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Towards Universality in Automatic Freeway Incident Detection: A Calibration-Free Algorithm

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University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Manoel Mendonca de Castro-Neto entitled "Towards Universality in Automatic Freeway Incident Detection: A Calibration-Free Algorithm." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Civil Engineering.

Lee D. Han, Major Professor

We have read this dissertation and recommend its acceptance:

Thomas Urbanik II, Frederick Wegmann, William Seaver

Accepted for the Council:

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A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Manoel Mendonca de Castro-Neto
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ABSTRACT

Freeway automatic incident detection (AID) algorithms have been extensively investigated over the last forty years. A myriad of algorithms, covering a broad range of types in terms of complexity, data requirements, and efficiency have been published in the literature. However, a 2007 nationwide survey concluded that the implementation of AID algorithms in traffic management centers is still very limited. There are a few reasons for this discrepancy between the state-of-the-art and the state-of the-practice. First, current AID algorithms yield unacceptably high rates of false alarm when implemented in real-world. Second, the complexities involved in algorithm calibration require levels of efforts and diligence that may overburden Traffic Management Center (TMC) personnel.

The main objective of this research was to develop a self-learning, transferable algorithm that requires no calibration. The dynamic thresholds of the proposed algorithm are based on historical data of traffic, thus accounting for variations of traffic throughout the day. Therefore, the novel approach is able to recognize recurrent congestion, thus greatly reducing the incidence of false alarms. In addition, the proposed method requires no human-intervention, which certainly encourages its implementation.

The presented model was evaluated in a newly developed incident database, which contained forty incidents. The model performed better than the California, Minnesota, and Standard Normal Deviation algorithms.

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LIST OF ACRONYMS

AID	Automatic incident detection
CHP	California Highway Patrol
DR	Detection rate
FAR	False alarm rate
FHWA	Federal Highway Administration
IMS	Incident management systems
MTTD	Mean time to detection
NNet	Neural Network
PeMS	Freeway Performance Measurement System
SND	Standard normal deviation
TTD	Time do detection
TMC	Traffic management center
TMS	Traffic management system
TSC	Technology Service Corporation
VDS	Vehicle detection station

CHAPTER 1

INTRODUCTION

1.1 RESEARCH PROBLEM

Traffic incidents, particularly vehicles accidents (collisions), are known to be one of the major causes of freeway congestion. With the advance of loop detector technology, traffic management systems (TMSs) have deployed freeway incident management systems (IMSs) to efficiently respond to incidents in the form of prompt incident detection and clearance. In addition to congestion, road incidents also cost the lives of 1.2 million people annually around the world, and seriously injure another 20 to 50 million road users (Dinh-Zarr, 2008). As will be discussed later in this manuscript, both congestion and fatality rate levels may be reduced with the deployment of efficient incident detection systems.

Numerous automatic incident detection (AID) algorithms have been proposed in the literature during last five decades. However, for desired levels of detection rate (DR), those algorithms yield unacceptably high false alarm rates (FARs) when implemented in the real world. Besides, simulation-based AID studies attempt to emulate incidents by simply blocking lanes with stalled vehicles - the speed reduction of vehicles driving through the incident location have not been modeled in AID simulation studies to date. On the other hand, AID studies verified with real data have been primarily based on computationally sophisticated methods whose extensive calibration and training efforts may discourage wide deployment by TMS personnel. The fact these models are typically

configured to perform under very specific operational conditions for which they were calibrated, makes their implementation not only difficult, but also inefficient but also inefficient when the operational condition drifts from the assumed norm. All these, and other, problems have kept AID algorithms from being widely implemented; as found by a nationwide survey involving 32 TMSs (William and Guin, 2007), where it was concluded that only 12.5% of the centers claimed to have been using a fully functional AID algorithm.

Another major problem of existing freeway AID models is *transferability*, which is the model's ability to perform satisfactorily at different locations with little or no recalibration efforts. The vast majority of the AID algorithms found in the literature are based on static (fixed) thresholds values for incident declaration, which leads to poor performance, as traffic state is mostly dynamic and fluctuates substantially throughout the day.

In addition, the calibration of some of the simplest detection algorithms relies on the availability of an incident dataset, whose development may be very time-consuming, especially considering that the necessary incident information recorded in crash reports, such as starting time and location, are usually imprecise and often inaccurate for incident detection research purposes. Therefore, these pieces of information would have to be corrected through cumbersome investigation of the traffic loop-detector data, or by the offline application of an incident detection algorithm with minimal weight given to the time to detection

1.2 RESEARCH OBJECTIVE

The goal of this research is to develop and test an AID algorithm that requires no calibration by implementing historical data of traffic to improve universality and performance. Traffic databases contain valuable information that can help traffic engineers discern normal and abnormal flow conditions; this is the primary objective of AID algorithms. The main idea of this research was to verify whether the use of that historical information could eliminate the need of algorithm training without compromising performance – acceptable levels of FAR, DR and mean-time-to-detection (MTTD). Such approach addresses the shortcomings of algorithms with fixed thresholds values by implementing demand-sensitive thresholds, thus enhancing the algorithm's desirable transferability, or universality. To accomplish this goal, three main tasks were initially conducted:

1.2.1 Literature Review

A comprehensive literature review on freeway AID and related topics (e.g.: traffic data quality, traffic flow theory) was performed and continuously updated, covering studies appearing on journal publications, conference proceedings, and technical reports.

1.2.2 Traffic and Incident Database Development

Using California's Freeway Performance Measure System (PeMS, 2009), an incident-database containing 40 incidents was developed for this research. All incidents were reported in the California Highway Patrol (CHP) incident logs. In addition, 5.5

months worth of 5-minute loop-detected data gathered from the northbound direction of Interstate 880, or I-880N, were extracted from PeMS data archive for this study.

1.2.3 Implementation of Existing Algorithms

After the incident database was compiled, existing AID algorithms prominent in the literature identified and coded. These include the California algorithm, the Minnesota algorithm, and the Standard Normal Deviation (SND) algorithm. These established and well-known algorithms were compared with the proposed approach.

1.3 DISSERTATION ORGANIZATION

This manuscript consists of seven chapters. Following the introduction, Chapter 2 provides a background on freeway AID focusing primarily on: the macroscopic effect of incident on traffic, the existing algorithms and their limitations, and the significant discrepancy between the state-of-the-art and the state-of-the-practice in the field. Chapter 3 describes the data used in this research as well as the methodology used to build the incident database. Chapter 4 describes the implementation of the existing models to be used for comparison. Chapter 5 contains the description of the proposed approach and its application. Chapter 6 provides a discussion of the proposed model. Finally, Chapter 7 outlines the conclusions and recommendations for future research.

CHAPTER 2

FREEWAY AID BACKGROUND

2.1 THE BENEFITS OF PROMPT INCIDENT DETECTION

AID has been investigated for almost five decades, with the first studies dating back to as early as 1960s (May, 1962). Since then, numerous articles covering a wide range of detection algorithms have been proposed. The reason AID has been extensively explored lies in the importance of efficiently detecting incidents to reduce congestion and number of fatalities/injuries (Ozbay and Kachroo, 1999).

Incident detection is the first of the main three stages of IMSs. The second is the *response* stage, whose time spans from the detection of the incident to the arrival of the emergency unit at the incident scene (response time). The third and final stage is called *clearance*, which is the duration between the arrival of the emergency unit and the removal of the incident from the freeway (clearance time).

The effects of the time to detection (TTD) on crash fatalities were investigated by Evanco (1997). Using the nationwide data from the Fatality Analysis Reporting System, Evanco concluded that a reduction in the average notification time (time between the occurrence of an incident and the notification to the emergency medical response unit) from 5.2 minutes to 3 minutes could drop fatality rate in the U.S. urban freeways and expressways by 11% (450 lives/year). A further decrease in notification time to 2 minutes could reduce fatality by 15.9% (652 lives/year). As for economical benefits of rapid incident detection, the author used the crash-related monetary costs derived by Miller

(1993) and concluded that, for the reduction in notification time to 3 minutes, the comprehensive monetary benefits are about $931 million per year, whereas an average incident notification time of 2 minutes could bring savings as high as $1.352 billion per year (number are in 1997 US dollars).

As for capacity reduction, the benefits of rapid incident detection are more clear and easier to quantify. Chassiakos (1990) presented a simplified pictorial representation of the reduction in delay caused by a faster freeway incident response (Figure 2.1). This figure shows an incident occurring at time T1. The shaded area represents the delay reduction when the incident is cleared at time T2 instead of time T2'. This cumulative time-flow diagram shows that small time reductions in detection time can considerably reduce traffic delay caused by the incident. For the record, Figure 2.1 suggests that no delay incurred on diverted demand, which may be a strong deviation from reality.

2.2 MACROSCOPIC IMPACT OF INCIDENTS ON FREEWAY TRAFFIC

This research focused on freeway traffic. Studies dealing with incident detection on surface streets can be found in Sheu and Ritchie (1998), Han and May (1990), Han (1991), Cullip and Hall (1997), and Hawas (2007).

Incidents generally lead to congestion upstream of the incident location. As it is well known, upstream loop-detector occupancy is expected to increase as vehicles reduce speed and most likely form a queue that reaches the upstream detector station. In the mean while, downstream occupancy decreases if the incident bottleneck chokes the traffic flow. The reduction in flow rate is expected to be observed at both downstream

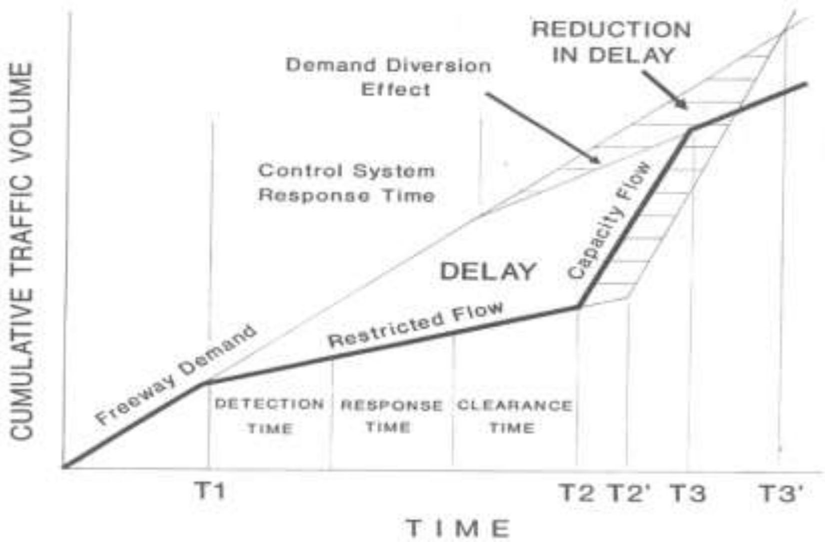
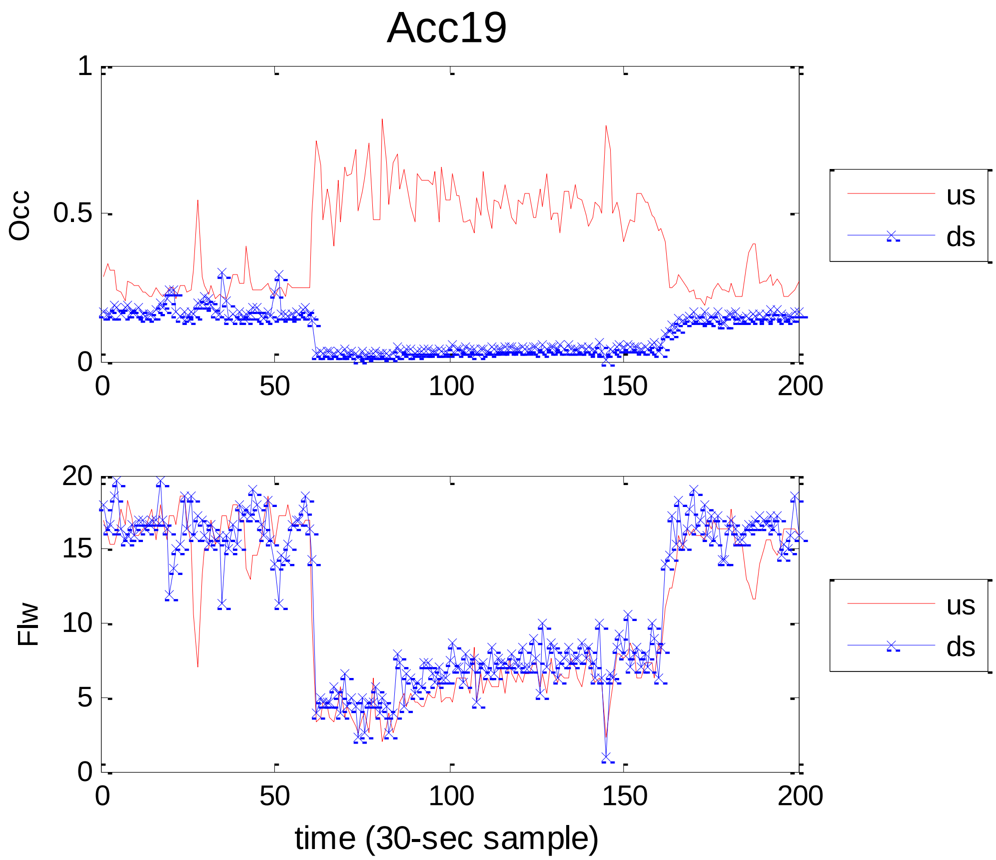


Figure 2-1 Delay reduction provided by fast incident detection (Chassiakos, 1990)

and upstream locations. Figure 2.2 illustrates such a pattern, where flow (in veh/30sec/lane) and loop occupancy (fraction of time occupied/lane) averaged across all lanes are shown for the vehicle detector stations (VDSs) immediately up- and downstream of an incident that occurred on I-880N, California, on November 9, 2006. The incident was a collision involving 4 vehicles, according to the CHP report.

2.3 EXISTING AID ALGORITHMS

As mentioned in Chapter 1, numerous AID algorithms have been proposed in the literature. Different types of technologies have been evaluated for AID, including video-based detection systems (Tzamali et al, 2006; Mak and Fan, 2007; Fries et al, 2007), automatic vehicle identification (Balke et al, 1995; Hellinga and Knapp, 2000; Khoury et al, 2003; Mouskos et al, 1999), cell phones (Skabardonis et al, 1998; Tavana et al, 1999;


Acc19
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time (30-sec sample)
us
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Figure 2-2 Usual effects of incidents on traffic on up- and downstream stations. Collision involving 4 vehicles on I-880N, on November 9, 2006.

Parkany and Xie, 2005), and even acoustic-signal-based systems (Harlow and Wang, 2001). However, the vast majority of the existing models are based on data gathered from inductive loop-detectors. Loop-detector-based AID algorithms can be basically grouped into four main categories: comparative, statistical, artificial-intelligence-based, and traffic-modeling-based.

2.3.1 Comparative AID Algorithms

Comparative algorithms are based on the comparison of traffic parameters (mainly occupancy) between adjacent stations. These algorithms assume that, for neighboring stations, traffic variables present similar values when traffic is under normal conditions. The first promising comparative algorithm - and perhaps the first promising AID method in general - was developed by the California Department of Transportation. The famous “California algorithm” consists of a binary decision tree in which differences in occupancy between neighboring stations are compared against threshold values (Figure 2.3). The three features of the algorithm (occdf, occrdf, and docctd) to be checked against their respective thresholds (T1, T2, and T3) are explained in Table 2.1. At every time interval, say 30 seconds, the algorithm checks if each of these three features exceeds its predetermined threshold value. If they all do, an incident alarm is triggered.

Right after the development of the California algorithm, the Federal Highway Administration (FHWA) contracted the Technology Service Corporation (TSC) to develop and evaluate new comparative AID algorithms. Ten new algorithms, also based on the California binary decision tree structure, were developed and compared with the California algorithm (Payne, 1976; Payne et al, 1976; Payne and Knobel, 1976; Payne

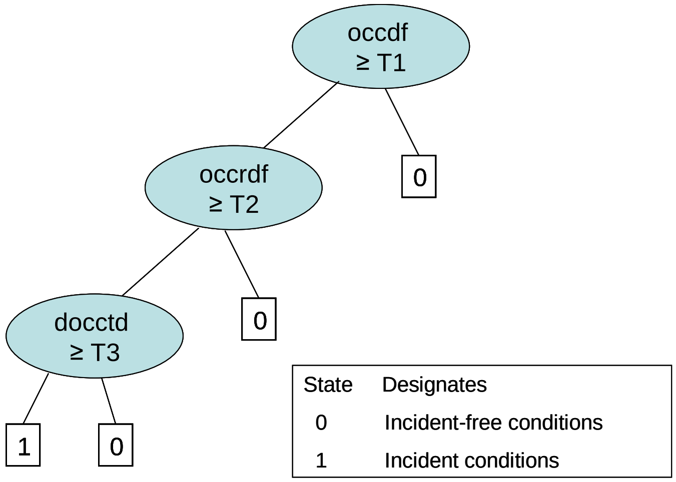

Figure 2-3 Decision-tree structure of the California algorithm

Table 2-1 Description of features used in California Algorithm

Feature	Description	Definition
occ(i,t)	Occupancy at station i, for time interval t (percent)	-
docc(i,t)	Downstream occupancy	occ(i+1,t)
occdf (i,t)	Spatial differences in occupancies	occ(i,t) - occ(i+1,t)
occrdf(i,t)	Relative spatial differences in occupancies	occdf(i,t)/ occ(i,t)
docctd(i,t)	Relative temporal differences in downstream occupancies. “z" is the number of time intervals past t.	[occ(i+1,t-z) - occ(i+1,t)]/ occ(i+1,t-z)

and Tignor1978; Tignor and Payne, 1977). The details of each algorithm are beyond the scope of this proposal, but in summary, they are variants of the California algorithm with some enhancements to reduce false alarms. For instance, algorithm 7 replaces *docctd* with *docc*, suppresses incident signals after the initial detection, and performs a persistency test that requires *occrdf* to be greater than its threshold for two consecutive time intervals. Algorithm 8 is algorithm 7 with a compression wave check – if a compression wave is detected downstream, the AID quits for 5 minutes. Algorithm 10 classifies traffic into low, moderate, and heavy, by simply comparing occupancy with threshold values. No incident check is performed if traffic is light. If traffic is classified as heavy, algorithm 7 is used, and if traffic is moderate, a new feature based on temporal speed change is applied. A study that compared the ten TSC-algorithms concluded that algorithms 7 and 8 presented better performance, as shown in Figure 2-4 (Payne and Tignor, 1978). This figure shows that for desired levels of FAR (less than 0.5%), DR is too low (around 70%). A comprehensive study comparing TSC algorithms 7, 8, 9, 10, and another decision tree algorithm can be found in Levin and Krause, 1979. Due to its appealing meaningfulness and simplicity, the traditional California algorithm has been one of the main benchmarking methods for testing new AID approaches, and therefore it was included in this research for comparison as well.

2.3.2 Traffic-Model-Based AID Algorithms

Under this category fall those algorithms that are primarily based on traffic flow fundamentals. Persuad and Hall (1989) proposed a model applying catastrophe theory to macroscopic flow. Stating in simple terms, catastrophe theory can be used in systems

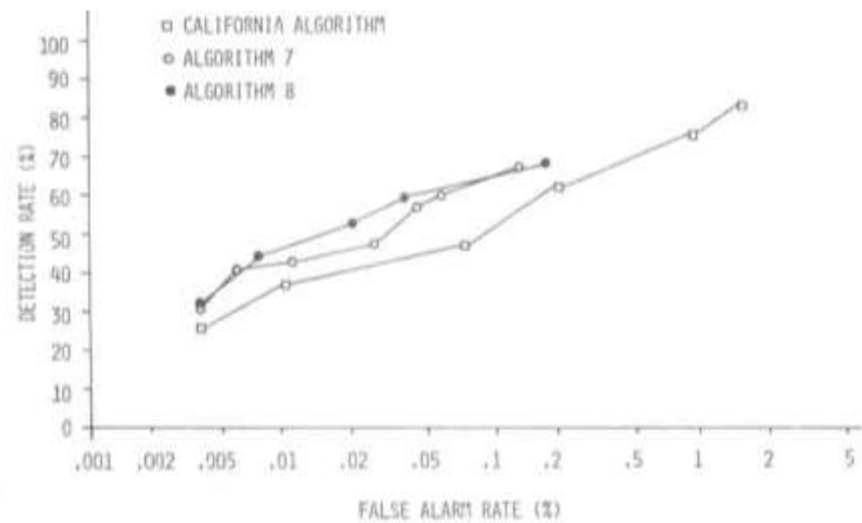

Figure 2-4 Evaluation of TSC comparative algorithms (Payne and Tignor, 1978)

where one variable changes suddenly while other correlated variables change smoothly. Persuad and Hall (1989) applied this idea for incident detection based on the fact that the transition from non-congested to congested regimes is marked by a sudden drop in speed, accompanied by smoother changes in occupancy and flow. Their method, which is known as the McMaster algorithm, basically consists of defining a boundary between congested and uncongested flow-occupancy regions (Figure 2-5), and of identifying a speed threshold to distinguish congested from uncongested speeds (Persuad and Hall, 1990). A limitation of this method is that it relies on accurate speed measurements, which is not always available on TMSs. Besides, even though single-stations algorithms as the McMaster algorithm may be able to effectively detect congestion, they lack the potential that comparative methods have in differentiating congestion between recurrent and non-recurrent. Additional detection methods involving macroscopic traffic modeling can be found in Jin and Ran (2009), Willsky et al. (1980), and Kuehne (1898).

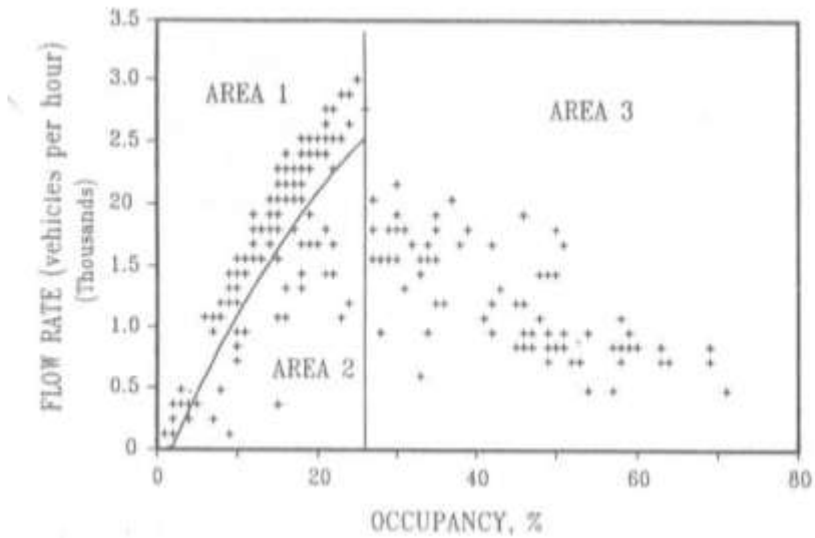

Figure 2-5 McMaster algorithm. Area 1 represents free-flow traffic conditions, whereas areas 2 and 3 represent congestion (Persuad and Hall, 1990).

2.3.3 Statistical Algorithms

This category includes algorithms that perform short-term prediction of traffic variables. If the predicted value deviates enough from the observed value, than an incident alarm is triggered. One of the earliest approaches is called the standard normal deviate (SND) model (Dudek and Messer, 1974), in which the standardized value of the traffic control variable is checked against control limits that are based on the mean and the standard deviation of the data. The classical SND model formulation is

$$SND = \frac{\hat{x}(t) - x(t)}{S}$$

where $x(t)$ is the observed value and of the traffic variable, $\hat{x}(t)$ is its predicted value (e.g.: mean), S is its standard deviation. If variable *SND* exceeds a predetermined threshold, an incident alarm is triggered. Other statistical algorithms have used alternative

predicted values to the mean for $\hat{x}(t)$, including nonparametric regression (Tang and Gao, 2005). Other time series models used to forecast traffic volume for incident detection purposes have been tested by Cook and Cleveland (1974), and Ahmed and Cook (1982).

It is worth noting that no single forecasting technique performs well due to the high levels of noise inherent to 30-sec traffic data. Therefore, time-series models are usually combined with filtering techniques or other models to enhance prediction capability (Stephanedes and Chassiakos, 1993).

2.3.4 Artificial-Intelligence-Based AID Models

With the advent of artificial intelligence, dozens of AID studies have been introduced and tested using artificial NNet and fuzzy logic (Ishak and Al-Deek, 1998; Ishak and Al-Deek, 1999; Adeli and Samant, 2000; Cheu and Ritchie, 1995; Cheu et al, 2004; Srinivasan et al, 2004; Jin et al, 2001, Peeta and Das, 1998). Some authors have combined them with other advanced models such as Wavelet theory (Samant and Adeli, 2001; Ghosh-Dastidar and Adeli, 2003) and Wavelet transformation with linear discriminant analysis (Samant and Adeli, 2000). Such methods are complex in terms of application and interpretation.

2.3.5 Mixed Models

Some models are actually a combination of different types of approaches. For instance, based on an incident database, Levin and Krause (1978) combined the probability of an incident occurrence with the information on the second feature of the California algorithm (*occrdf* – the relative difference of occupancy between adjacent

stations) through Bayesian modeling. This approach attempts to model the probability that an incident has actually occurred given that an alarm is signaled.

A famous mixed model known as Minnesota algorithm is a combination of statistical (time series filtering) and comparative types of algorithms (Stephanedes and Chassiakos, 1993). The Minnesota algorithm applies a low-pass filter (moving average) on the spatial differences in occupancies (*occdf*) of the data before and after a particular time period. For instance, using a 3-minute moving average on 30-sec, the smoothed value at an instant t is

$$y_a^t = \frac{1}{6}\sum_{k=0}^{5} occdf_{t+k}$$

In other words, y_t^a is the average of the spatial difference in occupancies up to 3 minutes after instant *t*. It is worth noting that there is an inherent delay in this approach as it waits 3 minutes after an instant t to determine if an incident has occurred – this does not mean that minimum time to detection is 3 minutes, though. As for the data before the instant t, a moving average window of 5 minutes was used in their study, as follows

$$y_b^t = \frac{1}{10}\sum_{j=1}^{10} occdf_{t-j}$$

If a normalized difference between y_t^a and y_t^b exceeds a threshold value, an incident alarm is triggered. The normalization is relative to m_t, which is related to the pre-incident occupancy and is computed as

$$m_t = \frac{1}{10}\max\left(\sum_{k=1}^{10} occ_{t-k}; \sum_{k=1}^{10} docc_{t-k}\right)$$

In other words, m_t is simply the maximum value between the 5-min average occupancy on the downstream VDS and that of the upstream VDS, both before instant *t*.

The Minnesota algorithm applies two sequential tests. First, it compares the normalized quantity $\left(y_t^a / m_t\right)$ against a threshold (Thr1), meaning that high values of difference of occupancy between stations may be caused by an incident. If Thr1 is exceeded, congestion is detected, and the second test is performed by comparing the normalized value of the difference $\left(y_t^a - y_t^b\right) / m_t$ against a second threshold (Thr2). If Thr2 is exceeded, the detected congestion is classified as incident. The second test aims to detect sudden changes in occdf (incident) without alarming increases in occdf caused by recurrent congestion. This is the idea of the use of a low-pass filter. Therefore, the Minnesota algorithm is a hybrid model as it compares occupancy in time and space between neighboring stations and also applies a simple time series data filtering technique to reduce the noise in the data in an attempt to minimize false alarms. Since the Minnesota algorithm has been included in various AID studies for comparison, this algorithm was also included in this research.

2.3.6 Other Advanced Models

Other AID algorithms have been based on rather sophisticated techniques, including support vector machines (Yuan and Cheu, 2003; Kim et al, 2007), Bayesian networks (Zhang and Taylor, 2006), cumulative sum of log-likelihood ratio (CUSUM) (Teng et al, 2003, Teng and Qi, 2003), and wavelet theory (Wang and Zhang, 2005;

Karim and Adeli, 2002; Karim and Adeli, 2003; Teng and Qi, 2003). The major drawbacks of these studies are described in the following section.

2.4 THE PROBLEM OF HIGH FALSE ALARMS

As it usually occurs in detection systems, there are trade-offs to be considered among DR, FAR, and MTTD. In the case of freeway AID, for desired levels of DR, FARs have been unacceptably high for operational purposes (Williams and Guin, 2007). In the case of freeway operations, where detection algorithms continuously verifies the existence of incidents for numerous VDSs simultaneously, apparently low FARs may actually demand huge, if not unfeasible, emergency response deployment. For instance, considering that real-time data are fed into the system in 30-sec time periods, and that the occurrence of an incident is checked at every time period; an AID algorithm with FAR of 1% would yield, on average, 28.8 false alarms per day per pair of neighboring VDSs, which means that, for a single freeway segment containing 70 VDSs, approximately 2,000 (24hours/day x 3600sec/hour / 30sec x 0.01) false alarms would be triggered daily! This represents an average of one false alarm every 45 seconds. Not knowing if such incident alarms are in fact false without further investigation, the TMC personnel would respond to them diligently at first but soon grow weary of the constant “wolf-crying” and discredit the otherwise useful AID. The system would eventually be rendered useless and abandoned.

2.4.1 Inherent Characteristics of Traffic Contributing to False Alarms

The high occurrence of false alarms in freeway AID systems can be attributed to several factors. First, there are situations where traffic may exhibit incident-like patterns when in fact there is no incident. For instance, recurrent congestion caused by geometrical bottlenecks also increases occupancy on upstream detectors while decreases occupancies downstream of the bottleneck. As it is well known, recurrent congestion occurs when traffic demand exceeds the capacity level, whereas non-recurrent congestion occurs when traffic capacity is reduced below the demand level.

Other common situations where substantial differences in occupancy between neighboring stations may occur are:

- <u>Significant on- and off-ramp traffic volumes.</u> Depending on the VDSs locations, relative to the ramps, difference in levels of traffic may occur. An illustration of this is shown in Figure 2-6, where part (a) shows historical profiles of 5-min occupancy for two adjacent VDSs located on interstate I-880-N, in California. The historical profiles were computed as the median calculated over a period of 5.5 months–median was chosen because it is less sensitive to extreme values than the mean is. As it can be noted, occupancy is historically higher on upstream during the AM peak-hour (between 07:30 and 09:30). It is clear that an AID should use this information to avoid false alarm rates. This recurrent difference in occupancies may be associated to the high volume of morning peak-hour traffic exiting the freeway onto 98th Avenue, right before the DS VDS (Figure 2-6c). Another situation where ramp volumes may cause significant differences in

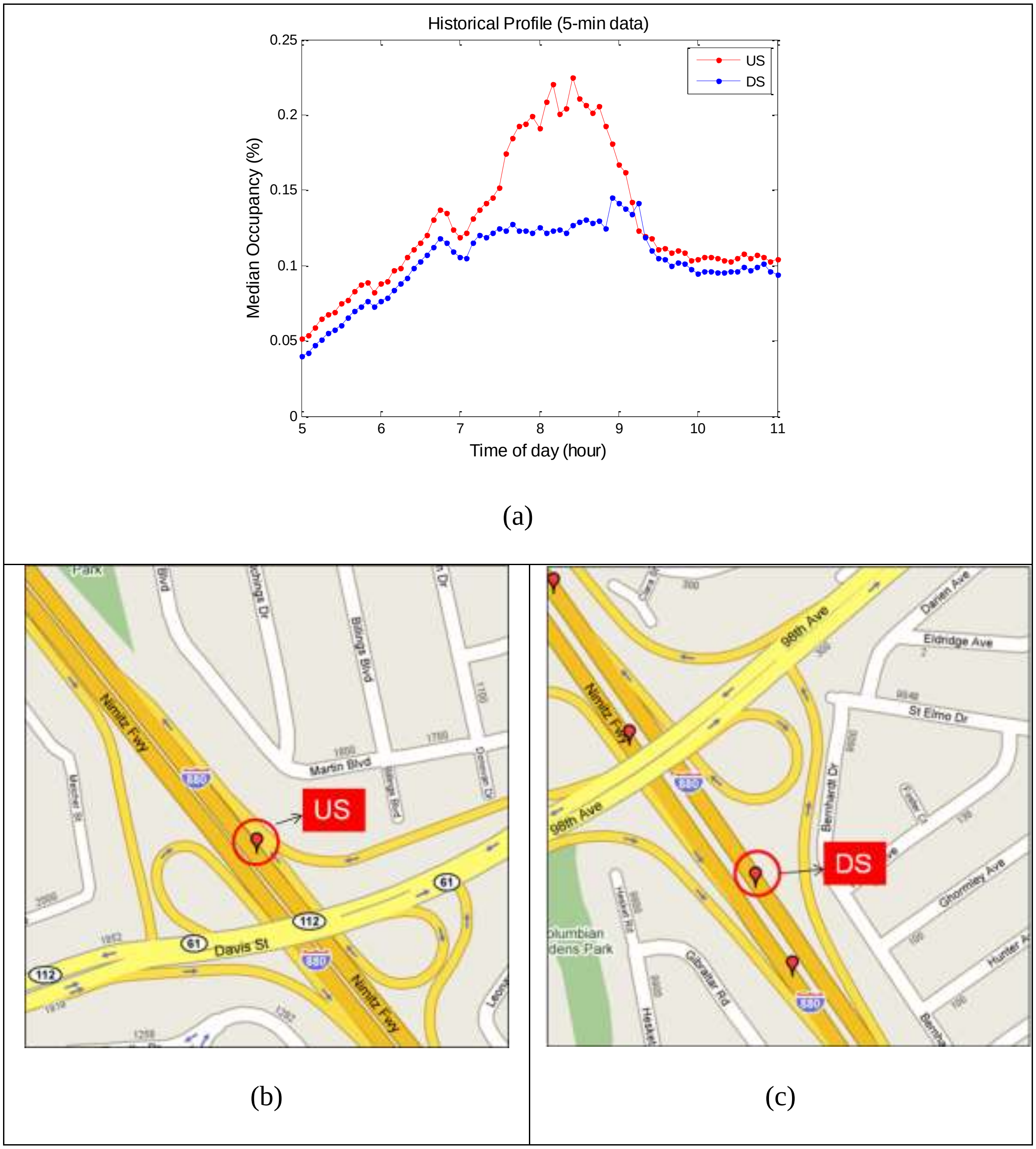

Figure 2-6 a) Historical difference of occupancy between neighboring stations on I-880N; b) Upstream VDS#400333; c) Downstream VDS #400360

occupancy between stations is the presence of high traffic volumes entering a freeway, as those coming from major freeway-freeway interchanges.

- Compression waves. Under heavy traffic conditions, speed variations may cause compression waves that propagate in a direction counter to the traffic flow. This phenomenon is a significant contributor to false alarms (Payne and Tignor, 1978);
- Difference in operational speed. For constant flow, lower speeds lead to higher loop occupancy. Differences in operational speeds may result from enforcement (regulatory speed) or from terrain grade differences;
- Loop-detection failures. They may result from failure in the loop detector itself, in the communication infrastructure, or in the data archival system (Smith et al, 2003). These types of failures can result in sequential reporting of occupancy=0 while flow>0, or the opposite (flow=0 while occupancy>0), which clearly represent unfeasible traffic conditions that trigger incident false alarms.
- Space between stations. If VDSs are not closely spaced, the time traffic takes to flow between stations may cause a spatial difference in occupancies. If two VDSs are 1 mile apart, a platoon traveling at 60mph would take around 1 minute to travel between the stations. The same pattern could propagate for several miles, causing a wave of false alarms.
- High noise of 30-second data. The higher the resolution of the data, the noisier the observed values. Due to a number of reasons (e.g.: presence of trucks), traffic may assume various states within 30 seconds. This has been widely recognized as

one of the main challenges faced by AID algorithms (Stephanedes and Chassiakos, 1993; Abdulhai and Ritchie, 1998). Figure 2-7 shows an example of how such noise reflects in the difference of occupancy between two neighboring stations.

- Intra-day variation of traffic. The difference of 30-sec occupancy between stations varies with traffic flow. This is shown in Figure 2-8, which was generated from simulation to isolate the effect of traffic demand from other variables such as roadway geometry, weather, and traffic composition. The traffic micro-simulation software used was VISSIM version 4.3 (PTV Vision, 2007).

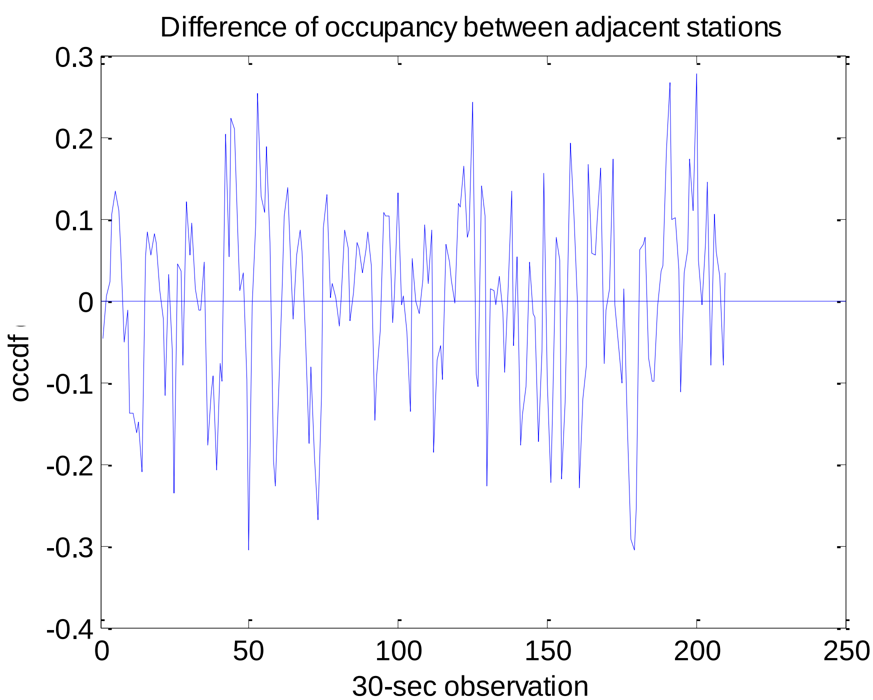

Figure 2-7 Noise of 30-sec occupancy differences between adjacent stations. Data from VDS#400341 and VDS#400094 on 2006/11/06

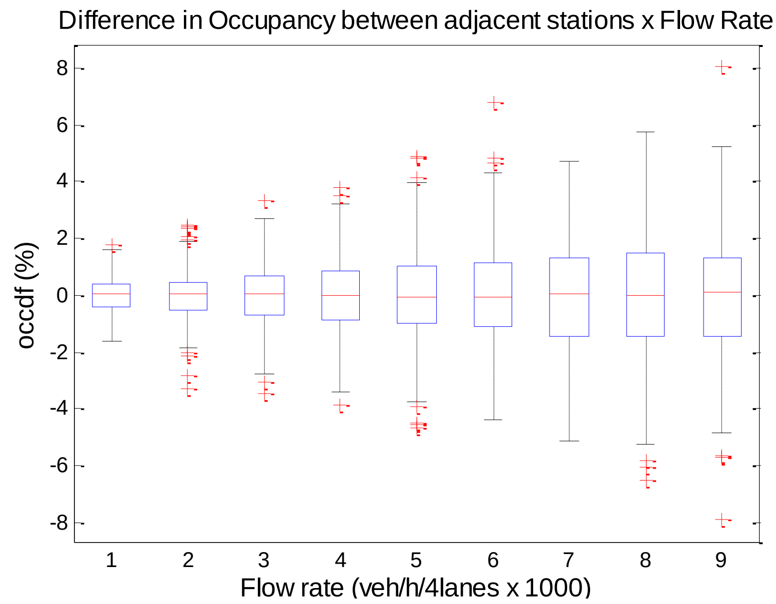

Figure 2-8 Occ differences between adjacent stations vs. flow - simulated data

2.4.2 Existing AID Algorithms' Limitations Contributing to False Alarms

In addition to the above mentioned factors inherent to traffic contributing to the occurrence of false alarms, AID models proposed in the literature present two major problems that are conducive to increasing levels of false alarms, namely calibration complexity and lack of universality (or transferability). As for the former, even the simpler algorithms require considerable calibration efforts (not to mention the development of an incident dataset, which is not always available) to determine the best algorithm threshold values for each individual, or pair of, stations. However, in practice, AID thresholds should dynamically change to adapt to natural variations of traffic throughout the day, as it was shown in Figure 2.8; in fact, the variable shown in that figure, *occdf*, which is the difference in occupancy between adjacent stations, is one of the most common variables used by existing AID algorithms.

Another major issue of newer AID algorithms is their training complexity. Not that the author of this dissertation does not acknowledge the powerfulness of new advanced data-based techniques, but sophisticated algorithms such as the ones based on artificial intelligence require calibration efforts that are expensive in both computational and human terms. Training these algorithms requires special skills, which may not in the best interests of local TMS' personnel. Moreover, algorithms requiring extensive fine-tuning calibration fall short in transferability, which makes the deployment of the algorithm in different sites an issue (Mak and Fan, 2005, Stephanedes and Hourdakis, 1996).

2.5 STATE-OF-THE PRACTICE OF AID: A NATIONAL SURVEY

The aforementioned shortcomings have kept AID algorithms from being widely implemented in the US. This was the conclusion of a recent nationwide survey on the use and conception of AID algorithms at 32 traffic management centers (TMCs) located throughout the US and one TMC in Ontario, Canada (Williams and Guin, 2007). The following are some important findings revealed by the survey, which was responded by key managers from the TMCs.

- The most used incident detection methods are: 1) visual detection by operators using close-circuit television (CCTV) cameras; 2) detection by freeway or law enforcement patrol; and 3) detection by mobile phone users (Figure 2-9), in that order.
- The average MTTD was 8.5 minutes. Among the non-algorithmic methods, mobile phone call-in presented the lowest MTTD (4.5 min), whereas the average MTTD for AID algorithms was 4 min (Figure 2-10). Therefore, the

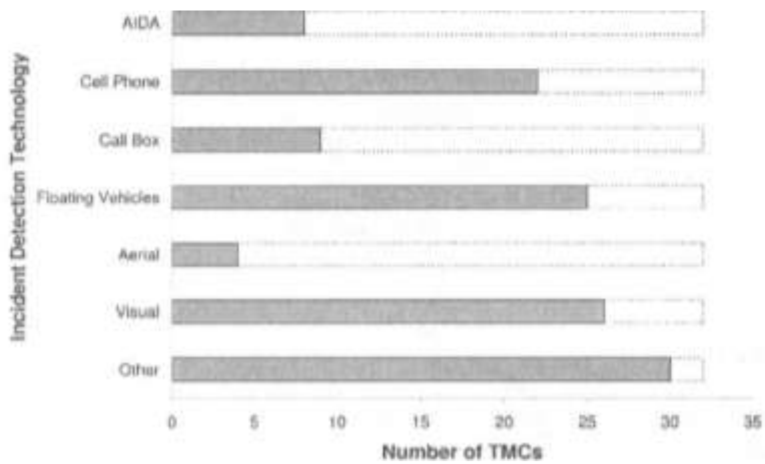

Figure 2-9 Incident detection method use (Williams and Guin, 2007).

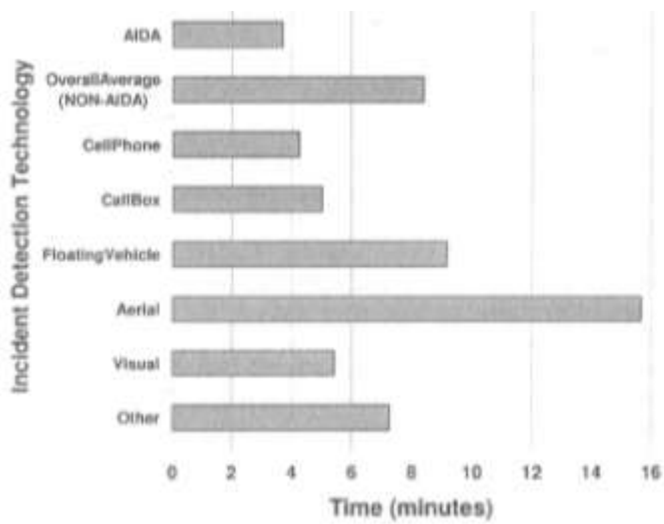

Figure 2-10 MTTD by type of detection method (Williams and Guin, 2007)

authors concluded that if the high FAR problem of AID is properly addressed, the overall MTTD of the TMCs could be significantly reduced.

- 70% of the respondents considered the existing methods of incident detection to be inefficient.
- Even though 53% of the centers have an AID algorithm integrated to their system, only 12.5% considered their AID to be operational (Figure 2-11). In fact, more than half of all TMCs with integrated AID algorithm either ignore or, worse yet, have disabled the AID functionality.
- The main reported reasons for the limited use of AID algorithms were, in order: 1) high rate of false alarms; 2) difficulty in calibration; 3) low detection rates. Figure 2-12 shows the number of times that a reason was ranked in the position represented by the bar type. For instance, false alarm was ranked as the first main issue 7 times and the second main issue 4 times, while *calibration* was ranked as the first main issue 5 times and the second issue 4 times.

The authors of that survey suggest that there are two ways of addressing the problem of algorithm calibration complexity. The first way is through a fully self-learning algorithm, that is, an algorithm that could improve its performance without human intervention as new data are fed into the model. Second, an alternative approach would employ deductive modeling based on traffic flow theory. The authors stated that "*An algorithm based on such an approach would eliminate the need to learn unique local incident patterns, relying instead on deviations from traffic-flow-theory-based*

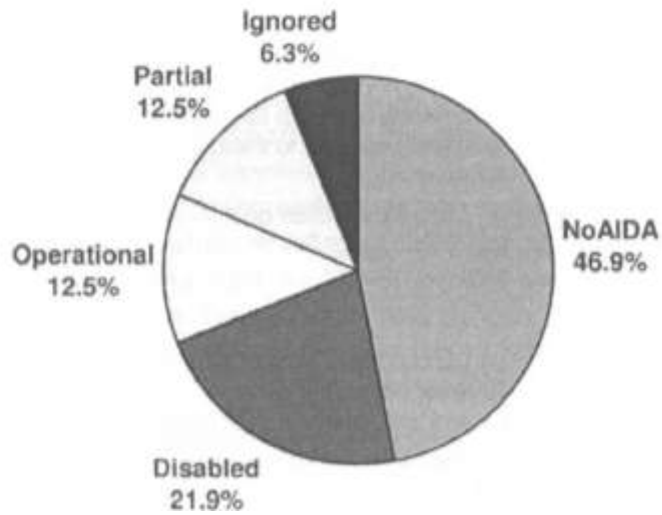

Figure 2-11 AID algorithm use (Williams and Guin, 2007).

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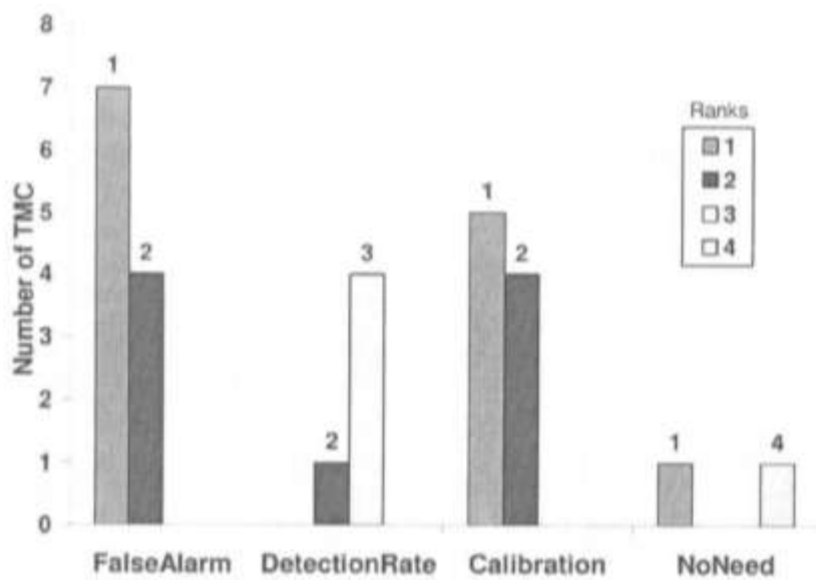

Figure 2-12 Ranked challenges to the use of AID algorithms (Williams and Guin, 2007)

predictions of stream dynamics". They continued, "*Calibration would still be involved in terms of defining the mathematical relationships between traffic operations data (flow, speed, and occupancy). However, adaptive parameter estimation for fundamental traffic flow relationships might support detection system that is simpler to implement on a broad scale and more robust than traditional pattern-matching-based methods.*"

CHAPTER 3

CASE STUDY: CALIFORNIA I-880N

3.1 SCOPE OF STUDY

In this research, the northbound facility of I-880N was selected as the “test bed” because this section of freeway had been studied before and was deemed to have one of the highest crash frequencies in the San Francisco Bay Area, California (Skabardonis et al., 1997). In addition, as incident research on I-880 was developed in the 1990s, the creation of a new dataset on the same interstate could foster comparative studies related to safety, e.g. incident frequency, by comparing safety information from the database developed in the past and the one developed herein.

The freeway I-880N (Figure 3-1) is located in the Bay Area, California. It goes through Alameda and Santa Clara counties. It is a 46-mile facility, of which 21 miles have an HOV lane. It has a total of 311 loop detectors that form 75 VDSs. Its AADT is approximately 125,000 veh/day (north bound facility only). For this research, 5.5 months (from June/01/2006 to Nov/15/2006) of both 30-second and 5-minute lane-by-lane loop detector data of flow and occupancy were collected from all 75 VDSs. This amounts to a total of 180 billion and 60 million measurements of 30-sec and 5-min data, respectively. The raw data were downloaded, sorted and organized into a database using a code written in SAS programming language, using SAS® software, version 9.1 of the SAS system.

Figure 3-1 Interstate 880-N (source: PeMS/Google Maps)

3.2 INCIDENT DATABASE DEVELOPMENT

One of the major challenges found in AID research is the scarcity of incident field data. Consequently, a good number of quite recent studies are still based exclusively on simulations (Chen and Wang, 2009; Cratbree and Stamatiadis, 2007; Cheu et al., 2002, Madanat et al, 1996). The main reason for this is the difficulty in obtaining incident information that is accurate enough for AID research purposes; basic information such as incident start time and location are often not precisely, and occasionally erroneously, reported on incident record systems such as those maintained by freeway patrols, law enforcement units, and other agencies associated with IMS programs. The inaccuracy and imprecision of such reports are often inherent to the data collection process; for instance, the recorded start time of an incident usually comes from the perception of those involved in the incident, or merely from a rough estimate or guess from the officer filing the crash report. Even in the fortuitous case of someone actually observing a crash scene as it unfolds, the event time reported based on watch or cell phone display may not be in sync with the real-time traffic data being collected at the local TMC. This difference between the unsynchronized watch of a fortuitous observer and the TMC computer clock, may sometimes be a couple of minutes or even more, would inadvertently introduce an undesirable time shift in the incident data.

These problems have kept researchers from computing, and, hence, optimizing the MTTD of their AID algorithms (Teng et al., 1999, Ishak and Al-Deek, 1998). Besides, it is well known that a substantial portion of incidents are never reported. According to Roess et al. (2004), it is estimated that, approximately, only 50% of all traffic incidents

are recorded on any type of incident log. This casts a shadow on some so-called normal traffic data as they might not be really incident-free and are, therefore, unsuitable for algorithm training purposes.

In light of these data quality challenges and the importance of evaluating and validating AID algorithms, a handful of efforts have been made towards the creation of incident datasets that are accurate enough for AID research purposes. These include the databases developed by Payne and Tignor (1978), Dia and Rose (1997), Browne et al. (2005), Mak and Fan (2006b), and Roy and Abdulhain (2003).

A fairly well-known incident database, containing information of both traffic and incidents on a section of interstate I-880, was developed to investigate the effectiveness of the Freeway Patrol Service (FPS) program in California (Petty et al., 1996; Skabardonis et al., 1997). Since its creation, the I-880 incident database has been used in many studies including Jin et al. (2002), Yuan and Cheu (2003), and Srinivasan et al. (2005). A similar incident data collection effort was performed on freeway I-10, in Los Angeles area (Skabardonis et al., 1999).

In order to fulfill the main objective of this research, a new incident database was developed. The choice of building a new dataset instead of using an existing one was due to two reasons. First, the wealthy of spatio-temporal traffic information provided by PeMS allied with the incident records of the California Highway Patrol, also freely available through PeMS, made it possible to construct a reliable database that contains accurate information for the purposes of this research. Second, the new incident dataset

resultant from our research adds to the resource of the field of AID study, serving as an alternative ‘test bed” for the development of new AID techniques.

3.2.1 The Freeway Performance Measurement System (PeMS)

The data used in this research came from the Freeway Performance Measurement System (PeMS, 2009), a project conducted by Caltrans, the University of California at Berkeley, and the Partnership for Advanced Technology on the Highways (PATH). The richness and organization of information—freely available—provided by PeMS is extraordinary. Many research studies in different areas of transportation have been facilitated not only by the availability of the data themselves, but also by the user-friendly online tools provided by the system for data query, import, and visualization. PeMS also conducts analyses to diagnose and impute erroneous loop detector data at the 5-min aggregation level (Chen et al, 2003). In addition, from the 30-sec raw data gathered by over 10,000 loop detectors, the system identifies and reports bottlenecks; performs aggregation in both temporal (5-min, hourly, weekly, monthly, yearly) and spatial (lane, section, freeway, district) levels; provides several performance measures (e.g. VMT, delay, travel time); and provides incident information recorded by the California Highway Patrol (CHP). All these and another plethora of information can be visualized though interactive plots and charts. Moreover, the physical infrastructure of the roadway system can be seen from aerial photos and satellite images through the built-in Google-Maps/Earth application. The quality and richness of data information contained in other freeway traffic datasets generated to date pale by comparison with what is now available by PeMS.

3.3 INCIDENT DATASET DEVELOPMENT

Forty lane-blocking incidents were collected for this research. The process of incident mining is described as follows. First, the CHP incident logs were studied—all incident reports used in this research can be found in Appendix A. For a reported incident, the corresponding traffic data for the VDSs surrounding the stated location were scrutinized. The start time reported on the CHP report was checked against the time when traffic flow was first disturbed; as expected, they usually do not match on the minute-level. Hence, in this research, the start time of an incident was the *apparent start time*, defined as the time interval immediately before the traffic disturbance was first observed, an approach that is not ideal but that has been implemented by other AID studies (Mak and Fan, 2006a). This was done by a thorough visual inspection of both 5-min and 30-sec time series of flow and occupancy data for both up- and downstream VDSs according to the following procedure. Initially, visual inspections on the 5-minute historical data were done to confirm that the perturbation in fact existed and that it was non-recurrent. An example of it is shown on Figure 3-2, where flow and occupancy for a few days before and after the day of an incident is displayed from 11:00 to 13:00, the time interval in which the accident occurred. This figure was generated by—and is a good example of the flexibility of—the PeMS user interface. Plots of historical profiles of occupancy and flow were checked against current values, as pictured in Figure 3-3 and Figure 3-4. Note in these plots that the current occupancy and flow of the stations deviate from the historical profile (medians), supporting the occurrence of the reported incident.

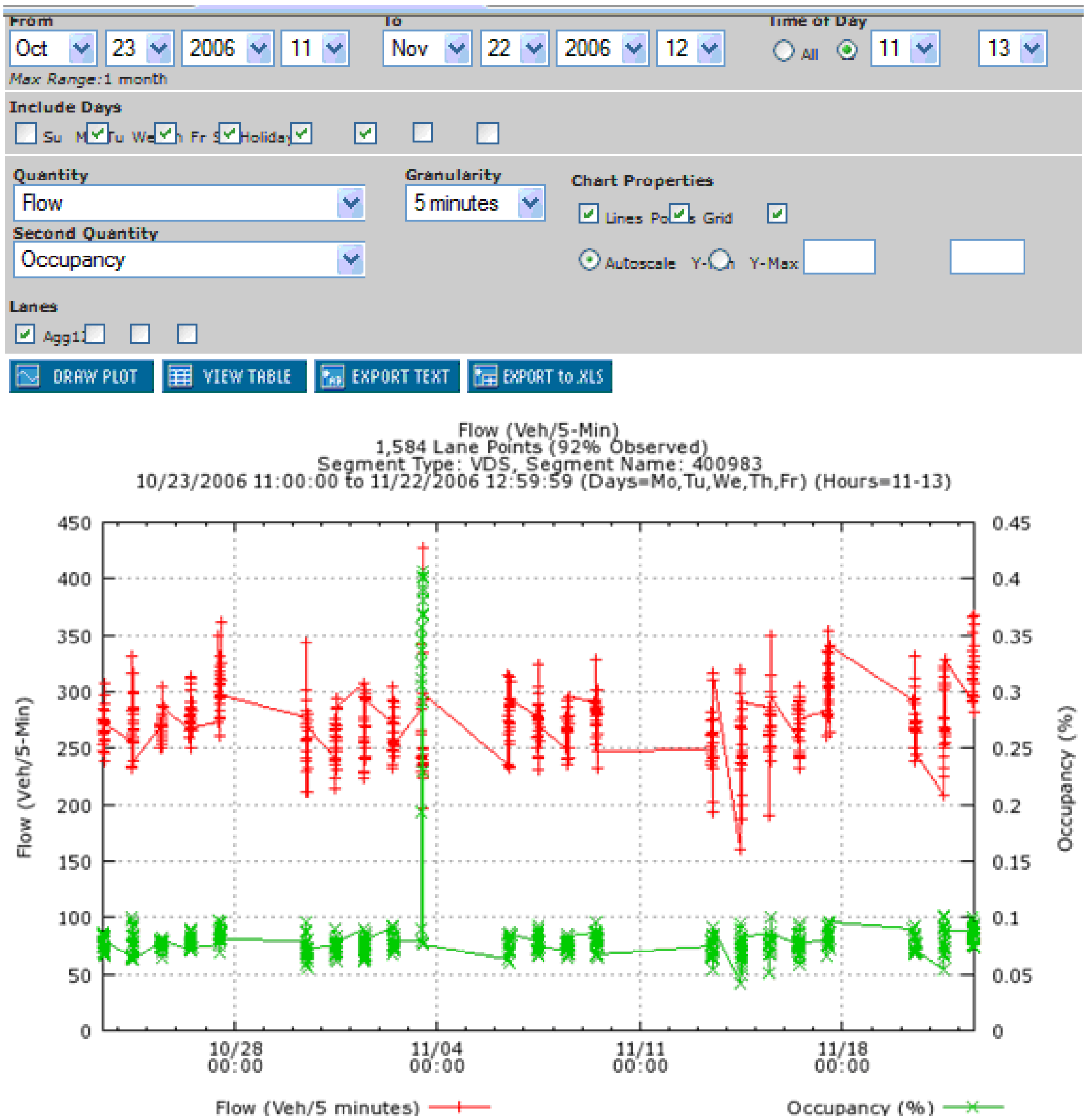

Figure 3-2 Initial verification of occurrence of the reported incident on 5-min data. Occupancy (DS station) is much higher than usual.

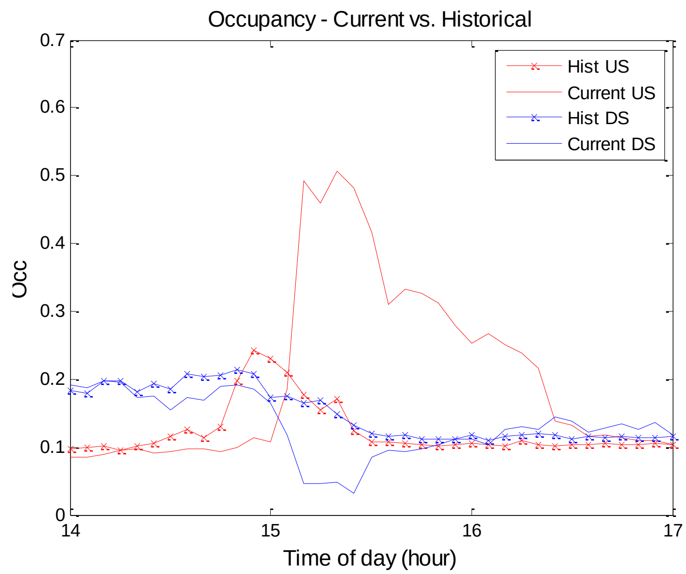

Figure 3-3   DS occupancy is higher than usual and US occupancy is lower.

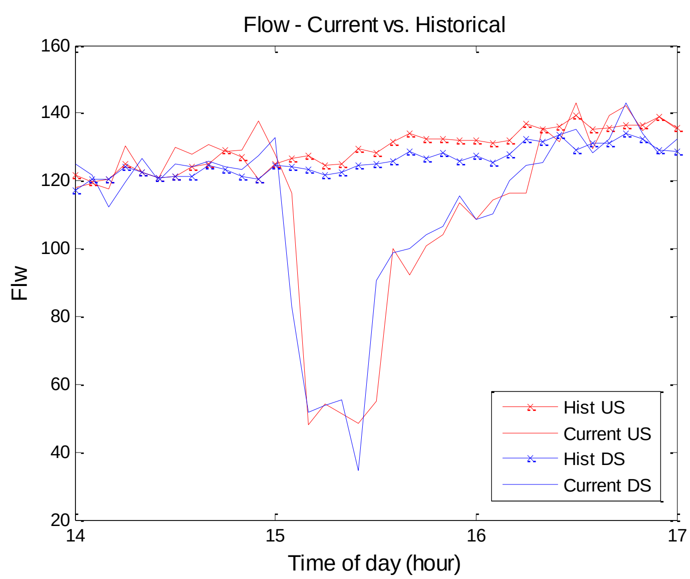

Figure 3-4   Significant decrease in flow in both stations.

After initial verifications on the 5-min data, the 30-sec data is studied. Average and lane-by-lane occupancy and flow of the VDSs are plotted to check the incident occurrence and determine its *apparent start time* (Figure 3-5 through Figure 3-8). If speed were also available, it could have been used to determine the apparent start time as speed gets disturbed relatively quickly on the presence of an incident (Corby and Saccomano, 1997).

3.3.1 Incident-Free Dataset Selection

Traffic data free of incidents were culled to evaluate the false alarm rate of the models. Data where recurrent differences in occupancy between neighboring stations are recurrent were of particular interest, as they are conducive to the occurrence of false alarms. Figures 3-9 and 3-10 show an example of such case; notice that the observed differences in occupancy between the stations are recurrent. Seventeen incident-free cases (refered to as *AccFree*) were selected, consisting of 46, 5 hours of traffic in total.

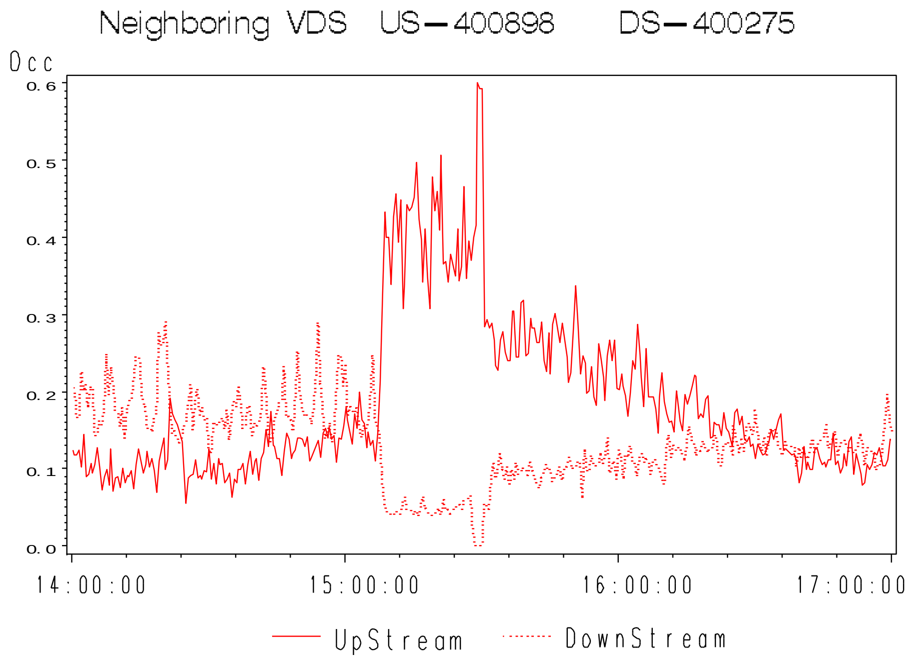

Figure 3-5 Average occupancy of US and DS stations

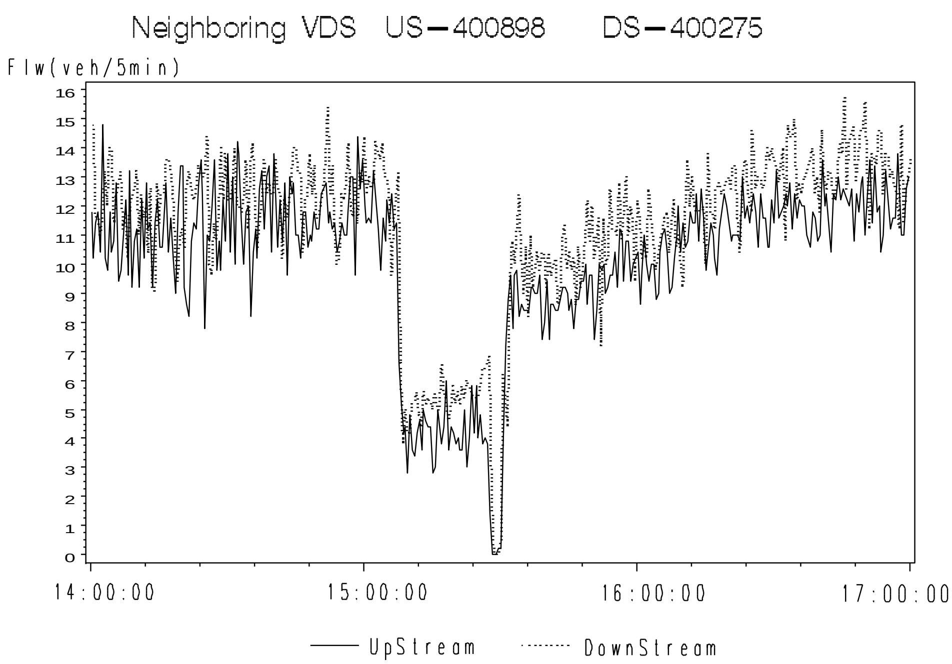

Figure 3-6 Average flow of US and DS stations.

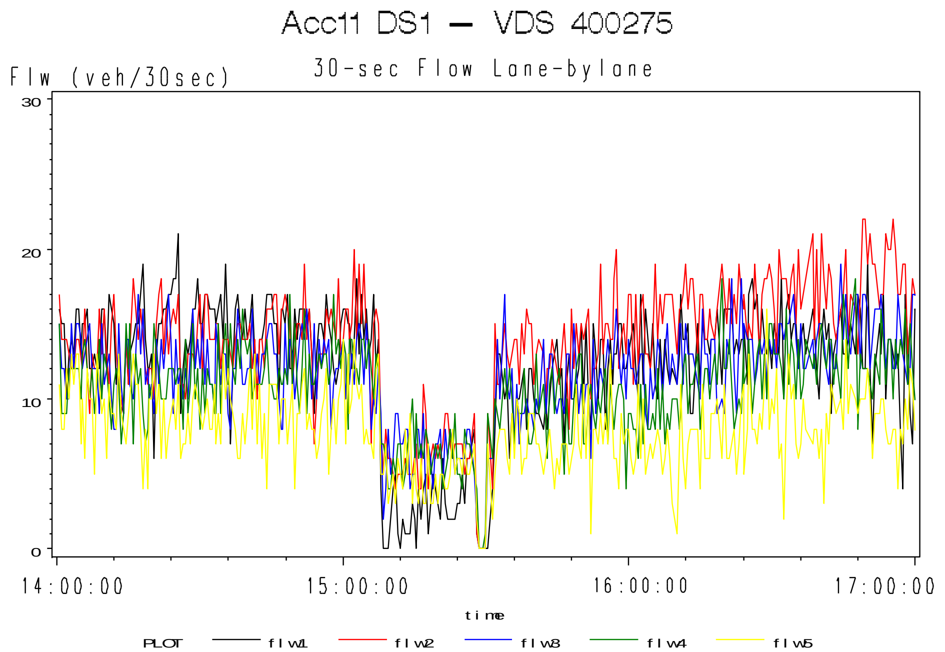

Figure 3-7   Lane-by-lane flow of DS station

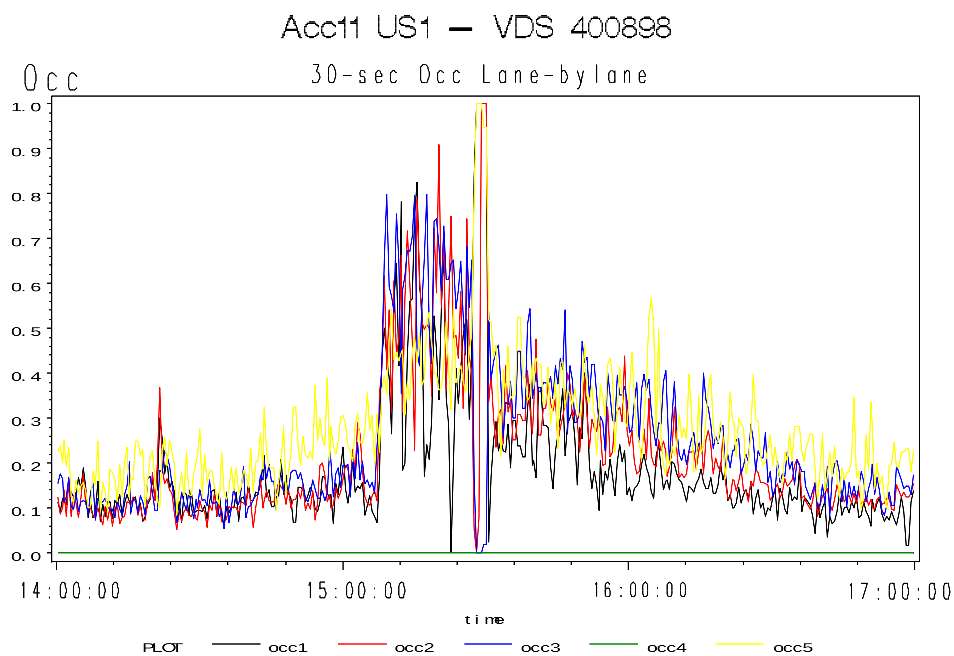

Figure 3-8   Lane-by-lane occupancy of US station

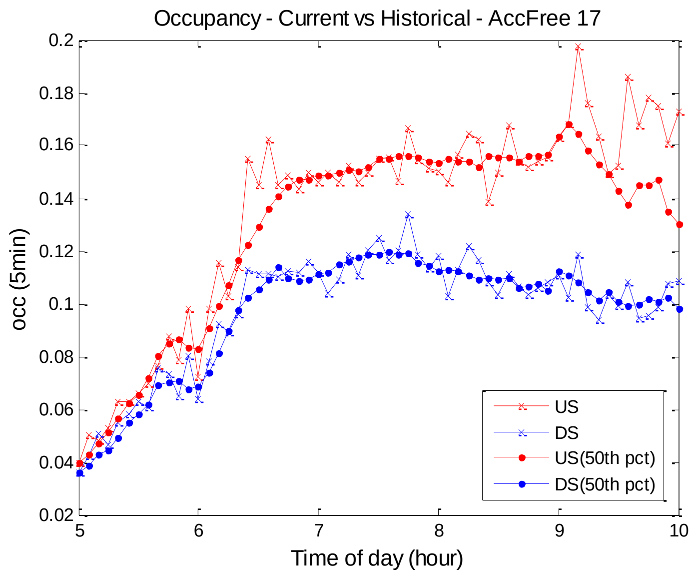

Figure 3-9 Current and historical difference of occupancy between a pair of stations

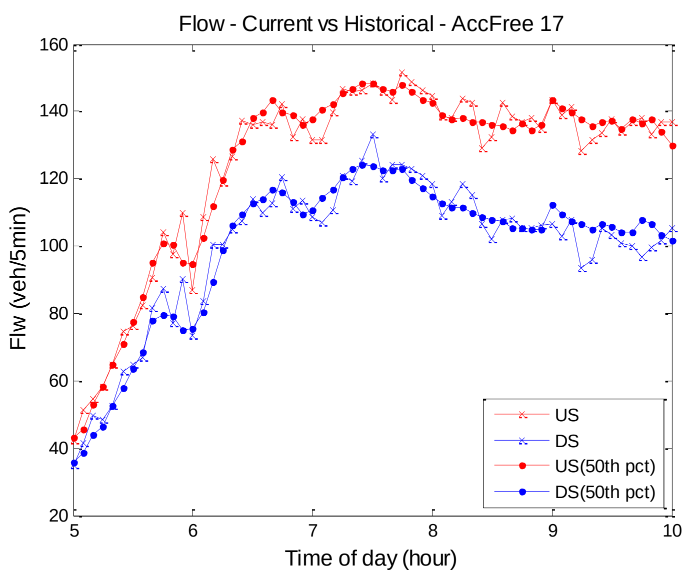

Figure 3-10 Current and historical difference of flow between a pair of stations

CHAPTER 4

EVALUATION OF EXISTING ALGORITHMS

As mentioned in Chapter 2, the existing algorithms that were evaluated for comparison purposes were California (Comparative), Minnesota (Hybrid), and SND (Statistical). The performance comparison was based on performance curves such as the ones shown in Figure 2-4. These DR x FAR curves have been widely used in previous studies to compare AID algorithms (Stephanedes and Chassiakos, 1993; Abdulhai and Ritchie, 1999), although other parameters for evaluating AID algorithms have been proposed (Browne et al, 2005; Petty et al, 2002; Teng and Qi, 2003).

Each curve relates to an AID algorithm, and each point on the curve represents the pair (mean DR, mean FAR) for a particular algorithm threshold set. The curve is formed by the points where FAR is minimized for each DR observed. As it can be seen, the best algorithm is the one whose curve leans towards the upper left part of the plot. The MTTD of each model will also be displayed in the plot. Twenty incidents were randomly chosen for training, and twenty for testing. As for the AccFree dataset, nine cases were randomly selected for training and 8 for testing.

4.1 CALIFORNIA ALGORITHM

The most traditional AID algorithm was the first one to be implemented. Each threshold (T1, T2, and T3) was tested from 0.05 through 1.00, with increments of 0.05 on the training dataset, which resulted in a total of 8,000 (20^3) combinations of thresholds. For each level of DR (from 0.8 to 1.0), the model with the minimum FAR was selected.

If two models have the same FAR, the one with the lowest MTTD is chosen. Figure 4-1 shows the performance of the five selected models. The selected models were then evaluated on the testing dataset. The results are shown in Figure 4-2. The number labels inside the plot area are the MTTD of the models. Table 4-1 summarizes the training and testing performance evaluations.

4.2 MINNESOTA ALGORITHM

The same approach was conducted in the application of the Minnesota algorithm. Each threshold (T1 and T2) was tested from 0.05 to 1.0 with 0.05 increments. Therefore, a total of 400 models (20^2) were tested in the calibration step. Window sizes of $y^a{}_t$ and $y^b{}_t$ were 10 and 6 observations, respectively, the values suggested by the authors who introduced the model (Stephanedes and Chassiakos, 1993). The training performances of the best models are shown in Figure 4-3. The chosen models were then evaluated on the testing dataset. The results are shown in Figure 4-4. and Table 4-2 summarizes the results.

4.3 SND ALGORITHM

Besides threshold T1, the window size (WS) of the look-back interval was also tested for different values—4, 6, 8, and 10 minutes. Since T1 ranged from 0.5 to 1.5 with 0.1 increments, a total of 584 (146x4) models were tested. Figure 4-5 shows the best algorithms for each WS. Notice that WS=8min achieved the best training performance. Therefore, this was the WS used on the testing stage, whose results are shown in Figure 4-6. Table 4-3 summarizes the performance.

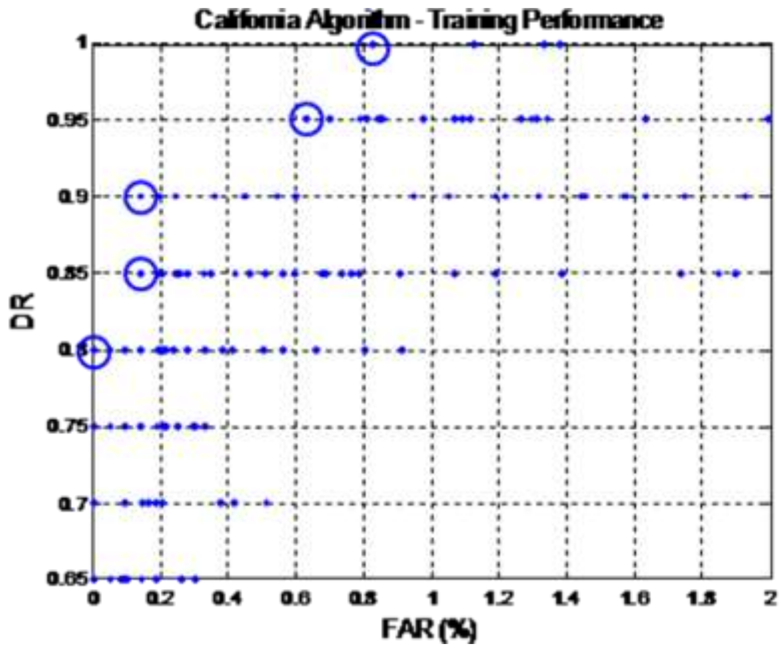

Figure 4-1 California algorithm calibration - models selection

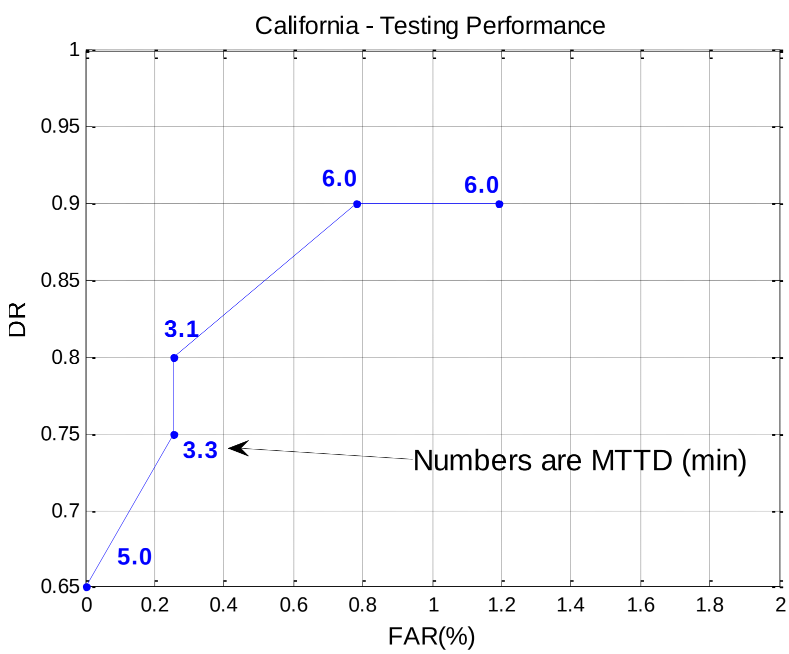

Figure 4-2 California algorithm - Testing performance

Table 4-1 California algorithm performance

California Algorithm						
Training				Testing		
DR	FAR(%)	MTTD(min)	Model#	DR	FAR (%)	MTTD (min)
0.80	0.00	4.88	1901	0.65	0.00	5.04
0.85	0.14	6.59	1862	0.75	0.25	3.27
0.90	0.14	6.00	1861	0.80	0.25	3.09
0.95	0.63	4.05	1841	0.90	0.78	6.00
1.00	0.83	2.80	1441	0.90	1.19	5.97

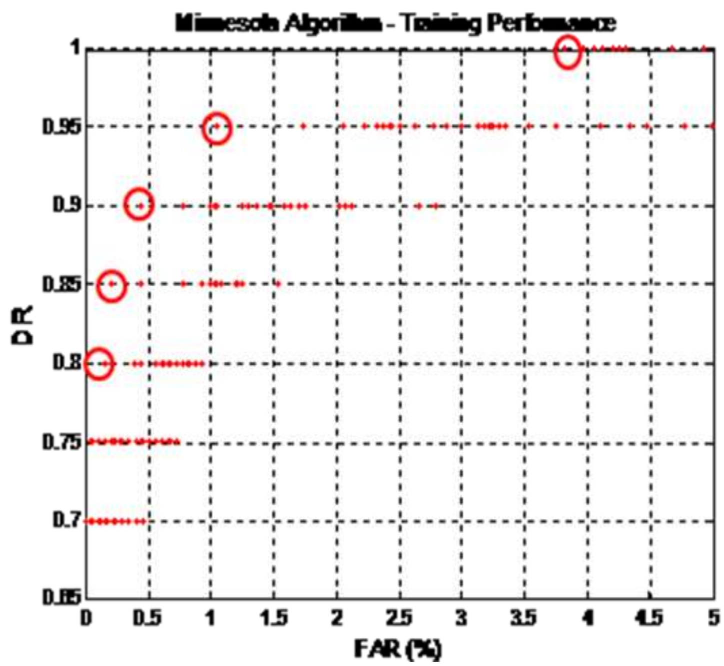

Figure 4-3 Minnesota algorithm calibration. Model selection

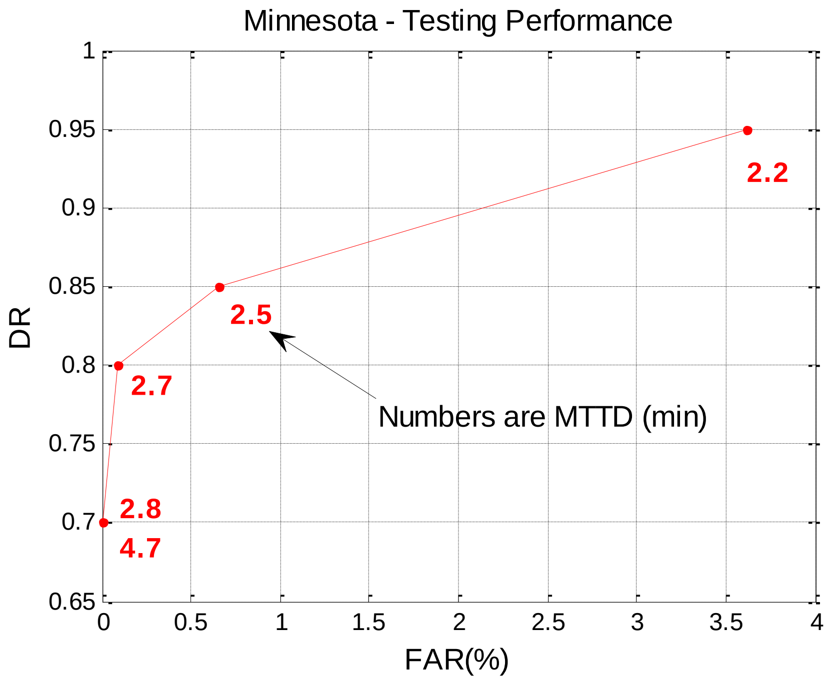

Figure 4-4 Minnesota algorithm. Testing performance

Table 4-2 Minnesota algorithm performance

Minnesota Algorithm						
Training				Testing		
DR	FAR(%)	MTTD(min)	Model#	DR	FAR (%)	MTTD (min)
0.80	0.16	5.22	20	0.70	0.00	4.71
0.85	0.22	3.47	19	0.70	0.00	2.75
0.90	0.45	3.06	18	0.80	0.09	2.69
0.95	1.05	3.39	16	0.85	0.66	2.53
1.00	3.83	2.38	130	0.95	3.62	2.21

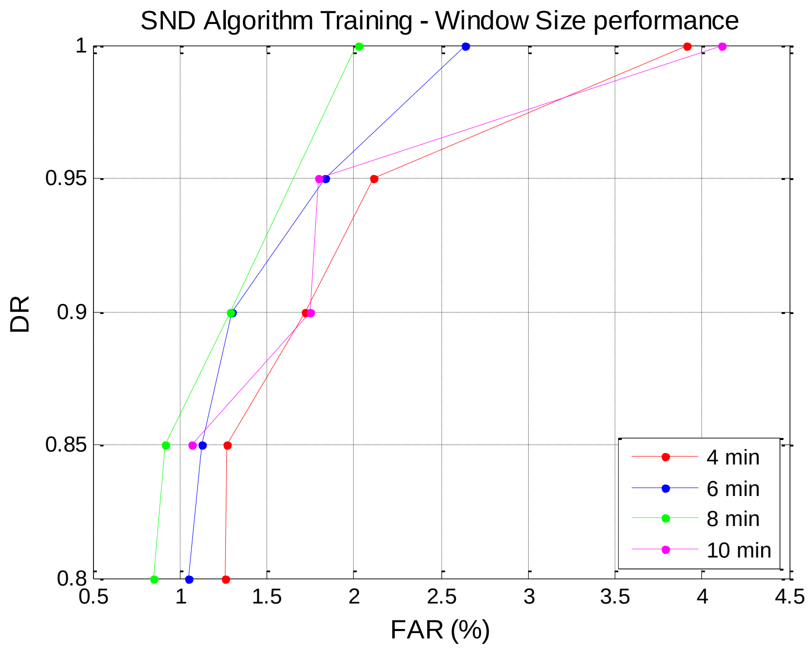

Figure 4-5 SND algorithm calibration. Model Selection

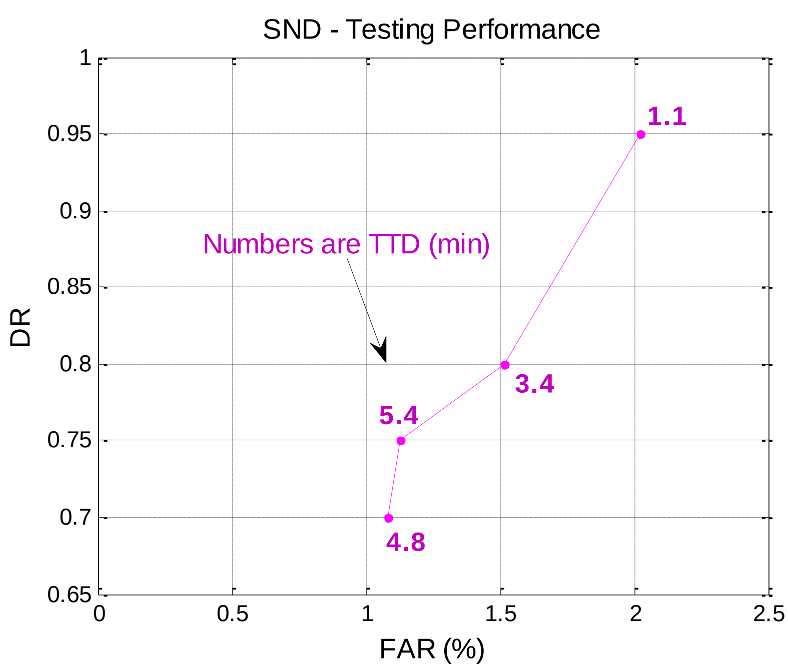

Figure 4-6 SND algorithm. Testing performance

Table 4-3 SND algorithm performance

SND Algorithm						
Training				SND (Testing)		
DR	FAR(%)	MTTD(min)	Model#	DR	FAR (%)	MTTD (min)
0.80	0.85	5.28	37	0.70	1.08	4.79
0.85	0.91	6.62	36	0.75	1.13	5.43
0.90	1.29	2.42	33	0.80	1.52	3.44
0.95	-	-	-	-	-	-
1.00	2.02	3.83	29	0.95	2.02	1.05

4.4 MODELS COMPARISON

Figure 4-7 shows the comparison of the existing models. The California algorithm presents the best FAR for DR≥0.85, but MTTD is considerably high (6min) and it missed 10% of the incidents. For DR=0.9, SND performed better than Minnesota. A detailed discussion of the results is presented in Chapter 5.

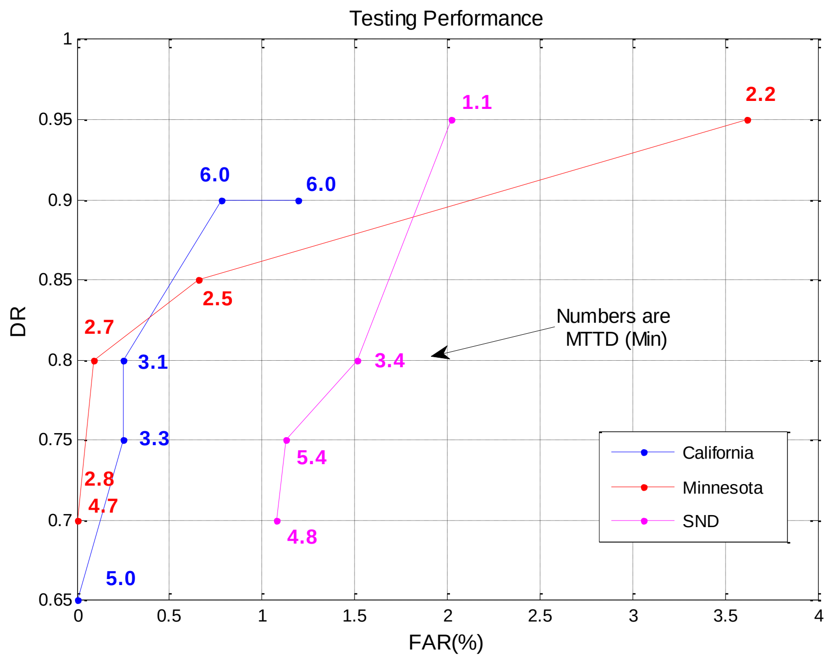

Figure 4-7 Comparison of classic AID models

CHAPTER 5

THE PROPOSED APPROACH

In Chapter 4, the existing models were evaluated. In the training process, a total of almost 9,000 models were considered, from which the TMS operators will choose one, or a couple, to be implemented. Besides, the selected model uses a fixed set of thresholds, which is not desirable for the reasons described in Section 2.4. In addition, the calibration process of the models requires the availability of an incident-dataset, which may not be available. This chapter describes, in details, the proposed AID algorithm, which tries to overcome those issues. Three key characteristics of the presented method should to be highlighted in advance: 1) the algorithm requires no training; 2) it is self-learning, as it needs no human intervention and becomes more powerful with time; and 3) its detection is based on a dynamic traffic-demand-sensitive threshold.

The fundamental idea of the algorithm is to identify what are the likely values of the 30-sec occupancy differences between up- and down-stream VDSs for a particular 5-min period of the day. The set of likely values is based on historical 5-min occupancy differences observed in previous days.

5.1 MATHEMATICAL FORMULATION

Consider $occdf30\sec_{(i)}(j,d)$ the difference of 30-sec occupancy between two adjacent stations inside the 5-min period (*j*), for a day (*d*) of the week. Notice that

i=1,2,…10, as there are ten 30-sec observations inside a 5-min period. It will be shown later that

$$occdf\,30\sec_{(i)}(j,d) \sim N(\mu_{30\sec}, \sigma^2_{30\sec}) \quad (1)$$

This means that, for a particular 5-min period of the day, the 30-sec differences of occupancy between two adjacent stations are normally distributed, as illustrated in Figure 5-1. If $\mu_{30\sec}$ and $\sigma^2_{30\sec}$ are estimated, then a one-sided confidence interval comprising acceptable maximum values of $occdf\,30\sec_{(i)}(j,d)$ can be constructed.

Let $occdf\,5\min(j,d)$ be the difference of 5-min occupancies between two adjacent stations for a particular 5-min period *j* of the day *d* of the week. Let $\mu_{5\min}$ and $\sigma^2_{5\min}$ be the mean and the variance of $occdf\,5\min(j,d)$ calculated over previous days. As it is

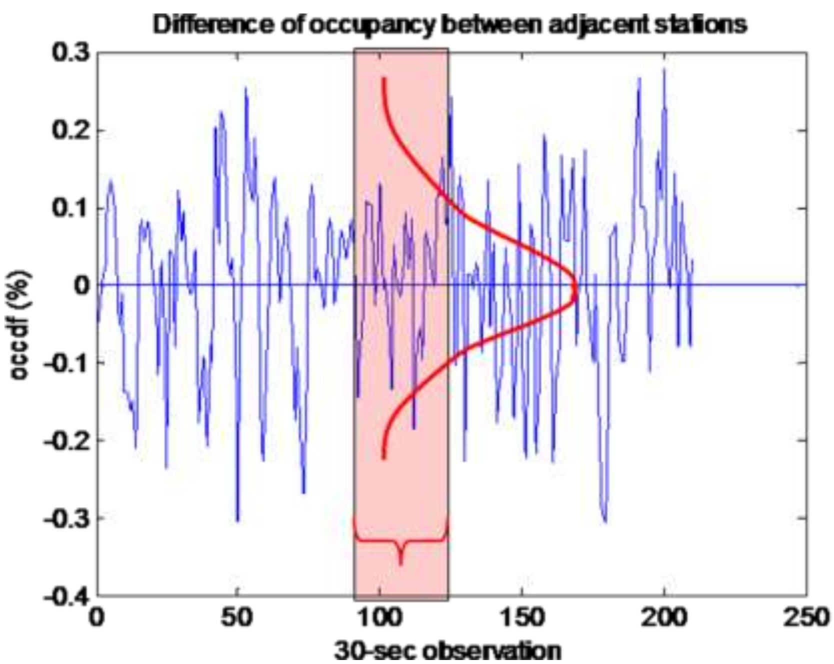

Figure 5-1 For a particular 5-min period, 30sec *occdf* is normally distributed

shown below, $\mu_{30\sec}$ is equal to $\mu_{5\min}$, which is also intuitive, because $occdf5\min(j,d)$ is the average of $occdf30\sec_{(i)}(j,d)$

$$\mu_{30\sec} = \frac{1}{p}\sum_{d}\frac{1}{10}\sum_{i=1}^{10} occdf30\sec_{(i)}(j,d)$$

$$= \frac{1}{p}\sum_{d}\frac{1}{10}\sum_{i=1}^{10} occdf30\sec_{(i)}(j,d)$$

$$= \frac{1}{p}\sum_{d} occdf5\min(j,d)$$

$$\mu_{30\sec} = \mu_{5\min}$$

Where *p* is the number of previous days included in the historical sample. Now that $\mu_{30\sec}$ is found as a function of historical $occdf5\min(j,d)$, there is only $\sigma^2{}_{30\sec}$ left to be determined, which can be found from $\sigma^2{}_{5\min}$ in the following way. Assuming $occdf30\sec_{(i)}(j,d)$ observations to be independent, we have:

$$\sigma^2{}_{5\min} = \sigma^2\left[\frac{1}{10}\sum_{i=1}^{10} occdf30\sec_{(i)}(j,d)\right]$$

$$= \frac{1}{10^2}\sigma^2\left[\sum_{i=1}^{10} occdf30\sec_{(i)}(j,d)\right]$$

$$= \frac{1}{10^2}10\sigma^2\left[occdf30\sec_{(i)}(j,d)\right]$$

$$= \frac{1}{10}\sigma^2{}_{30\sec}$$

$$\sigma^2{}_{30\sec} = 10\sigma^2{}_{5\min}$$

Therefore, $\mu_{30\sec}$ and $\sigma^2_{30\sec}$, the only two parameters to be estimated in the model, can be easily estimated from the historical values of $occdf5\min(j,d)$. Equation (1) becomes:

$$occdf30\sec_{(i)}(j,d) \sim N(\mu_{5\min}, 10\sigma^2_{5\min})$$

For a desired level of significance α, a one-sided $1-\alpha$ confidence interval for $\mu_{30\sec}$ can be defined, with the critical value of $\mu_{30\sec}$ being the threshold of the model.

$$p(occdf30\sec_{(i)}(j,d) > Thr) = \alpha$$

$$Thr = NormInv(\mu_{5\min}, 10\sigma^2_{5\min}, 1-\alpha)$$

Since the variance $\sigma^2_{30\sec}$ needs to be estimated, the t-Student distribution is used instead of the normal, although in this particular application the normal distribution could have been used because *n* is usually large (n>150). Therefore, *Thr* is computed as:

$$Thr = t_{student}Inv(\hat{\mu}_{5\min}, 10\hat{\sigma}^2_{5\min}, 1-\alpha) \quad (2)$$

If an $occdf30\sec_{(i)}(j,d)$ exceeds the algorithm's threshold, an incident alarm is triggered. Note that the threshold continuously changes every 5 minutes, accounting for changes in traffic based on its typical behavior.

5.1.1 Verification of the Assumption of the Model

The presented algorithm assumes that, for a particular 5-min period of the day, the historical values of $occdf30\sec$ are normally distributed. To verify the validity of this assumption, 30-sec occupancy data of VDS 400983 for six days were collected (October 4, 5, 10, 11, 24, and 31 of 2006). Chi-square goodness-of-fit tests were applied within

each of 288 five-minute periods of the day. Considering a level of significance of 5%, normality tests were not rejected in any 5-minute period of the day. Since the occupancy data for the selected station are normally distributed, it can be concluded that $occdf\,30\sec_{(i)}(j,d)$ is normally distributed as well, as $occdf\,30\sec_{(i)}(j,d)$ is the difference of occupancy between two stations.

5.2 ALGORITHM IMPLEMENTATION

5.2.1 Selection of Historical Sample

For each 5-minute period, the algorithm threshold changes according to the 5-minute occupancy differences observed in the previous days, as indicated by Equation 2. Since traffic is known to vary by day-of-the-week, only days with expected similar traffic behavior should be considered in the historical sample. For instance, when applied on Saturday, the algorithm should consider only previous Saturdays, or also Sundays, depending on how similarly traffic in those days behaves.

In this research, the following groups were considered to be homogeneous.

- Monday (business days)
- Tuesday, Wednesday, Thursday (business days)
- Friday (business days)
- Saturday, Sunday, and non-business days.

Therefore, when applying the algorithm on a Wednesday, all previous Tuesdays, Wednesdays and Thursdays that are business days are considered in the historical sample. The definition of the groups was not based on any formal analysis. However, the

visualization of the total VMT of the freeway facility during the period under analysis supported the way groups were defined (Figure 5-2).

Since the threshold largely depends on the variance of $occdf\,5\min(j,d)$ computed over previous days, it is important that outliers be identified and removed. Outliers may be caused by special events or by detection problems and must be excluded.

In this research, $occdf\,5\min(j,d)$ observations lying outside the interval $\hat{\mu}_{5\min} \pm 2\hat{\sigma}^2$ were discarded from the sample. Figure 5-3 shows an example of outlier removal. This plot shows $occdf\,5\min(18:55-19:00, Tue/Wed/Thu)$ for those days preceding the day of AccFree03 (2006/10/18). Of the 45 observations (days), notice that two of them were excluded. Therefore, those observations will not be part of the computation of the threshold for that time period.

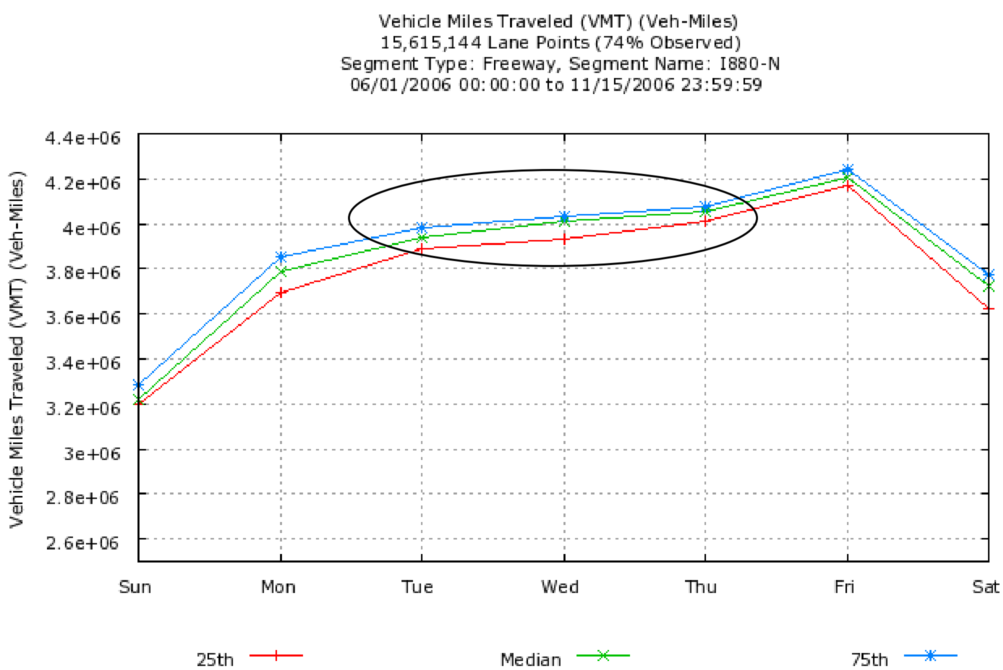

Figure 5-2 VMT by day-of-week during the period of analysis.

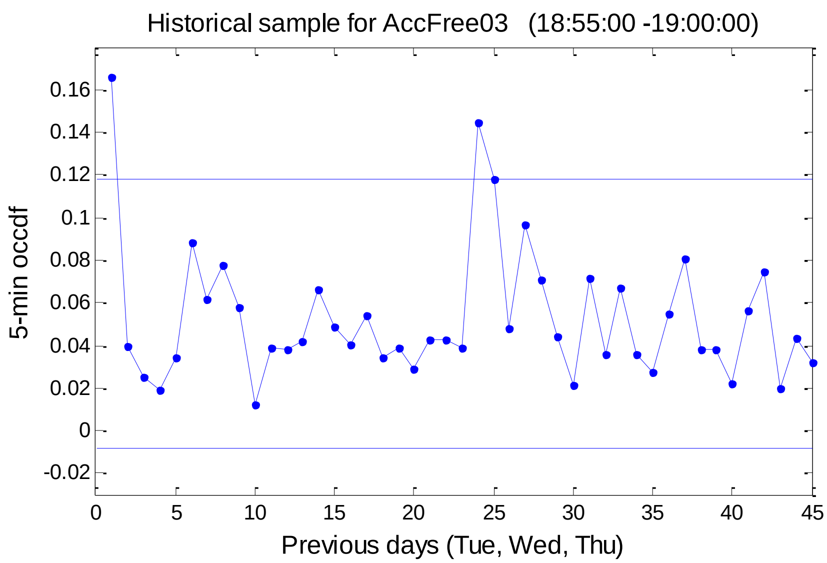

Figure 5-3 Historical sample - outlier identification and removal

5.2.2 Threshold Computation

After selecting and cleaning the historical sample, the $occdf\,30\sec_{(i)}(j,d)$ threshold of the 5-minute period of interest is determined from Equation (2). First, α was set to 0.01%. It is important to note that the value of α represents the desired false alarm rate.

Figure 5-4 shows the time-varying threshold obtained from the proposed AID model. The plot shows $occdf\,30\sec$ for Acc31, whose CHP report and general information are shown on Appendix A and B, respectively. The vertical dotted lines in Figure 5-4 specify the apparent start and end times of the accident. The relatively flat blue line is $\hat{\mu}_{5\min}$, the historical average of $occdf\,5\min(j,d)$. As shown in the same figure, the threshold stays high during the PM peak-period (until 7pm) and decreases afterwards,

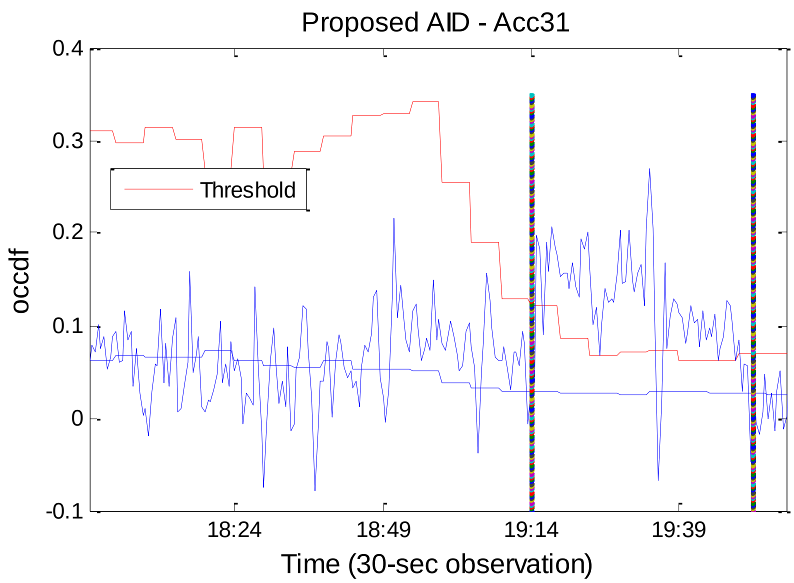

Figure 5-4 Acc31. Vertical lines represent the apparent accident start-and end-times.

allowing the algorithm to detect the accident from its start. Figure 5-5 illustrates the same type of plot for Acc22.

Similar plots for the incident-free data are shown in Figure 5-6 and Figure 5-7. Notice that in these cases the history-based thresholds are high enough to not sound an alarm, indicating that the observed differences of occupancy between the stations are actually recurrent. Hence, by considering historical information, the proposed AID algorithm avoids false alarms. Figure 5-8 shows that if a persistence test of one observation (i.e.: 30 seconds) had been used, the observed false alarms would have been avoided. Persistence tests have been applied in AID research, improving performance of the models (Sheu, 2004). However, it must be noted that persistence tests increases MTTD.

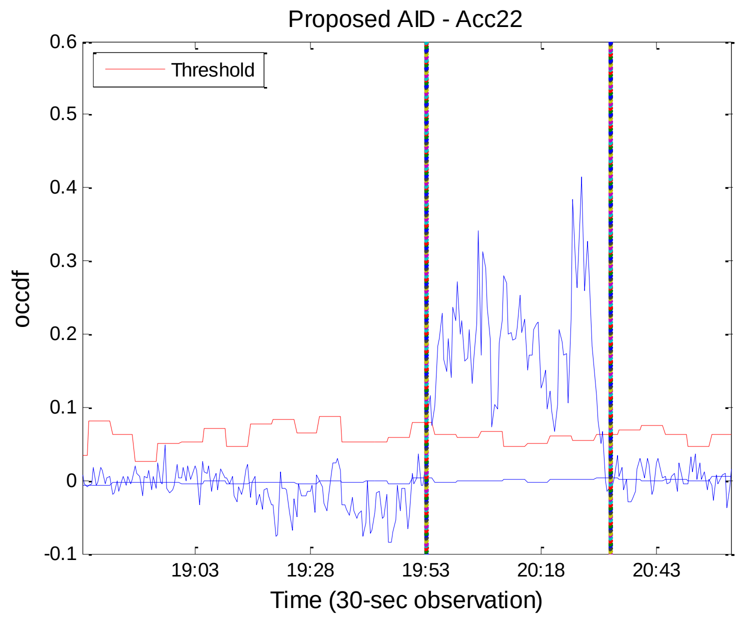

Figure 5-5 Acc22. Vertical lines represent the accident start- and end-times.

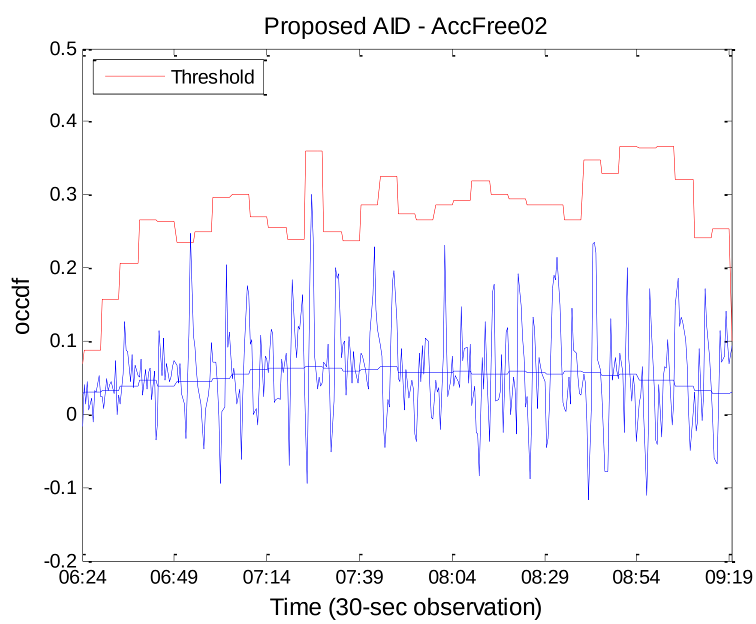

Figure 5-6 AccFree02. Dynamic, history-based threshold to reduce false alarm

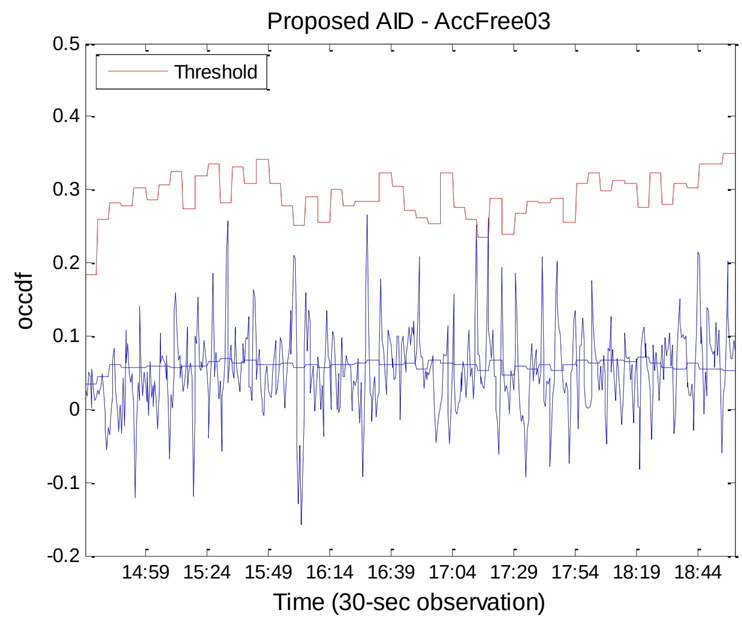

Figure 5-7 AccFree03. Dynamic, history-based threshold to reduce false alarm

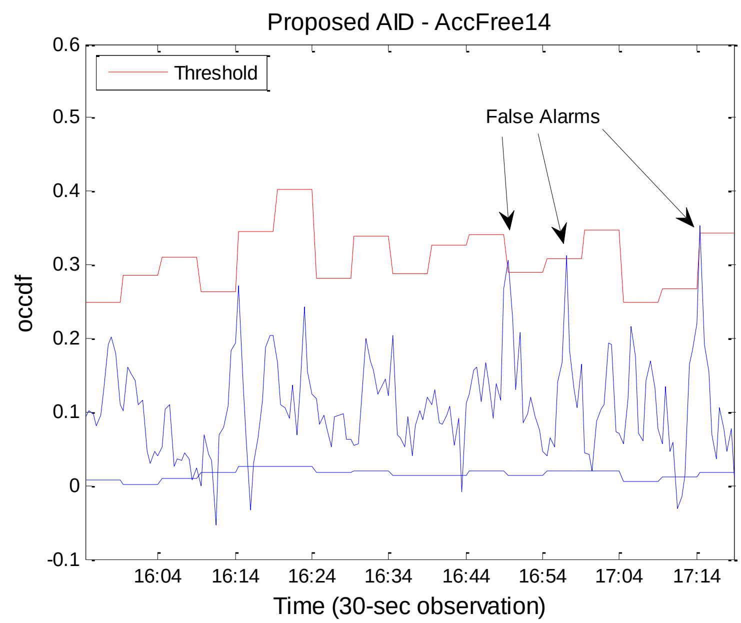

Figure 5-8 AccFree14. A persistence test of one observation would avoid the observed false alarms.

5.2.3 Model Evaluation

The performance of the proposed algorithm is shown in Figure 5-9. As opposed to the other models, the proposed one is represented by a single point in the plot because there is no set of threshold parameters to be calibrated. The relatively low FAR (0.25%) is achieved on the expense of a high MTTD (4.3 minutes). A lower MTTD can be obtained by increasing α , which consequently increases FAR, as the thresholds are lowered. Figure 5-10 shows the performance of the models for significance levels α =0.1%, 0.5%, and 1%. Notice the resulted decrease in MTTD. A detailed discussion of the results is presented in Chapter 6.

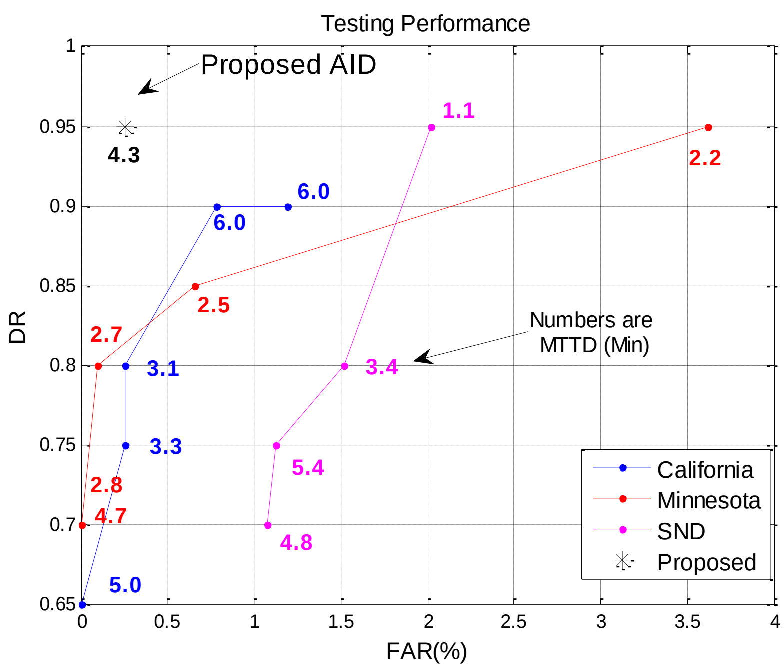

Figure 5-9 Models comparison. Proposed model with $\alpha = 0.01\%$

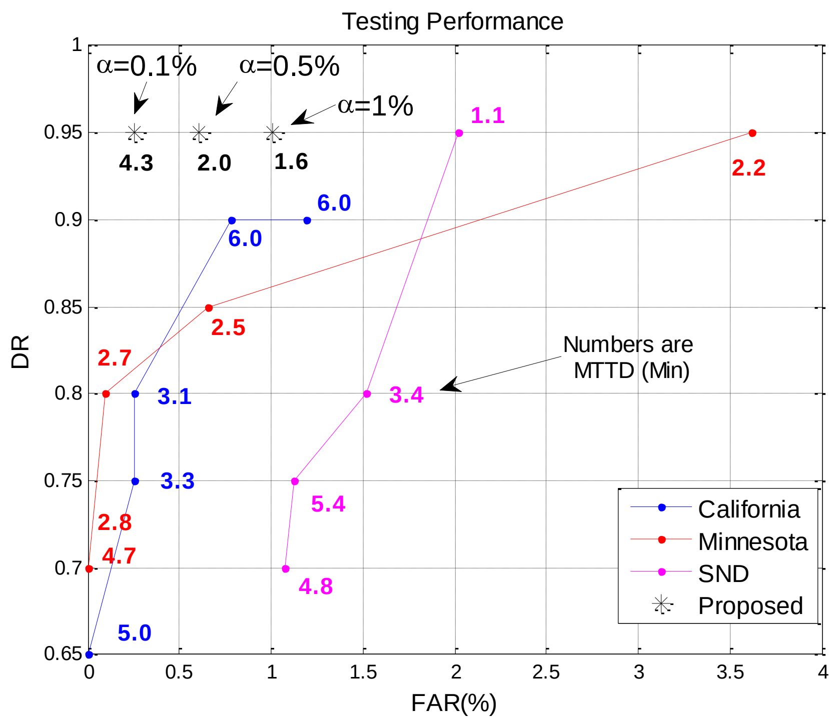

Figure 5-10   Models comparison.

CHAPTER 6

ANALYSIS OF THE RESULTS

This chapter discusses not only the performance of the proposed model in terms of DR, FAR, and MTTD, but also two foremost characteristics of AID models: ease of implementation and universality (transferability). It is widely recognized that these are among the most critical problems encountered in existing algorithms (Abdulhai and Ritchie, 1999).

6.1 EASE OF IMPLEMENTATION

The proposed AID algorithm requires no training, that is, no parameter calibration. This certainly encourages implementation as calibration usually requires significant time and human efforts that are not always available. In this research, for instance, the calibration process of the existing algorithms assessed almost 9,000 models, from which the TMS personnel should choose one, or a couple.

In addition, the calibration of existing approaches also requires the availability of an incident dataset, which must contain relatively accurate information such as start-time and location. As aforementioned, start-times reported in incident logs are not accurate enough for AID algorithm calibration purposes. Therefore, the traffic data must be scrutinized so the apparent start-time can be determined. Such process may be very time-consuming.

Even considering that a well documented incident database is available, and that the parameter calibration is fairly simple to conduct, the calibration process of existing

models will single out a parameter—or a set of parameters—that will perform well only in a narrow scope of traffic situations. In this case the model lacks transferability, which is discussed in the following section (Section 6.2).

Another remarkable feature of the proposed model that considerably simplifies implementation is that it is self-learning, that is, the more traffic data are received by the TMS center, the greater the ability of the model to capture the typical behavior of traffic. And this is done with no human intervention of any kind.

6.2 UNIVERSALITY (OR TRANSFERABILITY)

In addition to its ease of implementation, which is a highly desirable attribute towards model universality, the presented model is transferable to any traffic situation because it is based solely on the typical behavior of traffic for the particular time and location. Therefore, the logic of the model can be applied regardless of the type of roadway geometry (i.e.: number of lanes, grade), road functional classification, and very importantly, time. In the proposed model, the recurrent differences in occupancy are taken into consideration in the computation of the dynamic thresholds, as opposed to what occurs with the fixed-threshold algorithms that do not take advantage of historical traffic information.

A good example of the universality of the proposed model is shown in Figure 6-1. In this case (Acc28), the difference in occupancy caused by the accident was not large enough to make the existing models detect the incident; Figure 6-2 shows that even the California model that yielded the highest level of FAR was not able to detect that incident. Since during this particular time of the day the differences in occupancy are

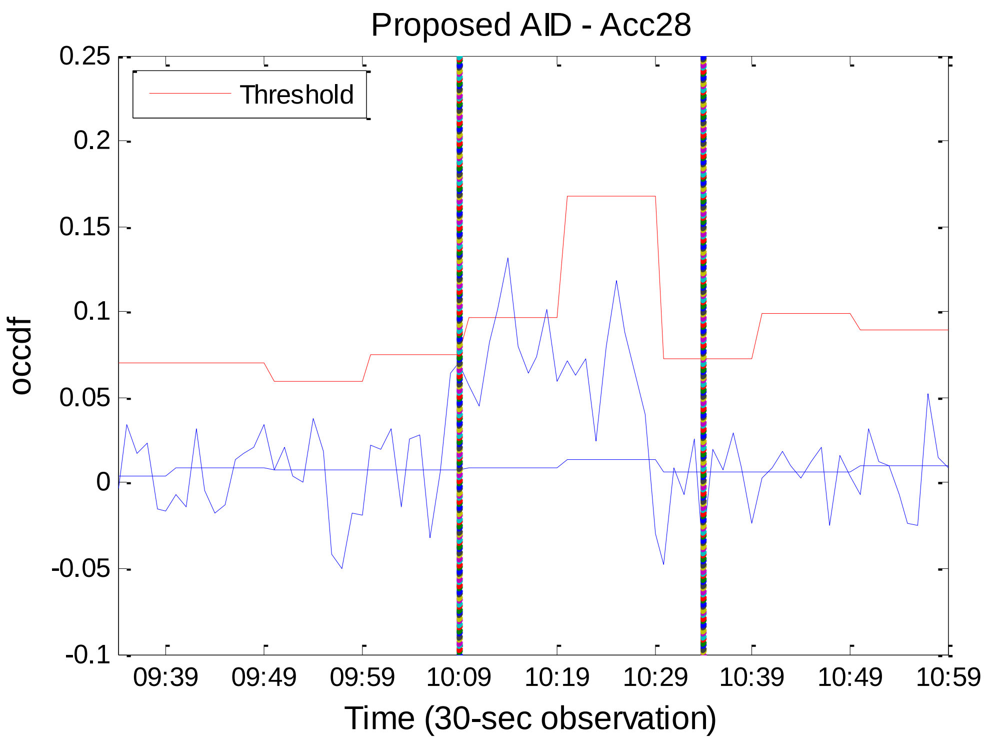

Figure 6-1 Acc28 detection by the proposed model

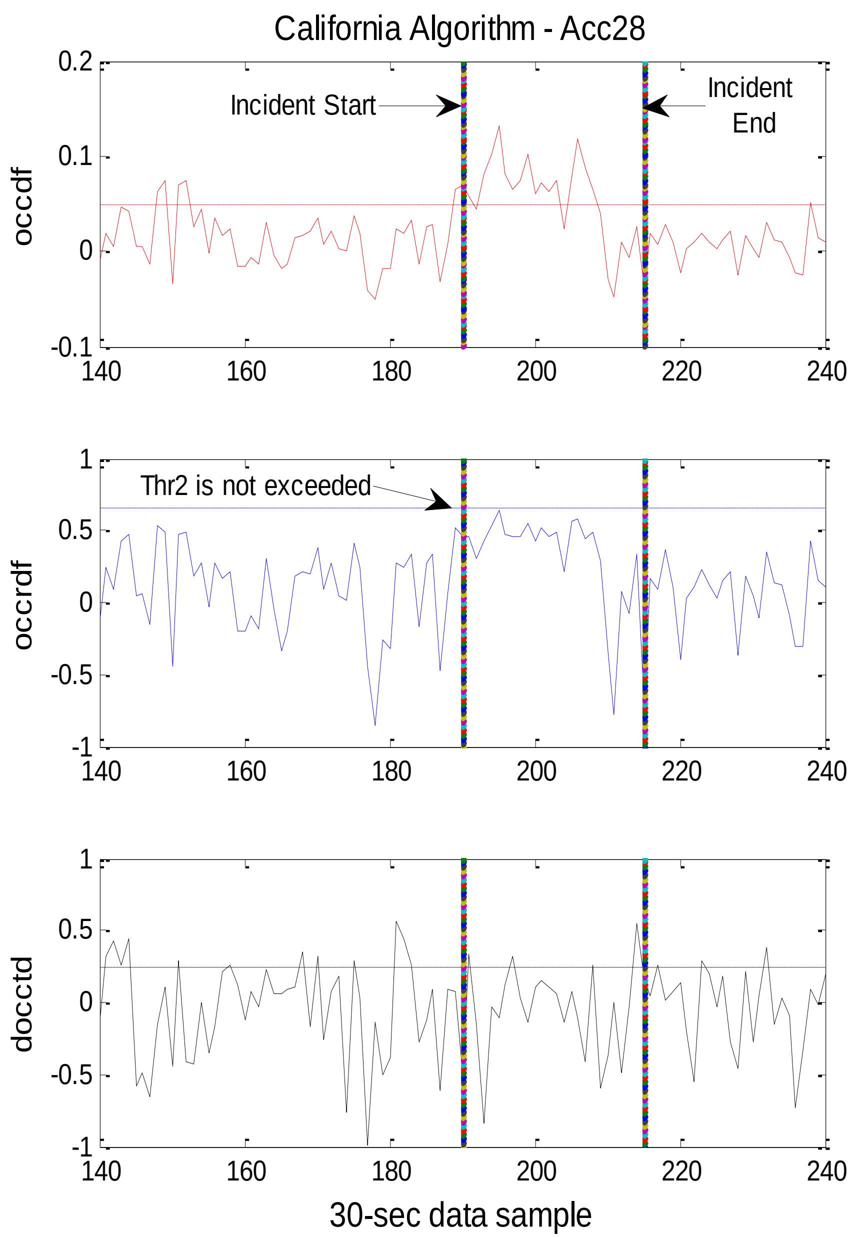

Figure 6-2 California AID algorithm missed Acc28

historically low—as indicated by the low thresholds themselves—the thresholds of the proposed model were low enough to detect the incident. Other examples of the detection ability of the proposed algorithm are shown in Figures 5-5, 5-4, 6-3, and 6-4.

Since the proposed algorithm DR was 95%, and there were 20 incidents in the testing dataset, the algorithm missed (barely) one incident—Acc23. It is shown in Figure 6-5. The high threshold is due to the high variability in *occdf* during that time (Monday peak-hour) in that location.

6.3 ALARM CONFIDENCE INDICATION

Even though the presented method provides a threshold for decision-making based on a specified level of significance α , the TMS operators can alternatively look at the

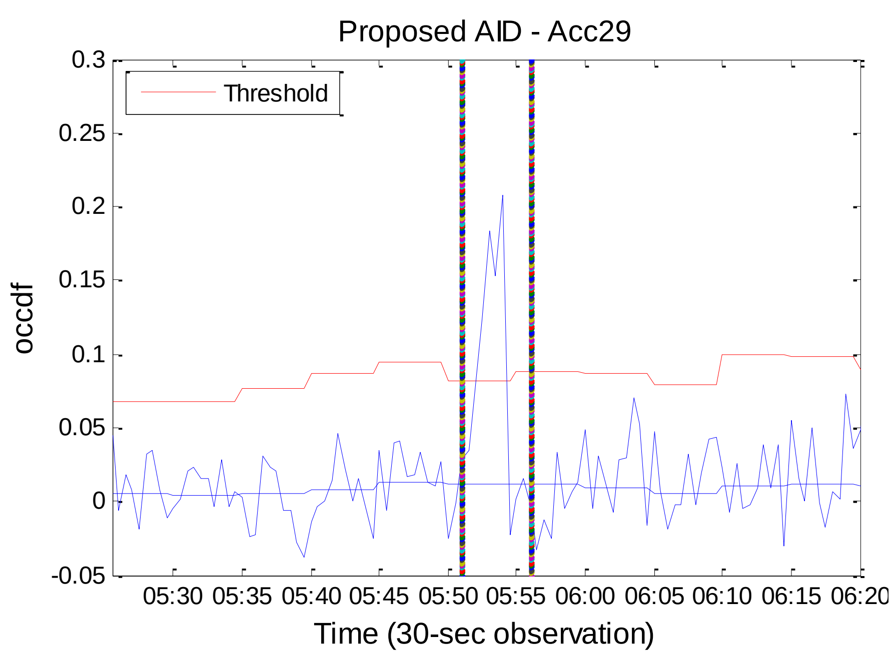

Figure 6-3 Acc29 detection by the proposed AID

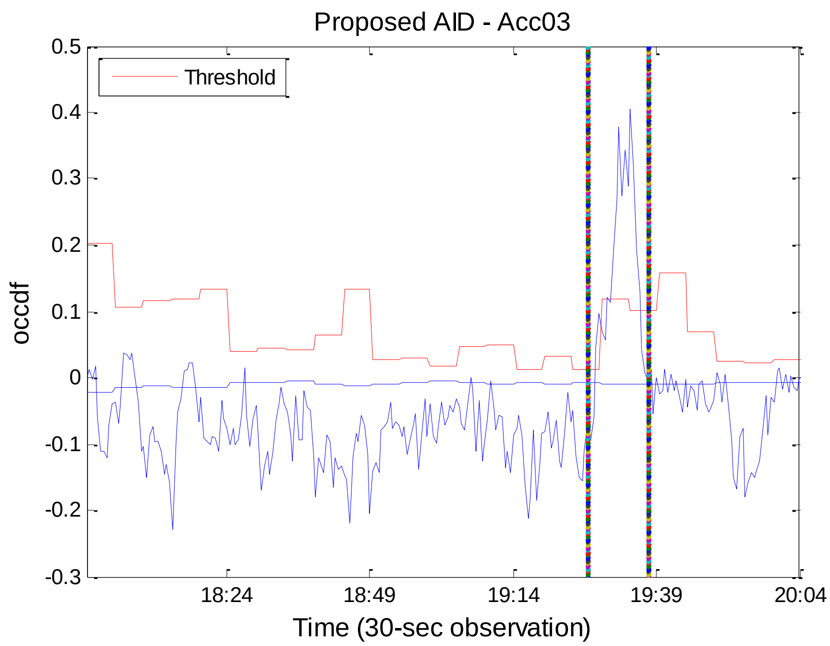

Figure 6-4 Acc03 detection by the proposed AID algorithm

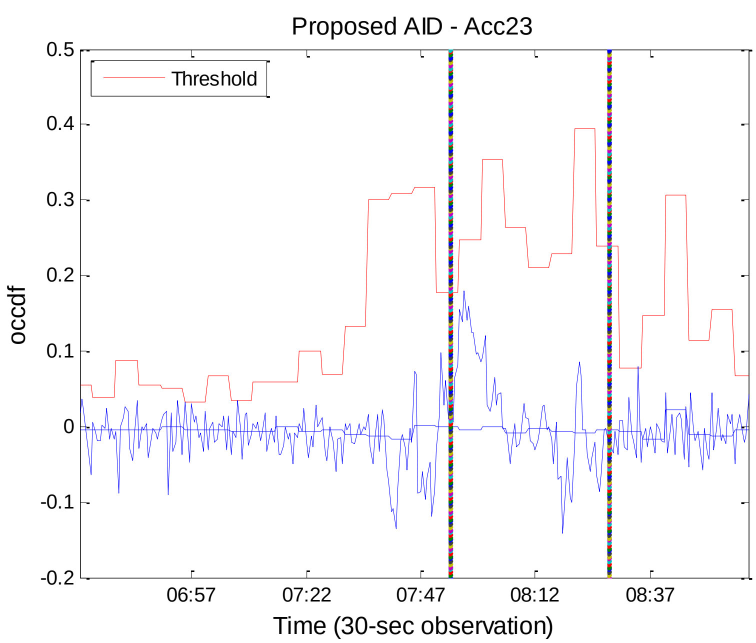

Figure 6-5 Acc23 - detection missed by the proposed method

cumulative probability associated with the observed *occdf*$_{30sec}$ value. More specifically, users can look at the observed *p-value*, which represents the probability of observing an *occdf*$_{30sec}$ equal to, or greater than, the observed value if no incident occurs. Therefore, TMS users may initially set a low threshold—choosing an α of, say, 2 %—and check the *p-value* associated with the alarm before taking further action. If the alarm is triggered by an observation that presents a very low *p-value*, the TMS operators may consider it to be an incident. They can also wait for the next observation and check its *p-value* before making the decision.

Another advantage of having a probability associated with the *occdf*$_{30sec}$ observation is that *p-values* may indicate the severity of the incident, as very low p-values mean that large *occdf*$_{30sec}$ are observed. Therefore, the TMS personnel may want to direct the response efforts by prioritizing those incidents where the p-values are lowest.

6.4 DETECTION PERFORMANCE

For ease of presentation, Figure 5-10 is copied as Figure 6-6. This plot shows that the proposed approach provided the best detection performance. For DR equal to 95%, Minnesota and SND algorithms presented considerably higher FAR. When α =1%, the proposed model MTTD is 0.5 minutes higher than that of the SND algorithm, but the FAR of the proposed method is half of that of SND. The comparatively low FARs are attributed to the proposed algorithm's accountability for recurrent differences in occupancy.

It is worth noting that even if the proposed and the existing AID models had performed equally, the proposed algorithm would still be valuable as it is much simpler to implement as well as more universal.

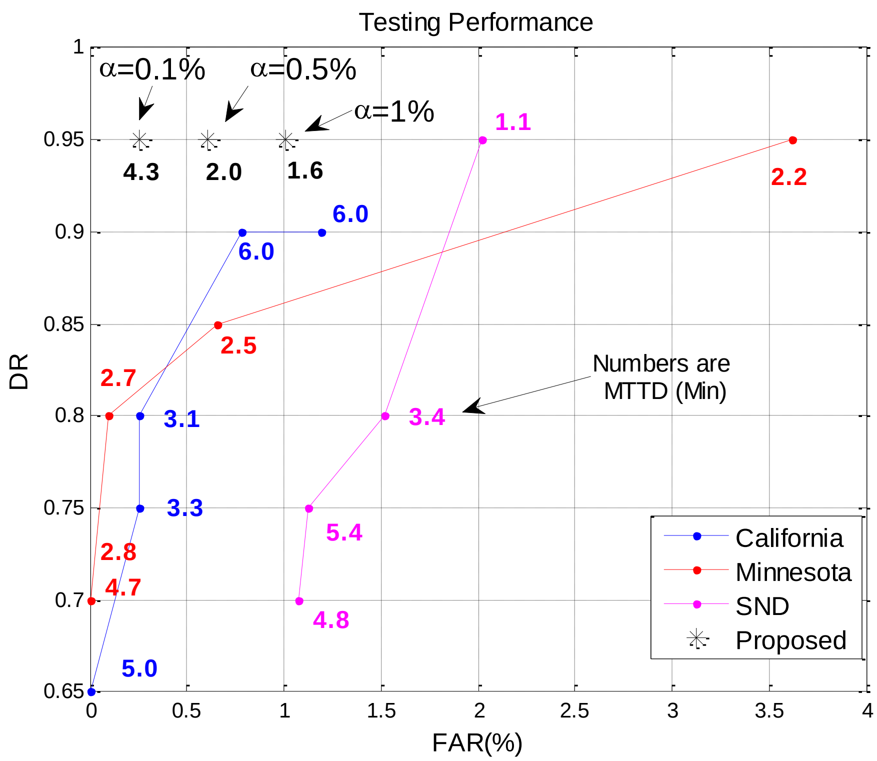

Figure 6-6 Performance evaluation of the proposed algorithm

CHAPTER 7

CONCLUDING REMARKS

This chapter summarizes the main findings of the presented research, focusing on the advantages and limitations of the proposed model as well as on recommendations for future research.

7.1 ADVANTAGES OF THE PROPOSED AID ALGORITHM

In addition to the better performance provided by the proposed model based on the traditional measures of effectiveness—DR, FAR, and MTTD—the presented AID model has other significant advantages when compared with existing models. The most important ones are:

- Ease of implementation. The presented algorithm dispenses calibration, which is an innovative way of approaching freeway incident detection .The method uses only historical average 5-min and current 30-sec occupancy data, which are commonly available in most TMS databases. Another feature that simplifies implementation significantly is that the algorithm is *self-learning*, that is, it requires no human intervention. Also, the more traffic data are inputted into the model, the greater its ability to capture the typical behavior of traffic, thus automatically improving incident detection performance.
- Universality. The proposed algorithm is designed to work in any spatio-temporal traffic configuration, as its dynamic threshold is based on the normal behavior of traffic on a particular pair of neighboring stations at a specific 5-min

period of the day. Therefore, no adjustment or calibration needs to be made when the model is applied at different sites and in different times of the day.

- Alarm Confidence Indication. Every alarm is accompanied by the probability of incident occurrence. This feature indicates how confident the model is about the triggered alarm, which enhances the TMS decision-making in terms of incident response. The probability also provides an indication of the severity of the incident.

7.2 LIMITATIONS OF THE PROPOSED AID ALGORITHM

There are basically two limitations of the proposed model that are worth noting. They are described below:

- In places and times when recurrent differences in occupancy between neighboring stations are frequently observed, the algorithm will miss incidents whose disturbance in traffic are not higher than those historically observed. In terms of traffic congestion, the missing of such incidents is not critical, as in this case the incident causes no more congestion than it is usually observed in the site.
- The proposed model is sensitive to the presence of outliers because thresholds are highly dependent on the variance of the historical data. Outliers caused by special events (e.g.: incidents) or detection failures have to be properly eliminated or smoothed.

7.3 OTHER FINDINGS

In addition to the main conclusions, other findings are worth noting:

- There is a strong discrepancy between the state-of-the art and the state-of-the-practice in automatic incident detection. Numerous models have been tested but their calibration complexity and low performance (high false alarm rate) have kept them from being implemented in the real world.
- The incident start-times reported on the crash logs usually deviates significantly from the *apparent start-time*, which in this research was defined as the time period immediately before the disturbance of traffic is first observed. Therefore, traffic incident databases supporting research on AID should not rely on the reported start-time.
- Frequently, traffic disturbances caused by accidents were first noticed in the downstream detection station in the form of occupancy and flow reduction, supporting the findings of previous studies.

7.4 RECOMMENDATIONS FOR FUTURE RESEARCH

The presented research is innovative in that it incorporates historical information of traffic to eliminate parameter calibration. This is just a first step; further research should be conducted to extend and improve the presented method. Following are some recommendations, most of which are going to be pursued by the author.

- Other techniques of <u>outlier removal</u> need to be investigated, as outliers may negatively affect the performance of the model. The presence of outliers of

$occdf5\min$ in the historical sample increases the variance of $occdf5\min$, which in turn inflates the variance of $occdf30\sec$ in a factor of 10. This obviously elevates the algorithm thresholds, decreasing the chances of detecting incidents. The ideal outlier removal technique would eliminate all high $occdf5\min$ observations coming from special events and erratic data while keeping the observations coming from normal operations. Outlier smoothing (not elimination) techniques should also be considered.

- The same approach can be tested using different traffic parameters, such as the 30sec difference of speeds. As opposed to occupancy, speed is expected to increase downstream and decrease upstream of an incident. In cases where speed measurements are not available, the ratio q/occ could be used as a surrogate, as done by previous researchers.
- Non-historical information could also be incorporated to enhance detection performance. For instance, traffic theory-based thresholds (e.g. if flow>5 veh/30sec/lane) could indicate that the triggered alarm may be false.
- Persistence test or data aggregation. 30-sec traffic data fluctuates considerably enough to generate discrepant values of occupancy between stations. The vast majority of false alarms yielded by the new algorithm would not have been triggered if a persistence test of a single observation (30 seconds) had been implemented.
- Thresholds were determined for 5-min periods. Other threshold aggregation levels could be evaluated.

- The detection performance of the proposed AID algorithm should be compared with that of other existing models, including the ones based on artificial neural networks. However, in addition to the detection performance, one should always assess the complexity and universality when comparing AID models.

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APPENDICES

APPENDIX A

Incident Reports – California Highway Patrol

Acc 01

Details for Incident No.640

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/17/2006 09:59:00
Location:	NB I880 JSO HEGENBERGER RD	End Time:	10/17/2006 11:26:00
Area:	OAKLAND	Duration:	87

Timestamp	**Description**
10/17/2006 10:00:00	BOTH VEHS ON RHS
10/17/2006 10:00:00	FREMONT PD UNIT VS UNK VEH
10/17/2006 10:10:00	CHP Unit Enroute
10/17/2006 10:15:00	CHP Unit Enroute
10/17/2006 10:16:00	CHP Unit Assigned
10/17/2006 10:19:00	PER ANOTHER CALLER - 2 SEMI S, WHI PK INVOLVED
10/17/2006 10:21:00	IN CD, TRYING TO MOVE TO RHS NOW
10/17/2006 10:21:00	#2 LN BLKED
10/17/2006 10:22:00	RP ADVD OFCR JUST NEEDS TO LOOK OVER HIS SHOULDER TO SEE OTHER VEHS INVOLVED
10/17/2006 10:22:00	CHP Unit Enroute
10/17/2006 10:22:00	UNKNOWN IF LNS 6 THRU 8 IS A SEPARATE TC
10/17/2006 10:23:00	#3 LN BLOCKED WILL BE CHECKING SHORTLY
10/17/2006 10:23:00	OTHER TC JSO THIS 1020 200 FT SO 3 BIG RIGS & PK
10/17/2006 10:24:00	OUT W/2ND TC #3 LN BLOCKED
10/17/2006 10:24:00	CHP Unit On Scene
10/17/2006 10:25:00	FIRE HAS BEEN NOTIFIED OF THIS, HAVING PARTIES W/1ST TC 1023 CLEARING 2ND
10/17/2006 10:25:00	HAVE OTHER UNIT ROLL TO 880 --NA
10/17/2006 10:26:00	OUT 2ND TC NEED BIG RIG TOW
10/17/2006 10:26:00	CHP Unit On Scene
10/17/2006 10:26:00	CHP Unit Assigned

10/17/2006 10:27:00	NEED BIG RIG TOW-ONE AND SAME
10/17/2006 10:27:00	1185 BIG RIG 80,000 FOR TANKER, WILL ADV
10/17/2006 10:30:00	3 VEHS ON RHS, STILL BLOCKING #2 & 3
10/17/2006 10:30:00	CHP Unit On Scene
10/17/2006 10:31:00	1039 BERRY BROS BIG RIG PRIOR W/ALL
10/17/2006 10:33:00	CHP Unit Enroute
10/17/2006 10:39:00	1ST TC 2 VEH 1182
10/17/2006 10:39:00	CHP Unit Enroute
10/17/2006 10:41:00	CHP Unit On Scene
10/17/2006 10:46:00	CHP Unit On Scene
10/17/2006 10:48:00	BERRY BROS 1097
10/17/2006 10:48:00	CHP Unit On Scene
10/17/2006 10:56:00	SEE IF BRIDGE CAN ROLL TO MOVE L FRONT BUMPER OFF TIRE OF BIG RIG
10/17/2006 10:58:00	96-10 ADV TOW IS JUST MOVING BIG RIG OO LNS, ALL LNS TO BE OPEN IN ABOUT 5
10/17/2006 10:58:00	1039 BRIDGE THEY ADV NEG TOO FAR TO ROLL DOWN THAT FAR
10/17/2006 11:00:00	ALL ON RHS
10/17/2006 11:03:00	TMC COPIES RHS
10/17/2006 11:26:00	2ND TC 4 VEH 1182

Acc 02

Details for Incident No.703

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	10/29/2006 08:35:00
Location:	NB I880 JNO N FREMONT BLVD	End Time:	10/29/2006 09:11:00
Area:	HAYWARD	Duration:	36

Timestamp	**Description**
10/29/2006 08:35:00	OTHER PRY IN CD
10/29/2006 08:35:00	MC DOWN MAN IN CD

10/29/2006 08:36:00	OFF DUTY MEDIC 1097
10/29/2006 08:36:00	1039 1141
10/29/2006 08:37:00	CHP Unit Enroute
10/29/2006 08:37:00	CHP Unit Assigned
10/29/2006 08:39:00	MC BLKNG #3 / RIDER IN CD
10/29/2006 08:39:00	CHP Unit On Scene
10/29/2006 08:40:00	CHP Unit On Scene
10/29/2006 08:41:00	#1,2,3 BLKD
10/29/2006 08:42:00	CHP Unit On Scene
10/29/2006 08:45:00	PER INVLD PRTY, SHE IS ON RHS 1/2 MILE JNO TC
10/29/2006 08:46:00	CENTRAL TOW 97
10/29/2006 08:46:00	CHP Unit On Scene
10/29/2006 08:48:00	ALL LNS OPEN EXCEPT #1 LN
10/29/2006 08:50:00	CHP Unit On Scene
10/29/2006 09:04:00	CHP Unit On Scene
10/29/2006 09:11:00	RDWY CLR

Acc 03

Details for Incident No.1852

Description:	1183 - Traffic Collision - No Details	Start Time:	10/28/2006 19:30:00
Location:	NB I880 JSO W TENNYSON RD	End Time:	10/28/2006 19:45:00
Area:	HAYWARD	Duration:	15

Timestamp	**Description**
10/28/2006 19:30:00	FACING SIDEWAYS #1
10/28/2006 19:30:00	SIL POSS HOND COMPACT VS CD
10/28/2006 19:32:00	CHP Unit Enroute
10/28/2006 19:40:00	PTY ON RHS
10/28/2006 19:40:00	CHP Unit On Scene
10/28/2006 19:45:00	CHP Unit On Scene

Acc 04

Details for Incident No.1251

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/23/2006 14:28:00
Location:	NB I880 AT HESPERIAN BLVD	End Time:	10/23/2006 15:13:00
Area:	HAYWARD	Duration:	45

Timestamp	Description
10/23/2006 14:37:00	CHP Unit Enroute
10/23/2006 14:38:00	CHP Unit Enroute
10/23/2006 14:42:00	CHP Unit Enroute
10/23/2006 14:45:00	CHP Unit Enroute
10/23/2006 14:47:00	CHP Unit On Scene
10/23/2006 15:11:00	CHP Unit On Scene
10/23/2006 15:13:00	CHP Unit On Scene

Acc 05

Details for Incident No.1778

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/18/2006 18:52:00
Location:	NB I880 JNO JACKSON ST	End Time:	10/18/2006 19:15:00
Area:	HAYWARD	Duration:	23

Timestamp	Description
10/18/2006 18:54:00	PEACH TOYT CAM BLKG #2 LN / SOLO VEH
10/18/2006 18:54:00	CHP Unit Enroute
10/18/2006 18:56:00	WHI FORD RANGER - NB JNO W A STREET - RHS
10/18/2006 18:56:00	RP CAN SEE 2ND VEH STOPPED NEAR W A STREET - IN #2 LN - THIS IS VEH THAT HE BELIEVES HIT HIS FORD RANGER
10/18/2006 18:56:00	WHI 04 FORD RANGER ON RHS W/HAZ LIGHTS ON

10/18/2006 19:00:00	1039 3A #3851 PALACE GARAGE ENRT FOR LINE 1
10/18/2006 19:15:00	CHP Unit Enroute
10/18/2006 19:15:00	CHP Unit On Scene

Details for Incident No.1782

Description:	1183 - Traffic Collision - No Details	Start Time:	10/18/2006 18:53:00
Location:	NB I880 JSO W A ST	End Time:	10/18/2006 18:53:00
Area:	HAYWARD	Duration:	0

Timestamp	**Description**
No records to display	

Acc 06

Details for Incident No.810

Description:	1183 - Traffic Collision - No Details	Start Time:	10/11/2006 11:52:00
Location:	NB I880 JNO THORNTON AV	End Time:	10/11/2006 13:28:00
Area:	HAYWARD	Duration:	96

Timestamp	**Description**
10/11/2006 11:54:00	GRY PK BLKG #1 ON SB SIDE
10/11/2006 11:54:00	GRY SMALL SD BLKG #1
10/11/2006 11:54:00	GRY PK TK VS GRY SMALL HB
10/11/2006 11:54:00	2 VEH TC
10/11/2006 11:58:00	PER ANOTHER CALLER DODG TK IS HIGH CENTERED ON CD
10/11/2006 11:58:00	CHP Unit Assigned
10/11/2006 11:59:00	1039 LLLCC - 1141 ENRT - ADVD POSSIBLY SB

10/11/2006 11:59:00	CARRIER WORK VAN BLKG #1 & 2
10/11/2006 12:00:00	1039 1141
10/11/2006 12:00:00	CHP Unit Enroute
10/11/2006 12:02:00	1039 CENTRAL TOW FOR CARRIER WORK VAN
10/11/2006 12:03:00	CHP Unit On Scene
10/11/2006 12:04:00	AND VEH ON CD
10/11/2006 12:04:00	SIG ALERT - #1-2 BLOCKED
10/11/2006 12:05:00	CHP Unit Enroute
10/11/2006 12:06:00	2 VEH 1-2 LANE AND ANOTHER ON RHS AND ANOTHER FUTHER DOWN-- ALL ON SB SIDE
10/11/2006 12:06:00	350 HIGH CENTERED IN CD
10/11/2006 12:06:00	CHP Unit On Scene
10/11/2006 12:07:00	CHP Unit Assigned
10/11/2006 12:08:00	CHP Unit On Scene
10/11/2006 12:09:00	1039 1141
10/11/2006 12:09:00	CHP Unit Assigned
10/11/2006 12:09:00	126-L - 1141 2 VEHS 1-2 LANES GORE PT THORNTON SB 880 - ONE PARTY LAYING IN BED OF PU - CONSCIOUS
10/11/2006 12:10:00	3A FOR GRY PU 8A0694 TO SB 880 AT THORNTON IN #1-2 LANES
10/11/2006 12:11:00	CHP Unit On Scene
10/11/2006 12:12:00	CHP Unit Enroute
10/11/2006 12:14:00	1039 25-C
10/11/2006 12:14:00	1039 DOTCC
10/11/2006 12:15:00	1039 3A C# 1655 ALL WAYS TOW ETA NEXT AVAIL DRVR
10/11/2006 12:15:00	CHP Unit On Scene
10/11/2006 12:16:00	CLOSING #1 JSO DECOTO
10/11/2006 12:16:00	CHP Unit Assigned
10/11/2006 12:17:00	VEHS USING RHS AND CD
10/11/2006 12:17:00	CHP Unit Enroute
10/11/2006 12:18:00	#1 CLOSED 1/2 MILE JNO THORNTON
10/11/2006 12:18:00	*** SIG ALERT ISSUED *** ACCIDENT BLOCKING #1 AND 2 LANES UNKNOWN ETO

10/11/2006 12:19:00	CHP Unit On Scene
10/11/2006 12:24:00	1039 DOT-CC
10/11/2006 12:25:00	CHP Unit On Scene
10/11/2006 12:28:00	CHP Unit Enroute
10/11/2006 12:29:00	CHP Unit On Scene
10/11/2006 12:33:00	25-M3 - 1141 SB JNO THORNTON IN CD -- 1039 1141
10/11/2006 12:33:00	LINE 43-PLZ STAND BY FOR ETA
10/11/2006 12:36:00	CHP Unit On Scene
10/11/2006 12:37:00	ALSO NEED SIGN TRUCKS ASAP
10/11/2006 12:39:00	^DOT TMT SIGN TRK SUPV ADVISED
10/11/2006 12:39:00	1039 DOTCC
10/11/2006 12:42:00	3A FB SB 880 IN GORE PT AT THORNTON OFR GLD GMC PU
10/11/2006 12:45:00	CENTRAL TOW TAKING 2 VEHS ON NB SIDE
10/11/2006 12:47:00	1039 3A C# 1827 ALL WAYS TOW ETA NEXT AVAIL,W/FB
10/11/2006 12:48:00	SWEEPERS 1097
10/11/2006 12:50:00	CHP Unit On Scene
10/11/2006 13:27:00	25-74 EM 95023 AT CENTRAL TOW
10/11/2006 13:28:00	CHP Unit On Scene

Acc 07

Details for Incident No.1187

Description:	20002 - Hit and Run - No Injuries	Start Time:	11/08/2006 14:32:00
Location:	NB I880 JSO HACIENDA AV	End Time:	11/08/2006 14:32:00
Area:	HAYWARD	Duration:	0

Timestamp	**Description**
11/08/2006 14:32:00	CHP Unit On Scene

11/08/2006 14:36:00	VICT VEH BOX VAN IN CD
11/08/2006 14:36:00	CHP Unit On Scene

Acc 08

Details for Incident No.520

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	11/09/2006 08:35:00
Location:	NB I880 JSO I238	End Time:	11/09/2006 09:54:00
Area:	HAYWARD	Duration:	79

Timestamp	**Description**
11/09/2006 08:36:00	PER RP LOG 521 / ADV VEH IS SMOKING / STARTING FIRE
11/09/2006 08:36:00	BIGRIG VS 2 SEDS/RHS AND 1 VEHS BLKNG #2/WHICH SPUNOUT
11/09/2006 08:37:00	1039 1141 / FIRE
11/09/2006 08:37:00	ROLLING 1141 FOR PRECAUTIONARY
11/09/2006 08:37:00	XRAY OO VEH BLEEDING FROM HER HEAD
11/09/2006 08:37:00	VEHS BLOCKING 3 LANES
11/09/2006 08:37:00	VEH VS BIG TRUCK
11/09/2006 08:38:00	PER ANOTHER CALLER BIG RIG DRIVER INJ ALSO // STILL IN VEH UNK IF TRAPPED
11/09/2006 08:38:00	CHP Unit Assigned
11/09/2006 08:38:00	CHP Unit Enroute
11/09/2006 08:39:00	CHP Unit Enroute
11/09/2006 08:43:00	CHP Unit On Scene
11/09/2006 08:44:00	#2,4 LNS AND WINTON OFR BLK D//BCST
11/09/2006 08:44:00	#2 LN OPEN
11/09/2006 08:45:00	CHP Unit On Scene
11/09/2006 08:46:00	1039 DOTCC FOR INFO// CMS S ON PLZ ADV WHEN CLEAR
11/09/2006 08:47:00	10-4 1039 DOTCC// CMS S OFF
11/09/2006 08:48:00	PLS CONFIRM THIS IS THE WINTON OFR OR THE A ST OFR THNX

11/09/2006 08:49:00	SO 1097 ALSO
11/09/2006 08:52:00	WINTON OFR PER OFCR
11/09/2006 08:55:00	PLZ ROLL BIG RIG TOW FOR CAR HAULER HAULING 6 VEHS
11/09/2006 08:55:00	CHP Unit Enroute
11/09/2006 08:56:00	SD PLZ ROLL BIG RIG TOW--I LL ROLL OTHER ROT
11/09/2006 08:57:00	1039 HARRY SANDS FOR TOYT COA
11/09/2006 09:00:00	1039 JACK JAMES TOW LINE 27
11/09/2006 09:05:00	CHP Unit Enroute
11/09/2006 09:12:00	CHP Unit On Scene
11/09/2006 09:13:00	CHP Unit On Scene
11/09/2006 09:15:00	PLS ADVS IF ANY ETO FOR THE OFR THANKS
11/09/2006 09:20:00	UNITS 1023 FOR BIG RIG TOW ONLY--ETA APPROX 15 TO CLEAR
11/09/2006 09:20:00	CORRECTION--A ST OFR BLK D,NEG WINTON OFR
11/09/2006 09:21:00	COPY THANKS/1039 DOTCC
11/09/2006 09:26:00	ETA FOR JACK JAMES--CAN ACCESS FM A ST OFR
11/09/2006 09:53:00	RAMP OPEN PER 75M
11/09/2006 09:54:00	COPY THANKS/1039 DOTCC
11/09/2006 10:00:00	CHP Unit Enroute
11/09/2006 10:20:00	CHP Unit On Scene
11/09/2006 10:44:00	CHP Unit Enroute
11/09/2006 11:04:00	CHP Unit On Scene
11/09/2006 12:02:00	CHP Unit On Scene

Details for Incident No.528

Description:	1182 - Traffic Collision - Property Damage	Start Time:	11/09/2006 08:40:00
Location:	NB I880 JSO I238	End Time:	11/09/2006 09:01:00
Area:	HAYWARD	Duration:	21

Timestamp	**Description**
11/09/2006 08:40:00	#2 LN

11/09/2006 08:40:00	RP IN WHI FORD PANEL VAN VS WHI SEDAN LATE MODEL
11/09/2006 08:42:00	2 SEP TC S
11/09/2006 08:42:00	PER ANOTHER THIS TC JSO HESPERIAN
11/09/2006 08:44:00	PER OTHER INV WHI SUBARU SW VS WHI VAN #2 LN
11/09/2006 08:48:00	PLZ ROLL FSP IF AVAIL,THANKS
11/09/2006 08:49:00	CHP Unit Enroute
11/09/2006 08:52:00	REQ PER TO USE HOV LN, STUCK IN TRAFFIC
11/09/2006 08:54:00	NEG HOV LN PER 75M
11/09/2006 09:01:00	CHP Unit On Scene

Acc 09

Details for Incident No.200

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	10/30/2006 05:50:00
Location:	NB I880 JSO EB SR92	End Time:	10/30/2006 06:33:00
Area:	HAYWARD	Duration:	43

Timestamp	Description
10/30/2006 05:50:00	1039 1141
10/30/2006 05:52:00	1039 C25-70 / WILL ADV DAYS
10/30/2006 05:59:00	CHP Unit Enroute
10/30/2006 06:00:00	ROLL 1185
10/30/2006 06:01:00	CHP Unit Enroute
10/30/2006 06:02:00	# 1 AND PART # 2 BLOCKED
10/30/2006 06:02:00	CHP Unit On Scene
10/30/2006 06:02:00	1039 JACK JAMES TO #1
10/30/2006 06:04:00	DOT CPZ ALL, 1039 DOTDCC FOR INFO
10/30/2006 06:05:00	1039 1185 LINE 11
10/30/2006 06:06:00	CHP Unit On Scene
10/30/2006 06:11:00	25-72 HAVE THE 1185 GO TO THE RS // RDWY WILL BE CLR WHEN 1141/FIRE CLRS
10/30/2006 06:12:00	CHP Unit Enroute

10/30/2006 06:17:00	CMS 1097
10/30/2006 06:20:00	CMS 1098 // 1039 DOTDCC
10/30/2006 06:26:00	CHP Unit On Scene
10/30/2006 06:33:00	ROLL 2 1185 FLT BEDS
10/30/2006 06:43:00	CHP Unit On Scene

Acc 10

Details for Incident No.2053

Description:	1183 - Traffic Collision - No Details	Start Time:	10/29/2006 20:50:00
Location:	NB I880 JSO EB SR92	End Time:	10/29/2006 20:59:00
Area:	HAYWARD	Duration:	9

Timestamp	Description
10/29/2006 00:06:00	PER OFCR HURN HE JUST SPOKE TO HAYWARD PD RO REPORTED VEH 10851 2HRS AFTER THIS TC
10/29/2006 01:15:00	1039 HAY PD / OFCR HURN REQ A HOLD ON 1110 FOR 10851
10/29/2006 01:23:00	SVS COPZ LN 35 FOR VEH STATUS/PLT INFO
10/29/2006 01:23:00	F# 508 345 06 PER LN 45
10/29/2006 20:51:00	3 VEH TC //IN #1 - #2
10/29/2006 20:52:00	1 VEH FACING CD
10/29/2006 20:52:00	VS SEDAN W/ WHOLE BUMPER OFF BLOCKING #1
10/29/2006 20:52:00	PER ANOTHER 3 VEH TC #1-3 LNS
10/29/2006 20:52:00	OLDER MODEL ACC VS MINIVAN
10/29/2006 20:53:00	CHP Unit Enroute
10/29/2006 20:54:00	BLKG #1 AND #2
10/29/2006 20:54:00	1039 1141
10/29/2006 20:54:00	UNK 4D HEAD ON INTO CD / PTYS NOT MOVING --ROLLING 1141
10/29/2006 20:54:00	INV IN SIL ACUR RL 4D - IN CD REQ 3A
10/29/2006 20:54:00	CHP Unit On Scene

10/29/2006 20:55:00	CHP Unit On Scene
10/29/2006 20:56:00	CHP Unit On Scene
10/29/2006 20:57:00	RDWY CLR
10/29/2006 20:57:00	1039 3A C# 3212 - AUTO GUARDIAN ON PRIORITY FOR LINE 13
10/29/2006 20:57:00	CHP Unit On Scene
10/29/2006 20:58:00	ROLL 1185 R
10/29/2006 20:58:00	CHP Unit On Scene
10/29/2006 20:59:00	1039 HARRY SANDS
10/29/2006 21:03:00	CHP Unit Enroute
10/29/2006 21:05:00	CHP Unit On Scene
10/29/2006 21:39:00	CHP Unit Enroute
10/29/2006 21:40:00	CHP Unit Enroute

Acc 11

Details for Incident No.1299

Description:	1183 - Traffic Collision - No Details	Start Time:	10/27/2006 15:09:00
Location:	NB I880 JSO W A ST	End Time:	10/27/2006 15:48:00
Area:	HAYWARD	Duration:	39

Timestamp	**Description**
10/27/2006 15:09:00	SIL 01 BMW SED VS 2 OTHER UNK VEH
10/27/2006 15:10:00	UNK IF VEHS ARE 1125
10/27/2006 15:12:00	3RD VEH - FACING CORRECT #2 LN
10/27/2006 15:12:00	BMW BLKG #1 FACING CORRECT WAY W/AIR BAG DEPLOYED
10/27/2006 15:12:00	CHP Unit Enroute
10/27/2006 15:12:00	WHI SD INTO CD
10/27/2006 15:13:00	CHP Unit Enroute
10/27/2006 15:19:00	FIRE 97 1/2 BLOCKED
10/27/2006 15:20:00	1039 DOTCC

10/27/2006 15:20:00	CHP Unit On Scene
10/27/2006 15:21:00	1039 ARROYO W/FB
10/27/2006 15:24:00	CHP Unit On Scene
10/27/2006 15:27:00	CHP Unit Enroute
10/27/2006 15:30:00	1039 DOTCC
10/27/2006 15:30:00	HAVE 1185 RESPOND TO VEH IN CD 1ST / 1039
10/27/2006 15:30:00	RDWY CLR
10/27/2006 15:33:00	TRAFFIC BACKED UP TO DECOTO RD, USE ALT ROUTES
10/27/2006 15:41:00	1039 CENTRAL TOW
10/27/2006 15:48:00	CENTRAL TOW IS ENRT FOR THE 146026
10/27/2006 15:59:00	CHP Unit On Scene

Acc 12

Details for Incident No.1107

Description:	1125V - Traffic Hazard - Vehicle	Start Time:	10/26/2006 13:44:00
Location:	NB I880 JSO HESPERIAN BLVD	End Time:	10/26/2006 14:04:00
Area:	HAYWARD	Duration:	20

Timestamp	**Description**
10/26/2006 13:44:00	GLD VEH SLOW LN
10/26/2006 13:51:00	1039 OFC
10/26/2006 14:04:00	CHP Unit Enroute

Details for Incident No.1123

Description:	C/FIRE - Vehicle Fire	Start Time:	10/26/2006 13:52:00
Location:	NB I880 JNO HACIENDA AV	End Time:	10/26/2006 14:45:00
Area:	HAYWARD	Duration:	53

Timestamp	Description
10/26/2006 13:52:00	FIRE ROLLING UP TO IT
10/26/2006 13:52:00	NOT 1097
10/26/2006 13:53:00	REFERENCE DUPLICATE INCIDENT 1125D1026
10/26/2006 14:08:00	PLS CALL FIRE BAC WITH ETA
10/26/2006 14:08:00	FIRE 1097
10/26/2006 14:17:00	THIS IS THE 1125
10/26/2006 14:17:00	CHP Unit On Scene
10/26/2006 14:20:00	1039 ALL STAR ON EXP
10/26/2006 14:20:00	VEH BLKG / NO SHOULDER TO PUSH OFF
10/26/2006 14:45:00	CHP Unit On Scene

Acc 13

Details for Incident No.1897

Description:	1183 - Traffic Collision - No Details	Start Time:	10/21/2006 19:03:00
Location:	NB I880 JSO W A ST	End Time:	10/21/2006 19:29:00
Area:	HAYWARD	Duration:	26

Timestamp	Description
10/21/2006 19:04:00	POSS MULTIPLE VEH TC // ALL IN #1 LN
10/21/2006 19:05:00	CHP Unit Enroute
10/21/2006 19:07:00	BLU 05 TOYT CAMRY VS 2 OTHER SEDS
10/21/2006 19:07:00	PER INVLD PARTY CAN SEE BEST WESTERN INN ON RHS
10/21/2006 19:08:00	1039 LLLCC - 1141 AS PRECAUTIONARY
10/21/2006 19:11:00	#1 BLKD
10/21/2006 19:11:00	CHP Unit On Scene
10/21/2006 19:12:00	IS PTY ON RHS
10/21/2006 19:12:00	CHP Unit On Scene
10/21/2006 19:13:00	SEES EMERGENCY VEHS COMING ON NB SIDE

10/21/2006 19:13:00	IN HOV LANE / OO VEH
10/21/2006 19:14:00	1039 1141 W/UPDATE ON BOTH TC S
10/21/2006 19:14:00	THIS MUST BE 2ND TC / DEFINITELY SB
10/21/2006 19:16:00	#1 -2 BLKD // SB
10/21/2006 19:16:00	72 W/ VIS SB 880 JSO PASEO GRANDE FOR 2ND TC
10/21/2006 19:16:00	SEES FIRE ON SB SIDE NOW
10/21/2006 19:18:00	CHP Unit Assigned
10/21/2006 19:24:00	CHP Unit On Scene
10/21/2006 19:26:00	1022 3A // WILL ROLL 1185 S ON EXPEDITE // #1 BLKD
10/21/2006 19:27:00	1039 HARRY SAND S TOW ENRT W/2 TKS
10/21/2006 19:28:00	1039 HARRY SAND TOW ON EXP W/3 TRUCKS
10/21/2006 19:28:00	1039 JACK JAMES FOR 3RD 1185
10/21/2006 19:29:00	RDWY CLR // ALL IN CD

Acc 14

Details for Incident No.2350

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	10/20/2006 21:35:00
Location:	NB I880 AT I238	End Time:	10/20/2006 21:53:00
Area:	HAYWARD	Duration:	18

Timestamp	**Description**
10/20/2006 21:37:00	1039 1141
10/20/2006 21:38:00	UNK VEH POS SD IN #2 AND #3
10/20/2006 21:38:00	CHP Unit Assigned
10/20/2006 21:39:00	CHP Unit Enroute
10/20/2006 21:41:00	BLCKNG #2 LANE
10/20/2006 21:41:00	1141 IS 1097 PER H32 WHO IS OVERHEAD

10/20/2006 21:41:00	CHP Unit On Scene
10/20/2006 21:41:00	CHP Unit Assigned
10/20/2006 21:41:00	CHP Unit Enroute
10/20/2006 21:47:00	1039 ENDOS TOW--THEY WERE TOLD VEH IS O/T
10/20/2006 21:47:00	#1,2 LANES BLCKD--VEH ON ITS ROOF IN #2 LANE
10/20/2006 21:47:00	CHP Unit On Scene
10/20/2006 21:53:00	ALL LANES OPEN
10/20/2006 22:41:00	CHP Unit On Scene

Acc15

Details for Incident No.571

Description:	1183 - Traffic Collision - No Details	Start Time:	10/18/2006 09:24:00
Location:	NB I880 JNO SAN CARLOS ST	End Time:	10/18/2006 10:53:00
Area:	SAN JOSE	Duration:	89

Timestamp	**Description**
10/18/2006 09:25:00	POSS 2 VEHS INVLD//WHI SED VS UNK SED//#2
10/18/2006 09:37:00	CHP Unit Enroute
10/18/2006 09:42:00	CHP Unit Enroute
10/18/2006 09:55:00	ON RHS NOW
10/18/2006 09:56:00	1185 TO RHS PLS
10/18/2006 09:57:00	1039 DICKS
10/18/2006 09:57:00	CHP Unit Assigned
10/18/2006 09:58:00	CHP Unit On Scene
10/18/2006 10:12:00	CHP Unit On Scene
10/18/2006 10:24:00	1039 DICKS LN 12
10/18/2006 10:24:00	CHP Unit On Scene
10/18/2006 10:27:00	CHP Unit Enroute

10/18/2006 10:33:00	CHP Unit On Scene
10/18/2006 10:53:00	CHP Unit Enroute

Acc16

Details for Incident No.473

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	09/22/2006 07:41:00
Location:	NB I880 JNO W WINTON AV	End Time:	09/22/2006 08:56:00
Area:	HAYWARD	Duration:	75

Timestamp	**Description**
09/22/2006 07:41:00	PD ROLLING 1141/ FIRE FOR PRECAUTIONARY
09/22/2006 07:41:00	PSBY TO PD SEVERAL VEHS INV
09/22/2006 07:42:00	CHP Unit Assigned
09/22/2006 07:43:00	CHP Unit Assigned
09/22/2006 07:48:00	73 W/POSS VISUAL JNO A ST IN CD AND PARTIAL LANE 1 BLOCKED
09/22/2006 07:49:00	LANES 1 AND 2 BLOCKED
09/22/2006 07:49:00	CHP Unit On Scene
09/22/2006 07:50:00	CHP Unit On Scene
09/22/2006 07:50:00	FSP ALMOST 1097 AND FIRE AND 1141 ARE 1097
09/22/2006 07:52:00	CHP Unit On Scene
09/22/2006 07:53:00	1039 SAN LEANDRO BOTH TRKS TO RHS
09/22/2006 08:04:00	1039 SAN LEANDRO TOW LINE 13
09/22/2006 08:41:00	CHP Unit Enroute
09/22/2006 08:56:00	CHP Unit On Scene

Acc17

Details for Incident No.1960

Description:	1125C - Traffic Hazard - Vehicle in Center Divider	Start Time:	11/09/2006 19:25:00

Location:	NB I880 JSO HESPERIAN BLVD	End Time:	11/09/2006 19:25:00
Area:	HAYWARD	Duration:	0

Timestamp	Description
11/09/2006 19:25:00	VEH IN CD
11/09/2006 19:25:00	CHP Unit Assigned

Details for Incident No.1970

Description:	1183 - Traffic Collision - No Details	Start Time:	11/09/2006 19:31:00
Location:	NB I880 JSO I238	End Time:	11/09/2006 20:36:00
Area:	HAYWARD	Duration:	65

Timestamp	Description
11/09/2006 19:31:00	BLK STRN VS SUV BLK G MID LN
11/09/2006 19:33:00	CHP Unit Assigned
11/09/2006 19:36:00	CHP Unit Enroute
11/09/2006 19:45:00	1141 1097
11/09/2006 19:47:00	CHP Unit On Scene
11/09/2006 19:51:00	ON RHS
11/09/2006 19:51:00	ROLL 2 1185 S---1039 ENDOS TOW FOR 2 1185 S
11/09/2006 19:51:00	CHP Unit On Scene
11/09/2006 20:35:00	ROLL ANOTHER 1185 BLK ACURA
11/09/2006 20:36:00	1039 ALLWAYS TOW

Details for Incident No.1969

Description:	1183 - Traffic Collision - No Details	Start Time:	11/09/2006 19:31:00
Locati	NB I880 JSO HESPERIAN BLVD	End Time:	11/09/2006 19:31:00

on:

Area: HAYWARD Duration: 0

Timestamp	Description
11/09/2006 19:31:00	3RD VEH ON RHS
11/09/2006 19:31:00	#2 // 2 UNK VEH S

Acc 18

Details for Incident No.1709

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	11/05/2006 18:22:00
Location:	NB I880 JSO W A ST	End Time:	11/05/2006 18:48:00
Area:	HAYWARD	Duration:	26

Timestamp	Description
11/05/2006 18:22:00	CHP Unit Assigned
11/05/2006 18:25:00	1039 CENTRAL TOW
11/05/2006 18:25:00	1039 1141
11/05/2006 18:27:00	CHP Unit Enroute
11/05/2006 18:33:00	CHP Unit On Scene
11/05/2006 18:43:00	CHP Unit Enroute
11/05/2006 18:48:00	CHP Unit Assigned

Acc19

Details for Incident No.480

Descrip	1183 - Traffic Collision - No Details	Start Time:	11/09/2006 08:20:00

tion: Location:	NB I880 AT STEVENS CREEK BLVD	End Time:	11/09/2006 09:19:00
Area:	SAN JOSE	Duration:	59

Timestamp	Description
11/09/2006 08:20:00	BLKG MIDDLE LNS
11/09/2006 08:20:00	4-5 VEHS
11/09/2006 08:21:00	1 VEH STUCK IN AIR BTWN 2 VEHS -- DRK BLU VEH
11/09/2006 08:23:00	CHP Unit Assigned
11/09/2006 08:27:00	1039 FIRE AND 1141
11/09/2006 08:28:00	ROLL 2 1185 S
11/09/2006 08:30:00	RE 1185 LN 8, WILL NEED 2 FB S AND 1 REG FOR TOTAL OF 3 TRKS
11/09/2006 08:30:00	1039 DICKS AUTO FOR 2 1185 S
11/09/2006 08:36:00	CHP Unit On Scene
11/09/2006 08:38:00	24-88 PLS ISSUE TFC ADVISORY 2 RIGHT LNS WILL BE SHUT DWN FOR FEW
11/09/2006 08:38:00	CHP Unit Assigned
11/09/2006 08:41:00	CHP Unit On Scene
11/09/2006 08:56:00	CHP Unit On Scene
11/09/2006 09:12:00	CHP Unit Enroute
11/09/2006 09:13:00	624-172 GRANTED 1 BLOCK OT
11/09/2006 09:19:00	CHP Unit Enroute

Details for Incident No.479

Description:	1183 - Traffic Collision - No Details	Start Time:	11/09/2006 08:19:00
Location:	NB I880 JSO BASCOM AV	End Time:	11/09/2006 08:21:00
Area:	SAN JOSE	Duration:	2

Timestamp	Description
11/09/2006 08:19:00	2 VEHS INVLD//1 VEH PART ON TOP OF ANOTHER/#2,3
11/09/2006 08:20:00	RP ADVS PRTY IN VEH UNDERNEATH STILL IN VEH//ALL OTHER PRTYS OO THIER VEHS
11/09/2006 08:21:00	CHP Unit Assigned

Acc21

Details for Incident No.1691

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	11/12/2006 20:07:00
Location:	NB I880 JSO MARINA BLVD	End Time:	11/12/2006 23:23:00
Area:	HAYWARD	Duration:	196

Timestamp	Description
11/12/2006 00:59:00	DOT CPZ, 1039 DOTDCC
11/12/2006 00:59:00	PER 75 GRAVES ADVD TIRE, BUMPER, CAR PARTS ON RHS - REQ DOT NOTIFICATION
11/12/2006 01:35:00	SVS VERIFIED ENTRY LN 150 / 4HLU033 / 22655-5 / PALACE GARAGE TOW
11/12/2006 01:35:00	SVS VERIFIED ENTRY LN 149 / 4ZOA298 / 22655-5 / PALACE GARAGE TOW
11/12/2006 01:35:00	SVS VERIFIED ENTRY LN 148 / 3VIX799 / 22655-5 / PALACE GARAGE TOW
11/12/2006 01:36:00	SVS VERIFIED ENTRY FCN# 1200631700181 / 5MWG312 / 22655-5 / ALL STAR TOW
11/12/2006 20:09:00	1039 1141
11/12/2006 20:09:00	CHP Unit Enroute
11/12/2006 20:10:00	1039 1141
11/12/2006 20:10:00	UNK VEH X CD HIT VEH COMING SB SIDE
11/12/2006 20:10:00	DRK HOND HIT CD BLKING $3 NB SIDE
11/12/2006 20:11:00	BABY TRAPPED IN VEH
11/12/2006 20:11:00	CHP Unit On Scene
11/12/2006 20:11:00	74 W/VISUAL//ALL SB LNS BLKD JNO WASH
11/12/2006 20:11:00	PTY EJECTED

11/12/2006 20:12:00	MALE AND INFANT TRAPPED IN VEH ON ITS SIDE
11/12/2006 20:12:00	CHP Unit Enroute
11/12/2006 20:13:00	APPEARS TC ON SB SIDE
11/12/2006 20:13:00	CHP Unit On Scene
11/12/2006 20:13:00	CHP Unit Enroute
11/12/2006 20:15:00	ISSUE SIG ALERT ALL SB LNS BLKD
11/12/2006 20:15:00	CHP Unit Enroute
11/12/2006 20:16:00	1039 DOTCC
11/12/2006 20:16:00	LATE ENRTY//1039 FIRE FOR JAWS OF LIFE AT 2013
11/12/2006 20:17:00	2 EJECTED//POSSIBLE 1144
11/12/2006 20:17:00	**SIG ALERT ISSUED** ALL LNS BLKD FOR A TRAFFIC COLLISION - EXP DELAYS - USE I238 AS ALT ROUTE - LOG 1691
11/12/2006 20:18:00	NOTIFY PD FOR 1184 ALL LNS BLKD FOR HOURS
11/12/2006 20:19:00	CHP Unit On Scene
11/12/2006 20:20:00	1039 ENTAC (OFCR COFFI 14591)
11/12/2006 20:20:00	CHP Unit On Scene
11/12/2006 20:20:00	1039 SLN PD WILL FOR 1184 MARINA ONR TO SB
11/12/2006 20:21:00	SB^
11/12/2006 20:22:00	RE: LINE 34 -- ASC FRM FIELD IF DOT SHOULD START W/ CONE TK
11/12/2006 20:24:00	CHP Unit On Scene
11/12/2006 20:24:00	PER S2 ALL EMERG VEHS HAVE PERMISSION TO GO W/WAY
11/12/2006 20:25:00	CHP Unit On Scene
11/12/2006 20:26:00	ROLL EVIDENCE FB TO SB SIDE
11/12/2006 20:26:00	ROLL FB TO NB SIDE
11/12/2006 20:27:00	PLS CONFIRM WITH S3 THIS IS GOING TO BE EXTENDED CLOSURE FOR NOTIFICATIONS
11/12/2006 20:29:00	REQ SIGN TK
11/12/2006 20:29:00	CHP Unit Enroute
11/12/2006 20:29:00	S2 AFFIRM ON EXTENDED CLOSURE
11/12/2006 20:31:00	1039 ALL STAR TOW W/FLAT BED TO NB 880 JNO WASHINGTON
11/12/2006 20:31:00	1039 PALACE GARAGE EVIDENCE TOW W/FLAT BED TO SB 880 JNO WASHINGTON
11/12/2006 20:31:00	CHP Unit Enroute

11/12/2006 20:36:00	PER SO - NEED NB LEWELLING OFR CLOSED
11/12/2006 20:36:00	PLS ASCERTAIN W/S2 IF BIG RIG CAN USE I580 - THX
11/12/2006 20:38:00	NEED TO CLOSE DOWN FRWY
11/12/2006 20:39:00	WILL HAVE 1141 ENRT THE W/WAY ON THE FWY REASON FOR HAVING TRFC
11/12/2006 20:39:00	PER ALCO FIRE REQ SB 880 AT WASHINGTON TRFC TO BE STOPPED
11/12/2006 20:40:00	SLN PD - SLN SGT HAS 880 AT MARINA CLOSED - HE REQ HE BE RELIEVED WHEN POSS
11/12/2006 20:40:00	VEHS ARE BLOCKING THE 1141S
11/12/2006 20:41:00	PALACE GARAGE LL, REQ TO USE RHS
11/12/2006 20:41:00	CHP Unit Enroute
11/12/2006 20:42:00	580 STOPPING TRAFFIC SB AT WASH
11/12/2006 20:42:00	CHP Unit On Scene
11/12/2006 20:43:00	**TRAF ADV**FOR ALT ROUTE USE I580 EB TO I238 WB TO I880 SB - BIG RIGS ARE ALLOWED ON I580
11/12/2006 20:43:00	1039 TMT
11/12/2006 20:45:00	CHP Unit On Scene
11/12/2006 20:47:00	CHP Unit On Scene
11/12/2006 20:49:00	ALCO FIRE LL, REQ SB LANES COMPLETELY SHUT DOWN
11/12/2006 20:52:00	CHP Unit On Scene
11/12/2006 20:56:00	^MARTIN FROM HAYWARD DAILY REVIEW WOULD LIKE S2 TO CALL HIM AT 510-432-5481 - PARTY ADV IT WOULD BE A WHILE
11/12/2006 21:03:00	CHP Unit Enroute
11/12/2006 21:14:00	INQUIRING WHERE THEY ARE TO RESPOND TO FOR CONE TK AND LANE CLOSURES
11/12/2006 21:16:00	CHP Unit Enroute
11/12/2006 21:21:00	CHP Unit Enroute
11/12/2006 21:25:00	CHP Unit On Scene
11/12/2006 21:27:00	PER S2 ALL LNS SHOULD BE OPEN IN 10
11/12/2006 21:28:00	DOT CPZ, 1039 DOTDCC
11/12/2006 21:32:00	1039 PALACE W/FB
11/12/2006 21:35:00	H32 ON AQUA ETA 12
11/12/2006 21:37:00	^JAIME FROM KTVU WOULD LIKE PAO TO CALL HER AT 510-874-0242 WHEN NOT 10-6
11/12/2006 21:41:00	CHP Unit Enroute

11/12/2006 21:43:00	CHP Unit On Scene
11/12/2006 21:45:00	CHP Unit On Scene
11/12/2006 21:54:00	THX-DOT CPZ, 1039 DOTDCC // CMS 1098
11/12/2006 21:54:00	S2//NB AND SB LNS OPEN
11/12/2006 21:54:00	MARINA ONR ALSO OPEN
11/12/2006 21:55:00	**SIG ALERT CANCELLED** ALL LNS OPEN
11/12/2006 21:55:00	CHP Unit Enroute
11/12/2006 22:00:00	PER S2 ALLOW BIG RIGS ON 580 FOR 1 HOUR LONGER
11/12/2006 22:15:00	25-75 IS LL INQ WHICH TOW COMPANY TOOK THE BLK MUSTANG
11/12/2006 22:21:00	RE LN 129,130 AUTH 22655-5
11/12/2006 22:24:00	H32 ADV NB AND SB TRAFFIC MOVING / NEG TRAFFIC BACKUP
11/12/2006 22:25:00	CHP Unit Enroute
11/12/2006 22:45:00	CHP Unit Enroute
11/12/2006 22:57:00	CHP Unit On Scene
11/12/2006 23:04:00	CHP Unit On Scene
11/12/2006 23:06:00	RE LN 134, 1039 S2, ADVD WILL HAVE PAO CONTACT DISPATCH FOR INFO
11/12/2006 23:13:00	UNK IF BOTH TC S NB AND SB ARE RELATED
11/12/2006 23:23:00	CHP Unit Enroute
11/12/2006 23:34:00	CHP Unit On Scene

Acc 22

Details for Incident No.1904

Description:	1183 - Traffic Collision - No Details	Start Time:	11/13/2006 19:44:00
Location:	NB I880 JSO MARKET ST	End Time:	11/13/2006 19:48:00
Area:	OAKLAND	Duration:	4

Timestamp	Description
11/13/2006 19:44:00	REQ 1185R FB FOR SIL TOYT IN CD

11/13/2006 19:44:00	3 VEHS
11/13/2006 19:45:00	CHP Unit On Scene
11/13/2006 19:46:00	1039 A/B TOW W/FLAT BED TO CD
11/13/2006 19:46:00	CHP Unit On Scene
11/13/2006 19:46:00	1039 A AND B W/FB TO CD
11/13/2006 19:48:00	1039 1141 C2//TO CD

Acc23

Details for Incident No.389

Description:	1183 - Traffic Collision - No Details	Start Time:	11/13/2006 07:56:00
Location:	NB I880 JSO MARINA BLVD	End Time:	11/13/2006 08:03:00
Area:	HAYWARD	Duration:	7

Timestamp	Description
11/13/2006 07:57:00	LBLU SD ON RHS
11/13/2006 07:58:00	CHP Unit Enroute
11/13/2006 08:03:00	SOLO SPINOUT NB JSO FLORESTA CALLING HIS OWN HELP

Details for Incident No.405

Description:	1182 - Traffic Collision - Property Damage	Start Time:	11/13/2006 08:03:00
Location:	NB I880 JNO WASHINGTON AV	End Time:	11/13/2006 08:04:00
Area:	HAYWARD	Duration:	1

Timestamp	Description
11/13/2006 08:03:00	BLK MITS VS WHI SUV
11/13/2006 08:04:00	CHP Unit Enroute

Acc24

Details for Incident No.1503

Description:	1182 - Traffic Collision - Property Damage	Start Time:	11/13/2006 16:48:00
Location:	NB I880 JSO 66TH AV	End Time:	11/13/2006 16:49:00
Area:	OAKLAND	Duration:	1

Timestamp	Description
11/13/2006 16:48:00	BLKG #1
11/13/2006 16:49:00	CHP Unit On Scene

Acc25

Details for Incident No.1646

Description:	1183 - Traffic Collision - No Details	Start Time:	11/14/2006 17:51:00
Location:	NB I880 JSO SCALES	End Time:	11/14/2006 18:16:00
Area:	HAYWARD	Duration:	25

Timestamp	Description
11/14/2006 17:51:00	BLKG 3 4 5 LANES
11/14/2006 17:52:00	CORRECTION 1 2 3 LANES BLKD
11/14/2006 17:55:00	1039 1141
11/14/2006 17:57:00	CHP Unit Enroute
11/14/2006 17:57:00	CHP Unit Assigned
11/14/2006 18:00:00	CHP Unit On Scene
11/14/2006 18:05:00	CHP Unit On Scene
11/14/2006 18:11:00	RDWY CLR MVG EVERTHING INTO THE SCALES
11/14/2006 18:14:00	CHP TMC CPZ RDWY CLR
11/14/2006 18:15:00	2 FLT BEDS PLS // 1 FOR A WHI HOND ACC // THE OTHER FOR WHI PKTK /// BOTH VEHS ARE NB IN THE SCALES
11/14/2006 18:16:00	1039 ALL WAYS TOW W/ 2 FB
11/14/2006 18:33:00	CHP Unit On Scene

11/14/2006 18:48:00	CHP Unit Enroute
11/14/2006 19:03:00	CHP Unit On Scene
11/14/2006 19:17:00	CHP Unit Enroute
11/14/2006 19:23:00	CHP Unit On Scene

Acc26

Details for Incident No.125

Description:	1183 - Traffic Collision - No Details	Start Time:	11/14/2006 02:40:00
Location:	NB I880 AT 29TH AV	End Time:	11/14/2006 03:29:00
Area:	OAKLAND	Duration:	49

Timestamp	**Description**
11/14/2006 02:40:00	VEH HIT RHS GUARD RAIL AND THEN STOPPED
11/14/2006 02:40:00	SOLO VEH SPUN OUT
11/14/2006 02:41:00	VEH NOW ON RHS
11/14/2006 02:42:00	JNO COLISEUM / BLOCKING SLOW LN / WHI SED
11/14/2006 02:42:00	CHP Unit Enroute
11/14/2006 02:51:00	BLKG #4 LN
11/14/2006 02:52:00	1039 ALL WAYS TOW ENRT W/ FB ON PRI
11/14/2006 02:56:00	2ND 1183 AT SAME 1020 / NEED UNIT FOR A BREAK / JSO 29TH
11/14/2006 02:57:00	CHP Unit Enroute
11/14/2006 02:59:00	S11 W/BREAK STARTED AT 66TH / 177 COPIES
11/14/2006 03:01:00	CHP Unit On Scene
11/14/2006 03:12:00	RDWY CLR
11/14/2006 03:23:00	ALL LNS OPEN
11/14/2006 03:27:00	CHP Unit On Scene
11/14/2006 03:28:00	1021 A AND B TOW / NEG TK AVAIL
11/14/2006 03:29:00	1039 MICKI S TOW // ETA 20

Acc27

Details for Incident No.360

Description:	1182 - Traffic Collision - Property Damage	Start Time:	11/14/2006 07:26:00
Location:	NB I880 JSO HEGENBERGER RD	End Time:	11/14/2006 07:37:00
Area:	OAKLAND	Duration:	11

Timestamp	**Description**
11/14/2006 07:26:00	RP INVLD/BLKNG SL LANE/VEH IS GRY DODG NEON VS DKBLU HOND
11/14/2006 07:27:00	CHP Unit Enroute
11/14/2006 07:28:00	ROLL FSP PLS
11/14/2006 07:28:00	CHP Unit Enroute
11/14/2006 07:32:00	FSP 97 NB AT HEG ONR
11/14/2006 07:34:00	1039 3A//C#314//MICKIS TOW NEXT AVAIL ON PRI
11/14/2006 07:37:00	CHP Unit On Scene

Acc28

Details for Incident No.777

Description:	1183 - Traffic Collision - No Details	Start Time:	11/14/2006 10:49:00
Location:	NB I880 AT I238	End Time:	11/14/2006 11:01:00
Area:	HAYWARD	Duration:	12

Timestamp	**Description**
11/14/2006 10:49:00	5 VEHS
11/14/2006 10:50:00	ALL ON RHS
11/14/2006 10:52:00	CHP Unit Enroute
11/14/2006 10:53:00	CHP Unit Enroute
11/14/2006 11:01:00	CHP Unit On Scene

Acc29

Details for Incident No.203

Description:	1125D - Traffic Hazard - Debris/Objects	Start Time:	11/15/2006 05:45:00
Location:	NB I880 JSO ALVARADO-NILES RD	End Time:	11/15/2006 05:47:00
Area:	HAYWARD	Duration:	2

Timestamp	Description
11/15/2006 05:46:00	CHP Unit Enroute
11/15/2006 05:47:00	PER ANOTHER CALLER //A LADDER //BLKNG #3

Acc30

Details for Incident No.192

Description:	1179 - Traffic Collision - Ambulance Responding	Start Time:	10/12/2006 04:55:00
Location:	NB I880 JNO MOWRY AV	End Time:	10/12/2006 06:04:00
Area:	HAYWARD	Duration:	69

Timestamp	Description
10/12/2006 04:56:00	#1-4 LN S BLOCKED
10/12/2006 04:56:00	4 VEH TC / SEMI VS VW VS 2 UNK VEH S
10/12/2006 04:57:00	VETTA SLAMMED INTO THE SIDE OF THE SEMI
10/12/2006 04:57:00	PER ANOTHER CALLER D/SEMI VS VOLKS JETTA
10/12/2006 04:58:00	1039 1141
10/12/2006 05:01:00	CHP Unit Enroute
10/12/2006 05:08:00	#1 LN BLOCKED
10/12/2006 05:08:00	CHP Unit On Scene
10/12/2006 05:11:00	MOVING PARTIES OVER TO RHS

10/12/2006 05:11:00	CHP Unit On Scene
10/12/2006 05:14:00	ALL LNS OPEN
10/12/2006 05:17:00	1039 ALL WAY TOW W/ 2 TRKS
10/12/2006 06:04:00	1039 WALT S

Acc31

Details for Incident No.1907

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/12/2006 19:25:00
Location:	NB I880 JNO INDUSTRIAL PKWY W	End Time:	10/12/2006 19:37:00
Area:	HAYWARD	Duration:	12

Timestamp	**Description**
10/12/2006 19:26:00	VEHS IN CD
10/12/2006 19:26:00	WHI NISS VS TAN MINIVAN
10/12/2006 19:28:00	CHP Unit Enroute
10/12/2006 19:29:00	CHP Unit Assigned
10/12/2006 19:29:00	CHP Unit Enroute
10/12/2006 19:32:00	CHP Unit On Scene
10/12/2006 19:37:00	CHP Unit On Scene

Acc32

Details for Incident No.1029

Description:	1183 - Traffic Collision - No Details	Start Time:	11/07/2006 13:25:00
Location:	NB I880 AT BROADWAY	End Time:	11/07/2006 14:21:00
Area:	OAKLAND	Duration:	56

Timestamp	**Description**
11/07/2006 13:25:00	TK PK VS UNK VEH / MID LANE
11/07/2006 13:29:00	L1039 JSO 7TH / 1179 / OT VEH

11/07/2006 13:29:00	REFERENCE DUPLICATE INCIDENT 1039D1107
11/07/2006 13:29:00	PER RP NISS NOT MOVABLE-REQ 3A
11/07/2006 13:29:00	PURPLE NISS SPORTS CAR #3-4 VS WHI BIG DUMP TK #2
11/07/2006 13:30:00	1039 1141
11/07/2006 13:32:00	1039 3A FOR PURPLE NISS//C#2534//AUTO GUARDIAN OAK-NEXT AVAIL ON PRI TO #3-4
11/07/2006 13:35:00	1039 96-S12 WILL ADVISE
11/07/2006 13:39:00	CHP Unit Enroute
11/07/2006 13:41:00	RE LINE 12 -- UNIT WILL ADV WHEN 1097
11/07/2006 13:44:00	NEG OT D VEH --- ASC FR S UNIT IF BIG RIGS CAN USE WB 580
11/07/2006 13:45:00	CHP Unit On Scene
11/07/2006 13:46:00	CHP Unit Assigned
11/07/2006 13:51:00	1039 DOTCC
11/07/2006 13:51:00	039 3A -- AUTO GUARDIAN WAS NOT ENRT WITH FLTBED - ROLLING ONE NOW
11/07/2006 13:51:00	MAKE SURE TOW IS FLTBED
11/07/2006 13:53:00	CHP Unit On Scene
11/07/2006 14:03:00	CHP Unit On Scene
11/07/2006 14:04:00	MEDIA INQUIRY IF UNITS CAN UPDATE STATUS ON LANES CLOSED THANKS
11/07/2006 14:04:00	PER CCTV BACKED UP TO 66TH AVE, 15 MINUTE DELAYS^
11/07/2006 14:08:00	3 AND 4 LANES CLOSED FOR NOW
11/07/2006 14:15:00	3A TO BOTTOM OF BWAY OFR PLZ
11/07/2006 14:16:00	BACKED UP TO HEGENBERGER, 25 MIN DELAYS^
11/07/2006 14:19:00	1039 3A C#2826 AUTO GUARDIAN TO BOTTOM OF THE BROADWAY OFR
11/07/2006 14:20:00	AUTO GUARDIAN ALREADY 1097
11/07/2006 14:21:00	CHP Unit On Scene

Acc33

Details for Incident No.1814

Description:	1183 - Traffic Collision - No Details	Start Time:	11/07/2006 18:31:00
Location:	NB I880 JNO W A ST	End Time:	11/07/2006 18:47:00

Area:	HAYWARD	Duration:	16

Timestamp	Description
11/07/2006 18:31:00	APPEARS LIKE 2 PARTIES BLKING #3 LANE
11/07/2006 18:32:00	CHP Unit On Scene
11/07/2006 18:33:00	BLKING #2 LANE
11/07/2006 18:34:00	MOVED TO RHS
11/07/2006 18:47:00	CHP Unit On Scene

Acc34

Details for Incident No.587

Description:	1183 - Traffic Collision - No Details	Start Time:	11/06/2006 09:28:00
Location:	NB I880 AT FRUITVALE AV	End Time:	11/06/2006 10:29:00
Area:	OAKLAND	Duration:	61

Timestamp	Description
11/06/2006 09:28:00	BIGRIG VS VAN
11/06/2006 09:31:00	INVD IN SIL HOND CIV VS LRG WHI VAN VS BIGRIG TANKER / BLKG LNS #2,3
11/06/2006 09:31:00	CHP Unit Enroute
11/06/2006 09:32:00	96-177 NB 880 AT HIGH ST IN HEAVY TRAFFIC
11/06/2006 09:38:00	DOT COPZ WHEN UNIT GOES 1097 PLZ ADV IF RIGS CAN USE W-580
11/06/2006 09:40:00	ADV S UNIT RE BIG RIGS ON 580
11/06/2006 09:40:00	4 VEHS 2 BIG RIGS & 2 PASSENGER VEHS #2 & 3
11/06/2006 09:41:00	1039 DOTCC FOR INFO
11/06/2006 09:41:00	CHP Unit Enroute

11/06/2006 09:41:00	CHP Unit On Scene
11/06/2006 09:42:00	1039 96-S12
11/06/2006 09:43:00	** PER 96-S12 BIG RIGS CAN USE 580 FOR NOW, WILL ADV WHEN RDWAY CLEAR **
11/06/2006 09:45:00	RDWY CLR, PARTIES OFF AT FRUITVALE
11/06/2006 09:47:00	REQ SIG ALERT FOR APPX 1 HR DUE TO TRAFF BACK UP
11/06/2006 09:48:00	1039 DOTCC FOR INFO
11/06/2006 09:50:00	ROLL 1 1185 ROT - SIL HOND CIV 2D (29TH JEO 880 NEAR OAK ANIMAL SHELTER)
11/06/2006 09:51:00	BIG RIGS CAN USE 580 FOR 1 ADDITIONAL HR PER 96-177
11/06/2006 09:51:00	RE LN 20
11/06/2006 09:54:00	1039 MICKIS TOW TO LINE 22
11/06/2006 10:29:00	***FOR TMC, BIG RIGS CAN ONLY USE WB 580, DUE TO THIS TC, CANNOT USE EB 580***

Acc35

Details for Incident No.654

Description:	1182 - Traffic Collision - Property Damage	Start Time:	11/01/2006 09:02:00
Location:	NB I880 JSO COLEMAN AV	End Time:	11/01/2006 09:30:00
Area:	SAN JOSE	Duration:	28

Timestamp	Description
11/01/2006 09:02:00	IN CD/RP INVLD-WHI TOYT TUNDRA TK VS DKCOLOR SED
11/01/2006 09:10:00	CHP Unit Assigned

11/01/2006 09:23:00	CHP Unit Assigned
11/01/2006 09:24:00	PT CRUISER IN #1 PLS ROLL 3A ON EXP THANKS
11/01/2006 09:27:00	1039 3A C# 974 ALONGI BROS ETA ON EXP
11/01/2006 09:29:00	NOW ON RS
11/01/2006 09:30:00	CHP Unit On Scene

Acc36

Details for Incident No.221

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/31/2006 06:15:00
Location:	NB I880 JNO 66TH AV	End Time:	10/31/2006 06:17:00
Area:	OAKLAND	Duration:	2

Timestamp	Description
10/31/2006 06:15:00	BLK MERZ AND WHI FORD PU ON RHS
10/31/2006 06:17:00	1039 TED AND JOES (BUT CANT HANDLE 4 PEOPLE)
10/31/2006 06:18:00	CHP Unit Enroute
10/31/2006 06:30:00	CHP Unit On Scene

Acc37

Details for Incident No.1324

Description:	1183 - Traffic Collision - No Details	Start Time:	10/31/2006 16:14:00
Location:	NB I880 JSO HESPERIAN BLVD	End Time:	10/31/2006 16:22:00
Area:	HAYWARD	Duration:	8

Timestamp	Description
10/31/2006 16:14:00	3 VEHS
10/31/2006 16:14:00	#4 LANE
10/31/2006 16:14:00	CHP Unit Enroute

10/31/2006 16:16:00	CHP Unit Enroute
10/31/2006 16:17:00	CHP Unit On Scene
10/31/2006 16:18:00	BLCKNG #5 LANE
10/31/2006 16:22:00	RDWY CLR--PLS CONTINUE FSP TO THE RHS
10/31/2006 16:22:00	CHP Unit On Scene

Acc38

Details for Incident No.1016

Description:	1125V - Traffic Hazard - Vehicle	Start Time:	10/30/2006 14:41:00
Location:	NB I880 JSO HESPERIAN BLVD	End Time:	10/30/2006 15:16:00
Area:	HAYWARD	Duration:	35

Timestamp	**Description**
10/30/2006 14:42:00	BLKG UNKN LN LANG BARRIER
10/30/2006 14:43:00	CHP Unit Enroute
10/30/2006 14:51:00	CHP Unit Enroute
10/30/2006 14:57:00	CHP Unit Enroute
10/30/2006 14:58:00	1039 ENDOS
10/30/2006 14:58:00	BLKNG #3
10/30/2006 15:02:00	CHP Unit Assigned
10/30/2006 15:12:00	CHP Unit On Scene
10/30/2006 15:15:00	MOVED TO HESP OFR / 1023 FOR 1185
10/30/2006 15:16:00	1039 ENDOS OF CORRECT 1020

Details for Incident No.1041

Description:	1183 - Traffic Collision - No Details	Start Time:	10/30/2006 14:52:00
Location:	NB I880 JNO LEWELLING BLVD	End Time:	10/30/2006 14:52:00
Area:	HAYWARD	Duration:	0

Timestamp	**Description**
No records to display	

Acc39

Details for Incident No.1477

Description:	1182 - Traffic Collision - Property Damage	Start Time:	10/23/2006 15:45:00
Location:	NB I880 JNO W TENNYSON RD	End Time:	10/23/2006 15:52:00
Area:	HAYWARD	Duration:	7

Timestamp	Description
10/23/2006 15:45:00	AND 1125D IN THE # 1LN
10/23/2006 15:51:00	CHP Unit On Scene
10/23/2006 15:52:00	OCCD NB JSO TENNYSON // AND DEBRIS SUPPOS TO BE IN RDWY
10/23/2006 15:52:00	CHP Unit Assigned
10/23/2006 15:58:00	CHP Unit Enroute

Acc40

Details for Incident No.2053

Description:	1183 - Traffic Collision - No Details	Start Time:	10/29/2006 20:50:00
Location:	NB I880 JSO EB SR92	End Time:	10/29/2006 20:59:00
Area:	HAYWARD	Duration:	9

Timestamp	Description
10/29/2006 00:06:00	PER OFCR HURN HE JUST SPOKE TO HAYWARD PD RO REPORTED VEH 10851 2HRS AFTER THIS TC
10/29/2006 01:15:00	1039 HAY PD / OFCR HURN REQ A HOLD ON 1110 FOR 10851
10/29/2006 01:23:00	SVS COPZ LN 35 FOR VEH STATUS/PLT INFO
10/29/2006 01:23:00	F# 508 345 06 PER LN 45
10/29/2006 20:51:00	3 VEH TC //IN #1 - #2
10/29/2006 20:52:00	1 VEH FACING CD
10/29/2006 20:52:00	VS SEDAN W/ WHOLE BUMPER OFF BLOCKING #1

10/29/2006 20:52:00	PER ANOTHER 3 VEH TC #1-3 LNS
10/29/2006 20:52:00	OLDER MODEL ACC VS MINIVAN
10/29/2006 20:53:00	CHP Unit Enroute
10/29/2006 20:54:00	BLKG #1 AND #2
10/29/2006 20:54:00	1039 1141
10/29/2006 20:54:00	UNK 4D HEAD ON INTO CD / PTYS NOT MOVING --ROLLING 1141
10/29/2006 20:54:00	INV IN SIL ACUR RL 4D - IN CD REQ 3A
10/29/2006 20:54:00	CHP Unit On Scene
10/29/2006 20:55:00	CHP Unit On Scene
10/29/2006 20:56:00	CHP Unit On Scene
10/29/2006 20:57:00	RDWY CLR
10/29/2006 20:57:00	1039 3A C# 3212 - AUTO GUARDIAN ON PRIORITY FOR LINE 13
10/29/2006 20:57:00	CHP Unit On Scene
10/29/2006 20:58:00	ROLL 1185 R
10/29/2006 20:58:00	CHP Unit On Scene
10/29/2006 20:59:00	1039 HARRY SANDS
10/29/2006 21:03:00	CHP Unit Enroute
10/29/2006 21:05:00	CHP Unit On Scene

10/29/2006 21:39:00	CHP Unit Enroute
10/29/2006 21:40:00	CHP Unit Enroute

APPENDIX B

Accident Dataset Information Table

ACCIDENT INFO - TRAINING DATASET						
Accident	**Date**	**DOW**	**Duration (min)**	**US VDS**	**DS VDS**	**Distance (miles)***
2	2006/10/29	Sun	29.0	400534	401613	0.89
4	2006/10/23	Mon	11.0	400180	400529	0.33
6	2006/10/11	Wed	82.0	400716	401545	0.87
9	2006/10/30	Mon	63.5	400165	400640	0.21
10	2006/10/29	Sun	26.5	400041	400419	0.26
13	2006/10/21	Sat	90.0	401003	400275	0.66
15	2006/10/18	Wed	34.5	400951	400057	0.76
18	2006/11/05	Sun	50.0	400898	400275	0.45
24	2006/11/13	Mon	25.0	400608	400949	1.24
25	2006/11/14	Tue	38.5	400309	400417	0.56
26	2006/11/14	Tue	13.5	400341	400607	0.58
30	2006/10/12	Thu	9.5	400490	400137	1.47
32	2006/11/07	Tue	51.0	400094	400983	0.87
33	2006/11/07	Tue	19.0	400275	400939	0.24
34	2006/11/06	Mon	32.5	400341	400094	0.81
36	2006/10/31	Tue	29.5	400608	400949	1.24
37	2006/10/31	Tue	26.0	400990	400515	0.28
38	2006/10/30	Mon	40.0	400990	400515	0.28
39	2006/10/23	Mon	71.5	400041	400165	0.44
40	2006/10/29	Sun	19.0	400041	400165	0.44
ACCIDENT INFO - TESTING DATASET						
Accident	**Date**	**DOW**	**Duration (min)**	**US VDS**	**DS VDS**	**Distance (miles)***
1	'2006/10/17'	Tue	45.0	400333	400360	1.0
3	'2006/10/28'	Sat	10.5	400928	400284	0.6
5	'2006/10/14'	Sat	19.0	400275	400939	0.2
7	'2006/11/08'	Wed	9.0	400180	400529	0.3
8	'2006/11/09'	Thu	87.5	400898	400275	0.4
11	'2006/10/27'	Fri	78.0	401003	400275	0.7
12	'2006/10/26'	Thu	67.0	400990	400515	0.3
14	'2006/10/20'	Fri	58.5	400529	400252	1.1
16	'2006/09/22'	Fri	35.0	400275	400939	0.2
17	'2006/11/09'	Thu	53.0	400180	400529	0.3
19	'2006/11/09'	Thu	53.0	400951	400057	0.8
20	'2006/11/11'	Sat	14.5	401003	400898	0.2
21	'2006/11/12'	Sun	120.0	400788	401517	1.3
22	'2006/11/13'	Mon	40.0	400983	400980	1.7
23	'2006/11/13'	Mon	34.5	401517	400574	0.8
27	'2006/11/14'	Tue	16.5	400608	400949	1.2
28	'2006/11/14'	Tue	12.5	400529	400252	1.1
29	'2006/11/15'	Wed	5.0	401062	401529	0.3
31	'2006/10/12'	Thu	37.5	400611	400928	0.3
35	'2006/11/11'	Sat	80.0	401003	400898	0.2

* Observed (not reported) time of disturbance in traffic.

** Distance between upstream and downstream stations

VITA

Manoel Castro-Neto was born in 1979, in Fortaleza, Ceará, Brazil, where he grew up. He graduated from Universidade Federal do Ceará in 2002, with a B.S. in Civil Engineering. In 2005, Manoel completed his M.S. degree in Civil Engineering with concentration in transportation engineering at the University of Tennessee. Still in 2005, he began both his doctoral work in Civil Engineering with concentration in transportation engineering and an MS in Statistics at the University of Tennessee. Manoel is a recipient of both the U.S. Dept. of Transportation's Eisenhower Graduate Fellowship and the International Road Federation's Executive Leadership Fellowship Program. His research interests include transportation operations, transportation planning and applied statistics.