A Novel System for Severity Estimation of Automotive Accident with Automatic Notification

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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. 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). 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. our system can notably reduce the time needed to alert and deploy emergency services after an accident takes place.

***Index Terms* — KDD, Microcontroller, vehicular networks, traffic accident assistance.**

I. INTRODUCTION

During the last decades, the total number of vehicle 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].

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) [2]. 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 objective on the long term, a fast and efficient rescue operation during The hour following a traffic accident (the so-called *Golden Hour* [3]) significantly increases the probability of survival of the injured, and reduces the injury severity. Hence, to maximize t he 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 [4]. The authors in [5] propose a condition monitoring system to obtain physiological signals for car driver's health condition monitoring by means of ECG and PPG (Photoplethysmogram) sensors attached to the steering wheel. The signals concerning heart rate are transmitted to a server PC via a Personal Area Network (PAN) for practical tests, being analyzed to detect drowsiness and fatigue. The results obtained from this system could be used to inform nearby vehicles about a dangerous driver status, but the system does not include notification of abnormal statuses since only a PAN is considered. Palantei *et al*. [6] designed a wireless system for remotely monitoring heart pulses obtained from ECG sensors. This system allows communication of the monitoring information 50 to 250 meters far from the person, but it is not indicated how the signal is processed to classify the status of the person. We propose to develop a complete KDD process, starting by selecting a useful data source containing instances of previous accidents. The data collected will be structured and preprocessed to ease the work to be done in the transformation and data mining phases. The final step will consist on interpreting the results, and assessing their utility for the specific task of estimating the severity of road accidents. The phases from the KDD process will be performed using the open-source Weka collection, which is a set of machine learning algorithms [8]

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 an 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.

II. SYSTEM STRUCTURE

A . PROPOSED SYSTEM

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.

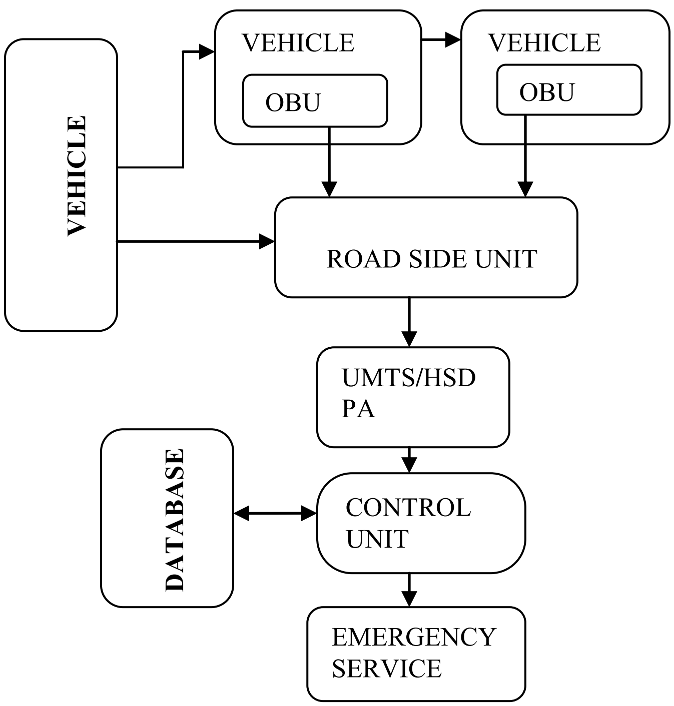


Fig.1. architecture of proposed system for automatic accident notification

1)ON-BOARD UNIT: 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. The OBU system, which relies on the interaction between sensors, the data acquisition unit, the processing unit, and wireless interfaces. 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 a fore mentioned communication paths. These messages, when disseminated among the vehicles in the area where the accident took place , also serve the purpose of alerting drivers travelling to the accident area about the state of the affected vehicle, and its possible interference on the normal traffic flow.

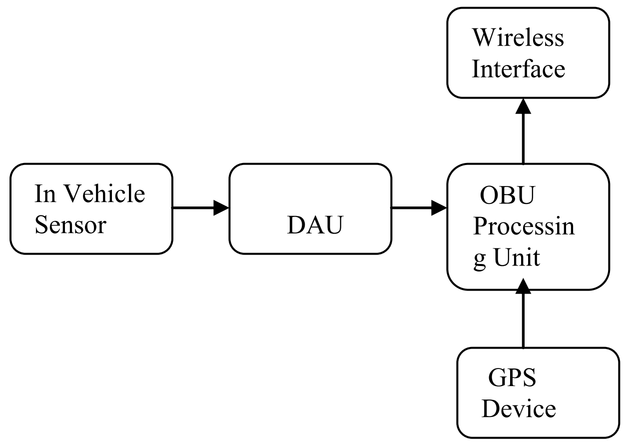


Fig.2. on-board unit

2) CONTROL UNIT: The Control Unit (CU) is associated to the response center in charge of receiving notifications of accidents from the OBUs installed in vehicles. In particular, the Control Unit Is responsible for dealing with warning messages, retrieving information from them, and notifying the emergency services about the conditions under which the accident occurred. One of the most important modules in the Control Unit is in charge of the Accident Severity Estimation, i.e., providing a relative measure of the potential effect of the collision on the integrity of the vehicles and people involved. To obtain this estimation, we make use of historical information about previous accidents contained in an existing database, through a process of Knowledge Discovery in Database (KDD).

*3)UMTS/HSDPA:*Universal Mobile Telecommunications System (UMTS). It is a third mobile cellular system . UMTS supports maximum theoretical data transfer rates of 42 Mbit/s.High-Speed data Packet Access (HSDPA) HSDPA enables downlink transfer speeds of up to 21 Mbit/s. Work is also progressing on improving the uplink transfer speed with the High-Speed Uplink Packet Access (HSUPA).

4. DATABASE: Database update module. The data collected from the notified accident are stored into the existing database of previous accidents, increasing the knowledge about the accident domain. The collected data is compared with the previous data to analyse the severity and to make an immediate action.

III. PROTOTYPE IMPLEMENTATION AND DESIGN

The data acquisition unit of the OBU was built using microcontroller programmed periodically to collect the information from the sensors .Basically these sensors are used accelerometer ,force resistive sensor, vibrational sensor ,power supply and gps as shown in fig 2.when an accident occurs, given three sensors collect the information's of severity of the accident and the gps is used to detect the position of the vehicle after that the information's are given to the microcontroller. the data collected are structured into packets and are forwarded through zigbee

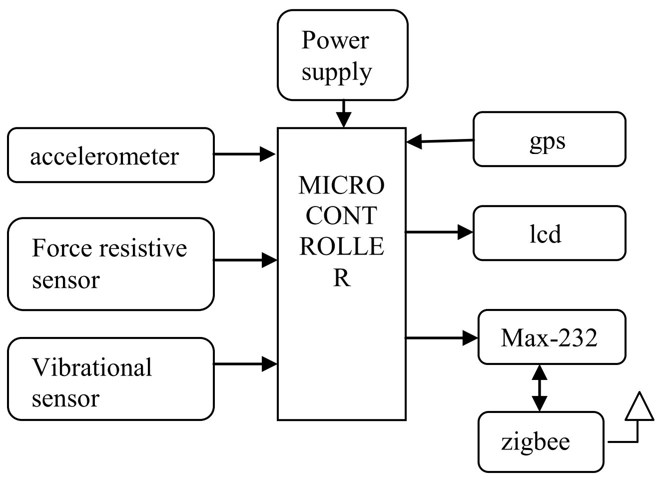


Fig.3. microcontroller based system

1)MICROCONTROLLER: The PIC16F877A microcontroller is a single-chip computer. Micro suggests that the device is small, and controller suggests that it is used in control applications. Another term for microcontroller is embedded controller, since most of the microcontrollers are built into (or embedded in) the devices they control. A microprocessor differs from a microcontroller in a number of ways. The main distinction is that a microprocessor requires several other components for its operation, such as program memory and data memory, input-output devices, and an external clock circuit. A microcontroller, on the other hand, has all the support chips incorporated inside its single chip. All microcontrollers operate on a set of instructions (or the user program) stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations.

Microcontrollers have traditionally been programmed using the assembly language of the target device. Although the assembly language is fast, it has several disadvantages. An assembly program consists of mnemonics, which makes learning and maintaining a program written using the assembly language difficult. Also, microcontrollers manufactured by different firms have different assembly languages, so the user must learn a new language with every new microcontroller he or she uses. Microcontrollers can also be programmed using a high-level language, such as BASIC, PASCAL, or C. High-level languages are much easier to learn than assembly languages. They also facilitate the development of large and complex programs. In this book we shall be learning the programming of PIC microcontrollers using the popular C language known as mikro C, developed by mikro Elektronika. consist of two 8-bit (TMR0,TMR2) timer/counter with PrescalarOne16-bittimer/counter. Brown-out detection circuitry Parallel Slave Port (PSP): 40/44pin-deviceonly.

Special Microcontroller Features 100,000 erase/write cycle Enhanced Flash Program Memory Typical. Self-reprogrammable under software control. Single-supply 5V In-Circuit Serial Programming. Watchdog Timer (WDT) with its own on-chip RC oscillator Programmable Code Protection Power-Saving Sleeping Mode.

*2)ACCELEROMETER:*An accelerometer is a device that measures proper acceleration ("g-force"). Proper acceleration is not the same as coordinate acceleration (rate of change of velocity). For example, an accelerometer at rest on the surface of the Earth will measure an acceleration g= 9.81 m/s^2 straight upwards. By contrast, accelerometers in free fall orbiting and accelerating due to the gravity of Earth will measure zero. Accelerometers have multiple applications in industry and science. Highly sensitive accelerometers are components of inertial navigation systems for aircraft and missiles. Accelerometers are used to detect and monitor vibration in rotating machinery. Accelerometers are used in tablet computers and digital cameras so that images on screens are always displayed upright. Accelerometers are used in drones for flight stabilisation. Pairs of accelerometers extended over a region of space can be used to detect differences (gradients) in the proper accelerations of frames of references associated with those points. These devices are called gravity gradiometers, as they measure gradients in the gravitational field. Such pairs of accelerometers in theory may also be able to detect gravitational waves. An accelerometer measures proper acceleration, which is the acceleration it experiences relative to freefall and is the acceleration felt by people and objects. Put another way, at any point in spacetime the equivalence principle guarantees the existence of a local inertial frame, and an accelerometer measures the acceleration relative to that frame. Such accelerations are popularly measured in terms of g-force.

3)VIBRATIONAL SENSOR: A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge. Piezoelectric sensors have proven to be versatile tools for the measurement of various processes. They are used for quality assurance, process control and for research and development in many industries. It has been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a tilt sensor in consumer electronics or a pressure sensor in the touch pads of mobile phones. Vibration sensors can also be used to harvest otherwise wasted energy from mechanical vibrations. This is accomplished by using piezoelectric materials to convert mechanical strain into usable electrical energy.

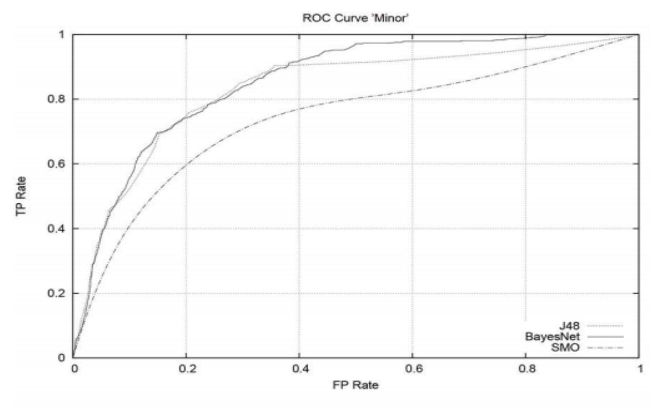
4)GPS: In typical GPS operation, four or more satellites must be visible to obtain an accurate result. The solution of the navigation equations gives the position of the receiver along with the difference between the time kept by the receiver's on-board clock and the true time-of-day, thereby eliminating the need for a more precise and possibly impractical receiver based clock. Applications for GPS such as time transfer, traffic signal timing, and synchronization of cell phone base stations, make use of this cheap and highly accurate timing. Some GPS applications use this time for display, or, other than for the basic position calculations, do not use it at all.Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions such as reusing the last known altitude, dead reckoning, inertial navigation, or including information from the vehicle computer, to give a (possibly degraded) position when fewer than four satellites are visible. Basic GPS measurements yield only a position, and neither speed nor direction. However, most GPS units can automatically derive velocity and direction of movement from two or more position measurements..

*5)ZIGBEE:*ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15 standard. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics,[1] ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi. ZigBee is a low-cost, low-power, wireless mesh network standard targeted at wide development of long battery life devices in wireless control and monitoring applications. Zigbee devices have low latency, which further reduces average current. ZigBee chips are typically integrated with radios and with microcontrollers that have between 60-256 KB flash memory

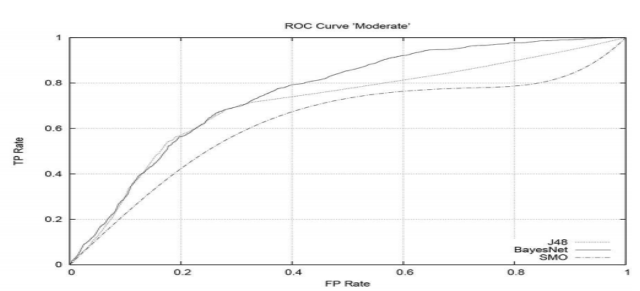
*6)LCD:*A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

IV. RESULT

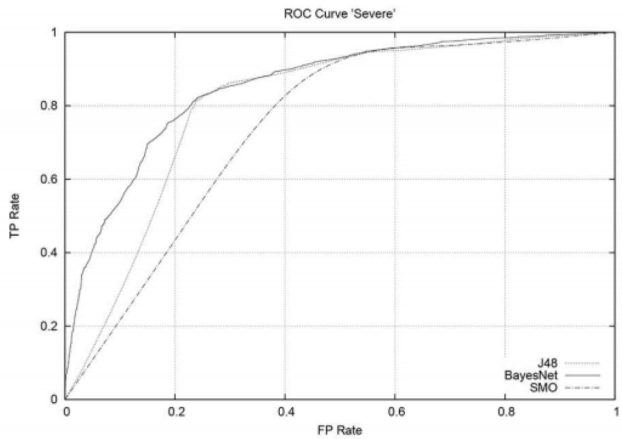
The result shows that, the ROC curves obtained for the three selected classification algorithms when studying accidents and their effect on both the damage on the vehicle and the passenger injuries.



(a)



(b)



(c)

Fig.4. a) Minor damage with no injury . (b)Moderate damage with non-incapacitating injury. (c) Severe damage with fatal injury

V. CONCLUSION

In this paper, we designed and implemented a prototype for automatic accident notification and assistanc 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. Moreover, the positive results 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.

VI. REFERENCES

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