

NEW POSSIBILITIES OF DETAILED DOCUMENTATION OF CASTLES AND RUIN AREAS USING STATIC AND MOBILE LASER SCANNING TECHNOLOGY

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Keywords: castle, ruins, mobile laser scanning, cultural heritage, Lipnice nad Sázavou

Abstract:

Huge areas of middle-aged castles or their fragments were always a great challenge for geodesists. Difficult terrain conditions, inaccessibility of exteriors situated on the rocks' outcrops, huge destructions and vegetative cover always made it difficult or disallowed their detailed documentation. Even after the complete documentation of building structures was done, their settlement into the terrain was carried out only in complete situations of wider scales and typical cuts and it was almost impossible to measure and display these situations exactly. Detailed survey of these structures, their usually huge fortification system, industrial background or their already archaeologised parts apparent today only in shallow terrain topography, requires more exact and spatially complex data. 3D laser scanning technology gives appropriate results, the obstacle for its mass utilization in care of historical monuments and monuments research in the Czech Republic generally was economical costiness for complex targeting and hardware and software demands for full-valued data assimilation. Mobile mapper technology, which enables fast and very detailed capturing of building exteriors, could cover exactly that part of documentation related to wider relations of the construction and its surroundings and therefore it leads to creation of primary base for precise documentation of individual parts, models of projected modifications, archaeological situations etc. We would like to present possibilities and also difficulties of this solution on the example of castle area Lipnice nad Sázavou documentation.

1. INTRODUCTION

Extensive areas of medieval castles or their remainings have always been a great challenge to geodesists surveying them. Difficult terrain conditions, inaccessibility of exteriors situated on rock outcrops, vast destructions and vegetation overlay have always made their documentation more difficult or even impossible. However, even if complex surveying documentation of building structures finally took place their positioning into terrain situation was demonstrated only in bigger scales and typical profiles. It was practically impossible to make an exact surveying and display more complex terrain positions correctly.

However, from the logical point of view and according to research experience the terrain configuration of fortified buildings is tightly connected to them as strategically placed objects. And we do not have in mind

only palace parts of castles but their often vast outside fortification or outer ward. The research subject is thus their whole functioning area. This is the only way to deeper understanding strategic plans of builders of that time and the building in its complexity.

As it is obvious from the text above the detailed research of castle functioning area consisting of standing constructions, their archeologized parts and terrain relief require far more exact and space-complex documentation base.

3D laser scanning technology brings such required results and is to certain extent used in castles and ruins documentation. The difficulty in its greater application in heritage protection and monument research generally in the Czech Republic is both in its financial aspect in the case of complex survey of castle areas, and hardware and software requirements for the full use of data by professionals from these fields. Majority of the projects realized was accompanying documentation of archeological research results or focused on scanning of individual building parts for the purpose of historic structure research documentation accompanying the reconstruction of the object.[1]

Only in some examples we can find survey conveying the whole object. [2] All examples we know were employing static laser scanner.

2. RESEARCH OF CASTLE LIPNICE NAD SÁZAVOU

The need to make documentation base in the extent of the area complex situation resulted from research of castle Lipnice nad Sázavou. The castle from the first half of the fourteenth century stands on a rocky hillock above the town.



Figure 1: The Lipnice castle, view from west, photo V. Hyhlík, 1957

The heart of the castle is created by three huge tower-like buildings connected by circumferential rampart into trapezoid ground plan which is occupied by two magnificent palaces. The outer fortification was preserved as a ruin.

Medieval and early modern age building development of the castle is rather complicated as it is obvious from historic structure research from 1970's. Its slightly architecture met the requirements and representation needs of its influential owners – the family of Lipá and the Masters of Landštejn and Vartenberk whose members held important statesmanlike functions. The castle reached its vintage form in 1530's during the time of family of Trčka of Lípa which was followed by a long period of stagnation. After fire in 1869 the castle became desolated and its partial reconstruction took place as late as in 1920's. The castle went through the greatest building repairs in 1970's and 1980's which often meant devastation of values.

Despite the existence of above mentioned basic research it belongs among significant castle buildings about which we do not know much. That is why two years ago the research and documentation which would work with the preserved sources more systematically and with the help of modern means was reintroduced.

Older surveying base documents originated in a number of phases from 1960's to 1980's. They always concerned only individual parts of the castle. Their quality is changeable because they were made for different purposes – from very quality surveying of the current state in a scale 1:50 realised by specialised geodetic groups SURPMO to plans of technical-economic studies which have purely informative character.

Nowadays, when new researches are taking place base documents created by methods of 3D laser scanning and photogrammetry are commonly used.

Their application was considered to be used even for surveying the complex area situation so that a detailed base including terrain configuration of wider surroundings, building position and maps elevation data was created. In the spring of 2011 there was an opportunity to test the only mobile mapping system in the Czech Republic at that time – Lynx Mobile Mapper – for this application.



Figure 2: Lynx Mobile Mapper platform placed on a car body

3. USING OF MOBILE MAPPING TECHNOLOGY IN THE HERITAGE SECTOR

The company Geovap s.r.o. offered this technology to be tested for its usability in the area of cultural heritage protection. Thus, it was possible to examine its characteristics and therefore gain experience for further similar commission.

Concerning the investor/user the aim was to decrease acquisition costs, increase speed and detail of surveying and its possible usage. At the same time we also paid attention to the technology limits, actually the limits of the conditions while scanning. The output was to be, except for the point cloud itself, a contour map with contours of 0,5 m corresponding to similar surveying by conventional geodetic methods including their accuracy. Further outputs were to be testing ortho views of point cloud of outer selected facades.

Lynx Mobile Mapper technology is a system with the scanning speed of 400 thousand points per second. To get the basic idea – it concerns a device set up from a position and orientation system and a scanning part with two highly accurate lidar sensors and four digital video cameras. The whole device is placed on a car body.

Our test took place in March, thus not during vegetation period. The travel plan of the car was along passable roads through the village centre, around the castle and to its courtyard and along the accessible terrain in its close surroundings. The whole way took one hour and half and the scanning itself was started up only in one direction of the way. The total scanning area reached was around 7 ha and the resulting point cloud contained approximately 120 million points. For the purpose of the documentation of the castle situation an area as big as 2 ha was chosen. There we can register area of approximately 10 % where the building density or configuration of the terrain did not enable scanning. However, we did not approach reparatory surveying of private places or places of worse accessibility and we did not complete the surveying by static machine.



Figure 3: The contour map of the area generated from point cloud

During the way further limit factor appeared - the surrounded main bailey of the castle restricts the visibility of satellites, which influences the accuracy of position system. However, it was possible to compensate this drawback by manual lowering of point clouds.

The outputs – the general plan of the situation with the contours, cross sections and front views were made without any further correction by automatic functions. From the point of view of the investor/user – supplier of historic structure research and also castle administration the result is very satisfactory. It creates exact base for making a plan of the complex castle situation including terrain configuration. The speed of surveying such vast area, low costs when compared to the conventional way, accuracy and utilizability of data – that all shows the positive aspects of broader employing this technology in similar commission. To fill in the blind spaces in the point cloud it will be necessary to prepare the travel plan of the car better so that it can get also to parts of areas difficult to access or to complete the data by scans from a static scanner or use maps elevation data from accessible sources of airborne laser scanning.

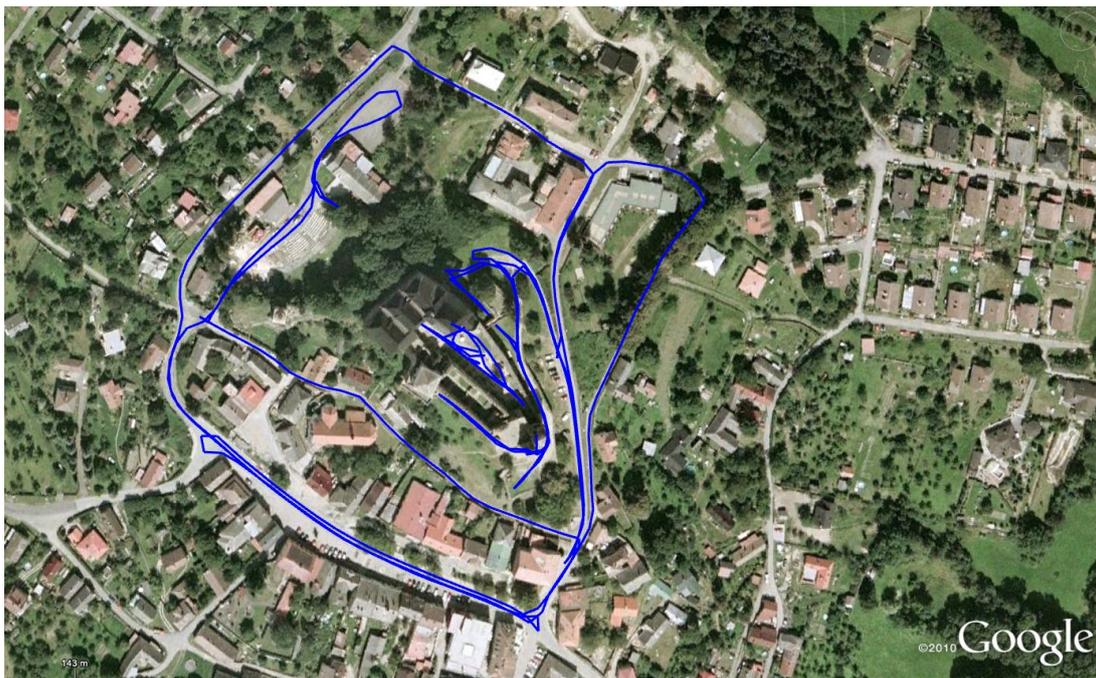


Figure 4: The vehicle trajectory in terrain

4. CONCLUSION

Primarily, this way is suitable for surveying objects visible at sight and situated on road networks. A lot of castles and castle ruins hidden in forests and situated in a difficult terrain configuration do not certainly meet these requirements. On the other hand, there are a lot of examples of medieval or early modern age feudal buildings incorporated into town or village structure or those visible due to deforestation. In such cases the

application of mobile scanning is certainly useful and can thus due to its speed and price become an attractive method.

5. REFERENCES

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