International Journal On Engineering Technology and Sciences – IJETS™
ISSN(P): 2349-3968, **ISSN (O):** 2349-3976
Volume I, Issue VI, OCT - 2014

AN AUTONOMOUS PEOPLE FRIENDLY INTELLIGENT TRANSPORTATION SYSTEM

***N.Mathiarasi*[#1], *T.Sureshkumar*[*2]**

[#]*PG Scholar, Nandha College of Technology*
Erode, Tamilnadu, India
[1]*mathiarasi13@gmail.com*
[*]*Assistant Professor, Nandha College of Technology*
Erode,Tamilnadu,India
[2]*sureshkumartt@gmail.com*

Abstract—*New communication technologies integrated into modern vehicles offer an opportunity for better assistance to people injured in traffic accidents. Recent studies show how communication capabilities should be supported by artificial intelligence systems capable of automating many of the decisions to be taken by emergency services, thereby adapting the rescue resources to the severity of the accident and reducing assistance time. To improve the overall rescue process, a fast and accurate estimation of the severity of the accident represent a key point to help emergency services better estimate the required resources. This paper proposes a novel intelligent system which is able to automatically detect road accidents, notify them through vehicular networks, and estimate their severity based on the concept of data mining and knowledge inference. Our system considers the most relevant variables that can characterize the severity of the accidents (variables such as the vehicle speed, the type of vehicles involved, the impact speed, and the status of the airbag). Results show that a complete Knowledge Discovery in Databases (KDD) process, with an adequate selection of relevant features, allows generating estimation models that can predict the severity of new accidents. We develop a prototype of our system based on off-the-shelf devices and validate it at the Applus+ IDIADA Automotive Research Corporation facilities, showing that our system can notably reduce the time needed to alert and deploy emergency services after an accident takes place.*

I. INTRODUCTION

During the last decades, the total number of vehicles in our roads has experienced a remarkable growth, making traffic density higher and increasing the drivers' attention requirements. The immediate effect of this situation is the dramatic increase of traffic accidents on the road, representing a serious problem in most countries. As an example, 2,478 people died in Spanish roads in 2010, which means one death for every 18,551 inhabitants [1], and 34,500 people in the whole European Union died as a result of a traffic accident in 2009 [2]. To reduce the number of road fatalities, vehicular networks will play an increasing role in the *Intelligent Transportation Systems* (ITS) area. Most ITS applications, such as road safety, fleet management, and navigation, will rely on data exchanged between the vehicle and the roadside infrastructure (V2I), or even directly between vehicles (V2V) [3]. The integration of sensoring capabilities on-board of vehicles, along with peer-to-peer mobile communication among vehicles, forecast significant improvements in terms of safety in the near future.

Before arriving to the zero accident objectives on the long term, a fast and efficient rescue operation during the hour following a traffic accident (the so-called *Golden Hour* [4]) significantly increases the probability of survival of the injured, and reduces the injury severity. Hence, to maximize the benefits of using communication systems between vehicles, the infrastructure should be supported by intelligent systems capable of estimating the severity of accidents, and automatically deploying the actions required, thereby reducing the time needed to assist injured passengers. Many of the manual decisions taken nowadays by emergency services are based on incomplete or inaccurate data, which may be replaced by automatic systems that adapt to the specific characteristics of each accident. A preliminary assessment of the severity of the accident will help emergency services to adapt the human and material resources to the conditions of the accident, with the consequent assistance quality improvement [5]. In this paper, we take advantage of the use of vehicular networks to collect precise information about road accidents that is then used to estimate the severity of the collision. We propose estimation based on data mining classification algorithms, trained using historical data about previous accidents. Our proposal does not focus on directly reducing the number of accidents, but on improving post collision assistance. The rest of the paper is organized as follows: Section 2 presents the architecture of our proposed automatic system to improve accident assistance. Sections 3, 4, and 5 provide details of our Knowledge Discovery in Databases (KDD) model adapted to the traffic accidents domain.

II. OUR PROPOSAL

Our approach collects information available when a traffic accident occurs, which is captured by sensors installed onboard the vehicles. The data collected are structured in a packet, and forwarded to a remote Control Unit through a combination of V2V and V2I wireless communication.

Based on this information, our system directly estimates the accident severity by comparing the obtained data with information coming from previous accidents stored in a database.

This information is of utmost importance, for example, to determine the most suitable set of resources in a rescue operation. Since we want to consider the information obtained just when the accident occurs, to estimate its severity immediately, we are limited by the data automatically retrievable, omitting other information, e.g., about the driver's degree of attention, drowsiness, etc.

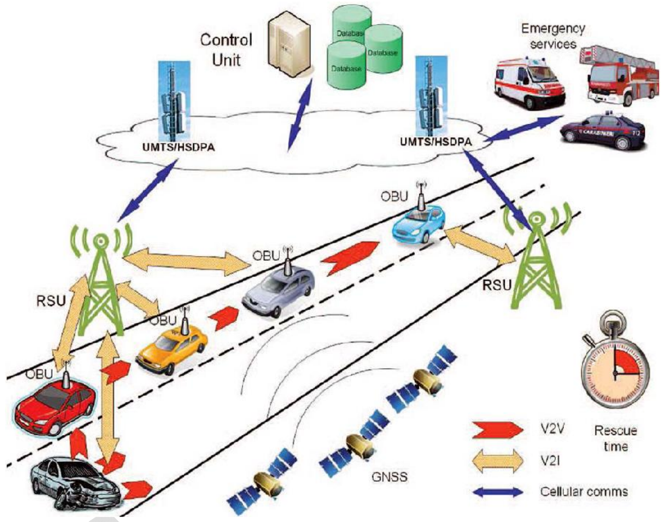

Fig 1 Architecture of our proposed system for automatic accident

III. ARCHITECTURE OVERVIEW

Fig. 1 presents the overview of the vehicular architecture used to develop our system. The proposed system consists of several components with different functions. Firstly, vehicles should incorporate an On-Board unit (OBU) responsible for: (i) detecting when there has been a potentially dangerous impact for the occupants, (ii) collecting available information coming from sensors in the vehicle, and (iii) communicating the situation to a Control Unit (CU) that will accordingly address the handling of the warning notification. Next, the notification of the detected accidents is made through a combination of both V2V and V2I communications. Finally, the destination of all the collected information is the Control Unit; it will handle the warning notification, estimating the severity of the accident, and communicating the incident to the appropriate emergency services.

The OBU definition is crucial for the proposed system. This device must be technically and economically feasible, as its adoption in a wide range of vehicles could become massive in a near future. In addition, this system should be open to future software updates. Although the design of the hardware to be included in vehicles initially consisted of special-purpose systems, this trend is heading towards general-purpose systems because of the constant inclusion of new services. The information exchange between the OBUs and the CU is made through the Internet, either through other vehicles acting as Internet gateways (via UMTS, for example),or by reaching infrastructure units (Road-Side Units, RSU) that provide this service. If the vehicle does not get direct access to the CU on its own, it can generate messages to be broadcast by nearby vehicles until they reach one of the aforementioned communication paths. These messages, when disseminated among the vehicles in the area where the accident took place, also serve the purpose of alerting drivers traveling to the accident area about the state of the affected vehicle, and its possible interference on the normal traffic flow [6]. Our proposed architecture provides: (i) direct communication between the vehicles involved in the accident, (ii) automatic sending of a data file containing important information about the accident to the Control Unit, and (iii) a preliminary and automatic assessment of the damage of the vehicle and its occupants, based on the information coming from the involved vehicles, and a database of accident reports. According to the reported information and the preliminary accident estimation, the system will alert the required rescue resources to optimize the accident assistance.

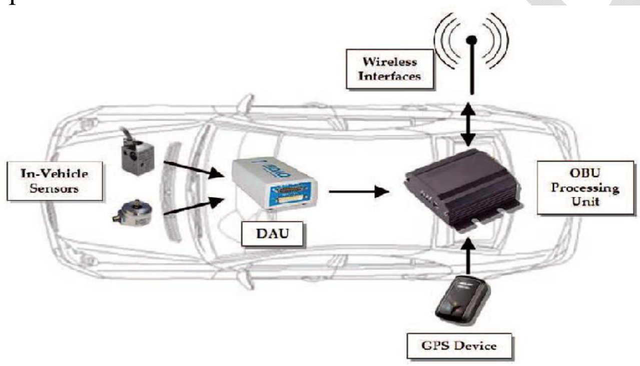

Fig. 2. On-board unit structure diagram.

IV. ON-BOARD UNIT STRUCTURE

The main objective of the proposed OBU lies in obtaining the available information from sensors inside the vehicle to determine when a dangerous situation occurs, and reporting that situation to the nearest Control Unit, as well as to other nearby vehicles that may be affected. Fig. 2 shows the OBU system, which relies on the interaction between sensors, the data acquisition unit, the processing unit, and wireless interfaces:

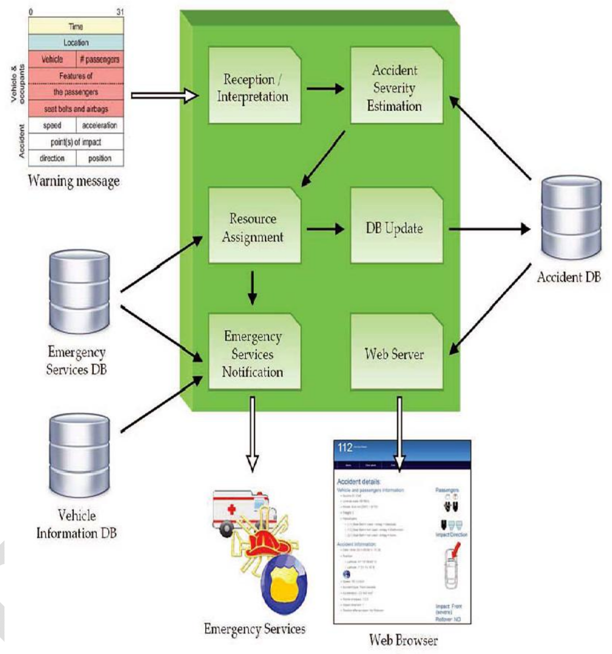

Fig. 3. Control unit modular structure.

In-vehicle sensors. They are required to detect accidents and provide information about its causes. Accessing the data from in-vehicle sensors is possible nowadays using the On-Board Diagnostics (OBD) standard interface [7], which serves as the entry point to the vehicle's internal bus. This standard is mandatory in Europe and USA since 2001. This encompasses the majority of the vehicles of the current automotive park, since the percentage of compatible vehicles will keep growing as very old vehicles are replaced by new ones. Data Acquisition Unit (DAU). This device is responsible for periodically collecting data from the sensors available in the vehicle (airbag triggers, speed, fuel levels, etc.), converting them to a common format,
and providing the collected data set to the OBU Processing Unit.
OBU Processing Unit. It is in charge of processing the data coming from sensors, determining whether an accident occurred, and notifying dangerous situations to nearby vehicles, or directly to the Control Unit. The information from the DAU is gathered, interpreted and used to determine the vehicle's current status. This unit must also have access to a positioning device (such as a

GPS receiver), and to different wireless interfaces, thereby enabling communication between the vehicle and the remote control center.

V. KDD APPROACH

The KDD approach can be defined as the nontrivial process of identifying valid, novel, potentially useful, and understandable patterns from existing data [8]. The KDD process begins with the understanding of the application specific domain and the necessary prior knowledge. After the acquisition of initial data, a series of phases are performed:

1) Selection: This phase determines the information sources that may be useful, and then it transforms the data into a common format.
2) Preprocessing: In this stage, the selected data must be cleaned (noise reduction or modeling) and preprocessed (missing data handling).
3) Transformation: This phase is in charge of performing a reduction and projection of the data to find relevant features that represent the data depending on the purpose of the task.
4) Data mining: This phase basically selects mining algorithms and selection methods which will be used to find patterns in data.
5) Interpretation/Evaluation: Finally, the extracted patterns must be interpreted. This step may also include displaying the patterns and models, or displaying the data taking into account such models.

VI. PROTOTYPE IMPLEMENTATION AND VALIDATION

To test the correctness of the proposed design, a prototype was built using low cost off-the-shelf devices. We measured the capacity of the system for correctly detecting and notifying the accident to the Control Unit, and the generation of appropriate severity estimations from the collected data.

VII. PROTOTYPE DEVELOPMENT

The Data Acquisition Unit of the OBU was built using an ARM microcontroller, programmed to periodically collect data from in-vehicle sensors. Basically, these sensors are accelerometers and gyroscopes that indicate the severity of the impacts received by the automobile or the occurrence of a rollover that might endanger the integrity of the occupants. Communication between the microcontroller and the Processing Unit is done by sending UDP packets through an Ethernet interface. The OBU Processing Unit in our prototype is a general-purpose Asus Eee PC netbook, equipped with a solid state disk (SSD) to minimize the possibility of damage due to impact in crash tests. The vehicle position and speed are obtained using a GPS device accessible using Bluetooth.

The Control Unit prototype for the initial tests was built using common software components, allowing fast prototyping with little cost. The reception/interpretation module was implemented using the Java programming language. This module acts as a concurrent server, creating different execution threads to handle each message received, which allows exploiting multiprocessor or multicomputer architectures. Databases are managed using the MySQL relational database management system. MySQL was selected because of its scalability and easy integration with the additional components of the Control Unit. The Web server for the visualization module is Apache. To support dynamic content, we use the PHP (Hypertext Preprocessor) technology, which is easily integrated into Apache. By combining these technologies and MySQL, users can visually check the system status.

VIII. PROTOTYPE VALIDATION

The prototype was validated at the Applus+ IDIADA [23] Passive Security Department facilities in Santa Oliva (Tarragona, Spain). These facilities house one of the most sophisticated crash test laboratories in the world, and constitute an official center for approval under the Euro NCAP program. Due to the cost of using real vehicles in the collision experiments, the e-NOTIFY prototype tests were performed using a platform (known as "sled") that moves on rails in order to collide against a series of metal bars that simulate the deformation suffered by a vehicle body to absorb the impact.

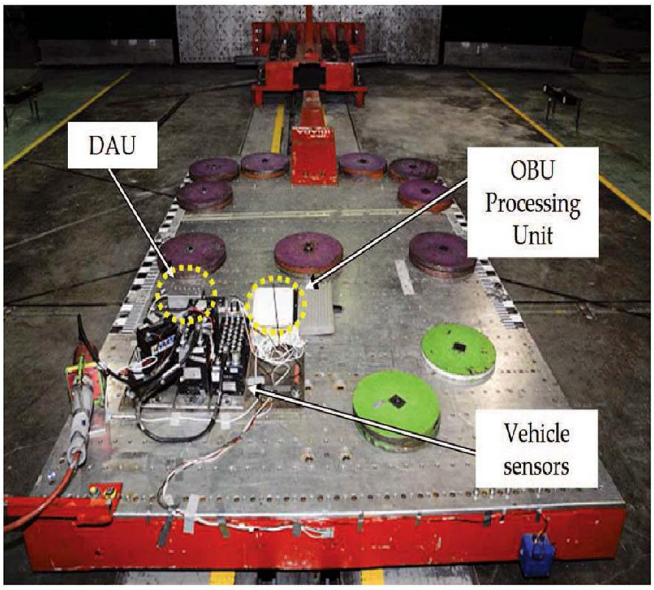

Fig 4 Sled with the prototype installed before a crash detection test.

IX. CONCLUSION

The new communication technologies integrated into the automotive sector offer an opportunity for better assistance to people injured in traffic accidents, reducing the response time of emergency services, and increasing the information they have about the incident just before starting the rescue process. To this end, we designed and implemented a prototype for automatic accident notification and assistance based on V2V and V2I communications. However, the effectiveness of this technology can be improved with the support of intelligent systems which can automate the decision making process associated with an accident. A preliminary assessment of the severity of an accident is needed to adapt resources accordingly. This estimation can be done by using historical data from previous accidents using a Knowledge Discovery in Databases process. Most of the existing work focused on data mining in traffic accidents is based on data sets where a very limited preprocessing and transformation were performed. After a careful selection of relevant attributes, we showed that the vehicle speed is a crucial factor in front crashes, but the type of vehicle involved and the speed of the striking vehicle are more important than speed itself in side and rear-end collisions. The status of the airbag is also very useful in the estimation, since situations where it was not necessary to deploy the airbag rarely produce serious injuries to the passengers. The studied classification algorithms do not show remarkable differences, but we demonstrate that, if we are able to classify the accidents depending on the types of impacts, we can noticeably increase the accuracy of the system, especially for front crashes where the vehicle is usually the striking one. To this end, we developed a prototype that shows how inter-vehicle communications can make accessible the information about the different vehicles involved in an accident. Moreover, the positive result achieved on the real tests indicates that the accident detection and severity estimation algorithms are robust enough to allow a mass deployment of the proposed system.

REFERENCES

[1] [Dirección General de Tráfico (DGT). (2010). *The Main Statistics of Road Accidents Spain* [Online]. Available: http://www.dgt.es/portal/es/seguridad_vial/estadistica

[2] Eurostat: Statistical Office of the European Communities. (2012) *Transport Statistics in the EU* [Online]. Available: http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/ data/main_tables

[3] J. Miller, "Vehicle-to-vehicle-to-infrastructure (V2V2I) intelligent transportation system architecture," in *Proc. IEEE Intell. Veh. Symp.*, Eindhoven, Netherlands, Jun. 2008, pp. 715–720.

[4] F. Martinez, C.-K. Toh, J.-C. Cano, C. Calafate, and P. Manzoni, "Emergency services in future intelligent transportation systems based on vehicular communication networks," *IEEE Intell. Transp. Syst. Mag.*, vol. 2, no. 2, pp. 6–20, Oct. 2010.

[5] M. Fogue *et al.*, "Prototyping an automatic notification scheme for traffic accidents in vehicular networks," in *Proc. 4th IFIP WD*, Niagara Falls, ON, Canada, Oct. 2011.

[6] M. Fogue *et al.*, "Evaluating the impact of a novel message dissemination scheme for vehicular networks using real maps," *Transp.*

Res. Part C: Emerg. Technol., vol. 25, pp. 61–80, Dec. 2012.

[7] B&B Electronics. (2012). *The OBD-II Home Page* [Online]. Available: http://www.obdii.com

[8] U. Fayyad, G. Piatetsky-Shapiro, and P. Smyth, "The KDD process for extracting useful knowledge from volumes of data," *Commun. ACM*, vol. 39, pp. 27–34, Nov. 1996.

[9] M. Hall *et al.,* "The WEKA data mining software: An update," *SIGKDD Explor.*, vol. 11, pp. 10–18, Nov. 2009.

[10] European New Car Assessment Programme (Euro NCAP). (2012) *Test Procedures* [Online]. Available: http://www.euroncap.com/testprocedures.aspx

[11] Nat. Hwy. Traffic Safety Admin. (NHTSA). (2012). *National Automotive Sampling System (NASS) and General Estimates System (GES)* [Online]. Available: http://www.nhtsa.gov/NASS/

[12] Nat. Hwy. Traffic Safety Admin. (NHTSA). (2012). *FTP Site for the General Estimates System (GES)* [Online]. Available: ftp://ftp.nhtsa.dot.gov/GES/

[13] [13] K. Yu and E. Dutkiewicz, "Geometry and motion-based positioning algorithms for mobile tracking in NLOS environments," *IEEE Trans. Mobile Comput.*, vol. 11, no. 2, pp. 254–263, Feb. 2012.

[14] M. Hall, "Correlation-based feature selection for machine learning," Ph.D. dissertation, Dept. Comput. Sci., Univ. Waikato, Hamilton, New Zealand, 2008.

[15] R. Kohavi and G. H. John, "Wrappers for feature subset selection," *Artif. Intell.*, vol. 97, pp. 273–324, Dec. 1997.

[16] J. R. Quinlan, *C4.5: Programs For Machine Learning*. San Francisco, CA, USA: Morgan Kaufmann Publishers, Inc., 1993.

[17] G. F. Cooper and E. Herskovits, "A Bayesian method for the induction of probabilistic networks from data," *Mach. Learn.*, vol. 9, pp. 309–347, Oct. 1992.

[18] J. C. Platt, *Fast Training of Support Vector Machines Using Sequential Minimal Optimization*. Cambridge, MA, USA: MIT Press, 1999, pp. 185–208.

[19] T. Fawcett, "ROC graphs: Notes and practical considerations for researchers," HP Labs, Palo Alto, CA, USA, Tech. Rep. HPL-2003-4, 2004.

[20] P. Bradley, "The use of the area under the ROC curve in the evaluation of machine learning algorithms," *Pattern Recognit.*, vol. 30, no. 7, pp. 1145–1159, 1997.

[21] SAE Int. (2010). *DSRC Implementation Guide – A Guide to Users of SAE J2735 Message Sets Over DSRC* [Online].

[22] M. Modsching, R. Kramer, and K. Hagen, "Field trial on GPS accuracy in a medium size city: The influence of built-up," in *Proc. 3rd WPNC*, Hannover, Germany, Mar. 2006, pp. 209–218.

[23] IDIADA: Instituto de Investigación Aplicada del Automóvil. (2012). *Applus+ IDIADA Web Site* [Online]. Available: http://www.idiada.es

[24] U.S. Dept. Transp.– Research and Innovative Technology Administration (RITA). (2012). *Safety Pilot Program Overview* [Online]. Available: http://www.its.dot.gov/safety_pilot/

[25] Amoroso, G. Marfia, M. Roccetti, and G. Pau, "To live and drive in L.A.: Measurements from a real intervehicular accident alert test," in *Proc. IEEE WCNCW*, Paris, France, Apr. 2012, pp. 328–332.

[26] H.-S. Shin, S.-J. Jung, J.-J. Kim, and W.-Y. Chung, "Real time car driver's condition monitoring system," in *Proc. IEEE Sensors*, Kona, HI, USA, Nov. 2010, pp. 951–954.

[27] E. Palantei *et al.,* "A 2.5 GHz wireless ECG system for remotely monitoring heart pulses," in *Proc. IEEE APSURSI*, Chicago, IL, USA, Jul. 2012, pp. 1–2.

[28] S. Jung, H. Shin, J. Yoo, and W. Chung, "Highly sensitive driver condition monitoring system using nonintrusive active electrodes," in *Proc. IEEE ICCE*, Las Vegas, NV, USA, Jan. 2012, pp. 305–306.

[29] T. Beshah and S. Hill, "Mining road traffic accident data to improve safety: Role of road-related factors on accident severity in ethiopia," in *Proc. AAAI AI-D*, Stanford, CA, USA, Mar. 2010.

[30] T. B. Tesema, A. Abraham, and C. Grosan, "Rule mining and classification of road accidents using adaptive regression trees," *IJSSST*, vol. 6, no. 10–11, pp. 80–94, 2005.

[31] S. Sohn and H. Shin, "Pattern recognition for road traffic accident severity in Korea," *Ergonomics*, vol. 44, no. 1, pp. 107–117, Jan. 2001.

[32] S. Y. Sohn and S. H. Lee, "Data fusion, ensemble and clustering to improve the classification accuracy for the severity of road traffic accidents in Korea," *Safety Sci.*, vol. 41, no. 1, pp. 1–14, 2003.

[33] M. Chong, A. Abraham, and M. Paprzycki, "Traffic accident analysis using machine learning paradigms," *Informatica*, vol. 29, no. 1, pp. 89–98, 2005.

[34] T. K. Anderson, "Kernel density estimation and K-means clustering to profile road accident hotspots," *Accident Anal. Prev.*, vol. 41, no. 3, pp. 359–364, 2009.

[35] R. Nayak, D. Emerson, J. Weligamage, and N. Piyatrapoomi, "Road crash proneness prediction using data mining," in *Proc.14th Int. Conf. EDBT*, New York, NY, USA, 2011, pp. 521–526.