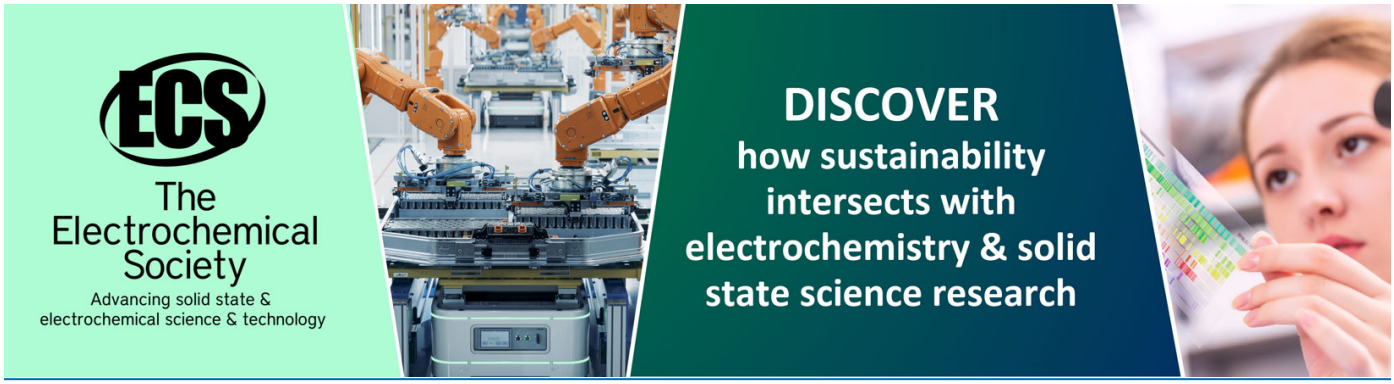
Comparative analysis of two self-portraits by Igor Vasiljev using non-invasive methods



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Comparative analysis of two self-portraits by Igor Vasiljev using non-invasive methods

M Djuric[1], V Jovanovic[1], Z Velikic[2], M Jovanovic[1]

[1]ArtLab, Bulevar Kralja Aleksandra 391, Belgrade, Serbia
[2]Institute of Physics, Pregrevica 118, Belgrade, Serbia

E-mail: vmaja74@gmail.com

Abstract. This paper presents a research on materials and techniques used in two paintings dating from October 1952, signed by Igor Vasiljev. The aim of the research was to provide important answers from the art history standpoint and explain the existence of two almost identical self-portraits. Standard non-destructive diagnostic methods for painting examination were applied. First, a qualitative analysis of recorded visible reflectance spectra in 350-1100 nm domain was performed, and then its results were regarded along with the information obtained applying imaging techniques such as UV induced fluorescence, VIS-NIR-IR reflectography and radiography. Since the paintings do not have a varnish layer, the UV fluorescence gave especially interesting results, showing difference in used paints. Although the comparative colorimetric spectra indicated the use of same pigments but different mixtures in most points, the infrared reflectography showed very clearly the existence of underdrawing and significant changes in composition (*pentimenti*) on only one painting. In addition, the details of that painting observed under the great enlargement indicated great spontaneity of paint application. While a visual inspection of these two self-portraits suggested the same author - a very talented and creative Igor Vasiljev, a comparative analysis of the results obtained by spectroscopic and imaging techniques showed that there is a significant difference between them.

1. Introduction

The existence of two paintings "Self-portrait in Rubashka[1]" signed by Igor Vasiljev, dating from the same period, has drawn the attention of connoisseurs and admirers of his art. The application of scientific methods in the analysis of these paintings, primarily the painting process, materials and techniques used, has opened some new questions, but also showed the potentials of various nondestructive methods. The accent has been put on the use of imaging techniques, since their results have indicted a different creation process of these two self-portraits. Inclusion of other non-destructive methods has significantly expanded the field of research and contributed to a better understanding of the artistic process of Igor Vasiljev, especially considering the fact that his work has never been explored in that way before.

Painting A (figure 1) - Self-portrait in Rubashka, dimensions 70 x 50 cm, was executed in oil on kraft paper that has been laminated to cardboard. It has been signed in the lower right angle: Igor X 52. Already at a first glance, before going into any detail, the painting possesses distinct marks of the portraits painted by Vasiljev during that year. The line of his drawing is strong, Van Gogh-like exiting

[1] from Russian руба́шка - a type of shirt or tunic traditionally worn by Russian peasants

but precise, with no hesitation. His stroke is clear and spontaneous, consisted of rich brush deposits and a transparent background.

Painting B (figure 2) – The paper carrier is made of transparent paper, dimensions 71 x 50 cm, laminated to a cardboard, dimensions 71,5 x 53 cm.

Figure 1. Self-portrait in Rubashka, painting A, visible light

Figure 2. Self-portrait in Rubashka, painting B, visible light

Igor Vasiljev (1928-1954) was the descendant of Russian immigrants and intellectuals, born in Belgrade. He painted intensely since 1948 and in 1953 he organizes his first solo exhibitions in Belgrade and Zagreb. The same year he gets accepted in the Association of Fine Artists of Serbia as its youngest member. He died in an accident in 1954. The cause and circumstances of the accident are still a mystery and a subject of speculation. Utterly distinctive, consistent and charismatic, he left a signature in Serbian painting after the Second World War. Nine solo exhibitions have been organized posthumously, the last one in March 2018 at the Gallery of Serbian House of Army in Belgrade. The "Self-portrait in Rubashka", in the ownership of Canvas Art Gallery, has drawn the attention of the numerous visitors from all generations on that occasion.

2. Experimental

The chosen set of non-destructive techniques has provided ultra-high resolution digital images at multiple wavelengths, including ultra-violet fluorescence, visible, infrared reflectography and X-ray radiography. Besides these, UV-VIS-NIR and XRF spectroscopy were applied in selected points as well.

2.1. Visible (VIS) examination (400-700nm)

The first step in the analysis of paintings was surface examination under uniform illumination and raking light. The high resolution digital images were acquired with a Nikon D700 (figure18) and CANON EOS 6D (figure 1, figure 2); camera lighting source was TUNGSRAPAR-SPOT4 lamp.

The high resolution digital photography showed clear traces of pencil made preparatory drawing, along with a significant difference in painting technique.

In both paintings, A and B, a cardboard of similar type and age has been used as support, but the difference is in the type of paper which served as a carrier of the drawing and the painted layer. The paint application of both works is very expressive, yet it is of a much less uniform thickness in painting A. Painting B on the other hand, is characterized by a uniform paint layer.

2.2. UV induced VIS-NIR fluorescence

Besides the information on the areas of retouch or the type of varnish, UV induced fluorescence can also be a method for obtaining data about pigments, especially in case of the examined paintings [1].

The UV light source was UV-Handleuchte uf LED 5000 lamp (Uniflux Germany). The UV induced fluorescence was recorded in visible (CANON EOS 6D) and IR region (Samsung S1050). Since there is no varnish layer, differently colored fluorescence is evident [2].

A difference between the two paintings is noticeable on the UVF photos in the visible area (figures 3 and 4). Pigments from painting A fluoresce much more intensely and in different colors. The fluorescence of one part of the yellow paint in orange is particularly visible only on this painting, suggesting that different mixtures of pigments were used in A and B.

Figure 3. Painting A, UVF - visible region

Figure 4. Painting B, UVF - visible region

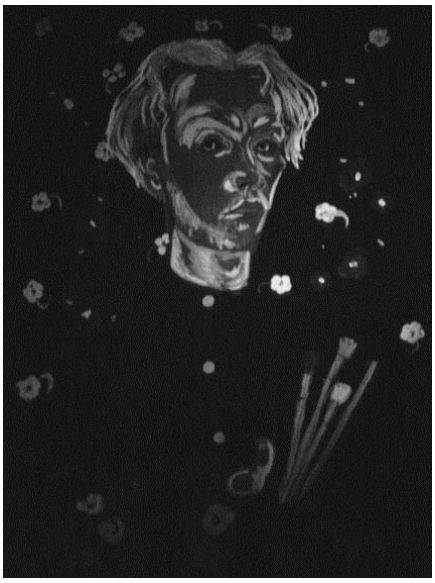

Figure 5. Painting A, UVF - NIR region

Figure 6. Painting B, UVF - NIR region

The UVF photos in NIR region (850 - 1100nm) (figures 5 and 6) have shown fluorescence on both paintings not only of yellow, but also of other paints for which it can be assumed to contain the same yellow pigment, most probably Cadmium yellow [2,3]. The only visible difference in yellow parts is in the fluorescence of the yellow brush which doesn't fluoresce on painting B in the IR region as well, indicating the use of another pigment.

2.3. IR reflectography (NIR-SWIR)

Comparison of paintings at different wavelengths in the IR region can provide additional information about the material and the painting technique. IR reflectography has been done in the NIR and the SWIR area using Samsung S1050 camera with 850nm - 1100nm filter; Nikon D600 with 950nm - 1100nm filter and LR-SWIR InGaAs PhotonicScience camera with 1600nm filter (bandpass 50nm).

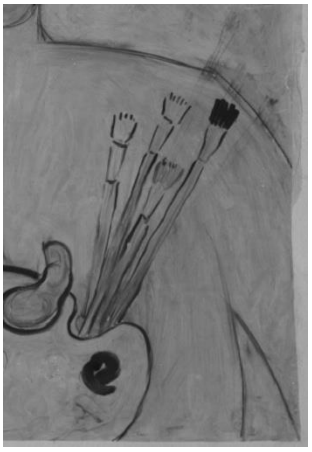

Figure 7. Brushes, painting A, 1600 nm

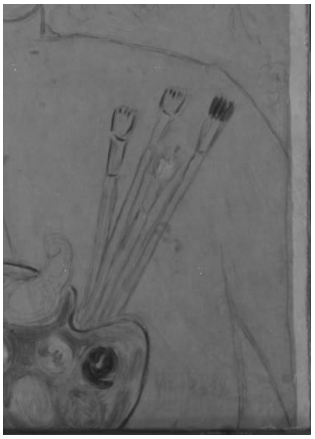

Figure 8. Brushes, painting B, 1600 nm

Figure 9. Head, painting A, 1600 nm

Figure 10. Head, painting B, 1600 nm

Besides showing the preparatory drawing, obtained images were also used for determination of certain pigments, considering the differences in their transparency in the IR region.

Observation of the recordings in visible and IR region (figures 7 to 10) led to a conclusion that there is a clearly visible and solid preparatory drawing executed in graphite pencil, with a very dynamic and rich tone colors gradation and thickness of lines on painting A. The drawing on painting B was made in such manner that colored areas are linearly confined, i.e. each colored space is precisely contoured.

Also, the change in the position of brushes and figure can be noticed on painting A, which is not the case on painting B. A different transparency in the IR region is especially noticeable at 1600nm, which indicates the difference in strokes. The yellow colored brushes of painting B show evident reflectivity in the IR region. Moreover, higher reflectivity and lower contrast can be noticed on this painting, probably because the support is less covered with paint, which has already been noticed on the photographs taken in the visible area.

2.4. X-ray radiography

All of the noted differences have been confirmed by digital radiography as well. The imaging has been performed using Roentgen scanner HD-CR 35 NDT Plus by DURR, Germany. Several recordings have been made with different exposition periods and different cathode tube voltages.

X-ray radiography can provide a wealth of information not obtainable with other techniques, for its capability to cross all layers of a painting. With this method it is possible to discover underlying paintings, investigate author's *pentimenti*, previous conservation treatments, hidden inscriptions and signatures, structural anomalies, etc. [4].

No *pentimenti* have been noticed on the X-ray recordings (figures 11 and 12), but the difference in the painting technique and in the background has been spotted: painting A has thicker coating and most of the colors are mixed with white. It is also clear that the yellow paint is absorbing the X-rays. Painting B shows a uniform background, with most prominent details painted in yellow which is also non-transparent for the X-rays.

Figure 11. Painting A, radiography

Figure 12. Painting B, radiography

2.5. UV-VIS-NIR reflectance spectroscopy

This technique enables the recognition of spectral characteristics of pigments by comparing them with a standard base. Performing comparative analysis in the UV-VIS-NIR region it is possible to make presumptions about the spectral features of the background as well.

Spectroscopic analysis has been done in several spots (figures 13 and 14). Considering the results obtained with previously described techniques, only spectra of green and yellow paints will be presented. Spectra were obtained with AvaSpec 2048-usb2-VA-50 Avantes specrometer in 400 - 1100nm area

Figure 13. Spectroscopy spots of the green paint

Figure 14. Spectroscopy of the yellow paint

2.5.1. Green paint. Spectra of the spot number 3 (figure 15) are different in shape and indicate most probably the use of different green pigments when colouring the outer edge of the iris, while the ones of the spot number 4 (figure 16) clearly show presence of yellow in the green paint. Spectra of painting B show much higher reflectivity in the NIR region.

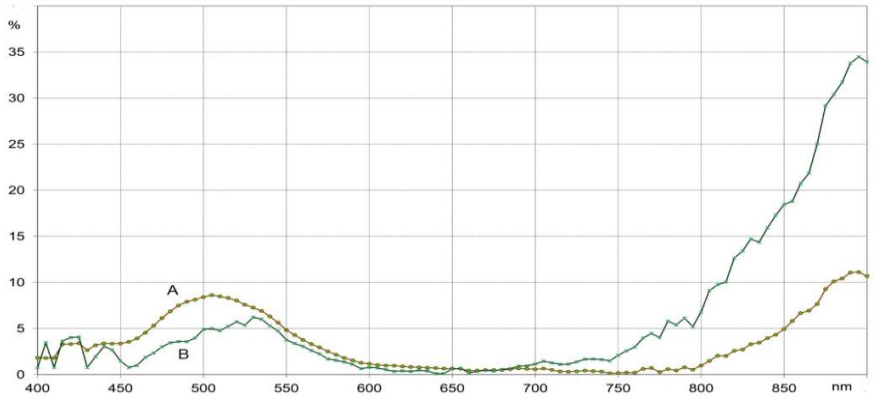

Figure 15. Reflectivity vs wavelength of green paint in spot number 3

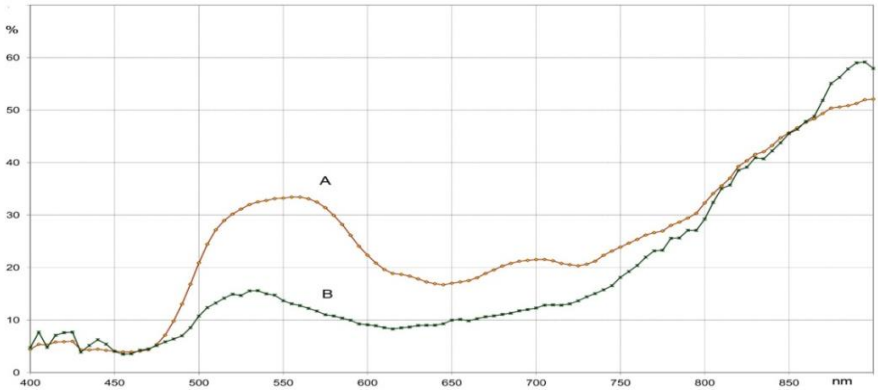

Figure 16. Reflectivity vs wavelength of green paint in spot number 4

2.5.2. Yellow paint. The largest difference between the paintings has been noticed in the yellow paint spectra, especially of the yellow brush (figure 17). Already the UV images have shown completely different properties of the yellow paints from the two paintings. Spectral analysis indicates different mixture of pigments in the yellow paint: the spectra of the spot on painting A is moved much more towards the orange, while the one on painting B has a higher content of green.

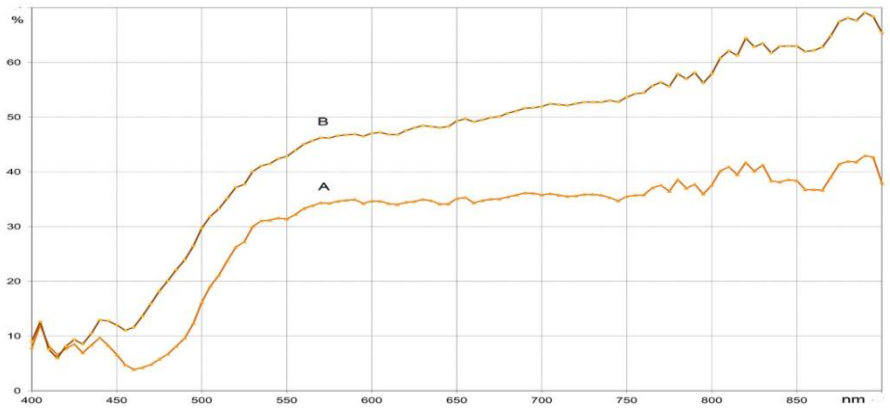

Figure 17. Reflectivity vs wavelength of yellow paint in a spot on the brush

2.6. XRF spectroscopy

The XRF spectra were obtained by means of the ARTAX X-ray analysis device model 200, from Bruker Microanalysis GmbH, spot 0,65mm.

The analysis depth depends mostly on the type of material that has been analyzed. The limitation of the technique when it comes to examination of paintings is that it is not possible to know for sure in which layer the detected element is situated.

The analysis has been performed at the same spots of both paintings in which VIS-NIR spectra were made: the yellow brush as well as the green at the outer edge of the iris. Obtained results were compared to the available database [5]. Based on this data, the paint composition in the selected points has been determined (table 1).

Table 1. Results of the XRF analysis.

	Elements detected	Pigment
Yellow brush, painting A	Cd ,S ,Zn, Ba, Se, Pb	Cadmium yellow, Cadmium orange
Yellow brush, painting B	Pb, Sb, Zn, P	Naples yellow
Green brush, painting A	Zn, S, Ba, Cl, Cu, Ca	Phthalo green
Green brush, painting B	Zn, S, Ba, Cr, Fe, Ca, Cu	Chrome green
Background	Zn, Ba, S	Lithophone

3. Discussion

Observation of the two self-portraits with the naked eye has led to the notion that the paintings are similar in terms of pigments that have been used, but quite different when it comes to painting technique, stroke, etc. Technological and stylistic characteristics of painting B give an impression that tracing/copying of the drawing from painting A could have taken place. This is also indicated by the fact that the drawing of painting B has been made on a transparent paper, its tone colors gradation is much poorer and the line has quite a uniform thickness.

Information obtained by means of the imaging techniques continued to point to a different way of the occurrence of these two paintings, but have also indicated the use of different pigments.

Very few pigments, such as: Zinc white, Cadmium yellow, Cadmium orange, Cadmium red and Madder Lake, have strong fluorescence [3]. The fluorescence of the yellow paint is very interesting: in some parts it fluoresces green and in some parts it fluoresces orange (figures 18 and 19). A similar case has been presented in an article which explains it as the degradation of Cadmium yellow pigment

[6], but in our case the XRF analysis has shown the presence of Selenium which indicates the possibility of the use of Cadmium orange (which also fluoresces orange) in the yellow paint. Cadmium-based pigments are highly absorbing for the X-Rays, which is also visible in the radiography images. Images in the NIR have shown strong fluorescence not only of the yellow, but of the most part of the green as well, hence it can be assumed that it has been mixed with the yellow pigment. Since some details from painting B fluoresce only in the IR region, it is possible that it is a cadmium pigment, because the fluorescence of cadmium pigments falls in the red and the infrared part of the electromagnetic spectrum [3], unlike the yellow brush which has been done in the Naples yellow and it doesn't fluoresce. The latter is also highly absorbing for the X-Rays, hence it is not possible to use radiography in order to distinguish those pigments.

Figure 18. Yellow painted detail, visible light

Figure 19. Yellow painted detail, UVF

These images have determined the spots in which to perform the spectroscopy and the XRF analysis: the yellow and the green painted areas.

The difference between the yellow pigments has been confirmed by the XRF analysis. The VIS-NIR spectra (figure 17) show good superposition with the spectra from the database [7], only that our spectrum of the spot on painting A is more shifted toward the red, which corresponds to the detected Selenium, typical for the Cadmium orange [8].

It has been confirmed by the XRF analysis that there is no Cadmium yellow in the non-fluorescing green paint. Comparison of its spectrum with the standard spectra of the green pigments [7] has led to the conclusion that the most probable pigment in the spot 3 of painting A is Phthalo green, keeping in mind that this technique shows a huge dependence of the support, which has also been shown in the IR image. Pigment Chrome green has been found in spot 3 of painting B, again by combining the data of the appropriate spectra and the XRF analysis. Its reflectivity in the NIR region is independent of the type of support [8]. X-Radiography supports this by showing higher X-ray absorption in the area of spot 3 in painting A, which is explained by the higher atomic mass of Copper versus Cadmium.

4. Conclusion

Applied techniques and examinations have shown some differences in the used pigments as well as in the production process of these paintings such as: different preparation of support, different preparatory drawing, change in position.

Two pigments that have most probably been used are Cadmium yellow and Cadmium orange (red), which produced different effects in UVF image, although it may also be due to the degradation of Cadmium yellow. This certainly requires further examination, for example the application of FTIR. The same Cadmium pigments have been used on painting B, except on the brush, which was clearly visible on the IR recording. The XRF analysis has confirmed it is Naples yellow, its spectrum matches the one recorded in that spot.

Green pigments are completely different on both paintings: Phthalo green has been used in painting A, while Chrome green has been used in painting B. This was clearly indicated by the recorded spectra and the IR images, which confirmed the transparency of these pigments in the IR region [9]; the final identification was made by XRF.

The information that can be obtained with imaging techniques overcome their usual purpose, however more research is necessary in order to precisely determine them, but even then a multitechnical approach in diagnostic research should be preferred, because each technique has its own limitations due to a high number of influencing variables.

In the light of a newly discovered self-portrait by Igor Vasiljev from the same year, but different month (November), the research will be expanded in order to make further technological and stylistic comparisons.

Acknowledgments

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