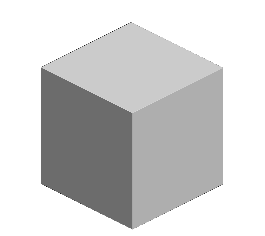
Chapter 7

**DEPTH AND SIZE PERCEPTION**

1. The old B-grade science fiction movies often used scale models. Godzilla was actually crushing small buildings only a few feet high. These models were filmed up close to make them look bigger, but to make the illusion more compelling, the film of the collapsing structures was slowed down, rather than played at normal speed. Applying your knowledge of motion parallax and optic flow, why does this work?

*Hints and discussion: Because the objects are shot at a close distance, motion-based depth cues could in principle reveal this fact. The slowed down film simulates the optic flow associated with events that are farther away. Thus the buildings more effectively look like large objects viewed from a distance rather than small objects viewed close up.*

1. When learning to draw, it can be challenging to depict depth properly – that is, to draw a 3-dimensional world on a 2-dimensional canvas. One of the most basic lessons in drawing involves applying the laws of projective geometry to portray depth through the use of cues such as texture gradients, linear perspective, and relative size. Imagine drawing a cube. Cubes have 6 square sides, but from a given perspective, only 3 will be visible and will not project a square shape to the eye, as shown:



But note also that this effect is unique to vision, and not touch. When one touches the cube, each square side always “projects” a square shape to the skin. If one was born blind and only learned about cubes by touching them, it is difficult to imagine one could learn to draw cubes in perspective, at least not without special training. Consider then the drawings of Esref Armagan, a painter born without eyes and without any education or training, has learned to draw perspective, and portrays visual depth quite accurately in his work.

<http://armagan.com/paintings.asp>

How do you think he figured this out?

*Hints and discussion: Is it possible an understanding of visual depth is innate? Or maybe he just figured out the nature of depth intellectually?*

1. In considering the importance of experience on perceptual function, the French philosopher William Molyneux once famously sent a letter to John Locke, posing a question now known as Molyneux’s question. Here is the question verbatim from the letter:

Suppose a man born blind, and now adult, and taught by his touch to distinguish between a cube and a sphere of the same metal, and nighly of the same bigness, so as to tell, when he felt one and the other, which is the cube, which is the sphere. Suppose then the cube and the sphere placed on a table, and the blind man made to see: query, Whether by his sight, before he touched them, he could now distinguish and tell which is the globe, which the cube?

Molyneux is asking whether the blind man, seeing things for the first time, could recognize the cube, which feels like a square sided object when held in the hand, but does not project square shaped images to the eyes when seen in perspective. Molyneux and Locke agreed that the answer was “no” and that the blind man would require experience looking at the object while touching it in order to start recognizing it by sight alone. Considering what you know of Esref Armagan’s paintings, do you agree with them?

*Hints and discussion: This discussion is a follow-on to the previous question. Armagan’s ability to understand depth and perspective without visual experience raises the possibility that experience is not required.*

1. Researchers have employed virtual reality for a great many purposes, and one of the more interesting applications to emerge in recent years has been for video games and home entertainment, as evidenced by the hype surrounding the *Oculus Rift*, an affordable head mounted display intended to be a consumer product. Head mounted displays use two small screens inside a helmet worn over the eyes to display a 3D world. The two screens enable the use of binocular depth cues, in addition to the usual monocular depth cues already present in images – as a result, virtual worlds have a compelling sense of depth. However, many studies have found that distance is consistently underestimated in virtual worlds – this despite all efforts to employ all depth cues correctly. Given your understanding of depth perception from the chapter, why do you think this might occur?

*Hint and discussion: One thing that cannot be changed about head mounted displays is the small visual field. One hint to provide students is that a small visual field (or placing a frame around an object) can make objects look bigger. When objects look bigger than they are, they can also appear as closer than they are, requiring students to apply knowledge of size-distance invariance. We also cannot typically touch virtual objects, so we receive no feedback when trying to interact with a virtual world. Also, the depth cue of accommodation is in conflict with the other cues. Inside the helmet, the eyes are accommodating to the small screens that are a few inches from the eye, while all other cues are specifying distances much further away.*