Automated Vehicle Decision Support System (AVDSS) for inclement weather

This paper explores the difficulties associated with inclement weather for connected vehicles in particular tractor trailer trucks. During inclement weather, studies show that financial loss to the trucking industry associated with delay is over $9 billion dollars annually (FHWA, 2012). There is additional loss due to crashes associated with inclement weather including nearly 4000 fatalities and 104,000 injuries in 2012 (NHTSA, 2012). Inclement weather can include snow, rain/thunderstorms, wind, ice, visibility issues and many others. With the advancement of automated vehicles, if several trucks are connected in travel and one makes a particular decision during inclement weather of whether to stop or continue on through the weather event, this impacts all of the vehicles that are connected. Decisions during inclement weather are typically made by the individual driver called naturalistic decision making. There is not currently a method to assist truck drivers with that decision.

Decision support systems (DSS) have been used in many areas including winter maintenance and the Department of Defense. There are many types of DSS in use today including artificial intelligence and neural networks. A Bayesian Belief Network (BBN) can assign a combined probability of delay or crash based on empirical data. The BBN uses a graphical representation of a probability dependency model. Using real data of delay and crash can then be compared to the naturalistic decision.

Using a Bayesian Belief Network (BBN), weather data (snow, ice, wind, rain/thunderstorms and visibility) and probability for delay and crash are input into the network based on previous studies and empirical data. A storm category was developed ranging from 0-3 for each of the five weather parameters listed above. A delay probability based on reduction of speed cited from existing literature was developed and input into the BBN. A crash probability was also developed. This was limited to miles traveled rather than by storm category due to lack of data. Six past storms were modeled with several scenarios within each storm.

One of the storm results of probabilities of delay and crash is shown in the presentation. These were then combined using the geometric mean to develop an index ranging from 0-10. This was done due to the large difference in percentages between crash probability and delay probability. The crash probabilities were low due to the crash rate during actual weather events. But they were nearly 10x that of normal driving conditions. The final indexes were assigned a decision based on the results of those indexes.

These decisions were then compared to a small survey of trucking firms to determine three of the main items in the model. These are the storm category, decisions during example storms and how high the probability of risk has to be in order to delay or stop. The survey shows that the drivers think a storm is less severe than the data show, most drivers would never stop in severe storms but claim they would stop if they knew the risk was 3x or less than normal driving conditions. This shows that although they claim to stop the data of existing crash and delay does not support their decisions highlighting the inefficacy of NDM.

With the growing use of connected vehicle technology, the decisions of one driver become more important as it may affect several drivers. The AVDSS is more robust than NDM and the decision is data driven. Quantifying the risk has not been done in the past. As connected vehicles become more prominent this decision tool becomes critical for truck decision making.