Analysis of Digital Images of The Shroud of Turin

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Abstract

A variety of digital enhancements were performed on imagery digitized from the 1931 Enrie photographs of the Shroud. The enhancements provide supporting evidence that the right eye area of the Shroud image contains remnants of patterns similar to those of a known Pontius Pilate coin dating from 29AD.

In addition we have noticed some patterns on the Shroud image which need further explanation. Specifically,

(1) there appears to be a dark band going almost all around the head being interrupted by a white rectangular region located just above and between the eyes;
(2) just above the dark band on the back of the head a is second dark band;
(3) between the waist and to just above the knees is a rectangular area just darker than that which surrounds it.

ANALYSIS OF DIGITAL IMAGES OF THE SHROUD OF TURIN

1. The Shroud of Turin

The Shroud of Turin is a linen cloth 14 feet 3 inches long by 3 feet 7 inches wide. It is a faded straw in color and is located in the Cathedral of St. John in Turin, Italy and has been located in a triply locked silver casket there almost continuously since 1578. On the cloth is a blood-stained negative image of what appears to be the front and back of a male human body. The cloth is historically important because it has been thought to be and today some think it to be the burial cloth which wrapped the front and back of Jesus Christ (Vignon, 1937; Stevenson and Habermas, 1982).

During 1978, the Shroud was extensively examined by the Shroud of Turin research project (STURP). The image on the Shroud is darker than the linen. Under microscopic examination, the non-blood-stained darker areas correspond to a "yellow discoloration of the linen fibers which make up the threads of the cloth" (Stevenson and Habermas, 1982). The threads are composed of many fibers and the only fibers which are discolored are the topmost fibers in each thread. The number of topmost fibers discolored corresponds to the darkness of the cloth. From this microscopic examination it is apparent that the image on the cloth is not produced by any known painting mechanism.

Wilson (1979) provides an excellent account of what is known about the history of the Shroud and links the Shroud to the Mandylion or Image of Edessa. Weaver (1980) provides a brief illustrated discussion of the Shroud. Meacham (1983) reviews much of what is scientifically known about the Shroud and provides a summary of hypotheses and interpretations people have had concerning the Shroud. The material in this paper is based on a report by Haralick (1983).

Figure 1 shows a photographically negative enlargement of the upper half of the Shroud.

2. The Purpose of the Digital Processing

Digital image processing of the Shroud image is not new. Lorre and Lynn (1977), in order to remove noise, enhanced the images by Fourier filtering and median filtering. Jumper, Jackson, and Devan (1977) produced contrast enhancements. The specific purpose of the digital image processing and enhancement reported here is to examine and enhance the enlargement of the right eye area to see whether a shepherd staff's pattern around which some of letters TIOUCAICAPOC could be observed. Filas (1982) and Whanger (1983) have each suggested some correspondence between such a pattern, which is the one on a Pontius Pilate coin, and the one observed on the Shroud. In discussing ancient burial customs, Hachlili (1979) first suggested that "coins originally must have been placed on the eyes of the deceased" and then Hachlili and Killebrew (1983) suggested that "the coins had been placed in the mouth, not on the eyes". Filas (1981) disagrees with the latter statement. In discussing the coins on eyes hypothesis, Meacham (1983) indicates that there is "no general agreement on the inscription or on the identification of the protuberances as coins."

Jackson, Jumper, Mottern, and Stevenson (1977) and Jackson, Jumper, and Stevenson (1978) noticed when examining the Shroud face in the pseudo three dimensional relief display of the VP-8 Image Analyzer that the display showed

objects resembling buttons over each eye. In trying to explain what these objects might be, they consulted Bender's (1894-1895) article on "Beliefs, Rites, and Customs of the Jews Connected with Death, Burial, and Mourning". Bender quotes Frazer (1886) who said "The Jews put a potsherd, and the Russians coins on each of his eyes" referring to the eyes of a dead person. On the basis of this statement Jackson, Jumper, Mottern, and Stevenson (1977) surmised that there existed an "ancient Jewish burial custom where objects (potsherd fragments or coins) were apparently sometimes placed over the eyes." They naturally conjectured that the objects were coins since they appeared to be nearly circular and approximately the same size. They indicate that in a private communication Wilson had suggested that there were "several Judean Bronze Lepton coins which are about the correct size as the buttonlike images. In particular a Lepton of Pontius Pilate coin in A.D. 30-31 seems to agree especially well."

Hachlili and Killebrew (1983) suggest that Jackson et. al. (1978) have misinterpreted Frazer's quote. They argue that "nowhere in Frazer's passage does one find mention of an ancient Jewish custom of placing coins over the eyes of the deceased. The only reference to the placing of coins is with respect to the then modern day Russians. Contemporary Jews, Frazer claimed, placed potsherds over the eyes." Then they say that this same mistaken interpretation was made by Wilson (1978).

It is interesting that Hachlili (1979) in discussing burials preserved in Jericho Hills writes:

"Coins were also placed in the tombs. Two coins were found with coffin burials, one dating to the reign of the Hasmonean king, John Hyrcanus II (63-40 B.C.) and a second from the time of Archelaus (4 B.C. - 6 A.D.). Two additional coins of Herod Agrippa I (41-44 A.D.) were found in a skull. The coins originally must have been placed on the eyes of the deceased (probably as payment to Charon, the guardian of the River Styx where, according to Greek mythology, the dead must cross in order to arrive at their ultimate destination". Then Hachlili and Killebrew (1983) write:

"A reexamination of the evidence now leads us to believe that the coins had been placed in the mouth, not on the eyes, as only one coin was found in one skull and two coins stuck together were found in the second skull. The latter occurrence indicates that they had been placed together, that is, in the mouth, as opposed to separately, one over each eye."

From this discussion it is clear that the prior archeological evidence for coins on the eyes is tenuous. However, Filas (1980, 1981, and 1982) made a visual comparison of an enlargement of the right eye area of the Shroud face and a Pontius Pilate lepton coin dated from 29 A.D. and struck in Palestine during the rule of Tiberius Caesar. A photograph of one is shown in Figure 2. The coin is obviously badly pitted and worn. Pontius Pilate coins such as the one shown in Figure 2 were minted from about 29 A.D. through 31 A.D. and these coins had variations in the lettering, abbreviation, and spelling. In coin 16 on page 149 of Madden (1967) is a portrayal of one Pilate coin which clearly shows the sequence TIBEPIOUKAICAPOC around the lituus. The most discernible letters in the coin shown in Figure 2 are TIOU. Figure 3 suggests a location for the partial letter sequence IOUCAIC and lituus to help identify where they are located. The technique used to create Figure 3 is discussed later in the section. Filas concluded that the right eye area of the Shroud had features which resembled this coin. In this section we explore Filas' suggestion that there is evidence for the imprint of such a coin on the right eye area of the Shroud.

According to Filas the letters TIOUCAICAPOC are about 1 mm in size and are supposed to appear around the sides and top of the lituus on a Pontius Pilate coin. Thus, we next examined the area around the lituus of the Shroud image for any evidence of such letters.

Because the letters occur as bright patterns we processed the image to enhance faint patterns just brighter than the background black. This means that small gray tone variations in the dark image must be expanded and made to appear as large gray tone variations while large gray tone variations in the bright range must be compressed and made to appear as small gray tone variations. Figure 4 shows a contrast stretched image whose gray tone intensity is 128 $\log_2$(10+ gray tone intensity of original 1931 Enrie image). The AI should appear on the upper left part of the lituus just where its crook begins. Examining Figure 4 and seeing how any portion of the TIOUCAICAPOC sequence could match, we notice that on the upper left part of the crook are some bright segments which indeed match to an A and an I. Just to the left and below the A is a bright segment which could be a fourth of a C. Just to the left and below this bright patch is about two thirds of a U being on its side and just below it is a patch which is about three quarters of an O. Just to the right and slightly below the top I appears a faint C. Also, looking for further evidence for the C between the U and A we can see that the bright small segment which was a partial remnant of a C in the low pass filtered image now has in the enhanced image attached to it some gray tone patches

which make it more of a complete C. Figure 5 shows the outline of Figure 3 overlayed on the enhanced image of Figure 4.

The overlay of Figure 3 was created by laying a clear piece of cellophane over a photograph of the coin. Then using a view graph marker pen, the outline of the coin's boundary, the lituus and the letters O and I were traced on the cellophane. The cellophane was then put over a piece of white paper and put in front of the TV camera where its picture was compared to the previously digitized Shroud right eye. To register the two images, the position of the TV camera was adjusted until there was minimal perceived motion on the monitor screen when flickering between the letter O and lituus of the Shroud right eye and the outline. Then the additional letters UCAIC were marked on the cellophane so that they approximately corresponded in position to the Shroud right eye on the TV monitor.

A careful examination of the outline of Figure 3 overlaid on the coin of Figure 2 shows that letters picked out from the Shroud right eye have corresponding markings on the coin. To see this in detail, take a transparent piece of cellophane on which the coin outline, lituus, and letters are copied. Align the coin outline on the cellophane with the coin image of Figure 2. Then carefully examine the coin image in each place where the cellophane suggests a letter. You will discover that the coin has markings which are consistent with the approximate position and shape of each of the letters. Are these correspondences chance correspondences? Or do they provide supporting evidence for an imprint of the Pontius Pilate coin on the right eye area of the Shroud? We could argue for the latter since the size and shape of the letters were necessarily ignored during the alignment process and the correspondence was discovered after the independently done alignment.

Thus in the enlargement of the right eye image we find supporting evidence for:

(1) a bright oval area
(2) a shepherd's staff pattern as the main feature in the bright area and
(3) bright segment patterns just to the side and top of the staff pattern, which in varying degrees match to the letters OUCAIC

Because the matching patterns are not immediately discernible in the clutter of the weave, this evidence cannot be said to be conclusive evidence that an image of the Pontius Pilate coin appears in the right eye of the Enrie Shroud image. That is, if one had no hypothesis about what one should be seeing, upon seeing the enlargement for the first time one would not necessarily or immediately conclude that the eye area contained an image of the coin. The evidence is definitely supporting evidence because there is some degree of match between what one would expect to find if the Shroud did indeed contain a faint image of the Pilate coin and what we can in fact observe in the original and in the digitally processed images.

3. Some Exploratory Analysis

In this section we illustrate some patterns we noticed on some of the enhancements done to the Shroud and which have not been extensively discussed in the literature.

Figure 6 shows frontal and dorsal views of the head portrayed on the Shroud. By aligning the dorsal view with the frontal view, it is apparent that there is a dark band which seems to continue from the forehead and just over the eyes all around the back of the head. Also, on the back of the head just above this band, appears two more bands with very narrow separation. Barbet (1963) and others have suggested that the narrowness of the face was due to a chin band being wrapped around the head. Could these upper two bands be the chin band wrapped around the top of the head?

Having fixed attention on the band in the frontal view, it seems that this band is interrupted by a white rectangular area in the forehead going from just over the left eye to just over the right eye. Does this band and rectangular area correspond to anything?

Figure 7 shows an enhancement of the frontal area from the waist to the knees. Looking carefully at this enhancement it is possible to discern that there is a dark rectangle going from the waist to just above the knees. The corner of this rectangle very sharply cuts the fifth finger of the right hand. Figure 8 provides a surface plot of this same area. Notice how there seems to be a slightly depressed rectangle in exactly the place it appears on Figure 7. The sharp corner of the rectangle cutting through one of the fingers of the hand is unmistakable.

It is impossible for digital image processing to provide an interpretation to the patterns mentioned in this section. Perhaps archeologists and Shroud scholars will be able to say whether these patterns are real. If they are real, they may be able to suggest some reasonable interpretation.

4. Conclusions

Although the patterns in the right eye area of the Shroud image have a large random component, the enhancements suggest that there is some correspondence between them and those on a Pontious Pilate coin. To help confirm this correspondence, an

edge image of the coin should be made and overlayed on the right eye area of the Shroud. This would help determine whether the enhanced letters and staff shapes from the Shroud are in fact positioned in the same places as those on the coin. If they are, it would strengthen and support the suggestion that the pattern in the right eye area corresponds to an imprint of the coin. Of course, because of the poor condition of the coin, getting a good edge image of it will be difficult. Another possibility would be to cross correlate the line drawing showing the lituus and letters of the coin with the enhanced enlarged shroud image of the right eye area to see how much better the alignment we used compares with all other possible alignments. Increasingly lower correlations for increasingly differing alignments would strengthen the correspondence argument.

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Figure 1: Photographically negative enlargement of the upper half of the Shroud portraying a frontal view of a male.

Figure 2: Shows a photograph of a Pontius Pilate lepton coin.

Figure 3: Suggests the size and location for some of the letters and the lituus on the Pontius Pilate coin.

Figure 4: Image whose gray tone intensity is $128\log_2(10+$ gray tone intensity of original image).

Figure 5: Lituus and letter outline overlayed on the enhanced image of Figure 4.

Figure 6: Shows frontal and dorsal views of the head from a photographically negative 1931 Enrie.

Figure 7: Shows an enhancement of the frontal area from the waist to the knees from a photographically negative 1931 Enrie. Corners of darker rectangular area are marked with arrows.