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A Data Driven Approach for Safe Route Planning

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ABSTRACT

The rate of road accident fatalities depends on many factors including vehicle, roadway, environmental and driver characteristics. This research aims at reducing accidents using a data driven approach. Route planning applications such as Google Maps consider shortest time from a start point to a given destination. However, there are roads with design issues or high-risk roads that can result in fatal accidents and should be avoided. Although there are existing accident risk maps to help drivers to avoid such roads, these maps can be confusing and must be manually interpreted by drivers to find the safest path. The manual interpretation of the map is a time consuming and difficult task which results in ignoring the risk maps by drivers, due to complexity. This research aims at developing a novel tool to find the safest route. The resulting safe route is then compared to the path suggested by Google Maps.

KEYWORDS

Accident Records, Fatalities, OpenStreetMap, Routes and Routing, Shortest Path Algorithms, Traffic Safety

INTRODUCTION

Despite advances in car technology and stricter rules to improve motor vehicle safety, many people still lose their lives due to automobile accidents. According to the National Vital Statistics Report (NVSR) (Xu, Murphy, & Kochanek, 2016) there were 35,369 motor vehicle fatalities in 2013 in the United States, of which 25,048 were male and 10,321 were female. In 2013, crash deaths resulted in $44 billion in medical and lost work costs. Texas had the highest cost ($4.89 billion) and California had the second highest cost ($4.48 billion) while the District of Columbia had the lowest cost ($34 million). In the state of Maryland, the cost of deaths was $690 million,of which, $6 million was for medical costs and $684 million was for costs due to loss of work (CDC, 2015). Work loss costs are estimates that a dead person would have earned during his or her lifetime. It includes the total estimated salary, benefits and value of household work for an average person with the same age and sex over the remainder of his or her lifetime (CDC, 2015). The National Safety Council [NSC] (2015) reported 14% upward trend in motor vehicle fatalities for January through June 2015 from the corresponding period of time in 2014.

Considering how many people rely on technology to navigate while driving, there needs to be an approach that allows a driver to choose the safest path to a destination. Research has shown

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the willingness of professional drivers to take the safest routes (Bie, Arem, & Igamberdiev, 2010). However, at this point, there are no tools that exist to allow drivers to find the safest route to their destination. This paper presents a novel approach to design a safe route planner that uses accident occurrence data combined with open source routing solutions to reroute drivers to take the safest route to a given destination. Environmental conditions such as weather and day light are also an important factor in road safety. With this in mind, the safe route planner allows users to filter historical accident data based on parameters such as year, month, hour, weather conditions, light conditions.

The resulting safe route is presented as an alternative to the path suggested by traditional routing approaches that are based on the fastest route by considering speed limit combined with traffic congestion. To the best of our knowledge there are no studies addressing safety of drivers by combining real accident data with existing routing algorithms and open source maps to find safest roads to a given destination.

The paper is organized as follows: In the Related Work section, the authors present the summary of works related to this research. The Methodology section presents the dataset used in this research, the steps used to preprocess the data and the architecture of the safe routing planner. The Results section presents the observation and evaluation of the new framework where the result of the new routing method is compared with the fastest route recommended by Google Maps.

The main contributions of this paper are as follows:

- The authors propose a novel approach to design a safe route planner that incorporates real crash data and a state of the art routing algorithm to find the safest path to a given destination;
- The proposed system allows drivers to interactively find the safest route by filtering historical crash data along with environmental conditions such as day light and weather;
- The authors validate and compare the results of the safe route planner with directions from Google Maps;
- The authors identified the deadliest road section with 24 motor vehicle fatalities in Maryland and Washington DC using the proposed system. The safe route planner suggested an alternative path to avoid the high risk of accidents.

RELATED WORK

This section presents existing research that is related to the safe route planner. This includes research on reducing automobile fatalities, existing research on road assessment, and dynamic traffic routing.

Research on Reducing Automobile Fatalities

The rate of road accident fatalities depends on many factors including distractions, speed, driving behavior, road conditions, and weather. There has been a lot of research to reduce the fatality rate. In particular, a number of papers studied the relationship between driver distraction and motor vehicle fatalities (Tseng, 2005; Wilson & Stimpson, 2010; Young & Regan, 2007). Solomon, Nguyen, Liebowitz, and Agresti (2006) evaluated the effectiveness of red light cameras and found that data mining can be used to identify patterns and rules to reduce fatalities. Electronic Stability Control (ESC) has also been evaluated and recommended for use in reducing road fatality rates (Lie, Tingvall, Krafft, & Kullgren, 2006; Farmer, 2004). A study conducted by Crandall, Olson, and Sklar (2001) on head-on passenger car collisions in the U.S. confirms the effect of airbag and seat belts in reducing fatalities. Qiu and Nixon (2008) performed a systematic review and meta-analysis of studies from 1967 to 2005 to evaluate the effect of adverse weather on vehicle crash rates. Moreover, there are a number of tools available to generate a heat map of the accidents to identify high risk areas to help drivers to be aware of the road risks (Hilton et al., 2009; Pack et al., 2009).