State-of-the-art intelligent road design model with genetic algorithms, geographic information systems, and CADD

M.K. Jha[1] C. Davis[2] M.-W. Kang[3]

[1]*Center for Advanced Transportation and Infrastructure Engineering Research, Department of Civil Engineering, Morgan State University, Baltimore, MD 21251, USA*
email: mkjha@eng.morgan.edu
[2]*Department of Engineering and Technology, Virginia State University, 1 Hayden Drive, Box 9212, Petersburg, VA 23806, USA, email: daviscq@yahoo.com*
[3]*Department of Civil and Environmental Engineering, University of Maryland, College Park, MD, 20742, USA, email: mkang5@umd.edu*

subm. 11th May 2006 *approv. after rev. 20th July 2007*

Abstract

A state-of-the-art intelligent road design model is developed that has the ability to simultaneously optimize 3-dimensional highway alignments, exploit Geographic Information System (GIS) maps and databases for enhanced practical applications, and view detailed design features, including road animation and digital terrain models. We provide an overview of the integration of the highway design procedure using an AutoCAD-based package called RD 2000 with a Highway Optimization Model (HAO) developed by our research team. The initial 3-D highway alignment optimization problem with genetic algorithms was studied by our research team in 1996; since then successive enhancements to the model has been made resulting in several real-world applications. The development of the intelligent road design model enables integration of CADD and digital terrain modeling capabilities to the developed genetic algorithms and GIS-based optimization model. An example from Maryland demonstrating full potential of the model is presented. Several future enhancements to the model are also discussed.

Keywords – Intelligent road design, highway alignment optimization, Genetic algorithms, GIS, CADD

1. Introduction

There are numerous alternatives that must be analyzed when planning and designing roads. Many complex and conflicting factors have to be considered. Among these factors include topography, geology, hydrology, land-use and values, environmental impacts, construction procedures and costs, traffic flows, safety, interfaces with present and future networks, life-cycle maintenance and user costs, and political concerns and preferences. Numerous uncertainties exist and poor location settings can occur when selecting transportation facilities. Billions of wasted dollars have resulted from last minute design changes and relocations. This is attributable to the complexity associated with manually attempting to optimize the locations of transportation facilities and lack of automated methods for this task. Some noted projects that have fallen into this persona of planned, ongoing, and recently completed/failed projects are shown in tables 1 and 2.