APPLICATION OF 3D TERRESTRIAL LASER SCANNING IN GEODYNAMIC MONITORING

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ABSTRACT

During last 10 years, geodesists from the Faculty of Geodesy, University of Zagreb, together with geologists and tectonicians established and performed a number of series of GPS-measurements on the Geodynamic Network of the City of Zagreb. The results of these campaigns emphasized the spots with higher level of geodynamic activity, resulting in damages on objects: houses, walls, churches. Therefore, the technology of threedimensional laser scanning has been employed in order to capture much more detailed picture of fast movements. In the first experimental phase of the project, only rapidly sliding areas are observed. The main hypothesis of proposed research is to check if the technology of precise laser scanning is able to produce comparable point clouds showing the movements of objects in the field. As an additional source of information, this research should contribute to the better understanding of the processes below the Earth surface.

INTRODUCTION

This paper describes the research agenda at the Faculty of Geodesy, University of Zagreb related to the inclusion of threedimensional terrestrial laser scanning into geodynamic monitoring in the area of the City of Zagreb. Since 1997, a network of specially stabilized geodetic geodynamic points has been monumented and observed with GPS-technology in regular intervals. In the area of Granesina, the church of St. Mary, placed on top of a small hill, has suffered serious damage. The surrounding wall cracked as can be seen in Fig. 1. The wider area and fault directions contributing to the movement causing this damage is shown in Fig. 2. The question is raised how to monitor the spreading of the fracture. The same goes to the fracture shown in Fig. 3: the road in north-eastern part of Mount Medvednica. How to monitor the development of tectonically caused fractures?

One possible answer is to engage the threedimensional laser scanners: very efficient sophisticated instruments which measure tens of thousands points per seconds, (Luhmann et al. 2006), (Jacobs 2005). Compared to GPS-technology which – when set out for precise geodynamic measurements – measure coordinates of a single point within many hours and days.

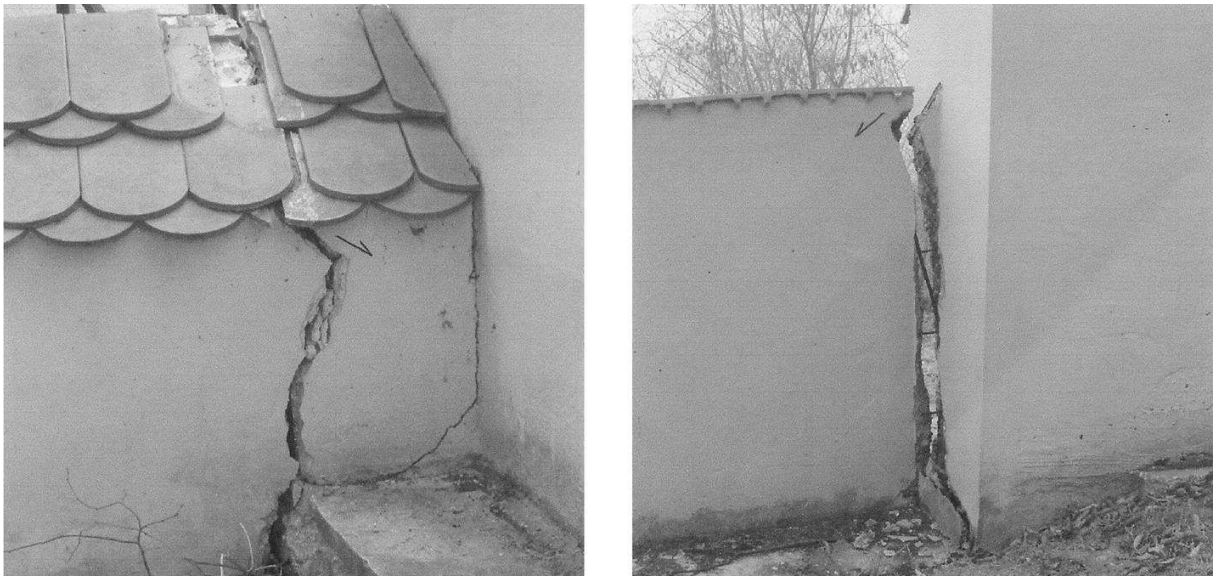

Fig. 1. The damages on fence walls around the church of St. Mary in Granesina.

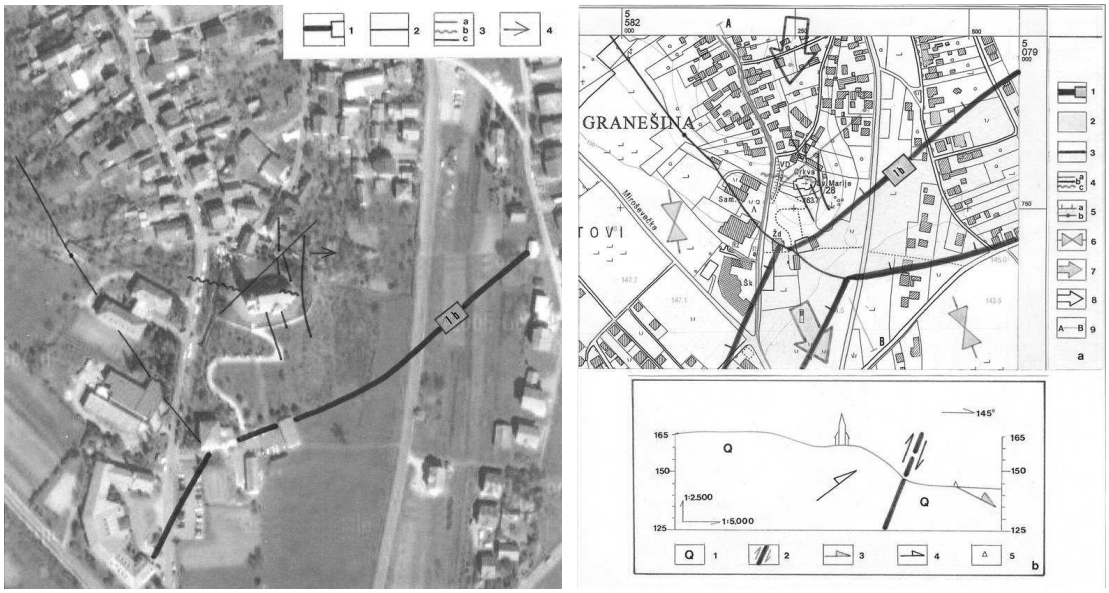

Fig. 2. Granesina area with fault lines draped over satellite scene (left) and a Croatian base map (right). The inset shows three-dimensional position of faults below the church of St. Mary.

Fig. 3. Damage on a road in the vicinity of the church of St. Mary in Granesina.

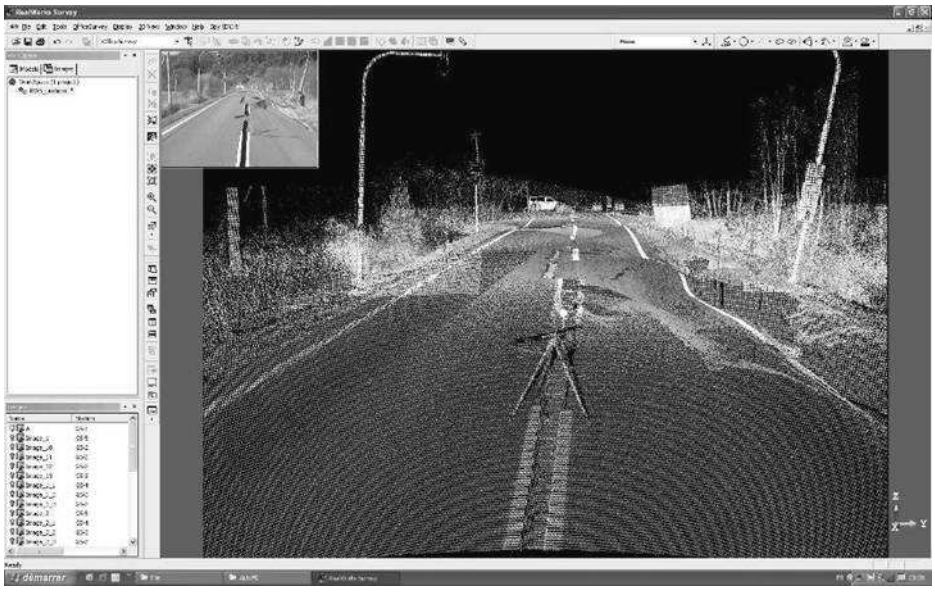

Fig. 4. Modern technology in reconstructing the damaged roads – laser scanning point cloud of the scene shown in inset.

Laser scanning is the best tool for precise surveying of damaged roads, providing the best possible starting point for future reconstruction. Combined with fault maps, sometimes it is cheaper to locate the roads at different route than to reconstruct it every time the fault is slightly moving.

Fig. 5. Field team of the Faculty of Geodesy with 3D laser scanner

Terrestrial scanning can be used in construction engineering, especially for buildings like highways, tunnels and bridges, even for deformation analysis (Gosliga et al. 2005). Some results obtained at a Croatian highway possible rockslide site are shown on Figures 5 and 6. It was pretty straightforward to obtain the model with isolines from the field scan pointcloud.

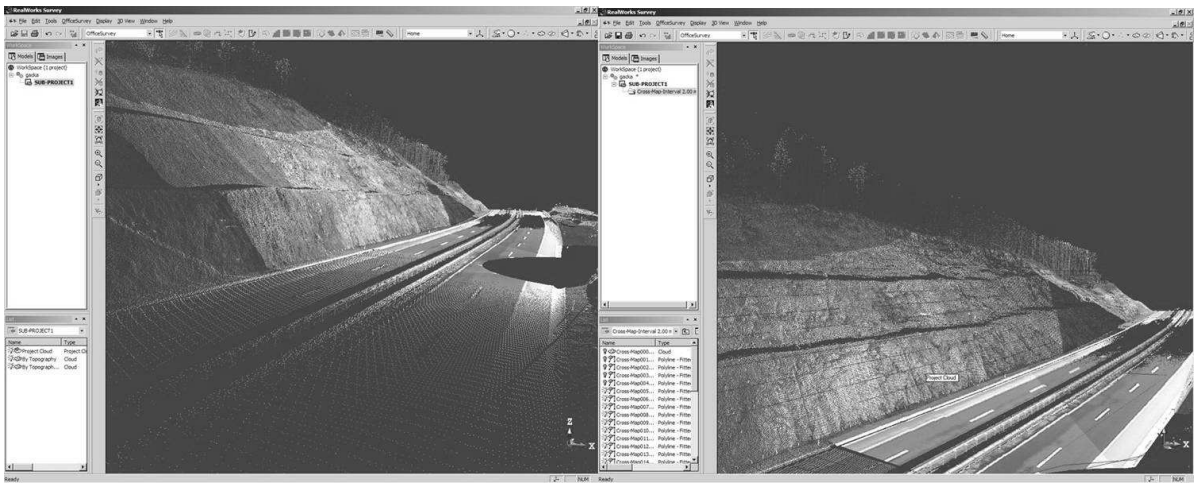

Fig. 6. The point cloud of the highway section below a possible rockslide (left) and a modeled isolines with model measurements (right)

The laser scanning technology can be successfully used to preserve architectural heritage (Vozikis et al. 2004). Such data and models can be used for the analysis of the structures and for reconstruction in case of any disaster event. The laser scanning can be used combined with photogrammetric methods (Becker et al. 2004). It can be used for industrial survey and production of as-built documentation (Sternberg et al. 2004).

Fig. 7. From the point cloud to the 3D vector model – architectural heritage preservation

CONCLUSION

Terrestrial laser scanning is the most promising new technology that relates geodesy with geoinformation science. It opens new possibilities in monitoring of slowly moving objects, structures and terrain features. High accuracy and repeatability of measurements is comparable to that of precise GPS-measurements. Main advantages include the possibility to capture the smallest changes in places that are not measurable by any other surveying methods and the possibilities to capture millions of points within a short period of time. Aside from monitoring the geodynamic movements, the technology of laser scanning is suitable for gathering the precise 3D data about all buildings, especially these belonging to architectural heritage. The models obtained can be used for reconstruction in case of damage by any natural disaster.

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