

Perspective at Small Visual Angles

Saturday, July 21, 2007

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1. Visual Angle

When an object, such as a building, is viewed by the human eye, an imaginary angle is created as shown in Figure 1.0. In this paper, this imaginary angle is called the “visual angle”.

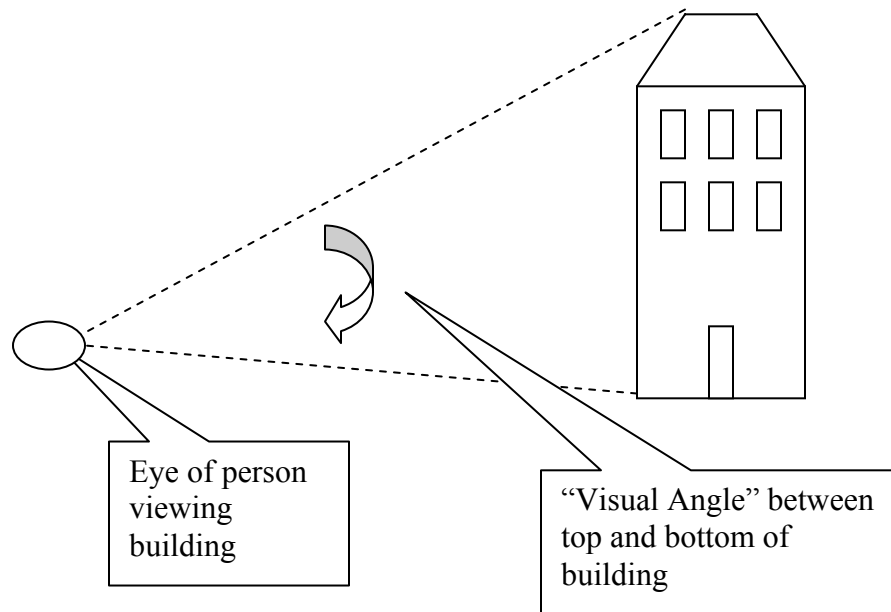


Figure 1.0
A visual angle created by a viewer

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Saturday, July 21, 2007

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The visual angle increases if the person stands closer to the building, as shown in Figure 2.0.

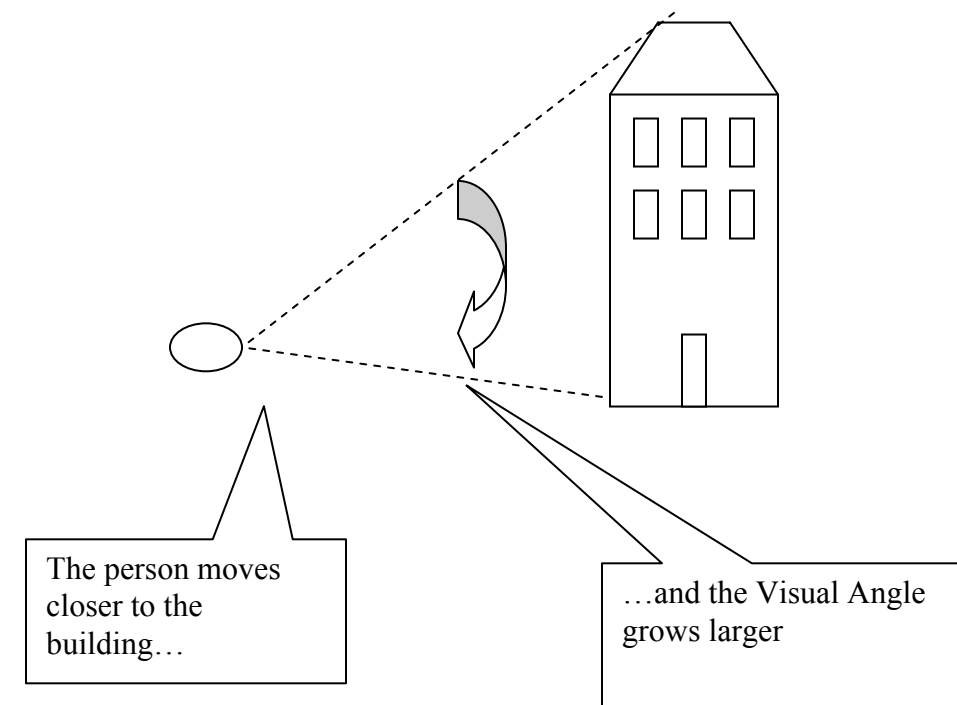


Figure 2.0
The viewer's visual angle increases as the viewing distance decreases

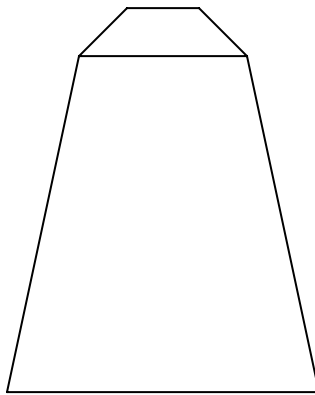
Perspective at Small Visual Angles

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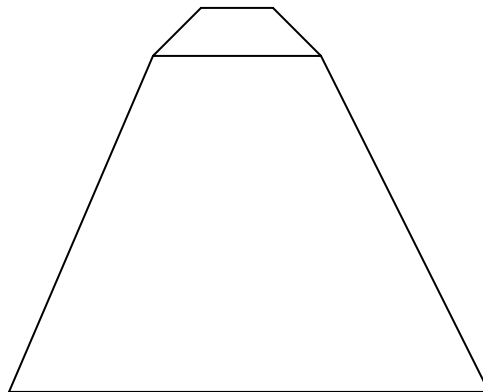
2. Perspective determined by Visual Angle

The visual angle determines what the building looks like to the viewer. The viewer in Figure 1.0 sees the outline of the building as follows:



The top of the building appears to be narrower than the base, because the top of the building is farther from the viewer than the base.

As the viewer moves closer to the base of the building, the visual angle grows larger, and the outline of the building's shape appears to change as follows. The viewer in Figure 2.0 would see the building with a different shape:



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3. Small Visual Angles

Suppose the viewer is far away from the building, as in Figure 3.0

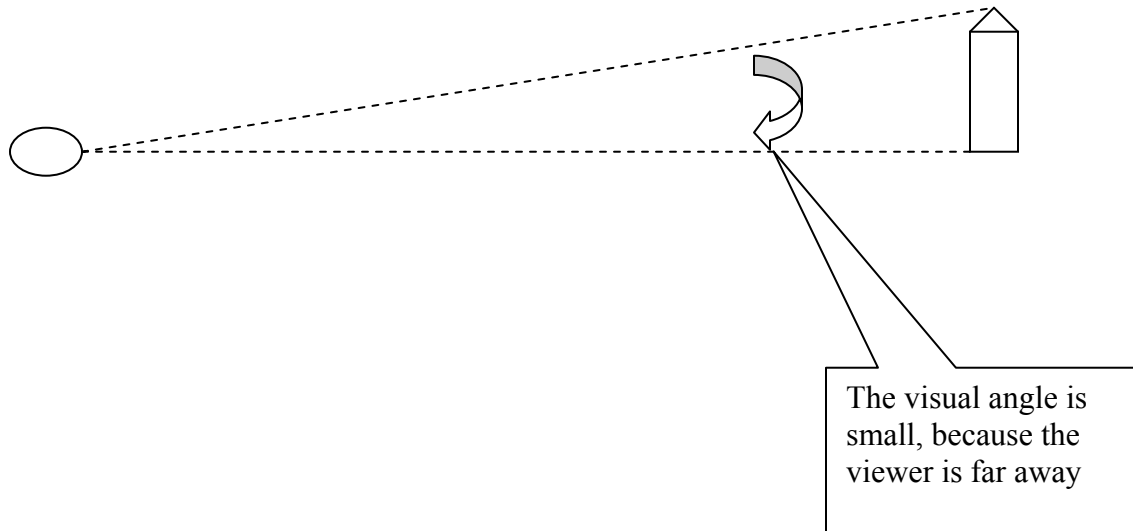


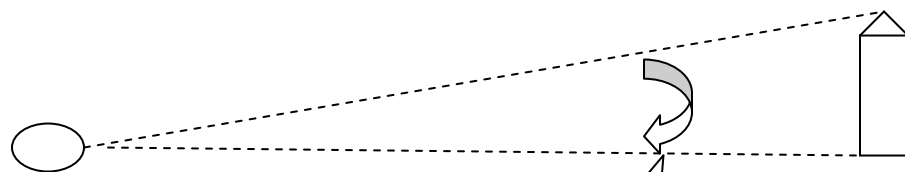
Figure 3.0
At great distances from an object, the visual angle is small

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Saturday, July 21, 2007

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If the viewer in Figure 3.0 moves a little bit closer to the building, the visual angle does not grow much bigger (Figure 4.0).



As the viewer moves a little closer, the visual angle stays small, because the viewer is still far away.

Figure 4.0

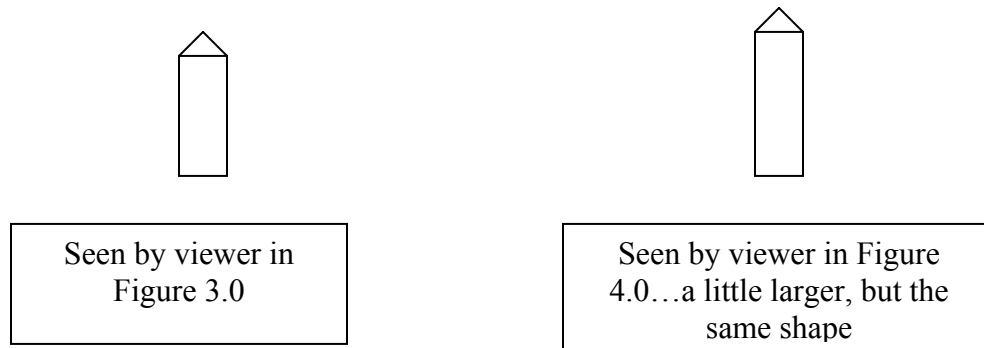
At great distances from an object, the visual angle is small even if the distance between the viewer and the object increases or decreases slightly

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Saturday, July 21, 2007

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The viewer in Figure 3.0 and the viewer in Figure 4.0 would see the building looking about the same, as follows:



Because the distance between the viewer and the building is so great, the top of the building looks as wide as the base. As the distance between a viewer and an object increases, the lines at the top and bottom of the visual angle become more and more parallel.

At an infinite distance, the visual angle is zero, and the angle's top and bottom lines are parallel.

When an architect draws an "elevation" picture of a building, the architect's picture shows the shape of the building as if the viewer is infinitely far away from the building.

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Saturday, July 21, 2007

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4.0 Small Visual Angles Under Magnification

If an automobile is viewed through field glasses from a great distance, the shape of the automobile will appear to be distorted (see Figure 5.0).

The part of the automobile that is more distant will appear to be “too wide”. This is because the distance between the front and the back of the automobile is much less than the distance between the automobile and the viewer. The width of the front and width of the back look about the same. The viewer is accustomed to looking at automobiles from short distances. At a short distance, the part of the automobile that is more distant will look much narrower than the part that is closer.

When automobiles are seen at great distances through field glasses, the parts of the automobile that are farther away from the viewer look “too wide”, because the viewer is not accustomed to viewing automobiles that are “subtended” by a small visual angle.

This illusion is created by the fact that the viewer’s experience causes him to remember that the more distant part of the automobile always appears to be narrower than the closer part. When the viewer sees the automobile from a great distance through field glasses, his memory informs him that the farther part of the automobile is “too wide”

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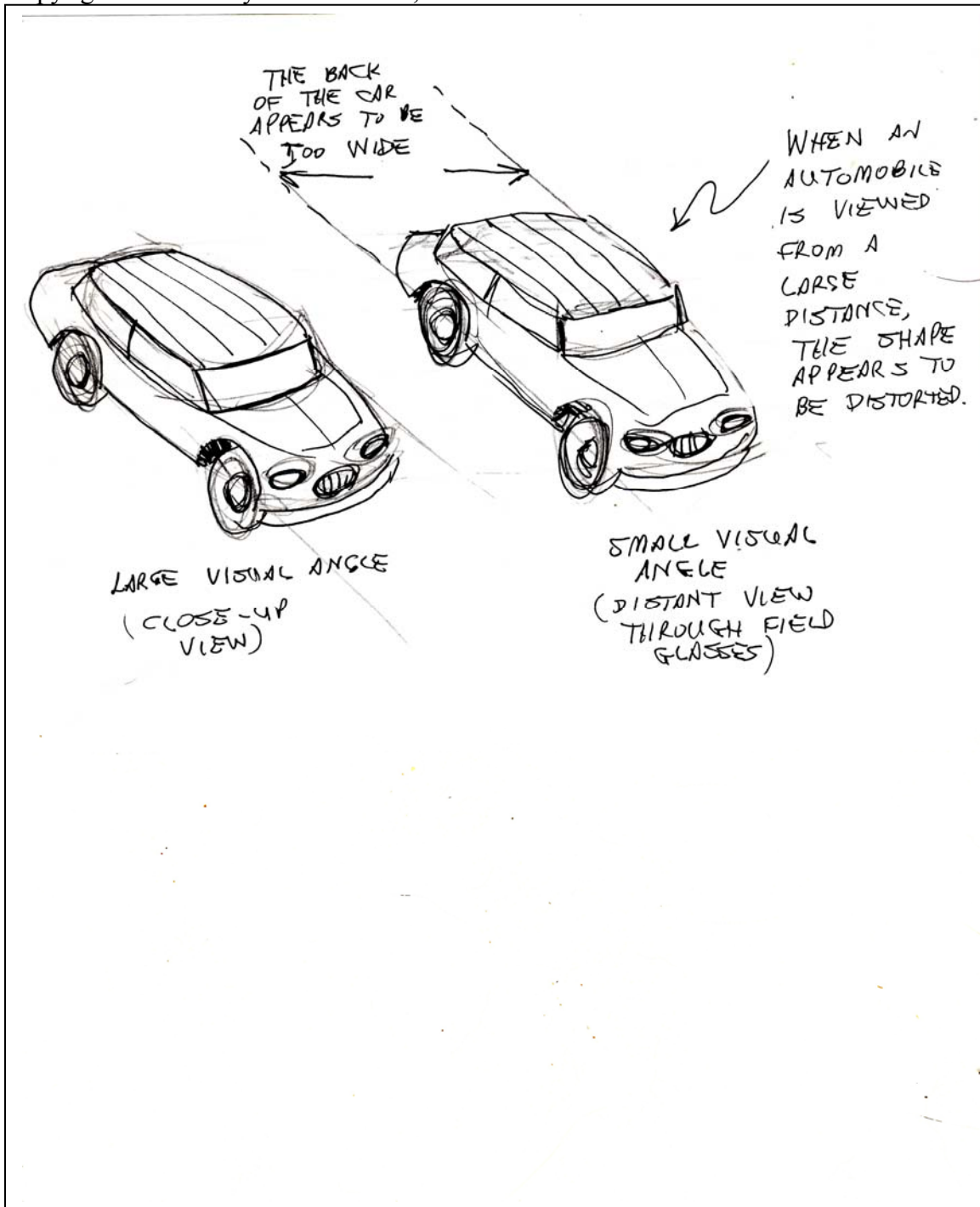


Figure 5.0

An automobile viewed from a great distance through field glasses will appear to be distorted. The part that is farther away will subtend almost the same visual angle as the closer part, giving rise to the illusion of distortion.