Smart Mobility and Driver Behavior correlated with Vehicular Networks under a Social Perception in Smart Cities

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***Abstract*—To manage the complications produced by the urbanization, the concept of smart city takes the lead by proposing mainly advantages, including the increase of quality and comfort of citizens by using information and communication technologies, as part of the key factors that contribute to develop Smart Cities. One of the most suitable concepts for improving road safety and such other services of Intelligent Transportation Systems, is especially the vehicular ad-hoc network, a particular application of the classical mobile ad-hoc networks. Following this perspective, our work proposes various approaches regarding smart mobility in Smart Cities, while offering a wide of range of safety application to ameliorate road safety, traffic efficiency and provide a green environment. Moreover, this paper conceives in the first way a framework for human smart behavior and mentality, then in the second part, we investigated the impact of the human driver behavior on ITS by suggesting an algorithm for categorizing driver behavior, using a contextual information about the driving environment, in order to propose a new model of communication to warn other vehicles on the road, so as to prevent accidents from happening and to ensure smart mobility with security aspects perspective. Likewise, we decided to integrate our approach to notify vehicles in the traffic, by providing smart mobility under a routing perception strategy. Furthermore, we demonstrate that even a complex behavior model can be represented using realistic simulation studies, the experimental results indicate that driver's behavior has a significant impact on traffic.**

Keywords*—*Smart City, VANET, ITS, Driver Behavior, Routing Protocol.

I. Introduction

In relation with the Smart Cities perception, various works have been conceived in previous literature, defining essentially, relevant conceptualization of Smart Cities, including the different harmony factors that make a city indeed smart. Broadly speaking, the concept applies the new information and communication technologies, in order to enhance quality of life and vivacity [1]. The Smart City initiatives can be identified according to some essential factors. These factors are built on the smart combination, they can be defined as follows, the management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment [2].

Deducing from a general principle, there will be four levels to assess the maturity of a smart city. The first level, takes into consideration that the city has already a highlighting strategy to design a smart city. The second level, the city is based on a planning and a comprehensive vision of relevance. Then the third level, applies the interest of the launching of the pilot initiatives. Finally, the last level, that requires the application and the complete implementation of at least one initiative.

According to the estimation of a United Nations report [3], approximately 70 percent of the world population will live in cities by 2050. To meet these challenges, cities that are more effective in resources and technology access, are necessary. This great increase will drive significant consumption of more energy and need more space to live. Thus, to limit the load, a new concept of cities came out. Smarter city exploits the new information and communication technologies to facilitate the access to urban services, including minimizing the effect of human activities on the environment. The Smart city, as the term would suggest, is a city that works with sustainable and intelligent way while incorporating a range of facilities and services using intelligent devices to ensure efficiency, increase comfort and quality of life of citizens with a minimum of resources.

Therefore, related to these facts, transport systems will have to face with some major challenges in the future to ensure a sustainable smart mobility, while avoiding unexpected problems and serious accidents. In the transport field, the congestion of urban traffic represents a serious problem from which suffers several cities. The phenomenon might be more alarming concerning the urban development of the city, as well as the improvement of living standards of its inhabitants. With the expansion of the number of vehicles in circulation along with the impact of human driver behavior, it becomes delicate to manage accordingly, the road traffic. This situation has led to a growth in road traffic that has strongly exacerbated the traffic congestion of transport systems. However, investigating and detecting the behavior of drivers are crucial to ensure road safety by alerting the driver and other vehicles on the road in case of abnormal driving behavior.

Related to the Intelligent Transportation Systems, the Vehicular ad-hoc network takes the lead, it is an emerged application of MANET, characterized by high mobility and permanently changes of network topology. To make Vehicular networks more efficient to provide services, vehicles must be able to communicate with each other. There are two main types of VANET communication, namely, the V2V (Vehicle to Vehicle)[4] this communication is established between two or more vehicles. This approach is more or less adapted to the short range vehicular networks. The second type of communication is V2I (Vehicles to Infrastructure), communication is established between the equipment of the existing network infrastructure such as wireless access points and vehicles available in the range of equipment.

We assume that the ideas proposed in this work could help to strengthen the efforts in order to design a smart city, by proposing an approach that defines a framework to dissect the human behavior's factor. Moreover, a smart city is a center of higher education, intelligent citizens and human skills. That being said, the emphasis on human infrastructure highlights social learning and education, towards more progressive smart cities, cities should start with human capital, rather than blindly believe that the information and communication technologies itself can automatically transform and improve cities.

This article aims to explore important dimensions that are critical for successful smart city, by combining between two approaches. In this context, we conceive in first way a framework for human smart behavior, offering solutions to overcome today's challenges, and in a second part to integrate the aspects of realism, we were interested to bring out the concept of human behavior, and we investigate his impact on intelligent transportation systems.

The concept of smart cities is based on the combination of intelligent term on its various factors. That said, we are interested in smart mobility, the element that defines the factor of smart transportation. Following this perspective, this work proposes an approach regarding the smart mobility concept, while offering a pertinent design to provide, simultaneously reduce environmental footprint and maximize the use of urban space. The idea in conjunction with the vision is to relate the intelligence to mobility for a safer mobility in terms of security, more intelligent by ensuring the fluidity and the comfort, as a result a cleaner mobility. In our approach, to improve the potential of an accurate smart mobility, the overall goal pursued is offering measures, as well as, increase the efficiency and safety, along with improving quality of travel (e.g. to minimize the travel time), including the environment impact (e.g. to minimize the fuel consumption and other air pollutants).

Likewise, we opted to emphasize the fundamental principle of routing, beneficial to ensure smooth and an appropriate communication related to the network. We decided to integrate our approach to warn other vehicles on the road, conducive to prevent abnormal cases from happening and to guarantee smart mobility, by modifying the strategy of a routing protocol to have complementary and ideal facts. The objective is to introduce the technique proposed in the OLSR (Optimized Link State Routing) protocol. Obviously, by providing an appropriate process, such routing mechanism could be helpful in exchanging control messages.

In short, the main points of the contributions of the work are listed below:
-Model the factors of human smart mentality to ensure the quality of rethinking a smart city.
-A context aware architecture for driver behavior detection system, by considering four sub-models that influence the driver behavior. Conceive the probability to minimize accidents, and alert the neighboring vehicles with the perspective of security aspects.
-Simulation of driver behavior classes, along with an integrated framework into simulator.
-In order to deal with these sophisticated classes, we have introduced the suggested technique in the internal configuration of OLSR protocol.
-We use a realistic VANET mobility traffic taken from the metropolitan area of Rabat (Morocco), in order to find and validate the best optimal configurations. This paper is organized as follows: Section 2 and 3 dissects the proposed models and algorithms, while section 4 defines the various simulations and presenting an interpretation of results, Finally, we conclude the paper.

II. Related work

We have especially proposed an algorithm for categorizing driver behavior, in order to measure the classes. The purpose of this perspective is linked to the problems of road traffic accidents. Every day, a thousand of people are victims of traffic accidents that are directly related to the driver behavior [5], certainly, the driver behavior is among the major factors in the origin of accidents. In this regard, aggressiveness at the wheel has become a phenomenon causing road traffic problems, by highlighting the excess of speed, drunk drivers and other types.

Various works have been proposed in antecedent reviews, derived from the driver behavior conceptualization [6], [7], it is an evidence that the majority of works conceived such an architecture based on sensors and simulators used to recognize the movements of drivers and so on [8]. Also, like in [9] the authors attempted to detect derived behavior based on video camera by extracting different real sensations to measure the levels and warn the drivers.
The perspective of this area is based on a classification of driver behavior using a variety of techniques and based on a predefined motion model. In [10] the authors proposed an approach to detect dangerous behaviors on the road, in order to alert other vehicles by disseminating warning message in the appropriate time. The model is derived from some observable states based on a predefined data that the prediction can be triggered according to the maximum probability criterion. Among other classification techniques that are found, in the work [11], a Bayes network is used to classify the driver behavior, by predicting the vehicle lane change. In [12] a hidden Markov modeling is used to model vehicles using clustering.

Generally speaking, the reason behind this vision is to discover anomalous driving in advance, in order to re-evaluate existing ITS solutions. Indeed, it may help to prevent accidents and to reduce aggressive behaviors. Furthermore, we integrate a classification of different reactions into classes, to show their impact in simulation results. More clearly, the driver behavior is implemented in the form of a configurable degree of aggressiveness by proposing a psycho-physiological view of the decisions relating to behavior.

III. Smart mentality approach

The concept is based on the idea of transforming citizens into passive consumers and active inhabitants who produce innovative ideas. In general, the initiative is often applied without highlighting the role of citizens, the participation is limited, comparing with other actors. Nevertheless, their partnership has a substantial and heavy influence in the whole. Certainly, we have to consider that citizens are consumers, whose needs and desires must be satisfied, but also invest in making them co-producers and active citizens.

Our key interest is to propose a framework (the Figure 1) based on the human factor, the ambition is to resize the best achievable initiatives for designing a suitable example of smart city. To improve an exemplary and honorable citizen, it will require an interaction between different systems, especially, the decision system, defined as the governmental and institutional organism, then the steering and operating system, for instance, the active citizens. All these actors react in such a way to ensure the relevance of human factors and influences of creativity. To establish synergy and complementary between the various factors, we have to optimize the core system to have the desired result. If one component is less developed than the others, the result will not probably be a great success. In short, the model that we designed has as features:
-Citizen Involvement in decision-making to keep coherence between the territorial offer (infrastructure, aesthetics, architecture), along with identity.
-Ensuring organized, active and peaceful citizen participation, citizens must, therefore, understand ideas about citizenship.
-E-government adoption and acceptance.
-Rethink the charm interactivity with citizens, while incorporating all the emotions of citizens in the process. The concept is to influence the ideas in their mind, in order to create emotional associations.
-Promoting citizen innovation, the necessity of the open data to better engage citizens.
-Investing in awareness campaigns and personal skills to become familiar with the concept.
-Participation in political decisions and strategies with the community.
-Acting on the culture, changing the mentality and way of thinking to ensure a successful change.
-Make the citizens believe that their potentials and smartness are factors of smart city success and not that the city will become an autonomous being, able to govern wisely.
-Develop knowledge and skills of engineering related on smart cities and supporting innovation in the field of smart cities.

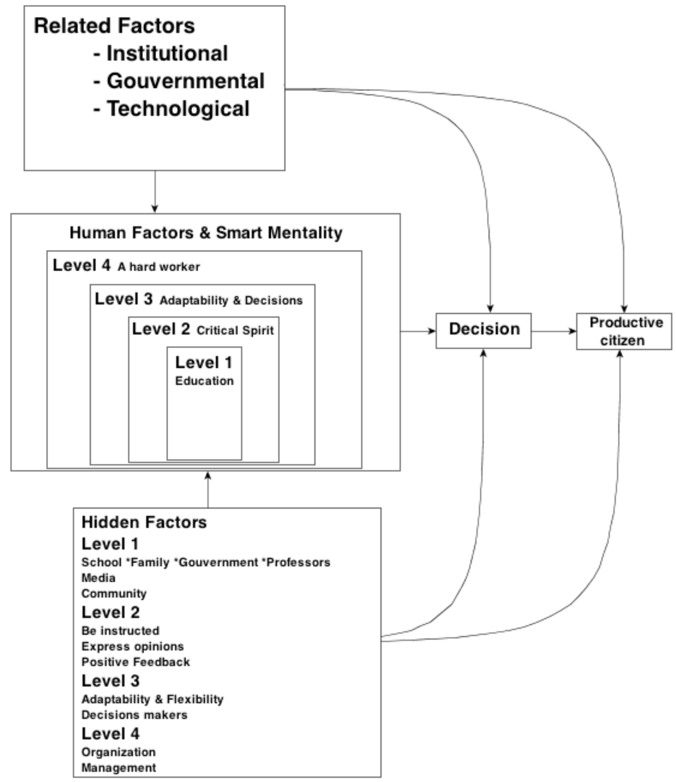

Fig. 1. Smart mentality intuition

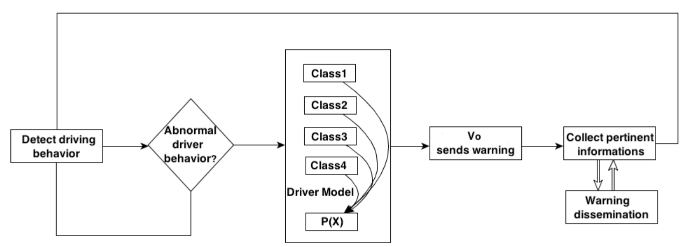

Fig. 2. Integration of the driver behavior classes into system

IV. Integration of behavior classes

A. Simulating the impact of drivers' behavior on city

For an eventual implementation in a real simulation of traffic, we integrated such classes of driver's behavior within the SUMO (Simulation of Urban Mobility), the traffic micro simulator to modulate the vehicles' mobility. We conceived a hypothesis configuration to implement the driving behavior, which include states that reflect on traffic and to configure the network variables. We have presented all the possible combinations of inputs, the model of probability can then, being able to detect the state of the drivers, as shown in the Table I. Applying all possible combinations, a basis of the combinations are defined in the Table II. All inspiration and conception details of classes are summarized in the Table V. The next section, emphasis already the approach defined with details.

That being said, the impact of the human driver behavior in this type of degree must be considered instead assuming and creating a perfect model of ITS. Using the proposed classes, we managed a number of simulation experiments to study the impact of actions taken by drivers offering different classes of mentality, the Figure 2 defines the core functionality of the system.

The objective is to detect dangerous behaviors on the road, in order to alert other vehicles by exchanging warning

Hypothesis vehicle	Class 1	Class 2	Class 3	Class 4
State	The Normal Behavior	The Drunk Driver	Driver Fatigue	The Unconscious Driver

TABLE I. HYPOTHESIS BEHAVIOR STATES

Probability	Combination
Class 1	- Degree of aggressiveness
	- Degree of Acceleration and Deceleration
Class 2	- Driver Imperfection
	- Stress
Class 3	- Degree of congestion
	- Degree of difficulty of travel
Class 4	- Lanes position
	- Reaction time

TABLE II. COMBINATION OF CLASSES PERCEPTION

message at the appropriate time. The model is derived on some observable states from a predefined data that the prediction can be triggered according to the maximum probability criterion.

In our case, we want to compute the driver behavior of each possible number of vehicles, the detection is constructed with a Naive Bayesian classifier, which is a probability classifier based on Bayes theorem [13]. The choice to use this model is, however, due to simplicity of the building and the utility of the contributions to outperform highly sophisticated approaches to identify driver behavior.

We would like to estimate the probability for each available behavior observation, for this reason the detection is then made using the Naive Bayes classifier, which selects the abnormal driving behaviors, that being by maximizing the probabilities derived from data, anchored in the Tables I, II, and V, to formulate pertinent decisions.

The classifier takes the attributes, and tries even so to predict its class probabilities based on the capturing observable context. As a matter of fact, such model is fast and easy to implement, and the accuracy is guaranteed. It should be noticed that the Naive Bayesian is not susceptible to the redundant features. Nevertheless, if we try to classify the capturing observations based on predefined classes. We can have almost the same results in some features of classes and it will not cause any problems. Though, this assumes that we have a reliable estimation of the probabilities.

The Table III recapitulates the significant notations that we pursue throughout the rest of the paper and the probabilities for the individual hypothesis are given by:

$$P(S_j|c) = \frac{p(c_1|S_j) * p(c_2|S_j)...p(c_n|S_j)p(S_j)}{p(c)} \quad (1)$$

To illustrate clearly the classification, based on the data already predefined in the Tables I, II, and V, a knowledge table is considered, after that the likelihood table is created by the probabilities. Decisively, the Naive Bayes assumes and determines the probability of each description given. Nonetheless, we can predict any classes by the posterior probability for a given observation.

By proposing an alliance of features, in particular, the posterior probability of class $P(S_j|c)$ given the state prediction for each training observation C. Using the Naive Bayesian makes

Symbol	Significance
V	Set of vehicles in the roads
m_w	Warning message
m_c	Classical message
B	Behavior of the driver
l_t	Label of the vehicle v_i
S_t	Type of state predefined
L_x	Location of the event for which the alert was generated
D	The separation distance
s_x, s_y	Emitting coordinates
r_x, r_y	Receiving coordinates
t_v	Time value
V_o	Observing vehicle
V_r	Reporting vehicle
R^{tx}	Maximum transmissions range
T	The maximum time duration allowed
d	The directional distance
S_t	Target Speed
P_t	Target Position
AD_t	Target Acceleration/Deceleration
TTL_t	Target Traffic Light
DI_t	Target Driver Imperfection
RT_t	Target Reaction Time
δ_i	Weighting Factor
$w(C_i)$	Weight function
$P(S_j|c)$	Probabilistic classifier

TABLE III. NOTATIONS

the assumptions that each c_i is conditionally independent of each other given S_j.

The detection is then made using a driver behavior method, which selects the abnormal driving behaviors, that being by maximizing the probability based on data already predefined in order to formulate pertinent decisions.

$$\gamma_{DB} = argmax_{s_i \epsilon S} P(S = s_i|C_1, C_2, C_3, C_4)$$
$$= argmax_{s_i \epsilon S} P(S = s_i) P(C_1, C_2, C_3, C_4|S = s_i)$$
$$= argmax_{s_i}$$
$$\text{P(S=s}_i) \prod_i P(C_1|S = s_i) P(C_2|S = s_i)...P(C_4|S = s_i) \quad (2)$$

An alert message denoted by B with four attributes, which proceed a warning alert about an eventual risk generated by the source of all its neighboring vehicles. We assume that a pseudonym identifies a vehicle that generated by the probability of each driver behavior, the event localization, and the time at which the alert message had been sent.

The detection of driver behavior can be triggered automatically by capturing observable states performed as follows:

$$B = (l_t, P(c|S_t), L_x, t_v) \quad (3)$$

Each state may be anchored by capturing observable context already predefined.

$$S_t = (C_1, C_2, C_3, C_4)$$
$$C_1 = Class1; C_2 = Class2; C_3 = Class3; C_4 = Class4; \quad (4)$$

The fitness function presented is proposed to give a landmark to detect a class in a vehicle's route, it consists of weighted cost components including the essentials states.

If the function is suspected of exceeding the norms, the

Algorithm 1. Exploits the accident warning messages Part 1

Part 1: detectAnomaly
Input:
(01) T_r set of trajectories road
(02) minCal // minimal calibrate threshold
Method:
(03) for(i=0; i<=count($T_r.tid$; i++)
(04) for(p=0; p<length.road-2; p++)
(05) if(Observablebehaviour > minCal)
(06) anomalousList.add((p).(p+1))
(07) r=getRadius(p,p+1,p+2)
(08) return anomalousList()

Algorithm 1. Exploits the accident warning messages Part 2

Part 2: driverClassifier
Input:
(01) anomalyList
(02) warning message m_w
(03) classical message m_c (ordinary message in VANET)
(04) Initialization all vehicles and get all coordinates
(05) foreach vehicles v_i in V do
(06) v_o collects the observed behavior
$B = (l_t, S_t, L_x, t_1)$
(07) Check severity of B using observable context
(08) if (B is in suspicious state) then
(09) if v_i is in warning mode) then
(10) create alert message m_w
(11) if first time sent warning message then
(12) calculate the ideal position of v_r
(13) newSource ← (idealPosition)
(14) computes t_v
(15) send (warning alert) to v_r
(16) create classical message m_c
(17) send to all neighbors
(18) for (every received message m_w) do
(19) if (first time receive warning message) then
(20) if (satisfy equation) then
(21) look up in for event state
(22) r=check.observablebehaviour()
(23) if r=1 then
(24) broadcast (m_w) to all neighbors
(25) else
(26) discard (m_w)
// Vehicle v continues the warning
// Vehicle r schedules the transmissions
(27) r. Schedule Message (Delay);
(28) end if
(29) end

detection is then, activated by the particular event.

$$\begin{cases} \omega(C_i) = \delta_1.S_t + \delta_2.P_t + \delta_3.AD_t + \delta_4.TTL_t + \delta_5.DI_t + \delta_6.RT_t \\ \sum_{i=1}^{6} \delta_i = 1 \end{cases} \tag{5}$$

The objective of these experiments is to evaluate the influence of the mentality parameters in traffic performance. The relevant solution is to conceive an appropriate model to enable fluidity in the exchange of warning messages, to ensure road safety by alerting the driver and other vehicles in case of abnormal problems.

Collecting the observed abnormal behaviors exposed by drivers, is one of the primary challenges to provide a pertinent solution. In addition to warn others vehicles on the road. In order to assure the communication fluidity, and to anticipate accidents from happening. The idea is to exploit a knowledge base collected to explore a probability calculation of an approaching emergency vehicle tending to alert and improve traffic efficiency by preventing violation of drivers in road traffic, and incident from occurring. The Algorithm 1 describes how vehicles proceed during the communication, however, if a severe event happens, by collecting information about the driver behavior in real time. As part of managing the warning notification related to the eventual risk, the system starts to prevent all the neighboring vehicles. The main objective of this part is to anticipate such scenario analyses of driver behavior, particularly as a high aggressiveness, traffic jams and accidents.

To consolidate the approach of smart mobility on transport field, we strongly derived our study on Vehicular ad-hoc networks. It is an application that represents vehicles as nodes, which characterized with a high mobility, each vehicle will be able to transmit and receive messages, that is to say, that are accessible to establish communication between vehicles through the wireless network. The vehicles are based on routing decision to calculate an efficient path in order to choose their ideal destination, and more effectively by exchanging warning messages via the vehicle-to-vehicle communications.

The consistency of success related to VANET is potential to increase road safety, especially in term of congestion and accident prevention. However, to accomplish their main goal the vehicles communicate with each other to escape abnormal traffic conditions. With this perspective of security aspects, we tried a proposition to strengthen the concept, based on the evidence that the exchanged messages in VANET influences the driver behavior.

B. *Visual perception configured in simulation under dangerous conductors*

The perception and understanding of the road environment by the conductors, influence strongly the road safety. It is therefore common to be interested with the decision of visual information on drivers, to determine the information provided by the road infrastructure, which are likely to help drivers in their task. With that, we have adjusted parameters related to the visual perception in among many situations of simulating the driver behavior, in order to study the impact of visual information under the behavior.

The reason why we explained with details the visual perception of human brain, is that we configure integrated framework into the simulator. The perception of the behaviors is organized in classes, that produce different reactions on presenting traffic information. The scope of perception in this context is, thus, making an internal model of the drivers, which is thereafter manipulated into a set of output. These classes are more psychological view oriented study outlined some dependencies between drivers' stress level, degree of aggressiveness along with their reaction. The attributes of classes use such a parameter calibration to distinguish which nature is the driver. Each feasible class has a set of attributes, the classification is then used to represent the correlation of a sequential step with the driver selection. As can be seen in the Table I and II, the classes contain statistical measurement, and the table V describes a large conceptual of the inspiration and conception of classes.

The lucidity idea was to perform some observations from inspiration, in order to propose a solution of an adequate information system, the basic concept is based from an inspiration of visual perception. Nevertheless, to have a better positioning, to easily dissect the information. To explore these inspirations,

we will take a look at the visual perception, evidently as a result of a complex information processing.
To demonstrate the impact and interest in this study, we were discussing the benefits of the functional anatomy of the brain. The visual cortex has multiple areas that correspond specifically to the various aspects of the visual stimulus, such as color, direction of movement, and forms. The information received by the occipital cortex is split in several other areas that participate in the development of visual perception, such as the temporal cortex, parietal cortex [16], [15]. Thus, the most parietal regions of the occipital cortex are an area that allows the location of the object and the temporal region of the occipital cortex is an area that allows the object recognition. The V1 and V2 areas play a very important role in the perception of contours and great visual perception. The area V4 contributes in color perception and V5 area provides a motion perception as defined in the Figure 3.

It is known that a higher brain functions locally alters the blood flow [16], [17]. When a brain area involved in task execution, the neurons in that area and all the connections are activated. However, the connections, synapses, exchange information, these activities consume already the energy. The small arteries supplying the brain regions expands to provide extra oxygen, all brain activity results in increased blood flow. The nerve messages emitted by retinal cells spreads to the brain, and more particularly to its peripheral portion called the cortex, where the data processing is carried out. The number of nerve cells is in action, in addition, the blood flow is important. The serious state of drivers in road traffic, can aggravate such complications in the brain's ability of visual perception.

As a continuation of the inspiration and conception of classes summarized in the Table V. We configured the visual perception model in dangerous conductors classes. By highlighting the configurable state of visual perception, specifically, in class 2, the class that refers to a driver intoxicated by alcohol, the conductor neglects the influences of their acts, as well as in class 3, in this type, the drivers associated with a low effectiveness, and including in the class 4, the unconscious drivers. However, the driver is supposed to be able to correctly identify, in time, the indications and all the different obstacles on the road. That being said, we discuss the relevance of the visual requirements in simulation.

The interest of this work is to offer a wider simulation of the driver behavior and to highlight the influence of the behavior when approaching in the intersections with traffic lights, for example. However, the aim is to find the results in order to interpret them for the improvement of intelligent transport systems in order to increase the driving efficiency. With this knowledge, we will then be in the position to estimate the systems proposed for the intelligent transportation systems in order to avoid any abnormal problem.

In consideration of the foregoing, the main objective of these experiments is to evaluate the influence of the driver's behavior parameters in real traffic. We dissect the effects that these classes will have on network performance, related to the travel time and the environment. Withal, the idea is to bring out the relationship between the visual context road and the driver behavior. In addition, it appears that among the reason of the most common causes of accidents on the roads, is, however, the problem of making or processing the information, leading to an inappropriate driving behavior, in particular, of the most dangerous drivers.

We looked at the relationship between the visual context and the behavior driver, it is therefore fundamental to be interested in the visual aspect to determine the decisions that will be taken. In addition, we are interested in the process of decisions in the approach of intersection related to traffic lights.

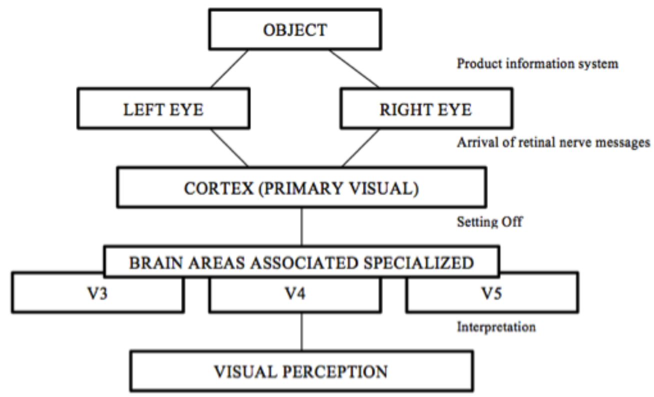

Fig. 3. Diagram of visual perception

C. *The model of VANET for detecting and alerting the drivers*

The work proposes an improved intelligent transportation system offering the opportunity to exploit the benefits of smart mobility. The relevant solution is to conceive an appropriate model to enable fluidity in exchanging warning messages, in order to notice the observable behavior.

Affecting at the same time, two factors, namely the smart transportation, ensuring optimization of routing message, and the smart environmental to also contribute to more efficient use of cleaner environment, by reducing the fuel consumption, and more pollutant emissions. We assume that all the vehicles are equipped with the GPS system for the initial location, antennas, OBU, and other sensing devices, to obtain a vehicle's position, speed and acceleration, including the VANET connection system with the 802.11p, a draft amendment to the IEEE 802.11 standard for vehicular communications. The algorithm determines how vehicles proceed during the communication. However, if a severe event happens, like a detection of a considerable driver behavior derived from predefined classes, the source starts a warning alert about an eventual risk of all its neighboring vehicles. When the behavior driver is detected, the model provides a reliable way to select a reporting vehicle in such ideal position, in order to rebroadcast the emergency message to all other neighboring with a support during the confirmation of abnormality. For a suitable selection of the reporting vehicle, we will have to satisfy the following conditions. Like the reception of message in success circumstances, and the farthest directional distance related to other vehicles.

In our model, each vehicle periodically broadcasts pertinent information, one of the primary tasks of vehicular communications. When an observing vehicle receives the broadcast message, it computes the driver behavior, the current state already predefined in classes that can be characterized by capturing a set of observable and abnormal context. It immediately forwards it to the reporting vehicle. After receiving the message from an observing vehicle, the reporting vehicle examines the reliability of the alert based on the last received information, then it re-broadcasts the message to the nearby vehicles with a view to cover a large area. The warning messages should be propagated to all neighbors with a certain number of hops, while based routing protocol perception.

The algorithm 1 defines our considered model, where V indicates a set of vehicles in the roads; m_w represents a warning message generated by the observing vehicle and broadcasted by the reporting vehicle; m_c a normal message generated by vehicles. The algorithm allows discovering anomalous driving behaviors: first it identifies abnormal movements based on abrupt acceleration, deceleration and direction change. These abnormal movements are classified in an internal model comprising different reactions on presenting traffic information.

Secondly, it analyses the area where abrupt movements happened, the speed and the maximal speed of the road in order to classify the drivers. The pseudo code of the algorithm is split into two main steps a find abrupt and a driver classifier.

Furthermore, we consider that a vehicle is a neighbor of another when the distance between both vehicles is lower than the wireless transmission range, so that the communication between them can be possible. To estimate the state of network connections, we use the information on each vehicle's position and maximum transmission range. Maximum transmission range R^{t_x} represents the communication range that can be achieved using maximum transmission power.

$$d_e = \sqrt{(s_x - s_y)^2 + (r_x - r_y)^2} \tag{6}$$

$$d_v = d_e \cos\theta \tag{7}$$

$$\theta = \arctan\frac{s_x - s_y}{r_x - r_y} \tag{8}$$

$$D = T(1 - \frac{d_v}{R^{t_x}}) \tag{9}$$

In relation with the distance calculation, the warning emitter uses such distance, it computes a delay, which will be used to compute the final delay to retransmit the message. The metric to estimate the performance of the network is the distance covered by the message from the given route. The formulas are represented by (6), (7), (8), (9). Where $(s_x - r_x)$ and $(s_y - r_y)$ are the vehicles coordinates v_o and v_r, $d \leq {R_s}^{t_x}$, which means that vehicle v_r can successfully receive a message from vehicle v_o.

One of the ideas that was included, is nevertheless, the detection of the reaction preparing time, this can be defined, by reference of the time which an observed vehicle reacts in order to send the captured decision into the reported vehicle. As a matter of fact, let v1 and v2 be the eventual speed, respectively, of the V_o and V_r with of course the transmission range R^{t_x}, the V_o attempts to send the observations to the V_r. Hence, the reaction time is the time between these vehicles enters the R^{t_x}. However, the reaction can be defined as R_t is $R^{t_x}/(V_1 - V_2)$. That said, the speed here is multiplied by time, so it is equals the length.

V. Routing protocol perception

Concerning the evaluation for an efficient and reliable emergency message, the metrics that we have studied are the packet delivery ratio and the average delay end-to-end. Afterwards, we have elected the OLSR, the Optimized Link State Routing Protocol [18], [19] as the proactive routing protocol for our model implementation. We favored the OLSR for our implementation, the reason behind this choice is that the OLSR is defined as a link state protocol, which each node reports its direct links to its neighboring nodes.

When we define a short overview related to this protocol, we can dissect that the advantage recognizes this type of protocol is the absence of the prior discovery route, that being said the destination is stored in the routing table, the protocols keep updating this table in each node, and with every change of network topology, however, these routing tables are updated. OLSR uses the technique of MRP (Multipoint Relays), the idea is to reduce the storm of broadcast, this mechanism consists in ignoring a set of links and direct neighbors which are redundant for the calculation of the shortest path routes. One of the reasons of our choice is that this protocol has a number of characteristics that make it suitable and promotes its use in vehicular networks, especially on exchanging message warning. It is particularly appropriate for the network with applications that require short transmission delays.

This protocol has a number of characteristics that make it suitable and exposes its use for VANETs networks, among others, it reaches an adequate performance in relation to the delay used to express the transmission of data packets in large networks, adapted to topology changes, simple and can be applied in different types of systems. It is particularly convenient for the network with applications that require short transmission delays, just like as the majority of the vehicular network applications, and especially the exchanging warning message.

Besides the fact that it comes with several promising advantages, the proactive protocols are inapplicable, for the reason that too many signaling messages are required for a perfect vision of the topology, indeed the requirement to maintain the routing table for all possible routes. Such a disadvantage may be insignificant for low-density scenarios. However, for a congested network, this will trigger an overload control message that could consume more bandwidth and causes network congestion.

However, we can bounce back with an intelligent and lucid use. That being said, to optimize the performance of routing decision, we realized some changes affecting the internal configuration strategies of the protocol. Thus, calculating an optimal configuration for the parameters of this protocol is crucial before deploying it, because it could decisively improve the quality of service, with strong involvement of the expansion of the network's data rates and reduces the network load. Afterwards, we will be based on the basic idea of electing the specialized nodes MPR in OLSR, the function of this particular entity is to reduce the overhead of flooding messages by minimizing the duplicate transmission within the same zone. Consider the MPR as a relay gateway, beneficial for ensuring the interaction between cluster head and classical members.
Due to its proactive nature, OLSR works with a periodic

Originator Address		
Link Code	Reserved	Link Message Size
Neighbor Address		
…..		
Link Type	Reserved	Link Message Size
Neighbor Address		
…..		

Fig. 4. OLSR Hello Message Format

Originator Address	
Advertised Neighbor Sequence Number (ANSN)	Reserved
Advertised Neighbor (MPR Selector) Address	
…..	

Fig. 5. OLSR TC Message Format

exchange of messages, already defined, the Hello and TC messages. The idea was to calibrate the QoS (Quality of Service) routing extension for OLSR by modifying the selection of the entity and the TC messages to spread the QoS information throughout the road. The Figures 4 and 5 [18] show, respectively the basis format of a Hello message and TC message.

To make the vehicles understand what another vehicle notifies, a specific common message format is necessary. The different types and codes are simultaneously used to identify different driving notifications. The type field indicates the different main categories of driving decisions. Each type includes its corresponding codes and indicate which driving decision the vehicles wants to notify. They are defined based on classified driving behavior (from type 0x01 to 0x05). Obviously, there are three types of control messages: the Hello messages, the topology control (TC) messages, multiple interface declaration MID message. To achieve the optimization, the Hello message and TC message format has been modified. The modifications are presented below:
Reserved field: the first three bits are used to encode the version number of this extension of the message (001).
Prob Value: this Fields maintains the probability value of the anomalous vehicle.
The different types and codes are simultaneously used to identify different driver behavior.
Type: the value type field indicates the different classes of predefined driver behavior.
Code: each type includes its corresponding codes in order to capture the driver behavior.

However, this type of message is essentially derived from the original Hello message, which makes them common filed. In fact, the vehicles use this type of message to broadcast the data. In addition, this data contains the pertinent information about the types and the identifier of the issuing vehicle. Supplementary, we conceived an acknowledgment message format, used by the vehicle source conducive to ensure the delivery of information, in order to alert neighbors over the traffic road. In the Table IV, all classes and codes defined in the format are listed, including its descriptions.

Type	Code	Data
Class 1	0x01	Probability of: control the speed of each vehicle, maintaining an ideal position between lanes, avoiding sudden acceleration.
Class 2	0x02	Probability of: a sudden acceleration, driving without maintaining the proper lane position, and driving without controlling the speed.
Class 3	0x03	Probability of: Increases of travel times, increases the stress, augmentation of stops, and provoked jams frequently
Class 4	0x04	Probability of: a high speed, high degree of acceleration and put other traffic participants at risk causing accidents.
Emergency warning	0x05	Used to alert other vehicles about the environmental emergency -0x00 Minor warning -0x01 Medium warning -0x02 High warning

TABLE IV. THE DESIGN COMPONENTS OF TYPES IMPLEMENTING IN PACKETS

VI. SIMULATION PARAMETERS AND INTERPRETATION OF RESULTS

The main objective of these experiments is to evaluate the influence of the driver's behavior parameters in real traffic. We dissect the effects that these classes will have on network performance, related to the travel time and the environment. To ensure the efficiency of the proposed approach, the simulations are conducted to verify these things. As we defined in the previous part, in the simulation, each vehicle is equipped with the OBUs, Which in turn contains the interface of VANET communications with a certainty of transmission range. So that, clearly, allows vehicles to exchange information with neighboring vehicles. As mentioned already, the vehicular communications can only be established if the distance between the vehicles is less than their transmission range. We have an intuition that a vulnerable personality cannot only affect road safety, but also the environment such as an increase in the fuel consumption, pollutant emissions, the level of traffic noise, and also the quality of life for people living near the road. In experimental steps, we compare the results obtained on the Table V to define an effect of realism.

In this phase, we anticipate our approaches conceived by means of simulation experiments. The analysis will be derived from SUMO (Simulation of Urban Mobility) [20] the open source simulator refers to urban mobility. It allows the user to build a custom route topology, and also it helps to import different card formats in many cities worldwide. Likewise, in order to calculate pollutant emissions, we use the EMIT model a statistical model for instantaneous emissions and fuel consumption of vehicles integrated in SUMO. We have used NS2 (Network Simulator 2) [21], [22] the network simulator of general purpose. To ensure the interactions between those tools, the simulation will be based on the MOVE (Mobility model generator for vehicular networks) [23] to generate a model of mobility within the VANET simulations. This tool is developed on the upper layer of the open-source micro traffic simulation software. Nevertheless, we applied a realistic scenario for traffic simulations taken from the Open Street Map as described in the Figure 6, by considering a road network section from the city of Rabat in Morocco, and taking into consideration real parameters of traffic. As a next step, the Figures 7, 8 and 9 define respectively the procedure to generate a real traffic simulation, since the capabilities

Fig. 6. Generalization of a real map of Rabat (Morocco) using Open Street Map

Fig. 7. Import the map of Rabat (Morocco) using Open Street Map by the simulator SUMO

to import road networks from Open Street Map until the configuration and visualization of the simulations. The main parameters of the simulation are summarized in the Table V.

We evaluated the average travel times in the Figure 10 based on the vehicle density. It is evident that the average travel time increases, when the abnormal classes takes the lead. However, the normal class1 was performing the best results versus the other classes, which confirmed by a constant stability in comparison with the large raising measurements of average travel time respectively in the class2, the class4 and the class 3.

The graph depicts that the first class does not affect the travel time, as a result that the driver tends to eliminate all the negative facts by respecting all predefined recommendations. Obviously, all undesirable and an unplanned events are avoided in this context.

The Figure 11 shows the analysis of the observed vehicles' consumption results depending on various classes. The graph confirms that the fuel saving consumption is directly proportional and has an affinity with driver behavior classes. Nevertheless, related to the first class, the fuel consumption is lowest when compared to the other classes. It is exactly the same thing happened to the CO_2 emissions as it can be seen from the Figure 12, these emissions created by burning fuel are directly related to the fuel consumption rate. That said, when the percentage of fuel increased, the emissions of the CO_2 realize a dramatically expanded and vice versa.

Furthermore, the class 2, 3 and 4 produce negative effects

Fig. 8. Visualization of the real world of Rabat (Morocco) by the simulator SUMO

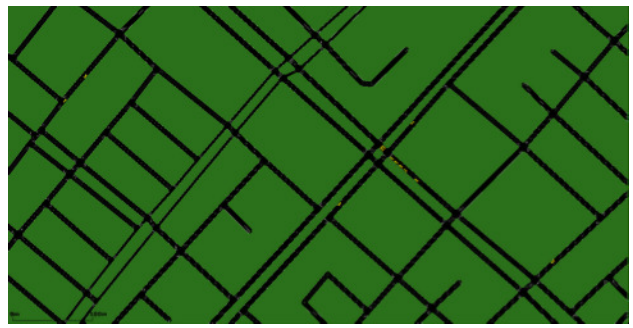

Fig. 9. Vehicle movements Visualization of traffic roads

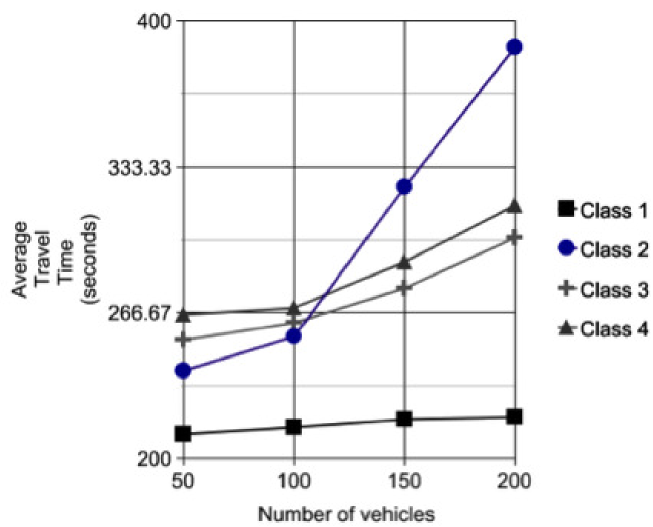

Fig. 10. Average travel time of Class 1, Class 2, Class 3, and Class 4, as a function of vehicle density.

into the traffic's performance of all metrics. The results of pollutant emissions can be depicted respectively in the Figures 13, 14, 15, 16 and 17. As it is possible to note from precedent figures, we defined the rest of pollutant emissions, PM, NO_x, CO, CH, and the noise level emissions. These abnormal classes anchor the highest rate, the emissions are influenced by the augmentations of misbehavior in the traffic load. On the other hand the normal class takes the lead with a mixture of the rise and stability.

Obviously, the variability of states has a negative reaction,

Class	Description	Simulation of classes
Class 1	The Normal Behavior, in this class the driver concentrates on the driving task and apply all the classical recommendations.	The simulation of this class is similar to the classical simulation related to the intelligent transportation systems. Concerning the simulation, we control the speed of each vehicle, maintaining an ideal position between lanes, avoiding sudden acceleration. -Calibration and control speed of vehicle -Ideal position between lanes -Avoiding sudden acceleration -Respect of traffic lights
Class 2	This class refers to a driver intoxicated by alcohol. An aggravated category, the drivers in this class neglect the influences of their acts and all the recommendations.	This class can be simulated on changing the impact of driving preferences We simulated this state by triggering a sudden acceleration, driving without maintaining the proper lane position, and driving without controlling the speed. -Sudden acceleration -Change lane and vehicle position -Speed / visual perception -Traffic signal violation
Class 3	Drivers ignore totally any procedure considering that the fatigue impairs mental processing and decision-making abilities. This behavior associated with a loss of effectiveness in driving.	This class can be simulated by integrating these factors Increases of travel times, increases the stress, augmentation of stops, and provoked jams frequently Provoked stress: -Traffic lights -Accidents and jams -Stops -Driver imperfection -Reaction time / visual perception -Changes the speed randomly
Class 4	Drivers ignore totally any procedure and advices. The unconscious driver.	This class can be simulated by changing the impact of driving preferences Simulated a high speed, high degree of acceleration and put other traffic participants at risk causing accidents. -High speed -High acceleration -Disrespect of traffic laws -Driver reaction and imperfection
Probability	The probabilistic class and an algorithm to alert other vehicles on the road by disseminating warning message	An approach to exploit the accident warning messages and updates the vehicle routes. Disseminating the alert message in due time, delivering the warning to the largest number of vehicles.

TABLE V. BEHAVIOR CLASSES

Parameter	Value
Simulators	MOVE/ NS-2/SUMO Classes integrated in SUMO
Packet size	512 bytes
Mac Layer	802.11p
Radio propagation	Two Ray Ground Model
Minimum speed	60 km/h
Maximum speed	120 km/h
Simulation area	$3000x1000m^2$
CBR rate	1-5 packet(s)/second
Simulation time	1000s
Traffic type	UDP (CBR)
Map type	OSM (Open Street Map)
Confidence interval	95%
Number of vehicles	50 to 200
Movement type	Random
Transmission time	From 10 to 950s (1000s)

TABLE VI. SIMULATION PARAMETERS

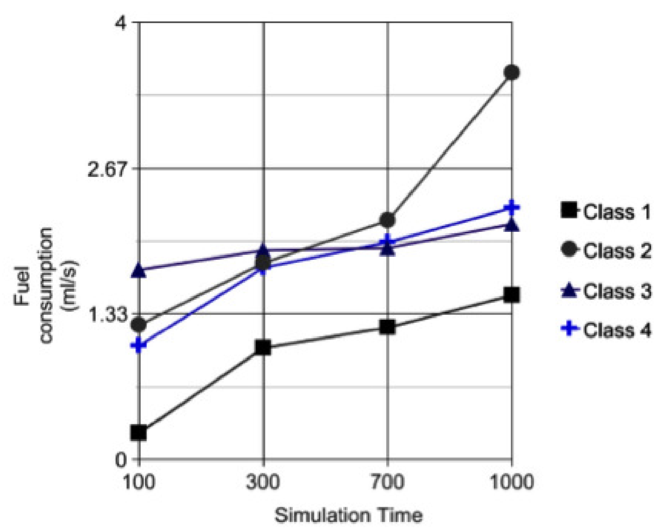

Fig. 11. Fuel consumption rate of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

also have a dangerous effect on road safety, that being said the management of road safety and environments have much in common. These driver behaviors affect the mobility metrics and traffic. Nonetheless, the higher speeds lead to more incidents, that being said, the accidents are an important cause of congestion.

A quick glance in the proposed algorithm, the objective is to provide a reduced time of the average end-to-end delay and a relevance gap in the delivery ratio, branded satisfying benefits in routing the detect message about abnormal drivers.

The model exploits the communication to facilitate exchanging messages, and thereafter detects undesirable events. The approach applies a model management, by providing in

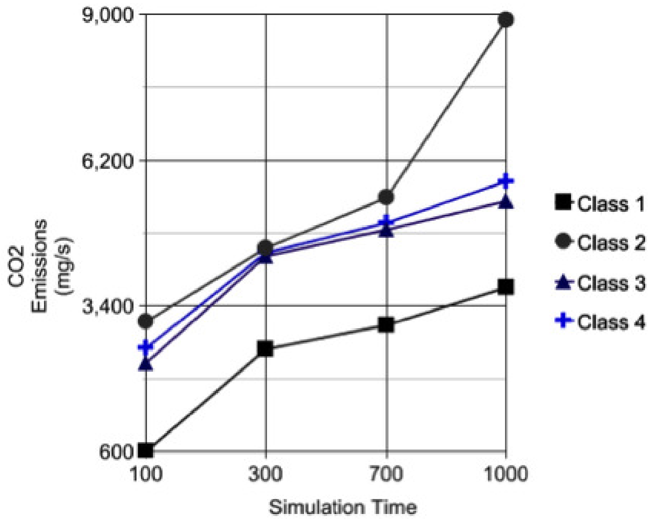

Fig. 12. CO_2 Total emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

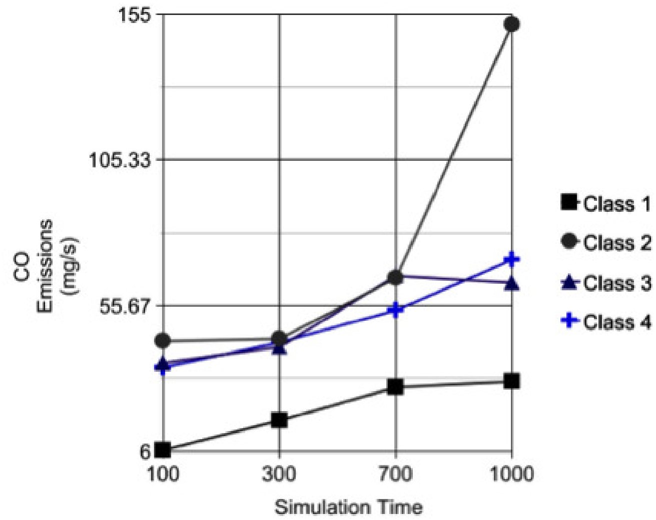

Fig. 14. The Carbon Monoxide (CO) emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

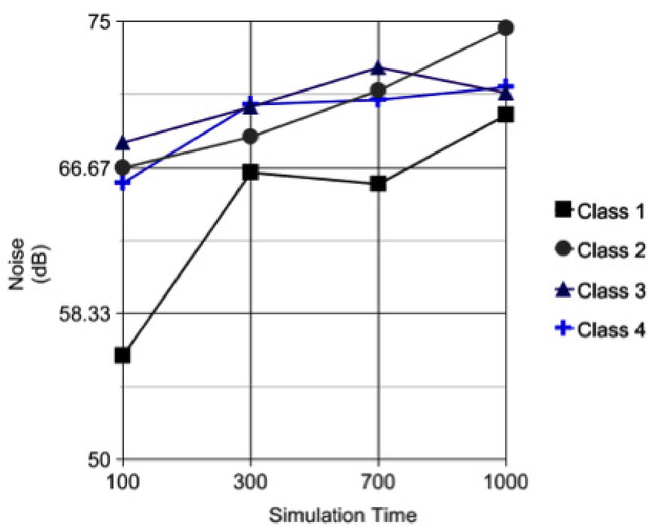

Fig. 13. The Noise emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

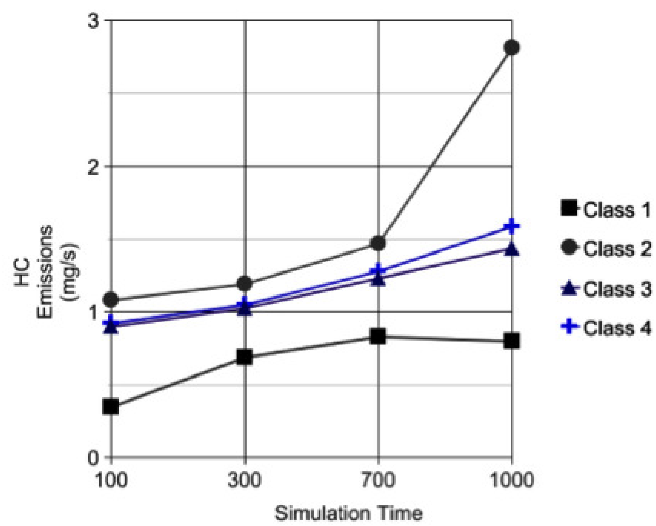

Fig. 15. The Hydrocarbons (CH) emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

exchanging control message to inform the nearest drivers. Derived from antecedent evaluations, we have an intuition that the suggested model could mark an acceptable benefit in terms of quality of service and optimization. In the future work, we are planning to extend the functionality by others routing protocol and implementing of the system. Also, we intend to analyze the performances of our deployed system in more realistic scenarios by using traces of real environments.

The Figures 18 and 19 define the performance of routing the multi-hop emergency message compared to the classical routing decision. A quick glance in the Figure 18 shows that in traffic with density, using the transmission protocol UDP (User Datagram Protocol), our proposed model provides a reduced average of end-to-end delay. The suggested architecture branded satisfying benefits, the reason for the observation is that whatever the important generated messages, the fluidity of architecture tend to stabilize the network and indicates a higher multi-hop broadcast efficient.

In the Figure 19, as we can catch from the graph using CBR (Constant Bit Rate) traffic, the highest rate that is anchored by our model. We can see that the average of the packet delivery ratios of the multi-hop emergency broadcast under our proposed protocol stays stable, while the packet delivery ratio varies related to the classical routing. Likewise, we observe a little decrease in the average, which is logical since the size and the number of messages is largest within the classical one, but that is not bad since the PDR, as shown in the eventual figure, is almost clearly outperforms, which demonstrates the relevance of the routing concept.

In the Figure 20, we evaluated the average travel time, based on average vehicle numbers. As we can be seen, the average varies for traffic flow, the traffic with the management of packets using OLSR. It's an evidence that the proposed

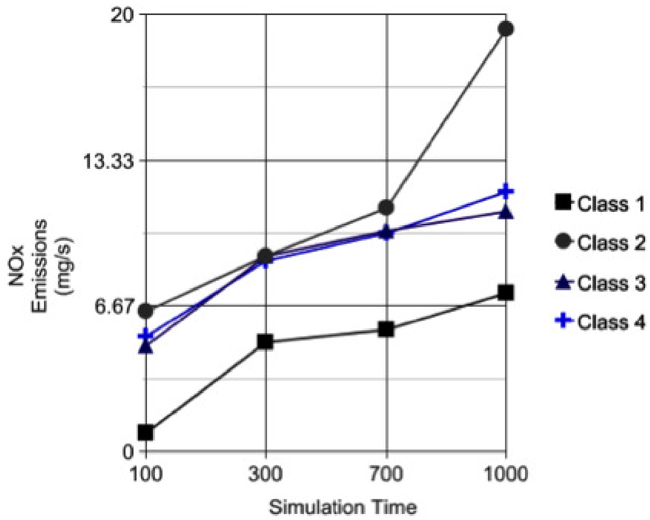

Fig. 16. The Nitrogen Oxides NO_x emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

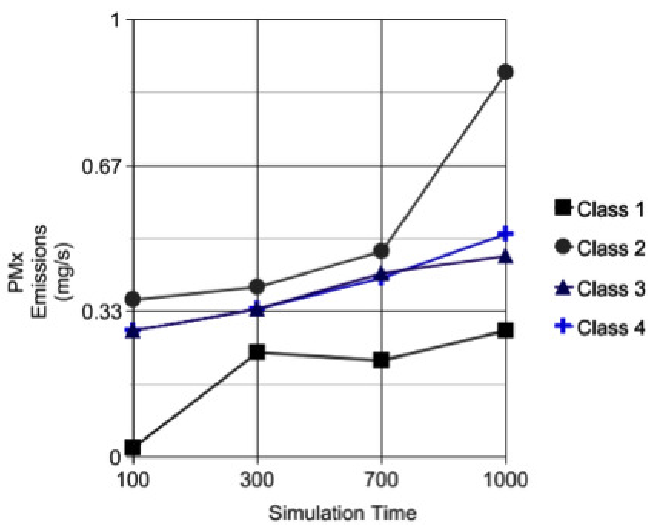

Fig. 17. The Particulate Matter (PM) emissions of Class 1, Class 2, Class 3, and Class 4, depending on simulation time.

solution can decreases the average travel time. However, the idea is to perform the possibility of the concept to propose a brilliant solution. One of the reasons allowing this kind of resolutions is the vehicles position, in particular the source one can be conveniently determined according to the modified packets.

In addition, the Figure 21 defines the identification time with a comparison between the message packets proposed and a basic process altering image processing and sensors in roads for identification, the data are transferred to the base stations. Of course, the transmission time is almost lowest than other solution. The reason is that the transmitted message is through via wireless technology. Therefore, for processing image, it takes a necessary time to identify anomalous driver and alert the sink. Furthermore, although the image processing can still perform better in real time.

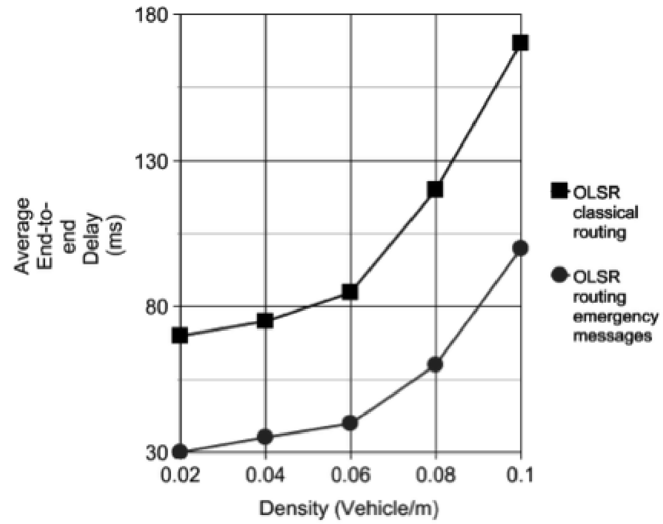

Fig. 18. Average End-to-end delay of multi-hop emergency broadcast for OLSR classical routing, and the modified OLSR routing emergency messages, depending on density.

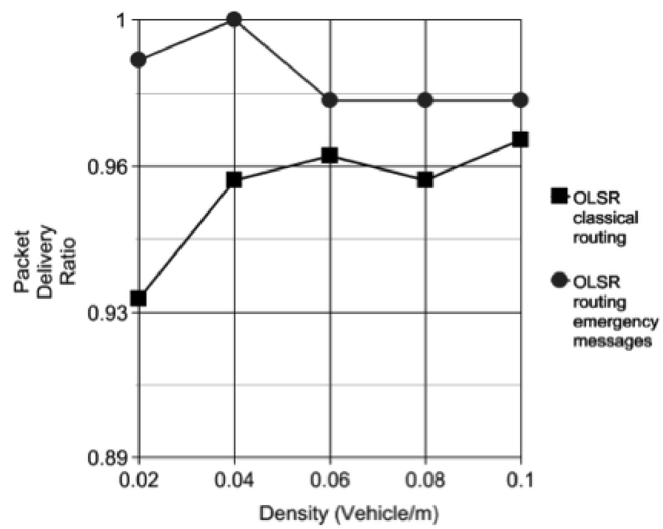

Fig. 19. Average Packet delivery ratios of multi-hop emergency broadcast for OLSR classical routing, and the modified OLSR routing emergency messages, depending on density.

VII. Conclusion

The metamorphoses of smart city generate an appropriate need for safety application in vehicular communication. In particular, evaluating and detecting the behavior of drivers are so crucial to ensure road safety by routing the warning alert in the best conditions in case of abnormal driving. In this paper, we projected a large conceptualization of smart city, in consideration of modeling the factor of human smart mentality. Thereby, we proposed approaches that are composed of three components: a framework for a smart mentality approach, an integration of behavior classes to simulate the impact of the driver's behavior on city, and a model of VANET for detecting and alerting the drivers to enable fluidity in

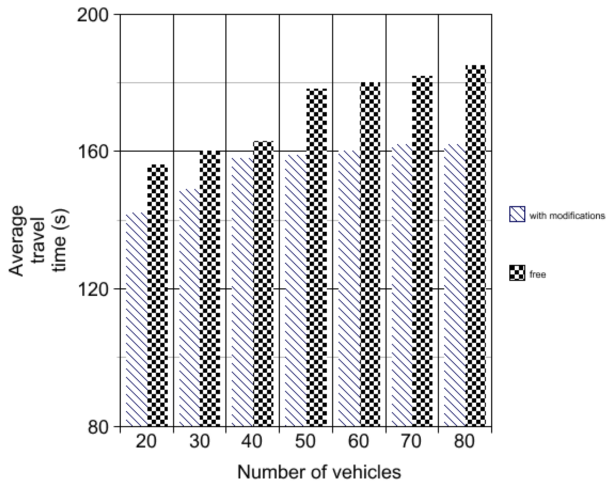

Fig. 20. Traveling time of individual vehicles for free flowing traffic, and the traffic with the management of packets using OLSR

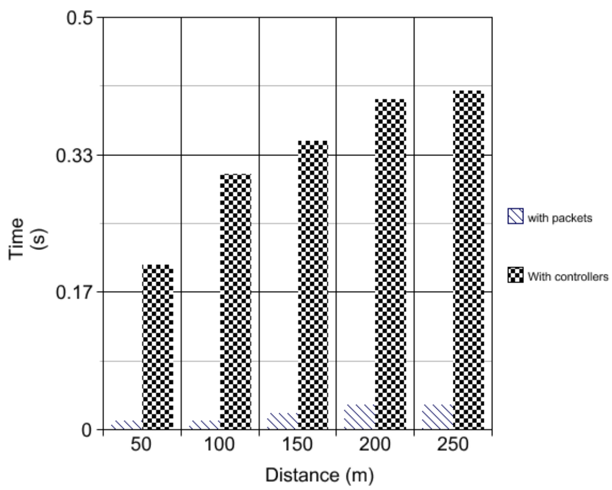

Fig. 21. Reaction time with the comparison between the message packets proposed and a basic process altering image processing and sensors in different distances when the message is transmitted

exchanging warning messages, and conceive the probability to extremely minimize accidents and alert the neighboring vehicles.

The suggested model marks an acceptable benefits in terms of quality of service and optimization. In the future work, we are going to extend the functionality by others routing protocol and implementing the system. Furthermore, we intend to analyze the performances of our deployed system in more realistic scenarios by using traces from real environments.

REFERENCES

[1] Taewoo Nam and Theresa A. Pardo. Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, pages 282–291. ACM, 2011.

[2] Hafedh Chourabi, Taewoo Nam, Shawn Walker, J. Ramon Gil-Garcia, Sehl Mellouli, Karine Nahon, Theresa A. Pardo, and Hans Jochen Scholl. Understanding smart cities: An integrative framework. In *System Science (HICSS), 2012 45th Hawaii International Conference on*, pages 2289–2297. IEEE, 2012.

[3] Brian Handwerk. Half of humanity will live in cities by years end. *National Geographic News*, 13, 2008.

[4] Y. Hernafi, M. Ben Ahmed, and M. Bouhorma. An approaches' based on intelligent transportation systems to dissect driver behavior and smart mobility in smart city. In *2016 4th IEEE International Colloquium on Information Science and Technology (CiSt)*, pages 886–895, October 2016.

[5] WHO | global status report on road safety 2015.

[6] Takashi Imamura, Hagito Yamashita, Zhong Zhang, MD Rizal bin OTHMAN, and Tetsuo Miyake. A study of classification for driver conditions using driving behaviors. In *Systems, Man and Cybernetics, 2008. SMC 2008. IEEE International Conference on*, pages 1506–1511. IEEE, 2008.

[7] Masahiro Miyaji, Mikio Danno, and Koji Oguri. Analysis of driver behavior based on traffic incidents for driver monitor systems. In *Intelligent Vehicles Symposium, 2008 IEEE*, pages 930–935. IEEE, 2008.

[8] Tobias Gindele, Sebastian Brechtel, and Rdiger Dillmann. A probabilistic model for estimating driver behaviors and vehicle trajectories in traffic environments. In *Intelligent Transportation Systems (ITSC), 2010 13th International IEEE Conference on*, pages 1625–1631. IEEE, 2010.

[9] Mandalapu Sarada Devi and Preeti R. Bajaj. Driver fatigue detection based on eye tracking. In *2008 First International Conference on Emerging Trends in Engineering and Technology*, pages 649–652. IEEE, 2008.

[10] Manuel Fogue, Piedad Garrido, Francisco J. Martinez, Juan-Carlos Cano, Carlos T. Calafate, and Pietro Manzoni. Evaluating the impact of a novel message dissemination scheme for vehicular networks using real maps. 25:61–80.

[11] Sayanan Sivaraman and Mohan Manubhai Trivedi. Looking at vehicles on the road: A survey of vision-based vehicle detection, tracking, and behavior analysis. 14(4):1773–1795.

[12] Amardeep Sathyanarayana, Pinar Boyraz, and John HL Hansen. Driver behavior analysis and route recognition by hidden Markov models. In *Vehicular Electronics and Safety, 2008. ICVES 2008. IEEE International Conference on*, pages 276–281. IEEE, 2008.

[13] Nir Friedman, Dan Geiger, and Moises Goldszmidt. Bayesian network classifiers. 29(2):131–163.

[14] Yukiyasu Kamitani and Frank Tong. Decoding the visual and subjective contents of the human brain. 8(5):679–685.

[15] Alan Cowey. Cortical maps and visual perception the grindley memorial lecture. 31(1):1–17.

[16] Yukiyasu Kamitani and Frank Tong. Decoding the visual and subjective contents of the human brain. 8(5):679–685.

[17] Bernard Mazoyer. L'imagerie crbrale: IRM et TEP: Cerveau. (302):42–49.

[18] Thomas Clausen and Philippe Jacquet. Optimized link state routing protocol (OLSR). Technical report, 2003.

[19] Yassine Hernafi, Mohamed Ben Ahmed, and Mohammed Bouhorma. ACO and PSO Algorithms for Developing a New Communication Model for VANET Applications in Smart Cities. *Wireless Personal Communications*, pages 1–37.

[20] DLR - Institute of Transportation Systems - SUMO Simulation of Urban MObility.

[21] The Network Simulator - ns-2.

[22] Yassine Hernafi, Mohammed Bouhorma, Mohamed Ben Ahmed, Anouar Boudhir, and Yasser Abdulrahman Alluhaidan. Clustering Architecture for Smart Mobility Control: Application to Pilgrims in the Great Mosque in El Hajj. *Journal of Theoretical and Applied Information Technology*, 78(1):84, 2015.

[23] Feliz Kristianto Karnadi, Zhi Hai Mo, and Kun-chan Lan. Rapid generation of realistic mobility models for VANET. In *Wireless Communications and Networking Conference, 2007. WCNC 2007. IEEE*, pages 2506–2511. IEEE, 2007.