ABSTRACT

Title of Dissertation: A GEOGRAPHIC INFORMATION SYSTEMS-BASED MODEL FOR HIGHWAY DESIGN OPTIMIZATION

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Construction of a new highway requires selection of a minimum cost route, which involves careful planning, design, right-of-way acquisition, and construction. Selection of the most economical route is a complex process which depends on detailed assessment of a number of factors including geographic features and damage to properties and environment. A computerized highway design model can greatly assist in evaluating several alignment alternatives, can save time and money, and can help in making reliable decisions.

The proposed highway design models seek to minimize alignment-sensitive costs subject to a set of design constraints. Previous studies on highway design optimization had limited practical application due to a number of deficiencies. First, cost functions were not formulated precisely, limiting the reliability of the solutions. Second, the huge amount of manual data input prevented solution of the real size

problems. Third, the models were not able to work with real maps, thereby limiting practical application.

This dissertation starts by investigating major cost components in highway optimization and addressing inherent deficiencies in the existing optimization models that limit their practical application. Geographic Information Systems (GIS) are exploited and costs sensitive to geography are comprehensively formulated. GIS-based algorithms are developed to compute right-of-way costs using spatial relations. Mitigation of wetlands and floodplains is considered and a detailed earthwork-cost formulation is developed. GIS-based methods are also developed to automatically supply input data for alignment optimization, such as land-cost, land-use type, and topography.

Genetic Algorithms (GA) are used for optimization due to their effectiveness at searching in a continuous search space where numerous local optima exist. A bi-directional communication link is established between the GIS and the GA to develop an integrated model enabling continuous exchange of data during the optimization process.

The models and algorithms are applied in a number of example studies including studies using real maps and databases from Maryland. The results, including applications of the proposed method to solve real problems, show significant improvement over previous models. The computational efficiency of the proposed models is also assessed. It indicates that problems of reasonable size can be solved on personal computers.

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by

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