Modeling Istanbul: World's Largest Scanning Project

by Geoff Jacobs

With a population of over 12 million, Istanbul is the world's 5th largest city. Its rolling terrain, rich architecture, and Bosporus Strait views also make it one of the most magnificent. In 2003, UNESCO designated large portions of the historic Istanbul peninsula as protected areas. All further development of these areas was stopped until a detailed and highly accurate as-built 3D city model could be created for use by the city planning commission. It was urgent to complete the 3D city model as quickly as possible to lift the moratorium on development.

The need to create the model quickly and with high accuracy triggered the largest terrestrial scanning project ever undertaken: 48,000 buildings (11,000 of which had great historic importance), 1,500 hectares, 5.5 million m² of facade, and 400 km of city streets. Included in this project was the creation of highly accurate and detailed 3D models of many cultural landmarks, including the famous Topkapi Palace and Hagia Sophia mosque.

The project was conducted by IMP – BİMTAŞ, the Istanbul Metropolitan Municipality's Directory of the Protection of Historical Environment. Over a period of 18 months it involved approximately 120 field & office staff and five Leica Geosystems HDS scanners, including one in mobile mode.

Requirements

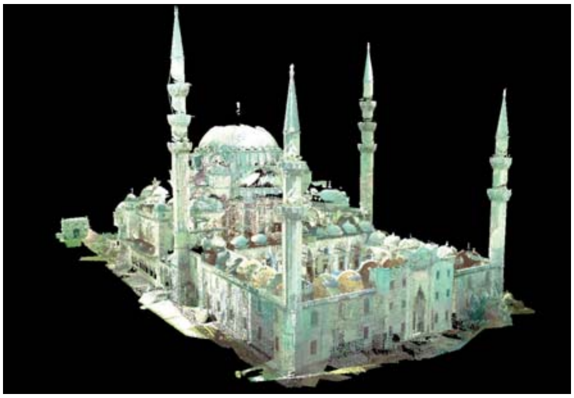
Requirements of 1/500 and 1/200 scale for the first and second degree protection areas were critical. This translated into a requirement of 2 cm point density for scanning facades. Landmarks, such as the Süleymaniye mosque, required an even higher scan density of 5 – 10 mm. All scan data had to be georeferenced for use in a city-wide GIS. Of course, the other critical requirement was the 18-month schedule.

After the data was collected, three types of deliverables were required. One was a 3D wire frame model of all of the external building facades and walls. For cultural landmarks, fully textured 3D models were required. For key city landmarks a third type of deliverable was needed: a physical, solid 3D model made

from computer models by a 3D printing device. These "exact replica" models are used on official occasions by city personnel.

Field Methodology

To accomplish the data collection of the building facades in the city's narrow and crowded streets, BIMTAS used four short-range, Leica HDS phase-based scanners (HDS4500) on tripods. Each featured



■ **Scanning the Suleymaniye Mosque required a long-range, high-accuracy Leica Geosystems laser scanner.**

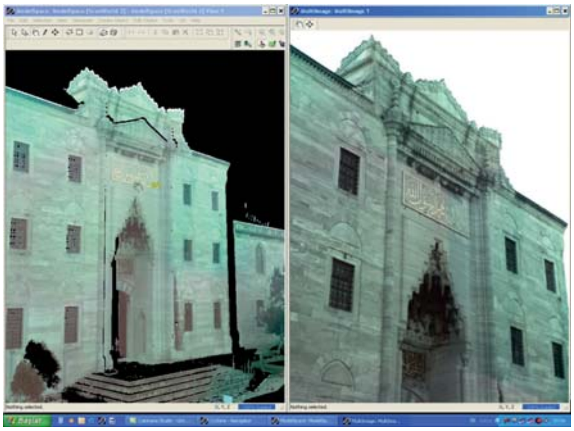
scan speeds >125,000 points/sec. Scans were registered and tied to control using scan targets placed on tripods, facades, or other convenient locations. Control points were surveyed with total stations.

For cultural landmarks, BİMTAŞ turned to Leica Geosystems' versatile, high accuracy time-of-flight scanner (HDS3000). Although not as fast as phase-based scanners, this scanner was needed to achieve high-accuracy (6 mm), high-density (5 – 10 mm spacing) scan data at long ranges. The Süleymaniye mosque, for example, features a 76 m minaret and 55 m dome.

As the project progressed, it became apparent that even with four static phase-based scanners, the schedule for the mammoth undertaking was in jeopardy. To remedy this, BİMTAŞ secured the system integration services of VisiMind from Sweden to develop a mobile scanning system for one of the phase-based scanners. BİMTAŞ was able to scan while driving up to 5 km/h in the crowded city streets and still achieve the required accuracy and 2 cm point density.

Deliverables

After the scan data was cleaned, registered, and geo-referenced (in Leica Cyclone Register software), office staff worked within a custom 3D CAD environment to create the final 3D wire frame CAD deliverables, including detailed stonework. These CAD models were, in turn, combined with high resolution photographs in 3D Studio Max to create final, textured models of stunning visual quality, all with 2 – 3 cm overall accuracy.



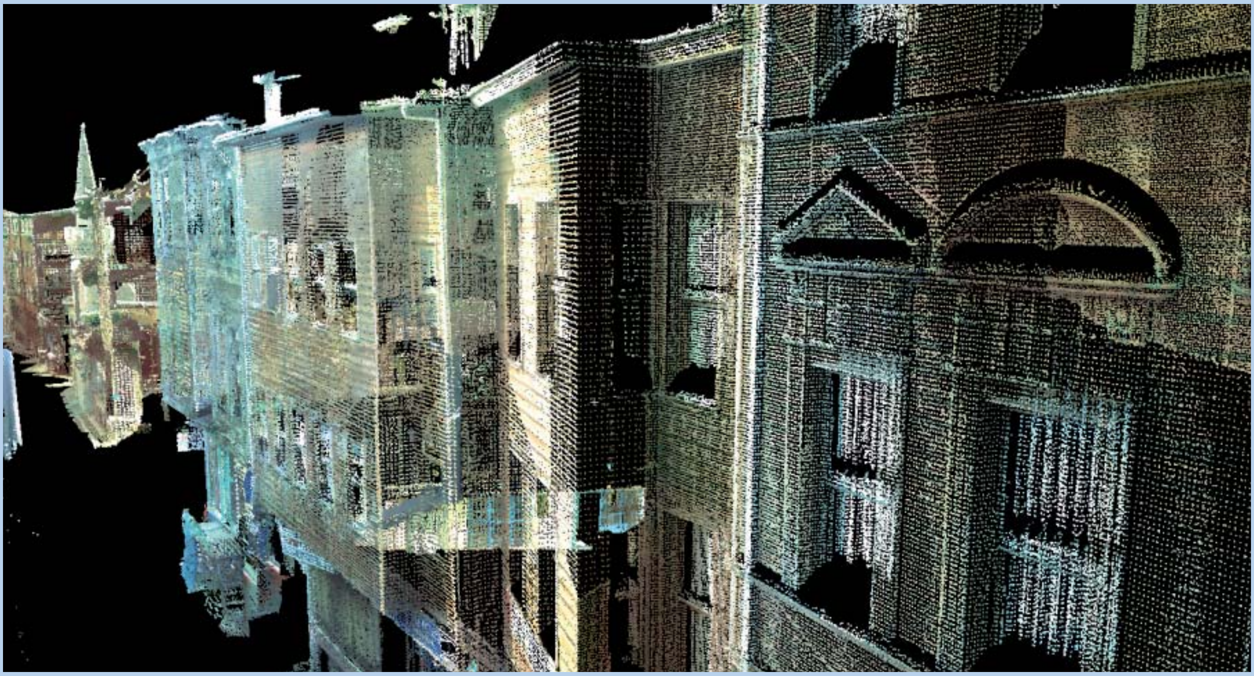
All laser scan data were accurately geo-referenced.

Happy Clients and More Customers

Working with a highly accurate 3D city model, Istanbul city planners were extremely pleased. Prior to this, they made important planning and zoning decisions based solely on 2D drawings and photos. With an accurate 3D model, they can better visualize proposed projects, overlaying them in 3D against the current city model. In particular, they can assess the impact of proposals on views across the city's many beautiful areas. Another big plus is their ability to accurately account for the rolling terrain and its impact on views affected by new proposals.

The Istanbul 3D City Modeling project was so successful that BİMTAŞ has received similar requests from other cities for their scanning and modeling services and executed additional projects with impressive and valuable results.

About the author:
Geoff Jacobs is Senior Vice President, Strategic Marketing, for Leica Geosystems' HDS business.



3D point clouds of facades along Suleymaniye Kirazli Mescit street.