A Road Network Shortest Path Analysis

Abstract

Rapid emergency response to the scene of a traffic accident and transportation of the injured to a medical facility is critical for saving lives. Traffic congestion is a major problem in urban areas and Davis County, Utah is no exception. Traffic congestion can disrupt emergency response, but dynamic network routing can offer solutions. A GIS can be a useful tool for determining emergency vehicle response routing, and the application of dynamic variables like historical traffic count data can help emergency response vehicles avoid traffic congestion and improve response times.

This research examines a methodology where route solvers based on Dijkstra’s shortest path algorithm in ArcGIS Network Analyst were utilized to identify the closest ground emergency response unit (e.g., fire station) and hospital (e.g., trauma center) to each incident and then solving the shortest path problem centered around emergency response routing scenarios. Cost attributes or impedances, namely distance, free-flow travel time and time-varying travel time originating from historical traffic data, were applied to each routing scenario to determine the shortest, fastest, and best (optimal) routes from an origin to a destination. The best route is defined as the route with the least travel cost determined by the impedance applied.

Results were analyzed and compared. Findings based on these routing analyses show that dynamic time-varying travel time derived from historical traffic count data can
optimize emergency response routing, improve travel times and validate that dynamic network routing can improve emergency response routing above static networks.

Although challenges and limitations existed in this research, it is believed that future improvements through the incorporation of live traffic data using GPS technology and traffic cams could greatly enhance this type of research and assist local public safety and EMS agencies improve levels of service as population growth and subsequent traffic congestion increases.