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Mobile Agent Protocol based energy aware data Aggregation for wireless sensor networks

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Abstract

Recently, mobile agents use in wireless sensor networks (WSNs) for data aggregation has acquired considerable attention. In client-server, sensor nodes (SNs) collect data and transmitted back to the base station or sink and thus consuming sensor nodes energy and surcharge the network bandwidth. Software entities called mobile agents (MAs) migrate among SNs in parallel for data collection, and then send this data back to the sink. It has been proven that itinerary planning for MAs in this paradigm is an NP-hard problem. Therefore, many solutions have been proposed to solve this problem. This paper, presents a novel itinerary planning algorithm for MAs based on cluster heads (CHs). In our proposed approach, instead of planning itinerary among all SNs, we plan itinerary just among CHs. First, we group SNs in clusters based on density of SNs then select some SNs as CHs. Second, we plan itineraries for MAs just among CHs based on minimum spanning tree algorithm (MST). At the end, we dispatch an optimal number of MAs for data collection and gathering from CHs. Simulation result shows that our MA Protocol based Energy aware data aggregation (MAPE) for WSNs performs better than previous proposed approaches.

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Keywords: Wireless Sensor Networks ;Data Aggregation ; Mobile Agents ; Client-Server; Itinerary Planning; Minimum Spanning Tree

1. Introduction

In the last few years there has been a growing interest in wireless sensor networks (WSNs),due to its use in wide spectrum of applications, such as smart transportation, habitat monitoring, agriculture, flood detection etc. WSNs [1,35] consist of a hundreds or thousands of autonomous sensor nodes (SNs) spatially distributed for data collection from the surrounding environment and sending these data to the sink or base station BS via multi-hop forwarding among SNs or cluster heads [29], [13]. In WSNs, data data are cooperatively and to combined multiple SNs, thus, one can remove the redundant information through in-network aggregation [34].

Client-server (CS) paradigm based WSNs is widely used for data fusion/aggregation; in this paradigm, each SN in the network communicate its collected data to the sink or base station. But with the growing size of the network,

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CS paradigm suffer from many drawbacks, such as the huge size of the collected data that have to be communicated back to the sink, given the low bandwidth of WSNs. Recently, a new paradigm has emerged as an alternative to the traditional CS paradigm, it's called mobile agent MA paradigm[5,4]. MA is a software entity that migrate from SN to SN for data gathering[12,18].In comparison to CS ,MA paradigm has many features[20].

Many researches focus on reducing the amount of energy consumed by nodes and network to increase the network lifetime. Thus, several energy dissipation models[17] have been proposed to optimize energy consumption in each area of WSNs, such as routing, localization, coverage, security, etc. Most of MA routing protocols are energy efficient for data gathering task in comparison to CS, also it take less time to complete an assigned task[27]. Planning itinerary for MA is the most challenging problem with MA paradigm, and it's a NP-Hard problem[31]. The itinerary of MA is the the route that should be followed by the MA among SNs in order to accomplish an assigned task[33].

In this paper, we take in consideration the challenges mentioned above and novel itinerary planing algorithm is proposed. Our proposed mobile agent protocol based energy aware data aggregation for WSNs (MAPA) is based on planning itinerary just between CHs. MAPA plans itineraries efficiently based on minimum spanning tree, and then an optimal number of MAs dispatched for data gathering from those CHs.

The rest of this paper is organized as follows: Section 2 gives a brief overview of related work. In Section 3, the network model is presented. Section 4 describe our proposed protocol. In Section 5, we describe the simulation setup and discuss the performance analysis. Finally, we conclude this paper in Section 6.

2. Related work

Recently, there have been a growing interest in MAs paradigm based WSNs, but the problem with this paradigm is planning itinerary for MA. Many searches have been conducted solve the problem and many solutions have been proposes . In[26] authors propose two algorithms for itinerary planning problem; local closest First (LCF) and global closest first (GCF) algorithms. For LCF, the migration of MA starts from the base station/sink to the nearest SN to the current location. GCF chooses the SN nearest to the station/sink instead. In LCF, the SNs to be visited at last are the SNs located far from the station/sink, and thus gives a poor performance. In the other hand, GCF produces a long route and bad performance. mobile agent-based directed diffusion algorithm (MADD) has been proposed in[10], this algorithm propose the directed diffusion as in CS model[19], for MAs paradigm. MADD choses the SNs located far from the base station/sink as the first SNs ti beincluded in the itinerary.

Another energy efficient solution is described in[11], it's called itinerary energy minimum for first-source-selection (IEMF), this algorithm chooses the first SNs in the itinerary with minimum energy cost.An iterative solution of IEMF named itinerary energy minimum algorithm (IEMA) has bend proposed in[11]. In IEMA, the energy cost are used to decide the next visiting SNs. In[31] authors have proposed a genetic algorithm (GA) that gives a better performance than the previous mentioned algorithms but it's time-expensive.

In[32,33], authors have proposed dynamic itinerary planing algorithm for tracking application, the MA travel to the nearest SNs to the location of the target and extract information about the target. The planning of itinerary is done by implying cost function that includes : energy cost, remaining energy and information gained. When the MA starts collecting the required information about the target, it it terminates its migration and travel again to the base station/sink[32,33].The drawback of this algorithm is it's expensive in time and lack of information for MA to travels back to the base station/sink.

Shakshuki et al[28] have proposed software agent-based directed diffusion algorithm, a static itinerary planning that is calculated at the sink. The cost of routing and the remaining energy are the two metrics used by this algorithm to choose the next destination SN. In[23] authors have proposed Esau-Williams heuristic[16] used mostly in design problems of network and adapts it the WSNs.In near-optimal itinerary design (NOID) algorithm multiple the sink dispatches the MAs to visit SNs, but this algorithm implies computational complexity.

Chen et al.[7] have proposed MST-MSIP. MST-MIP use minimum spanning tree to plan itinerary among SNs. To each group of SNs a MA is assigned then the sink dispatch the MAs in parallel for data collection from SNs. A data collection scheme is proposed in[2] with emphasis of the effect of ferry's path. In this scheme the decision of selecting cluster heads is based on their residual energy and their distance from the ferry path.

In[9 30] authors propose an algorithm named directional source grouping (DSG). DSG draw a circle around the base station/sink by varying the circles' radius and iteratively divide a directional sector zone then an itinerary of MA