Engineering Applications of Artificial Intelligence 133 (2024) 108037

Contents lists available at ScienceDirect

Engineering Applications of Artificial Intelligence

journal homepage: www.elsevier.com/locate/engappai

Intelligent optimization of highway alignments: A novel approach integrating geographic information system and genetic algorithms

Botan M. Ahmad AL-Hadad *, Wrya H. Nadir, Glpa Ali M. Jukil

Erbil Polytechnic University (EPU), Erbil Technology College (ETC), Road Construction Department, Erbil, Iraq

ARTICLE INFO

Keywords:
Highway alignment design
Intelligent genetic algorithms and geographic information system model
Station point approach
Corridor search

ABSTRACT

Searching for a near-optimal highway alignment is essential to achieve safe, efficient, and cost-effective transportation infrastructure. The challenges with the traditional design approach lie in its reliance on geometric elements which may lead to alignments that are complex, financially burdensome, and environmentally disruptive despite exploring a wide search area.

This paper presents a novel and intelligent approach for highway alignment optimization, focusing on the development of the alignment using station points within a reduced domain. The approach involves utilizing a pre-generated Least Cost Path from a Geographic Information System (GIS) model, serving two purposes: first, determining the reduced search domain, and second, using it as input for genetic algorithms (GAs) until a near-optimal alignment is achieved. This approach simplifies the design process, reduces costs, and yields alignments that better harmonize with various relevant factors.

The integrated GIS-GA model of this study helped reduce the whole search space to a confined tubular square corridor (CTSC), where the best alternative exists. Additionally, the method introduced a new perspective on highway alignment design, challenging conventional practices. The model is validated using comprehensive and sensitive scenarios for key parameter values. The results reveal that the search time is significantly reduced and that better solutions are located in real-time. This methodology has the potential to revolutionize the way transportation engineers and planners approach highway alignment projects, resulting in more efficient, well-informed, cost-effective, and context-sensitive designs. Further studies are highly recommended to fully explore the implications and applications of the proposed methodology.