Reconstruction of a Fatal Fire Utilizing a Long Range 3D Laser Scanner

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On a routine mission on a rocky island on the Croatian coast in August 2007, twelve firemen lost their lives. This case posed the question: How did twelve firemen die on a mountainous island without a flammable substance near them?

During the scene investigation, police had found 105 important items of evidence spread across the large rocky terrain; however, they did not have the equipment or the knowledge to capture and preserve this evidence properly. For instance, an inquiry of the original measurements taken on scene revealed that there was an error of 1-2m for a horizantal spacing of 20m and an error of 64m in the elevation above sea level for one important item.

FIG 1: Base station 80 cm above sea level.

A team of experts was assembled, including the author of the text, to map the crime scene. This was an interesting case because precise documentation of a crime scene with dimensions of 1000x500 m was performed using a long range laser 3D scanner. Due to the dimensions of the scene, a collaboration with geodesist Zlatan Novak was conducted. The collaboration concluded that the most valuable approach would be to scan the scene with a long range laser 3D scanner. Zlatan Novak also proposed the use of a Canadian Optech 36D long range laser 3D scanner, coupled with a GPS/GLONASS receiver Topcon HIPER+ (Plus) GNSS and data registrator Topcon FC-100 with Top SURV package. This equipment enabled the 1000x500 m area to be measured with a precision of 1-3 cm.

FIG 2: Optech 36D long range laser 3D scanner coupled with GPS/GLONASS receiver Topcon HIPER+ (Plus) GNSS

FIG 3: Data registrator Topcon FC-100 with Top SURV package

All measured points were in absolute coordinates. Scanning was performed from six different hills. Therefore, six different point clouds were used to create a single point cloud of the area of interest. Later, the point cloud data was transformed to a 3D polymesh, and then was imported into the CAD/CAM software, Maya, for various 3D reconstructions and simulations.

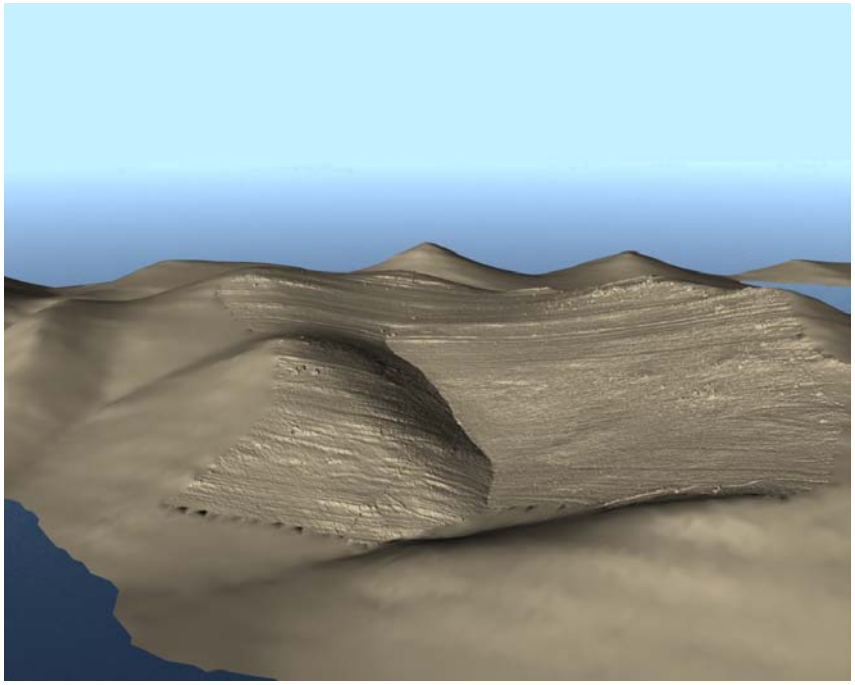

FIG 4: High resolution 3D model of scanned area inserted in low resolution 3D model of rest of the island.

Dense laser 3D scanning of this immense area rendered a huge data set that was impossible to process with available computers, so the resolution of original point cloud data was reduced by a factor of 50. A 3D model of the scene, with reduced resolution, was still of excellent quality; however, 3D models of trees and bushes suffered severe deformation.

FIG 5: Photograph of a detail on scene of crime

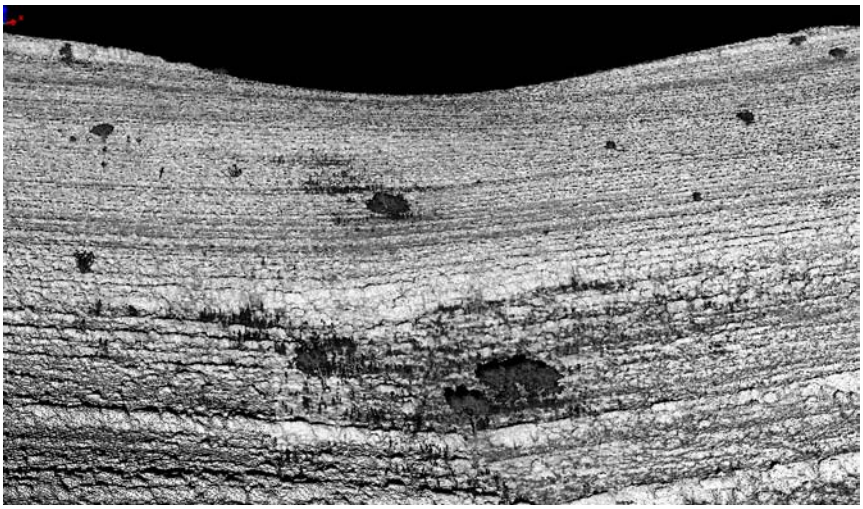

FIG 6: Original 3D point cloud of the same detail on scene of crime

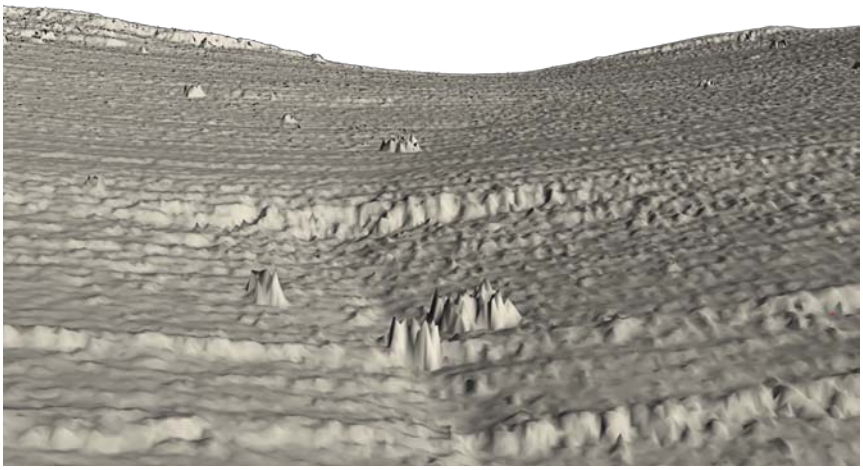

FIG 7: 3D model with reduced resolution of the same detail on scene of crime

During laser scanning, police errors were discovered. Henceforth, all items of evidence were repositioned. This was a starting point for 3D reconstruction.

In this case, it was possible to extract digital data from a camera that one of the deceased fireman had utilized during the fire. According to the EXIF data of the extracted photographs and using the shapes of nearby rocks and bushes to create known cmaera positions, it was possible to calculate the speed of the firemen walking and the movement of the fire front. The images were also used to reconstruct the path of the firemen from the moment the helicopter landed until the moment of the last photograph.

FIG 8: Forensic 3D reconstruction showing 3D models of firemen walking across 3D model of scene of crime created by laser 3D scanner

Due to the lack of ignitable material, one hypothesis was that the firemen died because the helicopter accidently poured gasoline over them. With a forensic 3D reconstruction based on laser 3D data and the EXIF data, it was possible to reject such a hypothesis.

FIG 9: Forensic 3D reconstruction showing landing of firemen and helicopter leaving the site

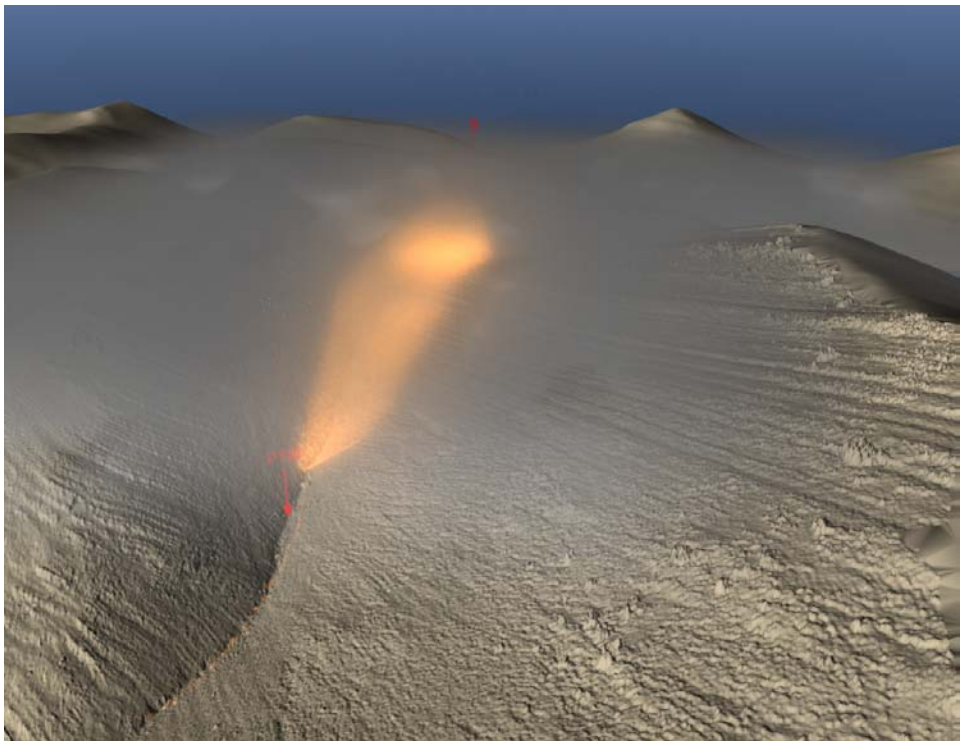

FIG 10: Forensic 3D reconstruction showing the rapid combustion of flamable gas mixtures originated in a fire front on remote locations and accumulated in a canyon by a strong wind (from a high perspective)

The team of several court experts finally concluded that the most probable cause for the deaths had been a rapid combustion of flamable gas mixtures originating in a fire front in a remote location that accumulated in a canyon by a strong wind. It is likely that the firemen were transversing the canyon at the moment that the firefront of this original smaller fire ignited the flamable gas mixtures accumulated in the canyon causing a flash-over. This produced extremely high temperatures estimating roughly 1100-1800 ^{0} C.