

Visibility and Dead-Zones in Digital Terrain Maps

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Abstract

The problem of detecting the visible and hidden areas of a topographic surface from a given viewpoint is well known, and has applications in GIS and other fields. The computational geometry literature is rich with solutions based on a polygonal representation of the surface. This work confronts the problem by working directly on the Digital Elevation Map which represents the terrain surface. We present an algorithm that processes discrete lines of sight from the viewpoint to the surface perimeter, and tests the unit-sized terrain elements along the discrete cross-sections defined by these lines. The algorithm is very efficient, performing $O(n)$ testing operations, consisting of a few additions and no more than one multiplication each, where n is the number of the terrain elements in the map.

Keywords: Digital Terrain Maps, GIS, Terrain Modeling, Discrete Lines, Visibility Maps.

1 Introduction

Given a terrain surface and a viewpoint, the visibility problem is defined as the detection of the portion of the terrain that is visible from the viewpoint. This problem has a large variety of applications in the geographical information systems (GIS). For example, the selection of the best locations for viewpoints, which is important to widely differing tasks like tourism and military monitoring. The visibility from specific points of view is an important tool for path planning, especially in a cluttered environment. For landmark-based navigation the visibility information assists in locating landmarks expected from a certain viewpoint, in an algorithm that iteratively decreases location error.

It is important to note that the terrain visibility problem addressed by this paper *is not* the classical problem of rendering a terrain model through a viewpoint

Since the terrain models are represented by digital maps, the problem can be redefined as a problem of coloring the discrete points of the map which are visible or hidden from a given viewpoint. The digital terrain map is a finite set of points on the terrain surface. The set of points can be the vertices of a polyhedral surface, usually consisting of a triangular irregular subdivision, or it can be regularly spaced in a grid form. The latter case is internally represented by an array of heights which we call digital elevation maps (DEM).

An elevation map colored by the colors of the corresponding aerial photograph is called a *digital terrain map* (DTM). DTMs are usually produced from a pair of stereo photographs and thus they