Review on Monitoring Systems of the Road Network

Souad El houssaini *, Abdelmajid Badri
Laboratory of Electronics, Electrotechnics, Automation & Information Processing
Faculty of Sciences and Technology of Mohammedia, University Hassan II Mohammedia-Casablanca, P.O. Box 146, Mohammedia, Morocco
*souad_elhoussaini@yahoo.fr

***Abstract*—The network monitoring is a way to detect quickly and effectively all problems having an impact on the road network and to evaluate them in a structured way. It also helps to allocate resources on the basis of priority in order to address, in timely, the urgent situations and to secure the road to protect other users that could potentially be affected by an incident. Generally, this type of service allows essentially the location of people in distress and need assistance. This paper presents a review and synthesis of current knowledge on geolocation systems, used in the context of the monitoring of the road network, such as emergency call network, embedded system in vehicles and video cameras. We also present our new approach for an intelligent system of management of road safety; this system is a combination of GSM, GPS and Web-GIS to provide an ideal environment for the conception and test of an intelligent surveillance system in real time.**

Keywords: Road safety; Monitoring; Web-GIS; GSM; GPS.

I. INTRODUCTION

Road safety has always been a primary preoccupation. Road transport, including all means of transport, is the most dangerous and costly in human lives. Thus, road accidents can cause serious injury and death; these effects can also lead to the significant economic losses for the countries. According to statistics, the situation is more alarming, so monitoring sites is still a topical issue.

The accidents are a leading cause of death. An important indicator of survival rates after an accident is the time between the accident and when emergency medical personnel are sent to the scene. In addition, each minute passes without the victim receives emergency medical treatment can make a big difference in the survival rate, for example, the analysis shows that reducing the response time of an accident of 1 min correspond to a difference of 6% in the number of lives saved [1]. If we eliminate the time between when an accident occurs and when the first responders are sent to places we will reduce the mortality rate of 6% [1] and [2]. Thus, time is critical for the survival of injured in a serious accident. Often, the obstacles, faced by stakeholders, slow the time required to arrive at the caller. So, the rapid detection of accidents can save lives by reducing the time required for information to reach emergency responders because every minute counts when someone is injured in a traffic accident. For this reason the effective monitoring of the road network is essential. The monitoring function is dedicated to consistently monitor the road network and detect anomalies, to respond to emergencies and to secure, if necessary, the places. In general, intelligent monitoring systems have a crucial role in the security.

Thus, in order to improve the chances of survival for passengers involved in accidents, it is desirable to reduce the response time of rescue. A faster and more efficient rescue will increase the chances of survival and the recovery of injured victims. It also allows the priority allocation of resources to address, in timely, the urgent situations and to secure the way in order to protect other users that could potentially be affected by an incident. Thus, once an accident occurs, it is crucial to manage effectively and quickly emergency. Generally, this type of service allows essentially the location of people in distress and need assistance.

The purpose of this review and synthesis is to present a state of the art of the main monitoring systems of road network. This work allowed us to discuss these systems according to their diagnosis of operating, their performances and to deduce their respective advantages and disadvantages. This paper summarizes also *our contribution in this field of investigation;* the new approach of our system of management of road safety is also examined.

II. STATE OF ART OF MONITORING SYSTEMS OF THE ROAD

A. ECN *(*Emergency Call Network*)*

1) Historical Context

Until recent years, dynamic road equipments that are Emergency Call Stations (ECS) were the only means available to the user, usually in distress, for emergency or for advice on roads.

The first ECN were built in the early 70s by motorway concessionaires and government services in charge of urban express ways. During their deployment, the experience and the quality research led, in the late 80s and early 90s, to a series of standards giving them an official status. The regulation is implemented with the publication of laws, instructions and guidance documents.

The implementation of ECS on road is not mandatory but their installation is gradually spreading to all networks with high traffic, without following a real logical itinerary.

In the following, we present the study of the European context. First recall that, in the different European countries, the calls for emergency cover very different realities, whether for the content of calls, whether by numbers called or by the actors involved or also by the type of the track on which the motorist circulates. But despite the variety means of calls and organizations, various European countries (Germany, Britain, Italy, Holland, France...) have adopted a broadly similar functional organization based on the principles presented in the following.

2) The Diagnostic Operating of ECN

In case of breakdown or traffic accident, person having problems must first lead to the emergency terminal nearest then call the number, so the communication request is made by short press on a push button. Location is then given by specifying the number of the freeway, direction of travel and a reference point.

The ECS are located along the railway, every two kilometers on motorways and in each direction, one kilometer on urban expressways, and all four kilometers on highways equipped. They are of the type "hands free". The basic operational characteristics of ECN are the detection and localization of one or more calls with the establishment of bilateral communication (full duplex).

The CCS (Centralized Call Station) allows the identification and location of ECS, the establishment of the telephone connection to the calling or called ECS, the self-test operation of the network and memory of defects with edition logbook, it also has a Database geographically with the location and telephone numbers of emergency services (firefighters, police, breakdown, ambulances, etc.).

Some Centralized Call Stations are equipped with a map with voice synthesizer permitting, on the basis of a simple questionnaire in several languages, the dialogue between the operator and the foreign user making a call from one of Emergency Call Stations connected to it. The operator, having taken note of the nationality of the user, sends in his language a series of questions requiring yes or no answer that can be easily understood from the form it has.

The organization of the treatment of a call from an ECS is given below:

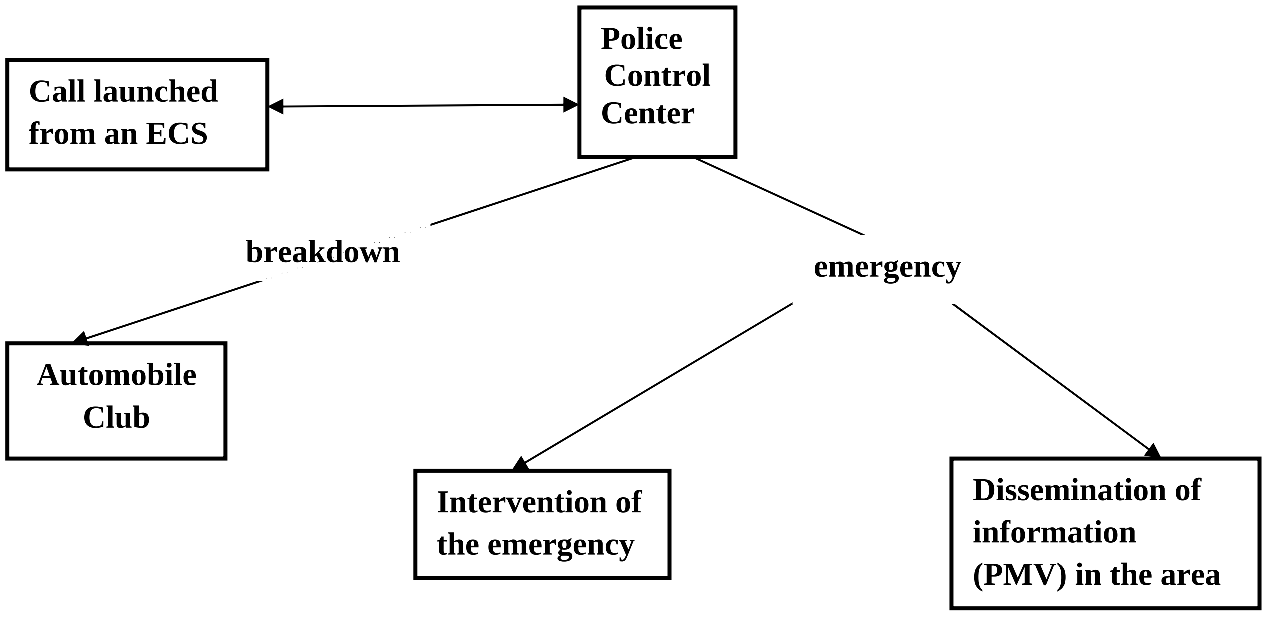

Fig. 1. Diagram treatments of emergency calls using the ECS [3]

3) Synthesis

The ECS in service respond to a very old standard, which has more than forty years, in addition:

1 - ECN can locate the place of the call, but not necessarily the location of the incident. Localization is effected by means of existing markings: numbers of roads, milestones, signs, etc. so the caller is informed of the event, but not necessarily at the site of the event;

2 - Person having problems must walk to the terminal to call;
3 - ECN requires maintenance and renovation;
4- The routes equipped with emergency stations are the most circulated routes (motorways and major roads), so there is no initiative to develop ECS outside these networks;
5- They are expensive.
It was therefore necessary to evolutes the technology ECN on the territory. The ECN will be therefore transformed due to the technological developments and to the change of users habits and service organizations.

4) The Scenario Study of Perspectives

To overcome the disadvantages mentioned above, studies on the renewal of the emergency call network is already underway. Progress will continue both on the technical and organizational terms. Technological developments will focus on fiber optic networks along the motorway network for dynamic management of traffic and will be used for the passage of the phone signal, and possibly on the ECS using GSM. But significant developments are currently focused on the implementation of an automated emergency service. This new service will replace the ECS with "ECS in your car" in other words, "embedded emergency calls stations" [4]. The following section presents the required solution to equip vehicles embedded with systems combining GPS and GSM to ensure the location and transmission of information.

B. *The Embedded System in Vehicles*

1) Introduction

One approach to eliminating the delay between accident occurrence and first responder dispatch is to use in vehicles automatic or manual detection accident and systems of notification. These in-vehicle systems sense when accidents occur and immediately alert emergency personnel without need to know exactly where you are. In other words, any motorist knows now that his car is equipped with advanced technological means to make the car safer, cleaner and more powerful, indeed a "smart car". These embedded systems in cars will save many lives and will significantly reduce the severity of accidents.

2) Historical Context and Definition

In the old method of notification of an accident, a witness of the accident calls the police for help. The witness provides information on the location of the accident and the killed. Once the police are notified, they coordinate the relief efforts in alerting the fire department and medical services quickly. With the advancement of communication technologies, this method is developed; the latest innovation is embedded systems in vehicles. We will present some reporting systems and their services.

The eCall system. The eCall system in-vehicle is defined as follows in eCall Memorandum of Understanding (5]: The eCall system in-vehicle is an emergency call generated manually by vehicle occupants or automatically via activation of the sensor in vehicles. These sensors can alert local agencies responsible for emergency response by providing GPS coordinates corresponding to the position of the vehicle. It is one of the greatest efforts of road safety made under the eSafety initiative of the European Union, which will be generalized in 2014 [6]. eSafety aims to improve road safety by installing intelligent safety systems based on advanced electronics technologies in road vehicles, eCall has the potential to significantly reduce the number of fatalities and serious injuries by accelerating the response emergency services.

From 2009 [7], the European Union has made (in the program E-MERGE) installing an alert device mandatory in every new vehicle commercialized in the European Union. This system should automatically alert emergency services in case of accident using mobile phones and GPS [8] and bring rapid assistance to motorists involved in the accident. For example, PSA Peugeot Citroën, the big French car company, showed a version of the eCall system in cars (Fig. 2). Other manufacturers such as BMW (ConnectedDrive) and Volvo (OnCall) have their own systems available.

Fig. 2. SOS button in the scoreboard of PSA Peugeot Citroën [9]

The ERA system. The Russians advanced compared to Western Europeans and they appointed their own version of the eCall system [10], known as ERA, for the year 2013. They will use GLONASS, the Russian GPS system. Of course, the GPS is always used, and the real benefit today is to use GLONASS in addition to GPS for greater reliability particularly in urban areas compared to the use of GPS alone.

The OnStar system. OnStar [11] is an in-vehicle security, where the security system created by General Motors (GM) in the United States for assistance on the road. Both systems eCall and OnStar are in fact very similar. Unlike eCall, OnStar provides a navigation system and road assistance in case the vehicle is stolen, it can also unlock the vehicle remotely. However, eCall is more ambitious because it is expected to support all the marks of vehicles in the area of the European Union, while OnStar is only supported by GM in the United States.

3) The Improvements of Current Context

Several studies have been conducted in the field of notification of accidents using telematics applications; in fact, several improvements have emerged following the work of different authors.

Recent advances in technology allow smartphones to detect car accidents in a more portable and more profitable way than the conventional solutions in cars. So it is possible to introduce new services using smartphones as user interface model eCall in many different contexts to improve the response time of emergency services [12].

We cite the project WreckWatch [13] which describes how smartphones, such as iPhone and Google Android (more than 50 percent on the part of Smartphone [9]) can automatically detect accidents, immediately inform the central server to emergency and provide information on the situation through photographs, GPS coordinates and channels of communication. This project also describes how the sensors of smartphones, network connections and web services can be used to provide information on the situation for first responders.

In this regard, [14] proposed to combine existing vehicles with smartphones to reach a solution to improve the safety on the road. They have developed an application that communicates with the internal bus of the vehicle and Bluetooth communication to determine whether the accident occurred and to estimate the severity of these accidents. The retrieved information is then submitted to emergency services and emergency call is automatically established. This is illustrated in Fig. 3.

Fig. 3. Improved application of embedded systems in vehicles based on smartphones [14]

Other authors [12] show how sensors embedded in smartphones detect the event of a significant acceleration indicative of an accident and use the high conECNtion 3G for transmit the necessary information to a central server. Then the server processes the information and informs the authorities and all emergency contacts (see Fig. 4).

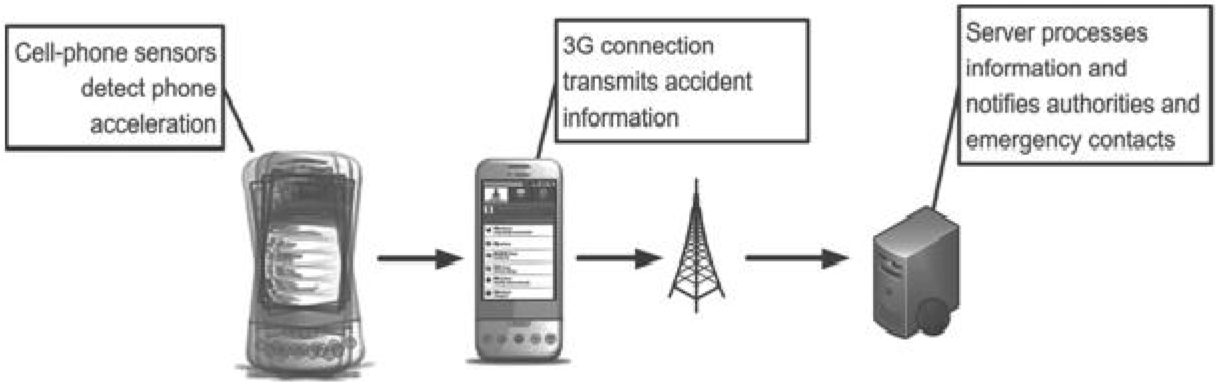

Fig. 4. Another accident detection system based on smartphones [12]

Another famous application is the car connected to the Internet. The automotive industry [14] is the subject of a major strategic change to more ecological vehicles and safer, also introducing new services vehicles such as eco-driving support and Internet access. Today, a car buyer will almost certainly be an Internet user. For Telematics applications like the eCall system, it is sufficient to connect to the wireless network 2G GSM / GPRS giving global coverage. GPRS is the best way to send the position data of an accident with an SMS text message as a back-up.

4) The Obvious Advantages and Disadvantages for Clients and Emergency Services (of the eCall System Case)

As a result of the supposed advantages, the European Commission would like to see a higher degree of implementation of eCall [5], and at that time, it seems possible only by a mandatory implementation. But it does not mean that these embedded systems have disadvantages that must be learned into consideration.

Advantages:

- If the driver launched a manual eCall and after he pushed the "Cancel" button within 6 seconds, no data is sent or voice call is established, which shows that a misuse of the SOS button (by children, for example) can be avoided [15].
- The eCall service will have major impacts on achieving the objectives of eCall (Reduction of the average response time of an accident by 50% in rural areas and 40% in urban areas, reduction of the number of fatalities on roads with approximately 2500 deaths each year, reduction of the severity of the accident by 15% cost to save more than € 20 billion, [5] and [16]). This response time is reduced because the emergency services are notified immediately in the event of an accident and they gave the exact location of the accident.
- The ability to communicate effectively with the vehicle occupants to refine the analysis of the situation, and whatever their native language in the European Union, because thirty languages are spoken by the personnel of IMA (Inter Mutuelles Assistance) on the plateaus telephone assistance.
- The precise location of the accident through the transmission of GPS coordinates.

Disadvantages:

- The European Commission notes that, despite the quality of intelligent systems based on technology of information and communication, market share extends slowly. However, it takes many years until most of the vehicles in our streets are equipped with these new features.
- There is such strong resistance against the eCall in-vehicle, especially if it would be made mandatory on all new cars in the Community. This resistance stems from fear to achieve private life and personal data, because the driver could be continuously monitored [5].
- It is not rare to find these services limited to luxury cars on the market or on a specific geographic market and especially even in a specific brand. For example, the United States, it was only in 2007 that the automatic notification options become standard in GM vehicles and they are only available in North America [5]. So embedded systems in vehicles [13], however, are not available in all cars because they are impractical or too expensive to install in existing vehicles, plus the cost of the subscription service.
- There is a need for the single European emergency number 112 to be operational for fixed and mobile calls throughout the European Union (EU). Unfortunately, not all member states of the EU are able to support the emergency services complete 112.

C. *The Video Cameras*

1) Introduction

A few years ago, monitoring is ensured by the presence of police on the roads which informed of any anomalies of the road [17]. In recent years, there has been a growing interest in the use of automatic mechanisms which can provide information on the behavior of cars on the highways and roads of the city. The most attractive of them is the detection by video images. A study of video processing techniques for traffic applications [18] demonstrates the importance of the topic. Therefore, the application of image processing and analyzing traffic video sequence by computer vision techniques, offers significant improvements to the existing methods of traffic data collection and traffic monitoring.

2) Operating System of Traffic Management by Video Images

Vehicle location [19] and fast data acquisition are important for Intelligent Transportation System (ITS), which uses sensor networks to monitor traffic and make adjustments to increase safety and reduce congestion on transport networks [20]. The Intelligent Transportation System [21] is a wide area of research where artificial intelligence techniques are applied to traffic data [22]. Traffic data can come from various sensors such as loop detectors, sensors, pneumatic, or cameras. Systems of cameras based on vision are more sophisticated and more powerful than those based on sensors placed on site because the content information associated with image sequences allows a specific tracking of vehicle. Thus, network cameras are a video monitoring system of traffic where the images are centralized to a PC such as the Prefecture of Police.

Progress over the last decade in the image processing has greatly automated controls of incident by video imaging. Previously, the cameras were connected to a Control Station (CS) that monitors the motorway network, 24 hours on 24, this classic vision system for traffic monitoring [17] is composed of a camera CCD (Charge Coupled Device) having a semiconductor sensor which encodes optical information into electric information [23]. The CCD camera captures video images online; these images are digitized and stored in a computer connected to the control room where the operator viewed multiple screens continuously. Now, if the images are always referred to such a CS, they are often treated by algorithms of digital image processing to detect automatically an incident. These images thus enable a treatment more important of video sources from a single CS of security. In this regard, there is a type of video cameras that are dedicated to monitoring to detect accidents automatically, called Automatic Incident Detection (AID) [17].

Video image detection involves the collection of data that describes the characteristics of the vehicles and their movement [17]. Some examples of these data are the number of vehicles, vehicle speed, vehicle size, and the type of vehicle (car, truck or bus). Therefore, it is possible to detect incidents after the accident location. In the end, according to the video, controllers can respond quickly to different situations that arise on the road.

3) The Main Algorithms of Image Processing

The processing algorithms of the video image, which are used for traffic analysis, rely on the detection of movement of it for segmenting the image areas. Among the techniques for detecting movement defined to date, the two most frequently used in traffic monitoring are the image difference method and the motion detection technique based on the characteristics.

Image difference. This technique is based on the fact that the differences between two frames captured at different time instants reveal regions in motion [24]. An image difference I is generated by calculating the absolute difference between two frames (I1 and I2) and thresholding the result.

$$I(x,y) = \begin{cases} 0, if\ |I_1(x,y) - I_2(x,y)| \le \theta \\ 1, \quad otherwise \end{cases}$$

where θ is an appropriate threshold. In the case of traffic monitoring, it is usual for I1 to be the input frame and I2 to be the reference frame (background). The reference frame is an image from the scene, without vehicles. The purpose of the threshold is to reduce the effects of noise and changes in the scene's lighting.

In other words, this technique is based on the presence or absence of objects in a given area and the movement or no movement is detected [25]. This is the case of the algorithm URBI. This simple method gave rise to system called Tripwire.

The user determines on image the areas in which treatment should be performed. In most cases, the principle of Tripwire is to set the image of pseudo-sensors, or sensors, consisting of lines or points defining a measuring zone sensitive to the movements of the traffic. Modifying pixels of the line is led to the passage of a vehicle on the line. Tripwire does not allow the recognition of shapes or tracking. Each sensor has a local and limited view of the object.

Motion detection based on the characteristics. This technique looks for the most important features frame by frame. The first step consists of identifying the appropriate feature. Once identified in the frames, a matching procedure must be done to find the correspondence from among those points in the following frames [24].

The TITAN algorithm [25] developed by the Centre of Mathematical Morphology of the School of Mines of Paris is one of the foundations that gave rise to system called Tracking. Tracking allows the recognition and tracking of moving objects. Vehicle detection is based on the research of the characteristics of light elements that compose them. Each vehicle is so identified. It is easily understood that measures its position and length are possible.

4) Historical and Current Context

Several research studies have been made in the field of video surveillance of the road network in different countries. We cite a few examples of these systems.

In 1985, the Technical Research Centre of Equipment developed, in France, a system called EURECA (Evénement Unique ou Rare Enregistré par Caméscope Automatisé), which allows the automatic video recording [26]. The system consists of a video camera and recorder controlled by a laptop computer [27], which records continuously a road scene. It consists of various sensors, chosen according to the type of event registered, that determine whether an image should be stored. If an interesting event has been detected during the period of the sequence, it is validated and stored in the cassette; otherwise the cassette is rewound to the end of the last sequence validated. Therefore, only the desired events are recorded on the cassette and you can see what happened before and after an event.

In 1993, the center highway of traffic monitoring and operational management of national roads, called CASTOR, was inaugurated in Geneva, Switzerland [28]. This is a very high ceiling room, monumental, supervised by twenty-three small screens. Alarms often sound. The giant screen is dominant, two operators, sometimes three, are sitting behind desks, their eyes fixed on one (or two) monitor (s) posed (s) before them on which they can make orders and manage alarms. The phone rings often, an operator answers. This room is shown in Fig. 5.

When an alarm sounds, the location and the type of incident are automatically displayed in the central panel of the CMI (Central of Monitoring and Intervention). This panel is the nervous system: it can schematize the highway at different geographic scales in order that operators can view the main movements and a variety of traffic incidents.

In case of incident, in addition to the information shown on the central panel, the three monitors located just below display immediately and automatically in chronological sequence the preceding and following incident of the camera, so that operators can respond to the most appropriate possible way and launch the warnings required by the situation.

The general operation of the video surveillance system and the tasks of the different actors can be summarized as follows: firstly, the system can transmit visual information about incidents on the monitored space. Based on this information, an intervention may initially be organized and controlled remotely by using cameras as well as available means of communication that provide the contact of actors separated by a relatively large distance, previously these cameras are all in black and white and also fixed, some have been replaced by color cameras, which the head is pivotable.

Since 1995, the company Mitsubishi has been involved in the development of an automated system variously called Traffic Accident Auto Memory System (TAAMS) or Auto Incident Recording System (AIRS) [27]. It is implemented first time in Japan before being used especially in the United States [29] and [30]. The system uses a video recording and consists of one or two cameras with directional microphones, a video cassette recorder and a central controller. The video and sound are recorded continuously on a storage unit. When the "crash-like" is detected, the pre-and post-accident scenes are sent from the memory unit to the record video. Next, the system is saved on the memory unit until another problem is detected.

The traffic monitoring systems formed the second and third generation of surveillance systems.

Fig. 5. CASTOR center in Geneva, Switzerland [28]

The second generation systems combine the technology Close-Circuit Television CCTV with the algorithms of computer vision and the artificial intelligence, the system CCTV is the first surveillance system, which is composed of a network of cameras that send signals to a central point, where security personnel can analyze what is happening on the environment through a visual views [23]. While the third generation systems are characterized by their nature fundamentally distributed and their use in a multi-sensors environment to provide a good understanding of the scene and to attract the attention of the human operator in real time.

The systems, that analyze the video content by artificial intelligence techniques, offer an automatic detection in real-time, an identification and an analysis of potential risks.

To summarize, any visual surveillance system follows these steps: the model and the acquisition of knowledge of the controlled environment [31], the detection and tracking of moving objects [32], the classification of objects [33] and the behavioral analysis [34].

Several improvements have been created following the work of various authors. For example, Bo et al. [35] have developed a distributed real-time self-monitoring which is used to interpret the situation on the highway to manage all videos traffic automatically. This system can be used to detect and report to the supervisor when an instance abnormally arrived. It is able to manage the cameras Pan Tilt Zoom (PTZ) which can change position and focus depending on demand, so the details of each vehicle can be calculated accurately. The freeway traffic videos are taken as input video from the PTZ camera, and then produces an analysis of the states and activity of the vehicles, if there is an abnormal instance, an alarm is sent to supervisors awake.

Other authors [17] presented a visual application which allows a study and analysis of traffic behavior on the principal roads (more specifically freeways and highways), using a video camera mounted on a relatively high place (for such as a bridge) with a large field of image analysis. There is a traffic monitoring system that allows the collection of certain traffic parameters and the detection of some of the most important and frequent incidents where the image processing module extracts the visual data of the scene by the spatio-temporal analysis.

This system is able to identify each vehicle that appears in each image and defines the type of vehicle and the actual situation which it occupies in the road. Once a vehicle is detected ([36] and [37]), it is closely followed by the images captured by the video camera; so that each vehicle is followed since it enters into the scene until that it leaves. With this monitoring, the system receives information vehicle: the parameters traffic, the location and speed of each vehicle, as well as the detection of incidents on the road. By segmentation, this system provides a sequence of images where the movements of objects in the scene are displayed.

In this regard, other improvements may be made as the use of more efficient video format such as MPEG-4 and H.264, which improve the quality of video input, also the installation of the optical fiber, which allows increasing the viewing quality and the transmission speed of the camera images.

5) Advantages and Disadvantages

The video surveillance system can facilitate the precise location of the vehicle relative to its environment. Therefore, these systems can generate many benefits for the users of the road in security and flow of traffic, but the network cameras are expensive. For example, in 2009, the French motorway network was equipped with about 2000 cameras [38].

For this reason, it is unlikely that such specialized automated systems will be used to provide global coverage of accidents on the roads, because in some places they cannot provide information on accidents undeclared to the authorities.

Furthermore, the networks of cameras require constant maintenance, which causes the disruption of traffic during maintenance.

Besides, the authors [27] argue that further examination capabilities of the camera showed that the practice real coverage of the camera system has been, for a number of reasons, slightly less than the theoretical coverage usable. There are a number of problems that have been encountered: the physical barrier as of the buildings and temporary works made on the streets can prevent visibility. While cameras can "see" at night, it might be hard to see some details. This problem is less important in urban areas because most streets are lit, but some points may still be dark. Other conditions like snow and mist can cause difficulties of management and visibility of cameras.

III. OUR PROTOTYPE DEVELOPED MSRS : MANAGEMENT SYSTEM FOR ROAD SAFETY

A. Introduction

Location-Based Services (LBS) is becoming an important application in mobile data services. Many services depend on and are using the position of the user to make customized services. An important application of LBS is the precise position wireless of calls for emergency and rescue operations. To make this service, the mobile phone is a valuable access point in such emergencies because the development of the mobile phone facilitates the reporting of incidents and shorter warning times.

So, the originality of our developed work is to use mobile phones to improve the effectiveness of emergency services. Users with devices of wireless geolocalisation can investigate their environment anywhere and anytime. Therefore, the location of the place of the incident is based on information collected by the mobile phone.

Currently the rapid development of new technologies of geographic positioning help to complete the process of road monitoring by creating most powerful systems that detect dangerous situations. For this reason, in our study, we developed a system for managing road safety in real time based on a combination of GPS, GSM and GIS technologies to provide an ideal environment for the design and testing of an intelligent surveillance system having a crucial role in the security [39]. In addition, it is not necessary to have an Internet connection to the statement; the requesting emergency may use a Short Message Service (SMS) of mobile telephony for urgent service request. SMS in the GSM system does not provide high-speed communications for mobile users [40]. SMS is low cost and can work in conjunction with voice services, it requires less radio resource compared to voice calls in building connections between mobile users and base stations. Indeed, the SMS can be a means rather effective and economical for mobile users. It is for these reasons that we chose to introduce the idea of SMS in our system.

There are several disadvantages to using a single technique of geolocalisation: inability to use, indoors, response time to the ignition geographic coverage, etc. The ideal is to find a mobile device that could use more of these techniques to improve the performance of our system.

Android is an example of a terminal able to use a hybrid method of geolocalisation due to its interface GSM and GPS receiver.

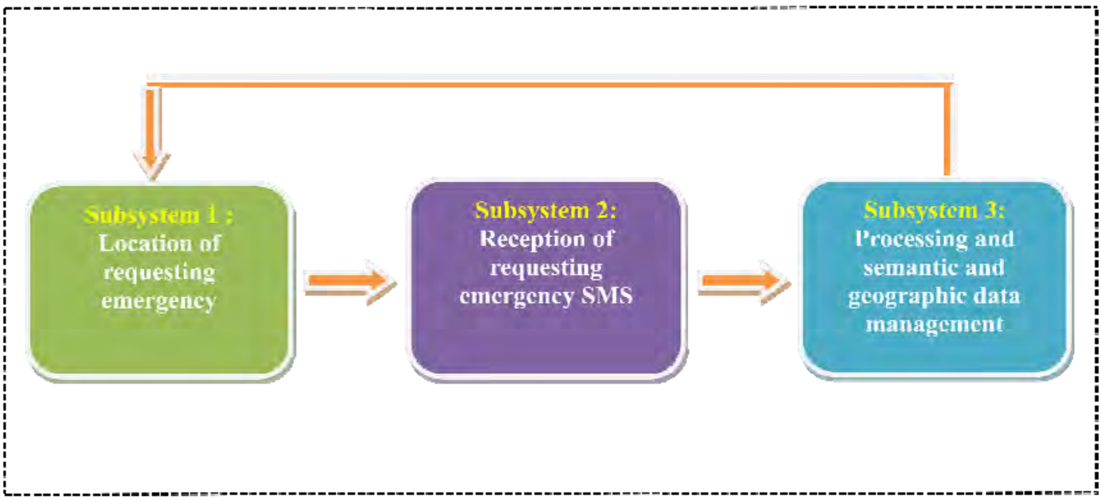

Fig. 6. Context diagram of the system

1) Detailed Architecture of the Proposed System MSRS

The proposed solution is illustrated by the schema of the Fig. 7.

Fig. 7. Process diagram of the proposed system MSRS.

Operating principle. The web framework is based on a three-tier architecture consisting of the client layer, middleware layer and the layer of the database. These components together provide a unified interface for consultation data, request and decision making for users.

First of all, after installing our program in Android mobile, the requesting emergency clicks the button "send SMS". Moreover, the position of the mobile will be sent in real-time to monitoring system using two different methods depending on the application:

Location by the Cell Identifier (indoor location): The information sent is retrieved from the cell site nearest, these include values of MNC (Mobile Network Code), MCC (Mobile Country Code), Cell ID (Cell Identifier) and LAC (Location Area Code). The information will still be used to retrieve the latitude and longitude of the mobile phone [39].

Location by A-GPS (outdoor location): The information sent is composed of Latitude and Longitude of the requesting emergency.

Information, constituting the minimum set of data known as MSD (Minimum Set of Data), is treated by the subsystem: the location of the requesting emergency, this minimum set of data includes the following information: "when "," where "and" who ". They are sent in both cases from the requesting emergency mobile to monitoring system by using the Short Message Service (SMS) through GSM network, so it is not necessary to have an Internet connection to request emergency, the Teleoperator has so relevant and necessary data to accelerate the response of emergency services even before direct telephone contact, by voice, with the requesting emergency. A GSM modem receives the SMS [39], then the monitoring system records in the database the data contained in the SMS in a centralized way. These data, which are available from client computers such that they are globally accessible and available on the Internet, are processed by the subsystem: the receipt of requesting emergency SMS. Then, Teleoperator called the requesting emergency to ask other information that constitutes the FDS (Full Data Set) (first he determines whether it is indeed an emergency situation and he examines then the nature: vital risk, many people involved ...). This information is processed by the subsystem: the treatment and management of semantic and geography data [42]. In the end, Teleoperator communicates the entire file to the emergency services territorially competent (civil protection, police ...). The transfer of this information becomes a key element in the planning of interventions by various stakeholders.

Location of requesting emergency. We have already mentioned that the first step of the proposed process is to locate the user's position via GPS or CellID. The application can use both GPS and CellID to locate its position. By comparing the measurements obtained from a mobile equipped with the application using the Cell-ID method and those of the application using the GPS (see Fig. 8) in different sites, the comparison shows that the second method could provide better localization of road accidents compared to the first method. So, with positioning based on the phone via a module integrated GPS, the positioning is accurate, but it can fail inside (as in the case of a bridge). In the case where GPS is not available at one time or it is not provided through the module integrated GPS, the application can operate in CellID.

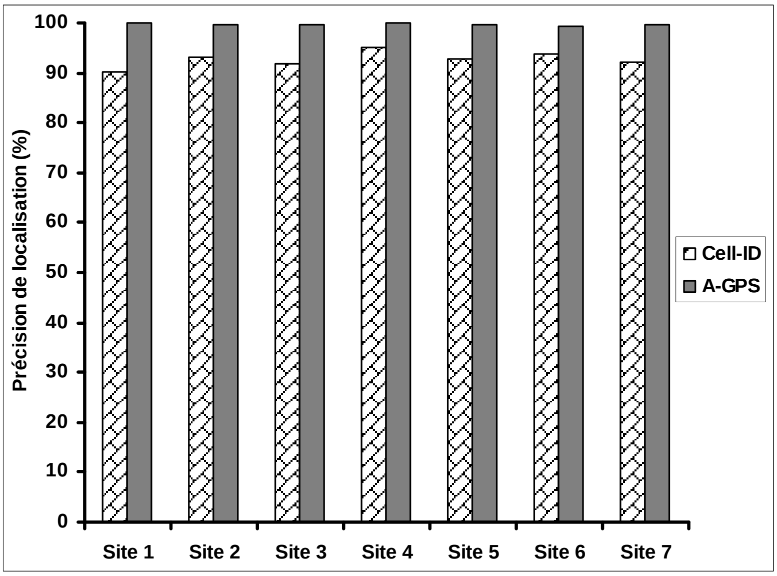

Fig. 8. The relationship between the site and the location accuracy using both methods of localization.

2) Discussion

According to the results of our system and by appearing them with other systems discussed above, we have the results summarized in the Table 1 below.

TABLE 1
A comparative study with other systems

	Solution 1: Our system	Solution 2: System using cameras	Solution 3: System using the cars supplied with an SOS button	Solution 4: System using ECN
Rapidity	++	++	++	++
Location accuracy	++	+	++	+
Maintenance	+	++	+	++
Cost	+	++	++	++

++ Convenable

\+ Passable

In general, monitoring systems of traffic based on cell phone are particularly suitable for developing countries, where there is a lack of resources for traffic monitoring systems, and where the penetration rate of mobile phones in population is increasing rapidly. According to [43], at the end of 2007, the penetration rate of mobile phones in the population was over 50% in the world, ranging from 30% to 40% in developing countries (with a annual growth greater than 30%) and 90% to 100% in developed countries [44].

Based on the results of our work, we find other advantages of our system as follows:

- The advantage of using SMS: if the host server is down, for example, user data can be stored in the services center of GSM and data can be received once the server is repaired.
- There are no communication problems: our system can also be used for deaf and dumb.
- The cell phone might be available on most roads without needing to install specialized detection equipment.
- The system is portable and easy to install.
- The manager has real-time information considered pertinent of the knowledge of the state of infrastructure and of the solicitation of the road network, which promotes a quick and informed decision making.
- In terms of application deployment, availability of services of the operating system Android / Google enables rapid diffusion of such application to users on a global basis.

IV. CONCLUSION

The demand for the emergency road services has increased around the world, especially with the development of wireless communication and location that promotes the development of applications for the management of road safety. In this review, we present a state of the art of the main monitoring systems of road network such as the system of treatment of emergency calls on motorways and road networks that they come from Emergency Call Network, the embedded system in automobiles and the system of the monitoring by video cameras. This work allowed us to discuss these systems according to their diagnosis of operating, their performances, their respective advantages and disadvantages and their improvements in the current context.

Actually, the new technologies help to complete the monitoring process by creating more powerful systems that detect dangerous situations. The advances in science and technology change the way of operation of emergency. As example, we present our contribution based on the development of an intelligent system offering another solution for the treatment of traffic incidents for the automation of monitoring. This system allows systematizing site security in order to optimize interventions and to guarantee a safe and effective monitoring in real time. It is based on advanced use of the opportunities offered by the mobile phone to improve the effectiveness of emergency services. There are other crucial points of our approach: first, the mobile, used for the declaration, already exists, so there is nothing to install, on the other hand, it is not necessary to have an Internet connection to the declaration, the requesting emergency may use a Short Message Service (SMS) for urgent service request, in addition, the mobile is at the reach of people for low cost.

ACKNOWLEDGMENT

This work falls within the scope of telecommunication projects. We would like to thank the Department of technology of the MESFCRST for financing our projects.

REFERENCES

[1] Evanco, W., 1996. The impact of rapid incident detection on freeway accident fatalities. Mitretek Systems, Inc., WN96W0000071.
[2] Rauscher, S., Messner, G., Baur, P., Augenstein, J., Digges, K., Perdeck, E., Bahouth, G., Pieske, O., 2009. Enhanced automatic collision notification system- improved rescue care due to injury prediction- first field experience. Paper Number: 09-0049, Proceedings of the 21st ESV Conference.
[3] Certu, Août 2000a. Traitement des appels d'urgence sur le réseau routier en Europe : Rapport de la situation en Grande-Bretagne.
[4] Certu, Août 2000b. Traitement des appels d'urgence sur le réseau routier en Europe : Rapport de la situation en Allemagne, Août 2000.
[5] Geuens, C., Dumortier, J., 2010. Mandatory implementation for in-vehicle eCall: Privacy compatible?, Computer law & security review (26), 385–390.
[6] European Commission eSafety Initiative, 2012. [Online]. Available: http://ec.europa.eu/information_society/activities/esafety/index_en.htm.
[7] Fernández, J., Cantalapiedra, F., Mata, M., Egido, V., Bemposta, S., 2006. Logging, alert & emergency system for road transport vehicles- An Experimental eCall, Black-box and Driver Alerting System, 384–389.
[8] European Commission (DG Enterprise and DG Information Society), *eSafety forum: Summary report* March *2003*.
[9] Malek, M., 2012. Telematic Future: eCall, Insurance, Drive-Share. GPS World (23), 30-31.
[10] Corbeau, S., Avril 2010. 40 ans d'innovation technologiques en matière de prévention routière. Des opportunités pour l'Assurance ? , MBA Manager d'entreprise spécialisation Assurance.
[11] OnStar by *GM, 2012.* [Online]. Available: http://www.onstar.com/.
[12] Thompson, C., White, J., Dougherty, B., Albright, A., and Schmidt, D.C., 2010. Using smartphones to detect car accidents and provide situational awareness to emergency responders. in MOBILWARE'10, (Chicago, IL, USA), 29–42.
[13] White, J., Thompson, C., Turner, H., Dougherty, B., Schmidt, D.C., 2011. WreckWatch: Automatic Traffic Accident Detection and Notification with Smartphones. Mobile Netw Appl (16), 285–30.
[14] Zaldivar, J., Calafate, C.T., Cano, J.C., Pietro Manzoni, P., 2011. Providing Accident Detection in Vehicular Networks Through OBD-II Devices and Android-based Smartphones. Proceeding LCN '11 Proceedings of the 2011 IEEE 36th Conference on Local Computer Networks, 813–819.
[15] Luique, J.L., Ferrer, X.C., Serra, X.H., 2004. Design and implementation of a J2EE platform to handle standardized telematics emergency calls originated from vehicles. IEEE, 2825–2829.
[16] Martinez, F.J., Toh, C.K., Cano, J.C., Calafate, C.T., and Manzoni, P., 2010. Emergency Services in Future Intelligent Transportation Systems based in Vehicular Communication Networks. IEEE Intelligent Transportation Systems Magazine (2), 6–20.
[17] Caballero, A.F., Gómez, F.J., López, J.L., 2008. Road-traffic monitoring by knowledge-driven static and dynamic image analysis, Expert Systems with Applications (35), 701–719.
[18] Kastrinaki, V., Zervakis, M., and Kalaitzakis, K., 2003. A survey of video processing techniques for traffic applications. Image and Vision Computing (21), 359–381.
[19] Zhao, Y., 2000. Mobile Phone Location Determination and Its Impact on Intelligent Transportation Systems. IEEE Transactions on Intelligent Transportation Systems (1), 55–64.
[20] Weiland, RJ., Purser, LB., 2009. Intelligent transportation systems. Transp Res 1:40AM.
[21] Cucchiara, R., Piccardi, M. , and Mello, P., June 2000. Image Analysis and Rule-Based Reasoning for a Traffic Monitoring System. IEEE Transactions on Intelligent Transportation Systems (1), 119–130.
[22] Masaki, I., Nov.–Dec. 1998. Machine-vision systems for intelligent transportation systems. IEEE Intell. Syst. (13), 24–31.
[23] Castro, J.L., Delgado, M., Medina, J., Ruiz-Lozano, M.D., 2011. Intelligent surveillance system with integration of heterogeneous information for intrusion detection. Expert Systems with Applications (38), 11182–11192.
[24] Sonka, M., Hlavac, V., and Boyle, R., 1993. Image processing, analysis and machine vision. Chapman & Hall.
[25] Crosse, J.Y., Octobre 1998. La détection automatique d'incidents par analyse d'image vidéo.
[26] SETRA – CSTR. EURECA – Evènement Unique ou Rare Enregistré par Caméscope Automatisé. Note d'Information 114. SETRA, 1998.

[27] Conche, F., Miles Tight, M., 2006. Use of CCTV to determine road accident factors in urban areas. Accident Analysis and Prevention (38), 1197–1207.

[28] Valérie, N., 2004. L'autoroute intelligente au service de la sécurité routière : l'exemple de l'autoroute de contournement à Genève. Espaces et sociétés (118), 95–111. DOI : 10.3917/esp.118.0095.

[29] Rich, J., 2004. The AIRS approach to analysing intersection crashes. Public Roads (67), 38–40.

[30] Ueyama, M., September 9–11 1996. The study of traffic accidents mechanisms at intersections by automatic recording systems. In: Proceedings of the Conference Road Safety in Europe, Birmingham (UK), 93–108.

[31] Mittal, A., and Paragios, N., 2004. Motion-based background subtraction using adaptive kernel density estimation. In Proceedings of the IEEE computer society conference on computer vision and pattern recognition (2), 11302–11309.

[32] Behrad, A., Shahrokni, A., and Ahmad, M., 2001. A robust vision-based moving target detection and tracking system. In Proceeding of image and vision computing conference.

[33] Fusier, F., Valentin, V., Brmond, F., Thonnat, M., Borg, M., Thirde, D., et al., 2007. Video understanding for complex activity recognition. Machine Vision and Applications (18), 167–188.

[34] Borg, M., Thirde, D., Ferryman, J., Fusier, F., Valentin, V., Bremond, F., and Thonnat, M., 2005. Video surveillance for aircraft activity monitoring. In Proceedings of IEEE conference on AVSS (1), 16–21.

[35] Bo, L., Qimei, C., Fan, G., 2006. Freeway auto-surveillance from traffic video. In Proceedings of 6th International Conference on ITS Telecommunications, 167–170.

[36] Fernández, M. A., Caballero, A.F., López, M. T., and Mira, J., 2003. Length-Speed Ratio (LSR) as a characteristic for moving elements real-time classification. Real-Time Imaging (9), 49–59.

[37] Mira, J., Delgado, A. E., Caballero, A.F., and Fernández, M. A., 2004. Knowledge modelling for the motion detection task: The algorithmic lateral inhibition method. Expert Systems with Applications (27), 169–185.

[38] Babari, R., Hautière, N., Dumont, E., Paparoditis, N., James Misener, J., 2012. Visibility monitoring using conventional roadside cameras – Emerging Applications. Transportation Research Part C (22), 17–28.

[39] El houssaini, S., and Badri, A., 2012b. Integrating LBS, GIS and SMS for the Effective Monitoring of Road Network. International Journal of Computer Science and Information Security (10), 1–6.

[40] Tang, M.C., Chou, C.N., Tang, C.H., Pan, D. C., and Shih, W.K., 2001. Exploiting GSM short message service for ubiquitous accessing. Journal of Network and Computer Applications (24), 249–267.

[41] El houssaini, S., and Badri, A., 2012a. Development of a GIS-Based Monitoring System for Road Network. Journal of Computing (4), 90–94.

[42] El houssaini, S., and Badri, A., 2012c. A web-based spatial decision support system for effective monitoring and routing problem. International Conference on Multimedia Computing and Systems *(ICMCS'12)*, 669–674, 10-12 May 2012, Print ISBN: 978-1-4673-1518-0, Digital Object Identifier: 10.1109/ICMCS.2012.6320116, ©2012 IEEE.

[43] Herrera, J.C, Work, D.B., Herring, R., Ban, X., Jacobson, Q., Bayen, A.M., 2010. Evaluation of traffic data obtained via GPS-enabled mobile phones: The Mobile Century field experiment. Transportation Research Part C (18), 568–583.

[44] Itu, 2008. http://www.itu.int/ITU-D/ict/statistics/ict/index.html, accessed on 09-23-2008.