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Lee Harvey Oswald Backyard Photo

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Abstract

More than forty-five years after the assassination of U.S. President Kennedy theories continue to circulate suggesting that the accused assassin, Lee Harvey Oswald, acted as part of a larger conspiracy. It has been argued, for example, that incriminating photographs of Oswald were manipulated, and hence evidence of a broader plot. We describe a detailed 3-D analysis of the Oswald photos to determine if such claims of tampering are warranted.

Keywords: Photo Forensics, 3-D Photo Analysis

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1. Introduction

United States President John F. Kennedy was assassinated on November 22nd, 1963. Shortly afterwards, Lee Harvey Oswald was arrested and charged with the crime. Because he was killed before his trial many questions surrounding the assassination remained unanswered. Since this time, numerous theories have circulated suggesting that Oswald acted as part of a larger criminal conspiracy involving a variety of government, international, or criminal groups. Many of these theories point to purported inconsistencies in the events of November 22nd and in the evidence collected against Oswald. One such example is a photograph of Oswald in his backyard holstering a pistol and holding a rifle in one hand and Marxist newspapers in

the other, Figure 1. Oswald claimed that this photo was fake[1]. In addition, many have argued that the photo is riddled with multiple inconsistencies, including inconsistent lighting, shadows, geometry, and proportions.

The Warren Commission [1] and the House Select Committee on Assassinations [2] investigated claims of photo tampering and concluced that they were unwarranted. Building on this earlier work, we describe a 3-D photo forensic examination that allows for a quantitative analysis of these scene properties. While only applied to this historic and controversial photo, this 3-D modeling methodology is applicable to a broad range of photo forensic situations.

2. 3-D Model

Well established techniques from photogrammetry [3] and computer vision [4] are often effective in making metric measurements from photographs. When presented with only a single image, however, these techniques face fundamental limitations in terms of what can be measured. A 3-D model of a scene affords a richer representation and expands the range of measurements that can be made. To illustrate this idea, we describe the construction and subsequent analysis of a 3-D model of the Oswald backyard photo, Figure 1. This model is constructed from five main parts: Oswald's head, Oswald's body, the ground plane, portions of the surrounding building, and the position of the light source (i.e., the sun).

In [5], the authors describe a 3-D morphable model for the analysis and synthesis of human faces. The model was derived by collecting a large set of 3-D laser scanned faces and projecting them into a lower-dimensional linear subspace. New faces (geometry, texture/color, and expressions) are modeled as linear combinations of the resulting low-parameter linear basis. The model parameters can be estimated from a paired profile and frontal image or from only a single frontal image.

We are fortunate to have access to contemporaneous profile and frontal views of Oswald in the form of a mugshot taken shortly after his arrest, Figure 2. These photographs provide the ideal input for constructing a 3-D model from the commercially available implementation of [5] (FaceGen,

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[1]We focus our analysis on only one of the three backyard photos, each of which show Oswald in his backyard with Marxist newspapers and a rifle.

Singular Inversions). Two views of the resulting 3-D model (Figure 3) show a good agreement with the original mugshot photo in Figure 2.

This 3-D head model was combined with a generic articulated 3-D body[2], and rendered in the 3-D modeling software Maya (*Autodesk*).[3] The ground plane, fence, and post under the stairs were created from simple 3-D primitives. The scene geometry, camera position, and direction of a distant light source (i.e., sun) were manually positioned until they matched the original photo.

Shown in Figure 4 is, from left to right, the original photo, our 3-D rendering, and a superposition of the original photo and the outline of our rendering. This figure shows a good agreement between the model and the original photo. Note that in this 3-D model both the scene geometry and lighting position are estimated, allowing for both a geometric and lighting analysis, as described next.

3. 3-D Analysis

Once constructed, a 3-D model affords a powerful representation for the quantitative measurement of scene properties. In this section the 3-D model estimated in the previous section is used to analyze the lighting, shadows, dimensions, and geometry in the backyard photo of Oswald.

Because of the inherent ambiguity in constructing a 3-D model from a single 2-D image, there are any of a number of 3-D geometries that would be consistent with the 2-D image. The model constructed here and the subsequent analysis simply show that there exists a consistent and plausible 3-D scene geometry, as opposed to a unique geometry.

3.1. Shadow

It may appear that the shadow cast by Oswald's body onto the ground, and the shadow under his nose are inconsistent with a single light source, Figure 1, and hence evidence of photo tampering. Specifically, the nose appears to be illuminated from above, and the body seems to be illuminated from Oswald's upper left. It has previously been pointed out, however, that

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[2]Alfred 1.2.0: www.creativecrash.com/maya/downloads/character-rigs/c/alfred

[3]A more detailed body was not constructed (e.g., [6]), because we were primarily interested in the shadow cast by the body, and the height of Oswald in the photo, for which a generic body sufficed.

the human visual system can be quite inept at judging inconsistencies in lighting and shadows [7, 8, 9].

With a 3-D model of the scene geometry and lighting, it is relatively easy to compare the shadows in the original photo and rendered scene. Shown in Figure 5 is a side-by-side comparison of the shadows. Note that the shadows on the nose, eyes, lower lip and neck are well matched, as are the shadow cast by the body onto the ground plane, and the thin sliver of a shadow from the vertical post onto the ground plane. These shadows, which at first glance appeared inconsistent, are in fact perfectly consistent with a single light source.

3.2. Height

The backyard photo of Oswald in Figure 1 was considered to be particularly incriminating because the rifle he was holding in the photo appeared to be the same as that used to assassinate Kennedy. It has been suggested, however, that the relative size of the rifle in Oswald's hand is inconsistent with Oswald's height. Our 3-D model can be used to determine relative dimensions in the 3-D scene. Most importantly, the 3-D model allows us to remove any perspective distortions that would bias the measurements made only from the original photo.

To begin, a cylinder was added to the 3-D model to mimic the rifle, Figure 6. Shown in the right panel of Figure 6 is a rendering of Oswald and the rifle where Oswald's articulated body was positioned upright and the rifle was placed in the same depth plane as Oswald's body. In this photo, the ratio of the length of the rifle to Oswald's height is 0.5824. Oswald was 5 feet and 9 inches tall (69 inches), which allows us to infer the rifle length l as:

$$\frac{l}{69} = 0.5824 \tag{1}$$
$$l = 69 \times 0.5824 = 40.186 \text{ inches} \tag{2}$$

According to the Warren Commission the rifle was 40.2 inches in length [1], only a fraction of an inch larger than that estimated from our 3-D model.

The rifle to height ratio measured directly from the original backyard photo is 0.6493 which would suggest a rifle length of 44.8 inches, several inches longer than the recovered weapon. This type of analysis is, of course, incorrect as it does not account for the obvious perspective and pose distortions in the photo. Our 3-D model allows for the removal of all such distortions and, in turn, to make accurate scene measurements.

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3.3. Posture

It has been argued that Oswald is leaning so far to the left as to be physically implausible. Our 3-D model allows for arbitrary views of Oswald's body and measurements of his posture. Shown in Figure 7 are four renderings of Oswald's body taken from the front, back, and left and right sides, each of which look qualitatively reasonable. The tilt of Oswald's body was measured to be a physically plausible five degrees from vertical.

3.4. Chin

At first glance it may appear that Oswald's chin in the backyard photo is too wide to be consistent with his chin in other photos (e.g., his mugshot) and hence evidence of a photo composite. Shown in the left column of Figure 8 is a photo of Oswald from his mugshot (top) and from the backyard photo (bottom). The yellow guidelines are drawn at the point in the top photo where the chin meets the jaw line. Note that the chin appears to be much wider in the backyard photo. Shown in the right column of Figure 8 are the corresponding 3-D renderings with neutral front lighting (top) and lighting to match the backyard photo (bottom). The yellow guidelines, of the same width as on the left, show the same apparent widening of the chin. From these 3-D renderings, it is clear that the apparent widening of the chin is due to the shading along the chin and jaw, and not to nefarious photo manipulation.

4. Discussion

We have described a photo forensic analysis of the historical and controversial Oswald backyard photo. This analysis employed a 3-D head, body, and scene model of our construction. This model was used to perform a quantitative analysis of scene geometry and lighting, each of which are shown to be consistent and physically plausible. Previous suggestions that this photo was manipulated or is a composite are not supported by this 3-D photo forensic analysis.

References

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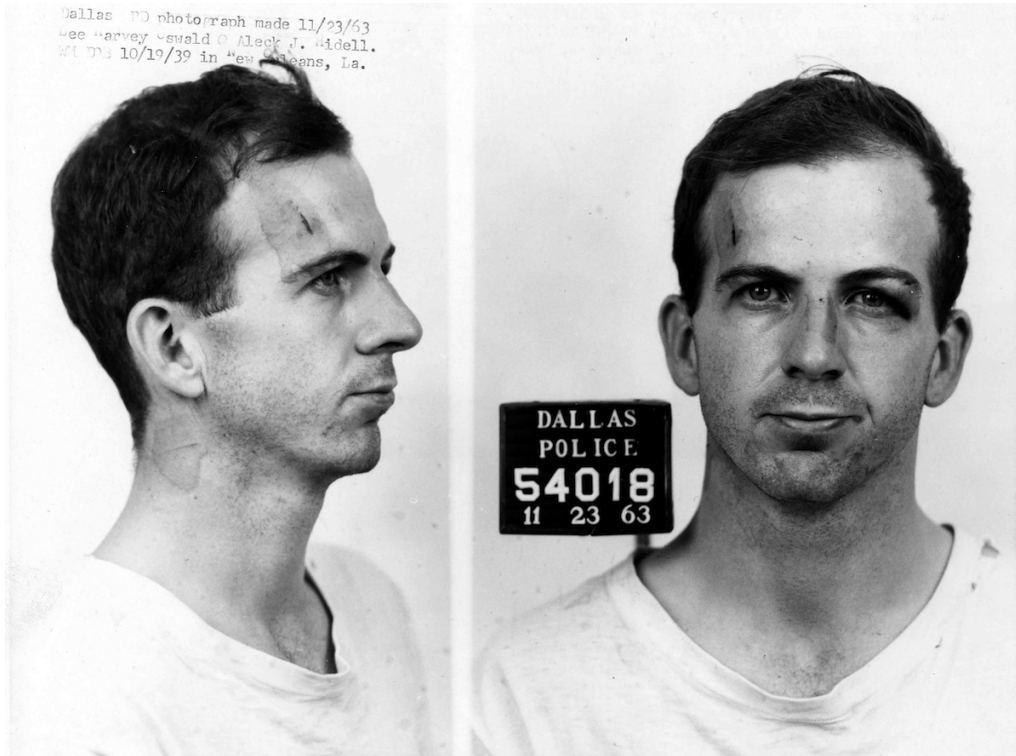
Figure 1: Lee Harvey Oswald in his backyard.

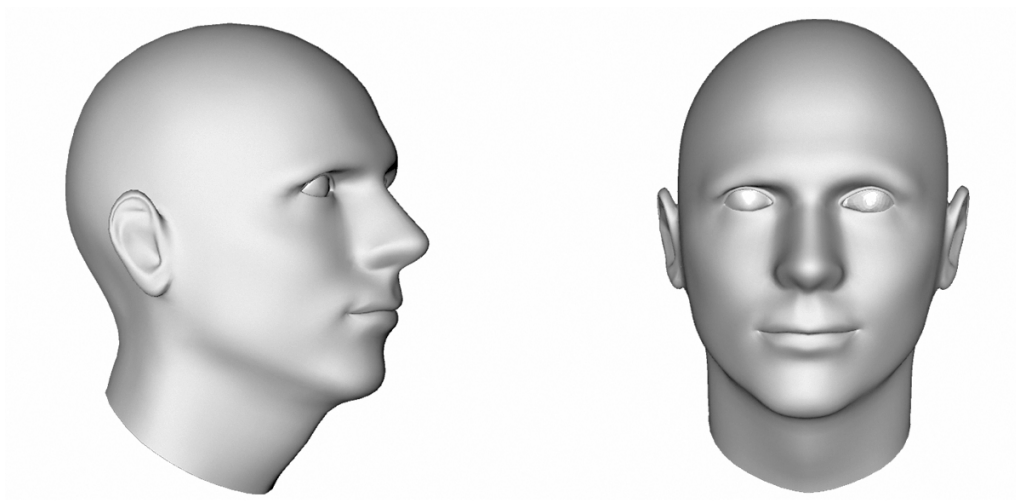Figure 2: Mugshot of Lee Harvey Oswald used to construct a 3-D model, see also Figure 3.

Figure 3: Two views of the 3-D model of Oswald's head, see also Figure 2.
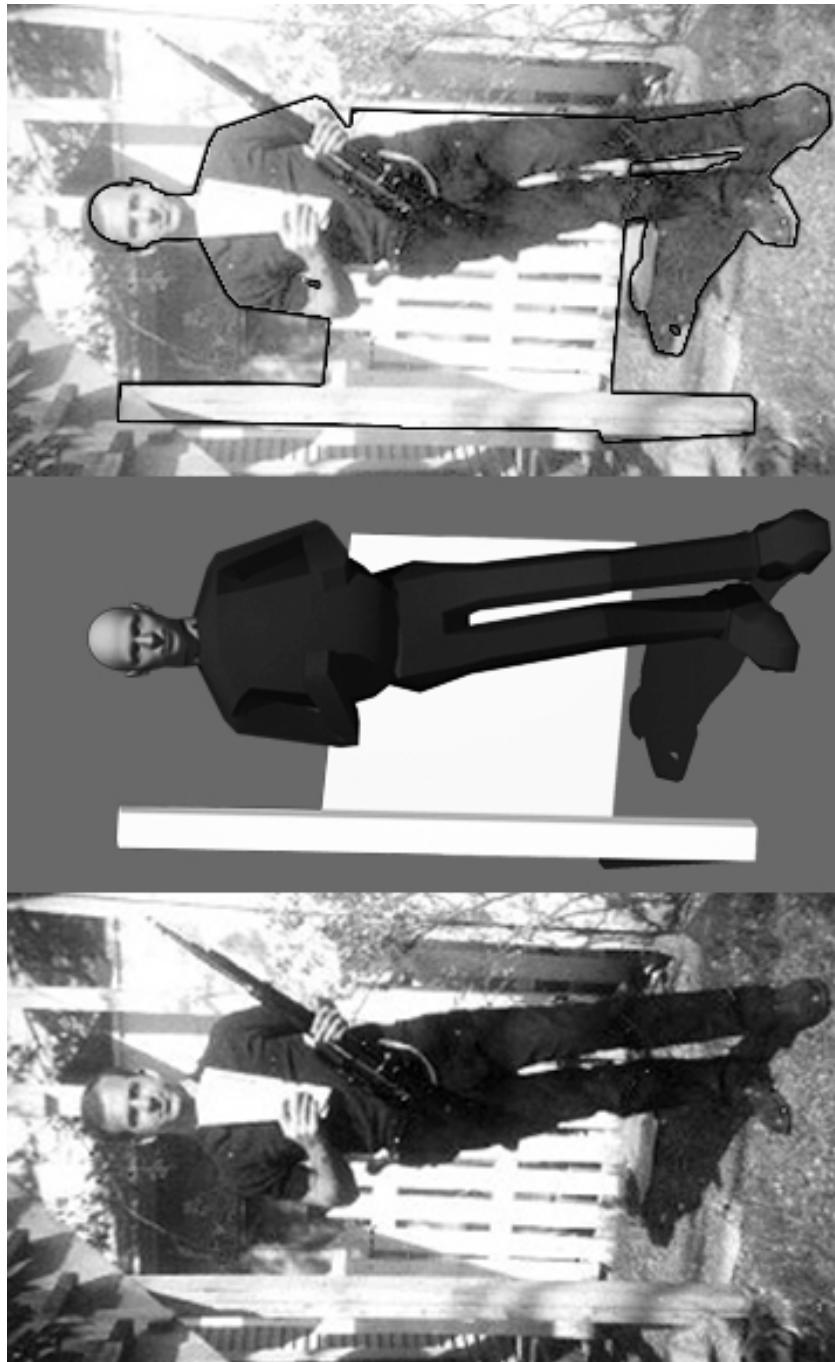
Figure 4: Shown, from left to right, is the original backyard photo, our 3-D rendering, and a superposition of the original and the outline of the rendering.
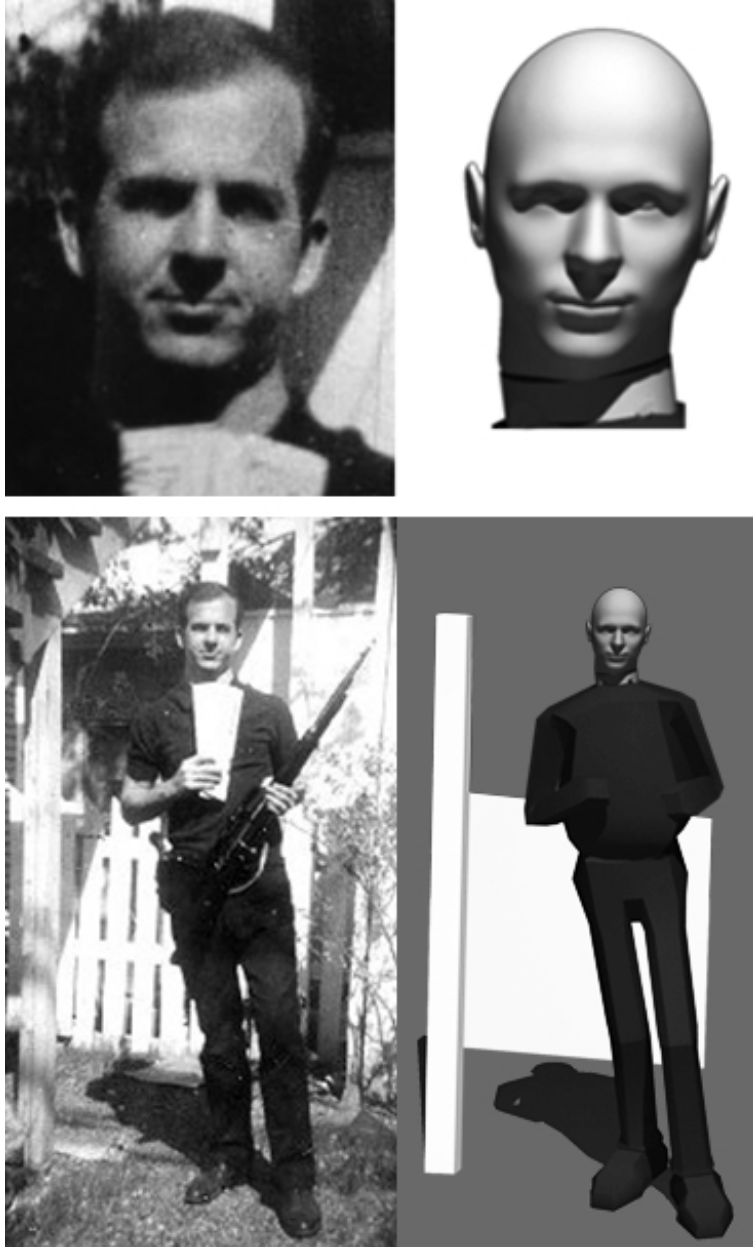
Figure 5: Shown below is the original photo and the 3-D rendering. Shown above is a magnified view of Oswald's head. Notice that the shadows on the nose, eyes, lower lip and neck are well matched, as well as the shadow cast by the body onto the ground plane, and the thin sliver of a shadow from the vertical post onto the ground plane.
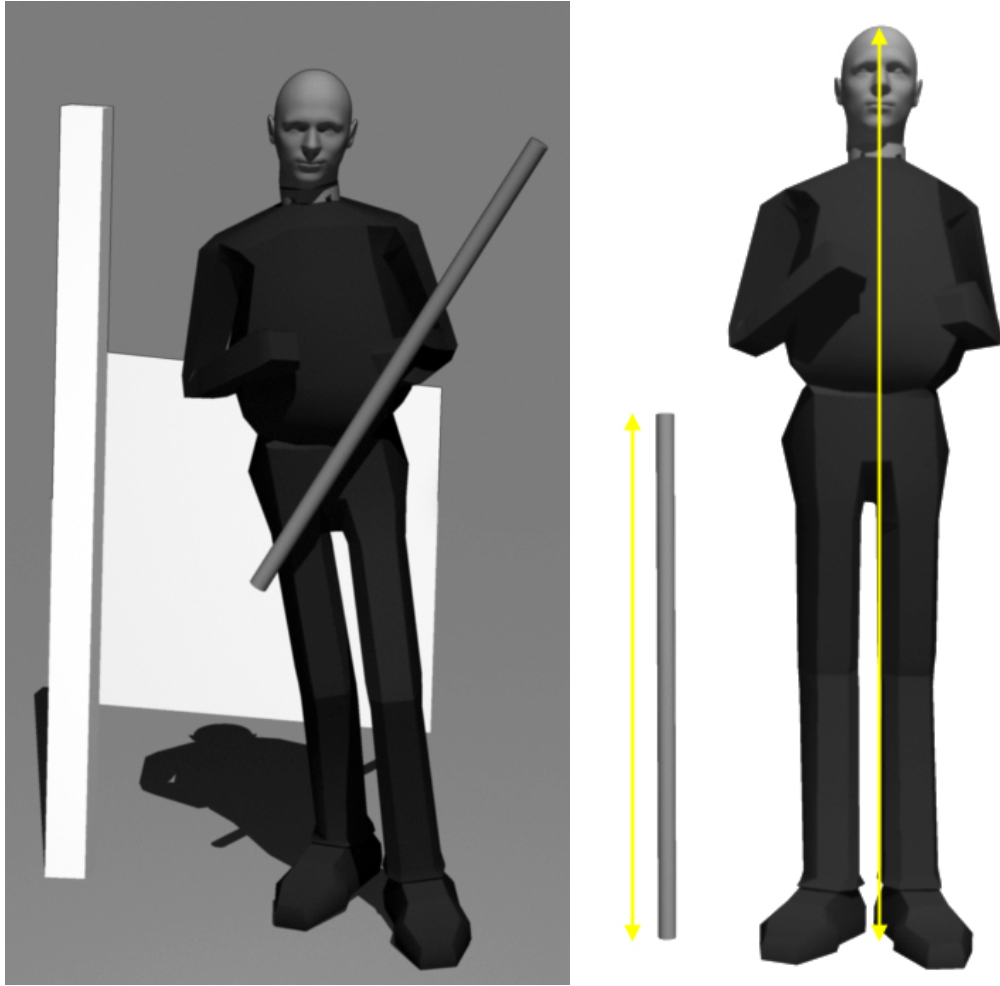
Figure 6: Shown on the left is a 3-D rendering of Oswald where the cylinder is consistent with the size and position of the rifle in the original photo, Figure 1. Shown on the right is a rendering where Oswald and the rifle are placed side-by-side and where Oswald's articulated body was positioned upright. The yellow lines denote the measured length of the rifle and the height of Oswald.

Figure 7: Shown are, from left to right, side, front, back, and side renderings of Oswald's body.
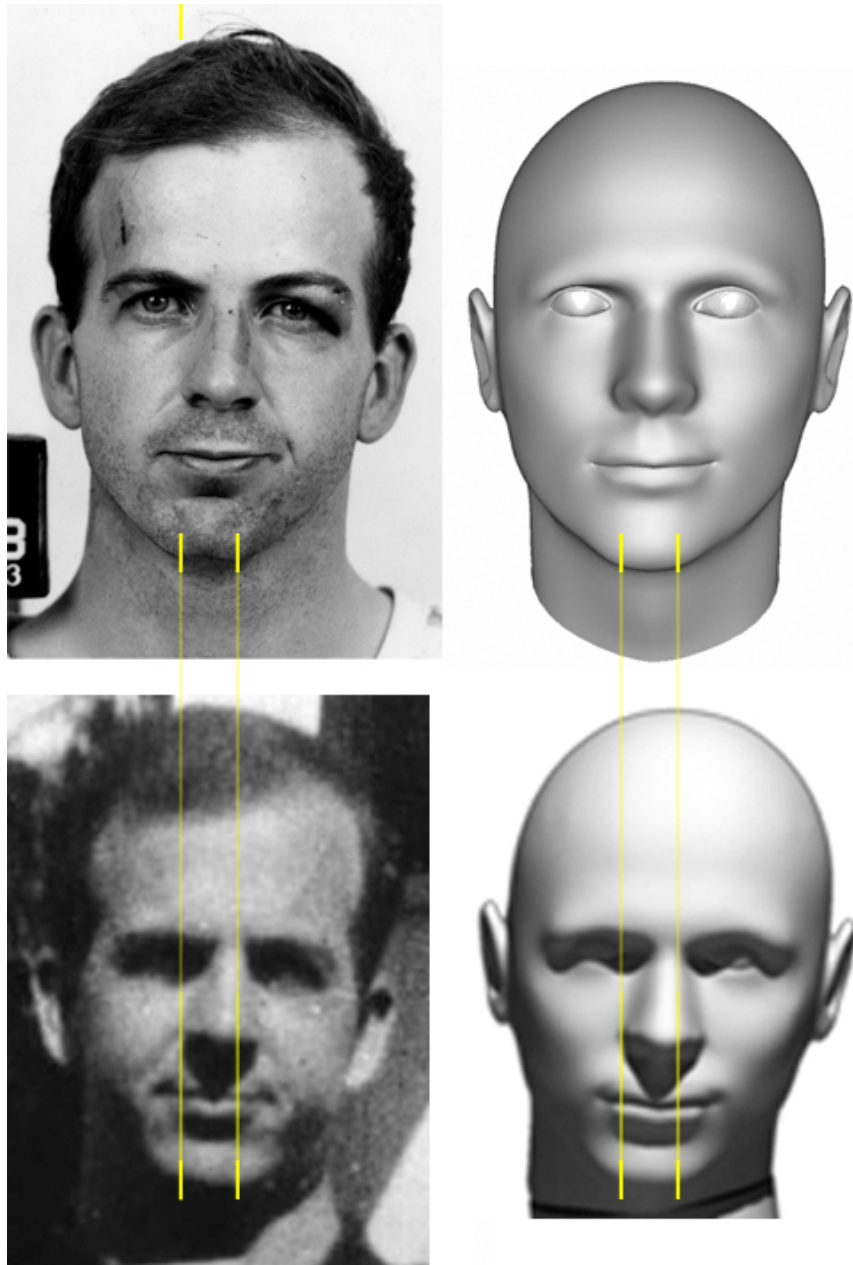
Figure 8: Shown along the top row are frontal views of Oswald with neutral front lighting. Shown below is Oswald and the corresponding 3-D rendering from the backyard photo. The yellow guidelines of the same width are drawn at the point in the top photos where the chin meets the jaw line. Note that the apparent widening of the chin is due to the shading along the chin and jaw.

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