Parallelized ACO based Routing for Stagnation Mitigation and Avoidance of Multimedia Traffic Over MANETs

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ABSTRACT

Ant Colony Optimization (ACO) (Deepalakshmi & Radhakrishnan, 2009; Sharma & Kotecha, 2011; Sharma, Karkhanawala, & Kotecha, 2011) is a meta-heuristic, suitable for optimized solutions to routing problem in Mobile Adhoc Networks (MANETs). ACO based algorithms are fully distributed, self-organizing, fault tolerant, and intrinsically adapts to changing traffic patterns. However, if the best path is preferred for routing over longer period of time, the exploratory behaviour of the ants may be affected, thus leading to stagnation of the best paths. The authors have reviewed various techniques used for stagnation control and avoidance (Li, Ma, & Cao, 2005). These include, Pheromone control (Schoonderwoerd, Holland, Bruten, & Rothkrantz, 1996; Wedde & Farooq, 2006; De Rango & Socievole, 2011), Pheromone heuristics control (Sim & Sun, 2003), Privileged pheromone laying (Wedde & Farooq, 2006; Stutzle & Hoos, 2000), Multiple ant colony optimization (De Rango & Socievole, 2011; Sim & Sun, 2003), and Multiple path routing (Upadhyaya & Setiya, 2009b) techniques. They also present a comparative analysis of these schemes with respect to the parameter on which they depend for stagnation avoidance. The paper also focuses on stagnation leading to losses of data, which can lay a drastic effect on the quality of multimedia transmission. The authors propose a scheme to improve the exploratory behaviour of ants, by paralleled release of two streams of forward ants in each iteration, along the path from source to destination. It is mentioned that the technique will improve the quality of multimedia routed through MANETs, due to the multipath based enhancements.

Keywords: Ant Colony Optimization (ACO), Ant Colony Optimization Algorithms, Mobile Adhoc Networks (MANETs), Routing, Stagnation

DOI: 10.4018/jaec.2013010103
1. INTRODUCTION

With the advancement in technological growth, more and more content on the internet contains multimedia in various forms. These types of applications fall in the category of IP based Multimedia System (IMS). For these systems, it is important to guarantee QoS requirements of traffic and effectively utilize network resources. In MANETs, the nodes are connected by wireless links and the architecture is infrastructureless. The bandwidth availability changes with more and more nodes adding up in a particular area. The topological changes due to mobility of the nodes further add on to the problems of managing data transmission in these environments. Links may break very often due to mobility of nodes. Also, there is absence of centralized authority and nodes are energy-constrained. Moreover, links are bandwidth-constrained and of variable capacity. For routing in MANETs, the Adhoc routing protocols (Sharma & Kotecha, 2011; Sharma, Karkhanawala, & Kotecha, 2011) are proactive, reactive or hybrid (using both proactive and reactive together) in nature.

Ant colony optimization (ACO) (Deepalakshmi & Radhakrishnan, 2009; Sharma & Kotecha, 2011; Sharma, Karkhanawala, & Kotecha, 2011) is based on Swarm Intelligence (De Rango & Socievole, 2011) which has proved to be highly beneficial in route finding inspite of the vulnerabilities of MANET environment. Swarm intelligence is used specifically for such cases where algorithms require heuristics for optimization of a combinatorial problem.

2. MULTIMEDIA NETWORKS (SHARMA & KOTECHA, 2011; SHARMA, KARKHANAWALA, & KOTECHA, 2011)

MPEG-1 provides near-VCR quality with typical rates between 1.5 to 3 Mbps and MPEG-2 achieves broadcast-TV and higher qualities at rates 5-30Mbps (or higher). MPEG-4 provides a wide range of quality and data transfer rates. Its initial commercial focus is video-on-demand, video conferencing, streaming at a quality higher than that of MPEG-1 but at only 300-400 Kbps. However, multimedia being compressed is not always a good solution for providing better utilization of the available bandwidth. If higher compression is needed to accommodate for more bandwidth limited networks, then the delay due to encoding may interfere with interactivity. The main goal of transmission of video in lossy environments is to maintain quality of transmission, in spite of losses during communication. In order to understand, the loss of what types of frames will adversely affect the quality of video broadcast by how much amount, we need to understand the frame types of MPEG. MPEG-2 has the following Frames:

- Intra or I-frames, carry a complete video picture. They are coded without reference to other frames and might use spatial compression but do not use temporal compression. Spatial compression uses the property that pixels within a single frame, are related to their neighbors; by removing spatial redundancy, the size of the encoded frame can be reduced and prediction can be used at the decoder to reconstruct the frame. A received I-frame provides the reference point for decoding a received MPEG stream;
- Predictive-coded, or P-frames, predict the frame to be coded from a preceding I-frame or P-frame using temporal compression. P-frames can provide increased compression compared to I-frames, with a P-frame typically 20%-70% the size of an associated I-frame. However, for theoretical analysis, they can be assumed to be half of the size of I-frames;
- Bi-directionally predictive-coded, or B-frames, uses the previous and next I-frame or P-frame as their reference points for motion compensation. B-frames provide further compression, typically 5%-40% percent the size of an associated I-frame. For theoretical analysis, the B frames are assumed to be 1/4th of the size of I-frames.
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