Handling Adverse Weather Situations in the Road network by Forecasting it using VANET

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ABSTRACT

Weather is a major factor which affects road safety and traffic flow. Weather conditions are based on temperature of the air. Bad weather situations affects safe driving. A prior knowledge of weather information is important for public safety in road and help drivers to handle the adverse situations. Several systems have been proposed to predict the weather conditions. But they do not forecast the weather information in advance and in addition to this, they need the support of road operators too. This paper presents a new system which forecast the weather conditions within a shorter period of time. The improvement of the short-term prediction will increase the system timeliness and the service provision, because no operator is required to warn end-users. Our new system also presents a distributed approach and it is based on a multi-agent and a rule-based system technologies. Thus the system is able to forecast adverse situations with a high degree of quality. This quality makes it possible to have trust in the system.

Keywords: *Expert system, Intelligent transport system, VANET*

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1. INTRODUCTION

Weather is a major factor that affects roadsafety and traffic flow. Adverse weather situations have a great impact on accident rates. It also affects driving conditions. Snow and rain increases slipperiness, fog affects visibility of drivers on road and wind speed affects stability of the vehicle. Previous studies reveal that drivers are not adapted to driving in adverse conditions. Real time information to the road user can be provided to improve road safety, especially during adverse situations. Variable Message Signs (VMS) is one of the most used on-trip information systems. VMS are connected to Traffic Control Centre (TCC) which displays different messages in the sign. Messages can be: text, pictogram or both.

Traffic management is a complex task because it presents high level of distribution. Traffic status can be monitored using different equipments. It is very difficult forroad traffic managers to control and manage traffic conditions. Advanced Traffic Management Systems (ATMS) provides help to these traffic managers. The combined use of various elements of ATMS, particularly weather monitoring (meteorological stations) and information systems (VMS, Radio Data System-Traffic Message Channel RDS-TMC…), helps in improving road safety in local areas. But this requires constant monitoring of road operators. To overcome thisissues, a non-supervised system that is required to support these road operators.

And also, the weather information provided by regional weather report services are not accurate as dedicated systems. This weather information is also not specific to a particular local but rather they provide report for a wider land area. An autonomous system can provide not only weather and traffic information but also provides relevant information to the drivers without the supervision of TCC. The information to the drivers can be provided by this system by analyzing and processing the weather information. But this system requires confidence to both the

information they provideor the data they receive. Therefore data quality is the key element in this kind of system and is also analyzed in some projects. Importance of service provision is also analyzed in this kind of projects.
In this paper we are going to present a new proposal to the expert system which can be used to identify adverse weather conditions in the local area network. The main objective of this extension is to provide weather predictions on adverse conditions in a short-term within a period of two hours with a high degree of reliability. The system quality is improved for this short-term predictionwhich increases the system timeliness and service provision. This improvement enables system to alert the end-users without the need road operators.
The proposed system uses VANET to make routing of information more efficient.VEHICULAR Ad-hoc Network (VANET) isan inter-vehicular network, assembled among moving vehicles. A VANET comprises of three noteworthy parts, specifically the Trusted Authority (TA), Road Side Units (RSUs) and vehicles (OBU). The TA gives an assortment of online premium administrations to the VANET clients through RSUs. The RSUs are settled at the road sides which are utilized to interface the vehicles to the TA. Every vehicle is introduced with an On Board Unit (OBU) which is utilized to perform all calculation and correspondence assignments. In this proposal, server forward the weatherinformation message in a secure manner and provides efficient authentication via Authority in VANET network and also allows RSU to forward messages to all OBU nodes.
The paper is structured as follows: In section II we present a review of various multi-agent systems used to forecast adverse weather situations and also their drawbacks. In section III we present an already designed system that is used to detect and warn about these weather situations. In section IV we present a proposed system which does not require the support of road operators to warn drivers about these adverse conditions. In section VI, the conclusions and further enhancements are discussed.

2. RELATED WORK

Joachim Wahle and Michael Schreckenberg proposeda system [2] which allows both historic and dynamic data to provide a short-term traffic forecast. This addressed the issue of anticipatory traffic forecast. This system performs online simulation of urban and freeway networks. But here vehicles leave at the boundary nodes and also the network grows empty sooner.
YellaSiril, KalidAskar and Mark Dougherty proposed an expert system[4] which provides an approach for predicting the extend of slipperiness by building and testing an expert system. Initially it is a very difficult task to analyze the strong relation between friction and accident risk on winter roads. But this approach solved the previous issues by predicting the slipperiness and also provides a safety measureto enhance traffic safety. But this system provides inaccurate information at times.
Raymond Lee and James Liu developed an innovative, intelligent multi-agent based environment, namely intelligent Java Agent Development Environment (iJADE) [10], to provide an integrated and intelligent agent-based platform in the e-commerce environment. Since traditional method requires intensive computations involving complex differential equations and computational algorithms, this method eradicates all the previous complex computations. iJADE is better than single-station prediction model and provides a significant performance improvement. But the data collected from few stations contains quite a bit of noise and many abnormal readings.
Anita Raja and Victor Lesser proposed a (DEC-MDP)-based model[3] that captures interactions when meta-level decisions made in one agent’s MDP affects the meta-level MDPs of other agents. This system addressed the issues of when and how the dynamic and uncertain characteristics of an open environment should be done and invested. This model deals with uncertainty and non-stationary including robotic path-planning. But the problem in this system is the explicit versus implicit communication among agents.
Marti, Tomas, Garcia and Martinez suggested a multi-agent system, DROOL- a rule based system[9] that allows friendly interface, to support traffic management in case of meteorological problems in the road network and also for managing weather situations. The main aim of this project is to reduce the difficulty of driving in bad weather conditions. DROOL allows local systems to work together to reduce the incident consequences. Here the regulation messages are only fired during weather situations.
Hashim Mohamed Aklhassan and Johnnie Ben-Edigbe proposed a scheme[8] that utilizes gauged rainfall information and direct empirical observations. It also uses weather radar data and inductive loop traffic data.
The adverse weather conditions degrade the prediction of highway capacities and this problem can be addressed in this scheme. It allows drivers to reduce their speed but the rainfall intensity should be investigated periodically.
Peter Kalina and Jiri Vokrinek suggested an algorithm which addresses the Vehicle Routing Problem with Time Windows(VRPTW). This uses a set of generic negotiation methods and stat-of-the-art insertion heuristics and also

allows us to be able to match the best known solutions. But here the strategy of the VRPTW case needs to be improved.

Robert Koeberlei, Dennis Jensen, Miranda Forcier proposed a scheme that evaluates how well each maintenance crew is doing with regards to achieving safe grip roads during and after storm events[7]. This scheme improves road safety and also reduces driving crashes and fatalities in winter. But this scheme uses only crash and road condition data.

MeeraNarvekar and PriyancaFargose developed a system that addresses a problem of accuracy of weather forecasting conditions. It focuses mainly on neural network with back propagation techniques[5] for daily weather forecasting. It minimizes the forecasting error but due to complex parameters there occurs a lack of accuracy.

Vicente, Tomas and Marta Pla-Castells developed a system[1] that uses a set of algorithms and rules to determine the weather and to forecast dangerous situations on the road network. Previous systems require support of road operators to inform drivers about weather changes. This model allows users to obtain information about the forecasted weathers within short period. But this system requires updation of algorithms and also historic data regularly.

3. EXISTING METHODOLOGY

In the existing system, a number of different routing algorithms exist for network packet transmission.The original idea is that the roadside infrastructure and the vehicles could communicate using wireless networks. To make networking operations such as routing more effective, researchers had developed a dynamic inter-vehicle network called vehicular ad-hoc networks (VANET).

Vehicular Ad-hoc Network (VANET) is a distributed, self-arranging communicationunite, which is assembled among moving vehicles. A VANET comprises of three significant parts, specifically the Trusted Authority (TA), Road Side Units (RSUs) and vehicles(OBU). The TA gives anrange of messages to the VANET clients through RSUs. The RSUs are situated at the road sides which are utilized to interface the vehicles to the TA. Every vehicle is introduced with an On Board Unit (OBU) which is utilized to perform all calculations and communication assignments. To improve the driving comfort, forecasted data ought to be given to the drivers in a perceptive and secured way. Therefore, VANETs are created to give engaging administrations. Likewise, it can offer the comfort and intelligent administration. These services make driving comfort, the Intelligent Transport System (ITS) allows to transmit the forecasted weather information at a very faster rate within a short period of time.

Two sorts of interchanges are performed in VANETs. The principal type is the Vehicle to Vehicle (V2V) communication in which the moving vehicles, with the help of OBU can communicate with each other. The second type is the Vehicle to RSU (V2R) communication in which the moving vehicles can communicate with the RSUs which are found aside the roads.

4. PROBLEMS IN THE EXISTING SYSTEM

Moving OBU nodes not having more capability to forward the message regularly. The main drawback is that it affects traffic flow and road safety to detect dangerous situations in the road networks. Communication range is also very short and unable to afford computational tasks with heavy complexity. Moving vehicular nodes does not have more capability to forward the message. Forecasting Message transmission is delayed.

5. PROPOSED WORK

By integrating various devices such as sensors, controllers, devices, and employing networking technologies (wireless sensor network) and middleware, this platform supports V2V and V2I communication mechanisms and is able to collect and exchange data among the drivers, OBU, and roadside infrastructure such as street lights.

In proposed system we are going to present a new extension of the expert system to identify adverse weather situations in a local road network. The Objective of this extension is to provide short-term predictions on adverse weather conditions for the next two hours with a high degree of reliability. Road Surface Conditions (RSC) and Road surface temperature (RST) are two of the main parameters to detect dangerous situations in the road networks.HIRLAM (High Resolution Limited Area Model) is the result of a project that emerged with the aim of providing a short-term weather prediction with acceptable reliability.

The proposed system consists of four units- Network formation, V2V Communication through RSU, Webserver Process and Weather prediction Rules. In the first phase, a Network is first formed with different regions. Regions are split based on the Mobile Sensor range .Each node sends “hello” message to same interest nodes. Once a node detects “hello” message from another node (neighbor), a network is formed comprising of same range nodes under a single RSU.

In the second phase, vehicles can communicate across the region which is generated by Authority. In RSU ,node name for OBUs are stored and it verifies with the authority. Before transmitting the data, RSU sends the forecast warning alert (VMS) to all OBU. V2V and V2I communication mechanisms helps to collect and exchange data among the drivers, OBU, and roadside infrastructure.

In this phase,RWIS(Road Weather Information System) senses several weather information (visibility, wind speed, precipitations, temperature…) using sensors.A Data Collection Station (DCS) collects traffic data from the road network(flow, speed, density….).All the processes are updated to the web server which receives the value from the DB via authority and forward it to RSU. We send Variable Message Signal (VMS), which shows message to road network users. Forecasted weather information is forwarded as Warning alert to RSU and monitor the delayed OBU for a short duration (2 hours above) based on the validated information.

In this phase, the prediction rules are based on the results produced by the Metro safety projects and the different studies are focused on the evolution of adverse weather situations and their impact on road traffic.

a. Snow Prediction Rules:

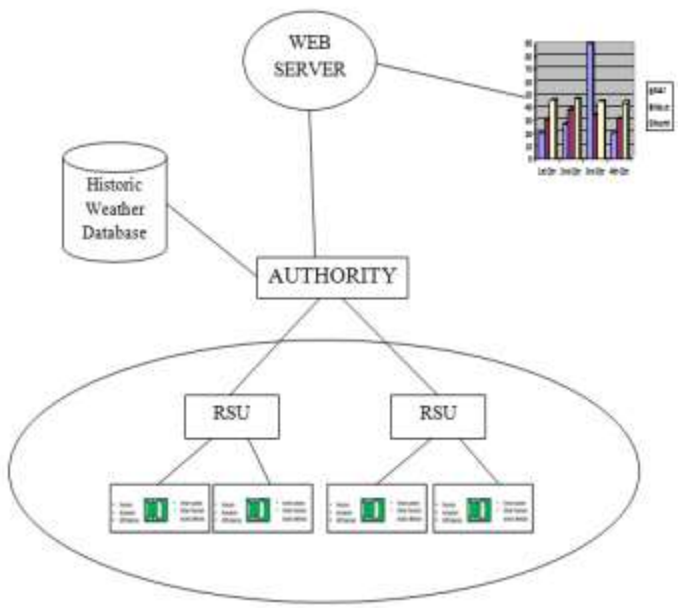
The main objective of the Snow Prediction Rules is to give a value of the parameter**Certainty** in order to sense the presence of snow on the road. When this parameter exceeds the value of 80%, the system is detecting a probable problem and triggers the equivalent alert.

b. Ice Prediction Rules:

The main objective of the Ice Prediction Rules is to give a value of the parameter **Certainty** in order to detect the presence of ice on the road. When this parameter exceeds the value of 80%, the system is detecting a potential problem and prompts the corresponding alert.

Algorithms used:

1. Detection Algorithm
2. Certainty Algorithm
3. Consistency Algorithm
4. Correlation Algorithm
5. Forecasting Algorithm
6. Historic Algorithm



1. Detection algorithm
The information received from RWIS sensors are monitored and configured using an initial parameter (visibility, slipperiness, humidity etc) and several thresholds.

2. Certainty Algorithm:
Each parameter has a value of certainty associated with it. The numeric certainty value ranges from 0(normal) to 100(most likely to occur). The value is determined by RS and also checks the HIRLAM for every 6 hours.

3 . Correlation Algorithm:
This algorithm correlates the information of different RWIS sensors using correlation functions and these functions depend on meteorological variable. It evaluates the relationship of one variable with other variables and it also assesses the quality of the information.

4. Consistency Algorithm:
This algorithm increases or decreases the level of certainty of Detection depending on the consistency of data with short-term historical evolution. It also compares the sensor value with the values of the same sensor type in close stations.

5. Forecasting Algorithm:
This algorithm performs a short-term prediction about the situation that could be produced in a short-term period. It uses the current values of the parameters, validated by coherence and correlation algorithms, to analyze the evolution of some parameters in order to determine and forecast adverse weather situations.

6. Historic Algorithm:
It uses the RS local database to compare the current data with previous historical data. When there is a warning, the information is stored in its own database. If the situation is true, the current data is updated with its related data.

7. CONCLUSIONS AND FUTURE ENHANCEMEMTS

This paper presents a new autonomous system to estimate weather conditions in a short period of time and to give users the dataobtained without the need of road operators. The model uses a set of algorithms and rules to predict the weather and to estimate dangerous situations in the road network. It has beenemployedusing a multi-agent method and tested with real data.This proposal will be an update of the algorithm that are taken into account, the information from various locations and scheming and forecasting will be done in an organized manner. The further enhancement can be made in the implementation using the forecasting algorithms and also it can enhance to provide communication between vehicles in different localities to exchange the alert messages. This allows safety driving and also prevents drivers to use the affected road network.

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