Non-invasive Investigation and Documentation in the Bieliński Palace in Otwock Wielki

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Abstract. The paper presents the ongoing project conducted by an interdisciplinary team at the Bieliński Palace in Otwock Wielki, near Warsaw (Poland). The main aim of the project is to document the architecture and architectural elements with the use of digital methods such as photogrammetry and 3D scanning, as well as investigating the construction phases of the palace, through the analysis of the digital data collected.

The Bieliński Palace is an example of élite architecture of the Baroque period in Poland. Thought the architect responsible for the original plans remains unknown, the plan, the proportions, as well as architectural details find good parallels in the finest buildings of the capital of that time, and show clear inspirations from the western examples of the architecture of the period.

Since the archival data is very scarce, the only way to learn about the history and construction phases of the palace is through a detailed analysis of the building's structure. To this aim we perform a series of analyses of the digital data, such as wall flatness analysis and laser beam refraction intensity. We believe that the careful analysis of the data collected for the purpose of documentation can reveal valuable information that will contribute to our understanding of the building's history.

Keywords: Architecture · Digital data analysis · Photogrammetry
TLS

1 Introduction

In this paper we would like to present our ongoing project at the Bieliński Palace in Otwock Wielki (Poland). The investigation is conducted by an interdisciplinary team of scientists from the Systems Research Institute of the Polish Academy of Sciences, the

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Department of Geodesy and Cartography of the Warsaw Technical University and the National Museum in Warsaw.

1.1 The Palace in Otwock Wielki

The Palace is located on an artificial island in the oxbow of the river Vistula, some 30 km SE of Warsaw. The building is part of a large complex, which includes a park and a grange. For many years it served as the summer residence for the Bieliński noble family (Fig. 1).

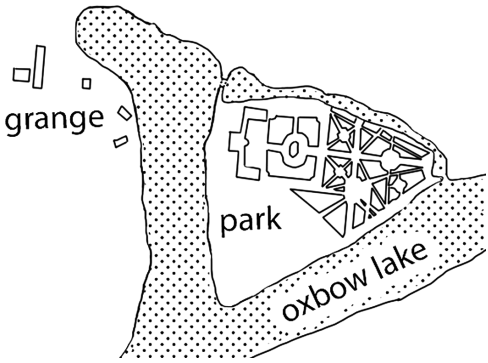

Fig. 1. Simplified plan of the palace complex in Otwock Wielki.

The construction in the palace begun in 1682 and finished by 1689. The palace was commissioned by Kazimierz Ludwik Bieliński. It is not known however who was the architect behind the plans. Architects that are sometimes connected with the plans of the palace are Tylman van Gameren, the baroque architect of king John III Sobieski, Carlo Ceroni and Józef Fontana, all known for their work in Warsaw.

The elements dating back to the 17th century are the main central part with two storeys, and side alcoves and the relief decoration of the exterior of the palace executed in pink stucco (Fig. 2).

Fig. 2. The Bieliński Palace in Otwock Wielki - view from the park.

The palace was remodelled around the year 1757. There is very little information on the duration of the remodelling and if this was a single construction phase or if there have been several phases. In the course of the remodelling the palace gained the actual form. On the right side of the entrance it is likely that an exterior staircase was removed and substituted with an interior one. In addition the plan modifications also included two new towers, as well as two wings and two separate annexes, which housed guest rooms, kitchens and other facilities. These annexes were connected to the main body by narrow galleries at the ground level.

The palace was abandoned for the second half of the 19th and most part of the 20th century, but during the Second World War German forces were stationed at the palace, which added to the progressive degradation of the palace. After the war the whole palace complex became the property of the state and became a summer residence for state officials. During this time various restoration works were done: electrical wiring was installed, new roofing was put in place, several rooms of the basement were cleared and a concrete pavement was constructed in front of the palace. All these works obscured the original tissue of the building. Since 2004 the palace belongs to the National Museum in Warsaw and houses the Museum of Interiors.

2 The Project

The study conducted so far concentrates on two rooms in the East wing of the upper floor. Some initial documentation has also been done in the basement under the main building. These two rooms have been chosen because they preserve mostly the original wall surface, with only minor conservation work (Fig. 3).

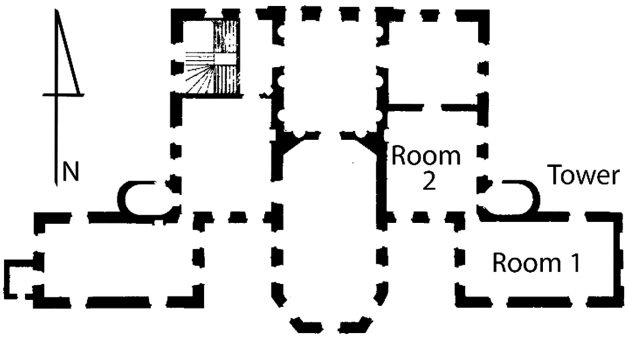

Fig. 3. A schematic plan of the first floor the palace.

The same set of rooms in the West wing have been largely renovated and no original surface remains. The Eastern rooms belong to two construction phases of the palace. Room 1 is located in the wing that was added as a result of the remodelling after 1757, whereas Room 2 belongs to the original part of the palace. Room 2 has direct connection to Room 1 as well as the tower. Hence this area was deemed the perfect

location to begin our investigation into the construction phases of the palace. Additionally, the walls of both rooms are entirely decorated with frescoes, which were the second focus of our investigation. The decoration of Room 2 comprises mostly of pastel landscapes with elements of architecture (Fig. 4a), while the main architectural element is a fireplace with a simple stone frame, crowned with antithetic winged stucco sphinxes, carrying on their back a tondo, which once contained a fresco now missing. Room 1 has a different type of decoration, in which the main elements are 9 figurative panels with allegorical scenes (Fig. 4b). Each scene is accompanied by a short Latin sentence within a decorative baroque frame. The additional painted decoration imitates stucco elements around the windows and doors with large gold figures crowning them. The scenes in the panels are executed in monochromatic brownish colours. Preliminary examination of the frescos reviled incised sketches done in wet plaster. The technique of the fresco still needs to be established.

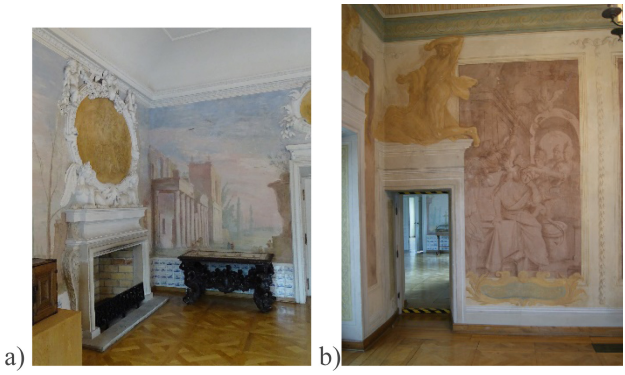

Fig. 4. (a) Fresco decoration of Room 2 and the fireplace, (b) Detail of the decoration in Room 1. (Color figure online)

The goals of the project have been formulated as follows:

1. To establish the sequence of the remodelling on the basis of the examination of the East wing: Was the tower first or the wing with Room 1? Or were they constructed simultaneously? Were the frescoes in Room 1 a part of the original decoration or were they added later?
2. To document the frescoes from Rooms 1 and 2 as well as possible, and to be determine the technique of their execution and the state of preservation [1];
3. To document the basements and to establish the original floor levels;

In the course of the investigation we added another goal, that is to use the recorded data for the analysis, to compare available non-invasive methods and to propose a methodology for working with digital data in the context of documentation and analysis of historic architectural buildings.

Due to the historical nature of the building the projects aims to employ possibly non-invasive analysis to limit the impact on the building degradation.

To this aim the following steps were undertaken:

1. For Rooms 1 and 2 a series of geodetic measurements was carried out in order to establish the ground control points, orthoimages of the rooms were generated, and a TLS point cloud was acquired for both the upper floor rooms as well as the basement;
2. Based on the data gathered the following analysis were conducted: a DSM (digital surface model), the flatness analysis, and the analysis of shaded DSMs.
3. The TLS data was used to analyse the intensity of laser beam reflection.

3 The Investigation

The photos for orthoimages were gathered using three different types of cameras: a Xiaomi action camera, a full frame Canon Mark II and a middle frame Hasselblad 50 and 100 Mpx cameras. Additionally 3D scans were taken with a Z + F 5006h scanner.

Through a series of analyses we were able to establish that action cameras are suitable for generating orthoimages that are sufficient for overall documentations of architectural objects [3]. The middle frame camera proved to be a great source of data for the investigation of architectural details as well as of the incised sketches for the frescoes [4]. The data from the full frame camera were used as reference. The scanner was used in the basement, as photogrammetry proved to be not suitable for rooms with poor light and repetitive wall texture.

The first analysis was the flatness of the wall abutting the tower in Room 1. This method was applied as a part of our investigation into the construction phases of the palace. In order to verify which part was built first, the wing or the tower, we have decided to check the relation between the two. Figure 5 presents the results of a plane being fitted into the point cloud, representing the investigated wall. The colours indicate the deviation of the points from the plane. For this specific wall the deviation between the fitted plane and the point cloud ranges from −0.03 mm to 0.015 mm. This allowed us to map the irregularities of the surface that are not visible to the naked eye. In Fig. 5 we can see changes in the wall surface that we identified as a blocked door and a irregularity in the middle of the wall that could be the result of the tower weight abutting the wall. The same phenomenon seems to happen on the edge of the wall. This might suggest an earlier construction date for the tower than the wing, as the Eastern wing wall was equally affected by the tower and the central, earlier, part of the palace.

The point clouds generated a DSM which is a solid base for analysis, as it reveals the structure of the surface, as the wall flatness analysis does, which otherwise could have gone unnoticed.

We decided to apply shading to the obtained DSMs in order to investigate the incised sketches for the frescoes. On the DSM model we can see the majority of the incisions, which provides the possibility to located them and trace them without the need to perform actual measurements on the fresco (Fig. 6). We hope that by examining those sketches we can learn more about the technique in which the frescoes were executed and about the artist who executed them [2]. We are also looking into the possibility of automatic detection and mapping of such incisions [4].

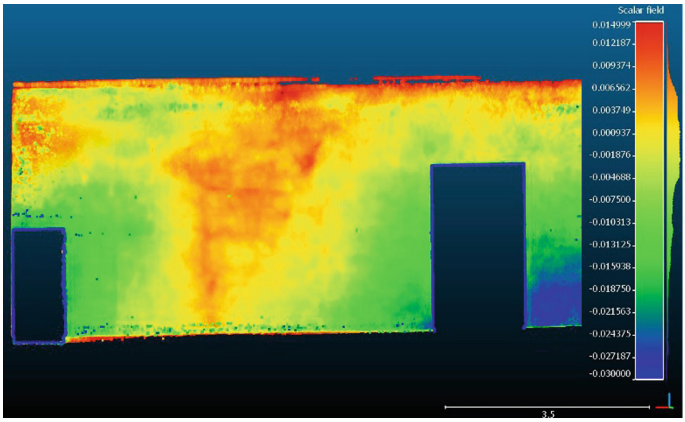

Fig. 5. Wall flatness analysis. The colour denote the distance of the fitted plane from the surface of the wall. The distance ranges from −0.03 to 0.015 mm. (Color figure online)

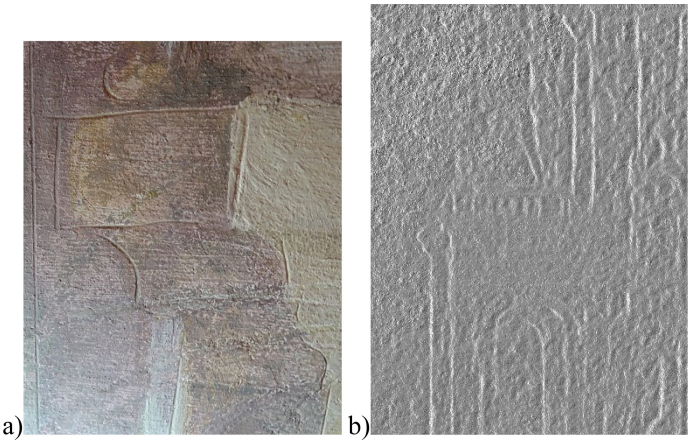

Fig. 6. The preparatory incised sketches for the fresco composition in Room 2: (a) photo (b) visible on the shaded DSM.

Such shaded models can also be used to investigate the surface of the wall. In Fig. 7. We see clear changes in the structure of the fresco, especially in the left-hand upper corner. Our preliminary theory is that they are the result of the wall being exposed to water. We believe that through seasonal monitoring over a period of time and the comparison of the DSMs, we will be able to establish whether this is related to the period of abandonment of the palace of if this an ongoing process, and conservators intervention is required [1].

The data from the laser scanner is not only a source of information about the geometry of the rooms. We investigated the additional dataset referring to the intensity of reflection of the laser beam. This investigation reveals mostly the information about

Fig. 7. DSM of a wall in Room 1, revealing an area possibly damaged by water.

the colours used, as darker colours absorb more light than light colours. Figure 8 shows the intensity of the laser beam reflection for the wall adjacent to the tower in Room 1.

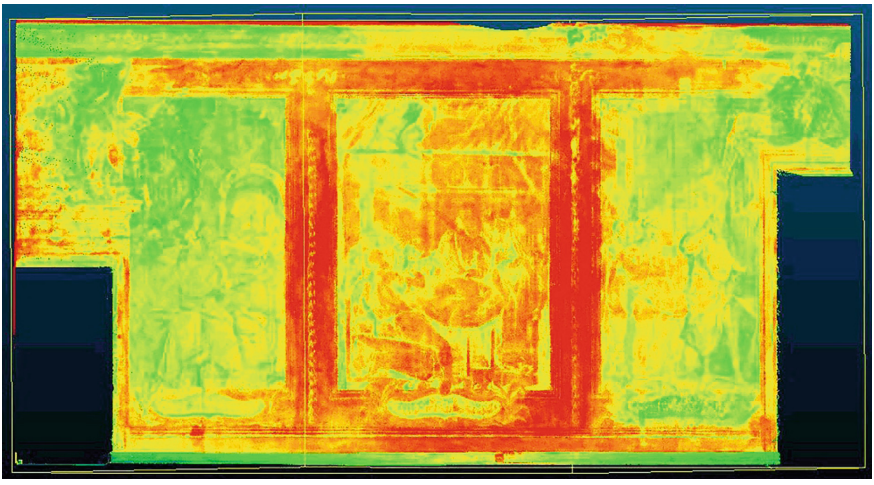

Fig. 8. Intensity of laser beam reflection for a wall in Room 1.

In the area of the middle panel a clear variation of intensity can be seen. The middle section is characterised by a higher beam reflection intensity than the neighbouring areas. The reason for this phenomenon still needs further investigation. This phenomenon may be connected to the fact that the region overlaps with the area of the wall influenced by the construction of the tower (as seen in Fig. 5). The difference of the intensity might be then explained by a change in humidity and/or wall temperature [1], caused by the abutting structure of the tower. This latter aspect shows that the intensity of the laser beam reflection can be used to search for changes in wall construction. It can also be a source of preliminary information before conservation works.

4 Results and Future Work

The conducted analyses have led us to the following preliminary conclusions:

1. The tower and the East wing of the palace were not built at the same time; this observation is corroborated by the wall flatness analysis and the modalities in which the two structures affect one another. Exact chronology of these two structures still remains to be established. The frescos in Room 1 are not part of the original decoration of this room, as evidenced by the blocked door leading to the tower.
2. We were able to assess the general state of the frescoes through the analysis of shaded DSMs and the intensity of the laser beam reflection. We could locate areas that need monitoring and if conservators intervention will be required.
3. The investigation of the relation between the incised fresco sketches and the structure of the surface will help us establish the technique of the frescoes execution without the need for samples. The non-invasive investigations allowed us to obtain information that would have been unavailable with the traditional methods. We strongly believe and hope that these results will help limiting the invasive tests (such as samples or trenches) or in some cases even avoid them.

As for the future works we plan to continue the investigation of the east wing, to further refine the building sequence of the palace.

The second area of interest for the study is the park surrounding the palace, which from old plans seems to have included a pavilion and a small pier for boats on the opposite side of the island from the palace. The planned works will focus on non-invasive methods, such as gravimetry and GPR. A survey of the park area is planned as we have already collected information about chance finds of garden sculptures. If more fragments are located they could provide hints about the style of the garden, of which we have no record. If the non-invasive methods reveal any remains, the last phase of the investigation will be to conduct a small scale excavation to verify the results of the non-invasive tests. The same methods as in the garden, that is gravimetry and GPR, will be employed in the effort to locate the original, exterior staircase.

The initial aim of the project was to document the interiors of the Bieliński Palace in Otwock Wielki using laser scanning and photogrammetry. The use of both these tools is well established in the field of cultural Heritage preservation and documentation. As the work progressed we encountered more and more research questions concerning the construction and chronology of the frescoes and the palace.

Since there are limited excavation possibilities, we decided to tackle the arising questions through the analysis of the already collected digital data. This approach gave promising results as presented above.

The approach is based on the form of documentation that is well established in the field, that is photogrammetry and laser scanning. The advantages of these methods are widely acknowledged amongst researchers. However, the advanced geometrical analysis of data coming from such methods is a relatively new subject. In the case of the investigation in the Bieliński Palace, it turned out to be very helpful in establishing preliminary hypothesis as to the sequence of constructions. And we hope it will allow us a more question-focus approach in the future. Nevertheless, it has to be noted that

the analysis themselves provide only partial information about the structure, and in many cases in order to draw solid conclusions, a complete investigation is needed.

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