INTELLIGENT VEHICLE BASED TRAFFIC MONITORING – EXPLORING APPLICATION IN SOUTH AFRICA

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ABSTRACT

The paper details the anticipated benefits an intelligent vehicle based traffic monitoring approach holds. The approach utilises advanced technology with the potential to reduce crashes and includes the monitor of vehicle speeds and flows, the identification of high crash risk locations and other aids for traffic and crash analyses.

The paper discusses the following:
1) The use of on board devices to attain exact crash points, reconstruction of crashes, including data on other vehicle's and obstruction's involvement in terms of speed, acceleration, deceleration, angle and impact points;
2) The mapping of crash data to identify high crash risk roads in terms of frequency of crashes, road attributes any other vehicle- and human-related parameters, and
3) The use of on board devices for the monitoring of traffic speeds and flows on all types of roads in relation to traffic light timings, speed limits to determine trends on a regional basis, etc.

The paper concludes with a brief exploration of ways to possibly adopt the technology in South Africa.

1   INTRODUCTION

The many approaches to the improvement of road safety centre around three main themes: safe drivers, safe vehicles and safe roads. Programmes aimed at addressing road safety problems are often segmented according to these themes depending on the level at which a road safety programme or project is targeted. If a hazardous location is to be improved, it is often more effective to consider all three themes in remedial measure development activities whilst area-wide, regional, sectoral or route/street issues can be addressed through a very narrow focus on a specific theme – typically improved design of road elements, road safety instruction at school targeting pupils of a particular aged group, etc. Vast improvements of vehicle safety have been brought about by technologies that assist drivers with vehicle controls, support systems and the human-machine interface – generally related to vehicle ergonomics but, arguably, with the added dimension of expanded exchanges of information among the driver, the vehicle and the road and environment. Technology is also applied to get better information on traffic operations and systems failures so that for instance the reaction to, and clearing of incidents can be effected quicker and with lesser side effects. Traffic engineering, crash investigation and analysis, and other procedures like road safety/risk assessments may also generally benefit from vastly improved transport/traffic related data that is generated from road and

vehicle technologies and systems and also more personal devices like mobile phones and navigation systems. On the pro-active side, technology driven advanced simulation models and road safety audit procedures are becoming more prevalent in road design processes to optimise the safety performance of new road infrastructure and traffic improvement projects.

Intelligent Transport Systems (ITS) refers to efforts to add information and communications technology to transport infrastructure and vehicles that promise to improve the management of factors that typically are at odds with each other, such as vehicles, loads, and routes with the objective to improve safety and reduce vehicle wear, travel times, and fuel consumption. (http://en.wikipedia.org/wiki/Intelligent_transportatio_-system: accessed March 2010). ITS uses advanced communications, sensors, and information processing technologies encompassing a broad range of wireless and wire-line communications-based information and electronics.

Whilst ITS technologies are aimed at relieving congestion, improving safety, and enhancing mobility and economic productivity, reaching its full potential impact is still some distance away. Notwithstanding, activities to support a "zero fatality" vision for road transport operations are gaining momentum. In the USA, the second Strategic Highway Research Program (SHRP 2) (www.trb.org/StrategicHighwayResearchProgram2SHRP2: accessed March 2010) was initiated and the road safety research area of the programme includes naturalistic driving studies (NDS). NDS is about gaining a better understanding of driver behaviour – an area of research that has been understated up to now. The euroFOT project in Europe (http://eurofot.org: accessed March 2010) focuses, amongst other, on the efficacies of in-vehicle systems with respect to vehicle and driver safety. High-end vehicular data loggers with incorporated accelerometers are used to also detect 'vehicle incidents', i.e. near-crashes. On the road infrastructure side, efforts are going towards road performance tracking that focuses on the risk assessment of the complete road network with the perspective that the application of simple engineering measures pays high dividends in reducing death and serious injury, e.g. the EuroRAP project (http://www.eurorap.org: accessed March 2010).

While globally much is happening in Science, Engineering and Technology Research and Development (SET R&D) with regard to transport/traffic operations and management systems to improve the performance of transport systems and road safety, such activities in South Africa or in Southern African Development Community (SADC) are less obvious. The South African National Roads Agency (SANRAL) is implementing ITS on a country-wide scale and will soon also roll out one of the largest electronic tolling systems in the world. These systems will be contributing to the efficient operation of the national road network and also towards various aspects of the improvement of road safety. For these systems to be operated effectively, they require a workforce with the necessary skills and aptitude to function in technologically advanced environments.

There are some other fields that are benefiting from technological advancements and that may be contributing to road safety already – fleet management systems, traffic signal systems, surveillance systems, etc. are some that can be mentioned in the South African context. However, currently there are limited efforts to apply technology, including using existing technology, to specifically support activities that would impact road casualty numbers. The CSIR initiated a SET programme, NyendaWeb, which includes the development of an open technology platform to facilitate collaborative R&D and researcher's access to transport/traffic data, which currently already represents a valuable resource. The general dire shortage of skills in South Africa and specifically so with

respect to operation and management of high performance transport systems, and concomitantly the low levels of interest in, as well as take-up of, relevant research in this field, is resulting in slow progress with the development of this potentially useful technology.

With all the technological advancements to benefit transport/traffic, there is thus a real opportunity to address the poor road safety performance in South Africa. However, much is still to be done to overcome the problem to effectively drive down the casualty count and there is the expectation that it must come from government's side. So far actions from government appear to have lower than expected impact, however, successful road safety improvement strategies require a comprehensive approach and it includes other players in the industry, specifically the drivers of vehicles.

The focus of the paper is on exploring a technology that, amidst rapid technological advancements that are seemingly not delivering tangible results for road users, particularly regarding road safety, can bring about awareness of the roles the driver, vehicle and road play in the risk profile of the South African road transport system. The technology of interest is the after-market on-board devices that have managed to penetrate the market to some levels – i.e. devices with Global Position System (GPS)-based functionalities. One such technology is GPS-based navigation and it is said to already contribute to road safety. The following are given as some of the benefits of in-vehicle navigation (Vonk, et al, 2007):

▫ It improves driver behaviour in unknown areas, heightens alertness and reduces stress levels.
▫ A GPS device reduces the amount of miles driven by 16 percent and reduces travel time in an unknown area by 18 percent. GPS systems assist motorists in identifying the location of features on, near or adjacent to the road networks - these include service stations, maintenance and emergency services and supplies, entry and exit ramps, damage to the road system, etc.
▫ Motorists are alerted through a constantly updated database of crash blackspots, primary school zones, safety camera locations and other hazardous stretches of road.
▫ Motorists also receive information on the current speed, average speed, maximum speed reached and estimated time to reach the destination.
▫ Real time traffic information is available and not dependent on road or weather conditions, etc.

There are thus two aspects of road safety that can be assisted by technology: 1) assistance to the driver to be a safer driver, and 2) capturing the in-operation data to learn more about the workload of the driver that relates to the driver's aptitude and the conditions in which driving takes place.

While in-vehicle navigation systems are becoming more common in the up-market vehicle market segment, and aftermarket systems being very popular, they are generally too expensive for the majority of vehicle owners or drivers and they are thus not as useful for the wide spectrum risk profiling of drivers in South Africa. However, another technology generally known as a "black box" that refers to devices on vehicles with varying levels of sophistication and broadly belonging to four main groups, i.e. trip logging-devices, passive GPS tracking devices, crash data recording devices and telematic devices (http://www.namic.org/-pcimagazine/050506/dataRecording.asp: accessed March 2010).

Wouters and Bos (2000) report the results of the introduction of driver monitoring with vehicle data recorders ("black boxes") into different fleets in Belgium and The

Netherlands. The drivers knew that their vehicles were equipped with such a device, but feedback about their driving performance based on the data collected was not part of the design of the study. Wouters and Bos analysed the crash occurrence of 840 vehicles, of which 240 were equipped with a data recorder. They estimate that the simple presence of data recorders led to a crash reduction of some 20%. It might be expected that the crash reduction would be even higher, if the technology would be used to provide feedback to the drivers about their driving performance.

Trip-logging devices are typically aftermarket devices that connect to the diagnostic link of vehicles' operating systems and record data such as distance travelled, speed, braking profiles and engine status with a time and date stamp. Passive GPS tracking devices are similar to trip-logging devices but with the incorporation of a GPS and is mostly also installed aftermarket. Crash data recording devices may be Original Equipment Manufacturer (OEM)-installed or aftermarket and typically record snapshots of data for a period before and then also after a crash situation. Telematic devices are the more advanced types of data recording devices and include real-time GPS tracking functionality and are capable of transmitting and receiving data over wireless networks. Vehicles on the higher end of the market are fully equipped with telematics from OEMs but a wide range of aftermarket products are available at costs that may be limiting to lower end vehicle owners. In South Africa many telematic systems are being used in the vehicle security and fleet management domains but there are also navigation device users and vehicle insurers that use some form of tracking device for pay-as-you-drive or other forms of vehicle usage profiling as a basis to determine the insurance premium of the subscriber.

Importantly, there are now telematic devices that incorporate accelerometers. Multi-axis accelerometers detect magnitude and direction of acceleration as a vector quantity and are used to sense position, vibration and shock. Adding high granularity acceleration data to the datasets of on-board devices significantly enhance the scope for analysis with respect to driver actions, vehicle manoeuvres and impacts in space-time. GPS and accelerometer functionalities thus combine powerfully for purposes of driver and vehicle profiling as well as crash investigation and reconstruction. The sections below will focus on the potential contribution that aftermarket telematic devices may bring to improve management of road safety and specifically with respect to driver behaviour.

2   OVERVIEW OF ADVANCED TECHNOLOGY USE IN CRASH INVESTIGATION AND ANALYSIS

Human-centred intelligent vehicles hold a major potential for industry. Since 1980, major car manufacturers and other firms have been developing computer-based in-vehicle navigation systems. Today, most developed/developing systems around the world have included more complex functions to help people drive their vehicles safely and efficiently. New information and control technologies that make vehicles smarter are now arriving on the market either as optional equipment or as specialty after-market components. These technologies are being developed and marketed to increase driver safety, performance, and convenience. However, these disparate individual components have yet to be integrated to create a coherent intelligent vehicle that complements the human driver, fully considering his requirements, capabilities and limitations. A fully intelligent vehicle must work cooperatively with the driver: an intelligent system senses its environment and acts to reach its objectives - its interaction-communication channels have a big influence on the type of intelligence it can display (Benshair et al, 2001; Bertozzi et. al. 2002)

In-vehicle telematics are sets of technologies that can be the basis for numerous services to road and transport users – they can either assist the driver with operating the vehicle (driver assistance) or fully controlling the vehicle (automation) - Bishop (2000). For this various supporting technologies can be used such as radar, magnetic referencing, GPS and digital maps. McCarley (2005) notes that there is significant interest among traffic management personnel in the use of automated warning systems to provide drivers with real-time information on hazardous conditions related to traffic, limited visibility, or roadway obstructions. But that the effectiveness of such systems in achieving desired traffic safety improvements has not yet been well quantified. Relative influences on traffic safety can be assessed in many ways, and overall conclusions must be based on an appropriate set of metrics and methodologies for a particular implementation.

Lotan and Yorak (2006) describe an in-vehicle data recorder (IVDR) designed for the purpose of monitoring and analysing driver behaviour in normal driving situations and not only crash or pre-crash events. The IVDR records the movement of the vehicle and this information is used in an index of the overall trip safety. Their validation study involved 33 drivers with IVDR-equipped vehicles. The experiment was conducted in two stages. Firstly a blind profiling stage with no feedback from the system to the drivers and then followed by a feedback stage where drivers had access to personal web pages with the information recorded by the system. The blind profiling stage data was used to investigate the connection between drivers' safety indices as captured by the system, and historic crash data. They found significant correlations between the two datasets, which suggest that the driving risk indices can be used as indicators to the risk of involvement in car crashes. This connection enabled them to also investigate the potential impact of the system on driving behaviour and on safety. The results show that the initial exposure of drivers to the system has a significant positive impact on their behaviour and on safety. Access to the feedback provided by the system has further impact on drivers' performance. However, they remark that follow-up efforts are required to sustain the positive impact over time.

According to Roetting, Huang, McDevitt and Melton (2003), behaviour based safety approaches have proven effective in reducing crashes in industrial settings, but cannot easily be extended to commercial driving. For considerable periods of working time, truck drivers are alone, and do not interact with peers. It might be possible to use data gathered by new in-vehicle technology to provide real-time and post-shift feedback to drivers about their driving behaviour. In their paper they report on the results of focus group interviews conducted with subject matter experts from the trucking industry (truck drivers, supervisors, managers, and other involved persons, such as insurance industry safety professionals). The focus groups discussed safety critical behaviours in commercial driving, the best way to provide feedback to truck drivers, and benefits of feedback by technology as well as concerns drivers and operators may have regarding monitoring and feedback systems. The focus group discussions showed that, in general, drivers would like to receive more feedback and that feedback by technology is acceptable, if designed and implemented properly. In addition, the participants had many suggestions on how to properly design and implement such systems.

The above references show that technology can have a significant effect on the way drivers approach the driving task and as a result on creating a safer road operations environment. However, the take-up of these technologies is generally slow and efforts to make its impact on road safety filtering through more rapidly are ongoing. The take-up in the developing world, though, will always be much slower and the expectation to have the ultimate safe vehicles to solve the road safety crisis soon is at least idealistic. But is there a way that technology can still make an early impact despite the aged vehicle fleets of the

developing countries including South Africa? The focus of this paper is on some of the available after-market technologies that generates and capture data that can be used in some form of risk profiling of the driver of the vehicle and also of the vehicle in the space-time context. Risk profiling typically considers driver behaviour related parameters, travel distance, time of day, location and road conditions factors. This type of data, even at a meta-level, would be useful in risk assessments of drivers, the vehicle and the road and environmental conditions. Vehicle profiling, particularly in the dynamic sense, may consider aspects such as acceleration/deceleration characteristics, dynamic responses, etc. Such risk assessments will provide much needed decision support with respect to programme or project development to address road user behaviour, vehicle and road management issues. Apart from being very useful for traffic safety engineering and management, the technology lends itself to contribute significantly to the science of crash investigation and reconstruction.

3   ASPECTS OF CRASH INVESTIGATION AND ANALYSIS

The unique nature of the "crash reconstruction" field in South Africa is resulting in practices that vary somewhat from those used in Europe and the US. The fact is that companies in general have not yet realised the potential of crash reconstruction as an economic tool, very few companies benefit from the advantages of proper crash investigations and the possible reconstruction of incidents. At the same time those making use of the services offered, expect to pay as little as possible. This mostly means that the forensic engineer doing the reconstruction limits him/her to the most basic aspects of the investigation/reconstruction. Basically, the nature of the law also allows for limited technical findings, as the legal aspects themselves play a major role in the final findings in the litigation processes. Often litigation cases pivot on amicable settlement rather than on defining contributory factors or on appropriate apportionment of cause and blame. As an example an eyewitness account carries more weight than an expert analysis, even where the eyewitness account can be shown as impossible through the use of science.

For the reasons stated above, the field is somewhat limited in terms of income from investigations and the experts have to use the limited resources available, while limiting the cost for investigations as far as possible. This means that if a vehicle has recording equipment installed, the recordings can be analysed to ensure a more accurate analysis of the incident. But recording equipment also has its limitations and the calibration must be verified by using physical information from the vehicle. This can be determined from gear ratios, final drive ratios, etc.

The limited financial backing as stated above causes the use of technology to be also limited due to the costs involved. For example a scene can be measured according to the minimum requirements for court purposes within a period of two hours by a trained investigator, which could be at an approximate cost of R1200-00, depending on the specific investigators fee. The same scene can be scanned with 3D laser technology, at a cost of approximately R10 000-00. As the minimum requirements for court purposes are sufficient to most clients, they will use the cheaper option, even though additional information can be obtained from a more detailed 3D measurement. At the same time the price of the laser technology is so high that no investigator in South Africa would be able to afford such equipment.

With the use of accelerometers as part of onboard telematics, however, the situation could be different. The technology is not as expensive and its uses may vary. From recordings, a qualified individual could calculate the exact movements of the vehicle leading up to and

including the actions of the vehicle during the impact situation. This impact situation was up to now the most difficult aspect to accurately describe. For implementation, however, a system needs to be developed that would be practical and at a relatively low cost. The analysis must also be done at a relatively low cost to be viable for the South African market. Basically this means that a full detailed analysis of all aspects, may not be required, but it could be limited to the most basic (just so that the minimum requirements of the law is satisfied.)

The technological advancements, especially in mobile device technology, along with the significant reduction of cost, afford a tremendous opportunity to demonstrate that utilising mobile devices could help to significantly aid the way in which traffic and crashes are monitored, and thus helping traffic planners and crash investigators to utilise these data sets for greater road safety planning and monitoring across a broader region, rather than in the usual manner where the identification of hazardous locations has generally been the most productive.

German et al, 2001 noted that event data recorders (EDRs) are installed on many late model cars and light trucks as an adjunct to air bag sensing and control systems and they deliberated the potential usefulness of such devices to traffic safety researchers. These EDRs afford access to a wealth of new data, enabling better understanding of on-road traffic safety issues, and providing opportunities for the development of new and effective countermeasures. Some of the tests they conducted included instrumented crash tests that facilitated the validation of the quantitative results obtained from onboard recorders, and in-depth investigations of real world collisions where results obtained using standard reconstruction techniques can be compared to the electronic data relating to crash severity. They also continued with studies that included an evaluation of pre-crash factors involved in real-world situations, based on in-depth investigation techniques, detailed occupant interviews, and analysis of a variety of pre-crash data elements obtained from event data recorders in collision-involved vehicles.

4   OVERVIEW OF FEASIBLE VEHICLE MONITORING TECHNOLOGY

There are clear indications that in-vehicle systems with some monitoring and/or feedback mechanisms have a positive impact on driver behaviour and that they may even have a moderating affect. Among the most important research in ITS is the development of systems that automatically monitor traffic flow at intersections. These automatic monitoring systems are based on local analysis of the behaviour of each vehicle at the intersection and the moderating affect will ultimately contribute to improved reliability of the technology as a result of more predictable driver behaviour. Kamijiko, Matsushita and Ikeuchi, 2000 indicate some of the advancements made in the development of technology with systems that can recognise bumping, passing, and jamming situations.

Toledo, Musicant and Lotan (2008) also describe the potential of IVDR systems to be used in various commercial and research applications as tools to monitor and provide feedback to drivers on their on-road behaviour. The implementation of IVDR is demonstrated using the example of the DriveDiagnostics system. Their system can identify various manoeuvre types that occur in the raw measurements, and use this information to calculate risk indices that indicate overall trip safety. Drivers receive feedback through various summary reports, real-time text messages or an in-vehicle display unit. Validation tests with the system demonstrate promising potential as a measurement tool to evaluate driving behaviour. Reductions in crash rates and the risk indices are observed in the short-term.

However, there are the more "simplistic" technologies that may offer cost effective in-vehicle system options that can be feasibly applied in the Southern African context. Systems or so-called "black boxes" exist with the following basic components:

▫ GPS sensor;
▫ 3-axis accelerometer;
▫ Automotive input connectors, i.e. controller area network CAN) bus;
▫ Bluetooth radio for communicating logged data or GPRS/EDGE/3G option. and
▫ Internal flash memory.

This type of black box logs data that is useful in crash reconstruction applications.

Crash reconstruction applications
Systems are available with the ability to record and analyse the following data sets and then to output the data into a map based application for investigation of the crash circumstances along with other relevant driving data sets. For each driven day and by trip, data sets with the following fields are typically generated:

▫ Driven mileage, time of driven mileage and speed
▫ Road types driven (rural, urban, highway)
▫ Acceleration categories, (normal/ hard braking/ very hard braking)
▫ Shock points or crash location and time of crash/shock point
▫ 3 second analysis of speed/angle prior to shock point/crash crash point
▫ Impact shock measurement in G-force
▫ Non fitted vehicle speed in relation to fitted vehicle collision point

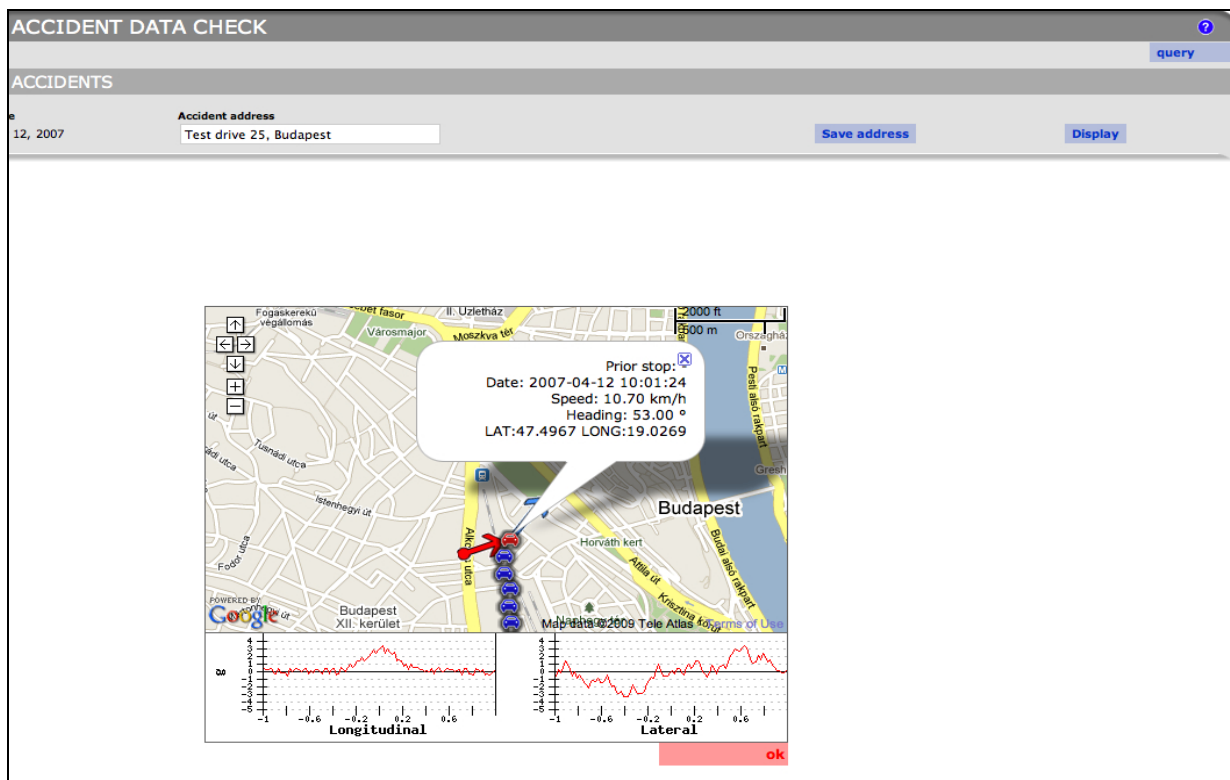Figure 1 below shows a crash reconstruction screenshot generated with appropriate application software.

Figure 1: The mapping application showing the point of shock along with timestamp and shock point

Figure 2 below shows the graphical identification of crash clusters. Further investigation into the individual incidents within these clusters can then be attempted on the basis of common circumstances such as speed, acceleration, deceleration, etc. prior to these common "shock points". A "shock point" is derived from space-time vectors and differentials (typical from accelerometer data) where the exceeding of certain threshold values would indicate a location of the occurrence of an incident – it could be a crash or even a near-miss situation.
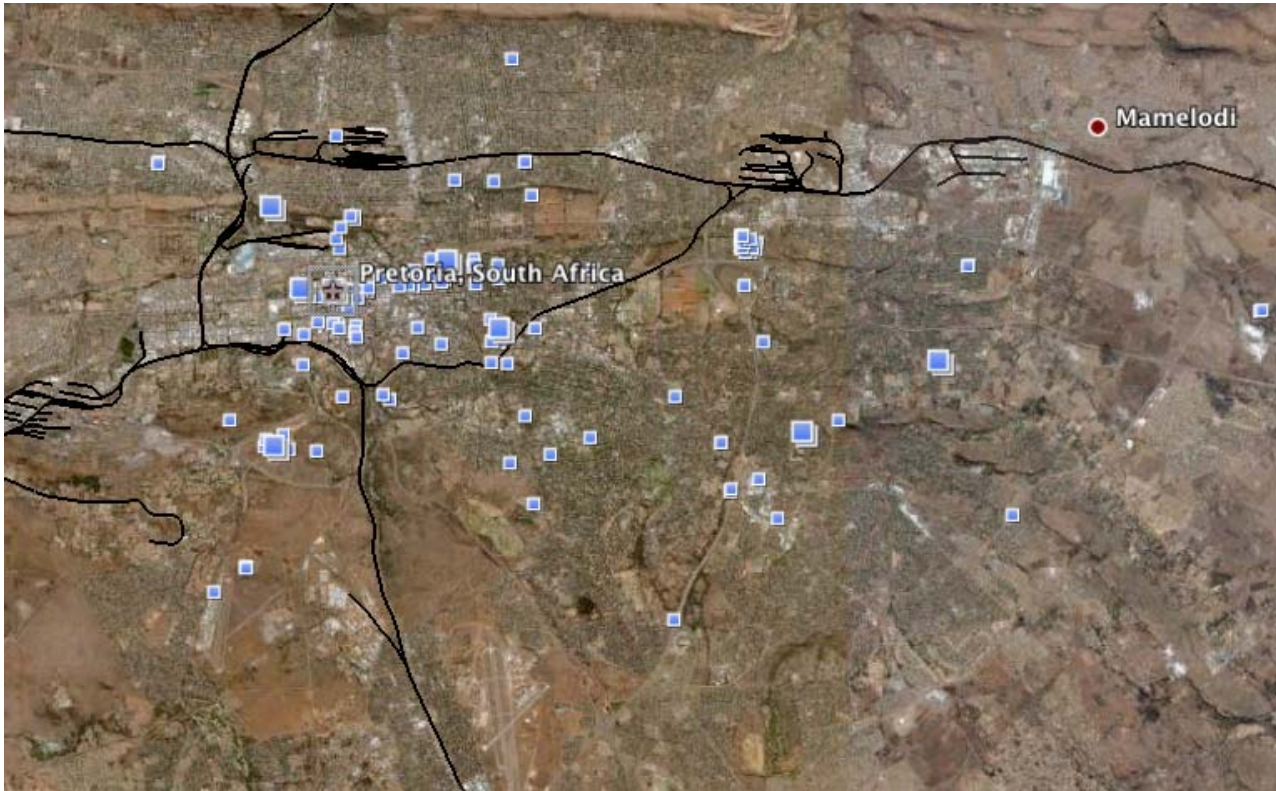

Figure 2: Identification of crash clusters in Pretoria

Where clusters of shock points are apparent, crash reconstruction applications assist with the identification of clusters with similar crash contributory factors. Detail analyses of these may lead to the development of appropriate remedial measures that can be applied as cluster/location specific or as route- or regional-based actions.

Speed Flow Monitoring.
Also using available data sets from the black box a wider area of traffic flow monitoring can be obtained. Wherever equipped vehicles drive, a considerable picture of traffic flow can be formulated by such things as time of day thereby giving a correlation of how the road network flows during various times of day. The traffic flow patterns that can be identified through appropriate analysis will provide planners with considerable data to inform planning and road design.

Crash Monitoring
With the incorporation of a multi-axis accelerometer into the black box and the ability to measure shock, speed, braking, angle and other relevant data, it allows a greater depth of data to be collected and thus means that non-fatal, and non-reported crashes can be incorporated into road traffic incident statistics meaning that a higher degree of road safety data can be collected to formulate decision making in regard to road layout, speed limits and other transport system management measures to alleviate the number of conflicts and concomitantly the number of crashes. Additionally, systems that make use of this

technology can also produce data sets relevant to speed of non fitted vehicles involved in a crash with a projected participant, which adds further relevance to data integrity.

5   IN-VEHICLE DATA LOGGER TECHNOLOGY IN ROAD SAFETY R&D

In keeping in mind that in South Africa motor vehicle insurance is not compulsory, the penetration of the respective telematic devices through market forces alone may limit the potential road safety benefits that may emanate from such systems. It is estimated that only 33 per cent of registered vehicles are insured. One of the reasons for not insuring is that the value of the vehicle is too low to warrant the high premium of the insurance. Yet vehicle insurance, or driver insurance which is more common in developed countries, is an instrument that can serve directly as a measure of the risk profile of a driver. Ideally this instrument should be the mechanism that determines the insurance premium of the driver thus serving as an incentive for the driver to change his/her risk profile so as to reduce the insurance premium.

Arguably, the opportunity exists to not only increase safety using active in-vehicle monitoring techniques as described, but also to yield high impact results in terms of the identified measures to alleviate the number of fatalities through strategies, policies, physical interventions, etc. It will also bring South Africa to the forefront of global Intelligent Transport System interest as a country that is proactive in terms of efforts to reduce the number of fatalities within the Southern African community.

How can the mentioned in-vehicle telematics, which arguably have relatively inexpensive options available, be rolled-out at a scale that will ensure relevant data capturing at statistically significant levels for analyses purposes? With about 15 000 government vehicles (gFleet) that are managed by Government, it provides an opportunity to implement the technology as a demonstration project. Such a demonstration may be constructed as follows:
▫ The fitting of 15,000 governmental vehicles (or a proportion thereof) of which there are some 8000 within the Gauteng Province with a mobile device as described, to enable data collection and active monitoring as described. The choice of utilising the governmental vehicle pool is strategic in terms of it also gives government officials greater management and monitoring tools for fleet management. It is envisaged that from usage of data from such a demonstration project, the following information can be obtained:
  - Knowledge of vehicle use in time and distance terms
  - Knowledge of driver behaviour
  - Knowledge and correlation of fuel used in the working day and identify high fuel usage by driver, vehicle and depot.
▫ This will enable real savings by identifying inefficiencies and actively identify the need for driver retraining or vehicle maintenance. Additionally, the authors believe that such a demonstration project data could also be utilised for risk measurement purposes and this would enable the reduction of governmental insurance costs in terms of negotiating a blanket insurance policy with an insurer based on a "pay-as-you-drive" or other relevant types of arrangements.
▫ Additionally, crash reconstruction data would be utilised for investigation into claims by drivers against governmental vehicles. This would also achieve greater economic savings for the Government in terms of claims and general insurance cost. Systems on offer typically have some of the following details:

- Data to be collected daily and processed from the floating vehicle data to a central server and by way of stored procedures for statistical analysis in regards to crash data and traffic speeds;
- Publishing of systems outputs on a weekly, monthly, quarterly and annual basis as may be required;
- Crash point clusters in tabular and GIS format identifying relevant areas for further investigation with the assistance of available crash reconstruction applications. This will identify any needs for possible road layout, traffic calming measures required to nullify high levels of crashes;
- Traffic speeds and flows of vehicles to attain greater understanding of daily patterns, rat runs and general traffic conditions in tabular and GIS format. This data can also be used by other application for the checking of traffic light timings in relation to traffic speed at relevant junctions. Driver behaviour data sets in GIS and tabular form identifying areas of speeding and excessive braking at specific locations, along road section, within areas, etc. allowing scientific information to be collected regarding driver behaviour in a real live network environment. Usage by day in time and distance terms crash reconstruction data for any governmental vehicles involved in a crash with identification of vehicle, place of crash, time of crash and where relevant other vehicle estimated speed at crash point. Fuel used against mileage undertaken.

6   CONCLUSION

In conclusion, there is a great opportunity to implement cost-effective telematic devices that can dramatically improve the knowledge about driver workload and risk profiles. It also appears that there is a feasible opportunity to implement a system in a controlled vehicle environment, gFleet that will create an opportunity to intensify the investigation and analysis of the South African road safety context. With such a system also comes the opportunity to build capacity and to do further upskilling in the R&D of road safety matters. A demonstration project as described with the analysis tools available could significantly aid our understanding of how, why and when traffic crashes occur, and through the techniques mentioned will allow the region to undertake better planning to thus reduce the number of fatalities on the country's road network.

The paper focuses on gFleet vehicles as a potential demonstration project mainly because it is a large fleet under the control of one owner. However, public transport vehicles and heavy goods vehicles are other sectors that can be targeted for utilising technology to generate and collect data to assist in the intensified analyses of crash contributory factors - and it may be particularly necessary with respect to public transport vehicles.

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