

Shape Perception of Mirror Surfaces from Monocular Images

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Three-dimensional shape may be perceived from monocular static images. Contours, shading, texture gradients, perspective and occlusion are well-studied cues to this percept. When looking at a smooth reflecting object, such as a silver plate, a stainless steel spoon or the side of a clean car, one additional cue is potentially available: the surrounding scene is reflected off the object, and the deformation of this reflection is a function of the shape of the object's surface. Our geometrical analysis indicates that this deformation allows recovery of depth, tangent plane and surface curvature when the external world has a known shape. Is this cue used by the human visual system?

In order to investigate this question we asked a number of human observers to discriminate between images of mirror surfaces of distinctly different shapes: a sphere, a cylinder and the neck of a vase. Such shapes have positive, zero and negative Gaussian curvature and generate very different distortions of the same scene. Our subjects were shown complete photographs of the three objects before the experiment in order to familiarize them with the shapes. The experimental stimuli were 100 photographs of large patches of each mirror surface. In order to facilitate the task we used a regular and known scene: the surfaces reflected a checkerboard pattern under diffuse lighting. Each patch was vignetted by irregularly shaped boundaries, in order to eliminate occluding boundary information and was viewed monocularly on a standard computer monitor. The subjects were asked to assign each of a hundred stimuli to one of the three objects in a forced-choice paradigm. 80% of our subjects were at chance in discriminating the three surfaces. The remaining performed at 70% correct indicating that specular reflection is at best a weak cue for most human observers when other cues are not available.