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Processing the Images Obtained by a Laser Scan of the Tomb of Tutankhamun

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Abstract

The possibility of secret chambers in the tomb of Tutankhamun, one of which could be the burial chamber of Nefertiti, was proposed in 2015 by Nicholas Reeves. He published a work in which he used images from high definition laser scans of the walls of the tomb, given by the site of Factum Arte. Reeves argued that in these images it is possible to see the “ghosts” of two hitherto unrecognized doorways. In fact, he is giving in his article - The Burial of Nefertiti? Amarna Royal Tombs Project Occasional Paper N1 - some processed images without discussing the method for processing them. Here, we use the images of the West- and North walls from Factum Arte and apply GIMP and ImageJ for processing them, to see if we obtain the same results given by Reeves.

Keywords: Ancient Egypt, Image processing

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Processing the Images Obtained by a Laser Scan of the Tomb of Tutankhamun

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Abstract: The possibility of secret chambers in the tomb of Tutankhamun, one of which could be the burial chamber of Nefertiti, was proposed in 2015 by Nicholas Reeves. He published a work in which he used images from high definition laser scans of the walls of the tomb, given by the site www.highres.factum-arte.org/Tutankhamun/ of Factum Arte. Reeves argued that in these images it is possible to see the “ghosts” of two hitherto unrecognized doorways. In fact, he is giving in his article - The Burial of Nefertiti? Amarna Royal Tombs Project Occasional Paper N1 - some processed images without discussing the method for processing them. Here, we use the images of the West- and North walls from Factum Arte and apply GIMP and ImageJ for processing them, to see if we obtain the same results given by Reeves.

Keywords: Image processing, GIMP, ImageJ.

Queen Nefertiti was the wife of Akhenaten and step mother to Tutankhamun. It was proposed recently that she could have been buried in a secret chamber in Tutankhamun's tomb KV 62 in the Valley of the Kings.

The possibility of secret chambers in KV 62 was proposed in 2015, when Nicholas Reeves published a work where he discussed the data obtained from high definition laser scan and photography of the walls of the tomb. He hypothesized that hidden chambers could exist behind the West and North walls of the tomb. Moreover, in the same work [1], Reeves proposed that one of these chambers could be the burial place of Nefertiti. Of course this hypothesis arose the interest of news media and also of the Egyptian government.

Egypt invited Hirokatsu Watanabe, a Japanese expert of Ground Penetrating Radar [GPR], for a survey of the tomb, in order to determine the presence of any void behind its walls. The survey was made in November 2015. National Geographic was co-funding this work. According to Watanabe, a hidden chamber existed in the tomb. A second survey, also commissioned by National Geographic, was carried out by Eric Berkenpas and Alan Turchik [2,3]. On this second survey, a Non-Disclosure Agreement exists and only the Egyptian Ministry of Antiquities can give information about the results. A third survey is currently run by a team of the Politecnico di Torino, of which Luigi Sambuelli is the expert of GRP surveying [4,5].

How were the images that stimulated these researches? We can see them and their discussion in the paper of Reeves, but also directly at the site <https://www.highres.factum-arte.org/Tutankhamun/>, by Factum Arte . As we read at the site <http://www.factum-arte.com>, Factum Arte is based in Madrid and Milano and is dedicated to "digital mediation, transformation and the production of works that redefine the relationship between two and three dimensions".

A team of artists, conservators and technicians are working together for the development and application of new technologies in several projects: one of them is that of the Facsimile of Tutankhamun's tomb (<http://www.factumfoundation.org/pag/207/Recording-the-Tomb>). For this project, new 3D scanning systems have been developed, having a resolution of 100 microns. According to Factum Arte, at “this resolution it is possible to study and understand the complexity of the surface and to monitor its decay”. The scan is precious for Egyptologists because they can have a “desk-based access to the smallest iconographic detail and brushstroke of KV62 scenes” [1]. For the conservators, it is fundamentals because it is showing “every crack, blemish and technical feature”. Moreover, it allows to see the architecture beneath the painting [1].

As told in the abstract of Reeves’ work [1], the scan of the tomb reveals, “beneath the plastered surfaces of the painted scenes, distinct linear traces”; some of them could be identified as the “ghosts” of two hitherto unrecognized doorways. Therefore, in analyzing the West- and North-wall surface scans, the Egyptologist found interesting features that allowed the suggestion of the existence of hidden chambers. In fact, Reeves is

proposing the “ghosts” of the doorways in the Figures 7, 15 and 16 of his paper [1]. It seems that these images have been processed in some manner; however, the processing method is not detailed in [1].

Let us try to understand this aspect of the research. Let us start from the surface scan of the West wall, selecting it from the corresponding panel of the web site (Figure 1). In the Figure 2 we can see it on the left. Note the niche in the wall for the amulets. On the right, the same image is given with brightness and contrast enhanced using GIMP (GNU Image Manipulation Program). From this result, it is my opinion that the images proposed in [1], had been processed to enhance contrast and brightness.

The Figure 3 shows the same original image of the Figure 2, filtered by means of the Retinex tool of GIMP (High Level, Scale 240/7, Dynamic 1,5). The right panel shows the same filter applied to the original image, with inverted grey tones (for the Retinex filter of GIMP, see please the GIMP tutorial, and for some applications to microscopy the reference [6]). In the Figure 4, we are showing also an image with the enhanced contrast, obtained by means of ImageJ, and an image obtained applying the FFT Bandpass filter of the same software.

We can repeat the processing for the surface of the North wall, with corresponding results (see an example in the Figures 5 and 6). Here we avoid the discussion of a possible presence of doorways; the reader can find it in the Reference [1]. In fact, the images here proposed are like those we can see in [1].

I prefer to show another fact, linked to the drawing of the figures of the frescoes. Before painting them, the artist sketched the figures and the sketch made some grooves on the plastered surface. We can see them in the image at <https://www.highres.factum-arte.org/Tutankhamun/>. Here, in the Figure 7 (upper panel), the grooves are not visible; however, we can use an ImageJ filter, the Mexican Hat, and highlight them, as in the lower panel of the same Figure. In conclusion, the images given by Factum Arte are an outstanding source of information, that can stimulate further processing of them and desk-based analyses of the techniques used by the Egyptian artists.

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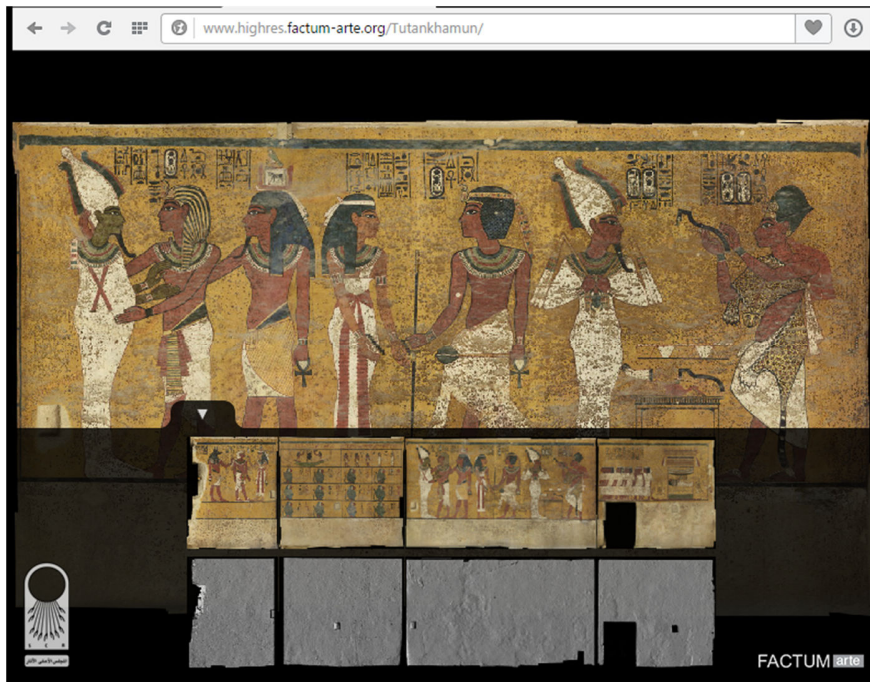


Figure 1: Snapshot of the site <https://www.highres.factum-arte.org/Tutankhamun/> (Courtesy: Factum Arte and Ministry of State for Antiquities and Heritage, Egypt). The lower panels are interactive. Selecting one of them, it is possible to move on the high-resolution colored images and on the grey-tone maps of the laser scan.

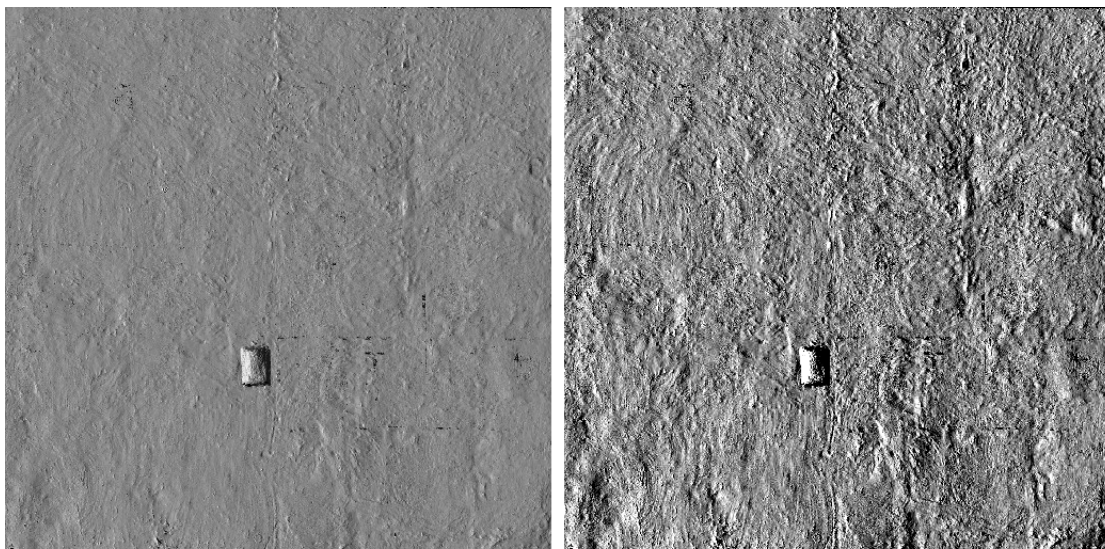


Figure 2: The surface scan on the West wall on the left (Courtesy: Factum Arte and Ministry of State for Antiquities and Heritage, Egypt). Note the niche for amulets. On the right, the same image with brightness and contrast enhanced by means of GIMP.

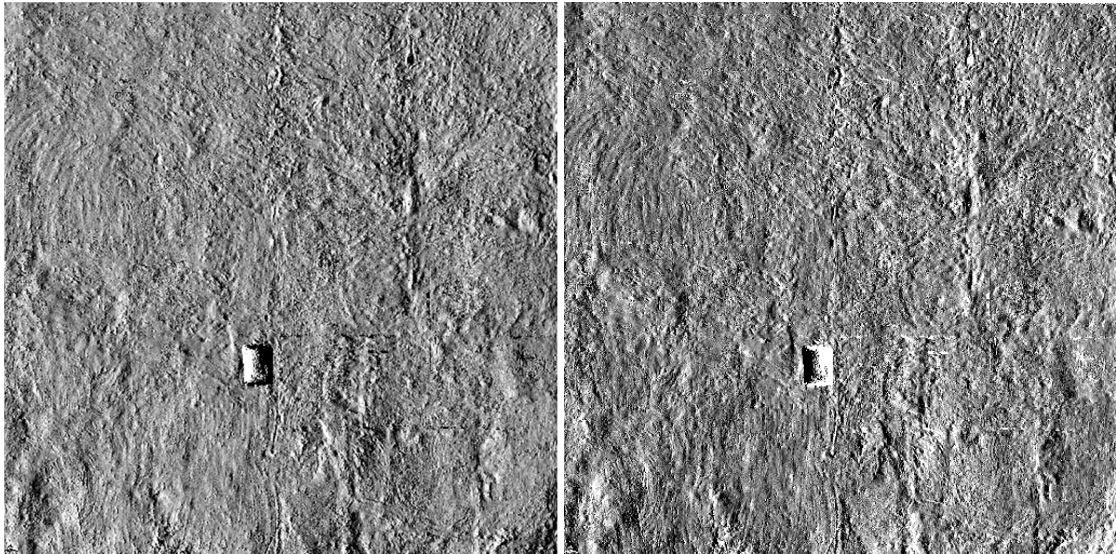


Figure 3: The left panel is showing the same original image of the Figure 2, filtered by means of the Retinex tool of GIMP (High Level, Scale 240/7, Dynamic 1,5). The right panel shows the same filter applied to the original image with inverted grey tones.

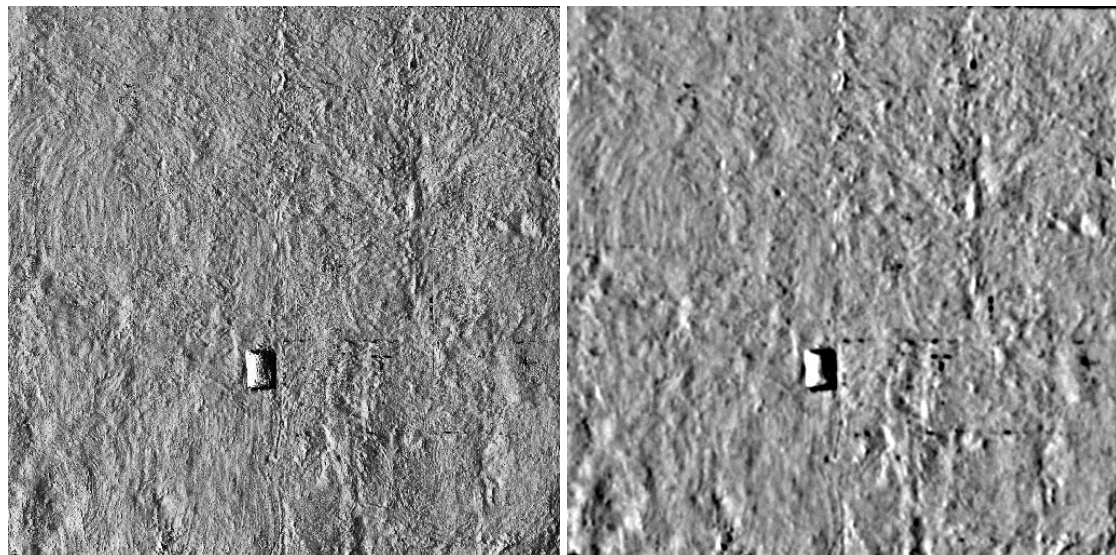


Figure 4: On the left, the image with enhanced contrast obtained by means of ImageJ (50%, equalized histogram). On the right, the effect of the FFT Bandpass filter of the same software.



Figure 5: The surface scan on the North wall (Courtesy: Factum Arte and Ministry of State for Antiquities and Heritage, Egypt).



Figure 6: The image of Figure 5 filtered by means of the Retinex tool of GIMP (High Level, Scale 240/6, Dynamic 1,3).

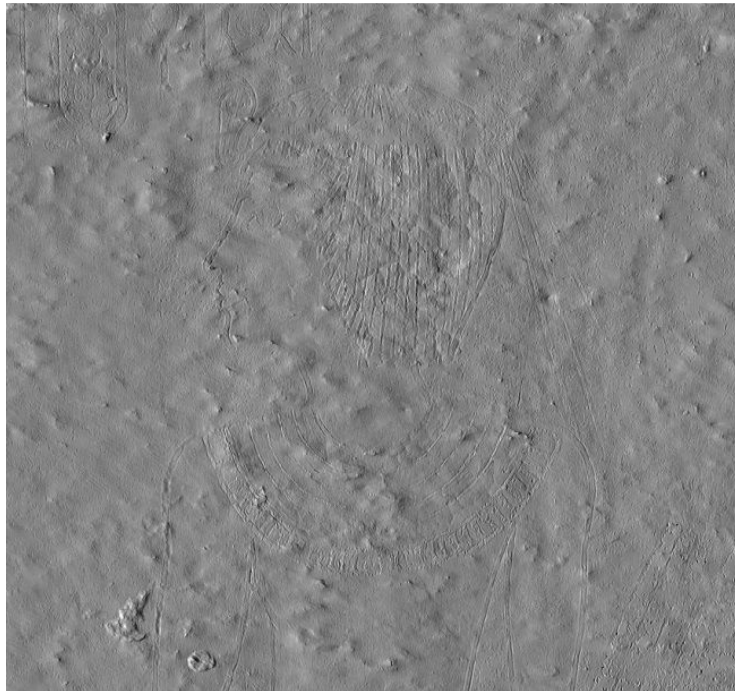


Figure 7: A detail of the laser scan on the North wall (upper panel) (Courtesy: Factum Arte and Ministry of State for Antiquities and Heritage, Egypt). To see the lines of the drawing, we can use the Mexican Hat filter of ImageJ (lower panel).