A Digital Imaging Analogy for the Shroud of Turin

Tom Dallis, ThD

Abstract

The Shroud of Turin is often described as resembling a photographic negative. This paper offers a second, limited analogy drawn from digital imaging. Shroud investigators reported that much of the body image's tonal variation arises from the local number of yellowed linen fibrils, rather than markedly different shades on individual fibrils. A digital image likewise gains its visible form from information recorded at many small locations, though a silicon sensor and linen operate by fundamentally different means. The analogy proposes no new image-formation mechanism or evidence for authenticity. It offers a familiar way to explain published observations to contemporary readers.

Introduction

Digital imaging has changed the way scholars examine ancient manuscripts. In New Testament textual criticism, projects such as the New Testament Virtual Manuscript Room and the Center for the Study of New Testament Manuscripts have made high-resolution images of Greek manuscripts available to scholars far from the collections that hold them. We can enlarge a page, compare readings, and return to the same image with colleagues elsewhere. Earlier photography documented manuscripts, of course; digital capture and online access have changed the scale and ease of that work. The ability to move between the whole page and its smallest visible details also encourages us to ask how an image is recorded in the first place.[1]

Photography has changed just as dramatically. Traditional processes used a prepared light-sensitive surface: a plate, film, or photographic paper. Light altered that material, and

[1] Institut für Neutestamentliche Textforschung, "New Testament Virtual Manuscript Room," https://ntvmr.uni-muenster.de/; Center for the Study of New Testament Manuscripts, "The Benefits of a Digital Manuscript Library," January 16, 2019, https://www.csntm.org/2019/01/16/the-benefits-of-a-digital-manuscript-library/. These projects provide extensive digital holdings, not images of every extant manuscript.

development made the image visible or permanent. In a digital camera, a lens directs light onto an array of photosites on a silicon sensor. Each site produces a measurement that is read electronically and converted into image data. The resulting picture can be processed and displayed without photographic film or a darkroom. None of this makes digital capture a process without physical causes. It simply records and renders an image by a different means.[2]

These changes invite a fresh look at a familiar description of the Shroud of Turin. People often call its body image a photographic negative because reversing its light and dark tones makes the figure more readily recognizable. That description concerns its appearance; it does not establish that the linen was made by photography. Might digital imaging offer another, carefully limited analogy for the way the image itself is distributed across the cloth?

What the linen records

The crucial observation is microscopic. Investigators with the Shroud of Turin Research Project (STURP) reported yellowed fibrils on the upper portions of threads in the body-image areas, with colored fibrils beside uncolored ones. The darker parts of the image did not principally contain individually darker yellow fibrils. Rather, they contained more yellowed fibrils within a given area. On their measurements, the color of individual image fibrils was relatively uniform, while their local number varied. The investigators therefore compared the visible shading to a halftone; Alan Adler later described it as an "areal density image."[3]

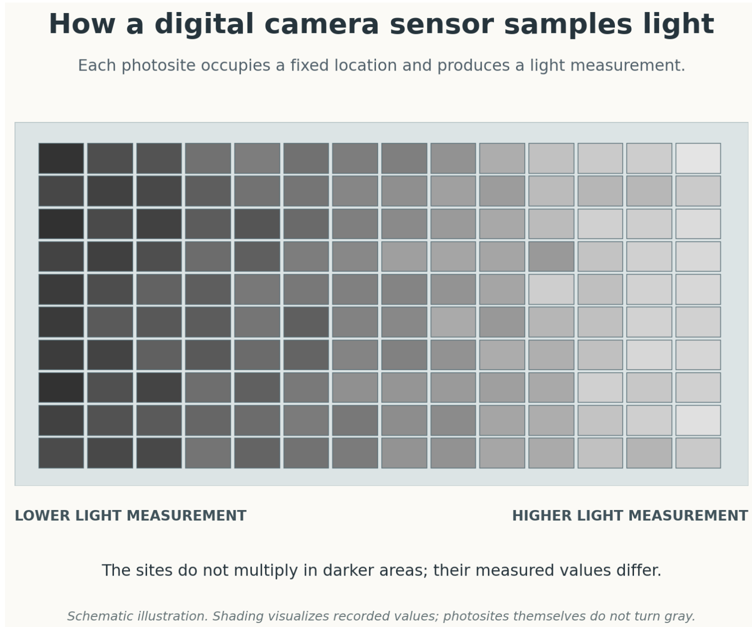
STURP also distinguished this body image from the blood marks and reported no applied pigment, binder, or photographic coating that accounted for the body image in its tests. Its chemical analysis favored a change associated with dehydration and oxidation of the linen or material at its surface, while leaving the initiating process unresolved. This distinction matters. The absence of an identified image-making deposit is evidence against some proposed methods,

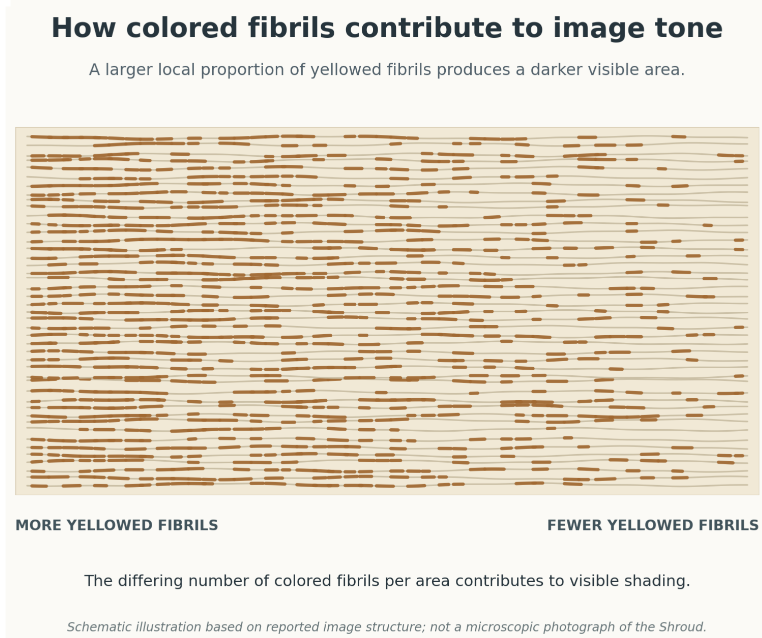
---

[2] Ben Long, *Complete Digital Photography*, 8th ed. (Boston: Cengage Learning PTR, 2014), 99–111, especially 100–102; George Eastman Museum, "Photographic Processes Video Series and Glossary," https://www.eastman.org/photographic-processes-video-series-glossary.

[3] Eric J. Jumper et al., "A Comprehensive Examination of the Various Stains and Images on the Shroud of Turin," in *Archaeological Chemistry III*, ed. Joseph B. Lambert, Advances in Chemistry 205 (Washington, DC: American Chemical Society, 1984), 447–76, especially 450–52, https://doi.org/10.1021/ba-1984-0205.ch022.

but it cannot prove that no transient substance or environmental condition was involved at any earlier stage.[4]





The image has a second feature at a larger scale. Jackson, Jumper, and Ercoline reported that variation in the frontal image intensity could be modeled by a relationship to the distance between a draped cloth and a human body shape. The familiar VP-8 displays this distribution of image brightness as relief; it does not itself photograph the body in three dimensions or determine the physical mechanism. The microscopic pattern and the larger tonal variation are therefore related questions: how do numerous small colored and uncolored regions combine into a coherent figure, and what determined their distribution?[5]

---

[4] Jumper et al., "Comprehensive Examination," 450–55; L. A. Schwalbe and R. N. Rogers, "Physics and Chemistry of the Shroud of Turin: A Summary of the 1978 Investigation," *Analytica Chimica Acta* 135 (1982): 3–49, https://doi.org/10.1016/S0003-2670(01)85263-6.

[5] John P. Jackson, Eric J. Jumper, and William R. Ercoline, "Correlation of Image Intensity on the Turin Shroud with the 3-D Structure of a Human Body Shape," *Applied Optics* 23, no. 14 (1984): 2244–70, https://doi.org/10.1364/AO.23.002244. Their modeled correlation does not establish a particular image-formation mechanism.

A comparison with digital imaging

DESCRIPTION: 1b 2-11 E 32X_0097: Slide 2-11 Body image rt. Eye [D13 location] 32X magnification (1b 2-11 E 32X) © Vernon Miller, 1978. No unauthorized reproduction of Material on other Websites is allowed without prior written permission from the shroudphotos.com copyright holder. Original photos are available for free at www.shroudphotos.com

In a digital camera, small sensing sites sample incoming light across the image plane. Their positions and measured values contribute to the image that appears on a screen. A dark part of the scene does not acquire extra pixels; the sites are already in place, and the values obtained at those sites differ. Processing, including the treatment of color and tone, then produces the photograph we see.[6]

The Shroud is not a silicon sensor, and a linen fibril is not an electronic pixel. Its colored fibrils are irregular in position and shape, and the image exists as a lasting physical discoloration rather than as stored numbers. Nevertheless, the comparison helps describe one aspect of what the investigators observed. Across a small region of the cloth, the proportion of colored to uncolored fibrils contributes to the tone perceived at ordinary viewing distance. In that limited sense, the image is assembled from many small image-bearing elements. We can call them pixel-like if we immediately explain where the analogy ends. STURP's term "halftone" remains an apt description of the effect.[7]

Silicon registers light as electrical information that a camera turns into pixels. Linen could register an exposure as a physical change in selected surface fibers. The analogy lies in recording

[6] Long, *Complete Digital Photography*, 99–109. Long distinguishes the photosite on the sensor from the pixel in the resulting image and describes the readout and processing stages.

[7] Jumper et al., "Comprehensive Examination," 450–52; Alan D. Adler, "The Shroud Fabric and the Body Image: Chemical and Physical Characteristics," in *The Turin Shroud: Past, Present and Future* (Cantalupa: Effatà, 2000), 51–73, https://www.shroud.com/pdfs/ssi43part11.pdf. The visual analogy is mine; the underlying observations and halftone description are theirs.

image information at many small locations, even though the materials retain that information in fundamentally different ways.[8]

Silicon Camera Sensor	Linen Cellulose
Light at a photosite produces an electrical signal. Electronics measure and store a value for that location.	Under some conditions, light can cause a lasting chemical change in linen, including yellowing. The changed fiber itself remains the record.
Photosites form a manufactured, regular grid.	Fibers form an irregular woven surface.
Different signal values supply tonal information at each location.	On the Shroud, investigators reported that much of the tonal variation comes from the number of yellowed fibers per area, rather than strongly different shades on individual fibers.

This perspective sharpens the contrast with a conventional photographic print on sensitized material. The Shroud does not show evidence of the silver-halide emulsion used in familiar film photography, nor did STURP identify an applied pigment or binder responsible for the body image. Its linen is itself part of the visible record. It would be misleading, however, to say that no chemistry is involved: the yellowing of fibers is a chemical alteration. My proposal concerns the spatial organization of that alteration, not an escape from physical or chemical explanation.[9]

The material comparison raises a more precise question: could the linen itself have recorded a spatially patterned exposure? The analogy leaves room for a light-based account of image formation. Researchers have produced some superficial, Shroud-like discoloration of linen with short ultraviolet laser pulses, though those experiments did not reproduce the complete body image or identify what happened to the Shroud. Light, radiation, contact, and chemical hypotheses must each be judged by whether they explain the actual distribution and properties of the image. For me, the Resurrection remains the most compelling ultimate explanation. The

[8] Canon Europe, "Image Sensors Explained," https://www.canon-europe.com/pro/infobank/image-sensors-explained/; Adler, "Shroud Fabric," 51–73; Giuseppe Baldacchini et al., "Coloring Linens with Excimer Lasers to Simulate the Body Image of the Turin Shroud," *Applied Optics* 47, no. 9 (2008): 1278–85, https://doi.org/10.1364/AO.47.001278. The comparison does not establish that light formed the Shroud image.

[9] Jumper et al., "Comprehensive Examination," 450–55; Schwalbe and Rogers, "Physics and Chemistry," 3–49. Conventional silver-halide photography is used here for comparison, not as an exhaustive inventory of every historical photographic process.

present comparison makes a narrower claim about the image that remains open to examination whatever one concludes about its cause.[10]

What the analogy contributes

The negative-like appearance of the Shroud has drawn attention since Secondo Pia photographed it in 1898. Looking through the experience of digital photography draws attention instead to how a faint image can emerge from small, separate contributions across a surface. This observation is not new in itself: STURP described the halftone-like character decades ago. What I propose is an accessible imaging framework that brings its fiber-level structure into conversation with the negative-like appearance and the measured variation in image intensity.[11]

The importance of light and shadow is central to this comparison. A grayscale digital image is created from many individual pixels assigned different brightness values, ranging from dark to light. In a color image, those brightness values are combined with red, green, and blue information. What makes the image visible is not the presence of the pixels themselves, but the variation among them. If every pixel were assigned the same degree of darkness or the same degree of brightness, the result would be a uniform field rather than a recognizable image. The image emerges because neighboring locations differ.

Conventional artistic methods generally require the application or deposition of an image-forming substance, such as pigment, dye, powder, or binder. STURP found no such material that could account for the body image. Instead, the image resides in a superficial alteration of the linen itself. This does not prove that light formed the image, since the initiating mechanism remains unknown. It does, however, make light especially interesting as a comparison, because

---

[10] Paolo Di Lazzaro et al., "Superficial and Shroud-like Coloration of Linen by Short Laser Pulses in the Vacuum Ultraviolet," *Applied Optics* 51, no. 36 (2012): 8567–78, https://doi.org/10.1364/AO.51.008567.

[11] Shroud images courtesy of © Vernon Miller, 1978. No unauthorized reproduction of Material on other Websites is allowed without prior written permission from the shroudphotos.com copyright holder. Original photos are available for free at www.shroudphotos.com.

light can carry spatial information and, under some conditions, produce superficial alteration of linen without leaving behind an added image-forming material.[12]

The Shroud behaves in an analogous way at the level of its visible image. Its image depends upon variations in light and dark across the cloth, but those tonal differences appear to arise largely from the local distribution of yellowed and unyellowed fibrils rather than from substantially different shades on individual fibrils. Areas containing a greater proportion of colored fibrils appear darker, while areas containing fewer appear lighter. The resulting differences in image intensity allow the human figure to emerge from the linen in much the same visual sense that differing pixel values allow a digital image to emerge on a screen. The analogy does not mean that linen fibers are pixels, but it helps explain how a coherent image can arise from many small, locally varying elements.

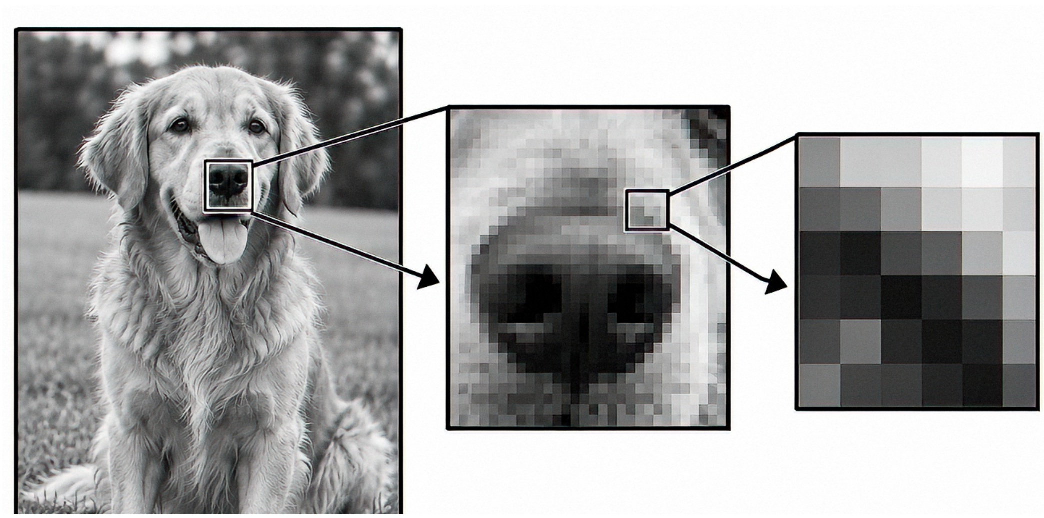
The analogy does not date the cloth, identify the man, or show that a medieval maker would have needed to know about digital cameras. Nor does it explain what physical process produced the image. It does, however, give any proposed formation process a demanding question to answer: how did it produce a coherent body image through the selective coloration of superficial fibers, with tonal differences arising largely from their local distribution? A closer comparison of calibrated microscopic images with larger-scale image intensity could make that question more exact.

The Shroud can therefore be described with care: it acts like a negative in one respect and, in another, like an image built from numerous small elements whose differing contributions of light and dark create the visible figure. It is neither a photographic print nor a digital file. Yet, like a digital image, its recognizable form depends upon variation from one small area to another. If every area were the same, no image would be seen.

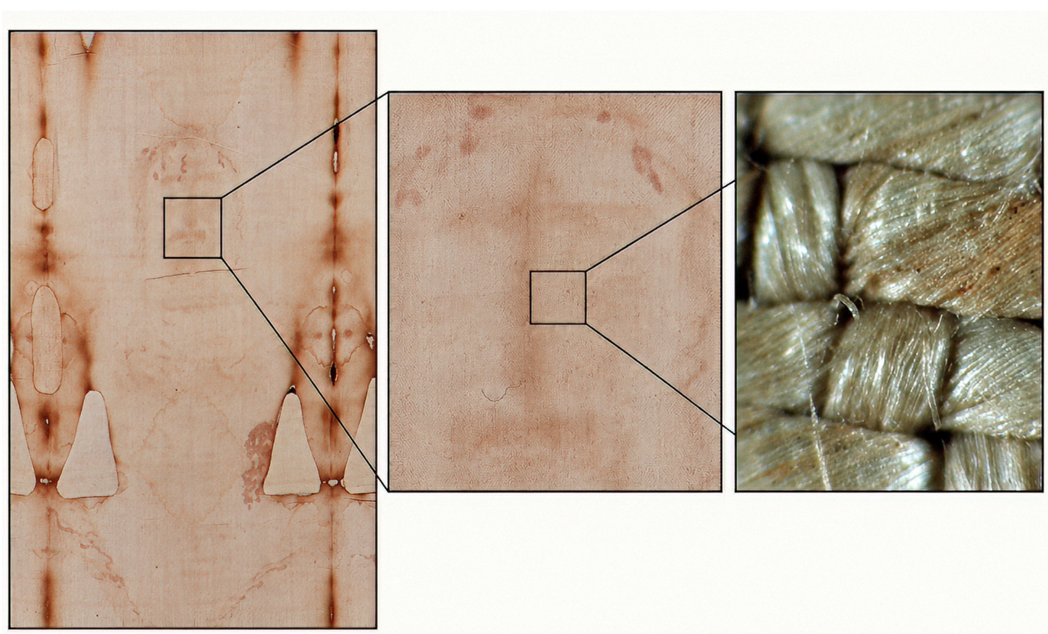
---

[12] Eric J. Jumper et al., "A Comprehensive Examination of the Various Stains and Images on the Shroud of Turin," in *Archaeological Chemistry III*, ed. Joseph B. Lambert, Advances in Chemistry 205 (Washington, DC: American Chemical Society, 1984), 447–76, esp. 450–55, https://doi.org/10.1021/ba-1984-0205.ch022; L. A. Schwalbe and R. N. Rogers, "Physics and Chemistry of the Shroud of Turin: A Summary of the 1978 Investigation," *Analytica Chimica Acta* 135 (1982): 3–49, https://doi.org/10.1016/S0003-2670(01)85263-6; Giuseppe Baldacchini et al., "Coloring Linens with Excimer Lasers to Simulate the Body Image of the Turin Shroud," *Applied Optics* 47, no. 9 (2008): 1278–85, https://doi.org/10.1364/AO.47.001278; Paolo Di Lazzaro et al., "Superficial and Shroud-like Coloration of Linen by Short Laser Pulses in the Vacuum Ultraviolet," *Applied Optics* 51, no. 36 (2012): 8567–78, https://doi.org/10.1364/AO.51.008567. The laser experiments demonstrate that light can produce extremely superficial coloration of linen under particular laboratory conditions; they do not establish that light produced the Shroud image.

The analogy may also help communicate these findings today. It offers no new microscopic observation or independent evidence for authenticity. Many readers, especially younger ones, know digital images better than darkrooms and developed negatives. Explaining how small, local contributions of light and dark form the Shroud's visible image gives them a familiar way to understand the published observations and invites them to examine the cloth for themselves.



From full image to close-up to pixel structure: digital images emerge from variations among many small image elements.



From facial image to close-up to linen weave: the Shroud's visible image likewise emerges from variations distributed across many small areas of cloth.