Geospatial Analytics to Improve the Safety of Autonomous Vehicles

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ABSTRACT
Finding the costs and risks associated with highway traffic routes would allow companies and people alike to find routes that offer a comfortable amount of risk. With the amount of traffic data being collected at a more granular level the ability to find costs and risks associated with traffic routes given real time circumstances is plausible. Weighing these data and finding the areas that are most accident-prone allows for an assessment of the probability that an accident happens and what the cost of that accident would be for any given route. This information is very valuable for both safety and cost saving for drivers and insurance companies.

KEYWORDS
Autonomous Vehicles, Data Analytics, Data Visualization, Geospatial Data, Insurance Industry, Risk Analysis, Road Safety, Self-Driving Cars

INTRODUCTION
“Road accidents are one of the most important problems being faced by modern societies. Apart from the humanitarian aspect of reducing road deaths and injuries in developing countries, a strong case can be made for reducing road crash deaths on economic grounds alone, as they consume massive financial resources that the countries can ill afford to lose” (Partheeban et al., 2008). Urban traffic is notorious for routine stoppages, delays and other forms of congestion. The urbanization and globalization of the world economies brings highly significant economic and societal impacts. These include significant monetary losses to the economy.

There are two general reasons for economic and societal costs to an economy. One is the monetary cost of accidents (safety) and the other is economic cost (lost revenue). “Compared to the economical and societal cost of traffic congestion, the last of traffic safety has a very high cost. As an illustration, in 1997 the cost for society of traffic congestion in the Netherlands was 0.8 billion Euros; the costs due to accidents was much higher, namely 8 billion Euros” (Louwerse et al., 2004).

The costs in the United States are much greater. “In 2010, there were 32,999 people killed, 3.9 million were injured, and 24 million vehicles were damaged in motor vehicle crashes in the United States. The economic costs of these crashes totaled $242 billion. Included in these losses are lost productivity, medical costs, legal and court costs, emergency service costs (EMS), insurance administration costs, congestion costs, property damage, and workplace losses. The $242 billion cost
of motor vehicle crashes represents the equivalent of nearly $784 for each of the 308.7 million people living in the United States, and 1.6 percent of the $14.96 trillion real U.S. Gross Domestic Product for 2010.” (Allahyar et al., 2006). These costs do not include estimates of the reductions in quality of life costs, when they are included, the total cost of societal harm increased to $836 billion in 2010.

Naturally, the greatest concern is for those who lose their lives in traffic accidents. Although traffic fatalities in the United States declined by nearly 25% during the period of 2003 to 2013, we lost 32,719 people in crashes on roadways during 2013. The number of people injured was 2.3 million (Gerdes et al., 2016).

Researchers in the Netherlands found that the greatest cost of vehicle accidents occurs on the rural and urban roads, not on the “motorways” (divided, limited access highways like a US Interstate). The secondary, underlying traffic network was found to be far less safe than the motorways. They found that more research should be focused on approaches to improve the traffic safety on urban and rural roads (Louwerse et al., 2004).

Much has been done to combat the economic and societal losses of vehicle accidents. During the past 25 years, a great amount of research and product development has gone toward the avoidance of accidents when they are about to occur. “Since the early nineties, there has been an increasing interest in the application of Advanced Driver Assistance (ADA) functions in cars and roads in order to make traffic safer and more efficient. ADA systems support or take over a drivers’ task, e.g. to maintain a safe speed or distance, to maintain the right heading and to avoid collisions” (Van Arem et al., 2003). Such measures include, Adaptive Cruise Control, proximity sensors (to warn of another vehicle when backing up or changing lanes), automated lighting and automated braking. The market for these systems seems to be strong because many cars now arrive with some of these items as standard equipment.

The focus of this research paper is to determine if there are cost effective ways to predict the relative safety of a specific transportation route on a given day and time. The successful result would provide information to a vehicle driver to increase traffic safety, improve the use of the existing traffic network, and enhance the tools of integrated traffic management.

This “route safety” information will complement the tools being developed to avoid accidents immediately before an accident. “Growing use of vehicles in the city has increased the number of accidents and reduced the safety level to the passengers. Alerting drivers about the condition of road, traffic and related aspect is crucial to safety and for the regulation of vehicle flow. To achieve this in timely manner, an accurate information is needed” (Purkait et al., 2016). Our aim should be to, “provide a cost-efficient, intelligent routing strategy by sending a safety packet delivery assurance by optimally measuring the fitness in terms of distance, moving direction and link quality metric.

There are many different factors that contribute to the likelihood of an accident occurring when a route is chosen. All these factors, when combined and analyzed properly, can add to the accuracy of a prediction (Zheng et al., 2008). One factor that contributes to the accuracy of a prediction is injury (Cafiso et al., 2007). For example, in the data set there are reports on whether or not the injury was major or minor. Interestingly the data has also been used to predict injury severity level based on area type (meaning type of road, rural or urban) (Abdel-Aty et al., 2004). Similarly, variables have also been found to contribute to higher risks associated with motorcycle accidents (Pai et al., 2008).

Weather also has been extensively studied and proven to effect accidents either positively or negatively in terms of probability (Golob et al., 2003). The model used a mix of these types of proven predictors mixed with some additional ones that were discovered to be important. These discovered predictors were derived from existing detailed accident data that illustrated the conditions surrounding the individual crashes that coincided with the route chosen. The output of the algorithm is a safety rating.
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