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ADVANCED REMOTE FIELD TRIAGE OF CAR CRASH VICTIMS

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Abstract

Following statistical analysis of the passenger cars sales in Ireland over the past 15 years, the extent to which this industry's success is impacted by the consumer's disposable income determined by macro-economic fluctuations is remarkable. Indeed, the Irish automotive industry of late is displaying much welcomed signs of recovery with traces of optimism among its key staff throughout. Moreover, a recent increase in the demand for transport is reflected in the significant rise in demand for private car ownership. However, as the number of vehicles on public roads gradually increases consequently it is also expected to lend to increased collisions and related casualties.

Car accidents are not necessarily all that similar. Crash victims can potentially sustain a wide array of injuries depending on the circumstances of the crash and the severity of the impact among others.

Victims can be broadly divided into three categories:

1. Those that will expire regardless of medical intervention,
2. Those requiring little or no assistance, and
3. Those capable of living, or making a good recovery from their injuries, with judicious medical intervention.

This paper concerns itself with the latter category and presents an advanced model for Remote Field Triage using telematics and Event Data Recorder technology. We explain the shortcomings of conventional "On-Scene Patient Triage" and highlight the need for further research in mapping the trauma injuries of crash victims. It is felt that the timely acquisition of processed real-time vehicle collision data will permit the Emergency Services to allocate the correct resources, thus significantly enhancing the survivability and rehabilitation of crash victims.

Introduction

In an ideal world, the way to reduce morbidity, mortality, and the socio-economic consequences of injuries sustained in a vehicle collision would be to prevent their occurrence in the first place [1]. However, when a vehicle collision occurs, and consequently personnel injuries are sustained, the Emergency Services must ensure that all casualties receive the right emergency care promptly at the scene and are transported to an appropriate medical facility for further evaluation and treatment where required [2].

Determining the facility to which an injured patient should be transported can have a profound impact on subsequent morbidity and mortality. Although basic emergency services are generally consistent across Accident and Emergency (A&E) Departments, certain hospitals have additional expertise and equipment for treating severely injured patients. These hospitals are known as “Trauma Centres”. Trauma Centres are classified by either the state or local authorities depending on the scope of resources and services available [2].

In Ireland, The National Clinical Programme for Trauma and Orthopaedic Surgery was formed to develop change initiatives which will improve and standardise the quality of care, to improve access for patients, and to provide a framework for the Health Service Executive (HSE), hospital managers, clinicians and the multidisciplinary teams caring for patients. The delivery of cost effective, evidence based healthcare is in the best interests of patients [3].

Contemporary Post-Collision Response

Currently, the Police and/or Emergency Services are notified, in the event of an accident, by either a Lay Bystander or an occupant in (one of) the involved vehicle(s). It should be noted, that a vehicle accident can leave even the most sensible of Caller shocked, stunned and more than a little shaken [2] – that’s if the casualties are lucky to have a Caller, or are ambulatory/conscious enough, in the first place!

The *Call Dispatcher*, a member of the control centre staff to which the emergency call is routed, is responsible for the dispatching and overseeing of the emergency responses [4]. This staff member dispatches the most appropriate response to the incident using data collated by the *Caller*. It should be noted here that the allocation of *First Responder* resources is primarily dependent on the *Call Dispatcher’s* qualification of the *Caller* and the geographical location of the incident.

Eventually, when the *Paramedics* arrive, they will have to make an on-the-spot diagnosis of the casualties, implement a range of treatment modalities for the emergency setting [4] and decide which Trauma Centre is most appropriate for evacuation.

While all the above is happening, the causality’s *golden hour* (i.e. the period of time lasting for one hour, or less, following a traumatic injury being sustained wherein the highest likelihood that prompt medical treatment will prevent death [5] or further complications) is ticking away!

So, what can be done to give the *Causality* a greater chance of survival?

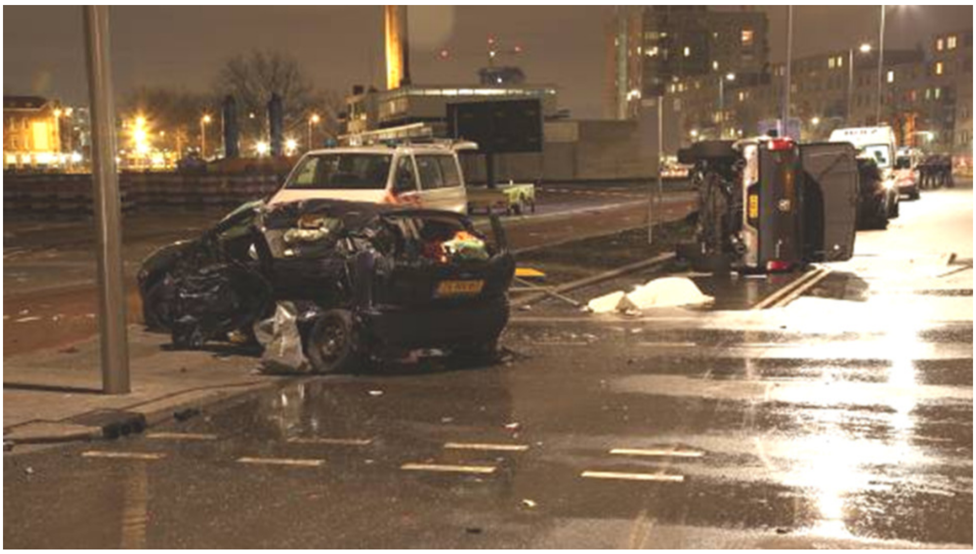


Figure 1 Typical Road Traffic Accident Scene (euDARTS)

Figure 2 Vehicle Impact Absorption – Leading to Reduced Occupant's Injuries (Peugeot Ireland)

The Modern Motor Vehicle to the Rescue

New vehicle research and development is a comprehensive process. During the design of pre-production models the motor vehicle manufacturer engages in extensive crash testing analysis of the proposed launch vehicle. It is at this stage that any modifications necessary are made to the vehicle structure and its passive safety systems.

These crash tests are initially performed in a virtual computerised environment and then, finally, on an actual vehicle at the manufacturer's safety facility [6]. Engineers from the vehicle manufacturer evaluate the collision data from their own in-house tests and from actual accidents recorded by accident researchers, scientists and police. The authors of this paper are all members of such a group, the Data Analysis Research Training & Service association (euDARTS).

Since the advent of the new millennium, there has been an exponential rise in the number of computer-based functions embedded in the modern automobile [7]. State-of-the-art electronics, digital networking and advanced communications systems have ensured that the modern passenger car owner enjoys advanced information and entertainment systems with satellite navigation now even becoming available as an option even on entry level models.

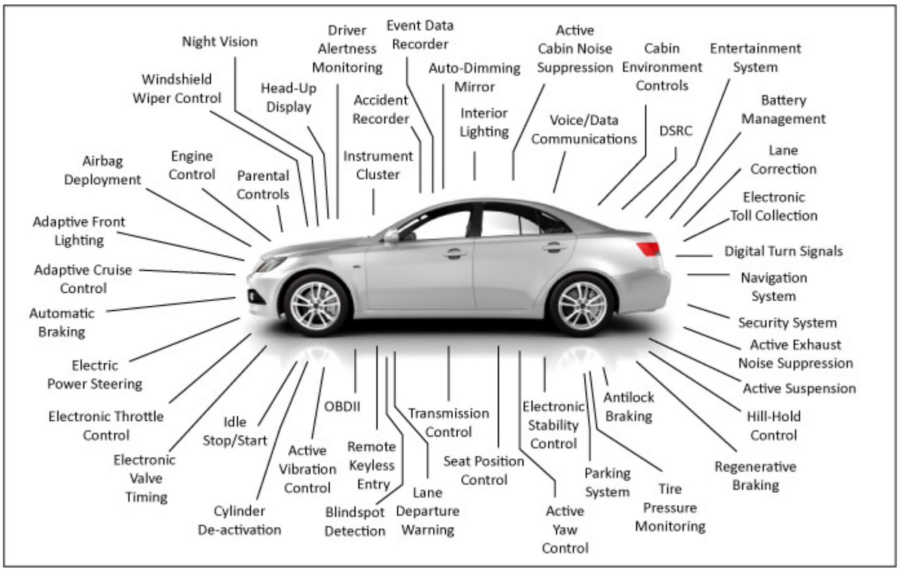


Figure 3 Automotive Electronic Systems (Clemson University)

The Global Positioning System

The Global Positioning System (GPS) is a satellite-based navigation system constituting a network of 24 satellites, which are evenly distributed over six orbits at an altitude of approximately 20,000 kilometres above the surface of the earth [8]. The satellites each circle the earth once every 12 hours. This ensures that theoretically, every point on the earth has radio contact with at least four satellites at any given time.

These aforementioned satellites at intervals of one millisecond, radio earthwards, their unique identification code, position and a high-precision clock timing signal. The GPS receiver in the vehicle's Radio Navigation System receives this satellite data and calculates how long the data transmission took by comparing the timing signal with its internal high-precision clock. If the navigation computer receives data from at least three satellites, it is able to calculate the position of the vehicle [8] with a high degree of accuracy (Triangulation).

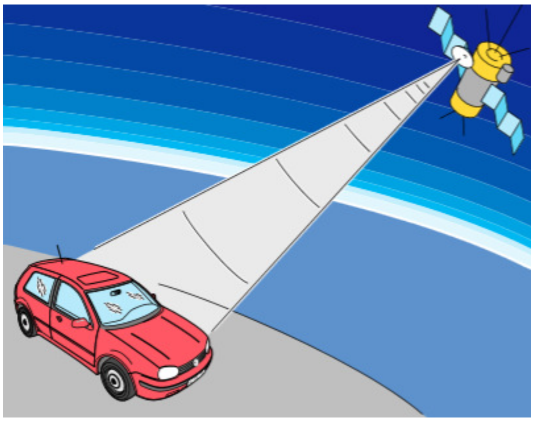


Figure 4 GPS Radio Navigation System (Volkswagen AG)

Telematics

As previously noted, even entry level new vehicles are offered with a wide range of optional equipment such as - GPS navigation, integrated hands-free cell phones, wireless safety communications, automatic driving assistance systems and *Telematics* among others.

The latter is the blending of the micro-controllers for these vehicular systems with wireless telecommunications technologies. The primary goal being the efficient conveyance of vehicular information over vast communication networks to improve a host of social/business functions or government-related public services. *Telematics*, therefore, is a convenient way of monitoring the location, movements, status and behaviour of a vehicle [9].

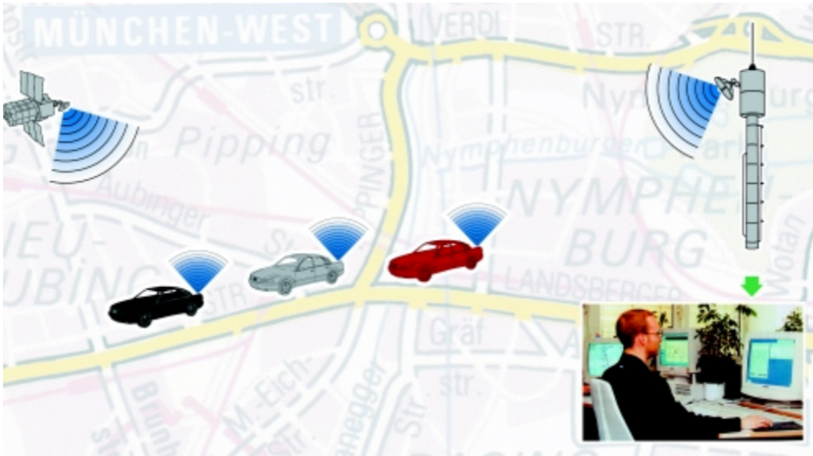
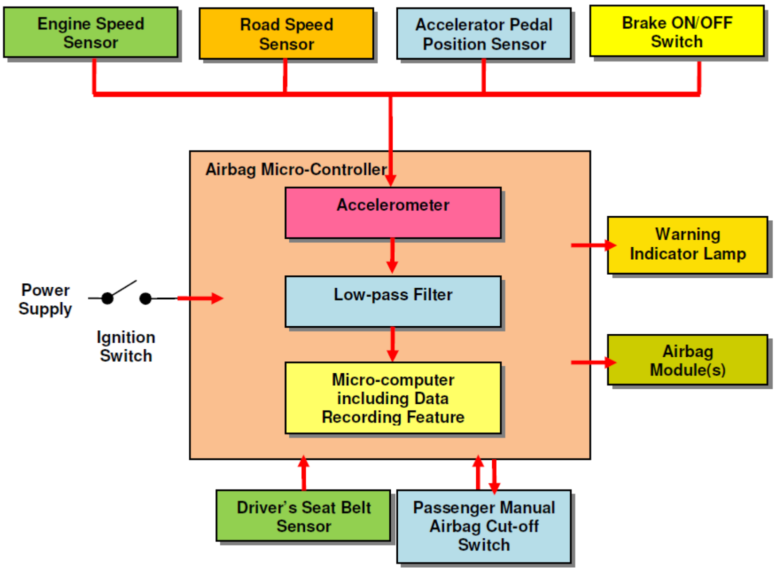


Figure 4 Overview of a Telematic Network (Volkswagen AG)

The Airbag Control Module

The Airbag Control Module (ACM) is a special function micro-controller, which comprises the acceleration sensor(s), capacitors (to ensure sufficient power to deploy pyrotechnics if interrupted), the evaluation electronics, the Event Data Recorder (EDR) and the diagnostic unit. The ACM is typically installed on or close to the centre tunnel in the front floor area of the vehicle. This centralised-interior location offers maximum protection for the ACM, whilst facilitating the easy laying of wiring and providing optimum alignment of sensors (angular acceleration measurement) or the Supplementary Restraint System [10].



The ACM constantly monitors the relevant parameters related to the vehicle operation before during and after a collision such as: rate of deceleration (Δv), road speed, brake pedal and throttle positions, seat belt fastened status, steering operation etc. [11]. The EDR function gives the ACM a crash recording capability quite similar to an aircraft's "black box" but without the cabin audio (voice) capability [12].

Figure 5 Schematic of an Airbag Control Module (James Long)

Advanced Remote Field Triage of Car Crash Victims

According to Microsoft's Bill Gates, "… the tools and technology of the digital age give us a way to easily obtain, share, and act on information in new and remarkable ways." [13]

Changes in automobile manufacturing methods and electronics technology take place rapidly in the motor industry. Micro-controllers, for many years, have formed the heart of numerous control systems found on motor vehicles [14].

As vehicle systems have evolved, it has become evident that there is a great deal of electronic and computing technology that is common to many other vehicle electronic systems. Consequently, increasing numbers of vehicular control units are being integrated within synergistic networks [15]. By connecting an automobile's computers together on this communication network, vehicle data can be easily shared back and forth [12]. This is the basis for our thesis, which we shall set out as follows:

> When an *equipped vehicle* becomes involved in an accident, EDR data from the ACM is shared along its communication network. The vehicle's phone/telematic control unit acts on this collision data and relays same to the Telematics Service Provider (TSP) – e.g. OnStar, ATX, etc.
>
> TSP evaluates the incoming data package, by comparing its crash data with an injuries database, and if necessary, notifies the Emergency Services and forwards them same.
>
> The data package will contain the vehicle's exact GPS location (from the Radio Navigation System) and the crash severity (from the EDR).
>
> The injuries database is constantly updated from information received from hospital A&E departments and collision data retrieved from the *associated vehicle(s)*.

Figure 6 Possible Use of Vehicle Data to Diagnose the Extent of a Patient's Injuries (The Car Doctor)

Conclusion

The global telematics market is poised to grow exponentially in the future, with approximately 104 million new cars expected to have some form of connectivity by 2025 [16].

The technical features of the telematic system, presented in this paper, show that the "tracking assist function" supports the detection of a vehicle, which expedites the recovery of crash victims by the ambulance services – no erroneous directions or getting lost en route.

Conveyed EDR data, when compared to an injuries database, will ensure that the *Call Dispatcher* selects the *best possible Emergency Medical Technicians* for the ambulance crew in order to provide the baseline level of pre-hospital emergency care to the casualty. The *Call Dispatcher* can also put the most suitable Trauma Centre "on notice" for receipt of the casualty.

The Call Dispatcher can also use the collision data to coordinate with other supporting emergency services (e.g. police, fire services, vehicle recovery, local authorities, etc.) to effect proper crash scene management systems.

Trauma Centres and Collision Data Retrieval specialists will have to works hand-in-hand with each other to keep the injuries database updated.

As you have seen, Telematic Triage is potentially a huge life-saving/enhancing feature, as it allows casualties to be triaged at the accident scene and the selection of the most appropriate medical response. Naturally, we feel that there is great potential for vehicle telematics, in this as yet untapped market, to more accurately guide trauma triage decisions for the near future.

References

[1] Sasser, S., Varghese, M., Joshipura, M., & Kellermann, A. (2006) *Preventing death and disability through the timely provision of prehospital trauma care. WHO Bulletin [serial on the Internet]. 2006 Jul; 84(7)*: Available at: http://www.who.int/bulletin/volumes/84/7/editorial20706html/en/print.html. [Accessed 19 September 2008].

[2] U.S. Department of Health and Human Services (2008) *Recommendations from the Expert Panel: Advanced Automatic Collision Notification and Triage of the Injured Patient*. Atlanta: Centers for Disease Control and Prevention.

[3] National Clinical Programme for Trauma and Orthopaedic Surgery (2015) *National Model of Care for Trauma and Orthopaedic Surgery (Draft)*. Dublin: Health Service Executive.

[4] Health Information and Quality Authority (2014) *Review of pre-hospital emergency care services to ensure high quality in the assessment, diagnosis, clinical management and transporting of acutely ill patients to appropriate healthcare facilities*. Dublin: Health Information and Quality Authority.

[5] American College of Surgeons (2008) *Advanced Trauma Life Support Program for Doctors*. United States of America: American College of Surgeons.

[6] Audi Service Training (2011) *SSP 605: Audi Occupant Protection – Passive Systems II: Audi Pre-Sense*. Germany: Audi AG.

[7] Daniels, J. (2001) *Modern Car Technology*. Sparkford: Haynes Publishing Ltd.

[8] Volkswagen/Audi Service Training (1998) *SSP 199: The Radio Navigation System*. Germany: Volkswagen AG.

[9] Audi Service Training (1999) *SSP 236: Audi Telematics – Sprach Bedienungssystem*. Germany: Audi AG.

[10] Volkswagen Service Training (1992) *SSP 152: Airbag in Volkswagen*. Germany: Volkswagen AG.

[11] Long, J. (2012) *The Use of Event Data Recorder Technology for Forensic Road Traffic Accident Analysis*. Published BSc Thesis. Dublin Institute of Technology.

[12] Halderman J. (2012) *Automotive Technology: Principles, Diagnosis and Service*. 4th Edition. New Jersey: Prentice Hall.

[13] Gates, W. (1999) *Business @ the Speed of Thought: Using a Digital Nervous System*. United States of America: Warner Books.

[14] Bonnick, A. (2001) Automotive Computer Controlled Systems: Diagnostic tools and techniques. Oxford: Butterworth-Heinemann.

[15] Bosch (1996) *Automotive Handbook*. 4th Edition. Germany: Robert Bosch GmbH.

[16] Ernst & Young (2013) *The Quest for Telematics 4.0: Creating sustainable value propositions supporting car-web integration*. United Kingdom: Ernst & Young Global Limited.

[17] EURO NCAP [Online] Available: http://www.euroncap.com/home.aspx [Accessed 2 March 2011].