COMP 4520: Undergraduate Honours Project

Ant Colony Optimization for Efficient Route-Planning in Vehicular ad-hoc Networks:

A Two-Page Proposal

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The Problem to be addressed

The problem to be addressed in this project is the issue of traffic congestion in urban road networks. This is a social, economic and environmental problem that lends itself to be addressed with the use of VANET (Vehicular Ad-hoc Network) research. The introduction of the *connected car* enables VANET strategies to be implemented and experimented upon for the purpose of reducing – if not eliminating – vehicular traffic congestion in high-density areas. Hardware and networking tools such as WAVE (Wireless Access for Vehicular Environments) and IEEE 802.11p (A specific amendment to the IEEE 802.11 WiFi standard for the explicit purpose of inter-vehicle packet transmission) provide the foundation for approaching the vehicular traffic congestion problem with a graph-theoretical approach.

This project intends to evaluate the performance of various mechanisms for *route planning* in vehicular ad-hoc networks (VANET). In contrast to more traditional shortest-path algorithms such as Dijkstra and A\*, Ant Colony Optimization (ACO) will be applied to develop a dynamic, heuristic approach to route planning. The usage of ACO for route-planning in vehicular networks is expected to provide an efficient mechanism for dealing with real-time changes in road traffic conditions while preserving the ability to discover and maintain an optimal route in such networks.

Key References and Justification

Three key references to be examined during this project’s execution are as follows:

* Gladia, J. Jerin, and S. Sathish Kumar “Route planning in VANET by Comparative Study of Algorithms*” International Journal of Advanced Research in Computer Science and Software Engineering* Volume 3, Issue 7 (2013)

*Route planning in VANET by Comparative Study of Algorithms* evaluates the performance of Dijkstra’s algorithm and Bellman-Ford for use in route planning for VANET systems. This paper provides a valuable performance benchmark upon which an ACO-based route planning strategy can be evaluated. The work also describes a clear methodology for evaluating candidate routes despite changing traffic conditions.

* Jindal, V., Garg, R., Bedi, P. (2015). MACO: Modified ACO for reducing travel time in VANETs. WCI 2015, At Kochi, India. DOI: 10.1145/2791405.2791476

*Modified ACO for Reducing Travel Time in VANETs* (MACO) provides a novel approach to using ACO in a vehicular route-planning environment. Instead of favoring paths with high pheromone values, MACO proposes that agents in an ACO-VANET system ought to be *repelled* from routes with high pheromone values. MACO’s “pheromone-repellent” approach provides a mechanism for representing traffic arteries with high density, which must be avoided in a traffic-sensitive route planning system.

* Rana, H., Thulasiraman, P., & Thulasiraman, R. K. (2013). MAZA-CORNET: Mobility aware zone based ant colony optimization routing for VANET. 2013 IEEE Congress on Evolutionary Computation. doi:10.1109/cec.2013.6557928

*Mobility Aware Zone Based Ant-Colony Optimization Routing for VANET* (MAZACORNET) describes a high-performance system for packet transmission in VANET. MAZACORNET enables vehicles to plan routes without exchanging routing information with all neighbouring agents. Though MAZACORNET’s focus is packet transmission as opposed to route planning, the paper lays the initial groundwork for an ACO-VANET metaphor and identifies useful concepts such as variable pheromone evaporation rates.

Methods for Addressing Problem

This project will address the problem of urban traffic congestion using route planning with *Ant Colony Optimization* (ACO). ACO is a heuristic-based swarm intelligence mechanism for discovering the shortest path from source to destination in a dynamic, decentralized manner. When traffic networks are modelled as graphs, ACO becomes a strong candidate for efficiently discovering and maintaining routes/paths in such networks.

This project will be focused on designing and implementing an ACO-centric algorithm for traffic sensitive routing in VANET. This algorithm will then be evaluated against other route-planning algorithms as a benchmark. Existing implementations of non-ACO route planning algorithms will be used for comparative purposes. The implementation of non-ACO route planning algorithms, as well as the underlying packet-transmission architecture in VANETs are outside of this project’s scope.

Expected Research Product

The expected product of this project is an ACO based algorithm for route planning and execution in VANETs. This algorithm will use ACO to transmit information about a road network’s state in a decentralized manner. The algorithm will continuously optimize a given vehicle’s route considering both travel time and route capacity. Vehicles will be able to use ACO to evaluate the state of the road network at every intersection in their path, adjusting their route as necessary to account for changes in traffic conditions.

The resultant route-planning strategy will be tested in a discrete-event simulator such as NS3 (Network Simulator 3) or SUMO (Simulator for Urban Mobility). The ACO-based route planning algorithm will be executed against a variety of road networks represented as graphs. The performance of the proposed algorithm will be then evaluated against traditional route-planning algorithms such as Dijkstra and A\* on the criteria of runtime complexity and vehicle travel time.