IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Issue-10 E-ISSN: 2347-2693

Multi-Agent Based Context Aware Multicast Routing in VANET

A. D. Devangavi[1*], Rajendra Gupta[2]

[1*]Information Science and Engineering, Basaveshwar Engineering College, VTU, Bagalkot, India
[2]Research Cell, AISECT University, Bhopal, India

[1]Corresponding Author: anildevangavi_s@yahoo.co.in, Mob: +919343186108

Available online at: www.ijcseonline.org

Received: 21/Sep/2017, Revised: 30/Sep/2017, Accepted: 15/Oct/2017, Published: 30/Oct/2017

***Abstract*—** Vehicular Ad-hoc Network (VANET) is a variant of Mobile Ad-hoc Network (MANET).The key goal of VANET is to facilitate communications among vehicles and also amongst vehicles and fixed infrastructure. Regardless of the fact that VANET is considered as a sub-class of MANET, it has distinctive features in terms of high mobility of vehicles, fabricating to recurrent topology changes, random node density and boundless network size. Hence most of the clustering algorithms considered for MANET are inappropriate for VANET. Much of the literature recently published focus on clustering in VANETs. However most of them are concentrated on diminishing network overhead value, number of clusters formed and do not consider the vehicles interests (viz. traffic congestion, looking for petrol pumps, free parking space, etc.). To decrease the complexity of transmissions, only context-aware data is required to be communicated to the intended recipients as needless information may cause a performance bottleneck in VANETs. Hence in this paper, we propose a context aware multicast/clustered routing algorithm based on agent technology which addresses above mentioned issues and improves the performance parameters associated with routing in VANET. The performance of the proposed scheme is tested with respect to bandwidth consumption, cluster formation time, multicast grouping time and communication overhead.

***Keywords*—** VANETs, Cluster, Multicast, Context, Interest**.**

I. INTRODUCTION

Vehicular ad-hoc network (VANET) is currently emerging technology which features many safety applications for transportation on roads. However, owing to the random mobility of vehicles in VANETs, communication links are frequently disconnected leading to regular change in network topology. Many of the existing routing protocols are prone to the consumption of high bandwidth and to the overhead associated to route discovery. Clustering forms a virtual communication backbone that facilitates efficient data delivery in VANETs. The consumption of scarce resources such as bandwidth is minimized [1]. In VANET, broadly two approaches are employed for clustering of vehicles: Static clustering and dynamic clustering. Static clustering is formed between Vehicles and fixed Infrastructure (V2I). In this communication Road Side Units (fixed infrastructure) act as static cluster heads [2]. To facilitate real-time communication and connectivity with the Internet all the vehicles are basically connected with Road Side Units (RSU). However, owing to the large distance between the RSUs, the vehicles with high mobility are not always connected to the RSUs. Dynamic clustering is formed amongst vehicles (V2V) and cluster heads are elected from cluster members. Thus dynamic clustering method eliminates the idea of static cluster heads. The dynamic clusters are in motion on the road and vehicles either join or leave the clusters according to their speed and proximity to identified cluster heads. As V2V communications are more flexible and independent of the roadside conditions, they are particularly attractive for the most developing countries or remote rural areas where the roadside infrastructures are not necessarily available [3] [4]. Some of the advantages of clustering in VANETs are (1) Entire network can be divided into smaller groups of moving vehicles. This also facilitates the usage of different protocols within and outside clusters (hierarchical routing) [5]. (2) Efficient usage of bandwidth, routing, distribution of resources and scalability (3) Better routing and network lifetime, Support scalability of network (4) Routing path is limited to the cluster head, thus leading to small sized routing tables, reducing the bandwidth demand and efficient use of limited channel bandwidth (4) Eliminate the redundant and highly tedious route discovery process. (5) Users can be classified into separate groups based upon their interests.

The main purpose of the clusters will be essentially to manage a specific region. As the vehicles continuously move in and out of the cluster to which they belong, their position also change frequently and links between vehicles will be regularly broken. This necessitates the development of alternative stable approach for the formation of clusters. Thus it is very important to consider the context information, viz.

interests in parking place, petrol bunks and etc. for the formation of clusters and thereby for route computation [6] [7]. However, the existing approaches do not completely address the outcome of the context information for the routing decision.

Rest of the paper is organized as follows. Section II discusses related works. In section III methodology is presented. In section IV structure of the proposed work is discussed. Network environment is mentioned in section IV. A. Section IV. B discusses mathematical models. Section IV. C describes the proposed agency. The proposed scheme for the work is stated in section IV. D. Section IV. E describes the algorithm for the proposed work. Simulated model for the proposed work is discussed in section V. Results and analysis are discussed in section VI. Conclusion is presented in section VII.

II. Related Work

Authors in paper [8] present a context-aware two level hierarchical routing protocol (CHTR) based on road connectivity and vehicle context in VANETs. The protocol makes use of gateway vehicles to trace the destination and calculates the best path based on QoS parameters. The path is computed based on road id's. Authors in paper [9] present a novel agent technology based clustering algorithm that takes into account vehicular interests. Clusters are formed considering the interests of the vehicles and thereby improving the efficiency of routing in VANET. Authors in paper [10] present a novel Autonomous Unmanned Military Vehicles (AUMVs) protocol to implement a Vehicular Ad Hoc Network (VANET) among unmanned Military Vehicles (MVs). The proposed protocol takes into account real time and dynamic war field scenario to perform cluster based multicast communication among AUMVs.

Authors in paper [11] presents a 2 layer stable clustering scheme based on adaptive multiple metric that includes features of both static and dynamic clustering methods. To achieve higher cluster stability, suitability value is computed to elect cluster head. Authors in paper [12] present a new context-aware congestion resolution protocol called as Minimum Calculated Desired Time (MCDT) for Intelligent Data Dissemination in VANETs. Parameters like Virtual connectivity, Packet delivery ratio and etc. are employed to compute best path.

Authors in paper [13] introduce an approach based on multi-agent system to solve the problems associated with uncertainty of routes, low PDR and delays in transmission. Authors in paper [14] present a multi-hop clustering technique "VMaSC: Vehicular multi-hop algorithm for stable clustering in Vehicular Ad Hoc Networks". The technique calculates similarity among vehicles by periodically exchanging a metric called stable mobility.

Authors in paper [15] present an efficient context aware multicast protocol that disseminates messages only to endangered vehicles that may be affected by the emergency event. To identify endangered vehicles motion properties based interaction among vehicles is computed. Minimum delay tree is calculated to identify the route to make sure fast delivery.

Authors in paper [16] presents a technique agent based intelligent information dissemination in VANETs employing static cognitive, mobile agents and other software agents. The critical information is autonomously collected, classified and disseminated by the vehicles with the support of cognitive software agent. Authors in paper [17] present a communication scheme based on multiple protocols. Based on the quality and stability of links which depend on the distance between the nodes and mobility, the selection of the protocol is made. The core of the scheme is the context engine processing context coming from different layers of the architecture.

Authors in paper [18] present multi-agent based information dissemination in VANETs, which is based on a set of static and mobile agents in VANET agency. The model supports context based Information search and access, Critical information dissemination, and location dependent services. The authors in paper [19] presents Agent based Context Aware Image Fusion for Military Sensor Networks (ACIF-MSN), a framework that supports the use of context aware sensors in the military field. Images gathered from different sensors are fused to get a clear image.

Authors in paper [20] present a novel topology control method for VANET, Position-based Prioritized Clustering (PPC). The technique incorporates position information into a novel hierarchical clustering technique. This work presents a novel heuristic clustering approach which incorporates position information to select cluster heads, which is similar to the calculation of a Minimal Dominating Set. A stable backbone is created by the cluster heads in highly dynamic environment. Authors in [21] present a scheme cluster-head gateway switch routing (CGSR) in which clustering is based on the concept of least cluster change. Stable clusters are thus formed.

Disadvantages of the existing algorithms:

- Employ MANET clustering algorithms to form and maintain the clusters. Hence stable clusters are not formed and computed path may not be the best.
- Clusters are formed to manage a specific region. Due to the mobility of the vehicles their position continuously change and the communication links are frequently broken.

- Focus on parameters like reducing network overhead, number of created clusters and do not consider the impact of context or vehicular interests e.g., looking for a free parking space, chatting, traffic congestion etc. for routing decision. Thus there will be substantial increase in overall traffic density as unnecessary information is transmitted leading to a probable performance bottleneck.

III. METHODOLOGY

In this paper, we propose a new approach for context aware clustered routing based on multi-agent system [22]. Every vehicle in the VANET is characterized by a defined context/interest as looking for parking space, petrol bunks, accident alert etc. We use a context-aware clustering approach where the virtual clusters are computed according to the context. The proposed work thus aims to optimize the information flow between nodes and decrease overall network traffic deployment. Accordingly the vehicle that detected the accident must send an alert message only for the vehicles which are interested in this information. Thus to minimize the complexity associated with transmissions, only context-aware data is required to be communicated to the intended recipients.

The proposed scheme works on the following procedure which is as follows:

- Clusters are formed by using position based prioritized clustering technique (PBPCT) and cluster head (CH) is elected based on the concept of Minimal Dominating Set (MDS) and Priority value.CH communicates its election as cluster head to all members of that cluster through a HELLO message. HELLO message comprises parameters such as unique vehicle ID (unique ID), Location Status (set as CH) and interests. It asks all other members to register their interest in non-emergency contexts.
- Every member vehicle updates the information of CH in their database. The members respond with a REPLY message. The message comprises of information such as unique ID, Location and Interest in one or more non-emergency contexts.
- Fast moving vehicles (Non cluster members) register their interests with nearby RSU.
- Whenever any vehicle detects any context (event/context vehicle), it reports the same to its respective CH.
- VNMA of CH categorizes the context, either as emergency context or non-emergency context and in case of non-emergency context to which specific interest it belongs. (5a) Information of emergency context will be disseminated to all vehicles.(5b) For non-emergency context of particular interest for ex. Parking place, Petrol bunks and etc., VNMA of CH sends a APPOINT message to the context vehicle. The Appoint message comprises of information such as appointment of the context vehicle as subgroup leader, a list of all vehicles in that cluster that have registered interest for that particular context and their locations. VNMA of Subgroup leader initiates by triggering a mobile agent which travels and forms a subgroup of all the vehicles of that interest [21]. At the same time CH communicates the context information with local RSU and CHs of neighbouring clusters. RSU in turn communicates that information with the registered fast moving vehicles and neighbouring RSUs. Likewise the information is communicated to the CHs of all the clusters in the environment through respective RSUs. Eventually subgroups are formed in each cluster [23]. Thus a group of vehicles with interest in that particular context is virtually formed with subgroups in each clusters and fast moving vehicles as its members.
- For typical contexts (no group exists and no list is prepared by VNMA of CH) requested by the vehicle for which it has not registered, the VNMA provides the information in association with RSU. VNMA of CH will add the new context in NKB with the list containing context vehicle as single member. It sends the information of the new context to all members and waits for the reply requesting for registration. It then sends APPOINT message to the context vehicle with the new list created and thus one more group is initiated.

Our contributions are as follows:

- Use of agent technology to collect context information (vehicle’s interests).
- Use of agents to optimize communication and minimize network traffic.
- Use of mobile agent to form groups and subgroups interested in particular contexts.
- Mobile agents are to used to reduce the communication cost.
- Various agencies are employed to spot and manage the emergency & non-emergency contexts.

The proposed work Multi-Agent Based Context Aware Multicast Routing in VANET (MCAMR) is compared with Two layer clustering scheme (TLCS) based on suitability value [2]. The advantages of proposed approach over 2LCS are as follows:

- Use of mobile agents to inform the election of Centre Head to all members of cluster.
- Use of mobile agents to form groups and subgroups within clusters.
- Selection of better path.
- Efficient usage of bandwidth.
- Reduction in overall traffic density and thereby avoid performance bottlenecks [6]. Small sized groups and

subgroups save everyone's time and increase productivity.

IV. STRUCTURING THE PROPOSED SYSTEM

This section presents the network environment, mathematical models, proposed agency, scheme and algorithm.

A. Network Environment:

The network structure is depicted in Figure 1.

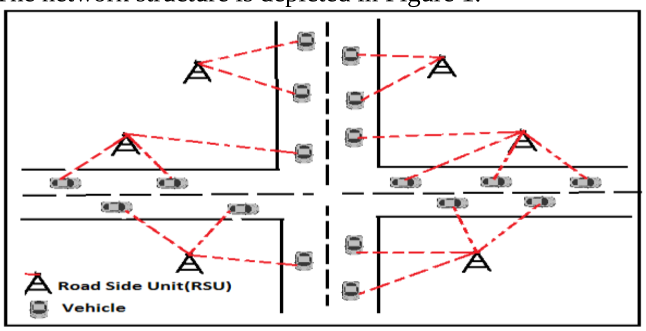

Figure1VANET Environment

This above figure presents the network environment in which we can notice that number of vehicles move with different speed in different lanes. Some of the assumptions in this work are: RSU exists at regular intervals and all the RSUs are networked , N number of Clusters exists in the environment, Initially the status field of all the vehicles in the cluster is set as member , For each cluster, cluster heads (CHs) are elected, All the clusters in the range of RSU are neighbouring clusters, Cluster heads of neighbouring clusters can communicate, Emergency contexts are communicated to all vehicles, For non-emergency contexts vehicles register/subscribe with their respective cluster head. Each vehicle communicates with other vehicle within its communication range (V_{Ran}) via V-to-V communication. The vehicles that lie within the transmission range of a particular vehicle are the neighbouring vehicles of that vehicle. Each vehicle's status and information (parameters) is updated by itself and also by neighbouring vehicles in a local database. The information is related to vehicle ID, position of the vehicle in terms of latitude and longitude, current speed of the vehicle, direction and etc. Every vehicle is connected to at least one road side unit (fixed infrastructure). Each vehicle communicates with road side units via V-to-R communication.

Practical implementation of the proposed scheme needs the following:

- Every vehicle must be equipped with a computational device comprising a real time operating system, wireless transceiver unit with dynamic ranges, GPS unit, speed sensing unit, inter-vehicle distance monitoring unit, cameras, fuel sensing unit, Traffic density sensor, accident sensor (body pressure sensor and vehicle speed sensor together sense the occurrence of accident), human interface, embedded tire air sensing unit, database manager, environment and road condition sensors, an agent platform with set of static and mobile agents. Every vehicle should have location based services.
- Every RSU must have a computational unit, wireless transceiver unit with dynamic ranges, real time operating system, agent platform, cameras and database manager and internet connection.

B. Mathematical models

Contexts (Critical information) may be of two kinds [16] [18].Firstly, there are emergency contexts such as traffic jams, accidents, fog etc., which have to be disseminated to other vehicles. Traffic density sensor can detect traffic jams and accident sensor (body pressure sensor along with vehicle speed sensor) sense the occurrence of accidents. Some contexts such as fog, fire and etc. need to be disseminated in an aggregated way.

Context detection by Aggregation of information [24]: The occurrence of a context is determined by the coherent relationship amongst the various parameters sensed by sensor node. Context detection process can be associated to the aggregation of all the information of a context observed by the related sensor nodes.

Let

i) $v_1^n, v_2^n, \; v_3^n, \ldots\ldots v_i^n$ be the associated parameter values sensed for the nth context and

ii) $V_{nt1}^n, V_{nt2}^n, V_{nt3}^n \ldots\ldots V_{nti}^n$ be the threshold values for the parameters for context n

Where n= 1, 2, 3….x, and i=1, 2, 3…..y

Based on the respective threshold, the sensed value of the parameter (context n) is set to 0 or 1 as given by Eq. (1)

$$\forall_{i=1}^{y} \; v_i^n = \begin{cases} 1 & if \; (V_i^n > V_{nti}^n), \\ 0 & Else \end{cases} \qquad (1)$$

Existence of a context is specified by Eq. (2)

$$C_{sp}^n = \begin{cases} Spotted & if \; \prod_{i=1}^{Y} V_i^n = 1 \\ Notspotted & Else \end{cases} \qquad (2)$$

Secondly, there are non- emergency contexts:

Road conditions, road works, weather conditions ahead are some of the contexts that fall in the category in between emergency and non- emergency contexts that should be disseminated to other vehicles.

i) Contexts such as fuel status, vehicle speed, neighbour vehicle distance, etc. that can be monitored by an agent for a particular vehicle. These contexts will assist the driver in

safer driving and it does not need to be spread to other vehicles.
The context is decided based on values sensed from sensors (weather sensors, speed sensors), neighbouring agents or the vehicle user. The information is also updated with the knowledge base.

Sensor state can be set to 1 or 0. Let every sensor be defined a threshold value by the manager agent in the vehicle. Let S_{R1}, S_{R2}, S_{R3}… S_{Rn} be the sensor reading noticed over a fixed time period ΔT.
i. e. ΔT is the duration between m and tm′ where tm′> tm and i=1, 2, 3…..n
If $S_{Ri} \geq$ threshold value then $S_{Ri}= 1$ Else $S_{Ri}= 0$
T_T be the total number of sensor transitions/readings
T_H be the total number of sensor transitions/readings during ΔT with $S_{Ri}= 1$
T_L be the total number of sensor transitions/readings during ΔT with $S_{Ri}= 0$
If $T_H>T_L$ then Sensor State is set to 1 Else Sensor State is set to 0 (3)

ii) Interests in contexts such as parking place, petrol pumps, and etc. Vehicle which detects this context will communicate the information to cluster head (if it is a cluster member) or nearby RSU (if it is a non-cluster member). This context information can be communicated to all other interested vehicles by cluster head and RSU.

Subgroups and groups

Let
M1C1, M2C1, M3C1…….MnC1 € C1
M1D1, M2D1, M3D1…….MnD1 € D1
M1C2, M2C2, M3C2…….MnC2 € C2
M1D2, M2D2, M3D2…….MnD2 € D2
C1, C2, C3 …Cn € C
D1, D2, D3 …Dn € D
E1, E2, E3……..En € E
C1, C2, C3 …Cn & D1, D2, D3 …Dn &…. € E
i. e. C U D U…€ E (4)

C1 (with members M1, M2...Mn), C2 (with members M1, M2...Mn)...…Cn (with members M1, M2...Mn) be the subgroups with interests in $context_{i1}$ and D1 (with members M1, M2...Mn), D2 (with members M1, M2...Mn) …Dn (with members M1, M2...Mn) be the subgroups with interests in $context_{i2}$ formed across clusters in the VANET environment.
i. e. C1, C2 …Cn € C where C is the group of vehicles interested in $context_{i1}$

D1, D2 …Dn € D where D is the group of vehicles interested in $context_{i2}$ and so on

E1, E2, E3 …..En are the regular clusters for the dissemination of emergency contexts. Thus the union of C, D and other groups in different contexts makes E which represents all clusters, groups and subgroups interested in different contexts.

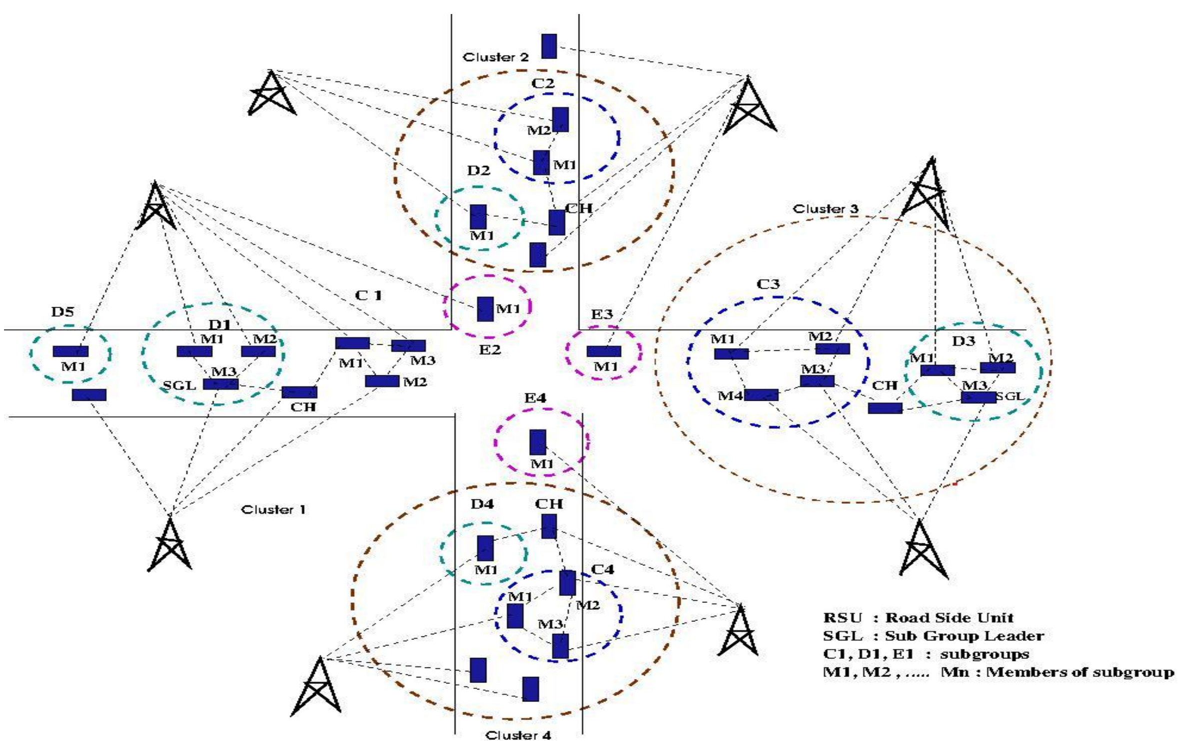

Figure 2 Groups and Subgroups across Clusters in VANET Environment

C. Proposed Agency

Various agencies are employed to perform communication among vehicles and road side units viz. Vehicle Agency, Road Side Unit Agency [13] [16] [18].

1) Node Agency

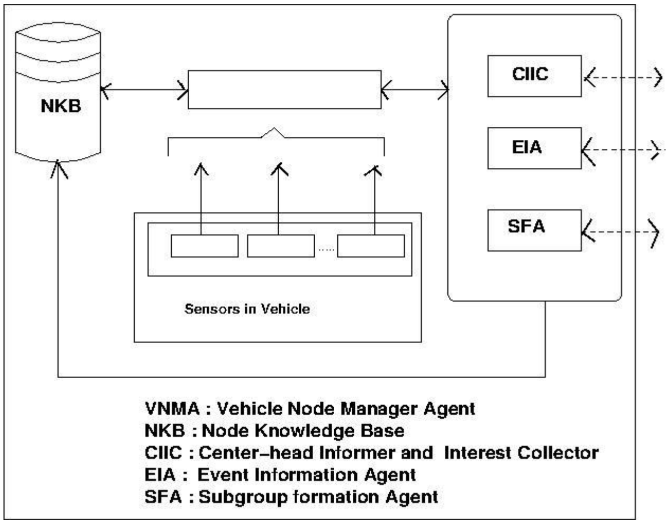

Figure 3 Vehicle Node Agency

Vehicle Node Manager Agent (VNMA): This is a static agent residing in every vehicle. It is responsible for the creation of all other static and mobile agents and node knowledge base (NKB). It assigns specific task to all the created agents and synchronizes the agent interactions. It monitors parameters like speed, direction, location, status, interest and unique vehicle ID of the parent node. It also monitors contexts such as fuel status, vehicle speed, neighbour vehicle distance, etc. of the parent vehicle. These events will assist the driver in safer driving and it does not need to be spread to other vehicles. It exchanges the mobility parameters like speed, direction and etc. with the neighbour nodes during the cluster formation phase [2] [20]. Upon the election of the parent node as cluster head it changes the status to CH. It communicates the information with nearby RSU. It then triggers Centre head Informer and Interest Collector (CIIC) agent to inform its election as CH to all other members of the cluster. It constructs and maintains separate lists of vehicles based on their interests. It continuously updates NKB with relevant information.

VNMA classifies the detected context (by itself or as informed by one of the VNMA of cluster members) [25]. If the context needs to be disseminated to other vehicles it triggers Event Informer Agent (EIA) and initiates group and subgroup forming based upon the context interests of the vehicles. In response to HELLO message from VNMA of CH, the VNMAs of other member vehicles respond with a REPLY message. VNMA of the vehicle change its status accordingly to CH or subgroup head.

Node Knowledge Base (NKB): It works according to blackboard architecture style and facilitates the communication and coordination among agents. Agents read or update the blackboard. It stores the mobility metrics, location and unique IDs of the parent and neighbour vehicle nodes. NKB of CH maintains separate lists of vehicles based on their interests. It comprises of information of all critical contexts such as accidents, traffic density and total number of critical information available.

Centre head Informer and Interest Collector (CIIC): This is a mobile agent. This is triggered by VNMA of the vehicle to inform all other members of the cluster about its election as centre head (CH). This agent travels around the network by creating its clones (a clone is identical copy of agent with different destination addresses) and propagates HELLO message. The message consists of the information such as its status as CH, unique ID and its location. For each visited vehicle, it updates NKB in coordination with VNMA of vehicle and collects REPLY message containing interests of the vehicles.

Event Informer Agent: This mobile agent is triggered by VNMA of CH to send APPOINT message to the context detecting node. The message is a triple consisting of appointment as subgroup head, list of other vehicle IDs with the same interest and their locations. Upon receipt of this the VNMA of context detecting node changes its status to subgroup head. VNMA of CH communicates the context information to RSU and neighbouring CHs.

Subgroup Formation Agent: This is a mobile agent triggered by the VNMA of context detecting node upon receipt of APPOINT message from VNMA of CH. Multiples clones of the agent are created. The agent and its clones move to all vehicles in the list and form a subgroup. During its visit to each node it updates respective NKB with the context information.

2) Road Side Unit agency

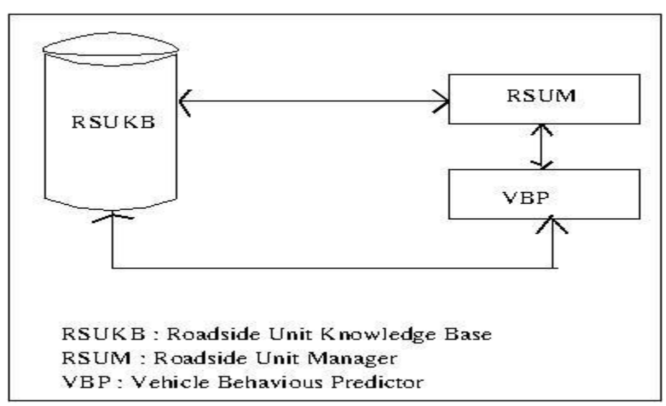

Figure 4 Road Side Unit Agency

Road Side Unit Manager (RSUM): It monitors the clusters in its range. All the RSUs are in the VANET environment are networked. It communicates the context information (received from one of its local CH) to other CHs in the range of parent RSU and also to other RSUs. In turn RSUM of all the RSUs will communicate the context information to CHs in their range. It also monitors and communicates the context information to the non-cluster member vehicles registered directly to it. RSUs are provided with location based services. Information of Contexts related to location based services viz. parking places, petrol bunks and etc. is provided by RSU. It periodically updates RSUKB with relevant information.

Road side Unit Knowledge base (RSUKB): It stores the information of clusters and cluster heads in the range of parent RSU. It also stores the information of number of subgroups and groups formed along with their heads. It maintains parameters like speed, direction, location, status, interest and unique vehicle ID of the non-cluster member vehicles registered to the parent RSU. Information of all contexts is maintained in RSUKB.

Vehicle Behaviour Predictor Agent (VBPA): This is a static agent residing in every RSU. It keeps track of the behaviour (speed, direction and etc.) of each vehicle in the cluster in the range of parent RSU. Using this information it predicts the future behaviour of the vehicle. Behaviour of vehicle plays vital role in subsequent cluster formation and maintenance phase. The relevant information is stored in RSUKB.

D. Scheme

- Clusters are formed by using position based prioritized clustering technique (PBPCT) and cluster head (CH) is elected based on the concept of Minimal Dominating Set (MDS) and Priority value [20]. CH communicates its election as cluster head to all members of that cluster through a HELLO message. HELLO message comprises parameters such as unique vehicle ID (unique ID), Location Status (set as CH) and interests. It asks all other members to register their interest in non-emergency context.
- Every member vehicle updates the information of CH in their database. The members respond with a REPLY message. The message comprises of information such as unique ID, Location and Interest in one or more non-emergency contexts.
- Fast moving vehicles (Non cluster members) register their interests with nearby RSU.
- Whenever any vehicle detects any context (event/context vehicle), it reports the same to its respective CH.
- VNMA of CH categorizes the context, (Eq. 2 and Eq. 3) either as emergency context or non-emergency context and in case of non-emergency context to which specific interest it belongs.
- Information of emergency context will be disseminated to all vehicles.
- For non-emergency context of particular interest for ex. Parking place, Petrol bunks and etc., VNMA of CH sends a APPOINT message to the context vehicle. The Appoint message comprises of information such as appointment of the context vehicle as subgroup leader , a list of all vehicles in that cluster that have registered interest for that particular context and their locations. VNMA of Subgroup leader initiates by triggering a mobile agent which travels and forms a subgroup of all the vehicles of that interest [21]. At the same time CH communicates the context information with local RSU and CHs of neighbouring clusters. RSU in turn communicates that information with the registered fast moving vehicles and neighbouring RSUs. Likewise the information is communicated to the CHs of all the clusters in the environment through respective RSUs. Eventually subgroups are formed in each cluster. Thus a group of vehicles (Eq. 4) with interest in that particular context is virtually formed with subgroups in each clusters and fast moving vehicles as its members.

For typical contexts (no group exists and no list is prepared by VNMA of CH) requested by the vehicle for which it has not registered, the VNMA provides the information in association with RSU. VNMA of CH will add the new context in NKB with the list with the context vehicle as a single member. It sends the information of the new context to all members and waits for the reply requesting for registration. It then sends APPOINT message to the context vehicle with the new list created and thus one more group is initiated.

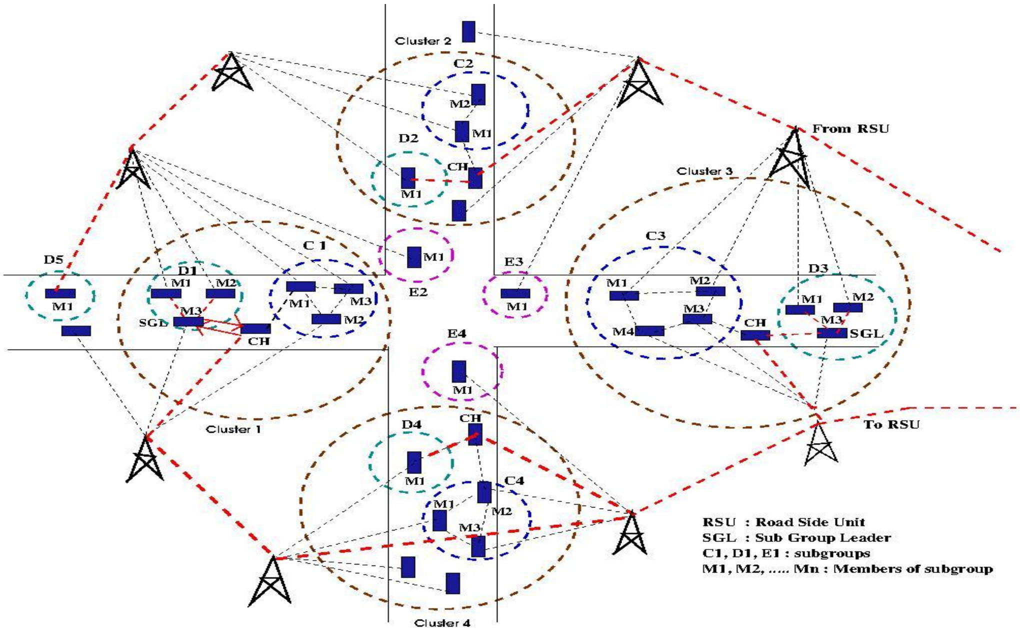

Figure 5 Example Scenario of context dissemination among interested vehicles

M3 (In D1) detects context. This information is communicated to its respective CH. CH categorizes the context. In the example the context is non-emergency for which several vehicles are interested. CH then APPOINTS M3 as the subgroup leader and asks it to form subgroup by sending the addresses of the vehicles (members of this cluster) i.e. M1 and M2 of D1. CH then sends the context information to parent RSU and neighbouring clusters (in this example, none). As RSUs are networked, the context information is disseminated to all RSUs. All the RSUs communicate the information to the CHs in their respective range, CHs in turn communicate the information to the vehicles interested in this context in their cluster. For non-cluster member M1 of D5, the information is directly communicated by the one of the RSU to which it is registered. Thus the context information is communicated to only the interested vehicles throughout the environment.

E. Algorithm

Algorithm for the formation of groups and subgroups based on particular interests of vehicles in $Context_{i1}$ is as below:

Input: A set of vehicles V= {V1…...Vn}
A set of RSUs R= {R1………Rn}
Each vehicle is connected to at least one RSU and has vehicle agency, RSU has RSU agency.
All the RSUs are networked.

Let $VNMA_{CH}$: VNMA of Cluster Head,
$VNMA_{M}$: VNMA of members of cluster and
$VNMA_{NM}$: VNMA of non- cluster member.

Output: Groups and subgroups based on particular interests of vehicles.

Algorithm 1: To Compute Groups and Subgroups based on the interests of vehicles in $Context_{i1}$

Begin

Step 1. Upon election $VNMA_{CH}$ triggers mobile agent CIIC to communicate HELLO message to all $VNMA_{M}$s of the cluster;

Step 2. $VNMA_{M}$s of all members responds with a REPLY message and register their contexts of interests;

Step 3. $VNMA_{NM}$ registers their interests in contexts with nearby RSU;

Step 4. If $context_{i1}$ is detected by any $VNMA_{M}$ of the cluster

Then

I. Communicate the information to $VNMA_{CH}$

II. $VNMA_{CH}$

a. Categorize the context ((2) and (3));

b. If context= emergency

Then

c. Communicate the context to all $VNMA_{M}$,$VNMA_{CH}$ and RSU;

Else

Trigger mobile agent EIA to communicate APPOINT message to $VNMA_{M}$ of the vehicle who has registered interested in$context_{i1,}$ nearby RSU and $VNMA_{CH}$s of neighbouring clusters;

Else if context is detected by $VNMA_{NM}$

Then

a. Communicate the information to nearby RSU which in turn communicates the information to nearby $VNMA_{CH}$;

b. Go to Label1;

Step 5. $VNMA_M$ upon receipt of APPOINT message

a. sets its status as subgroup head;

b. triggers mobile agent SFA and creates clones of it which travel to all $VNMA_M$ in the interest list ($context_{i1}$) and form a subgroup;

End

V. Simulation Model

The proposed technique is simulated by considering a Bangalore city map. The simulation is done using NS-2.34 [26] [27] to test the performance and effectiveness of approach. We consider "N" number of vehicles moving in a fixed region of length "A" Km. and breadth "B" Km. We consider vehicle to move in number of lanes "L". Communication coverage area for each vehicle is considered as "V_{RAN}" meters. At the beginning of

Figure 6 Bangalore City Map [28]

the simulation, vehicles are uniformly distributed in lanes. We assume free flow movement of vehicles i.e. we do not account for congestion that may arise in roads. Every vehicle is presumed to be equipped with a communication device and knows start position, start time of vehicle, route that it selects, and speed at which it travels. Safety distance of "R" meters is maintained from preceding vehicle for a certain tolerance time, and then change lane if possible. . At every intersection, we assume that each vehicle can choose to make either a left or right (if not a one-way road) or no turn. Mobility factor for each node is in between the range of "I" to "J" Kmph (Kilometres per hour).

A. Simulation Procedure

Simulation inputs are as follows: A= 5000m, B= 5000m, N= 50, V_{RAN} = 300m, I= 20 Kmph, J= 60 Kmph, L= 2, R = 4 mts. Simulation procedure for proposed cognitive agent model is as follows.

Begin

- Generate VANET in given road length by placing vehicles uniformly.
- Maintain a data structure at each vehicle to store information as specified by scheme.
- Apply mobility to nodes.
- Generate agency.
- Compute performance of system.

End

B. Simulation Inputs

The simulation input parameters are as below:

Table 1 Simulation input parameters

Simulation parameters	Values
Network simulator	ns-2.34
Simulation time	Simulation time: 600 seconds
Simulation area	5000m X 5000m
Number of vehicles	50/100/150
Communication range	300m/600m/900m
Speed	Minimum: 20 Km/hr., Maximum: 40 and 60 Km/hr.
Data type	Constant Bit Rate
MAC protocol	IEEE 802.11e EDCA based DCF
Safety distance between vehicles	4 mts.
Available bandwidth	5000 Mbps
Road type	Free way

C. Performance metrics

Some of performance metrics evaluated are as follows:

Table 2 Performance Metrics

Metric	Description
Cluster Formation Time	It is the time required to form the clusters. It is measured in msecs. Clusters are formed based on mobility parameters.
Multicast Grouping Time	It is the time required to form multicast groups (sub groups). It is measured in msecs. Multicast groups/subgroups are formed based on the context and mobility parameters.
Communication Overhead	It is the proportion of time spent communicating extra information other than required productive information. It is the overhead experienced to form clusters and multicast groups.
Bandwidth Utilized	It is the bandwidth consumed to communicate the information to all members of subgroups/groups.

VI. Simulation Results and Analysis

This section presents the results obtained during simulation. We compare results of proposed work with an existing clustering routing protocol TLCS. The below mentioned figures are generated based on the simulation results.

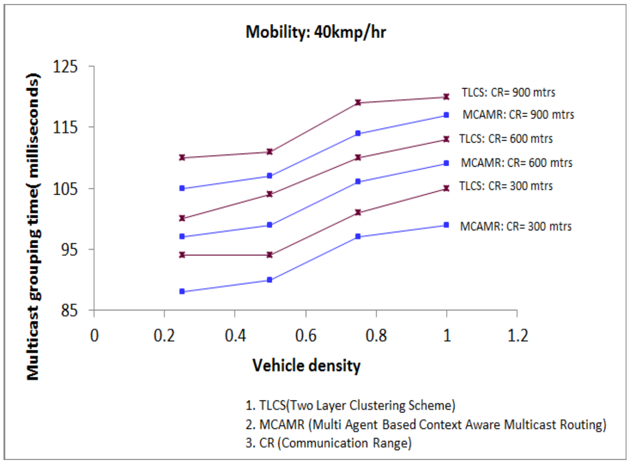

Figure 7 Multicast Grouping Time v/s Vehicle Density

Multicast Grouping Time (MGT)

Figure 7 shows the Multicast Grouping time (MGT) evaluated for TLCS and MCAMR protocols by increasing the communication range in the urban scenario. From the figure it is evident that MGT increases with the increase in communication range. The Multicast Grouping time of MCAMR is lower than TLCS clustered routing protocol even at higher communication range. This is because it makes use of intelligent software agents for computation of multicast groups.

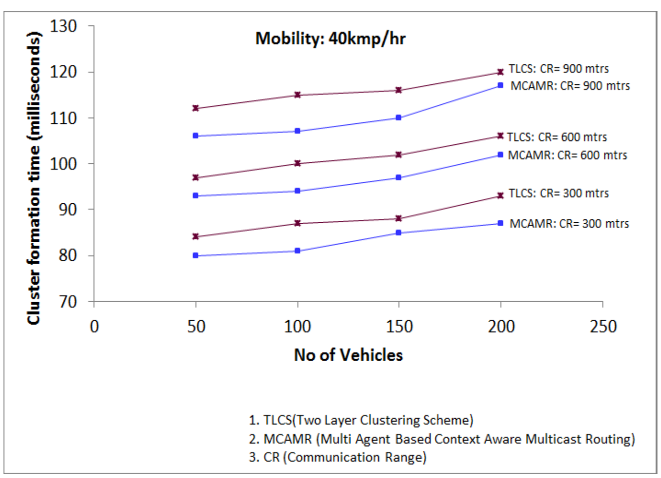

Figure 8 Cluster Formation Time v/s Vehicle Density

Cluster Formation Time (CFT)

Figure 8 shows the Cluster Formation Time (CFT) evaluated for TLCS and MCAMR protocols by increasing the communication range in the urban scenario. As depicted in the figure CFT increases with the increase in communication range. The cluster formation time of MCAMR is lower than TLCS clustered routing protocol even at higher communication range. This is because it makes use of intelligent software agents which predicts the change in the behaviour of the vehicles while forming the clusters.

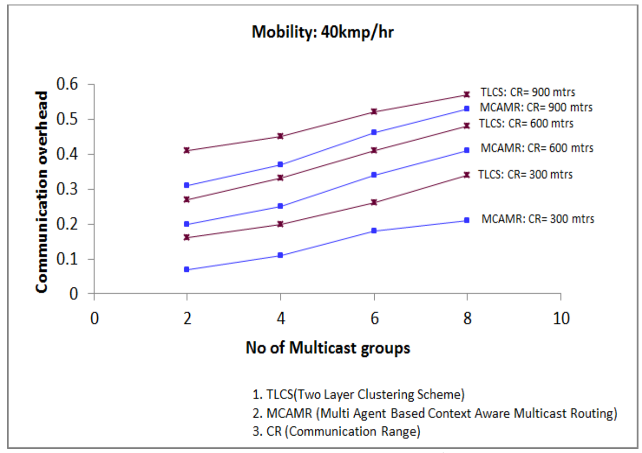

Figure 9 Communication Overhead v/s No. of Multicast groups

Communication Overhead (a)

Figure 9 shows the communication overhead evaluated for TLCS and MCAMR protocols by increasing the mobility in the urban scenario. Due to the nomination of the sub-group leaders and other related activities the overhead increases with the increase in the number of multicast groups formed as illustrated in the figure. The communication overhead of MCAMR is lower than TLCS clustered routing protocol even at higher number of multicast groups. This is because it makes use of intelligent software agents which take clever decisions in the issues regarding aggregation of the data and elimination of redundant data.

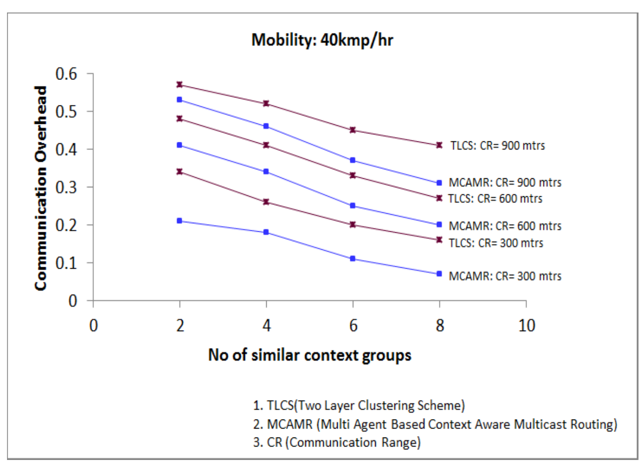

Figure 10 Communication Overhead v/s No. of Multicast groups

Communication Overhead (b)

Figure 10 shows the communication overhead evaluated for TLCS and MCAMR protocols by increasing the mobility in the urban scenario. As depicted in the figure the overhead decrease with the increase in the number of similar context multicast groups formed as the similar aggregated data is disseminated to similar context groups. The communication overhead of MCAMR is even lower than TLCS clustered routing protocol. This is because of the extensive aggregation of the data and elimination of redundant data through the use of intelligent software agents.

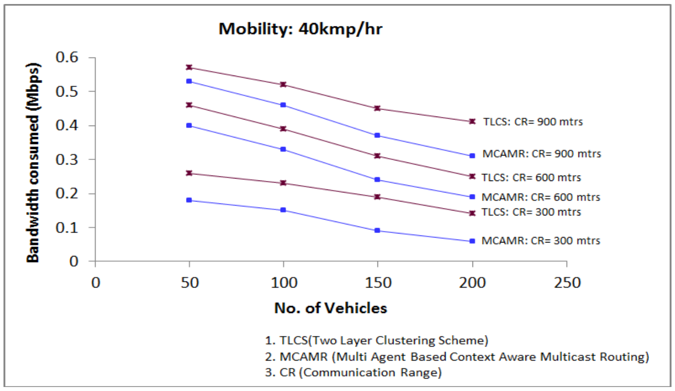

Figure 11 Bandwidth consumed v/s No. of vehicles

Bandwidth Consumed

Figure 11 shows the consumption of bandwidth for TLCS and MCAMR protocols by increasing the communication range in the urban scenario. The bandwidth consumed for MCAMR is lower than TLCS clustered routing protocol even at higher communication range. This is because it makes use of intelligent software agents which minimizes the percentage of retransmissions, duplication and redundancy of information to be communicated.

VII. CONCLUSION

VANETs own distinctive network features as compared to MANETs such as high speed nodes, continuously changing topology and etc. Thus it is obvious that MANETs clustering algorithms are not completely suitable for VANET environment as far as stability of paths is concerned. Hence, clustering algorithms developed for VANET environment must consider all vehicle dynamics. However most of them are concentrated on diminishing network overhead value, number of clusters formed and do not consider the vehicles interests which is defined as any related data used to distinguish vehicle from another (viz. traffic congestion, looking for petrol pumps, free parking space, etc.).Thus there will be substantial increase in overall traffic density as unnecessary information is transmitted leading to performance bottleneck. In this paper, we have proposed a new context aware clustering algorithm based on agent technology. Contrasting to most of the previous works, our clustering algorithm tends to group vehicles interested in the same context information so that context-aware data is communicated only to intended recipients. The simulation results show that our approach MCAMR performs well compared to 2LCS in terms of bandwidth consumption, cluster formation time, multicast grouping time and communication overhead.

Nevertheless, there are some issues to be probed in the proposed scheme, which can be taken up as imminent work: requirement of standard agent framework providing persistence and security to agents, resolving the issue of the active node failures during information aggregation process, positioning of the cameras related to various parameters, provision of safety to the sensors and overhead involved in the formation of subgroups. Likewise, it is planned to employ cognitive agents to challenge the aforementioned issues.

REFERENCES

[1] P. Gokulakrishnan, P. Ganesh Kumar. BEAM, "*Bandwidth Efficient Acknowledgement based multicasting protocol for Sub-Urban scenario in VANET*", Journal of theoretical and Applied Information Technology (JATIT), Vol.67, Issue.1, pp. 201-211, 2014.

[2] Hamid Reza Arkian, Reza Ebrahimi Atani, Atefe Pourkhalili, Saman Kamali, "*A Stable Clustering Scheme Based on Adaptive Multiple Metric in Vehicular Ad-hoc Networks*", Journal of Information Science and Engineering(J INF SCI ENG), Vol.31, Issue.2, pp.361-386, 2015.

[3] B. Hassanabadi, C. Shea, L. Zhang, S. Valaee, " *Clustering in Vehicular Ad Hoc Networks using Affinity Propagation*", Ad Hoc Networks, Part B, Vol.13, pp. 535-548, 2014.

[4] Shou-Chih Lo, Yi-Jen Lin, Jhih-Siao Gao, "*A Multi-Head Clustering Algorithm in Vehicular Ad Hoc Networks*", International Journal of Computer Theory and Engineering (IJCTE), Vol.5, Issue.2, pp. 242-247, 2013.

[5] Smitha Madhukar, "*Challenging Issues of a Context-Aware Mobile Computing Framework*", International Journal of Scientific Research in Computer Science and Engineering, Vol.1, Issue.6, pp.1-3, 2013.

[6] Celimuge Wu, Tsutomu Yoshinaga, Yusheng Ji, " *Context-aware Unified Routing for VANETs Based on Virtual Clustering*", In the Proceedings of 27th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), Spain, pp.1-6, 2016.

[7] Francesco Chiti, Romano Fantacci, Enrico Dei, Zhu Han, "*Context Aware Clustering in VANETs: A Game Theoretic Perspective*", In the Proceedings of IEEE International Conference on Communications (ICC), UK, pp.6584-6548, 2015.

[8] R. Kumar, S. Tripathi, R. Agrawal, "*Energy Efficient Routing Protocol for Secure Wireless Sensor Network*", International Journal of Computer Sciences and Engineering, Vol.5, Issue.4, pp.1-4, 2017.

[9] Vaishali Jain, Rajendra Singh Kushwah, "*Review of Various VANET Protocols Using NS-2 Simulator*", International Journal of Computer Sciences and Engineering, Vol.4, Issue.7, pp.76-80, 2016.

[10] Waqar Farooq, Muazzam Ali Khan and Saad Rehman, "*A cluster based multicast routing protocol for Autonomous Unmanned Military Vehicles (AUMVs) communication in VANET*", In the Proceedings of IEEE International Conference on Computing, Electronic and Electrical Engineering (ICE Cube), Pakistan, pp.42-48, 2016.
[11] Meysam Azizian, Soumaya Cherkaoui, Abdel hakim Senhaji Hafid, "*A Distributed D-hop Cluster Formation for VANET",* In the Proceedings of Wireless Communications and Networking Conference (WCNC), Qatar, pp.1-6, 2016.
[12] Amit Dua, Neeraj Kumar, Seema Bawa, Joel J. P. C. Rodrigues, "*An Intelligent Context-aware Congestion Resolution Protocol for Data Dissemination in Vehicular Ad Hoc Networks*", Mobile Networks and Applications (MOBILE NETW APPL), Vol. 20, Issue.2, pp.181-200, 2015.
[13] D.D. Shah, M.S. Selokar, "*Introduction of Complex Laplacian to Multi-Agent Systems*", International Journal of Scientific Research in Network Security and Communication, Vol.5, Issue.2, pp.30-36, 2017.
[14] Seyhan Ucar, Sinem Coleri Ergen, Oznur Ozkasap, "*VMaSC: Vehicular multi-hop algorithm for stable clustering in Vehicular Ad Hoc Networks*", In the Proceedings of Wireless Communications and Networking Conference (WCNC), China, pp. 2381-2386, 2013.
[15] Alvin Sebastian, Maolin Tang, Yanming Feng, Mark Looi, "*Context-Aware Multicast Protocol for Emergency Message Dissemination in Vehicular Networks*", International Journal of Vehicular Technology (Int. J. Vehicular Technol.), 2012.
[16] B. Mukunthan, B. Radha, S. Govindaraju, "*Probabilistic B-Tree Based Clustering Algorithm for Vehicular Ad-Hoc Network with Data Aggregation*", International Journal of Computer Sciences and Engineering, Vol.5, Issue.7, pp.82-87, 2017.
[17] Sławomir Kuklinski, Grzegorz Wolny, "*CARAVAN: A Context-AwaRe Architecture for VANET*", In Xin Wang (Ed.). Mobile Ad-Hoc Networks: Applications, InTech, pp. 125-148, 2011.
[18] S. S. Manvi, M. S. Kakkasageri, Jeremy Pittc, "*Multiagent based information dissemination in vehicular ad hoc networks*", Mobile information Systems, 2009
[19] S. S. Manvi, A. V. Sutagundar, "*Agent based Context Aware Image Fusion for Military Sensor Networks*", In the Proceedings of Fifth IEEE Conference on Wireless Communication and Sensor Networks (WCSN), India, pp. 1-6, 2009.
[20] Zhigang Wang, Lichuan Liu, MengChu Zho, Nirwan Ansari, "*A position-Based Clustering Technique for Ad-Hoc Intervehicle Communication*", IEEE transactions on systems, Man, and Cybernetics-Part C: Applications and reviews, Vol. 38, Issue.2, pp. 201-208, 2008.
[21] Ching-Chuan Chiang, Mario Gerla, "*Routing and Multicast in Multihop, Mobile Wireless Networks*", In the Proceedings of 6th International Conference on Universal Personal Communications (ICUPC), USA, pp.546-551, 1997.
[22] Samira Harrabi, Ines Ben Jaafar, Khaled Ghedira, "*Message Dissemination in Vehicular Networks on the basis of Agent Technology*", Wireless Personal Communication (Wireless Pers Commun), Vol. 96, Issue.4, pp.6129-6146, 2017.
[23] Maria Kihl, Mihail Sichitiu, Ted Ekeroth, Michael Rozenberg, "*Reliable Geographical Multicast Routing in Vehicular Ad-Hoc Networks*", In the Proceedings of Wired/Wireless Internet Communication (WWIC), USA, pp. 315-325, 2007.
[24] A. V. Sutagundar, S.S. Manvi, "*Wheel Based Event triggered Data Aggregation and Routing in Wireless Sensor Networks: Agent Based Approach*", Wireless Personal Communications (Wireless Pers Commun), Vol.71, Issue.1, pp. 491-517, 2013.
[25] M. S. Kakkasageri, S. S. Manvi, "*Connectivity and Mobility Aware Dynamic Clustering in VANETs*", International Journal of Future Computer and Communication (IJFCC), Vol.3, Issue.1, pp. 5-8, 2014
[26] *Network simulator: ns-2*, Available at: http://www.isi.edu/nsnam/ns [October 2010].
[27] Devipriya D., Muruganandan A., "*Road based Routing Protocol for VANET Using SUMO and Move*", International Journal of Computer Sciences and Engineering (IJCSE), Vol. 4, Issue.2, 2016.
[28] *Bangalore City Map*, Available: www.mapofbangalore.com [November 2007].

Authors Profiles

Anil D. Devangavi completed his B. E in Computer Science and Engineering from Karnataka University Dharwad, India and M. Tech from Visvesvaraya Technological University Belgaum, India. He is pursuing Ph. D in the area of Vehicular Ad-hoc Networks (VANETs) from AISECT University, Bhopal, India. Presently, he is working as Associate Professor in Department of Information Science and Engineering, Basaveshwar Engineering College, Bagalkot, Karnataka, India. He has published 3 international journal papers. His areas of interest are wireless network and VANETs.

Rajendra Gupta is Assistant Professor in AISECT University, Raisen. He is doctorate in Computer Science and having 18 years of working experiences in Government and Non-Government Sectors. His teaching and research areas belong to Networking, Network Security, Data Mining, Statistical Analysis and Computer Graphics and Multimedia. He has published 22 research papers in International and National Journals and completed a UGC minor research project. He has designed four SLM for MP Bhoj University, Bhopal on the topic of 'Computer Organisation and Architecture', 'Data Communication and Computer Networks', 'Software Engineering' and 'Operating System'. He is reviewer of two International Journals and member of Academic Body.