ISSN: 0975-766X
CODEN: IJPTFI
Available Online through
Research Article
www.ijptonline.com

VANET BASED EVENT NOTIFICATIONS: IN-VEHICLES' INTERNAL AND EXTERNAL-CERTAINTY OF OPERATIONS TO PROVIDE CONTINUITY OF TRAVEL ON THE ROAD ENVIRONMENT

P.Sivaram[1] and Dr. S. Senthilkumar[2]
[1]Assistant Professor, Department of CSE, Srinivasa Ramanujan Centre,
SASTRA University, Kumbakonam, Tanjore District, Tamilnadu, India.
[2]Assistant Professor, Dept. of CSE, University College of Engineering, Pattukottai, Rajamadam, Tamilnadu, India.
Email: ponsivs@src.sastra.edu

Received on: 08-02-2017 *Accepted on: 21-03-2017*

Abstract:

The enhanced features of Vehicular ADHOC Network (VANET) based Intelligent Transport System (ITS) are improving rapidly to provide services and application related activities to the vehicles on the road environment (RE). These kinds of services and applications are providing passive and active support to the transporters, while the vehicles are in halt or even in running on the road. The modernization of the systems under ITS, the development of applications for such VANET environment attracts the business community of vehicular society to invest and provide art of life style to the RE vehicles.

On the road, productive vehicles are in need of continuing their travel and their internal/external system operations are conditionally not to meet with uncertainty and continue their travel towards destination. The transporters are in need of such systems' development for uninterrupted travel during their journey plan. The proposed work is the optimization and the fitness functions matching to prove the certainty of operations are possible with internal/external of In-vehicles' (InVs') under VANET environment to assist and suggest the vehicle to continue their travel on the road without meeting any interrupt on their course of journey.

To bring the certainty of operations on internal/external to InVs in-vehicles under VANET, we take our two recent inter related research works using efficient event notification and a mathematical model is presented with this work, to enumerate the clarity on certainty of operations of vehicles to continue their travel.

Keywords: VANET, ORiVD-RDSS, RTR framework, RTS Protocol, TC-identification, T-CAED Algorithm, Certainty of Operations on InV: internal/external for uninterrupted travel.

1. Introduction

An automotive InV domains are occupied by various electronic control unit(s) (ECU) for effective synchronization, coordination and controlling with in overall InV network systems. The role of standard architecture in an automotive InV networks, reduces the complexity in providing services and maintenance [1]. The variety of services and applications and their developments are focusing towards the automotive sector to provide possible sophistications to the transporters. The lack of information available with the transporters, while on the road travel brings frustration, loss of time and cost spent on the course of journey towards destination. The researchers are concentrating in RE and the field of VANET based ITS to introduce trouble free travel related operations. In the proposed work, we are presenting the certainty of operations on internal/external of in-vehicles under VANET, RE. The certainty of operations on the internal InV ECU's network operations are the overcoming the uncertainty activities of InV, such as malfunction, inefficient performance, unexpected/uninformed failure halt on the road of vehicles. This is achieved by the system called ORiVD-RDSS, with RTR framework and RDS protocol support [2]. This ORiVD-RDSS, provides possible trouble fixes within its limits of operation,to the vehicles in remote manner and assists, suggests them for continuing their travel on the road without meeting any interrupt on their course of journey, due to InV ECU's network malfunction. This InV network operations are subjected to uncertainty of act and the ORiVD-RDSS activities are bringing the InV failure situations and operations towards certainty of operations on the internal (InV) mode and maintains the continuity of vehicles on the RE.

The second work is an external activity to the in-vehicles' operations on the RE with VANET based ITS support with running vehicles on the road, and in which the identification of traffic congestion (TC) and congestion avoidance (T-CA) is performed [3]. The TCs are identified and informed to the successor vehicles on the RE to avoid TC, and in which the external operations of the vehicles on the RE and their uncertainty is overcome with providing alternate paths as option one and relaxation related services as option two, to continue their travel. In this work, the running vehicles performance on the RE, in VANET are subjected to uncertainty of act, and the identification of TC and T-CAED algorithm related activities on RSU for efficient events dissemination, brings the vehicles' performance with certainty of operations on RE behavior, which eliminates unexpected, uninformed, and improper halt of vehicles on the RE, which restricts the road for other successor vehicles on the road, and maintains the continuous moments of vehicles towards destination, on the RE. The mentioned research works are based on the efficient event notification and dissemination of messages with the network components as vehicles' on-board unit(s) (OBU), road side unit(s) (RSU) and service base station(s) (SBS) of VANET. To bring the certainty of operations on internal/external to in-vehicles under VANET, we take our two recent inter related research works using efficient event notification to enumerate the importance of continuity of travel of vehicles on the RE, and a mathematical model with optimization and a combined fitness is presented with this proposed work.

2. Related Work

The Juan (Susan) Pan et al. [4] presented a system for congestion avoidance with a distributed vehicular traffic re-routing concept and the simulation results the introduced hybrid system increases the user privacy by ninety two percent on average over centralized system. The J. Contreras-Castillo et al. [5] represented with big data solutions for solving VANET challenges and with their analysis they clarified that this approach converts the VANET from depending on technology-driven to data-driven. The W. Li et al. [6] described about an attack resistant trust management scheme for securing VANET with their work and the analyzation with confirmation on such study adopts to a wide range of VANET applications to improve traffic-safety, mobility, and environmental protection with enhanced trustworthiness. The Y. Bi et al. [7] presented in their work to demonstrate the E-PMIPv6 extends the scalability of user mobility and greatly improves handoff efficiency in urban vehicular network(s) (UVN). The L. Li et al. [8] represented a new approach, with intelligent testing for autonomous vehicles, which provides a quantitative way to test the intelligence of autonomous vehicles.

The C.C. Lee et al. [9] presented an efficient multiple session key establishment scheme for VANETgroup integration, with the Chinese remainder theorem and a common structure of peer-to-peer based online social network. They concluded their presentation with the performance analysis as the scheme could significantly reduce the number of information transmissions and the field of application from one newcomer joining an existing group to group integration. The K. Liu et al. [10] discussed about the cooperative scheduling in hybrid VANET as a software defined network, which focuses on centralized scheduler at the RSU and the importance on algorithms in the form of software. The H.A. Omar et al. [11] presented their concept to provide significance on the important role of wireless technologies and their part in VANET, for vehicular safety applications and they reviewed the recent developments of the VeMAC protocol, including prototype experiments and on-road demonstrations of VeMAC-based safety applications implemented in real cars.

M. Rios [12] discussed about the opportunistic routing for VANETin a public transit system in the name of GeOpps-N, which focuses on the reduction on mean end-to-end delay in nodes on VANET. The M. Rohani et al. [13] elaborated about a novel approach for improved vehicular positioning using cooperative map matching and dynamic base station with DGPS concept, which addresses the importance of being the base stations are not necessarily static and the estimated corrections based on the GPS receiver's belief on vehicles positioning and their uncertainty on broadcasted to other receivers are overcome for VANET based applications. The H. Gong et al. [14] presented a work with cloud computing, which describes about the mobile content distribution with vehicular cloud in urban VANETs with the result analysis as cloud-based scheme performs better than inter-vehicle communication approach and cluster-based scheme. The Q. Zhang et al. [15] represented an autonomous vehicle traffic information systems, which focuses on dissemination model for large-scaleurban road networks with the results as the system has good autonomy on the overall performance in terms of the real-time data collection and rapid dissemination of congestion information in a large-scale urban road network. The J. Timpner et al. [16] presented a community of vehicles with trustworthy parking with the helping tendency to assist the neighboring vehicles to find space for parking.

These works are showing the importance on the development of VANET based applications to the vehicular society and the emerging growth on this field is in need of certainty of operations in it to bring the developed systems towards reliability. The existing components of VANET with ITS as RSU, vehicles, SBS, etc., are subjected to the concept of uncertainty in their operations. The new development of applications and systems on such environment must meet these components uncertainty level and must bring them towards uncertainty of operations, which leads the most admirable benefit to the vehicular society and our proposed work is focusing on such systems and applications development try to eliminate the uncertainty act of components to certainty of operations with the help of developed systems and applications.

3. Proposed work

3.1. Mathematical Model

This work takes recent two presented research works of ours and are [2] and [3]. The first work is the system implementation called ORiVD-RDSS [2] and the second is the identification of TC and T-CA using T-CAED algorithm [3]. Both works are focusing the system and application development for the VANET with ITS, acts intelligently on the VANET equipped RE. The system and the application activities are defined in the form of a mathematical model and is described as follows:

In combined mode of both works environment the system components are vehicles, RSUs and SBSs.

3.1.1. For the ORiVD-RDSS (Work 1: Internal) [2]:

The vehicles are coming under a set; and are having their own members of its domain and the set is defined as,

$\boldsymbol{V_i = \{v_1, v_2, v_3, \dots\}}$, of "$\boldsymbol{n}$" tuples,

where "$\boldsymbol{V}$" denotes set of vehicles, "$\boldsymbol{v}$" denotes an individual vehicle, "$\boldsymbol{i}$", denotes the vendors of vehicle make and "$\boldsymbol{n}$" denotes the DTCs of in-vehicle domains.

$\boldsymbol{V_{ij} = \{v_{11}, v_{12}, v_{13}, \dots\}}$,

where "$\boldsymbol{j}$" denotes a particular model of vehicle, which belongs to a specific vendor and the set can further have classified with variants of the specific vehicle model.

Every vehicle has their own sub domains of operations associated with them. These domains are power train, body, chassis, active safety, passive safety, telematics, diagnostics, and OBU. Such sub domains are being members in a vehicle set. Positively, in-vehicle set can be defined with its in-vehicle sub domains as,

$$\boldsymbol{v_i = \{[\, v_1^{PT}, v_1^{BD}, v_1^{CD}, v_1^{AS}, v_1^{PS}, v_1^{TD}, v_1^{DD}], [v_2^{PT}, v_2^{BD}, v_2^{CD}, v_2^{AS}, v_2^{PS}, v_2^{TD}, v_2^{DD}], \dots\}}$$

Each, in-vehicle domain members are defined with their own parameters, and every in-vehicle domain parameter are collected by diagnostic domain and is validated with the threshold value of the domain standard, to identify the DTC. The second component of the proposed system is RSU, which functions in the system with the wireless communication medium and is defined as,

$\boldsymbol{R_i = \{r_1, r_2, r_3, \dots\}}$,

where "$\boldsymbol{R}$" denotes a set of RSUs in ORiVD-DRSS, "$\boldsymbol{r}$" denotes a single RSU and "$\boldsymbol{i}$" denotes serial order number of RSU on the road side which are within a cluster.

The third component of the system is SBS, which is defined with its members in a set called "$\boldsymbol{S}$" and as

$\boldsymbol{S_i = \{s_1, s_2, s_3, \dots\}}$,of "$\boldsymbol{m}$" tuples,

where "$\boldsymbol{S}$" denotes a set of distributed SBS on the RE, "$\boldsymbol{s}$" denotes a single SBS, "$\boldsymbol{i}$" denotes serial order number of SBS on the RE and "$\boldsymbol{m}$" denotes the TFSs available on SBS for each vehicle on ORiVD-RDSS.

The entire system components are defined in a family of set and is,

$F_{ORiVD-RDSS} = \{V, R, S, A\}$, under the condition $n \leq m$.

where "V" denotes a set of vehicles, "R" denotes a set of RSUs, "S" denotes a set of SBSs, "A" denotes an association set and all are members of set $F_{ORiVD-RDSS}$.

In set "A" the members are associations of DTCs and their exact TFSs. This is the mapping from vehicle (DTC) to the SBS (TFS), which is the main goal of the system that provides right TFS for the DTC's sent by the vehicle through RSU.

The set V and its member variables can be mapped into set Sin terms of DTC and TFS and provides a relation called "u" and which is abided by the condition $n \leq m$.

$u \sim v$,if and only if $u_i = v_i$, for 3 consecutive models of the same vehicle and this satisfies reflexivity, symmetricity, and transitivity. Therefore, with the relation ~the equivalence classes may be defined as a set A and is,

$A = \{[u_1], [u_2], [u_3], \ldots, [u_t]\}$, such that $t \leq n$ and $t \leq m$and is an association set of all mapping classes in sets V and S. For example, the **DTC** from the vehicle and its equal **TFS** on **SBS**. For example,

$A = \{[DTC_1 = TFS_1], [DTC_2 = TFS_2], \ldots, [DTC_d = TFS_d]\}$,

In addition,

$[u] + [v] = [u + v]$ for all $[u], [v]$ and

$[u] * [v] = [u * v]$ for all $[u], [v]$,

This shows the possibility of operators on relations. The function mapping for the **DTC** to **TFS**, matching is given below,

$f : A \rightarrow S$and

$f([u]) = [u*]$such that $[u*]$belongs to $S$and $[u*]$ is the image of$[u]$.

where $[u]$ is a diseased one on vehicle, the $[u*]$ is an image on **SBS**, which replaces the diseased one with fresh software (SW) component.

The f is a well-defined function, which gives the equivalence mapping of diseased to fresh image SW component with appropriate searching technique for matching. The mathematical model, and its definition on the environment for the system gets the dimension of finite domain. On this basis of definition for the system, the application software development for ORiVD-RDSS in terms of client/server end are fixed with finite number of requirements to fulfill the system related operations to be accomplished with crisp and towards certainty of operations.

3.1.2. For the TC identification and T-CAED algorithm (Work 2: External) [3]:

The vehicles are treated as a set; and are having their own members of its domain and the set is defined as,

$\boldsymbol{V_i} = \{\boldsymbol{v_1}, \boldsymbol{v_2}, \boldsymbol{v_3}, \ldots\}$, of "$\boldsymbol{a}$" tuples, where $\boldsymbol{i} = \{\boldsymbol{1}, \boldsymbol{2}, \boldsymbol{3}, \ldots, \boldsymbol{a}\}$

where "$\boldsymbol{V}$" denotes set of vehicles, "$\boldsymbol{v}$" denotes an individual vehicle, and "$\boldsymbol{i}$" denotes the number of vehicles connected with the current RSU, "$\boldsymbol{a}$" as the maximum.

$\boldsymbol{v_i} = \{\boldsymbol{SP_i}, \boldsymbol{GPS_i}\}$,

where the individual vehicles are defined with two parameters of its InV operations and "$\boldsymbol{SP_i}$" denotes the current speed of the running vehicle, and "$\boldsymbol{GPS_i}$" denotes the current position of the vehicle on the RE, which belongs to the current connected RSU.

Now, $\boldsymbol{V_i} = \{[\boldsymbol{SP_1}, \boldsymbol{GPS_1}], [\boldsymbol{SP_2}, \boldsymbol{GPS_2}], [\boldsymbol{SP_3}, \boldsymbol{GPS_3}], \ldots\}$

The active RSU on VANET, collects the speed and GPS position parameters from the running vehicles.

$\boldsymbol{R_i} = \{\boldsymbol{r_1}, \boldsymbol{r_2}, \boldsymbol{r_3}, \ldots\}$,of "$\boldsymbol{b}$" tuples, where $\boldsymbol{i} = \{\boldsymbol{1}, \boldsymbol{2}, \boldsymbol{3}, \ldots, \boldsymbol{b}\}$

where "$\boldsymbol{R}$" denotes a set of RSUs in RE for a specified distance interval (cluster), "$\boldsymbol{r}$" denotes a single RSU and "$\boldsymbol{i}$" denotes serial order number of RSU on the road side within a cluster, in which "$\boldsymbol{b}$" is the possible RSUs within a cluster.

An RSU continuously monitors the connected vehicles speed and GPS positions in due course of identifying the TC, that is if a vehicle's speed goes below to 20 km/h, the RSU's TC-identification algorithm is initiated and in addition to speed, the vehicle's GPS position is collected from the OBU of the vehicle. With the GPS position the RSU analyses, whether the vehicle's halt is proper or improper on the road. The halt is proper means the road availability for the successor vehicles on the road is effective and the halted vehicle never blocks the road and other successor vehicles are running without any interrupt. The halt is improper means the current halted vehicle blocks the road and the road availability for the successor vehicles are not effective and makes them to stop forcedly. After the halt status of the current vehicle and its successor vehicles on the road are collected by the RSU in the form of GPS parameters. Then RSU identifies TC.

The entire system components are defined in a family of set and is,

$\boldsymbol{F_{T-CAED}} = \{\boldsymbol{V}, \boldsymbol{R}, \boldsymbol{Z}, \}$, where “$\boldsymbol{V}$” denotes a set of vehicles, “$\boldsymbol{R}$” denotes a set of RSUs, “$\boldsymbol{Z}$” denotes an association set and all are members of set $\boldsymbol{F_{T-CAED}}$.

$$\boldsymbol{Z} = \{\{\boldsymbol{r_1}: (\boldsymbol{v_1}, \boldsymbol{v_2}, \boldsymbol{v_3} \ldots)\}, \{\boldsymbol{r_2}: (\boldsymbol{v_1}, \boldsymbol{v_2}, \boldsymbol{v_3} \ldots)\}, \{\boldsymbol{r_3}: (\boldsymbol{v_1}, \boldsymbol{v_2}, \boldsymbol{v_3} \ldots)\}, \ldots\}, \text{and}$$

$$\boldsymbol{Z} = \{\{\boldsymbol{r_1}: ([\boldsymbol{SP_1}, \boldsymbol{GPS_1}], [\boldsymbol{SP_2}, \boldsymbol{GPS_2}], \ldots)\}, \{\boldsymbol{r_2}: ([\boldsymbol{SP_1}, \boldsymbol{GPS_1}], [\boldsymbol{SP_2}, \boldsymbol{GPS_2}], \ldots)\}, \ldots\},$$

The set $\boldsymbol{Z}$ is providing the mappings of the group of vehicles belonging to a specific RSU and every RSU’s in VANET, continuously monitoring all vehicles’ speed and GPS parameters, within its range of communication. With this scenario, RSU identifies TC and TC intimation is provided as first event notification to the successor vehicles and nearby successor RSUs and this activity is made possible with the communication range of a specific RSU.

The RSU further proceeds with the second event dissemination, at the earliest (i.e., immediate next to the first event notification), to the successor vehicles with the transporters’ interest of opting, two options to alert the successor vehicles to utilize the time interval between congestion occurred to the congestion cleared and is known as congestion avoidance. In congestion avoidance, the RSU’s T-CAED algorithm provides two options, among the first one is the optimum alternate route details, provided in the form of subscribe and utilize, and in option two, the relaxation related services, with respect to the transporters and passengers on the journey towards destination. The congestion avoidance is made possible with the immediate second event disseminated from the RSU, after identifying the TC. The successor vehicles acceptance on the congestion avoidance is presented in the form of CASR.

$$\boldsymbol{CASR_{SUCCESS\ RATE}} = \left\{\frac{\boldsymbol{V_{APO}} + \boldsymbol{V_{RPO}}}{\boldsymbol{V_{TOT}}}\right\},$$

where, $\boldsymbol{CASR_{SUCCESS\ RATE}}$ is congestion avoidance success rate; $\boldsymbol{V_{APO}}$ is the alternate path opted vehicles; $\boldsymbol{V_{RPO}}$ is the relaxation related services opted vehicles; and $\boldsymbol{V_{TOT}}$ is the total number of vehicles on the range of TC event dissemination.

4. InV’s Internal/External: Certainty of operations for Continuous run of vehicles on RE

In the given related two works, the transporters are provided with certainty of operations on travel activities with vehicles on RE, while travelling form source to destination, without meeting discontinuity on their plan of journey by the means of safe travel, utilization of internet enabled services, comfort and fastest travel, expected time and cost of travel, informed road environment, congestion avoidance and remote diagnostic support, etc. The certainty of operations of vehicles on the RE is the key factor of these works. The continuous movement of vehicles on the RE, without any internal or external interrupt, must continue their running on the road, until reaching the destination.

The environment of the vehicles on the RE with VANET and support of ITS is a dynamic, continuous, unknown and linear environment. The objective of the proposed system under ITS using VANET event notification, with two works is to let the running vehicles on the road, without meeting any uninformed halt. Based on the first work, the InV's internal domain malfunctions are overcome with the support of ORiVD-RDSS and the uncertainty act of InV domains malfunctions are made certainty of operations by the remote diagnostics support system and is treated as "Internal" as a key term in this paper. In the second work, the RE's impact on running vehicles as "External", which restricts the movement of running vehicles, are overcome by providing continuity of travel to the running vehicles on the road.

4.1. Internal:

The ORiVD-RDSS is an intelligent system of operations, where the subsystems are OBU based application frameworks [17] [18] [19] [20] and SBS based expert systems [21]. In OBU, the OBD-II standard DTCs are collected by the existing systems in InV, and transferred to SBSs through RSUs. The RSU transfers them to the SBS and the intelligent programs on it, identifies the right TFS for the request DTC and sends them to the requested vehicle in the form of responses. This DTC:TFS pair matching is held at SBS end and the RTR framework and the RDS protocol is the novelty of this proposed work. This type of fault fixing eliminates the improper and uninformed halt of vehicles on the RE, due to InV's network related problems, i.e., internally. This ORiVD-RDSS provides the support for InV networks to function properly and the reliability of the InV is extended and enhanced. This is the certainty of operations provision to the InV's on the RE, while they are in running condition.

The incident/accident is one of the reason to generate the road blockage, (i.e., the traffic congestion) and is being one of the cause to introduce the time delay in travel, uncomforted state on transporters during their journey and increased cost spent on travel. This is the major defect of current traffic monitoring and regulations system. Such problems are considered in the ORiVD-RDSS design, and based on InV related software malfunctions are treated with their fault tolerant capabilities to identify the DTC based on OBD II standard. The TFS for the specific DTC is provided with SBS wirelessly and during this process the vehicles are in continuous movement on the road towards destination. This shows the continuity of travel's achievement of running vehicles on the road, even they are suffered from InV related problems. The vehicle's internal processes are subjected to uncertainty of act by their design and development, and any engineering project/product is subjected to uncertainty until their life time and with ORiVD-RDSS, the InV's uncertainty of operations state is brought in to certainty of operations and road travel is provided with continuity.

4.2. External (Ant Colony Optimization):

To enumerate the external certainty of operations of the vehicles running on the road and to continue their travel on RE, the work 2 with TC identification and T-CAED algorithm processes are taken in to account and the descriptions follows: Let $< \boldsymbol{r_1}, \boldsymbol{r_2}, \boldsymbol{r_{13}}, \ldots, \boldsymbol{r_m} >$be the sequence of RSUs and the vehicles passing through them are having a time interval $[\boldsymbol{t_{r_i l}}, \boldsymbol{t_{r_i k}}]$where the "$\boldsymbol{t_{r_i l}}$" is the time of a vehicle, which enters in the communication range of a RSU "$\boldsymbol{r_i}$" and the "$\boldsymbol{t_{r_i k}}$" is the time of a vehicle, which leaves the communication range of a RSU "$\boldsymbol{r_i}$". After the TC identification, let a RSU, "$\boldsymbol{r_i}$" communicates TC information to the vehicle "$\boldsymbol{v_j}$". The vehicle "$\boldsymbol{v_j}$" is provided with immediate second event in the form of dissemination, and this event dissemination is in the form of publish/subscribe framework [22], has two options in it. Each option is having more than one sub options in it. The RSUs are publishing the options to the vehicles OBU and with the OBU information, the transporters are selecting any one option based on the interest and the time interval between TC occurrences to the TC clearance, the successor vehicles running on the road, bypasses the TC area visit and get caught on it.

In option one the alternate optimum path selection is provided to avoid the TC, with two sub options in it. The first sub option is the information about the paved route and its time of travel and distance of travel to bypass the current occurred TC. The second sub option of the option one is the information about the unpaved route and its time of travel and distance of travel to bypass the current occurred TC. In option two the transporters are provided with relation related services to avoid TC area and this is a business model, which provides business opportunities to the transporters as well as to the service providers. The services are the geo location intimation about the hotels, restaurants, hospitals, fuel refilling stations and relaxation related service providers. This benefits the transporters to relax them self and continue their travel. If the vehicle "$\boldsymbol{v_j}$" selects any of the relaxation based services "interest based halt", then "$\boldsymbol{r_i}$" collects the history of the vehicle. If the vehicle "$\boldsymbol{v_j}$" selects an alternate optimum route to continue its travel, then "$\boldsymbol{r_i}$" collects the history of the vehicle. The alternate routes are the sequence as $< \boldsymbol{r_{alt,1}}, \boldsymbol{r_{alt,2}}, \boldsymbol{r_{alt,3}}, \ldots, \boldsymbol{r_{alt,m}} >$ using Ant Colony Optimization as follows:

Let the transition probability if the ant at the vehicle "$\boldsymbol{i}$" to the vehicle "$\boldsymbol{j}$" is defined by

$$t_p(i,j) = \begin{cases} \frac{\psi(i,j)}{\sum_{k\epsilon N_i} \psi(i,k)} if\ k \epsilon N_i & otherwise \\ 0 \end{cases}$$

Where, "N_i" is the neighborhood vehicles set.

$\psi(i,j) = \psi(i,j) + \Delta\psi(i,j)$ is the pheromone update, and

$\Delta\psi(i,j) = \frac{P_1}{|i-j|} + (P_2 * P_{r_v})$, where

"P_{r_v}" is the path reliability metric and is obtained by,

$P_{r_v} = \frac{1}{F_{r_v} + B_{r_v}}$, where

"F_{r_v}", is the forward delivery ratio and is the probability of successful arrival of an event by recipient, B_{r_v}, is the probability of successful receipt of acknowledgement of recording the history of opted options at the SBS end, "P_1" is the distance parameter and "P_2" is the reliability path parameter.

The pheromone evaporation factor is given by.

$\rho(i,j) = (1 - \alpha).\rho(i,j)$, where "$\alpha$" is the evaporation factor.

The interest based halt of vehicle on such centers are treated as continuity of travel in this work context. These two options are providing the avoidance of TC and provides the continuity of travel for the vehicles on the road.

5. Conclusion and Future Work:

The vehicles on the road while running are subjected to uncertainty of act according to internal and external operations. The internal and external operations are based on the RE, the provision of continuity of travel to the running vehicles is the motivation and goal of the certainty of operations. The internal InV's uncertainty is overcome with ORiVD-RDSS formulation using RTR framework and RDS protocol to fix DTC with appropriate TFS. In this system formulation, we take the ECU's firmware reinstall/flash as the TFS applying process to the troubles, as the first version of our implementation and the other possible categories of fixes and their solutions can be proposed with the future work. The external RE's incidents/accidents are treated as obstacles on the road for the running vehicles, which blocks the continuity of travel, and is treated as uncertainty of operations. This external uncertainty is overcome with the help of TC identification and T-CA is performed with T-CAED algorithm's operation on RSUs, which provides the continuity of travel to the successor vehicles on the RE is being the provision of certainty of operations to the running vehicles in the form of external provision. As for internal and external uncertainty of operations, which are restricts the continuity of travel of vehicles on the RE, is provided with the help of proposed works and the certainty of operations are obtained with the optimization and the continuity of travel to the running vehicles are provided.

References

1. P. Sivaram and P. Rajaram, "AUTOSAR: In-vehicle Standardization with Certainty of Operations towards Globalization". International Journal of Innovations in Engineering and Technology, Vol. 4, Issue 2, pp. 66-71, 2014.
2. P. Sivaram and S. Senthilkumar, "An Efficient On the Run in-Vehicle Diagnostic and Remote Diagnostics Support System in VANET". Middle East Journal of Scientific Research, Vol. 24, No. 11, pp. 3542- 3553, 2016.
3. P. Sivaram and S. Senthilkumar, "Event Notification in VANET with Traffic Congestion Detection and Congestion Avoidance". International Journal of Printing, Packaging & Allied Sciences, Vol. 4, Issue 1, December 2016.
4. Juan (Susan) Pan, I. S. Popa and C. Borcea, "DIVERT: A Distributed Vehicular Traffic Re-Routing System for Congestion Avoidance", IEEE Transactions on Mobile Computing, Vol. 16, No. 1, pp. 58-72, 2017.
5. J. Contreras-Castillo, S. Zeadally and J. A. Guerrero Ibañez, "Solving vehicular ad hoc network challenges with Big Data solutions", IET Networks, Vol. 5, No. 4, pp. 81-84, 2016.
6. W. Li and H. Song, "ART: An Attack-Resistant Trust Management Scheme for Securing Vehicular Ad Hoc Networks", IEEE Transactions on Intelligent Transportation Systems, Vol. 17, No. 4, pp. 960-969, 2016.
7. Y. Bi, H. Zhou, W. Xu, X. S. Shen and H. Zhao, "An Efficient PMIPv6-Based Handoff Scheme for Urban Vehicular Networks", IEEE Transactions on Intelligent Transportation Systems, Vol. 17, No. 12, pp. 3613-3628, 2016.
8. L. Li, W. L. Huang, Y. Liu, N. N. Zheng and F. Y. Wang, "Intelligence Testing for Autonomous Vehicles: A New Approach", IEEE Transactions on Intelligent Vehicles, Vol. 1, No. 2, pp. 158-166, 2016.
9. C. C. Lee, Y. M. Lai and P. J. Cheng, "An Efficient Multiple Session Key Establishment Scheme for VANET Group Integration", IEEE Intelligent Systems, Vol. 31, No. 6, pp. 35-43, 2016.
10. K. Liu, J. K. Y. Ng, V. C. S. Lee, S. H. Son and I. Stojmenovic, "Cooperative Data Scheduling in Hybrid Vehicular Ad Hoc Networks: VANET as a Software Defined Network", IEEE/ACM Transactions on Networking, Vol. 24, No. 3, pp. 1759-1773, 2016.

11. H. A. Omar, N. Lu and W. Zhuang, “Wireless access technologies for vehicular network safety applications”, IEEE Network, Vol. 30, No. 4, pp. 22-26, 2016.
12. M. Rios, “GeOpps-N: Opportunistic Routing for VANET in a Public Transit System”,IEEE Latin America Transactions, Vol. 14, No. 4, pp. 1630-1637, 2016.
13. M. Rohani, D. Gingras and D. Gruyer, “A Novel Approach for Improved Vehicular Positioning Using Cooperative Map Matching and Dynamic Base Station DGPS Concept”, IEEE Transactions on Intelligent Transportation Systems, Vol. 17, No. 1, pp. 230-239,2016.
14. H. Gong, L. Yu, N. Liu and X. Zhang, “Mobile content distribution with vehicular cloud in urban VANETs”, China Communications, Vol. 13, No. 8, pp. 84-96, 2016.
15. Q. Zhang, H. Zheng, J. Lan, J. An and H. Peng, “An Autonomous Information Collection and Dissemination Model for Large-Scale Urban Road Networks”, IEEE Transactions on Intelligent Transportation Systems, Vol. 17, No. 4, pp. 1085-1095, 2016.
16. J. Timpner, D. Schürmann and L. Wolf, “Trustworthy Parking Communities: Helping Your Neighbor to Find a Space”, IEEE Transactions on Dependable and Secure Computing, Vol. 13, No. 1, pp. 12d-132, 2016.
17. Guihe Qin, A. Ge and Huansong Li, “On-board fault diagnosis of automated manual transmission control system”, IEEE Transactions on Control Systems Technology, Vol. 12, No. 4, pp. 564-568, 2004.
18. H. Cai and Y. Lin, “A Roadside ITS Data Bus Prototype for Intelligent Highways”, IEEE Transactions on Intelligent Transportation Systems, Vol. 9, No. 2, pp. 344-348, 2008.
19. A.X.A. Sim and B. Sitohang, “OBD-II standard car engine diagnostic software development”, International Conference on Data and Software Engineering (ICODSE), Bandung, pp. 1-5, 2014.
20. R. Malekian, N.R. Moloisane, L. Nair, B. S. Maharaj and U.A.K. Chude-Okonkwo, “Design and Implementation of a Wireless OBD II Fleet Management System”, IEEE Sensors Journal, Vol. 13, No. 9, pp. 1-11, 2014.
21. M. Beecroft and K. Pangbourne, “Personal security in travel by public transport: the role of traveller information and associated technologies”, IET Intelligent Transport Systems, Vol. 9, No. 2, pp. 167-174, 2015.
22. J.C. Mukherjee, A. Gupta and R.C. Sreenivas, “Event Notification in VANET with Capacitated Roadside Units”, IEEE Transactions on Intelligent Transportation Systems, Vol. 17, No. 7, pp. 1867-1879, 2016.