Computers and Electrical Engineering 000 (2018) 1–18

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Grey wolf optimization based clustering algorithm for vehicular ad-hoc networks☆

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ARTICLE INFO

Article history:
Received 11 July 2017
Revised 1 January 2018
Accepted 2 January 2018
Available online xxx

Keywords:
VANETs
Clustering
Ad-hoc networks
Grey wolf optimizer
Artificial neural networks
Intelligent transportation system

ABSTRACT

In vehicular ad-hoc network (VANETs), frequent topology changes occur due to fast moving nature of mobile nodes. This random topology creates instability that leads to scalability issues. To overcome this problem, clustering can be performed. Existing approaches for clustering in VANETs generate large number of cluster-heads which utilize the scarce wireless resources resulting in degraded performance. In this article, grey wolf optimization based clustering algorithm for VANETs is proposed, that replicates the social behaviour and hunting mechanism of grey wolfs for creating efficient clusters. The linearly decreasing factor of grey wolf nature enforces to converge earlier, which provides the optimized number of clusters. The proposed method is compared with well- known meta-heuristics from literature and results show that it provides optimal outcomes that lead to a robust routing protocol for clustering of VANETs, which is appropriate for highways and can accomplish quality communication, confirming reliable delivery of information to each vehicle.

1. Introduction

In current era, famous meta-heuristic techniques; Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), are becoming popular in computer vision and machine learning community. In computer

Abbreviations: ACO, Ant Colony Optimization; ACROA, Artificial Chemical Reaction Optimization Algorithm; BBBC, Big-Bang Big-Crunch; BHA, Black Hole Algorithm; CACONET, Clustering algorithm based on Ant Colony Optimization (ACO) for VANET; CFO, Central Force Optimization; CHs, Cluster heads; CLPSO, Comprehensive Learning Particle Swarm Optimization; CN, Cluster nodes; CSO, Curved Space Optimization; CSS, Charged System Search; GA, Genetic Algorithm; GbSA, Galaxy-based Search Algorithm; GLSA, Gravitational Local Search; GWO, Grey Wolf Optimization; GWOCNETs, Grey Wolf Optimization Based Clustering In Vehicular Ad-Hoc Networks.; ITS, Intelligent Transportation Systems; MANET, Mobile ad hoc networks; MOPSO, Multi-Objective Particle Swarm Optimization; PSO, Particle swarm optimization; ROA, Ray Optimization Algorithm; SWOA, Small-World Optimization Algorithm; VANET, Vehicular ad hoc networks.

☆ Reviews processed and recommended for publication to the Editor-in-Chief by Associate Editor Dr. G. R. Gonzalez.

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https://doi.org/10.1016/j.compeleceng.2018.01.002
0045-7906/

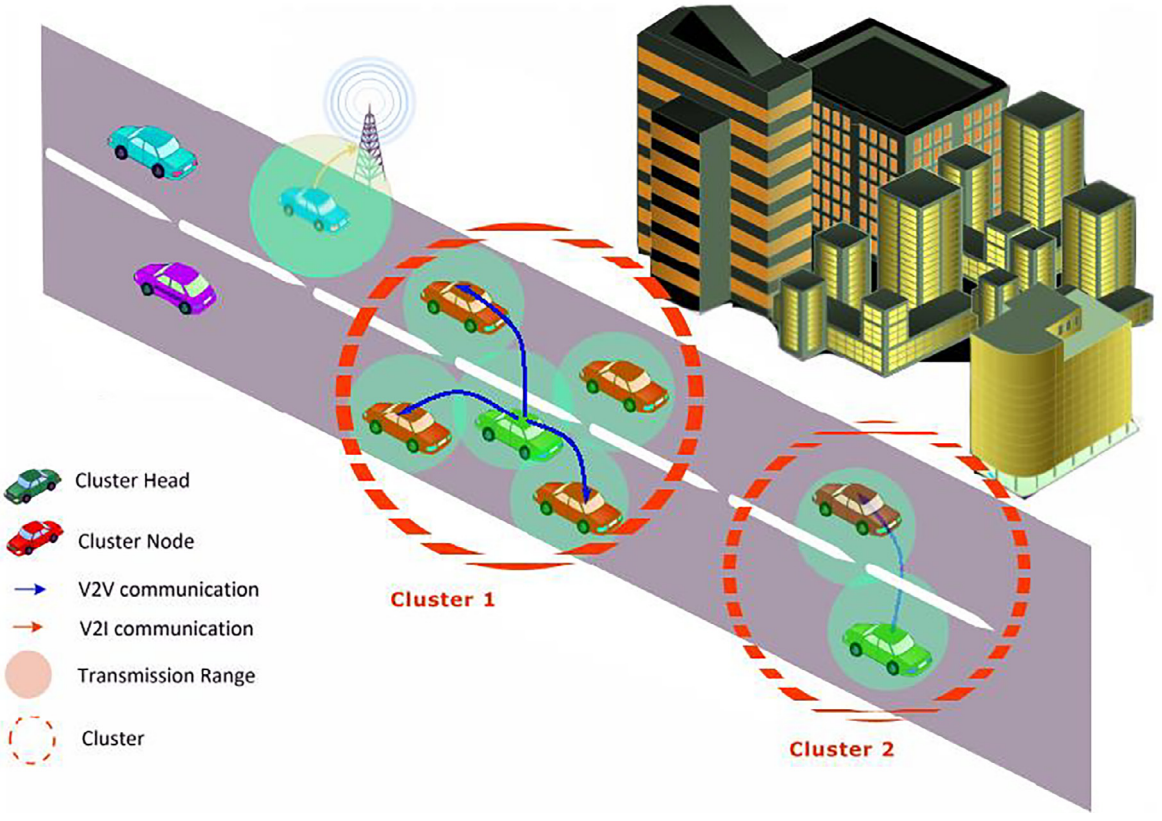

Fig. 1. Clustering in VANET's. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

science, meta-heuristics are playing a productive role and in many other fields as well. Due to the huge usage of meta-heuristics, it raises few questions. Why meta-heuristics techniques are now becoming more common as compared to any other methods. Scientists give the many logical answers regarding it. Flexibility, Deviation-free method, Simplicity/Easily Understandable, Local-optima avoidance are some of them. Flexibility of meta-heuristics algorithms increased the usage. These are enough flexible to solve the different problems of different natures. These methods, are lenient in applicability. Various meta-heuristics are derivation-free, because meta-heuristics solve the problems by using the randomness of variables. This method initiate with random solution, which exclude the calculation for the derivation of search space and make it more applicable for existing problems. Third, the meta-heuristics are imitative from the natural working or daily routine of animals, birds and insects etc., making it easy to understand and providing further chances for the researchers. Finally, these procedures focus on the explorations of working space, to reduce the stuck-ness of local solution. As, local solutions are not the proper solutions for any problem.

Vehicular ad-hoc network (VANET) is a primary branch of ad-hoc Networks in which transmission of data occurred between automobiles. In VANETs, there are also temporal or momentary creation of network for sharing of resources. VANETs is progressed to supplementary divisions based on method of communication. It contains Vehicle to Infrastructure (V2I), Vehicle to Vehicle (V2V), and hybrid communication (V2V-V2I). Vehicular network is dynamic network, in which nodes have inconsistent/random motion which causes frequently structural deviations of nodes. Consequently, this causes the network separation which results in the expiration of network. Its lifetime can be increased by forecasting the flow pattern or mobility pattern of vehicles, leading towards the extensive use of applications in commercially, multimedia, safety, emergency, managing of traffic applications. Moreover, Quality of Service (QoS) is mandatory for efficient transmission of data. Delay can be dangerous in scenarios such as safety and surveillance applications. Scalability is also one of the problems, which causes a lot of damage in the sustainability of network. Load balancing of the network must be managed for the lifetime of network. In this context, intelligent clustering algorithms, can play a vital role to create vehicular network more optimized, manageable, scalable and for equal distribution of network load. Clustering in network means, grouping of nodes on the basis of some likeness and unlikeness for achieving some specific goal with in the network. The likeness and unlikeness can be, by considering the different parameters such as distance among nodes, bandwidth availability etc. Clustering is also a proper method which varies from other clustering method on the basis of some rules and regulations. Cluster is formed by a collection of nodes. In the group (cluster), one of the cluster member or cluster node is selected as Cluster Head (CH). Fig. 1, shows the cluster spotted in red circle on a highway and their interaction with a blue colour. The size of cluster is

Please cite this article as: M. Fahad et al., Grey wolf optimization based clustering algorithm for vehicular ad-hoc networks, Computers and Electrical Engineering (2018), https://doi.org/10.1016/j.compeleceng.2018.01.002