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Self Adaptive Broadcasting Algorithm for VANET using Bio Inspired Computing

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Abstract: Vehicular Ad Hoc Networks (VANET) are wireless network that has a dynamic nature that leads to constant changes in its infrastructure. These networks are highly essential for the applications among cars on the road. Regarding traffic safety applications, warning messages have to be quickly and properly disseminated so that the required dissemination time gets reduced and the number of vehicles receiving the traffic warning information also gets increased. These challenges are addressed by bio-inspired solutions. For such similar problems and their naturally evolved biological solution approaches also exist for these networking paradigms. To provide efficient warning message dissemination among the vehicles the Bio Inspired Algorithms will be used. This paper makes survey of various warning message dissemination systems and takes a overlook on bio inspired solution.

Keywords: warning message dissemination, bio inspired computing, traffic safety, VANET.

I. INTRODUCTION

Vehicular Ad Hoc Networks (VANET) is wireless networks that do not require any fixed infrastructure. These types of networks are considered essential for the applications among cars on the road. VANET has become an important area of research and development because it has high potential to improve vehicle and road safety, traffic efficiency, and convenience for both drivers and passengers. Also it is an autonomous and self-organizing wireless communication network, where nodes in VANET act as a servers and/or clients for exchanging and sharing information among themselves.

VANET provides communication between vehicle-to-vehicle and vehicle-to-infrastructure based on wireless local area network technologies. Instead of fixed sensors real-time traffic data will be collected and disseminated by distributed mobile probes, used in the current infrastructure based systems. A distributed network of vehicles such as a vehicular ad hoc network (VANET) are infrastructure-less self-organizing traffic information system, wherein any vehicle becomes a mobile sensor and participates in collecting and disseminating useful traffic information. Traffic information dissemination in a VANET is a unique problem.

Regarding traffic safety applications, warning messages have to be quickly and properly disseminated so that the required dissemination time gets reduced and the number of vehicles receiving the traffic warning information also gets increased. These challenges are addressed by bio-inspired solutions. For such similar problems and their naturally evolved biological solution approaches also exist for these networking paradigms. To provide efficient warning message dissemination among the vehicles the Bio Inspired Algorithms will be used.

The structure of this paper is as follows. In Section II contain related work on the broadcast storm problem and adaptive schemes in VANETs. In Section III, the concept of Bio-inspired Computing is explained. The propose system is described briefly in the Section IV. Finally, Section V concludes the paper.

II. RELATED WORK

Traditional wireless ad-hoc networks broadcasting algorithms are not suitable for VANET. To deal with the rapidly changing network topology, a new broadcasting technique based on location information has been developed.

Manuel Fogue et al. [1] proposed PAWDS, a new adaptive approach that allows increasing the efficiency of warning message dissemination processes using the information about the urban environment where the vehicles are moving. The solution requires vehicles to make use of the information contained in their integrated maps to determine the profile type. Additionally, the beacons exchanged with neighbors are used to estimate the density of vehicles in the area. By combining these two inputs, our algorithm is able to tune the parameters of the dissemination process and mitigate broadcast-storm-related problems. The objective is to find a balance among different performance metrics. With this three different working modes (Full, Standard, and Reduced dissemination) were proposed to be selected depending on their efficiency in each situation.

Tseng et al. [2] proposed different schemes to mitigate broadcast storms. The Counter-based scheme uses a counter to keep track of the number of times the broadcast message is received, inhibiting rebroadcast when it exceeds a threshold. The Distance-based scheme calculates the distance between the sender and the receiver and only allows retransmission when the additional coverage area is large enough. The Location- based scheme is similar to the previous one, though requiring more precise locations for the broadcasting vehicles to achieve an accurate geometrical estimation of the additional coverage of a warning message.

Wisitpongphan et al. [4] developed the weighted p-persistence, the slotted 1-persistence, and the slotted p-persistence techniques. These three techniques are probabilistic and timer-based broadcast suppression techniques that does not solve the broadcast storm problem, but can mitigate the severity of the storm. These schemes are specifically designed for use in highway scenarios.

The Last One (TLO) scheme, presented in [5], tries to reduce the broadcast storm problem, finding the most distant vehicle from the warning message sender, so this vehicle will be the only allowed retransmitting the message. It brings a better performance than simple broadcast but this scheme is only effective in a highway scenario because it does not take into account the effect of obstacles (e.g., buildings) in urban radio signal propagation.

A stochastic broadcast scheme was proposed in [6] to achieve an anonymous and scalable protocol where relay nodes rebroadcast messages according to a retransmission probability. The performance of the system depends on the vehicle density, and these probabilities must be tuned to adapt to different scenarios. However, the authors only test this scheme in an obstacle-free environment, thus not considering urban scenarios where the presence of buildings could interfere with the radio signal.

The Cross Layer Broadcast Protocol (CLBP) [7] uses a metric based on channel condition, geographical locations, and velocities of vehicles to select an appropriate relaying vehicle. This scheme also supports reliable transmissions exchanging Broadcast Request To Send (BRTS) and Broadcast Clear To Send (BCTS) frames. CLBP reduces the transmission delay, but it is only conceived for single-direction environments (like highway scenarios), and its performance in urban environments has not been tested.

Mariyasagayam et al. [8] proposed an adaptive forwarding mechanism to improve message dissemination in VANETs. Vehicles compute the density of neighbor nodes to calculate a forwarding sector in which vehicles are not allowed to rebroadcast the message.

The Adaptive-ADHOC (A-ADHOC) protocol [9] uses a variable frame length to increase channel utilization and to reduce response time, but it is not really focused on improving message dissemination under urban environments. The Adaptive Road-Based Routing (ARBR) protocol [10] is an interesting approach to adaptive schemes in VANETs since it uses the current state of the traffic to classify the different road segments depending on the suitability for the routing process. Hence, there is some inherent information about the roadmap used during the process. Nevertheless, this protocol only allows end-to-end communication, with specific sender and the receiver nodes, whereas we are interested in the dissemination of warning messages to reach the highest possible number of vehicles.

Another adaptive algorithm with the same problem is the Junction-based Adaptive Reactive Routing (JARR) [11], a reactive position-based routing protocol that estimates the vehicle density on the available paths that can be used to send a message, also accounting for the direction and speed of traveling nodes in order to choose the optimal path. The formerly presented TLO approach was extended using a protocol that utilizes adaptive wait-windows and adaptive probability to transmit, named Adaptive Probability Alert Protocol (APAL) [12].

This scheme shows even better performance than the TLO scheme; however it was only designed to be used in highway scenarios. This protocol is designed to obtain efficient propagation of alert messages in only one direction of the topology, making it unsuitable for scenarios with complex topologies where we would want to disseminate warning messages in all directions around the affected area. Finally, the Adaptive Copy and Spread (ACS) [13] algorithm is an opportunistic data dissemination scheme for VANETs that adjusts the number of the message replicas inside the system to improve the data dissemination performance, etc.

III. BIO-INSPIRED COMPUTING

All biologically inspired computing is a field of study that loosely connects together subfields related to the topics of connectionism, behaviour and emergence. It is closely related to the field of artificial intelligence, can also be linked to machine learning. It is related to the fields of biology, computer science and mathematics. It uses computers to model nature, and parallel study of nature to improve the usage of computers. Bio inspired computing is a major part of natural computation. It takes bottom-up and decentralised approach. Bio-inspired techniques involve the methods of specifying a set of simple rules, a set of simple organisms which follows those rules, and a iterative method applies to those rules [14].

The bio-inspired networking research community is quite young, despite of ongoing research, projects, journal, special issues, and conferences in this field.

Bio-Inspired Algorithms can be divided into two classes, namely, Evolutionary Algorithms and Swarm based Algorithms which are inspired by the natural evolution and collective behavior in animals respectively.

Evolutionary computation (EC) is based on collective phenomena in adaptive populations of problem solvers. It utilizes the repetitive progress which includes growth, development, reproduction, selection, and survival. Evolutionary algorithms are non-deterministic algorithms or cost based optimization algorithms. The various evolutionary algorithms are genetic algorithm (GA), genetic programming (GP), Differential Evolution, evolutionary strategy (ES) and Paddy Field Algorithm.

Swarm Intelligence (Kennedy and Eberhart, 2001[17]) is an extension of Evolutionary Computing for implementing adaptive systems. Evolutionary algorithms are based on genetic adaptation of organisms whereas Swarm Intelligence is based on collective social behavior of organisms. As per definitions in literature, Swarm Intelligent encompasses the implementation of collective intelligence of groups of simple agents that are based on the behavior of real world insect swarms, as a problem solving tool. The word “swarm” is coined for the irregular movements of the particles in the problem space. SI algorithms are inspired by the collective behavior of animals; exhibit decentralized and self-organized patterns in the foraging process.

There are various algorithms under the field Swarm Intelligence such as Particle Swarm Optimization Algorithm (PSO), Ant Colony Optimization Algorithm (ACO), Artificial Bee Colony Algorithm (ABC), Fish Swarm Algorithm (FSA), Intelligent Water Drops Algorithm (IWD), Firefly Algorithm, Self-propelled particles, Bird flocking Behavior (BFB), etc. The Bird flocking Behavior (BFB) is discussed below.

A. Bird flocking Behavior

Flocking behavior was simulated firstly by Craig Reynolds on a computer in 1986. Flocking behavior is the behavior exhibited when a group of birds, called a flock, are foraging or in flight. Flocking is the collective motion of a large number of self-propelled entities and is a collective animal behavior exhibited by many living beings such as birds, fish, bacteria, and insects. It is considered an emergent behavior arising from simple rules that are followed by individuals and does not involve any central coordination.

Basic models of flocking behavior are controlled by three simple rules:

1. Separation - avoid crowding neighbors (short range repulsion)

2. Alignment - steer towards average heading of neighbors

3. Cohesion - steer towards average position of neighbors (long range attraction)

With these three simple rules, the flock moves in an extremely realistic way, creating complex motion and interaction that would be extremely hard to create otherwise.

- There several characteristics of birds flying in formation, such as Birds are highly mobile agents capable of flying independently for long distance with small energy.
- The birds only use local neighborhood information to direct their movement within the group.
- There is no specific bird that directs the movement of a flock. Yet, overall the flock moves in a directed manner [16].

These characteristics are significant to ad-hoc network behavior.

IV. Proposed Work

To improve the alert dissemination process in multihop wireless networks several approaches have been proposed but none of them were tested in real urban area, adapting its behavior to the propagation features of the scenario. The aim is to use a mapping technique by using biologically inspired networking solutions which is based on adapting the dissemination strategy according to street area where the vehicles are moving and the density of vehicles in the target scenario. Also to reduce the latency and to increase the accuracy of the information received by nearby vehicles when a dangerous situation occurs. Work flow of the proposed system is as follows:

(a) Classification of street profiles

(b) Location of vehicles and estimating vehicle density

(c) Generation of operation modes

(d) Broadcast messages

By adapting to the specific environment where the vehicles are located reduces broadcast-storm-related problems and also increase the efficiency of the warning message dissemination process. The obtained results will be optimized by applying Bio Inspired Algorithms such as particle swarm optimization that include Bird-Flocking Behavior.

There still remain significantly challenging tasks for the research community to address for the realization of many existing and most of the emerging networking architectures. Some of the most challenging questions in networking can only be solved in interdisciplinary teams tied to basic knowledge in engineering but also investigating unorthodox methods.

V. CONCLUSION

This review paper thus studies various approaches of warning message dissemination. It suggested the allowable ways to achieve effective warning message dissemination system. Various methodologies are studied in order to increase dissemination processes by using the information about the urban environment where the vehicles are moving. Techniques studied here are Profile-driven Adaptive Warning Dissemination Scheme (PAWDS), the counter-based scheme, the distance-based scheme, and the eSBR scheme. Along with these techniques Bio Inspired Algorithms are also studied that involves Swarm Intelligence which is further divided into various classes amongst which Particle Swarm Optimization which is inspired by the social behavior of bird flocking and fish schooling. Each of these techniques can be selectively applied as per the requirement.

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