Multiple Observer Siting on a Compressed Terrain

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1. Introduction

We consider the problem of multiple observer siting on a compressed terrain. The problem is to site a group of observers so as to maximize the amount of visible terrain; an application is the placement of watchtowers to observe a territory. In real life, we have access to only a compressed terrain because the original terrain requires too much storage. For our problem, we want to evaluate the quality of the compression provided by the compression scheme.

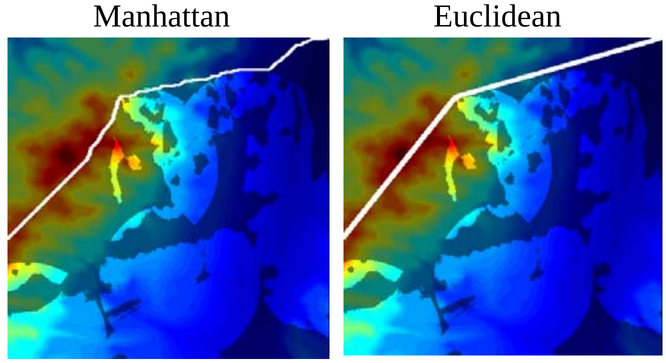
The usual way to evaluate a compression scheme is to calculate the average and the maximum errors of the compressed terrain. The approach may not be appropriate for this application because we are interested in avoiding detection. In this paper, we propose a new test protocol and new error metrics. Our new protocol is to compute a minimum-length path from the northwest corner of the terrain to the southeast corner, while avoiding detection, and our new error metrics are to examine path lengths and visibility errors.

2. Algorithm

We apply an algorithm due to Franklin and Vogt [1] to do the multiple observer siting. Our algorithm consists of four steps. First, compress the original terrain and then uncompress it to generate the alternate representation. Second, perform multiple-observer siting [1] on the alternate representation to generate a set of observers, along with the corresponding joint viewshed. Third, site the same group of observers on the original terrain, and compute the new joint viewshed. Finally, compare the two viewsheds to determine the difference in visibility between the two representations.

Our new test protocol for path finding is also a four step algorithm. Indeed, the first three steps are identical to the corresponding first three steps above. In the fourth step, we apply the A* algorithm to find the paths for both the original and the alternate representations. A word of caution in step four: the naïve method for computing the shortest path results in only the Manhattan distance being minimized. We propose a new scheme which seeks to minimize the Euclidean distance, without sacrificing efficiency. Our new error metrics consist of comparing the two path lengths and determining how much the paths are visible on the original representation.

Manhattan   Euclidean



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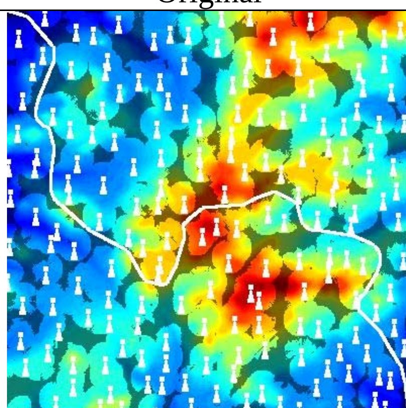
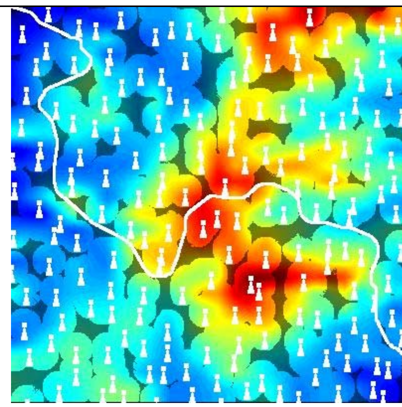
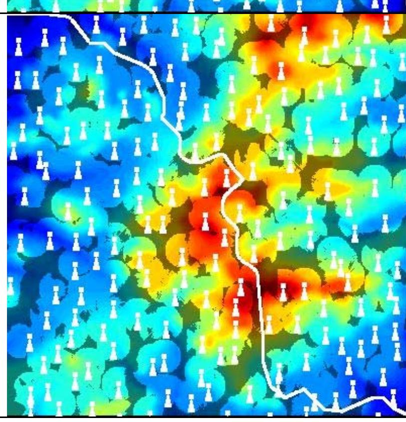
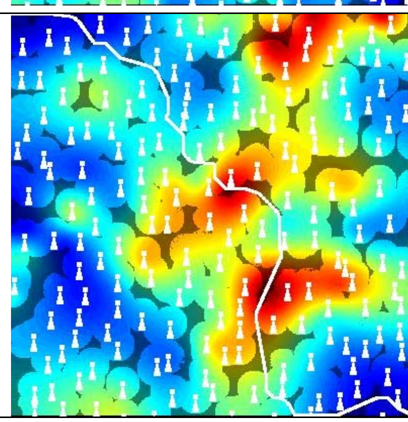
3. Results

Using our new protocol and error metrics, we compare two compression schemes: the famous JPEG 2000 and our new approach of TIN+ODETLAP (Overdetermined Laplacian Solver). The two schemes are competitive. There are cases where JPEG 2000 performs better, and there are cases where TIN+ODETLAP wins out. It appears that our new approach is better when the terrain is very heterogeneous, as illustrated in the example below.

	JPEG 2000	TIN + ODETLAP
Original Viewshed Size	123416	125520
Alternate Viewshed Size	135998	137117
Viewshed Error	9.76%	9.04%
Path Length Error	5.81%	0.23%
Path Visibility Error	1.56%	0.27%

	Original	Alternate
JPEG 2000		
TIN + ODETLAP		

References

[1] Franklin, W. R., and Vogt, C., Efficient multiple observer siting on large terrain cells, in *GIScience 2004*, University of Maryland.

[2] JPEG Committee, JPEG 2000, http://www.jpeg.org/jpeg2000/index.html, 2004.