Debunking the Moon Hoax Believers Using POV-Ray

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Abstract

There are a large number of web sites both claiming that no man ever landed on the moon and that man indeed has. Some evidence brought by the first group can be easily disproven by using the popular raytracing program POV-Ray.

This is a *work in progress*. I add to this as I find time. In the meantime, things may seem disjointed as I get the components organized. The date above will indicate when this was last updated.

Contents

List of Figures

1 A Simple View

We start with a simple view of an object and its shadow with figure 1 on the following page. Such a picture provides a reference for how everything is going to look. Another picture showing how items look in the air, a view the Apollo astronauts could not give us, is in figure 2 on page 4. A movie showing movement from the view in figure 2 on page 4 to figure 1 on the next page is downloadable as `polem.mpg`.

More specific information on POV-Ray may be found in § A on page 10.

2 Adding a Shadow View

In figure 3 on page 5, there are two poles on a small hill. Notice how the shadows diverge, similar in manner to pictures found on a web site Ian Goddard maintains,[1] which will be discussed in § 3 on page 7.

From the air, figure 4 on page 6 shows the same poles but from a view higher up.

A movie showing movement from the view in figure 3 on page 5 to figure 4 on page 6 is downloadable at `shadowsm.mpg`.

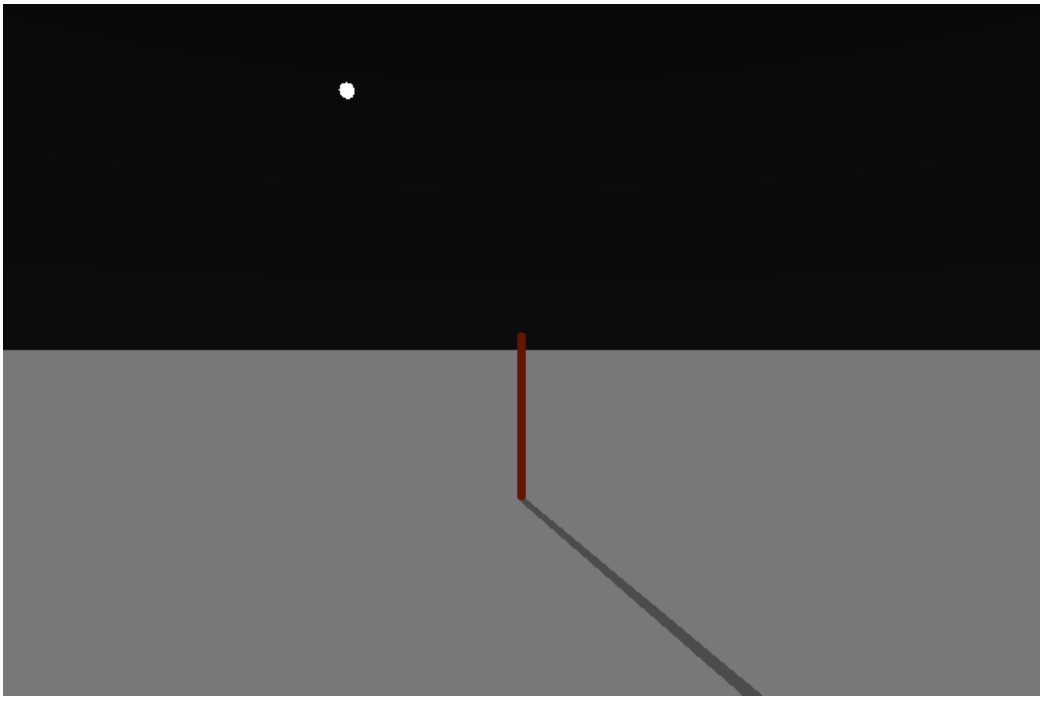

Figure 1: A Simple Pole View

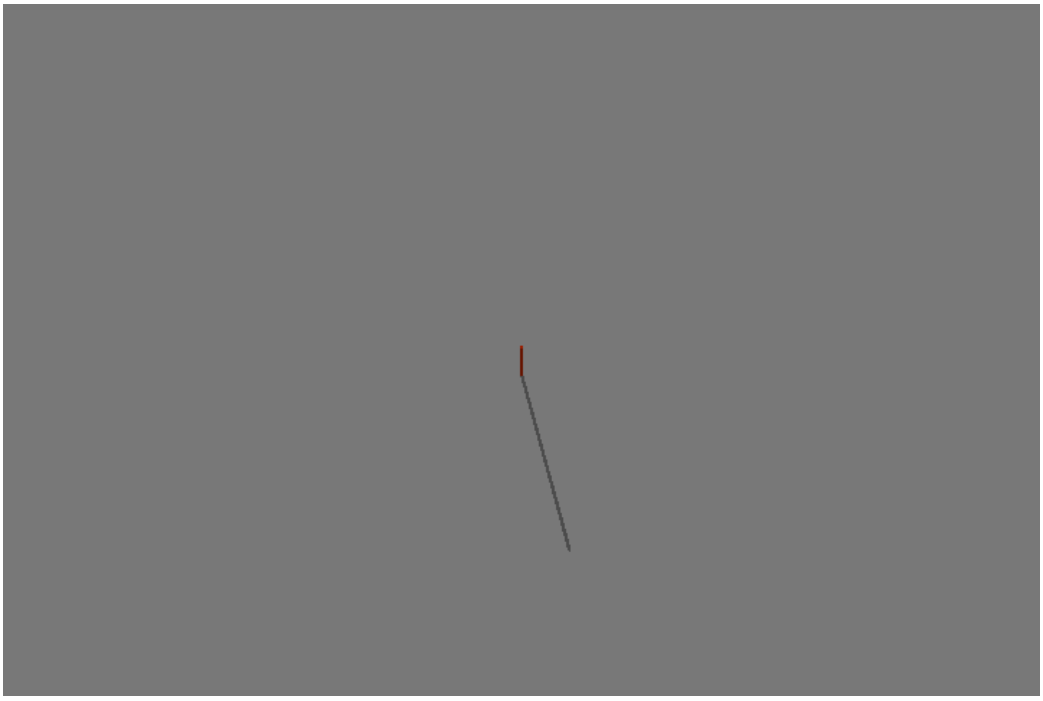

Figure 2: A Pole View In the Air

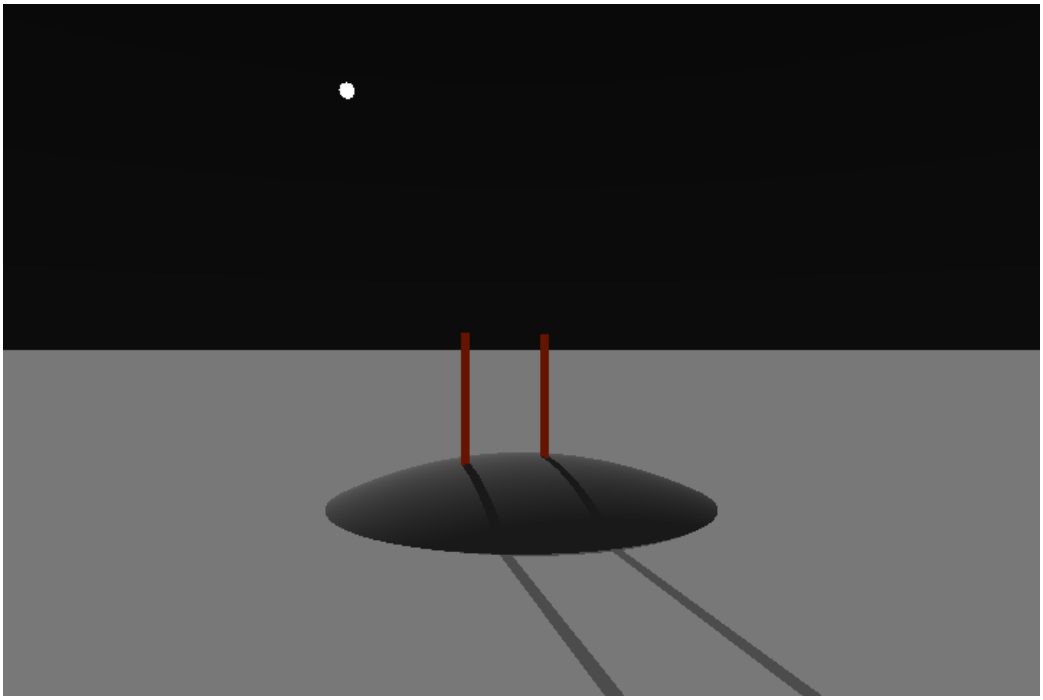

Figure 3: Two Poles Casting Shadows

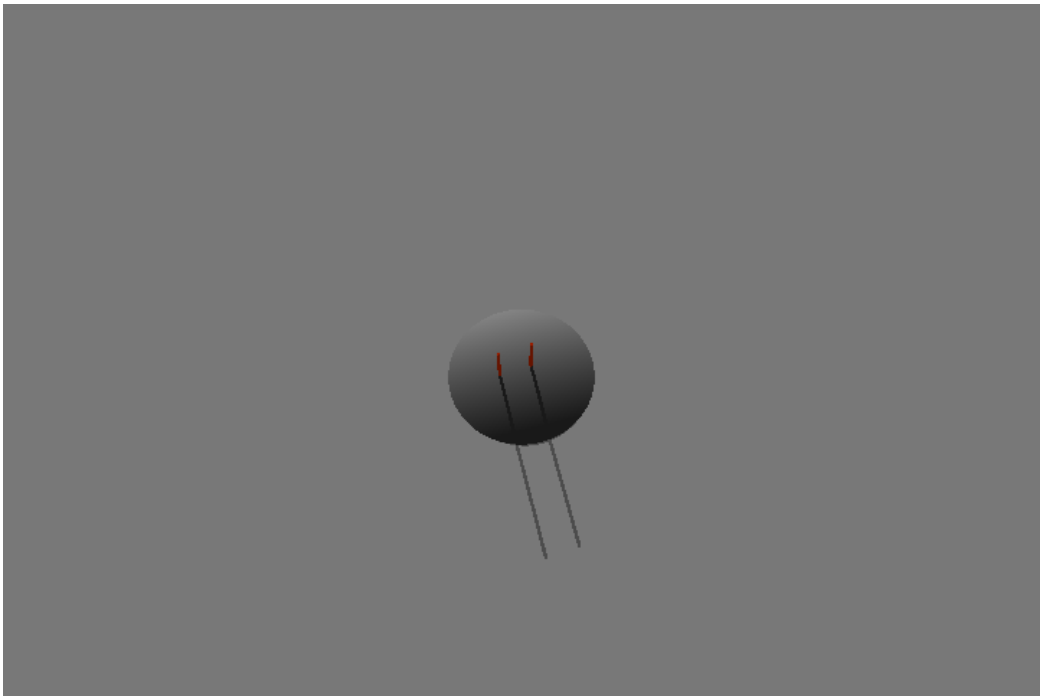

Figure 4: Two Poles Casting Shadows In the Air

Photo credit: NASA

Figure 5: Apollo Photo of Rocks On the Mound

3 Replicating Ian Goddard's Models

Ian Goddard has a web site[1] which excellently demonstrates how there was no moon hoax. I will replicate two concepts with POV-Ray in this section.

3.1 Rocks On the Mound

Figure 5 shows the original NASA photograph taken on an Apollo mission showing how the shadows diverge. Moon hoax advocates use the diverging shadows from the lander and the mound as "proof" that the moon landing was faked on a soundstage as the light source was too close to be done elsewhere.

Reproduction of this photograph involves getting the light source properly positioned with respect to the lander and the rocks. Figure 6 on the following page shows how we will reproduce the effect. From the air, figure 7 on page 9 shows the same view, with shadows from all the objects pointing in the right direction.

A movie showing the view from figure 7 on page 9 to figure 6 on the next page can be downloaded as `moundm.mpg`. The intent of the movie is to show that the

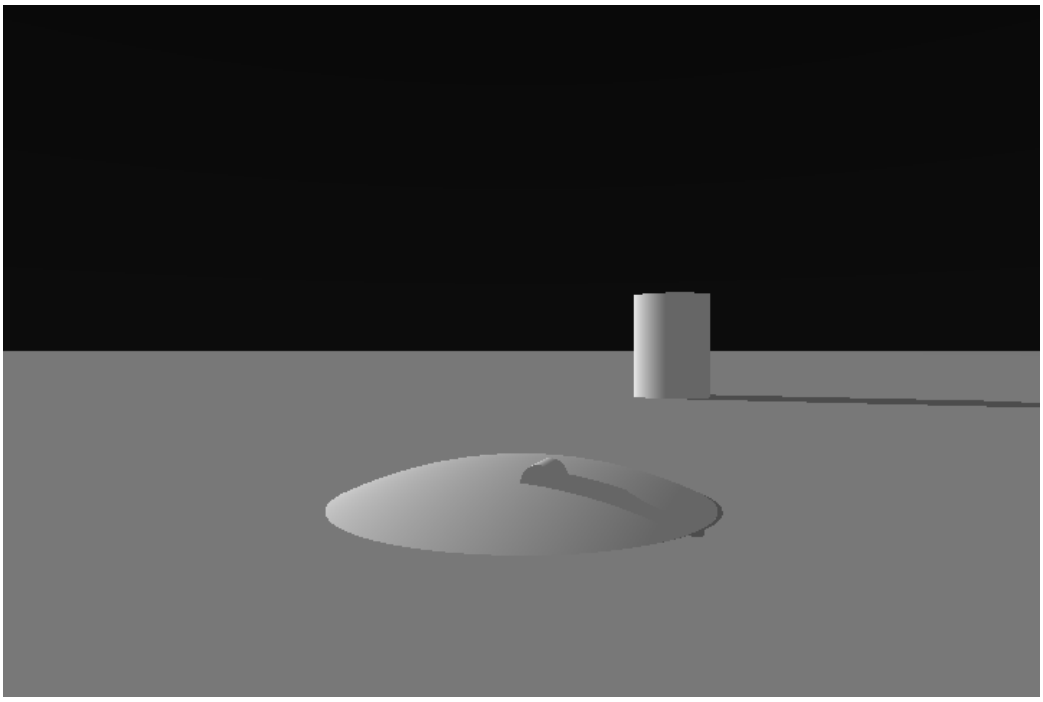

Figure 6: POV-Ray Rendering Of Rocks On the Mound

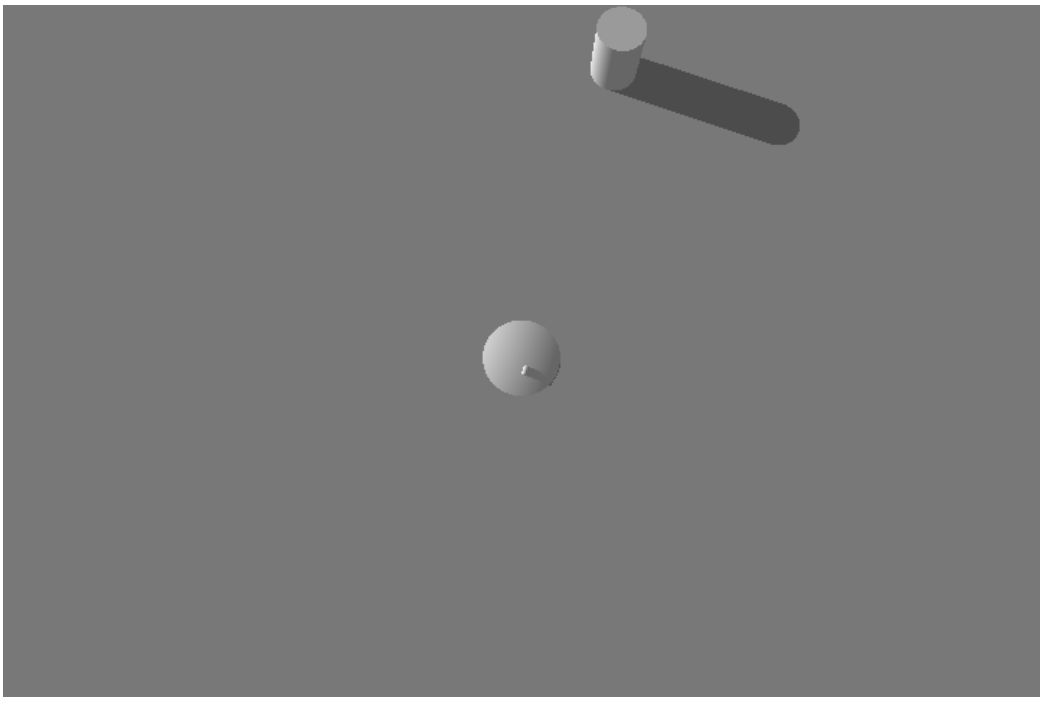

Figure 7: POV-Ray Rendering Of Rocks On the Mound From the Air

```
light_source {
   100000 * <-0.052336, 0.341551, -0.938405>
   color rgb <1.0, 1.0, 1.0>
   looks_like {
      sphere {
         100000 * <-0.052336, 0.341551, -0.938405>, 2000
         pigment {
            color rgb <1.0, 1.0, 1.0>
         }
         finish {
            ambient 1.0
         }
      }
   }
}
```

Figure 8: POV-Ray Sun Placement Commands

lines start out parallel, but due to the slopes on the mound, the light source appears to be closer.

A POV-Ray Usage Specifics

The raytracing program POV-Ray[2, 3] was used for the examples.

A.1 Sun Placement

The sun was set at a 3 degree horizontal and a 20 degree vertical angle from the origin by using the commands specified in figure 8. To calculate the unit vector $\langle -0.052336, 0.341551, -0.938405 \rangle$ shown in figure 8, we let θ represent the vertical angle and we let ϕ represent the horizontal angle.

From this, the following formulas represent the unit vectors used:

$$x = \sin\phi \tag{1}$$

$$y = \cos\phi \sin\theta \tag{2}$$

$$z = \cos\phi \cos\theta \tag{3}$$

Verification that $\langle x, y, z \rangle$ is a unit vector can be accomplished with the formula

$$x^2 + y^2 + z^2 = 1 \tag{4}$$

Using formulas 1, 2 and 3, as well as the relationship

$$\sin^2 \alpha + \cos^2 \alpha = 1 \tag{5}$$

the following computations are performed:

$$\begin{aligned}
& x^2 + y^2 + z^2 \\
&= (\sin\phi)^2 + (\cos\phi \sin\theta)^2 + (\cos\phi \cos\theta)^2 \\
&= \sin\phi \sin\phi + \cos\phi \sin\theta \cos\phi \sin\theta + \cos\phi \cos\theta \cos\phi \cos\theta \\
&= \sin^2\phi + \cos\phi \sin\theta \cos\phi \sin\theta + \cos\phi \cos\theta \cos\phi \cos\theta \\
&= \sin^2\phi + \cos\phi \cos\phi \sin\theta \sin\theta + \cos\phi \cos\phi \cos\theta \cos\theta \\
&= \sin^2\phi + \cos^2\phi \sin\theta \sin\theta + \cos\phi \cos\phi \cos\theta \cos\theta \\
&= \sin^2\phi + \cos^2\phi \sin^2\theta + \cos\phi \cos\phi \cos\theta \cos\theta \\
&= \sin^2\phi + \cos^2\phi \sin^2\theta + \cos^2\phi \cos\theta \cos\theta \\
&= \sin^2\phi + \cos^2\phi \sin^2\theta + \cos^2\phi \cos^2\theta \\
&= \sin^2\phi + \cos^2\phi (\sin^2\theta + \cos^2\theta) \\
&= \sin^2\phi + \cos^2\phi (1) \\
&= \sin^2\phi + \cos^2\phi \\
&= 1
\end{aligned} \tag{6}$$

(Note: the hard-coding of the unit vector in figure 8 on the preceding page must be changed in time.)

There are extra commands available in case an area light is desired, as documented in § A.2.

A.2 Area Light Computations

If soft shadows from objects distant from, say, the ground are desired, this effect is simulated with an area light. This simulates the necessary umbra and penumbra in a manner much like the sun.

There is a plane the area lights are attached to, so to speak. To determine which way and which length the axis vectors u and v with a distance d are drawn are computed with the formulas

$$u = d \times (y, -x, -z) \tag{7}$$

```
area_light
20000 * x, <0, 14142.1, 14142.1>, 15, 15
adaptive 4
circular
```

Figure 9: Extra Area Light Commands

and

$$v = d \times (-x, -z, y) \tag{8}$$

The commands used to do this are shown in figure 9.

In time, more accurate vector computation routines will be determined and used.

A.3 The Final Result

A picture showing a view of the "sun" approximating normal human visual angles is shown in figure 10 on the next page. This graphic is provided to check the placement and proportions of the sun. Code which generates this graphic is provided in figure 11 on the following page.

References

[1] Ian Goddard. Apollo moon photos: A hoax? Web site: `http://www.iangoddard.net/moon01.htm`.

[2] POV-Team. *Introduction To POV-Ray*, version 3.6.1 edition.

[3] POV-Team. *POV-Ray Reference*, version 3.6.1 edition.

Figure 10: View Of the Sun

```
camera {
   location <-0.5, 1.8, 8>
   look_at 100000 * <-0.052336, 0.258464, -0.964602>
   up y
   right 1.5*x
}
```

Figure 11: Code For View Of the Sun

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