3D properties of the Shroud revised

Version 1.0

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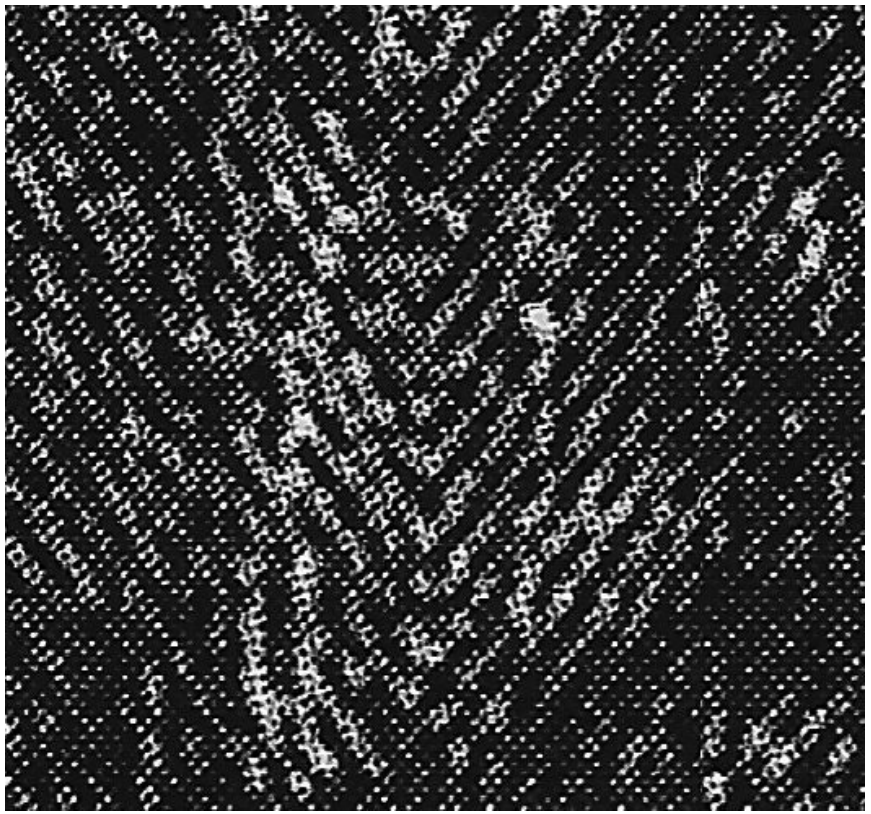
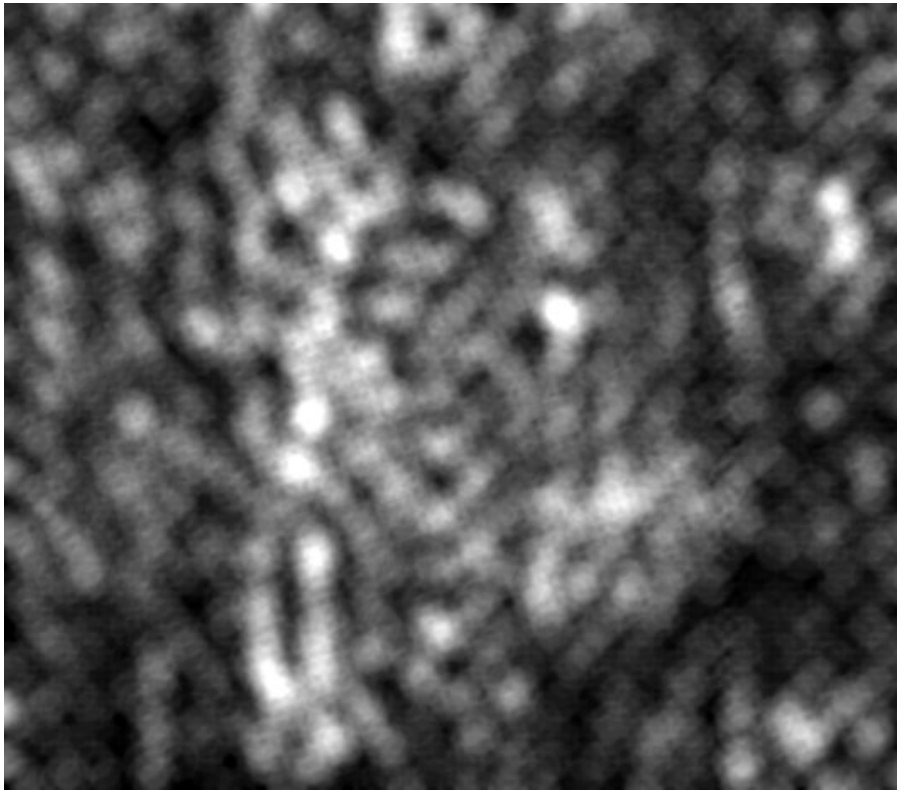
Part 2

So is there (and where) the 3D information on the Shroud?

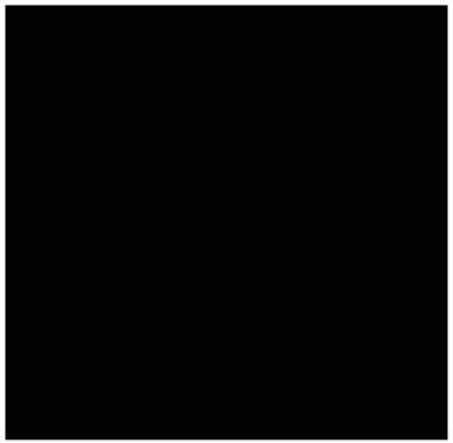
As we have seen in previous section: **yes**. The question where is also easy to answer: in the size and spatial distribution of image dots. The areas which have more and larger dots, are brighter averaged. Like statistical data, we must put them simply in appropriate size bins, not too large (or resolution will be too low) , and not to small (or we don't see continuous image). This is halftone effect.
Below right eye(lepton) area without smoothing (left) and averaged within the range of 12 pixels (right):





The mono-intensity images (like engravings) may produce apparent 3D images after much gaussian blur -but only due to their edges being smoothen, thus providing apparent gradation in tones.

Below on the left B&W square, on the right the same square but after applying 20-pixels gaussian blur. The only 3D information is due to the blur.



Contrary to that, the Shroud seems to carry inherent 3D information encoded somehow in its halftone image.

As we have seen, halftone printing was invented in the latter half of the 19th century...

And as we see: the Shroud image has no sharp edges -it is smooth (Process>Find Edges in ImageJ menu)

Correlation vs causation

This is extremely important part for determination of image formation mechanism!!!

Because it differentiate between deterministic formatin process (aside systematic effects, image intensity strictly depends **only** on the body-cloth distance), and probabilistic or stochastic formation procesess (image intensity, although correlated with body-cloth distance, depends on some random factors, and random deviations from the relation are expected).

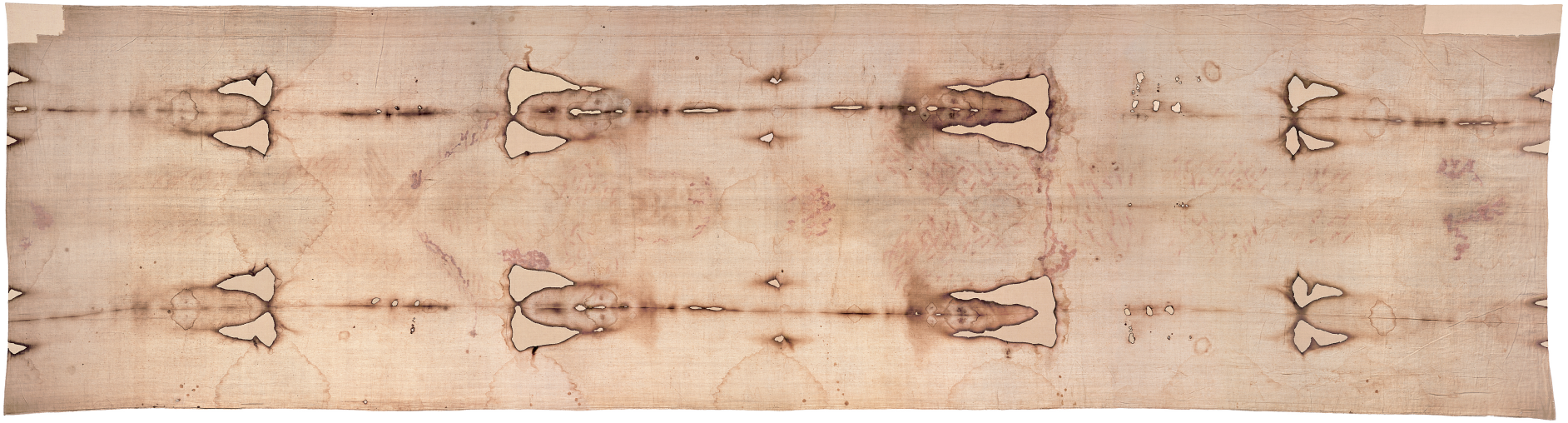
Thus the main question is: **are there any random, non-systematic deviations from the correlation formula?**

In the case of Hubble law, the reason for correlation was quickly identified: expansion of the Universe, according to the FLRW solution. But still some deviations, due to peculiar velocities differing from the general Hubble flow have been observed, and they were expected.

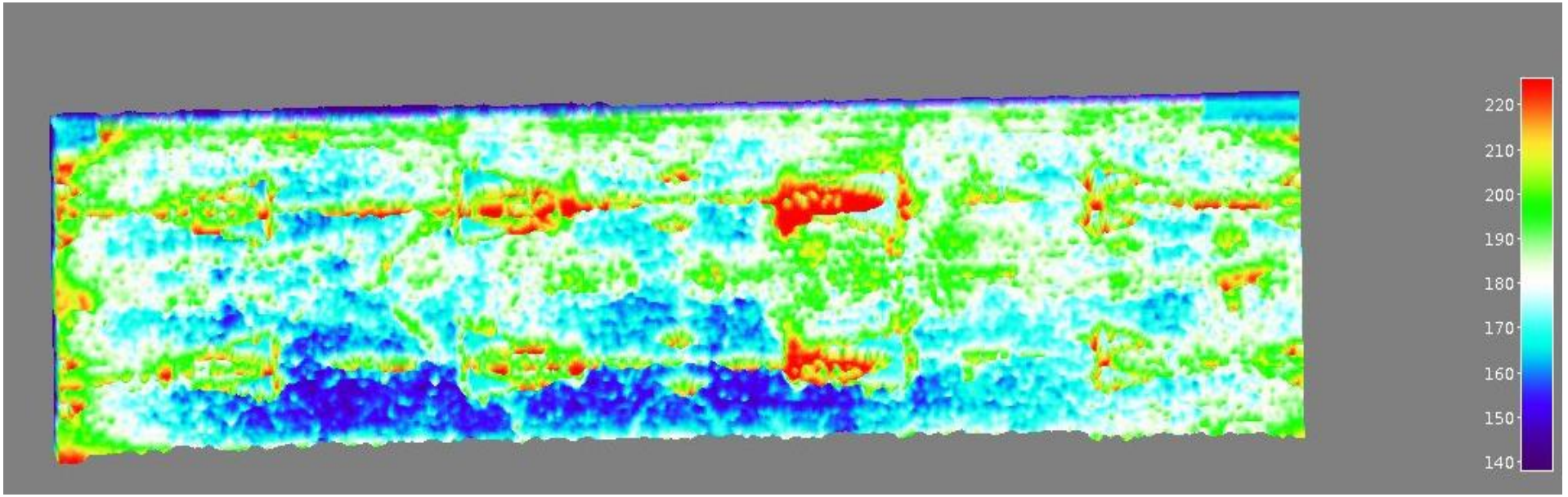
Systematic effects: the lighting parameters:

So far, by term intensity we considered only intrinsic intensity of the image. But the real life is not ideal, and in fact intensity of the each part of the image on the photo depends also on technique and conditions during taking that photo -particularly, lighting conditions, as the amount of reflected light depends primarly on the amount of light to which each point is exposed.

For example: Durante 2002 photographs. Excellent for viewing the Shroud in natural color:



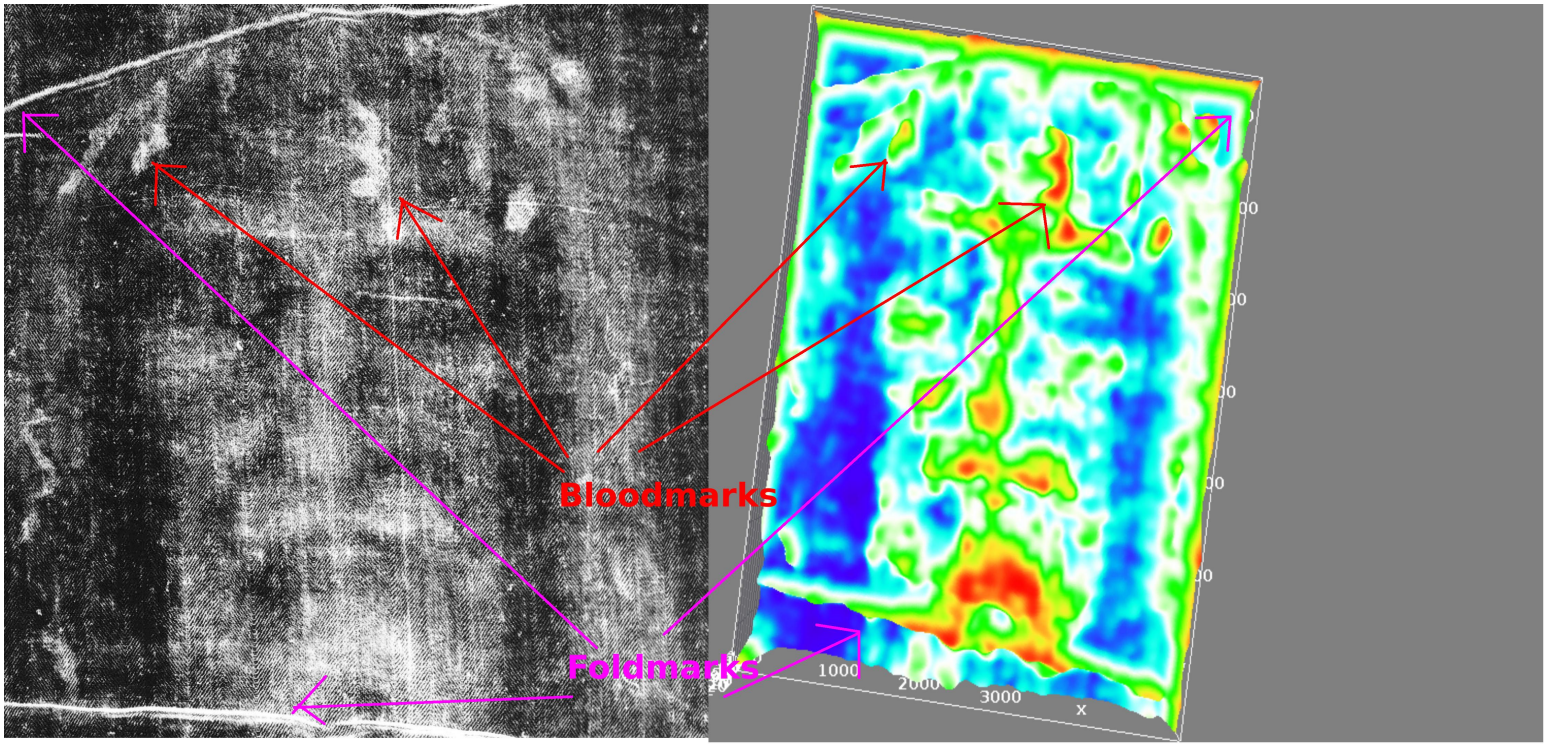
But complete failure with regards to analysis of the 3D properties of the Shroud:



As we can see, the upper part of the image is overexposed to light, compared with lower part -thus providing systematic bias in the intensity of the body image.

There is no such disadvantage (at least to that extent) in case of Enrie photographs.

Systematic effects: bloodmarks, foldmarks, watermarks, dirt etc.



Those are obviously present, and overlay the body image -and they are more intense (hence higher on 3D plots) than it. On B&W photographs they are indistinguishable from body image. You can get rid of them, at least in a very rough way, but this will be shown later.

There are also other systematic effects due to bandings and perhaps some secondary objects, but they will be adressed in later sections.

Overview

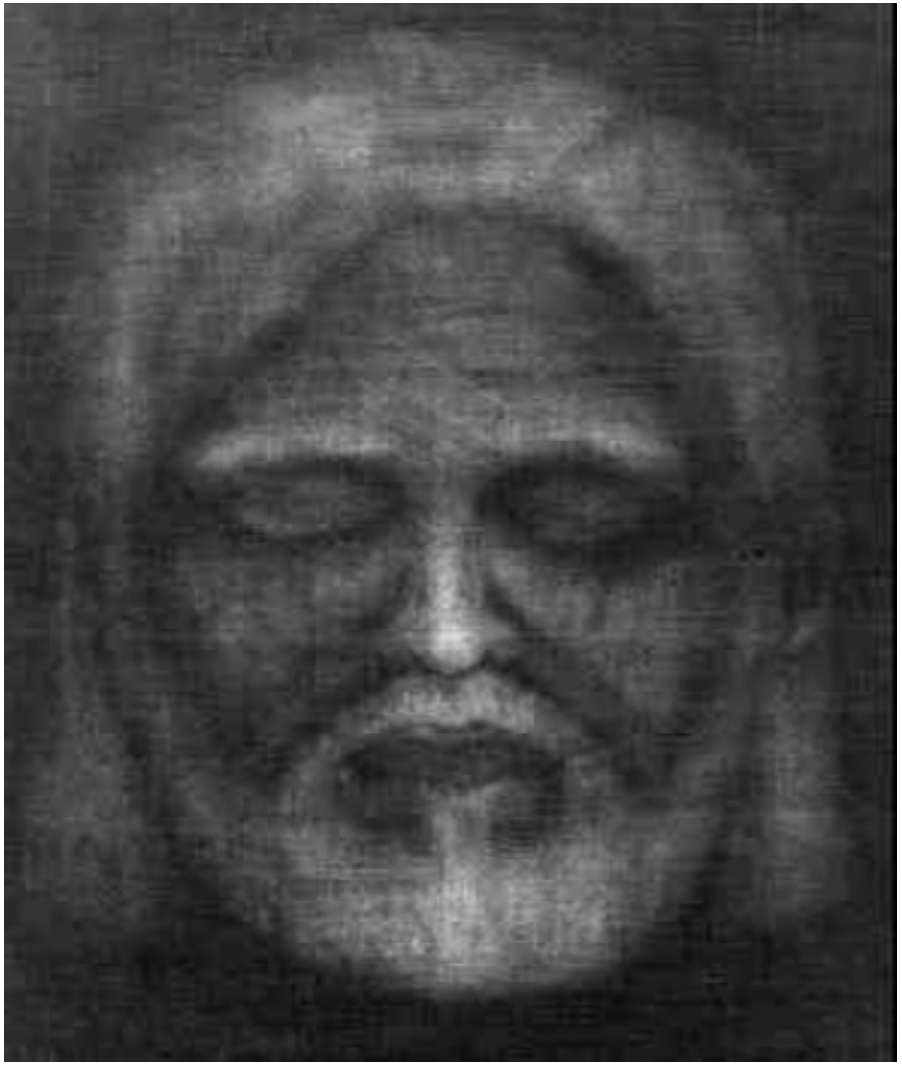
- There is intrinsic 3D information on the Shroud encoded in distribution of image „dots” creating halftone effect.
- There are many systematic effects, like lighting conditions during taking the photo, dirt, bloodmarks, foldmarks etc. superimposed on the body image on B&W photographs etc. One needs to be extremely careful when interpreting the 3D plots.
- There is a very important problem of „correlation vs causation” in the case of 3D plots of the Shroud. The question is whether relation between image average intensity and body-cloth distance is strictly adhered by image formation process, or whether there are random deviations from it. **This is crucial for determining the image formation process.**

The limits of correlation approach

As we discussed in previous sections, Vignon in 1902 observed that those parts of the body which should be further from the cloth are dimmer on negative photographs. 80 years later Jackson & Jumper determined the correlation. But this does not mean that such correlation is unique to the Shroud. The problem of 3D on the Shroud is much more complex than single statistical parameter.

In 1994 Craig & Bresee presented a paper (Journal of Imaging Science and Technology, Volume 38, No. 1, p.59-67.) on their dust drawing technique. This technique is unable to reproduce all the characteristics of the Shroud image for several reasons (e.g. lack of pigments), but here we are interested only in 3D properties.

Craig & Bresee positive and negative images



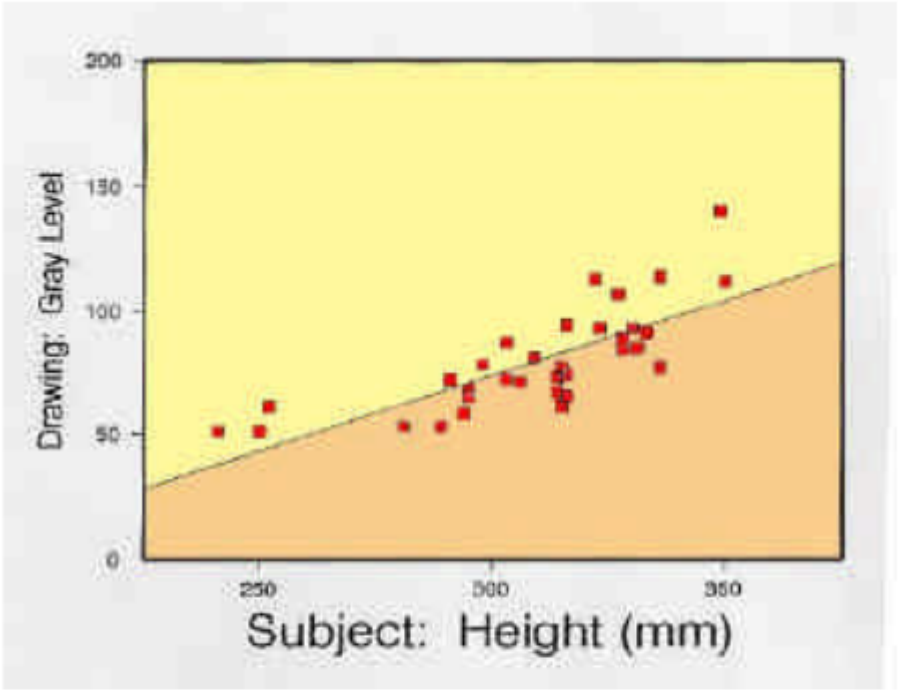


FIGURE 6 (b)
Feature gray level (in the image) versus height (on manikin) from the dust drawing using iron oxide/collagen.

present.

We then plotted these data of transmittance and cloth-body distance and determined a linear regression line shown in (Figure 2). As a measure of the degree of correlation we calculated the coefficient of determination, r^2, (correlation coefficient squared) given by (Ref. 10)

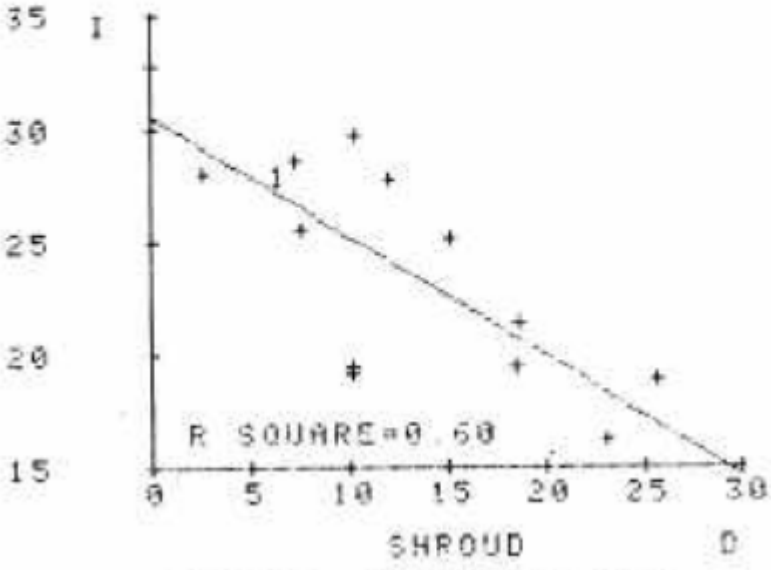
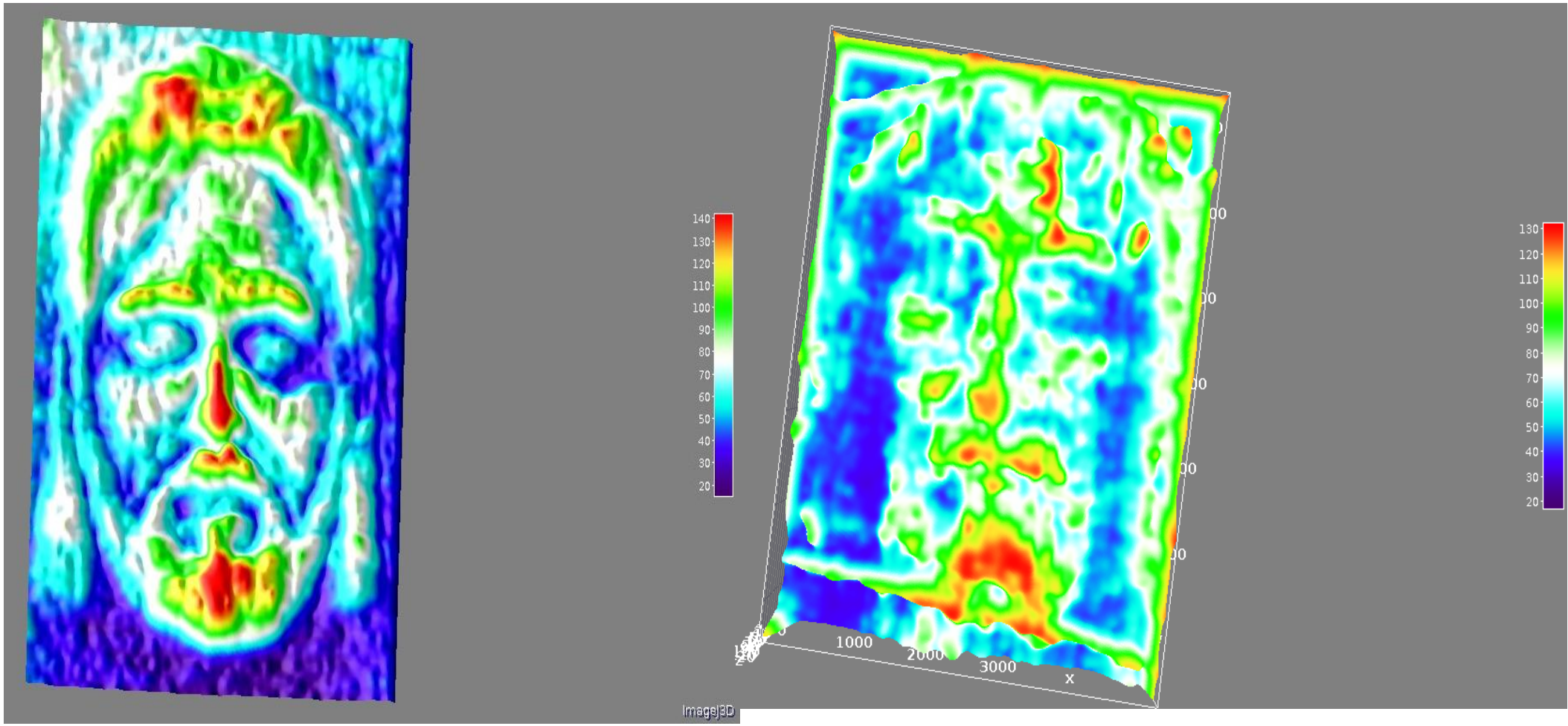


Figure 2. Shroud Correlation

Craig & Bresee did the same what Jackson & Jumper, and calculated correlation coefficient. Their result: R^2=0.59 was almost the same as Jackson & Jumper (R^2=0.60) as to the value, or even stronger due to the use of greater sample (33 points instead of 13).

This important lesson teaches us that in fact 3D effect does not limit itself to the presence of statistical correlation.

Craig & Bresee vs Shroud face 3D plots

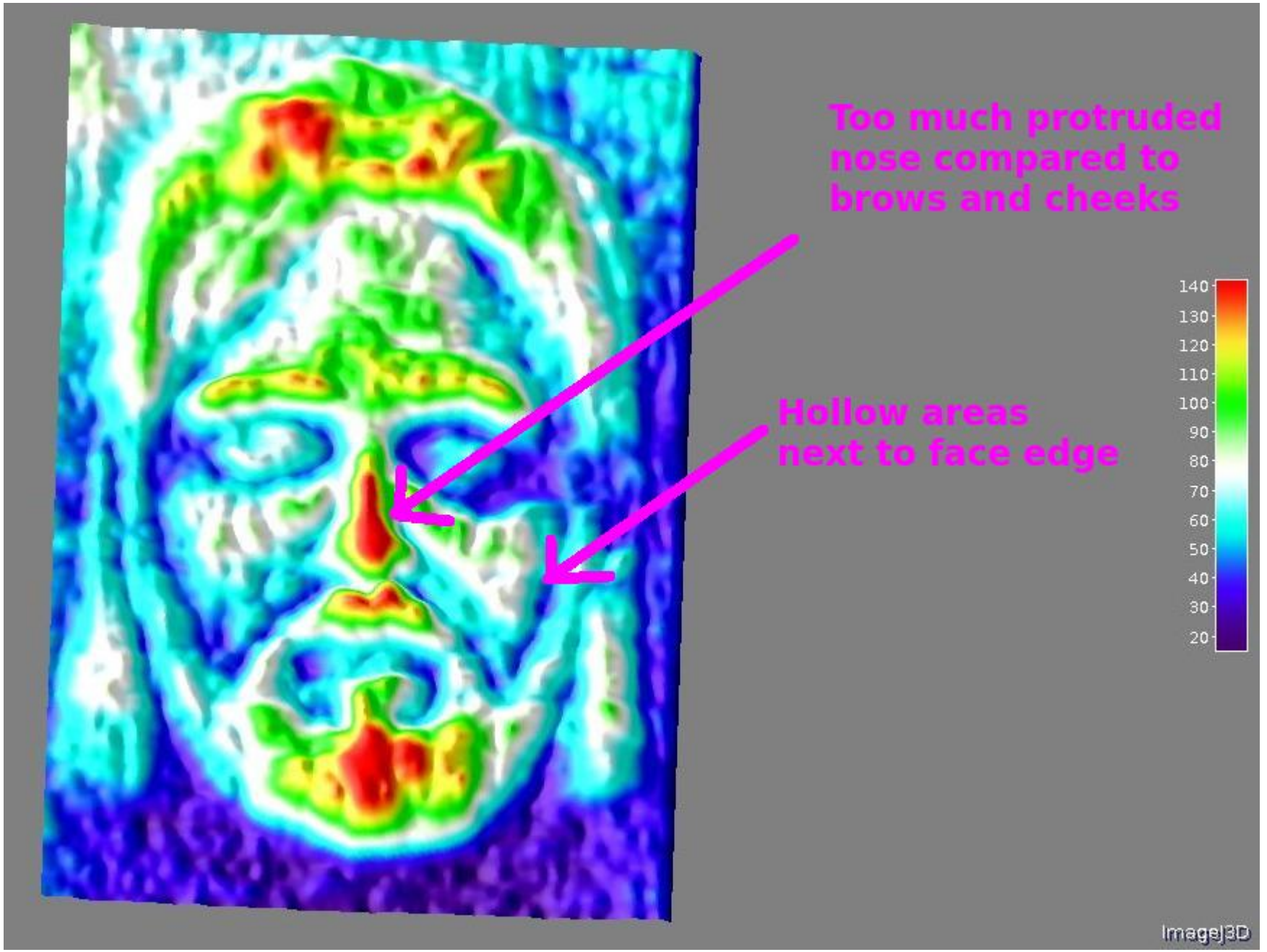


As correlation coefficient cannot discriminate between true or imitated body-cloth distance in this case, other approach is needed. Essentially an approach taken by Vignon -visual examination of all the body points and the estimation of their distance from the draping cloth vs distance. An examination that needs some experience and mainly the knowledge of the human body profile -which we all know from everyday life.

There are several features on the Craig & Bresee 3D plot that do not fit, and expose it as a work of human artist, instead of real body/face image. I will call them **fatal errors**. Contrary, the Shroud image is extremely realistic (in fact it should not have been with regards to the face, but I will explain later). No attempt of Shroud reproduction I know, was ever able to produce a convincing face that would fool a kid as a real human face.

In fact, as we will see later, the Shroud face contain several „fatal errors" which expose it as a work of an Artist -but unlikely human artist as we will learn **what** they are result of, and how they should be interpreted.

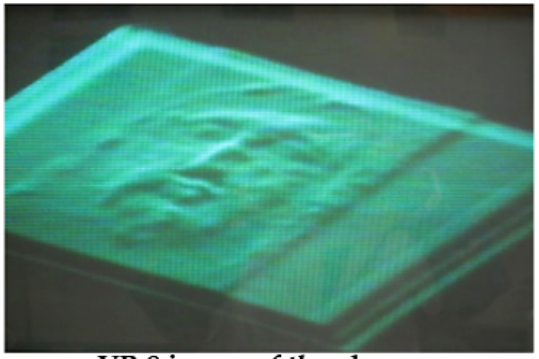
Some fatal errors of Craig & Bresee



Is it possible to paint, draw, or make photograph of a true 3D image?

Artist's "shade equals height" sketch

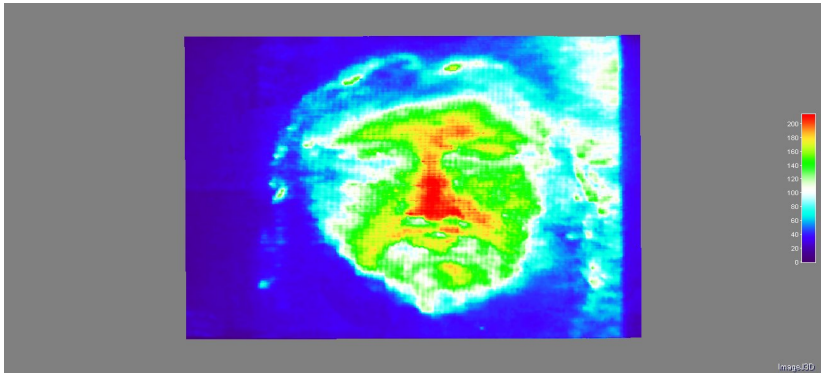
Negative of the above



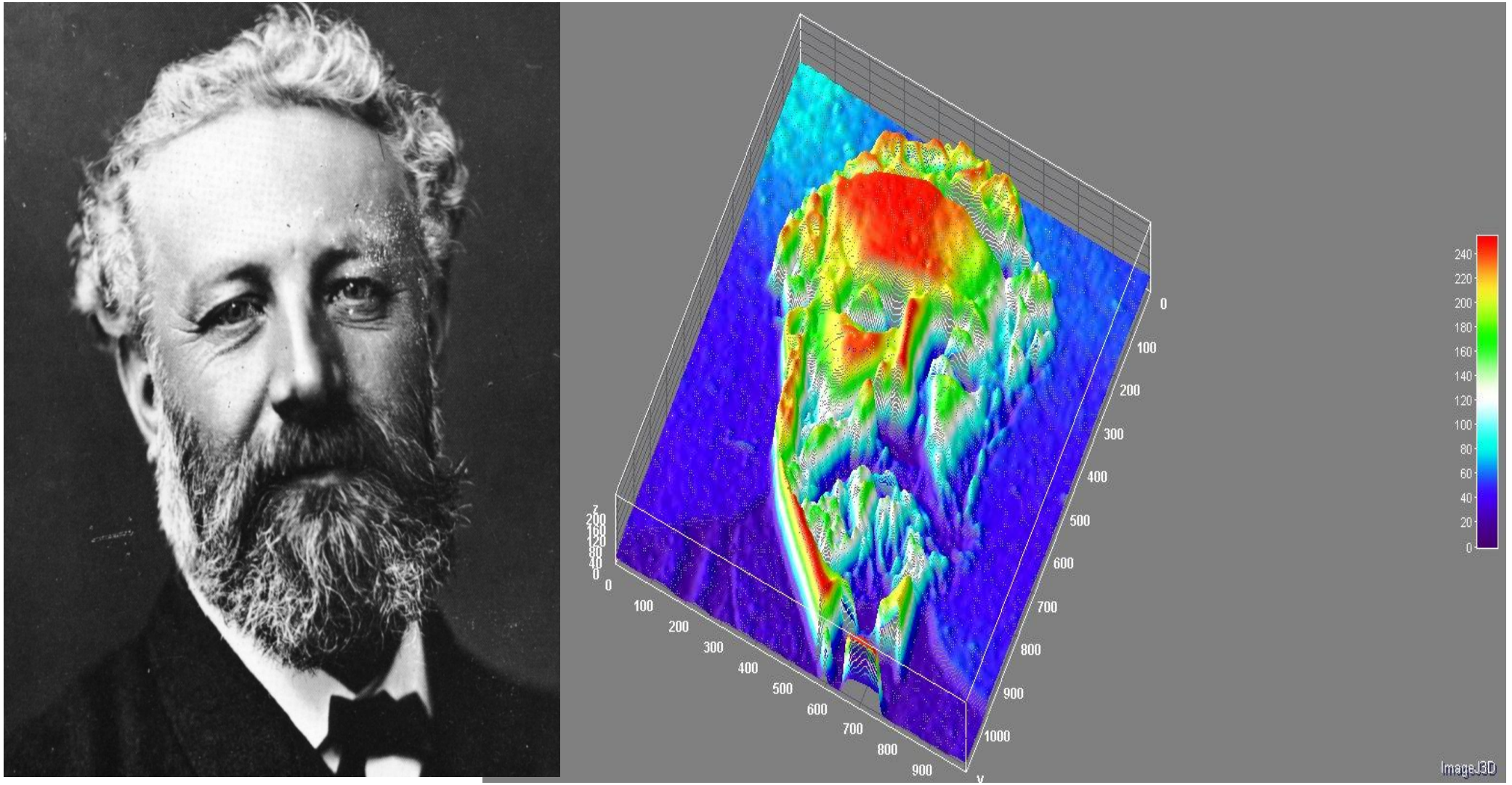
VP-8 image of the above

In theory: yes. All you have to do is to adjust the intensity of your image with regards to the expected body-cloth distance. Easy said, much harder done. Jackson & Jumper approached two professional criminal artists and asked them to draw the facial image similar to the Shroud, with all the contrast etc. limitations. The results were failure. When restrictions were removed, the results improved, but were barely satisfactory only when artists were actually copying negative photograph of the Shroud.
But even than the „fatal errors" seem unavoidable.

And making a 3D **halftone encoded** image seems **much, much, much harder**.



As to the photographs, their intensity depends not on the body-cloth distance , but on the relative **reflection coefficient** -and are very susceptible to lighting conditions. Add to this very likely presence of shadows and specular reflection, and you have a mess in 3D plots.



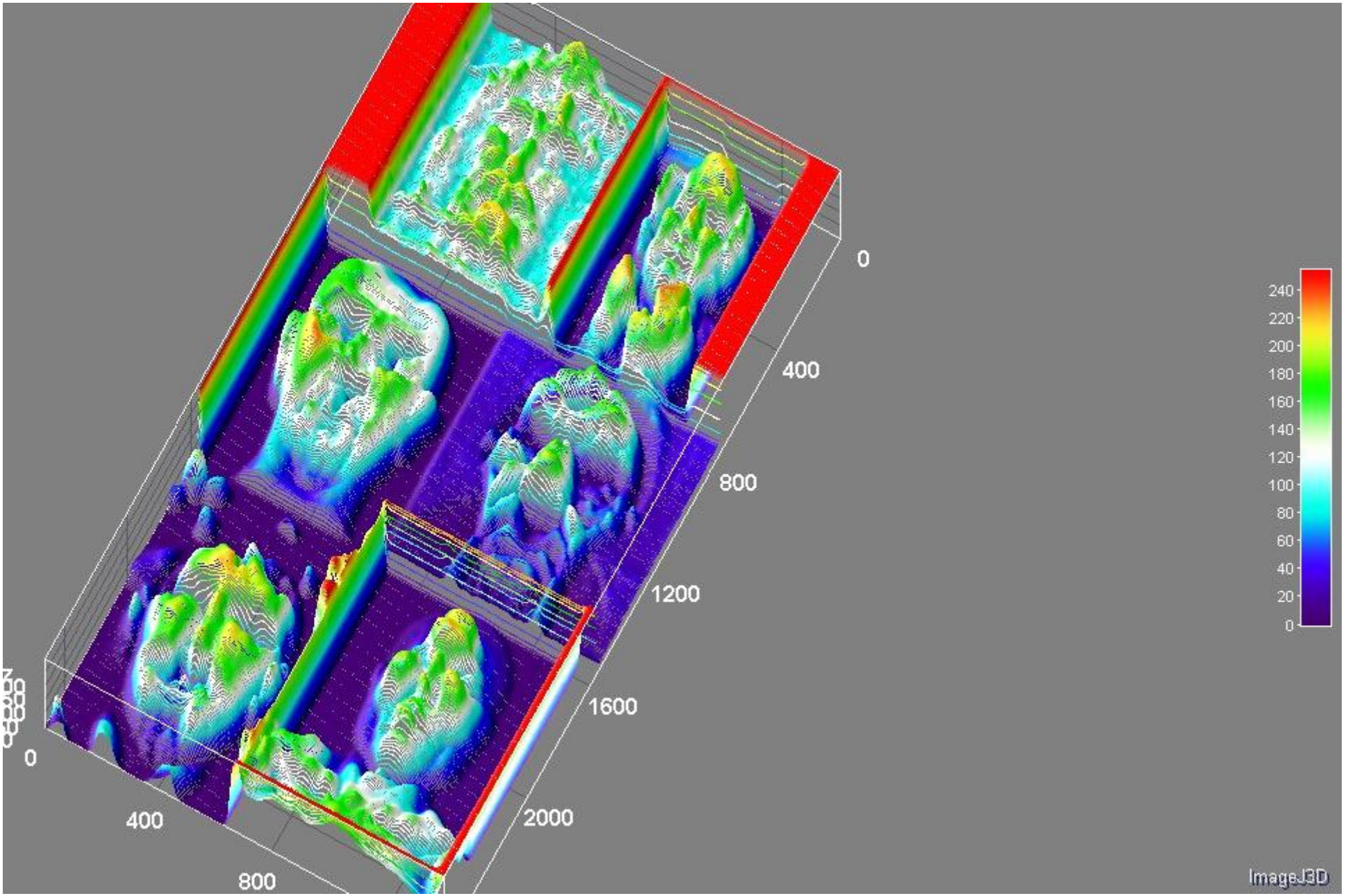
It is still possible in theory to obtain 3D photographic images -VP-8 was designed to process photographs -but in very specific conditions.

One of the necessary conditions to obtain relatively good 3D out of the ordinary photograph is face-on lighting , reducing the amount of shadowing.

Here is the collage prepared one time by Hugh Farey.

←

And here are the results. Only Shroud face looks convincing



To obtain good 3D information out of ordinary photograph, you must somehow disperse, or attenuate light reflected (or emitted) out of it.

Jackson and Jumper managed to do so, by coating model head with phosphorescent paint, and submerging it in attenuating liquid.

On the right you have the ordinary, albedo photograph of the model face, and attenuation photograph ->

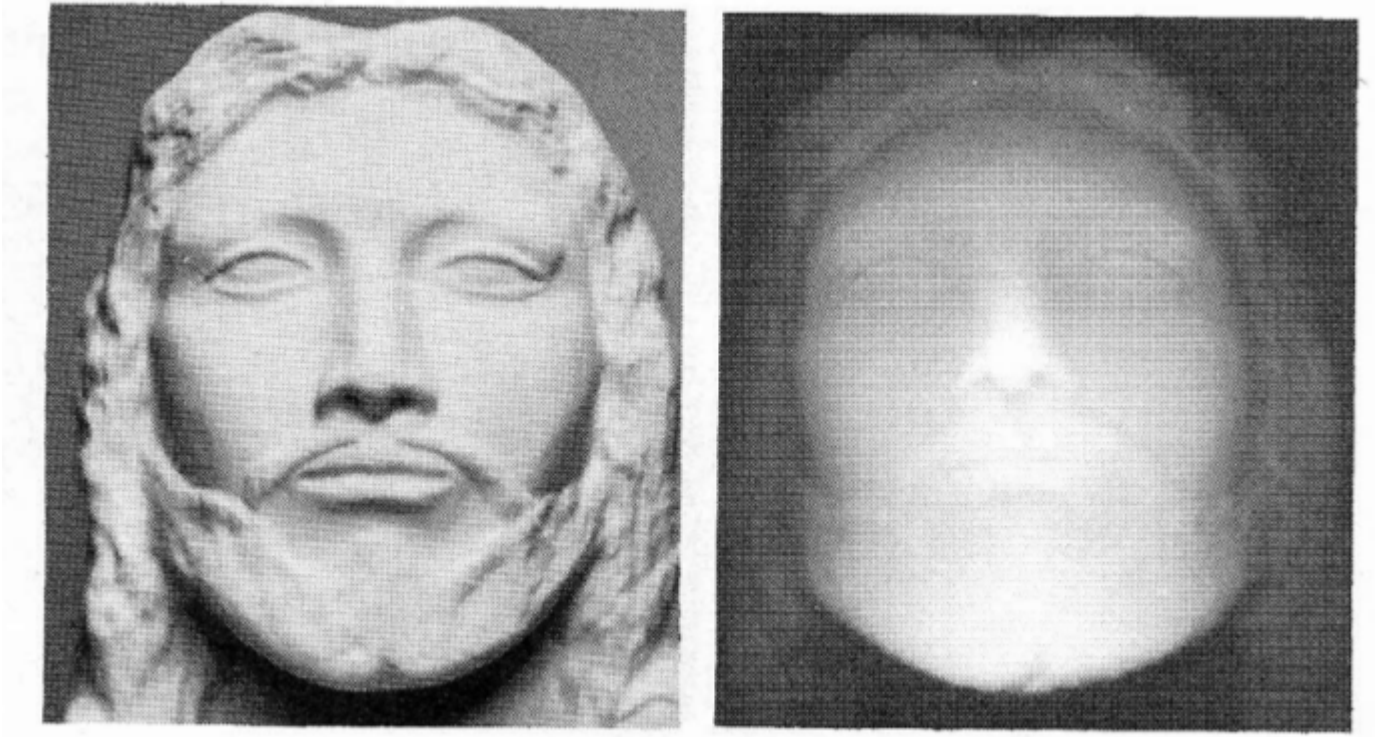


Figure 3. A. Albedo Face. B. Attenuation Distance Face.

Here are the results. Ordinary photograph has a very poor correlation -while attenuation photograph has a perfect correlation.

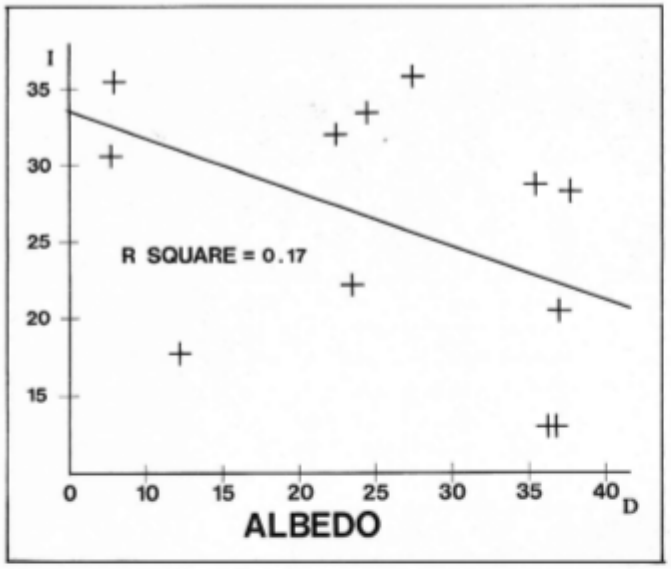
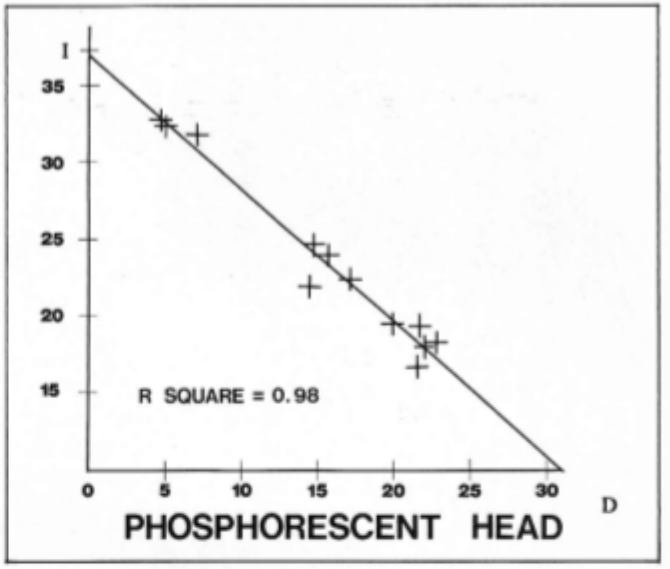


Figure 4. A. Albedo Correlation.



B. Attenuation—Distance Correlation.

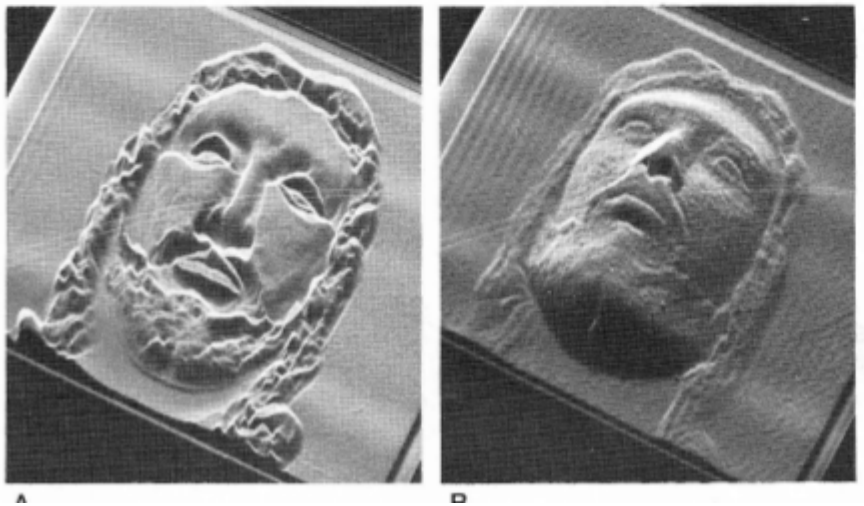


Figure 5.
A. Albedo VP-8.
B. Attenuation—Distance VP-8.
C. Plaster Profile.
D–E. Intensity Profile of B at Varying Reliefs.

So to obtain a good 3D image of the body image on the Shroud, you should provide good attenuation and/or dispersion on the way from all body/model points to the cloth. You can put your uniformly colored model in a glass or plastic bottle, filled with attenuating liquid of roughly this shape:

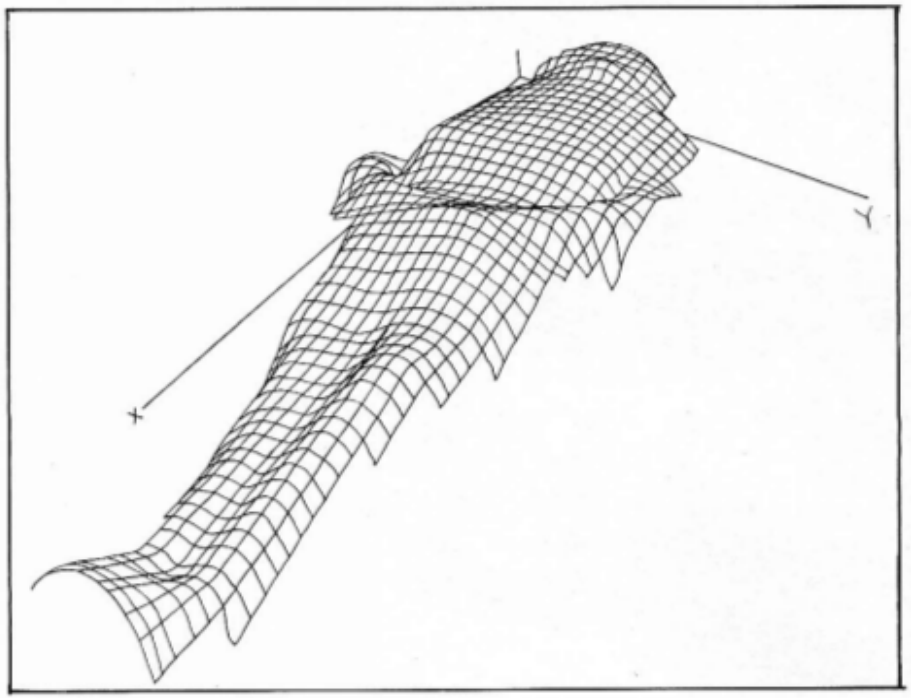


Figure 9. Deformed VP-8 Reference Shroud.

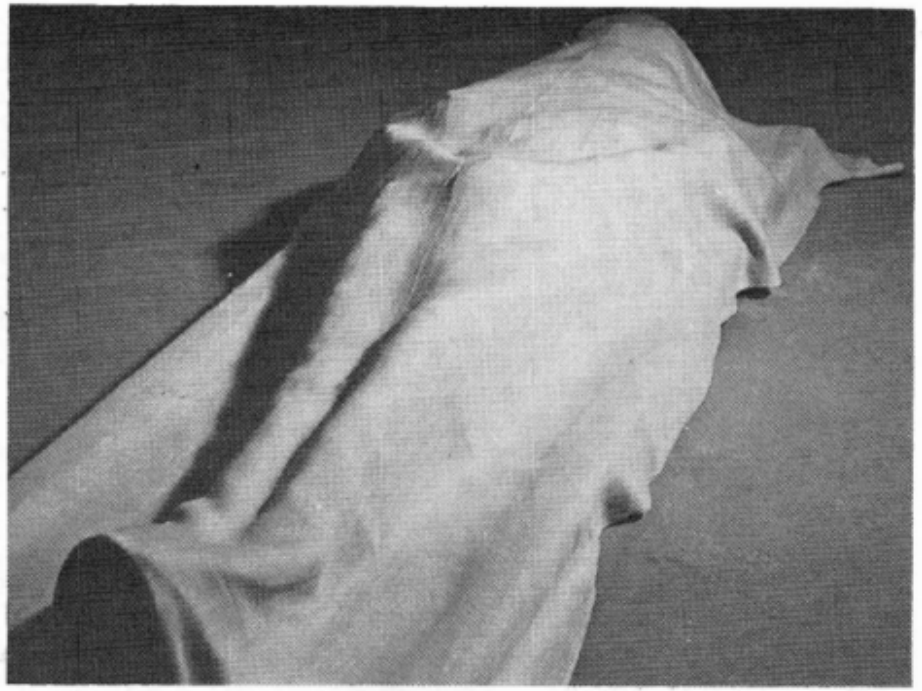
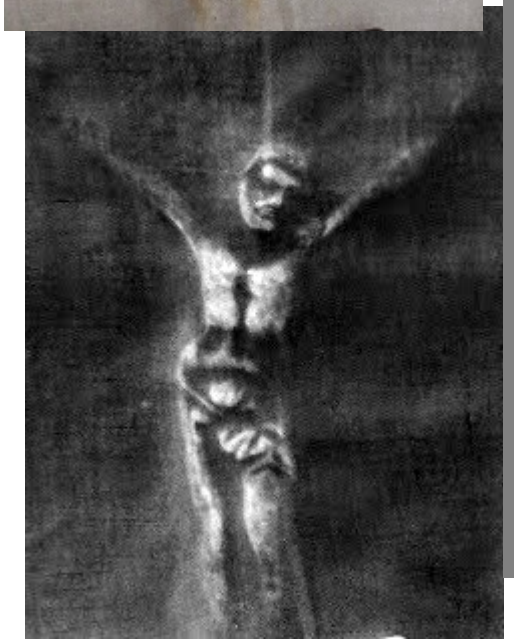
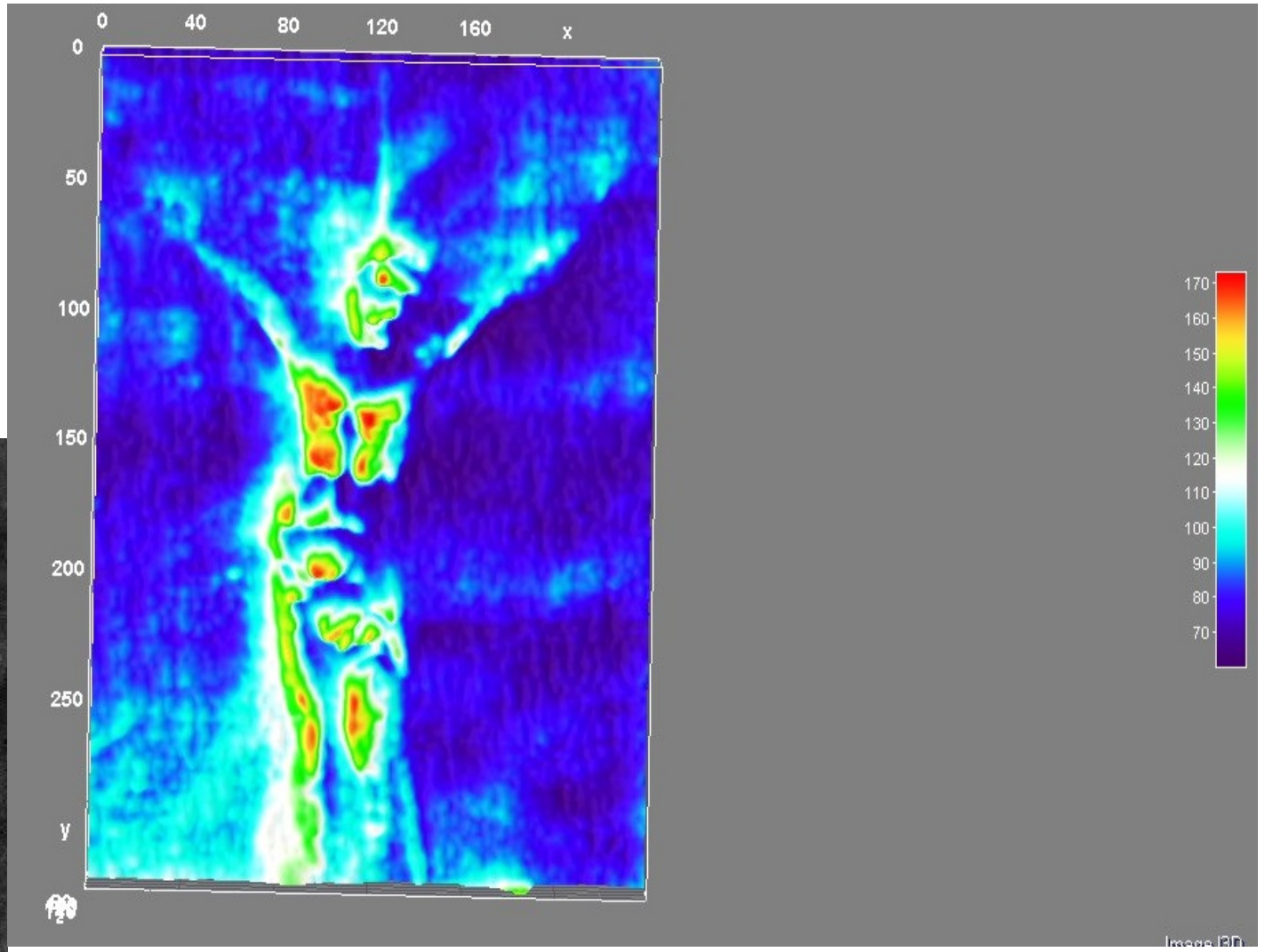


Figure 10. Line Cloth Draping Over Derived Image.

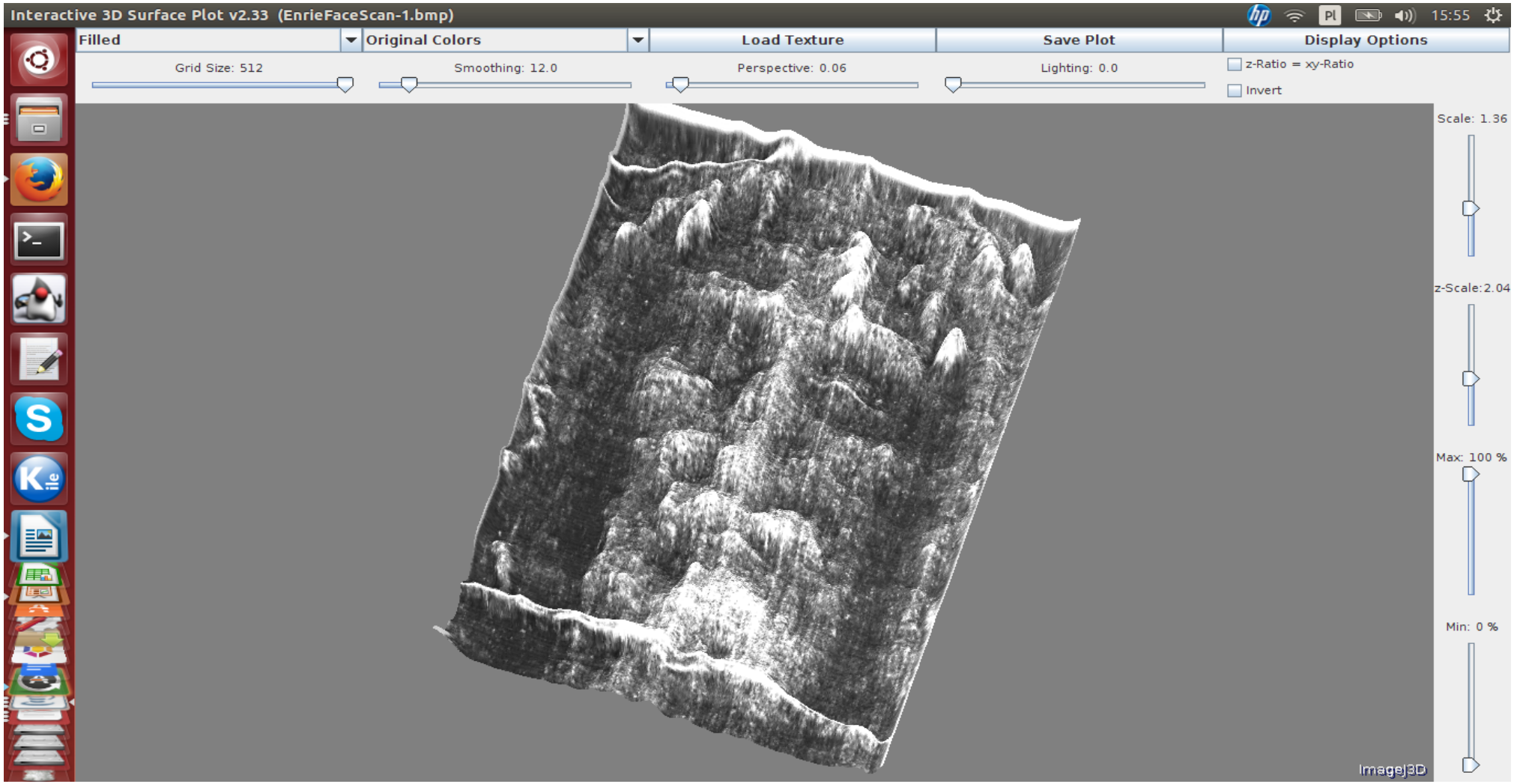
And even then, after taking a photo, you will not achieve **halftone** -it is a completely different technique. You need stochastic attenuation -that means modulating the chance that the light ray (or gas particle in case of diffusion mechanism) will hit the appropriate thread and **activate** its fibers.

There were many attempts to reproduce the Shroud image. Although many of them produce **apparent 3D**, all of them (except attenuation photography described before) suffer from „fatal errors” exposing their inability to accurately reflect (or mimic) the shape of the body.



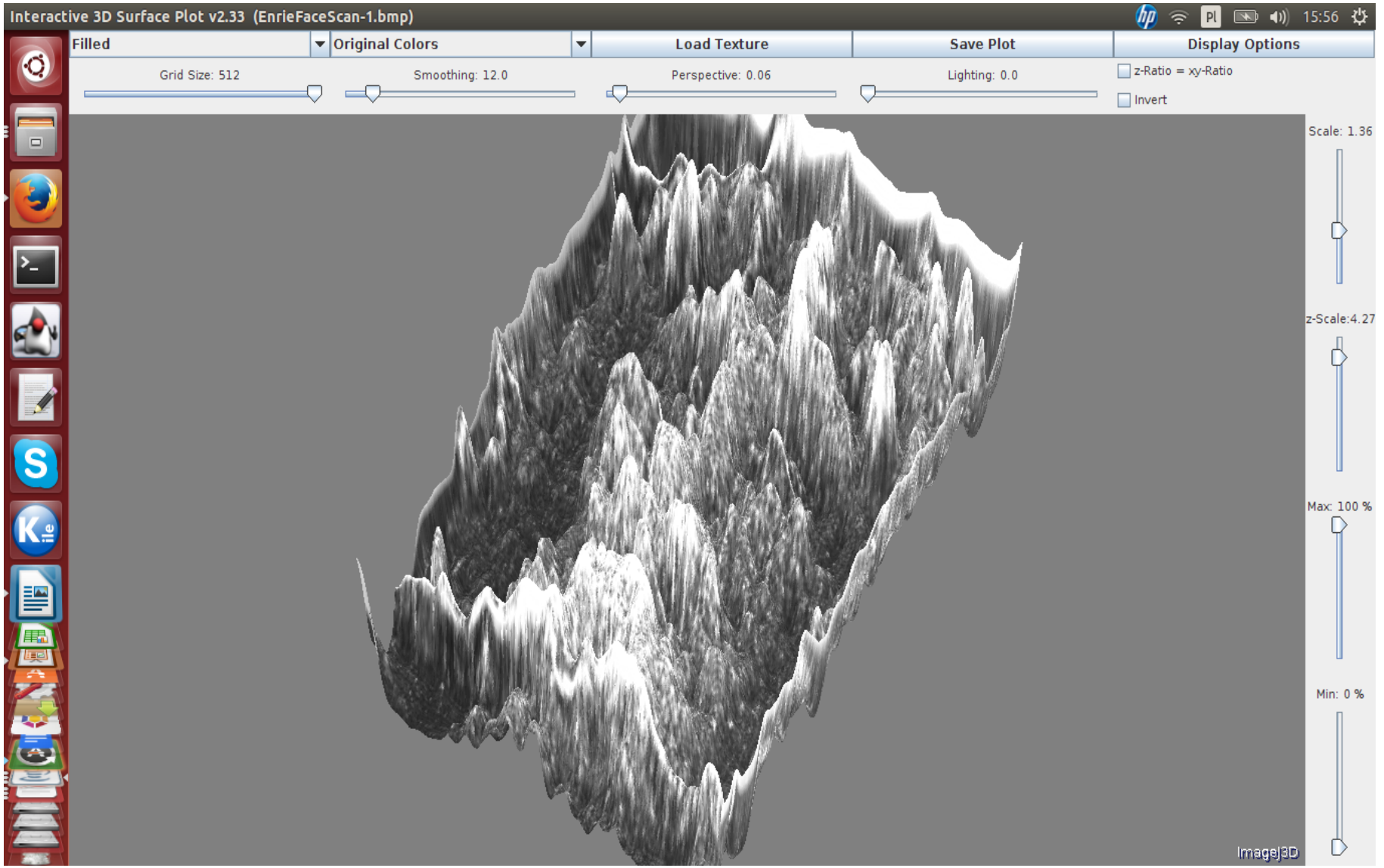


The sole reliance on visual perception of apparent 3D can be very dangerous, as it is very susceptible to change of settings and perspective. And besides, although on 3D plot s X,Y coordinates are well callibrated, the Z axis is usually not callibrated. This may be misleading, as we do not obtain what our perception expects (the 3D mold of ordinary face we are used to).



Here is the Shroud face in 3D. Looks quite realistic...

...but not now, despite the image settings are the same! This is the same face, containing the same information. The only parameters I changed are the angle of viewing, and Z-scale, which are responsible only for visualisation



That's why I insist on using more objective 'Thermal LUT' mode.

Overview

- The quality of 3D plot cannot be assessed solely on a single statistical parameter (correlation coefficient). What needs to be ascertained is general correspondence of obtained 3D plot with the shape of the body supposedly wrapped in the Shroud, given the expected distance between all points of the body and wrapping sheet of linen.
- This requires a lot of experience -you need to approximately know how the body was laid, and how the the Shroud was draping over it. To establish that, you need to perform an iterative approach, based on guesses, and subsequent approximations.
- All attempts to reproduce the Shroud image (except attenuation photography, which is probably unable to reproduce halftone effect) contain **„fatal errors”** -inconsistencies in 3D plot which reveal them to be artistic creations, and not the representation of actual human body (or any other input shape).
- When evaluating the shape of the 3D figure in ImageJ or similar, **NEVER EVER** rely solely on visual perception -or you may get fooled.

To be continued...