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Implementation of Random Forest Algorithm in Order to Use Big Data to Improve Real-Time Traffic Monitoring and Safety

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Abstract: *Nowadays the active traffic management is enabled for better performance due to the nature of the realtime large data in transportation system. With the advancement of large data, monitoring and improving the traffic safety transformed into necessity in the form of actively and appropriately. Performance efficiency and traffic safety are considered as an important element in measuring the performance of the system. Although the productivity can be evaluated in terms of traffic congestion, safety can be obtained through analysis of incidents. Exposure effects have been done to identify the Factors and solutions of traffic congestion and accidents.*

In this study, the goal is reducing traffic congestion and im-proving the safety with reduced risk of accident in freeways to improve the utilization of the system. Suggested method Manages and controls traffic with use of prediction the accidents and congestion traffic in freeways. In fact, the design of the realtime monitoring system accomplished using Big Data on the traffic flow and classified using the algorithm of randomized forest and analysis of Big Data Defined needs. Output category is extracted with attention to the specified characteristics that is considered necessary and then by Alarms and signboards are announced which are located in different parts of the freeways and roads. All of these processes are evaluated by the Colored Petri Nets using the Cpn Tools tool.

Keywords: *ITS, DMS, Big Data, Colored petri net, Random forest*

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I. INTRODUCTION

In the last few decades, we encountered with the advent of industrial and technological progress, and this progress is on the rise, One of the most controversial challenges, which is related to these developments, is the issue of the bulk volume of data and the Maintenance and extraction of needed data for usage. With the advancement of science and technology, it has become more pronounced the infor-mation and communication systems in the process of humanization, and this has led to the emergence of a term called Big Data, which this Huge collection of data, that are large, diverse, complex and complicated for storing, it needs analyzing and visualizing, processing more and more.

With appearance of Big Data, many issues have changed in the field of engineering, medicine, industry and transportation and etc…. so that scientists and organizations obtained the better results with analyzed this bulk data. Layers should be able to obtain the best results. One of the scienc-es that most commonly used is the transportation science.

With due regard to the importance of human health, this policy, it is ahead the challenges in order to improve the safety of these products, including the use of hardware and software. So far, numerous studies and research has been carried out in the field of transportation that led to the results and implementation of new methods for improving the safety of this material.

In this research, we have tried to find out that using the types Embedded sensors in the freeways, is collected the actual information from the Current and existing conditions, this means, in the freeways the current situation in the form of real-time and dynamic archives of the resource in 30 seconds intervals, consequently with analyzing this information performed in the promotion of the Safety. In fact, the design of the real-time monitoring system accomplished using Big Data on the traffic flow and classified using the algorithm of randomized forest and analysis of Big Data Defined needs. Output category is extracted with attention to the specified characteristics that is considered necessary and then by Alarms and signboards are an-nounced which are located in different parts of the freeways and roads. All of these processes are evaluated by the Colored Petri Nets until the figure out the correctness of the behavior of this system before the implementation phase.

In the following, the structure of the article explain as follows: In the second part, (2) the basic concepts are explained related to ITS[1], DMS[2], Big Data, CPN[3] datasets, and Random Forest. In Section 3 (3), a useful selection is described of previous and similar studies with the subject matter briefly and in Section 4 (4), the proposed method is described and, finally, to show the correctness the method presented in Section 5 (5) is a case study to evaluate and Modeling the proposed method.

II. FUNDAMENTAL CONCEPTS

1. Intelligent transportation system

Intelligent transportation means that a carrier can automatically be positioned on systems installed on it and direct the device at any time to the desired route and places. Intelligent transportation or ITS means the use and deployment of new technologies (such as communication computers, control systems, etc.) to enhance the level of safety, effi-ciency and cost effectiveness in transport, which can be generalized for various modes of transportation. Increasing transportation facilities has always been subject to widespread constraints due to the need for large investments and high implementation times. Smart systems use the elec-tronic system to change the current and inefficient system. These systems utilize the technology of telecommunication, electronics, hardware and software of the computer, using modern methods of management science and system planning, increase the safety coefficient of travel, comprehensive information, information control of traffic, reduce energy consumption, increase the quality and etc. The most important achievements of these systems are improving scheduling and planning of the transportation, improving transport management, increasing pawner satisfaction, improving route capacity and reducing traffic and accidents. Few items of the benefits of this system can be pointed including to reduce traffic and improve mobility, increase security, increase efficiency, reduce energy consumption and environmental pollution, eliminate constraints on financial resources and environment, competitive production, generate bad traffic data, entrepreneurship for advanced technologies.

2. Dynamic Massage signals

Dynamic Massage signals as variables Massage signals or flexible massage signals is one of the important components is the smart transportation system. The expansion of these facilities to provide real-time traffic information to drivers was incompatible in order to improve the operation, reduce the number of Collisions and help the drivers to create a more informed route decision, especially under the traffic conditions. According to the researchers in the past decades, real-time information is only available to the driver and transportation agency; also it is available for the public. Drivers are able to read their plans to ensure that they are not unnecessarily delayed. The Agency is particularly interested in applying the available capacity of the freeways from pass ways or networks, and improving safety and mobility. Information

1 Intelligent Transportation System
2 Dynamic Message Signs
3 Colored Petri-Net

indicating on DMS can be classified into three types:

1) Primarily Warning Messages:

primarily warning messages are intended to driver's pre-cautionary alarms and reduce accidental collisions, especially in emergency warning carriers.

2) Consultative Messages:

Advice messages provide information about a particular problem in the length of time to the beneficiaries. This information permits the drivers to change the speed or route before they reach the hardness area or encourage them to voluntarily select an alternate route for their destination.

3) Alternative route Messages:

Alternative route messages affected through using different paths of selected main routes.

3. Big Data

In the age of which the published information is rapidly increasing, almost all aspects of social activities are influenced by the information contained in it; the information that contains the volume, Variety and High transmission speed will often be known as Big Data [8]. Due to the Generalization and increase the popularity of the intelligent transportation system in the several past decades, the use of Big Data in the field of transportation has been possible, and these resources are collected continuously from a variety of sources in the large geographic scale. These Inconvenient appearance events, which are widely available of Extensive in dimensions and Rich in information, can significantly affect the understanding of their systems by practitioners. Forward Traffic management is possible to improve the performance of system due to the real-time nature of the Big Data in transit. Today, Big Data has become one of the topics that are being discussed in the tech-nology development process. In fact, the real challenge with large organizations is to get the maximum information that is currently available. And also predict what kind of data will be collected in the future. Indeed, how can we obtain and retrieve existing information and moreover, getting an accurate insight into past data is one of the key points in the debate which is expected in many executive meetings in organizations. With the explosion of data, Big Data has become a reality in many organizations. As organ-izations grow up, Information related to them also grows exponentially and increase the complexity of the data. Many large organizations in their different applications have a lot of data in a variety of formats. To the extent that the data is expanded their categorization becomes very dif-ficult with a particular algorithm or logic. Enormous organ-izations are faced with the challenge of keeping all infor-mation on a platform and have a consistent view of them. This unique challenge is known as the Global Big Data Revolution to understand all the data from different sources and to extract useful scientific information from them.

There are three words that define macro data: variety, speed and volume which are referred to as "3V" in folk terms, Figure (1) shows this important.

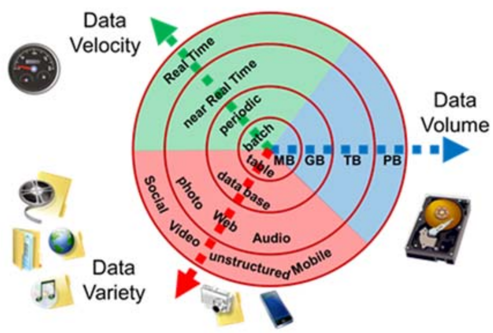

Figure 1. Compounds of a macro data

4. Colored Petri Nets

Colored petri nets are an expanded model of petri nets. A graphical petri nets model is displayed graphically by means of a two-part directional graph. In this model, the locations and transitions are shown with circles and a rectangle respectively. The tokens are also represented as black spikes inside the site (figure 2) [16].

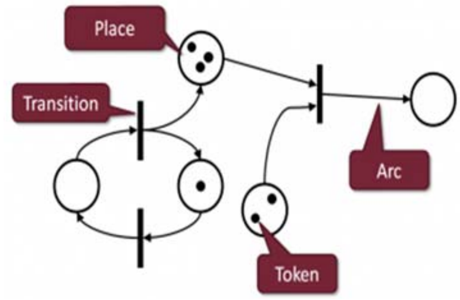

Figure 2. Colored Petri Nets Model

Colored Petri Nets locations: in one CPN a location is represented by a circle or oval. One location can contain zero, one or more beads from the color series. Each location of the CPN refers to a color set that specifies the type of beads that site can contain. Marking a location is a set of multiple.

Arcs of colored petri nets: The arches connect the sites to the transmissions. The arches connect the sites to the transmissions (Input arcs) as well as connecting transmissions to sites (output arcs). An expression is assigned to each arc. An arc expression has a form of "multi-set" that specifies the following: In the input arcs, the combination of beads is created when the transmission is activated in the outlet. Due to the Simplicity and Strong mathematical support of colored petri nets, these types of networks can be used to create a feasible model of architecture. Using a feasible model of these colored petri nets; one can assess the behavior and other non-tasking architectural requirements. In this research, such networks are used to create a model that is applicable to use the CPN Tools software to implement the applicable model of the proposed method so, we simulate the designed model and we can evaluate the model before it is implemented.

5. Random Forest

Random forest is an ensemble Classification which can be used for multi-dimensional designing for multipurpose classroom-shaped trees [3]. One-tree unit solving, has a high standard deviation. In contrast, the random forest provides an unbiased estimation of the α-classical error that can be added to the forest in the form of trees. Also, the law of large numbers ensures that the random forest will be resistant against over-fitting. One of the practical methods in random forest is to estimates Importance variable in the estimation of real-time traffic safety [19,7]. Random forest algorithm estimates the importance a variable (decrease in accuracy) When the OOB[1] data is supplant for that variable [6]. Another criterion is overall decrease in the defined knot impurities by dividing it by Griffin on dividing variable, in all the trees [2]. The problem of first criterion is to overestimate the importance of highly related variables [12]. The second criterion, in other words, does not work well with many predisposing agents [14]. Random forest produces trees that can be decomposed. In order to classify a new object, located a new input vector into a single root-catching tree. Each tree gives us a classification, and this is a form of perceived which that tree gives it a "rating" class. Among classified forest selected which one that contains the highest rating.

III. RELATED WORKS

In this paper, we have examined several methods based on ITS data for management and traffic control for evaluation and enhancement and improvement of its effectiveness.

In a method that has been performed to the effects of de-sign the freeways for safety the number of freeways and lions and curves is positively related to the frequency of the Collision. Fractal agents have also been studied in mountainous roads [12,9]. The result of this study is that the normal curves play an important role in collision events. Another method, related to the topic of research, was in the context of the measurement of congestion, the ratio of volume to capacity (V/C), determining with the traditional method and the level of los indicate the intensity of the collapse. But with these interpretations, traffic needs can be considerably changed in two consecutive time and place. Also, the capacity of the roads can be reduced due to accident [15]. (V/C) and (Los) storage capabilities do not have to be changed. However, ITS Big Data will provide more detailed information on traffic jams.

In another way, related to the subject matter of the re-search, (TTI)[2] was used widely to compare the Peak time with the Non-peak time of the congestion; Measurement of the congestion on the basis of the time including the load-ing

1 out-of-bag
2 Travel Time Index

congestion hours,(PTI)[1], delay, and etc. But ITS systems such as loop and information detectors store the speed of a point in the space. Congestion Measurement design for these systems based on speed [10].

In the context of another, relate to the topic of research they represented the (WSDOT)[2] , the congestion is determined on the basis of the real speed, which is detected by loop detectors and maximal-Allowed speed [11,5]. In the statement of these two researcher, was introduced the Congestion index. In comparison with the selection of a constant speed for the threshold of congestion, the (CI) is a more appropriate unit for the indication of the congestion intensity. Due to the fact that the maximum speed is dissimilar in different roads.

In a method for quantitative safety evaluation is presented a method based on the discrete-time Markov model, that It calculates the safety of the architecture based on the degree of component vulnerability and the number of visits to the components during program execution. A model is also provided for the evaluation of the safety based on the petri nets that performed for evaluation quantitative of the accessibility, performance, and security features of the architecture. In other words, using the discrete-time Marko model, the reliability of the architecture is calculated based on the reliability of each component and the probability of transition [18].

In a similar way to the subject of research, in the discussion real-time crash prediction, it was concluded that the frequency of the crash with the speed has a reciprocal relationship and it is Impact of congestion. But another researcher in the year 2009, Wangtatall, developed the congestion index based on time and represented that does not have an effect on the frequency of the crash with congestion on the basis of the analysis. In conclusion, expressed that the congestion can have a definite time and place [1].

In another method related to the subject of research, the researchers believed that it is essential the method of evaluating an effective traffic state to get system behave in the road traffic. Based on this theory, they selected urban roads for studying and evaluated real-time traffic state. Firstly, the traffic situation was divided into six categories and the evaluation of the traffic was considered as an important problem in the classification. Then, it was decided by the managers of the vehicle speed scale to select the evaluation index. On the basis of this, a new method for accelerating the integration and the factors of the company was present-ed in a new method for evaluating the traffic state. And the effectiveness of the results was verified by current actual flow data traffic [17].

1 Planning Time Index
2 Washington State Dot

IV. SUGGESTED METHOD

In this research, we have tried to find out that using the types Embedded sensors in the freeways, is collected the actual information from the Current and existing conditions, this means, in the freeways the current situation in the form of real-time and dynamic archives of the resource in 30 seconds intervals, consequently with analyzing this information performed in the promotion of the Safety. In fact, the design of the real-time monitoring system accomplished using Big Data on the traffic flow and classified using the algorithm of randomized forest and analysis of Big Data Defined needs. Output category is extracted with attention to the specified characteristics that is considered necessary and then by Alarms and signboards are announced which are located in different parts of the freeways and roads. All of these pro-cesses are evaluated by the Colored Petri Nets until the figure out the correctness of the behavior of this system before the implementation phase.

Suggested Method Architecture

Different sensors and cameras Embedded in the freeways recording the data and send in the database. All the data archived due to Massive volume of them. Figure (3) shows an overview of the architecture of the Suggested method. In the course of the first stage, a freeway is selected for evaluation-deformation. By considering the location of the sen-sors in different state modeling freeway using colored petri nets but in the next step, we began to collect data from the database. As shown in Fig. 3, these data are related to the freeway recorded at the time through the sensors and archived with a variety of properties in database. And then, for the purpose of extraction of data with the characteristics and their analysis for traffic management, used of a random forest

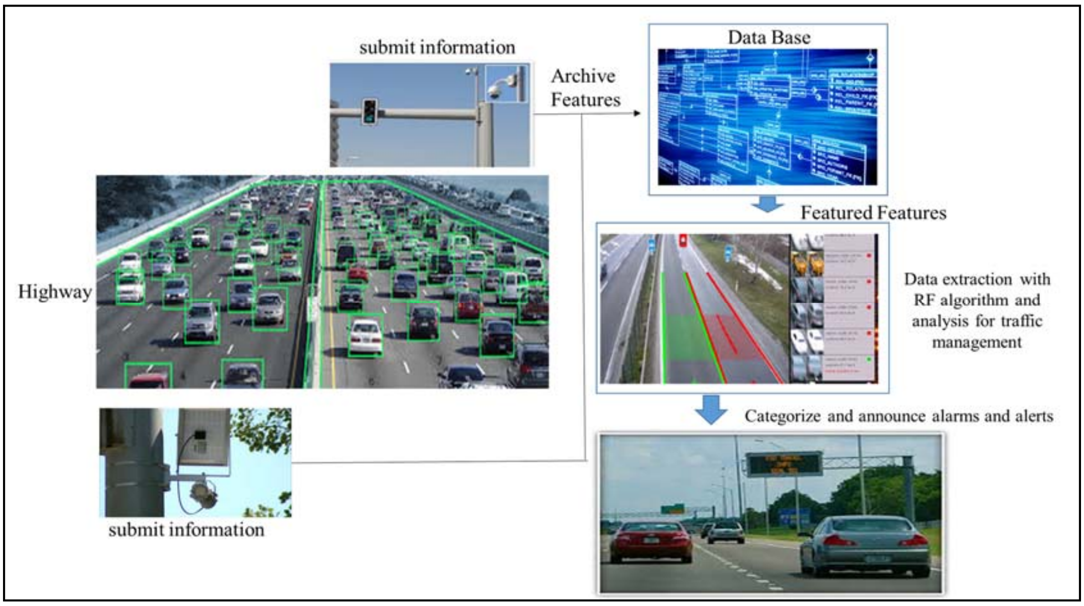

Figure 3. Architecture offered by the proposed method

algorithm and software package, Mat lab, we can access various categories and different formats. In the following, using Petri-Net-based algorithms for controlling the congestion and raising safety using the classification data we can manage the freeway.

Modeling Freeway

One of the ways to examine the modeling system's features is to study the system's modeling with a modeling method. Petri net are one of the best tools for modeling. Petri nets are suitable method for modeling based on mathematical logic that presented graphically. Each Petri net, using only four elements (location, transfer, arc, and nut), performs the modeling action. In order to reduce costs, we modeling the freeway instead of using real-time sensors on it. Therefore, for the modeling to be possible, we need to have a highway mapping of the petri net (Fig. 4).

In fact, for each line, a sensor is considered to be read and recorded information by means of passage of the device and is located on the freeway (km). Also, given the fact that the operation (Sense) is performed at the beginning of the kilometer of that input area, and then the equipment is moving along the freeway line. In the next steps, the equipment that traversed the freeway route, after the out-side of the range entered the second range that the sensor set is on the freeway depending on the time it was set, is a time unit-and speed. Until repeated the previous stages, and eventually we will have the extra data that has been col-lected on the corresponding freeway.

Preparation of Data from Freeway Modeling

The information received from the sensors consisted of the name of the vehicle, the speed of the gear, the speed, the number, the position, the capacity of the transmission, the capacity of the road, the demand for access and the route moving. The data are transmitted by the sensors to the database and in every 30 seconds the information is updated. These data are stored in the database. Our goal is to extract data, which can be used to reduce the number of accidents and in particular, to determine the critical points and in the event of an incident, we will help to manage the traffic.

Applying Random Forest Algorithm

Using the RF algorithm, we will compile a collection of input vectors that contains the data sent from the sensors. In another words, one can express this way $X = (X1, X2, \dots Xp)$ The set of P variable $Xj = (X1j, X2j, \dots Xnj)T$ It is also assumed that the y attribute is under examination (in this case, the occurrence crash or not), and n is the number of cars per sample. Also, b is the number of the tree and B is the total number of trees. We set the value of b to equal one. In step

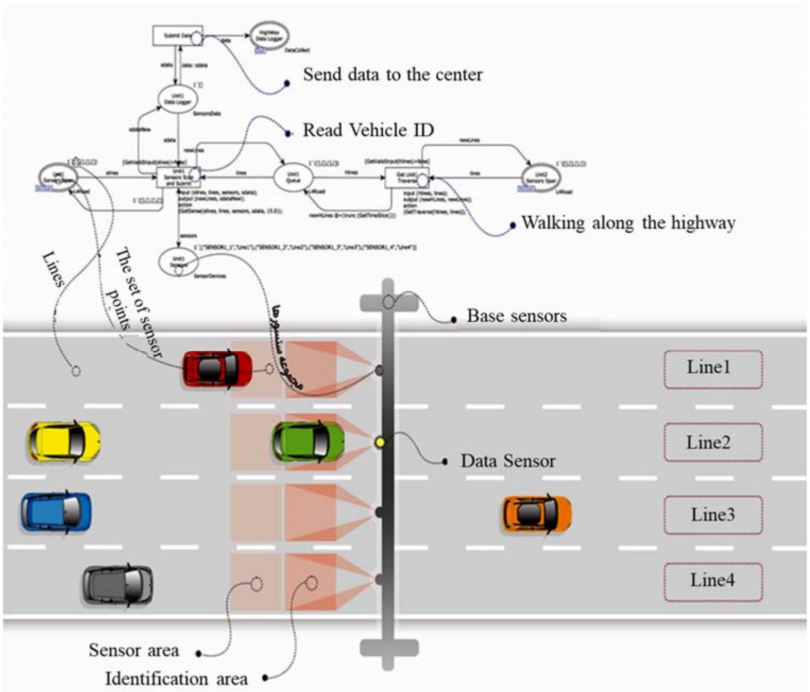

Figure 4. Freeway Component Mapping and Executive Model Based on Petri Net

k (θk), the sample is selected independently and with the same distribution of the data set. This collection is called "learning or teaching". Also, X randomly selected from the set of predicate variables in the study. The hypothesis function h (X, θk) is constructed using X and θk. Steps B is repeated to reach the tree number B. In the proposed method, to predict the occurrence of an accident or its absence, we assume the random forest algorithm:

$$P = \sum_{K=1}^{E} I\left(h\left(x \text{ و } \theta k\right)\right) = 1\ ) \quad (1)$$

$$Q = \sum_{K=1}^{E} I\left(h\left(x \text{ و } \theta k\right)\right) = 0\ ) \quad (2)$$

If P>Q, then the algorithm (RF) predict that x belongs to the class (1) (in this case, the crash occurs), and invers, if P<Q The algorithm (RF) predicts that x belongs to the class (0) (in this study, the crash does not occur). Figure 5 shows how this algorithm is implemented and applied.

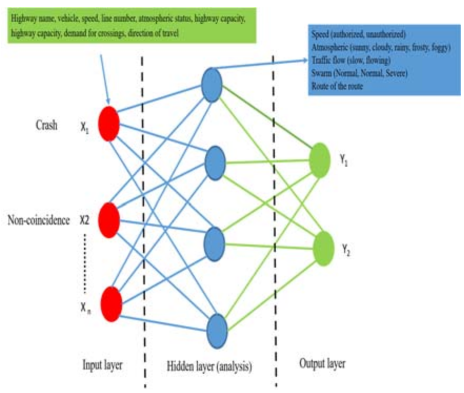

Figure5. Analysis of the Proposed Method in the RF Algorithm

V. CASE STUDY

To illustrate the proposed method be considered a freeway that includes features such as checking traffic, congestion, moving cars from source to destination, intelligence based on warning panels and, in the long run, preventing accidents. To reach this important point, the freeway consists of sensors on the way that immediately recorded the movement of all traffic in the central server with due regard to the speed of the load of the vehicle. In this stage, the goal is the modeling the freeway and recorded data of the equipment moving. Therefore, in order to become fully familiar with the form (6), can be remarkable a highway - the location of the sensors and the distance of them.

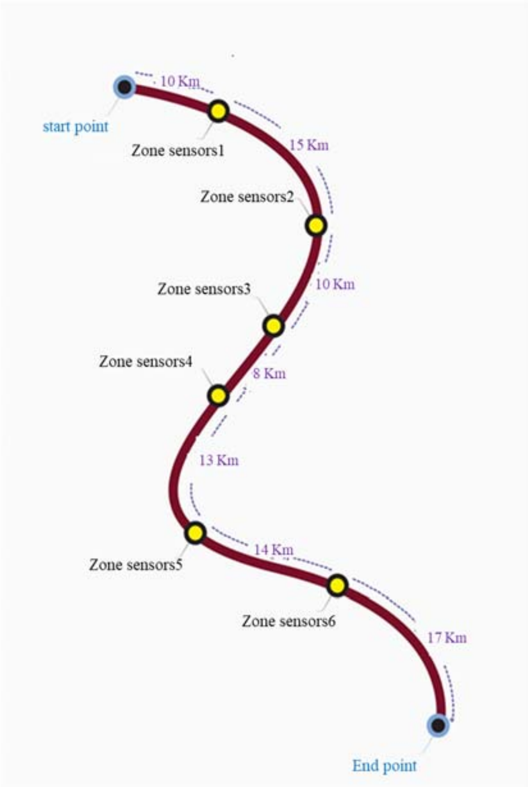

Figure 6. Conceptual Freeway Studied

The examples of the detected alarms of the sensor data are expressed by the RF algorithm in Table 1. In the following, Figure 7 shows the steps to implement the proposed meth-od on a case study.

Table (1) - Analyzed Alarms

Alarm	Moods
Speed	Authorized, Unauthorized
Atmospheric status	Sunny, cloudy, rainy, frosty, foggy
traffic flow	Slow, flowing
Congestion	Normal, Normal, Severe
path	The line of consideration

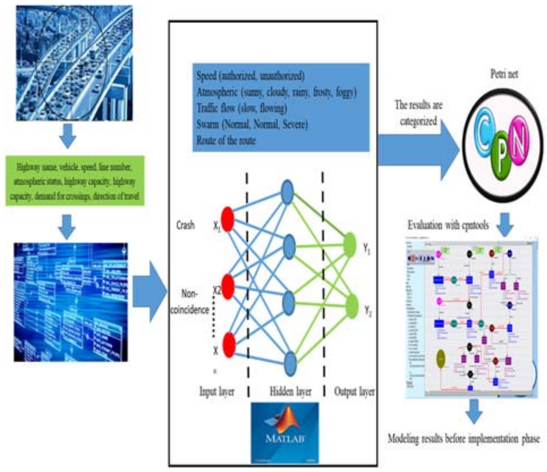

Figure 7. Steps to Implement the Proposed method

In order to arrive at the initial data, the simulation of the current process on the freeway is carried out by the petri nets. Figure 8 depicts an image of this model.

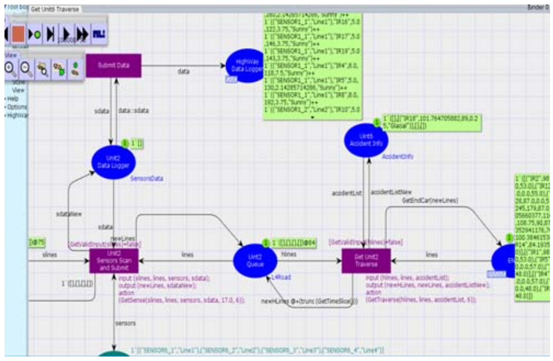

Figure 8. Freeway Simulation in Tools CPN

In addition, we show the sample of the obtained data from the normal freeway model in Table (2).

Name of the sensor	Line number	Number of plainclock	Time of transit	Speed	Traffic rate	Atmospheric traffic
SENSOR1_1	Line1	IR1	7	132	7.5	Sunny
SENSOR1_2	Line2	IR10	5	65	7.5	Sunny
SENSOR1_3	Line3	IR2	8	29	7.5	Sunny
SENSOR1_4	Line4	IR18	6	12	7.5	Sunny
SENSOR2_1	Line1	IR12	13	113	10	Sunny
SENSOR2_2	Line2	IR2	15	76	10	Sunny
SENSOR2_3	Line3	IR1	14	38	10	Sunny
SENSOR2_4	Line4	IR11	13	108	3.333333333	Sunny
SENSOR3_1	Line1	IR12	22	154	8	Sunny
SENSOR3_2	Line2	IR10	19	78	8	Sunny
SENSOR3_3	Line3	IR1	21	43	8	Sunny
SENSOR4_1	Line1	IR10	25	141	3.25	Sunny
SENSOR4_3	Line3	IR1	25	43	13	Sunny
SENSOR4_4	Line4	IR6	26	149	13	Sunny
SENSOR5_1	Line1	IR10	32	113	7	Sunny
SENSOR5_2	Line2	IR1	35	66	14	Sunny
SENSOR5_3	Line3	IR5	39	33	3.5	Sunny
SENSOR5_4	Line4	IR13	34	110	3.5	Sunny
SENSOR6_1	Line1	IR14	53	163	2.833333333	Glacial
SENSOR6_2	Line2	IR7	40	99	8.5	Glacial
SENSOR6_3	Line3	IR1	43	42	17	Sunny
SENSOR6_4	Line4	IR19	42	14	4.25	Sunny

Table (2) - Freeway Initial Data Output

By executing the model in normal conditions according to the data (5), the accident was reported in detail in the table (3).

Table(3) - Data from Freeway Accidents in Normal Mode

Number of plaincl	Average speed	Speed	Traffic rate	Atmospheric status
IR9	80.57894	189	3.1611	Sunny
IR20	78.36363	173	1.2533	Sunny
IR15	87.6	131	3.05	Sunny
IR13	96.57894	136	1.5861	Sunny
IR18	101.7647	89	0.25	Glacial

In order to understand the explicit definition of the water conditions, see also Table (4), to classify these data using the RF algorithm.

Table (4) - Atmospheric Conditions

Atmospheric status	Atmospheric code
Sunny	1
cloudy	2
rainy	3
Glacial	4
foggy	5

In accordance with the form (9), according to the proposed method, the data generated by the sensors are given to the RF algorithm, recognized the accident and non-accident classification comply with the characteristics (speed, Traf-fic rates, weather)

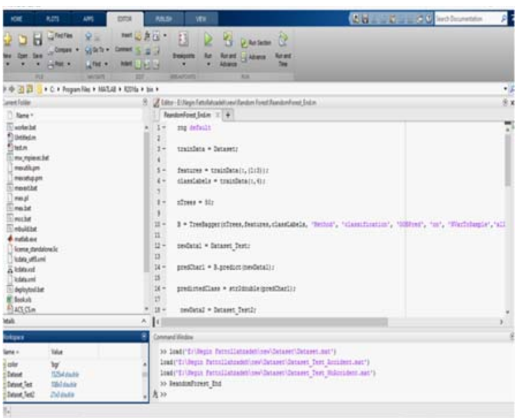

Figure9. Implementation of the Algorithm (RF) in Matlab

We continue to have the outputs from the implementation of the model

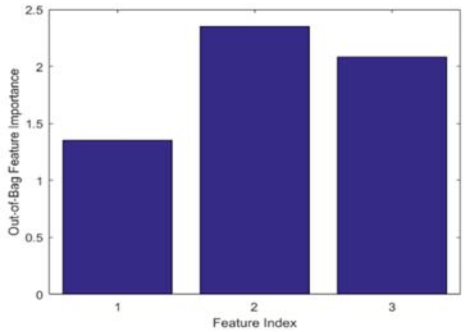

Figure 10. Effect of the characteristics

Fig. 11 showed the reliability of the diagnostic algorithm, RF which is carried out according to the data we have learned.

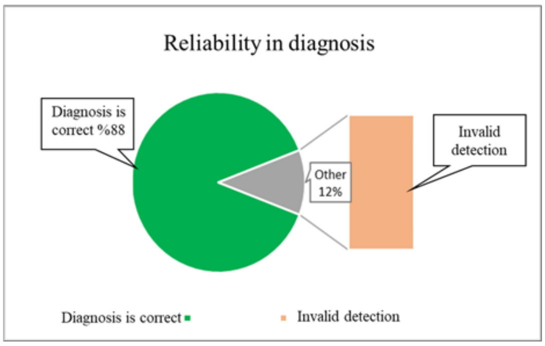

Figure 11. The Effect Level of Features

Alarms and precautionary warnings are provided by the proposed method to the equipment, assuming that drivers consider these warnings seriously and act accordingly, so the accident rate decreases (Figure 12).

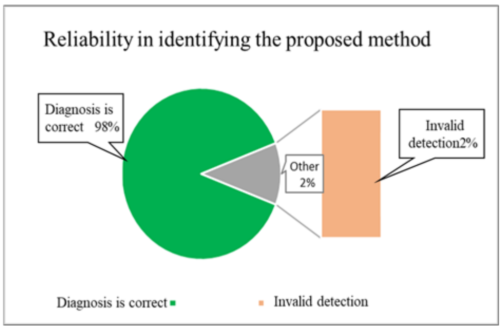

Figure12. Reliability in Diagnosis with the Proposed Method

VI. CONCLUSION

According to the results obtained in the study, alarms and warnings are carried out by means of a vehicle-based approach, with the consideration of warnings by drivers. Therefore, the accident rate is reduced and the situation is detected by accident and non-detection. In this way, we can prevent the occurrence of road accidents on the freeway, and this requires that drivers pay attention to the warnings of bulletin boards that are managed by the system. From the suggestions that can be mentioned for future work, the use of other intelligent algorithms such as neural networks to learn and offer suggestions, the use of intelligent gate-ways for communication with warning boards, in-the-way Facilitating warnings and using data-mining techniques and analyzing drivers' behavior in the field of higher education.

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