International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868
Foundation of Computer Science FCS, New York, USA
Volume 12– No.18, January 2019 – www.ijais.org

Design of an Improved Energy Efficient Routing Protocol in VANET using a Modified Route-Optimal Path Algorithm

Agballa U. B.
Department of computer science, Ahamadu Bello University, Zaria, Nigeria

Obiniyi A. A.
Department of computer science, Ahamadu Bello University, Zaria, Nigeria

Ayeni B. K.
Department of computer science, Ahamadu Bello University, Zaria, Niegeria

ABSTRACT
Vehicular Ad hoc Network (VANET) is classified as an application of Mobile Ad-hoc Networks (MANETs) that has the potential in improving road safety and providing Intelligent Transportation System (ITS). Along with its benefits, VANET is confronted with a lot of challenges ranging from the high energy consumption, instability issues resulting from high topology change. The major objective of developing a route optimal path algorithm is to minimize the chances of link failure and reduce energy consumption of nodes in the network. In this paper, to achieve this objective a modified route optimal path algorithm where nodes are in cluster form is proposed. In this approach, mobility prediction scheme is used for the network stability and two-tier mechanism is used to minimize the energy consumed through a Location Aided Routing (LAR) protocol. Experimental result using Network simulator 2 (NS-2) illustrates that the proposed technique improved energy consumption of nodes in the networks and result found indicates that proposed technique consumes less energy.

Keywords
VANET, Ad-hoc network, Energy consumption, Cluster head, Mobility prediction and network topology

1. INTRODUCTION
Traffic has to do with the movement of cars and pedestrians on the road or in an area. Traffic flow is the interactions between cars, drivers, pedestrians, motorcycles, other travellers and infrastructure which include highways, road signs, and traffic control devices [1]. To this effect, there is need to developing a standard road network with efficient communication and movement of traffic with regards to safety and comfort of driving.

In the middle of the 19th century, road traffic officers uses coloured lights, hand signal and semaphore to control and manage movement of pedestrians, vehicles on the road and by the year 1930s automatic traffic signals came to light. Car indicators were deployed widely by the 1940s, then in 1960s, different types of messaging signals where introduced to provide information to the drivers to adapt to the current circumstances [5]. The message transmitted through these means is however, very poor. Lately, countries such as USA, Europe and Japan have put initiatives for a safer and efficient driving situation. This provoked the interest of researchers toward vehicular communication technologies or Intelligent Transport Systems (ITS), facilitated and controlled by wireless network protocols in order for drivers to share plenty of information, like traffic information and directions of one other. This led to the introduction of Vehicular Ad-hoc Network (VANET). Vehicular Ad-hoc Network (VANET) evolved from Mobile ad-hoc network, it solves all the concerns associated to message dissemination between vehicles with regards to currently happening researches in wireless communication. An ad-hoc network is the associative connection of a collection of typically wireless mobile nodes without the needed intervention of any consolidated access point or existing infrastructure [9]. VANET allows vehicles to form a self-organized wireless network as of when needed. To enable a successful communication, a thorough path must be initiated to deliver the packet to its destination; this can be accomplished by designing an efficient routing protocol. Hence, transceivers and computerized control modules need to be present in the vehicles which provide them with the ability to communicate as network nodes [3]. The main purpose of VANET is to provide comfort and safety such as information about fuel station, weather condition, parking, road block and emergency warning. For providing this information, much energy is expelled during data transmission and all of these tell on the battery life span of nodes.

The paper is structured as follows: section 2 describes related works; section 3 makes a brief introduction to fundamental concept. Section 4 presents the proposed technique; section 5 gives the experimental evaluations and results.

2. REVIEW OF RELATED WORKS
A number of previous works related to Vehicular ad-hoc network for energy consumption was a motivation for this research. Some of the major researches are as follows.

Lochert et al., (2008) presented their solution of Road Side Unit (RSU) placement for a VANET traffic information system using a genetic algorithm. In order to cope with the highly partitioned nature of a VANET in an early deployment stage, they identify good spots for RSUs from a set of possible positions that are initially given [7]. However, their choice for the best set of RSUs highly depends on the traffic situation simulated in the experiments.

Husain et al (2010) presented a study of location aided routing (LAR) scheme for VANET in highway scenario using the performance metrics such as Packet Delivery Ratio (PDR), System Throughput, Average Delay and Routing Overheads. The LAR was tested against node density for various metrics [5]. The simulation was performed at significantly high node speed of 100km/h. The protocol shows good performance in vehicular communication environment which also shows that the PDR increases for moderate number of nodes but decreases at a higher network density.

The reason being that at higher network density, the connectivity between nodes is high resulting in less loss of packets. The system throughput of LAR increases from low to moderate network density but it decreases when the number of nodes is higher than 50 in the network. The reason for decrease in system throughput could be the high interference among the transmitted signals. Routing overheads and average delay decrease with the large number of nodes because of many routing paths and larger number of hops.

Zhang et al., (2013) proposed an Energy-Efficient Routing Protocol (ERBA) Using Movement Trends in Vehicular Ad-hoc Networks by considering driver's behaviors and vehicle categorization. Movement tendency is deployed by taking into account current and future directions. ERBA enables packet dissemination by employing proactive, prediction-based routing protocol for opting sustainable routes for application where delay is critical. Chosen methodology ensures that small and efficient route is selected with no loops [10]. ERBA analyzes real urban scenario from Shanghai project undertaken and correlates with AODV by considering performance metrics such as throughput, probability density function, neighborhood reliable links and end-to-end delay. It concludes that ERBA outperforms others in achieving better performance and least energy utilization by selecting conceives routes.

Deshmukh and Sonekan (2014) proposed an enhanced AODV protocol that will improves the performance issues on common AODV protocol using location based clustering mechanism so as to improve the route discovery phase and it refines route discovery phase and downplay energy utilization during message dissemination by engaging two tier procedure. The employed enhanced protocol also leads to reduction in overhead for each route and is capable of dealing with diverse traffic circumstances. They demonstrated their network topology with 19 mobile nodes and node 0 as a Road Side Unit (RSU)[4]. The proposed system enhanced protocol to work in various traffic situations.

Laroiya and Lekhi (2017) proposed the use of location aided routing (LAR) protocol for implementation of the concept of root and leaf nodes, where root nodes maintain a routing table, that assist in selecting apt route for transmission from source to destination, while preserving vehicle's energy. In their work all the nodes construct a logical tree in such a way that all the packets are passed from a leaf node to its parent nodes. In turn, a receiver node receiving data from the child node sends data to receiver's parent node after aggregating data with its own data. In this fashion, data flow from leaf nodes to the root node, which generally acts as the sink [6]. The idea behind constructing logical tree is that this avoids flooding and packets can be sent using unicast instead of broadcast. The root nodes are responsible to maintain the tree on the basis of distance between the nodes by using R-optimal path algorithm. According to the proposed work, simulating with 35 nodes and 50 nodes shows that energy consumption was improved by 56.7% and 38% respectively and within the space of 8 seconds packet delivery ratio drop by 64%.

3. CONCEPT

3.1 Cluster Head (CH) selection

In this paper, after cluster formation by the nodes some nodes in the clusters will be selected as the cluster heads (CHs). The rest of the nodes is considered as cluster members (CMs) and they will all establish connections to the CHs. A CH will collect information from its CMs which can be shared by CHs through the super peers. Therefore the criteria used for the selection of cluster heads includes: residual energy of nodes, the number of neighboring nodes, distance between node and its neighboring nodes.

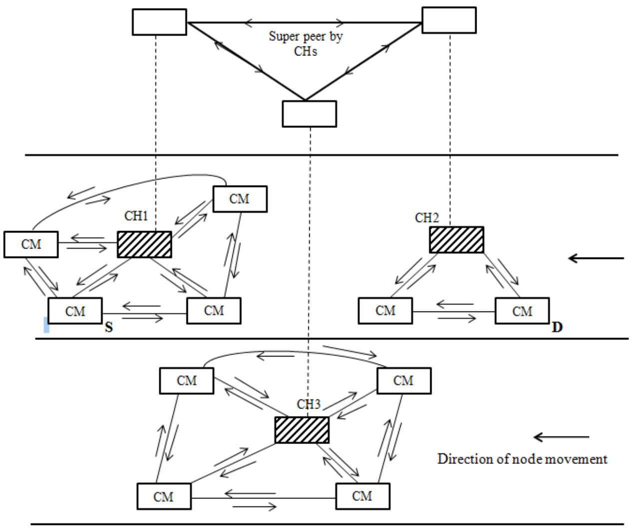

Figure 1: Architectural View of the Proposed Network System

3.2 Mobility Prediction

Mobility prediction allows two communicating nodes to determine the time they can remain connected if their mobility parameters such as position, speed and direction are known. Hence if two nodes **i** and **j** are within the transmission range r of each other. If $(\mathbf{x_i}, \mathbf{y_i})$ is the coordinate of mobile node **i** and $(\mathbf{x_j}, \mathbf{y_j})$ is for node **j**. Let $\mathbf{v_i}$ and $\mathbf{v_j}$ be the speeds, and $\boldsymbol{\theta_i}$ and $\boldsymbol{\theta_j}$ $(0 \leq \theta_i, \theta_j \leq 2\pi)$ is the directions of nodes **i** and **j** respectively. The Link Expiration Time (LET) is given by equation (1) [8].

$$LET = \frac{-(ab + cd) + \sqrt{(a^2 + c^2)r^2 - (ab - bc)^2}}{a^2 + c^2} \quad (1)$$

Where

$$a = v_i + cos\theta_i - v_j cos\theta_j$$

$$b = x_i - x_j$$

$$c = v_i sin\theta_i - v_j sin\theta_j$$

$$d = y_i - y_j$$

Note that when $\mathbf{v_i} = \mathbf{v_j}$ **and** $\boldsymbol{\theta_i} = \boldsymbol{\theta_j}$, **LET** is fixed at infinity when equation 1 is not applied.

3.3 Energy consumption model

Energy consumed is calculated based on the characteristics of the network interface card (NIC) in relation to electric current (I_{send} and I_{recv}) and power supply (V_{send} and V_{recv}) during the different states of the NIC, the size of the packets, and bandwidth used as shown in equations 2 and 3. Though during idle and sleep modes, the network interface also consumes energy, but it is assumed in this model that it is negligible. The following equations represent the energy consumed when the packets are transmitted (E_{send}) and when the packets are received (E_{recv}).

$$E_{send} = P_{send} * Time = (I_{send} * V_{send}) * \frac{PacketSize}{Bandwidth} \quad (2)$$

$$E_{recv} = P_{recv} * Time = (I_{recv} * V_{recv}) * \frac{PacketSize}{Bandwidth} \quad (3)$$

Finally, the total cost of a packet transmission is the sum of the costs incurred by the sending node (E_{send}), and all receivers (E_{recv}), whether they are or not the destination nodes. Hence

Total Energy cost =Energy consumed during transmission of a packet + Energy consumed for all the Nodes that received the pack

3.4 Flowchart of Proposed Algorithm

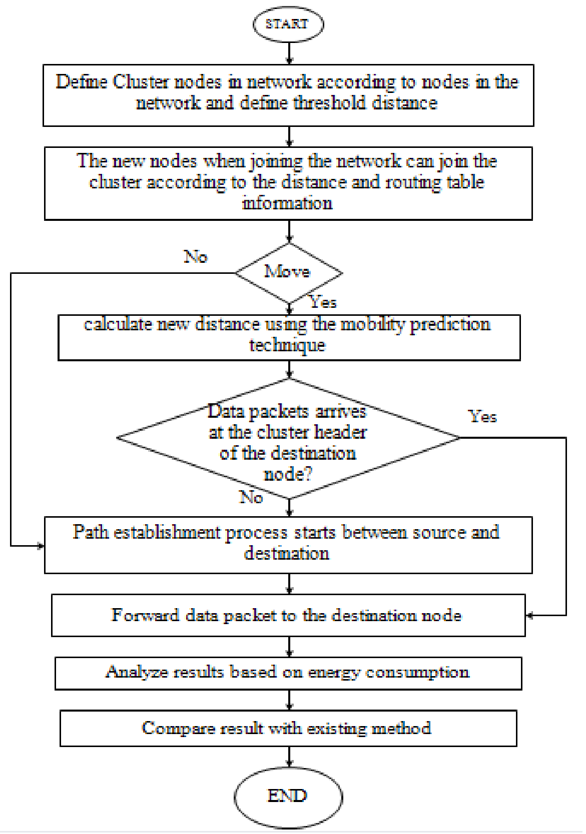

Figure 2: flow chat for modified rout optimal path algorithm

3.5 Experimental Evaluation

In this section the experimental results of the proposed technique are discussed. The proposed technique was simulated using Network Simulator 2 (NS-2) on Ubuntu version 14.04 operating system that has a processor of 2.30GHz Intel Core i7 with 4GB RAM and 500 HDD.

This system adopted the same parameters used by Laroiya and Lekhi (2017), these parameters are: NS-2 Simulator, simulation time of 500seconds, 35, 50 and 75 mobile nodes, 1000 m X 1000 m simulation area, Constant Bit Rate (CBR) traffic type, packet size of 512bytes.

The performance of the proposed system was measured based on three scenarios; Energy consumed by each node when using 35nodes, Energy consumed by each node when using 50 nodes and Energy consumed by each node when using 75nodes.

Table 1 and figure 3 show the analysis of Energy consumed by both the proposed and the existing Rout-Optimal path Algorithm.

Table 1: Energy Consumed (Joules)

Simulation time (sec)	No. of Nodes	Energy consumed (existing)	Energy Consumed (proposed)
500	35	39	26
500	50	89.44	54
500	75	112.32	72

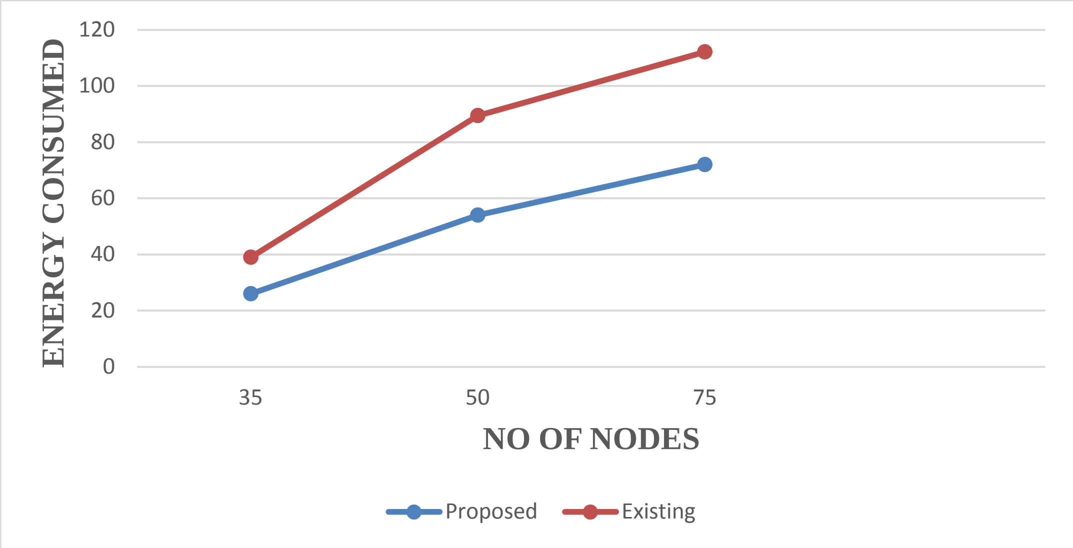

Figure 3: Graphical Analysis of Energy Consumption

4. CONCLUSION

The simulation results summarized in Table 1 and Figure 3 showed that the energy consumed in the existing work is higher than that of the proposed work was improved by 13J, 35.44 and 40.32J which is a percentage gain of 33.3%, 39.6% and 35.9% for 35, 50 and 75 nodes respectively. Hence the proposed work provided a better result in terms of energy consumption.

5. FUTURE RESEARCH WORK

For future work, research can be done so as to analyze the energy consumption and the quality of service obtained for Location Aided Routing (LAR) protocol.

6. REFERENCES

[1] Bernsen, J. and D. Manivannan (2009). "Unicast routing protocols for vehicular ad hoc networks: A critical comparison and classification." Pervasive and Mobile computing **5**(1): 1-18.

[2] Cano, J.-C. and P. Manzoni (2000). A performance comparison of energy consumption for mobile ad hoc network routing protocols. IEEE Modeling, Analysis and Simulation of Computer and Telecommunication Systems conference. PP. 57-64

[3] David, S. and R. Navaneethakrishnan R. (2017) "Energy consumption and load balancing compared with vanet and manet." International Journal of Pure and applied Mathematics. 166(12): 257-265

[4] Deshmukh P. and Sonekar s. (2014). “Improving Energy and Efficiency in cluster based VANETs through AODV Protocol”. International Journal of Computer Science and Information Technologies,**5**(3): 4788-4792

[5] Husain A., Akhtar K., Brajesh D. (2010). "A study of Location Aided Routing (LAR) protocol for vehicular ad hoc networks in highway scenario". International Journal of Engineering and Information Technology **2**(2): 118-124.

[6] Laroiya, N. and Lekhi S. (2017). "Energy Efficient Routing Protocols in Vanets." Advances in Computational Sciences and Technology **10**(5): 1371-1390.

[7] Lochert, C., Mauve M., Fubler and Hartenstein H. (2005). "Geographic routing in city scenarios." ACM SIGMOBILE mobile computing and communications review **9**(1): 69-72.

[8] Rappaport T. S. (1995)."Wireless Communication: Principles and practice." Prentice Hall, Upper Saddle River, NJ.

[9] Royer, E. M. and Toh C. K. (1999). "A review of current routing protocols for ad-hoc mobile wireless networks." IEEE Personal Communication. **6**(2): 46-55.

[10] Zhang D., Yang Z., Raychoudhury, Vaskar C. and Jaime. (2013). "An energy-efficient routing protocol using movement trends in vehicular ad hoc networks." *The Computer Journal* **56**(8): 938-946.