PHOTEK

Jeff Glickman
jeff@glickman.com
503.705.6900

PHOTEK
19405 148th Ave NE
Woodinville, WA

Board Certified Forensic Examiner
Fellow, American College of Forensic Examiners
Diplomate, American College of Forensic Examiners
Senior Member, Institute of Electrical and Electronics Engineers
Chair Emeritus, Institute of Electrical and Electronics Engineers, Seattle Section
Member Emeritus, State of Washington Forensic Investigations Council
Past-President, American Society for Photogrammetry and Remote Sensing,
Puget Sound Region

May 23, 2017

Mr. Ric Gillespie
TIGHAR
2366 Hickory Hill Road
Oxford, PA, 19363

RE: FORENSIC ESTIMATION OF SCALE IN OIL CAN PHOTOGRAPH

Dear Mr. Gillespie,

I understand that there is a TIGHAR research track which needs an estimate of scale for Amelia Earhart's right arm as seen in the photograph of Earhart carrying an oil can (Figure 1). I also understand that TIGHAR members identified the oil can in the photograph, and located one materially the same on Ebay ("exemplar"). This oil can was purchased so that direct measurements of an oil can materially the same to that seen in Figure 1 could be obtained. This report describes the process used to forensically estimate the scale coplanar with Earhart's right arm in Figure 1.

Approach. The exemplar, together with the oil can in Figure 1, will be used to estimate the scale to enable measurements along Earhart's right arm, as the oil can is coplanar with Earhart's right arm. Correct any distortions in the photographs. Correct any measurement confounders.

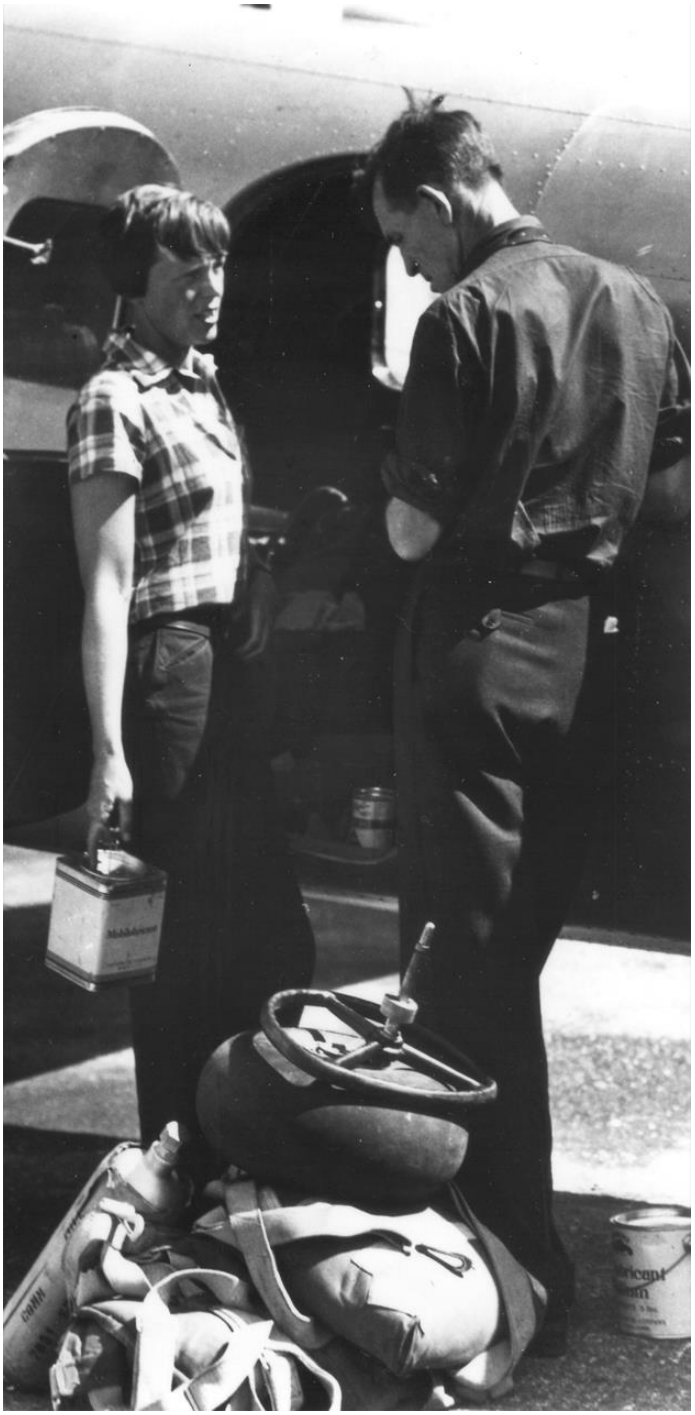

Figure 1. Photograph of Earhart carrying oil can (Photograph OilCan-HighRes.tif). (Source: Purdue University Libraries, E-Archives, Amelia Earhart Papers, George Palmer Putnam Collection, Purdue Identification Number b11f4i3 http://earchives.lib.purdue.edu/cdm/search/searchterm/b11f4i3)

Methodology. Choose a line segment along, or across the oil can seen in Figure 1 ("segment") and compare this to the exemplar. Use the exemplar to obtain the equivalent direct absolute measurement. Correct the segment for errors, including oblique orientation in 3 axes and photographic imaging distortions. Estimate the scale coplanar with Earhart's arm as the corrected length of the segment in pixels, divided by the equivalent measurement of the oil can exemplar in inches.

Orientation. The three axes of the oil can orientation are described as x, y and z, using the convention of Figure 2. Rotations around the x, y and z axes are named pitch, yaw and roll, respectively.

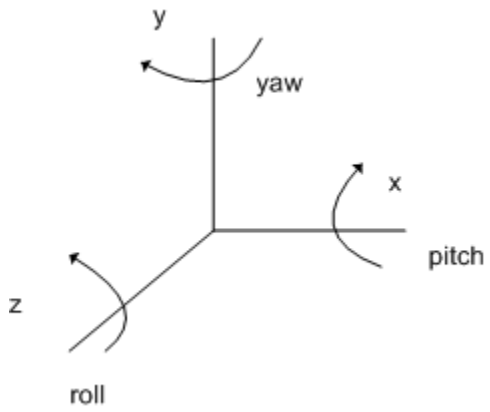

Figure 2. Axes convention.

Segment. The selection of the segment used to relate the exemplar, and the oil can seen in Figure 1, is important to minimizing the quantity and size of errors when estimating the scale: First, the segment must be coplanar with Earhart's right arm; Second, the segment must be parallel, or substantially parallel, with the image plane. The selected segment which meets these criteria extends diagonally across the top of the oil can, as shown in Figure 3.

The selected segment as seen in Figure 3 has the property of being materially centered beneath Earhart's right arm, as well as materially parallel with the image plane. This selected segment needs the smallest number of rotational corrections, as compared to other candidate segments.

Measurements. The segment in Figure 1 is 102.3 pixels, and the equivalent segment on the exemplar is 6 13/16" (6.8125").

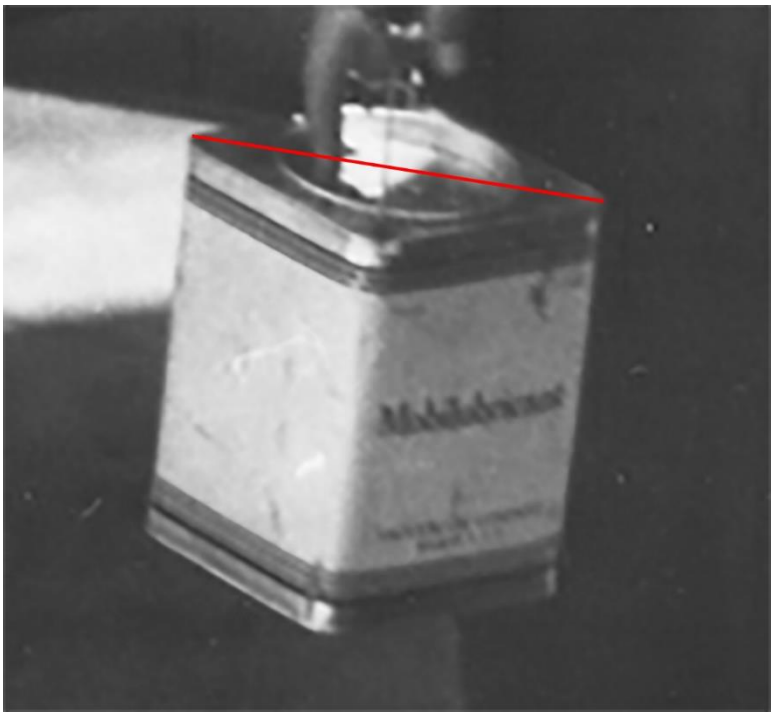

Figure 3. Selected segment shown in red.

Corrections. Measurement of the straight edges in Figure 1 show that no material barrel or pincushion correction of the image is required.

In Figure 1 the oil can exhibits rotations in all 3 axes, therefore the segment must be evaluated for roll, pitch and yaw rotational correction. The oil can has a small yaw rotation, which can be observed in the rotation of the wire handle, and requires evaluation and possibly correction. Once corrected however, neither pitch or roll correction is required because these rotations will not affect the measured length of the segment.

Yaw Correction. The yaw angle was estimated using measurements of the projection from three dimensions to two dimensions of a known equilateral triangle (the two endpoints of the segment, plus the top corner nearest the camera). The rotation was estimated using the arctangent of the ratio of the two sides of the equilateral triangle projected into two dimensions, resulting in an estimated yaw of 1.6 degrees.

The length of the segment in Figure 1 is corrected for yaw rotation using:

$$102.34\ pixels = \frac{102.3\ pixels}{\cos(1.6°)}$$

Scale. The image scale coplanar to Earhart's right arm is estimated as:

$$15.02\ \frac{pixels}{inch} = \frac{102.34\ pixels}{6.8125"}$$

Conclusion. Given the evidence and my experience in the field of photogrammetry and photointerpretation, I estimate that the scale coplanar with Earhart's right arm in Figure 1 as 15.02 pixels per inch. My estimate is based upon the facts that I have received and I reserve the right to revise my report should new information become available.

Sincerely,

Jeff B. Glickman, BSCS, BCFE, FACFE, DABFE
Past-President, American Society for Photogrammetry and Remote Sensing, Puget Sound Region
Chair Emeritus, Institute of Electrical and Electronics Engineers, Seattle Section
Member Emeritus, State of Washington Forensic Investigations Council
Fellow, American College of Forensic Examiners
Senior Member, Institute of Electrical and Electronics Engineers
Board Certified Forensic Examiner