



Ray Tracing

The work described here is from my MSc project to render atmospheric mirage phenomena, and supervised by Toby Howard. These images have dated, but at the time computing resources were quite modest. The first scene shown was ray-traced to show that my ray-tracer implementation worked in principle. This scene shows texture mapping, reflections, and transformed objects. On the left, the second scene shown was adopted as a test scene upon which various mirage conditions were applied. A simple scene was chosen in order to prove that the mirage effect was being reproduced as expected.

The Mirage Phenomenon

Mirages occur when light rays, under certain atmospheric conditions, begin to bend rather than travel in a straight line. Our brains misinterpret the visual information received because our experiences show that light travels in straight lines. These atmospheric conditions are seen when there is a variation in refractive index in the atmosphere, the action of which is similar to a lens with no shape since both the observer and the object exist inside it. The light bends as a result of a density gradient in the atmosphere.

Inferior Mirages

A hot desert, blazing sun, palm trees and the illusion of water is what many people associate with the word mirage. This scenario tends to arise when there is a drastic temperature decrease as the distance from the ground increases. For example as the sand in the desert heats up it warms a band of air directly above it by a significant amount relative to the air a few meters above the ground, and there exists a temperature gradient.

The light rays curve up towards the cooler air via a combination of refraction and total internal reflection. Drastic bending occurs closest to the ground which is where the temperature gradient is changing most rapidly with height. Inferior mirages result in an object or scene having an inverted and often somewhat distorted virtual image of itself.

Superior Mirages

This type of mirage can typically be observed over a lake, ocean, or snow covered land, which is substantially colder than the land above. Hence, again there is a temperature gradient. However, this time there is an increase in temperature with distance from the ground or surface. The rays curve towards the cooler air, and the resulting image appears elevated, perhaps even floating in the sky.



The Fata Morgana Mirage

The Fata Morgana is named after the fairy Morgan, who appears in some of the Arthurian legends as King Arthur's sister and was credited with the power of creating castles out of air. It is probably one of the most spectacular mirages to have been observed. This mirage has been known to have transformed flat surfaces into hills, valleys and snow capped peaks. The leader of the expedition to "Crocker Land" in 1913 journeyed 30 miles in search of a wonderful land that had obligingly appeared before realising that "Crocker Land" was a mirage. The conditions for this kind of mirage, is an inflection point temperature profile which can exist over an enclosed body of water on a sunny afternoon.

The pair of images on the left show the test scene pre and post inferior mirage. In the scene rendered with inferior mirage computation enabled, the spheres and the ground appear to be magnified. Virtual images of both spheres are visible and the spheres appear to be distorted in the vertical axis. This is as expected because all of the pixel displacement occurs in this direction.