Automatic Incident Detection (AID)

Freeway incidents cause injury, traffic congestion, increased environmental pollution, and cost millions of dollars every year in delay and damage. When there is an incident, minimizing the response time (the time from when an incident occurs to the time that emergency crews arrive on the scene) is crucial. A fast response time increases the survival rate of those with serious injuries and minimizes traffic jams and potential secondary incidents.

The Utah Department of Transportation (UDOT) asked the Utah Traffic Lab (UTL) to research the effectiveness of AID focusing on the following objectives:

1. Qualitatively evaluate and recommend an incident detection algorithm or algorithms for the UDOT Advanced Transportation Management System (ATMS).
2. Investigate the impacts of cellular telephones on incident detection and propose a strategy for future implementation.

Research institutions have studied AID since the 1970s. There are many different methods used in AID and even more algorithms per method. Methods are generalized and divided into five different categories.

AID Method Categories

1. Artificial Intelligence (AI)
2. Video Incident Detection (VID)
3. Catastrophe Theory
4. Statistical Methods
5. Pattern Recognition

AI is the newest technology used for Incident Detection. A neural network is one of the more common algorithms used in this category. A system is able to recognize specific traffic patterns and learn from events and experiences, much like the structure of human thought. Unfortunately, AI methods are still under development and require a training period before installation.

VID is a computer based system that uses cameras to detect incidents by recognizing drastic changes in pixilated images. Video Surveillance Cameras used to monitor traffic can also be integrated into the VID system.

Catastrophe Theory uses a single loop detector to detect sudden, discrete variations in flow speed or occupancy. The McMaster Algorithm, which is heavily researched, follows trends and detects radical changes in traffic patterns. This algorithm is effective at differentiating between recurring congestion and traffic incidents. Nevertheless, it requires calibration at each section of freeway, which can be time consuming.

Statistical methods use probability and

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distribution methods to detect drastic changes in traffic flow, speed, and occupancy.

Pattern Recognition sets a specific threshold of values based on the changes mentioned above. An incident is detected if traffic conditions exceed the defined threshold. Pattern Recognition is commonly used, however, it requires extensive calibration in order to set the thresholds.

The performance that each algorithm uses to detect an incident is based on the time it takes to detect the incident, the false alarm rate, and the percent of detected accidents (detection rate).

UTL found that the majority of the algorithms rely on inductive loop detection to collect speed, occupancy, flow or other measures. These are used to create thresholds that determine the bounds of "normal" flow.

In spite of the extensive research that has been done on AID during the past few decades, many still consider it flawed. Recurring problems with AID include too many false alarms, low detection rates, and the undetected effects of inclement weather. Some Departments of Transportation have shut down their AID algorithms altogether because of the problems that they have had.

Unfortunately, any adjustment of the values could result in more false alarms or less detection. For example, if you have a radio that has a lot of static, you have to turn down the volume to get less static. However, you may not hear certain details of the music if you turn down the volume. The same is true for adjusting detection values. If AID sensitivity is "turned down", the false alarm rates may decrease, but the incident detection rate will also decrease.

The advent of the cellular phone in the 1980s has had a dramatic impact on AID. A cellular phone user can contact the Highway Patrol or emergency medical services within seconds of the incident whereas most AID algorithms take one to two minutes to alert the Traffic Operation Center who has no power to immediately dispatch emergency medical services.

UTL recommends that UDOT continue to use cellular phones as primary incident detectors. It also recommends that UDOT use the algorithms that they already have. If UDOT chooses to explore other methods, UTL recommends McMaster or AI. Since UDOT already has surveillance cameras on many of the highways in the Salt Lake Valley, UTL suggests that it investigate the possibility of integrating VID.

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For more details, see our website.

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