

## HOLY CAVES IN 3D

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**Key words:** laser scanning, Holy caves.

The caves of Kiev Pechersk Lavra form a system of underground corridors subdivided into several parts the Near Caves, the Far Caves and the Varangian Caves. The caves are first mentioned in the chronicles in the year 1051. Initially occupied by the monks, they were later used to bury deceased monastery settlers. The caves serve as a resting place for imperishable relics of saints.

The idea of creating a 3-dimensional model of Lavra's caves was suggested by Kiev Pechersk Lavra coenobites. "Our aim is to attract public attention to the problem of preserving the Lavra Caves for future generations. Today the caves are in a desperate state and urgently need repair work," says Archbishop Pavel, Father Superior of Kiev Pechersk Lavra.

### Laser Scanning Using Leica ScanStation 2

In November and December 2008, laser scanning of St. Anne's Conception Church in the Far Caves of Kiev Pechersk Lavra was performed by Ukrgeodezmark Subsidiary Company in cooperation with the official Leica Geosystems dealer in Ukraine, Doka. The work was carried out within the scope of a cave laser scanning project with the goal of creating a visualization of the cave interior. Work specifications for this scanning project were developed by Ukrgeodezmark Subsidiary Company specialists Sergey Marchuk and Maksim Mikhailov.

Laser scanning with 2 cm resolution was performed using the new Leica ScanStation 2.

The work was carried out at night due to high cave attendance in the daytime. Previously created survey networks in the local coordinate system were used as a geodetic base for scanning. Additional measurements in those parts of the caves that presented difficulties were performed using a Leica TCR1201+ total station. "This is the most advanced equipment in the world today," assured Yuriy Serebrianny, Director of Doka, Ltd.

The Leica ScanStation 2 demonstrated high reliability in the work process and the scanning results are yet another testimony to its unparalleled performance. According to the statement made by Ukrgeodezmark's Director Nikolay Belous at the press-conference organized by Kiev Pechersk Lavra

priests, the equipment is so accurate that it records the slightest wall irregularities and even murals. "After all the work is done, it will be possible to walk through all of Lavra's caves while sitting on a couch with a cup of tea," said Mr. Belous. However, according to Project Manager Valentyn Kovtun, some of the caves remain unexamined since their entrances are still blocked up.

### Labyrinth Modelling

Based on the results of surface scanning and 3D modelling, the next step is a visualization of the entire cave labyrinth using proprietary technology. First, triangulation models of object surfaces are created with a 50 x 50 mm increment. This increment may be reduced to 25 x 25 mm for places with complicated surfaces and room interiors. Then the entire object is modelled by combining individual triangulation modules of object surfaces (walls, ceiling, floor etc).

All walls, floors and ceilings of caves and rooms are modelled using primitives of Polyface Mesh type. The scanning results are processed by the Leica Cyclone software suite. Three-dimensional models are created using specialized software by combining triangulation models generated based on scanning data with high-quality photographic material. As a result, a user can view the completed model, freely move around it and get additional information.

Future plans include creation of a three-dimensional Kiev Pechersk Lavra geographic information system (GIS). Availability of such a 3D GIS would allow reproduction of the unique Lavra architecture, including its smallest details, at any time with maximum possible accuracy and speed.

### 3D-Technologies: the Future of Visualization

Today 3D laser scanning is an integral and the most promising part of engineering surveying in the field of architecture, construction and historical and cultural heritage. Use of the latest laser scanning technologies from Leica Geosystems opens up new horizons for humankind in such areas as preservation of valuable historical and cultural objects for our descendants and ensuring general availability of the world's cultural heritage that would help spread

culture and knowledge among citizens of all countries. A 3D visualization model would enable many pilgrims who cannot come to ancient Kiev in person to take a virtual “walk” through the holy caves of Kiev Pechersk Lavra and pay their respects to the sacred Christian relics.

#### **Священні печери в 3D**

В. Ковтун, Ю. Серебрянний

Розглянуто використання технології наземного лазерного 3D-сканування на території комплексу Київ-Печерської Лаври.

#### **Священные пещеры в 3D**

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#### **Holly caves in 3D**

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The article is devoted to the technology of ground laser 3D scanning in the Kiev-Pechersk Lavra territory.



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