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# Potential of 3d laser point cloud data usage for the tourism industry

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## 1. Abstract

Laser scanning technology, both mobile and terrestrial, has encountered great technological advance during past few years. It gives us the opportunity to acquire great amounts of precisely measured data. 3d laser scanner technology is used in the development of tourism industry in some tourist places in Egypt, where this technology plays major roles in various fields that contribute to the industry of tourism, archaeology and preservation of ancient heritage. The point cloud plays major roles various fields that contribute to the tourism industry such as archeological exploration, heritage, monument preservation and 3d information technology. A much more suitable acquisition platform is 3d laser scanner where point cloud is collected with very high accuracy and details. The level of details is an essential requirement for tourism applications. National Research Institute of Astronomy and Geophysics NRIAG added Vehicle mobile laser scanner and terrestrial laser scanner systems to its Crustal Movements Laboratory–Geodynamic Department to investigate the potential of 3d laser scanners in various fields and disciplines such as the tourism industry and archaeological preservation. The main objective of this work is to cover several basic points, the elevation of the archaeological areas with high accuracy. Make photographic videos of archaeological sites. 3d modeling (virtual reality) is used for archaeological buildings and cemeteries and digitizing them with a very high accuracy especially as they are based on real data that helps in documenting them for future generations and preserving their historical value and restoration.

## 2. Introduction

The point cloud plays major roles various fields that contributes to the tourism industry such as archeological exploration, heritage and monument preservation, 3D information technology. With respect to each discipline an umbrella era is evolving this decade that it falls under the umbrella of modeling known as 3dCity model. 3DCity model is a hot topic for several disciplines by way of example, not exhaustive urban development, emergency response, infrastructure development and navigation. The value of 3D information has huge potential in the

modeling phase and how to manage and develop cities. However, in order to construct 3DCity model, surveying data is needed such as city plans, object coordinates, dimensions, facades and heights. City plan is achievable via satellite images with low level of details and becomes worse for extracting height information. A much more suitable acquisition platform is 3D Mobile laser scanner where point cloud is collected with very high accuracy and details. The level of details is an essential requirement for tourism applications such as heritage preservation, architecture documentation and archeological preservation.

The advent of 3D laser scanners brought about new methods of measuring volumes and examining physical features of the earth. It has been possible to map and measure the earth for hundreds of years, but due to 3D laser scanners, the speed and accuracy of mapping has advanced exponentially. It is now possible to take millions of precise measurements in seconds. 3D Laser Scanning is a non-contact, non-destructive technology that digitally captures the shape of physical objects using a line of laser light. 3D laser scanners create "point clouds" of data from the surface of an object. 3D laser scanning is a way to capture a physical object's exact size and shape into the computer world as a digital 3-dimensional representation.

NRIAG added recently: 1- a vehicle mounted mobile laser scanner 'MX2' that contains a state of art two head laser scanner, six 12mb cameras that covers 320o, two GNSS antennas coupled with highly sensible IMU unit **(Pfennigbauer & Ullrich , 2010).** The system can be rapidly deployed onto on- and off-road vehicles of all sizes. It also significantly reduces project field time and operator skill levels compared to traditional techniques. The two laser scanners scan both side collecting 36.000 points/second and rotate 20 cycle/second. The panorama camera composed by 6 individual cameras (5 horizontals and 1 to the top) creates a 30 Mpx panorama picture each 5 m. This cutting edge instrument is the only mobile laser scanner in Egypt that delivers high quality of 3D point cloud. 2- Trimble TX6 is a cost effective 3D scanning solution based on the same advanced time-of-flight technology as the Trimble TX8 Buckley **(Buckley et al., 2008a)**. Trimble TX6 is high scan speed and accuracy. It makes the most productive scanner in its class and it's built for demanding environments **(Bellian et al., 2005)**. The Trimble TX6 is a terrestrial mapping system that includes: 500,000 points per second with no compromise on scan quality or range. Integrated HDR camera to colorize scans. Easy to use onboard interface with no complex parameters. Integrated WLAN for remote operation from any mobile device. Upgradeable from 80m standard to 120 meters extended range. Data from the Trimble TX6 loads directly into Trimble Real Works and Trimble Scan Explorer software for automatic scan colorization and registration.

Produce powerful deliverables or export data to CAD software. Trimble TX6 offers best in class performance in terms of range, accuracy and speed. Pair with Real Works for a complete field to finish scanning solution.

The main objective of this research is to cover several basic points with high accuracy. 3D modeling (virtual reality) is used for archaeological buildings and cemeteries and digitizing them with a very high accuracy especially as they are based on real data that helps in documenting them for future generations and preserving their historical value and restoration.

## 3. Measuring Method

### 3.1 Data collection by mobile laser scanner

Initially, a number of GPS reference points are installed in any study area to obtain high resolution of the laser scanner path. The laser scanner has been set on the car dedicated to it (Fig. 1). GPS devices installed on the control points and followed by the operation of the laser scanner for five minutes without movement before the area to be studied at least 200 m and then move towards the area to be monitored. The laser scanner begins for monitoring the first track where the car speed is between from 20 to 30 km/h to provide higher density of points allocated. It moves to second track and so on to complete the monitoring of the area. After completion of monitoring the study area, the car is moving about 200 m and hold for another five minutes before finishing the survey in order to resolve the uncertainty and obtain high accuracy of the coordinates.


**Figure 1:** Initialization before starting in Saqqara area

## 4. Data Acquisition

### Field work and process measurements

The work is carried out on two separate stages. The first stage is field work and data collection. The second stage is data analysis, interpretation and display results.

### The first phase field works

First of all, any area is divided into several tracks and reference points (eg. Saqqara area, (Fig.2). The reference points are fixed in the area under study. Every reference point is monitoring for half an hour using GNSS receiver to get the highest possible resolution. The reference points are processing, adjusting and joining with IGS stations using Geomatics software for getting the highest accuracy **(Trimble, 2015).**

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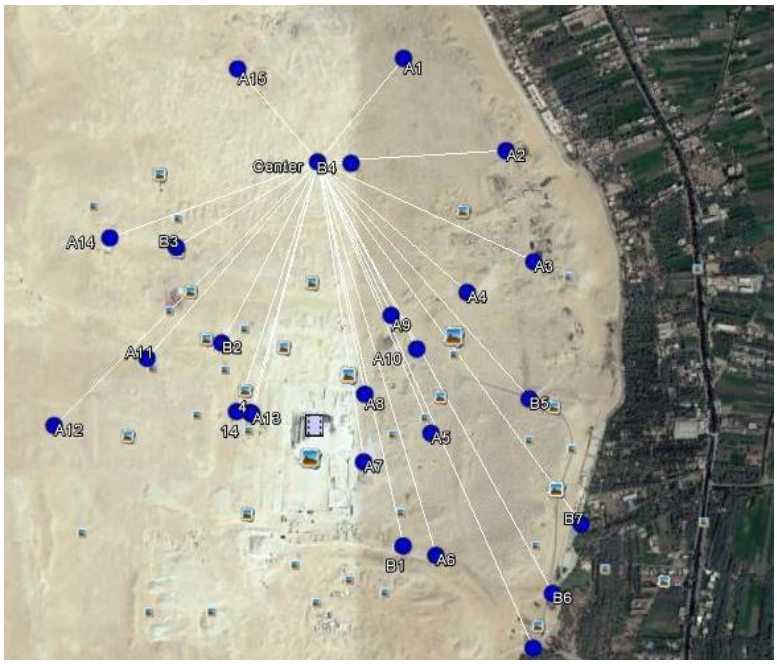


**Figure 2:** Reference points

### Second phase data analysis and presentation of results

The data is downloading from the control points. The data is adjusted and processed using a range of programs to get the exact coordinates of those points to be used during the analysis of laser scanner data. The laser scanner data analysis stage is begun by using a set of programs. Laser

scanner trajectory correction observed by GPS is installed on the device by using the Pospac software.

## 5. Applications of Advanced Laser Scanning Technology

The method of data collection, processing and output of the results in digital form in the digital cloud is one of the most original features that allow the user to employ in a wide range of applications. NRIAG used the 3D mobile laser scanner technology in the development of tourism industry in some tourist places in Egypt, where this technology plays major roles in various fields that contribute to the tourism industry such as archaeological discoveries and heritage and preservation. In this paper, we will address some of the places where this technique is used, for example not for exclusively (Saqqara, Bahariya oasis in the Golden Mummies Valley area, NRIAG buildings, Dahshour, Ahmed Hamdy Tunnel…etc).

### 5.1 Saqqara area

Trajectory of the track in Saqqara area as shown as in the figure (3). Where starts from Djoser Pyramid to the GPS station. Laser scanner trajectory correction observed by GPS is installed by using the Pospac software and use control points for getting the highest accuracy (2cm) as shown in figure (4). The monitored points cloud patch work using laser head by Trident program. Where in the end the registration data was made using images taken from cameras in the machine and the control points that has been monitored. We managed to get the diorama of the audited laser dot coordinates (Figs.5 to 10).

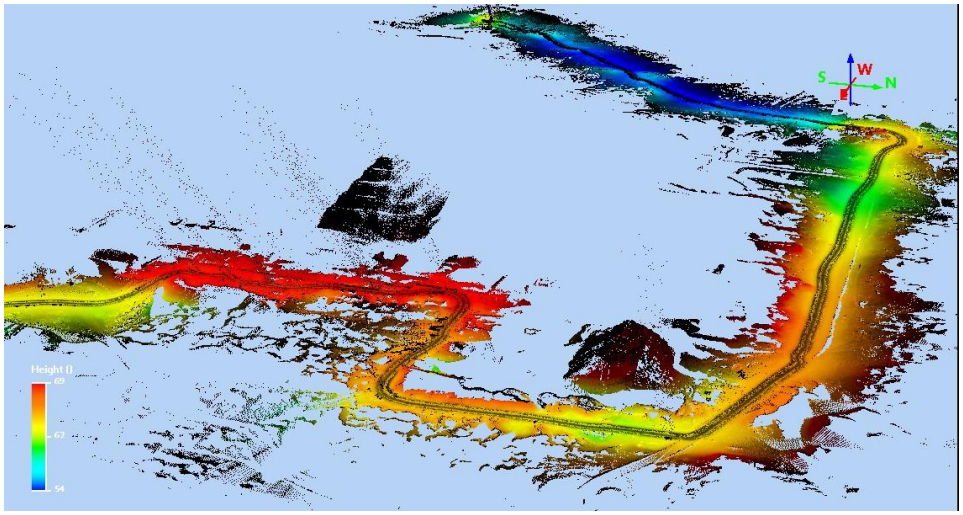


**Figure 3** Trajectory of the track in Saqqara area

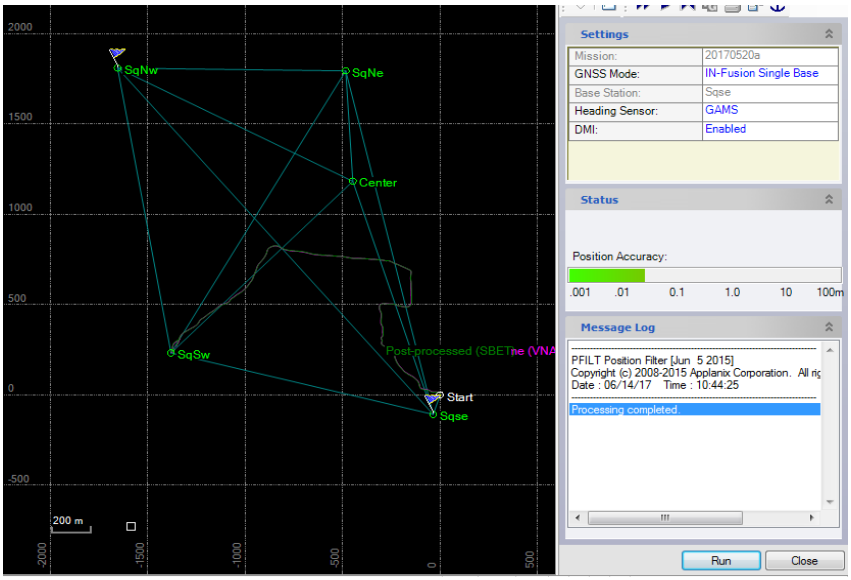


**Figure 4:** Shows trajectory correction for track

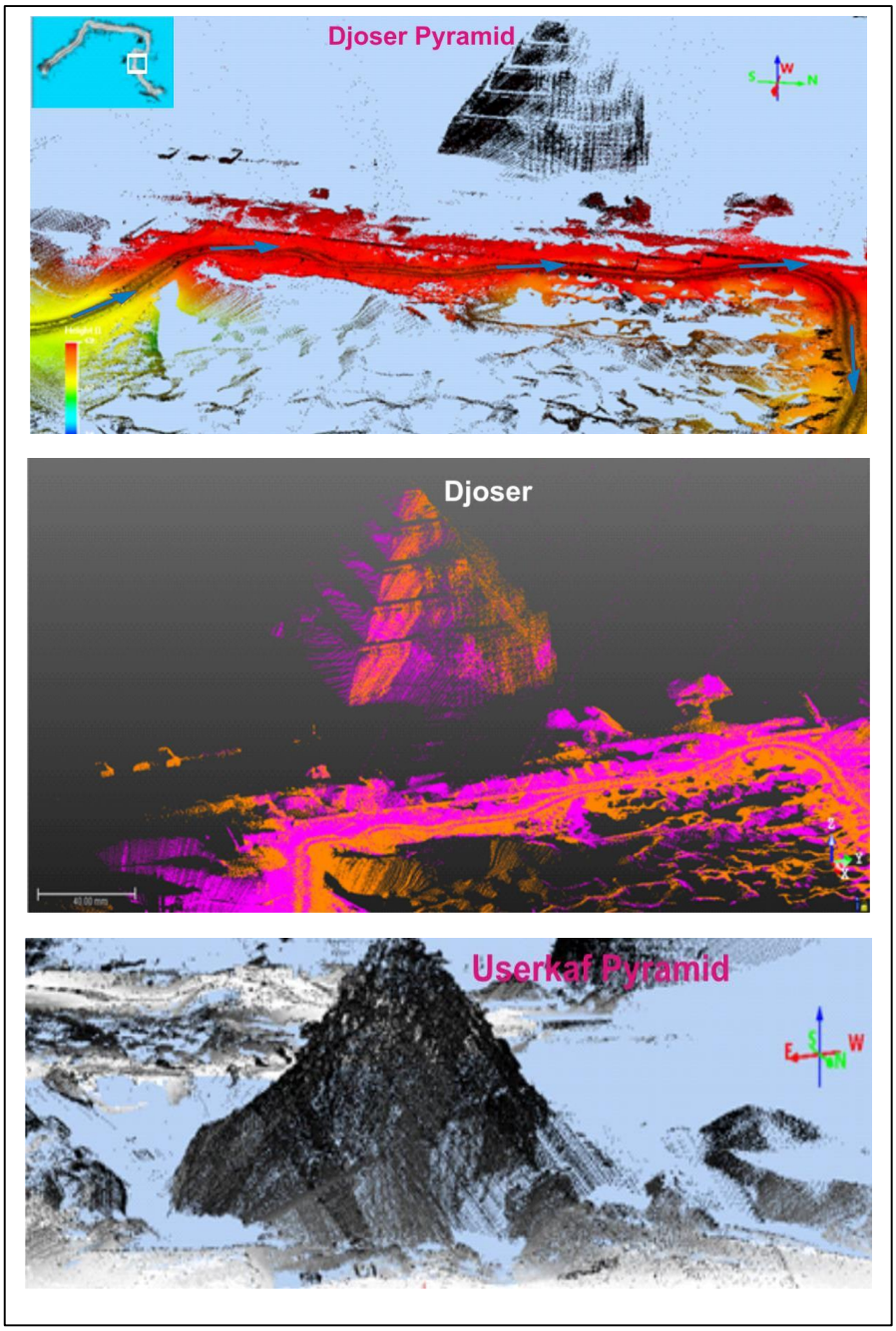


**Figure 5:** Some picture selected from the track

## 2. NRIAG buildings

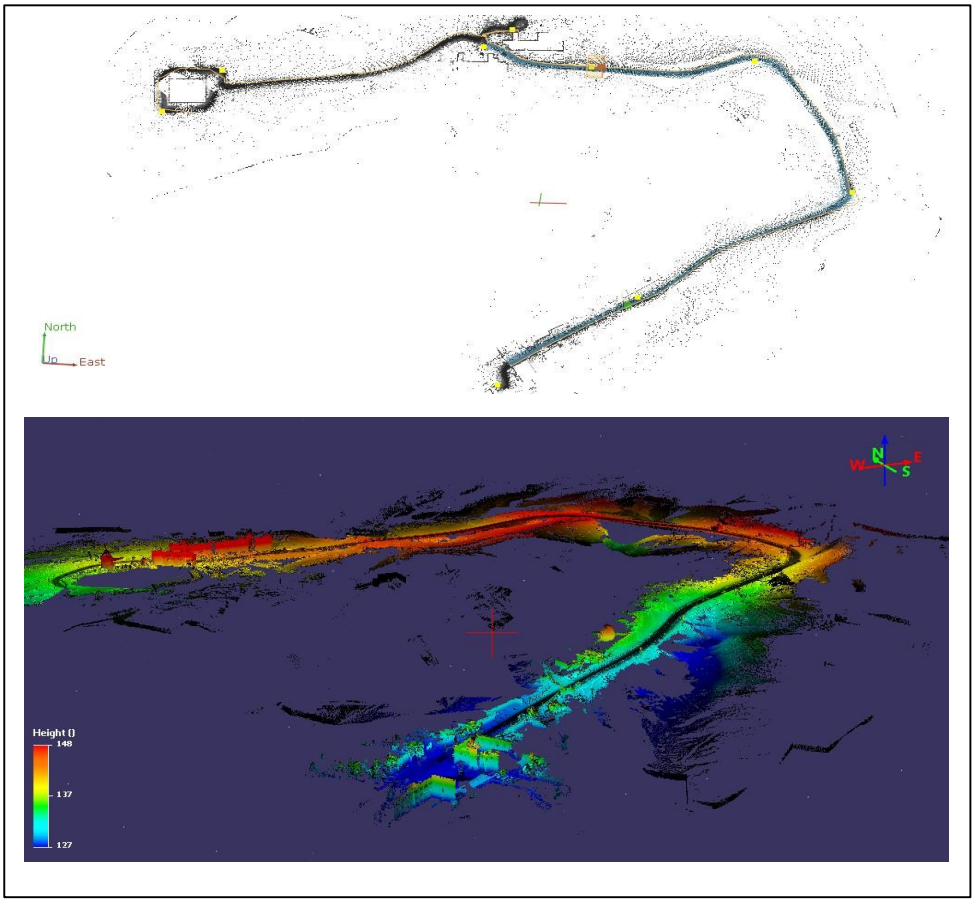


**Figure 6:** Trajectory of the track of NRIAG buildings

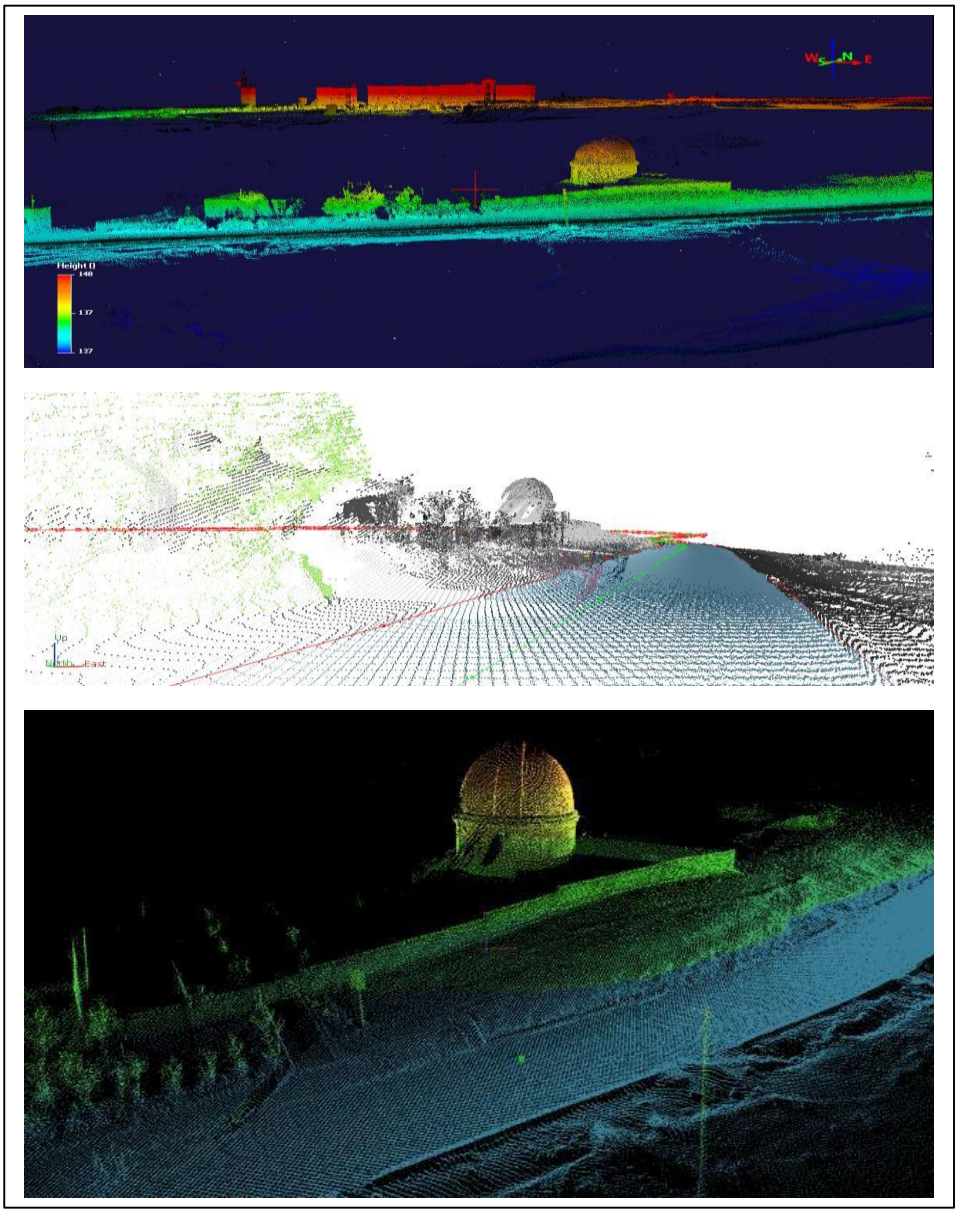

**Figure 7:** Some picture selected from the track

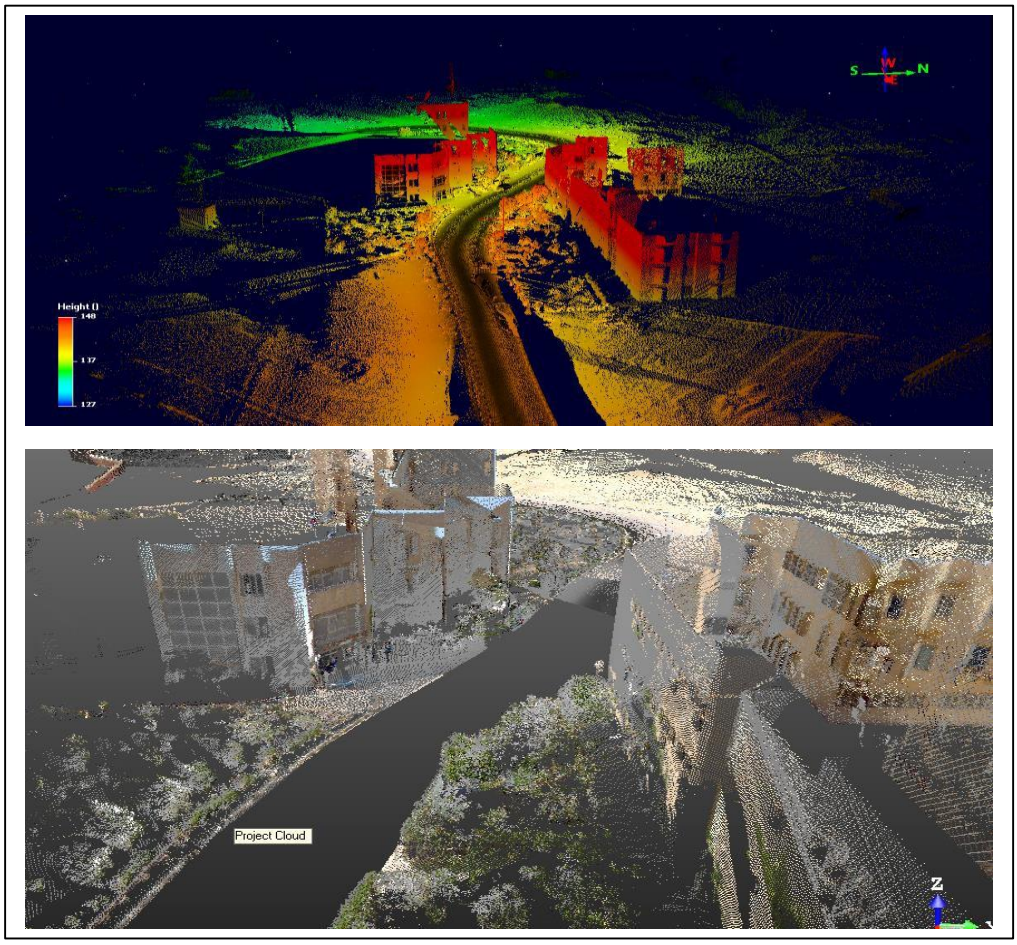


**Figure 8:** Some picture selected from the track

### 3. Ahmed Hamdy Tunnel

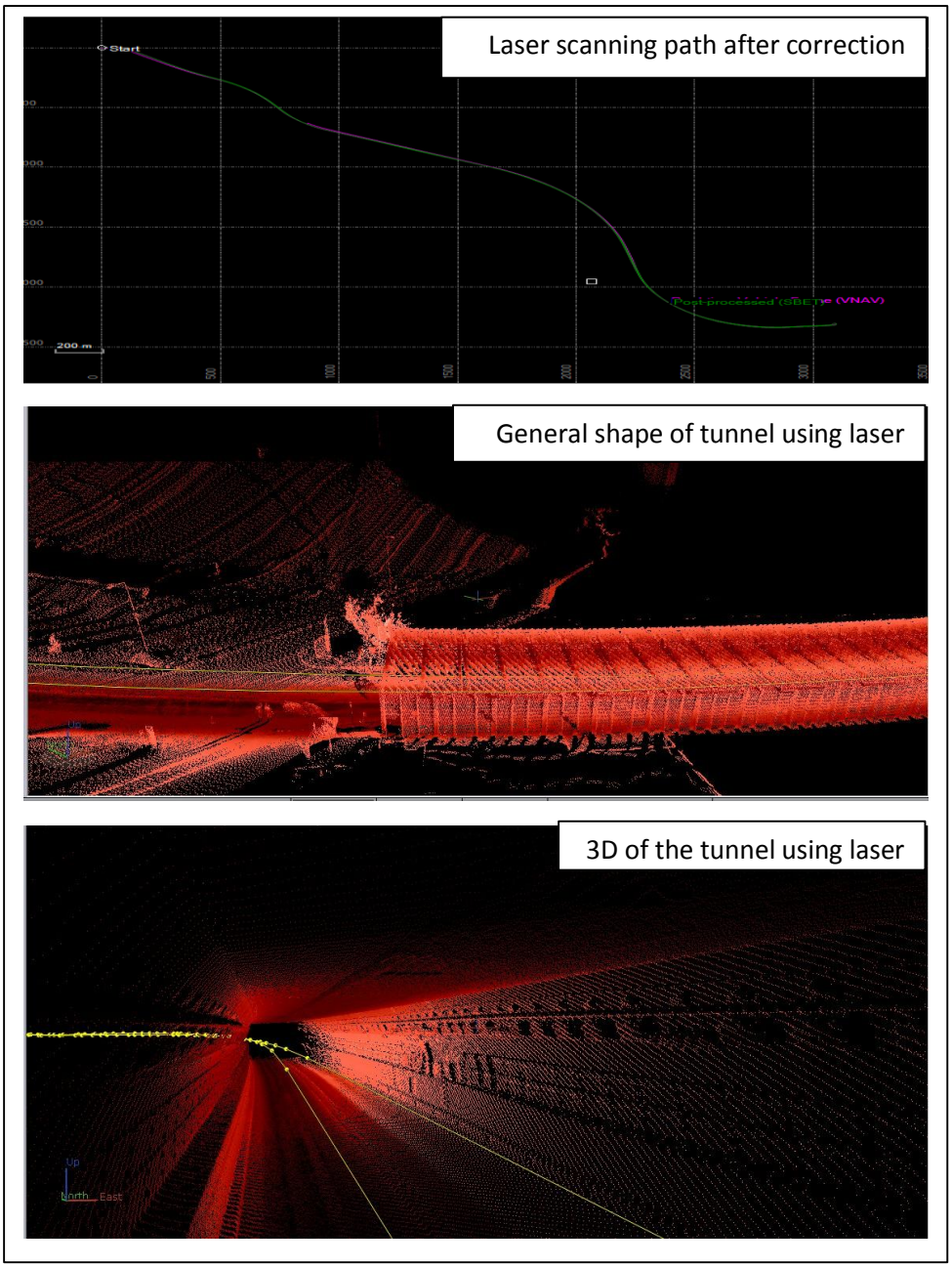


**Figure 9: Preliminary results of the laser survey of the tunnel of martyr Ahmad Hamdy**

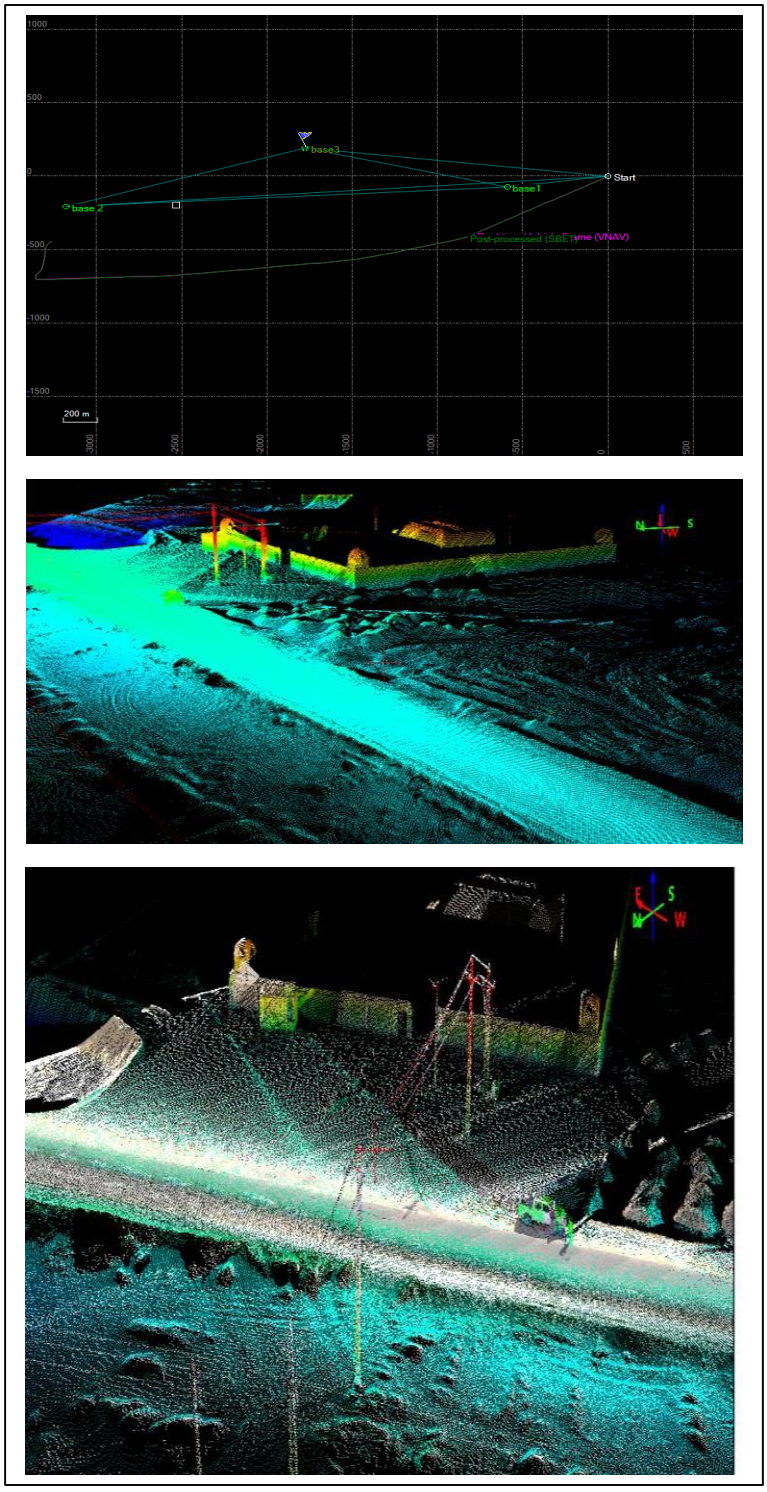


**Figure 10:** Trajectory correction for the track of Bahariya Oasis in the Golden Mummies Valley area

**Conclusions**

This research demonstrates the possibility of using 3D laser scanner technology in developing the tourism industry in some tourist places in Egypt. This technology plays major roles in various fields that contribute to the tourism industry such as archaeological discoveries and ancient heritage. Using IT for 3D laser scanner. This system is safe of archeology and anthropology. The resulting product of each scan is not a common model (tin, grid), but a point cloud (without constant distance between the points) for mobile laser scanner. Additionally, each point is given an additional attribute: spectral color information for the material that was represented. The point cloud behaved and could be processed as common (photogrammetric) models (change of viewing angle, rotation, translation, etc.). Document this data to preserve the archaeological areas of encroachment on the human side. The results obtained from this research are preliminary and need further study. Based on the preliminary results of the laser survey of the tunnel of martyr Ahmad Hamdy, it is recommended to conduct an engineering survey of the ventilation tower area to determine the causes of the cracks and the condition of the subsurface layers.

## References

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