

ABSTRACT

Vehicle Ad-hoc Network (VANET) is a modern technology based on Mobile Ad-hoc Networks (MANET) that encompasses both travelling vehicles and stationary base stations called the Road Side Units (RSU). The vehicles exchange information with near-by vehicles by using Vehicle to Vehicle (V2V) communication and they communicate with the RSUs by employing Vehicle to Infrastructure (V2I) communication. These communications are performed by using standards like IEEE 802.11p, Dedicated Short Range Communication (DSRC), Wireless Access to Vehicular Environment (WAVE) standards. VANET attempts to apply information and communication technologies in vehicles and highway road infrastructure in order to make transportation system as an intelligent one. VANET can support the society by offering economical solutions to applications for efficient and safe transportation.

In developing countries like India, the highway road transportation decides on the part of the Gross Domestic Product (GDP). The vehicle population in India has drastically increased over the past twenty years and it has made the highway roads to be filled with vehicles. The development of highway road infrastructure is not in proportion to the increased vehicle population. Globally, the highway road traffic accidents cause more human lives to die and get injured. Every day, the number of highway road traffic accidents are in the ascend and they result in increase of death and injury rates. In this context, the global community is taking a lot of initiatives for making transportation system to be intelligent to provide safe and efficient traffic as well as achieve a better socio-economical development. Certainly, it

is imperative to improve safety and efficiency in highway road traffic and transportation.

The main objective of this thesis is to present a smart system for highway road accident prediction and prevention that supports in implementation of intelligent transportation system in Indian highway roads. The proposed system makes an attempt to achieve safe and efficient transportation by predicting and preventing highway road accidents in a proactive manner. This thesis proposes three novel protocols for highway road accident prediction and prevention processes.

First, a novel proactive framework named Emergency Situation Prediction Mechanism (ESPM) is designed and developed for highway road accident prediction. This framework is instrumental in predicting the possibility of the occurrence of a road accident in advance before it occurs. In ESPM framework, the RSU performs prediction process based on periodical status report sent by the vehicle and the highway road traffic flow data. To sense and report the traffic flow data, a new Four Lane Sensor Grid (FLSG) is designed and used. Based on the traffic flow data, a Decision Matrix (DM) is constructed. If either the status report or the traffic flow data (ie value in DM) is abnormal, then the ESPM framework decides that a road accident is predicted. The ESPM predicts the road accident within 0.20 seconds and achieves a prediction accuracy of 92 percent in different highway scenarios.

Second, a Road Accident Prevention (RAP) scheme is designed and developed for highway road accident prevention process by employing a broadcast approach. To prevent highway road traffic accident, the RAP scheme broadcasts an Emergency Warning Message (EWM) to the vehicles that hold a high risk factor and travel in the high risk zone. The high risk zone is the one that is very closer to the possible accident site. The RAP scheme is

designed in such a way that it broadcasts the EWMs to the vehicles outside the coverage area of the RSU by using the Vehicular Backbone Network (VBN) structure. This approach reduces infrastructure cost as it reduces the number of RSUs required in the highway roads. The RAP scheme achieves a promising 93 percent in EWM notification task.

Third, a Bandwidth Efficient Acknowledgement based Multicast Protocol for Highway (BEAM-HW) is designed and developed for highway road accident prevention process by employing a multicast approach. There are scenarios in highway roads where there is no need for EWM dissemination to all the travelling vehicles. That is, the EWMs can be delivered only to a group of vehicles that are closer to the possible accident site and they need not be delivered to all travelling vehicles. In such a scenario, BEAM-HW is most suitable. The BEAM-HW protocol gives a chance to the vehicles to decide whether to receive an EWM or not. In BEAM-HW protocol, if the vehicles wish to join the Multicast Group (MG), then they can reply the join messages that are broadcasted. The RSU multicasts the EWM only to vehicles present in the multicast group. The BEAM-HW protocol also employs an acknowledgement mechanism to confirm the reception of the EWMs by the vehicles. In this way, the BEAM-HW protocol reduces the number of in-network message transactions and achieves an efficient utilization of the bandwidth. The BEAM-HW protocol achieves a 95.09 percent EWM notification for a group size of 102 vehicles among the vehicle density of 160 vehicles.

The performances of these protocols are evaluated and analyzed based on the extensive simulations carried out by using Network Simulator-2 (NS-2). This smart system definitely has a higher scope for prediction and prevention of the highway road traffic accident. Implementation of this smart

system requires a higher class state of art infrastructure in the highway roads. The deployment of such an infrastructure is the vision of India by 2020 and it requires more investment. The modern societies need this kind of a smart intelligent transportation system for achieving safe and efficient traffic. Therefore, it is imperative in near future to implement of this sort of a smart system so as to ensure safe and efficient traffic in the highway roads across the world.