Location based Queuing Schedule with d -Cover Algorithm on Wireless Ad-hoc Networks

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Abstract

Localization – the determination of the geographical locations of sensors is a rudimentary problem in wireless sensor networks. Most existing localization algorithms were designed to work well either in networks of static sensors or networks in which all sensors are mobile. The paper researched the problem of estimating the geographic locations of nodes in a sensor network where most sensors are without an effective self-positioning functionality . A novel algorithm for location in the optimization of Wireless ad-hoc networks was proposed. A distribution of the dispatch nodes can be obtained by the algorithm considering requirements, emergency response time and total system cost. The required region/nodes can be covered by the circles with radius d and everyone takes a dispatch point as center. Contributions to the well property of Gaussian convolution, the local demands level can be obtained and the distribution based on covers and sorted demands are more efficient.

Keywords

Localization, Weighted Least, Square Scaling, Discrete Time Queue.

1. Introduction

In the real scenarios, more and more emergency systems recently rely on WSNs technique so that assist human to accomplish the urban planning and construction , it is prerequisite to design the location of some publication facilities such as school, shops store, stadium, cinema, and so on.

Nowadays, wireless sensor network was wildly applied in industry, agriculture and military filed due to the diversity of applications. It includes countless cheaper sensor nodes that are capable of data gathering, data processing and radio communication. Sensor nodes integrated with embedded computation are randomly deployed pervasively for collecting information, for example temperature, humidity, light, etc [1]. Then the collected data is transmitted to internet through radio communications. Data that is beyond the defined limit will trigger the alarm system so as to remind people to take appropriate measures. Localization information is the main research field of target tracking. Thus, the accuracy of localization is crucial for localization algorithms that have a low level of accuracy provide useless information. In real scenario, it is a key issue of mesh network to provide Internet access for mobile users. A few of wireless mesh routers connect to wired networks by wired links to provide wired network access for mobile clients. These mesh routers are referred to the Gateways for differentiating them from other mesh routers. Mesh clients can access wireless mesh routers by wired or wireless connections. Figure.1 shows the architecture of wireless mesh networks, where dash and solid lines refer to wireless and wired links, respectively.

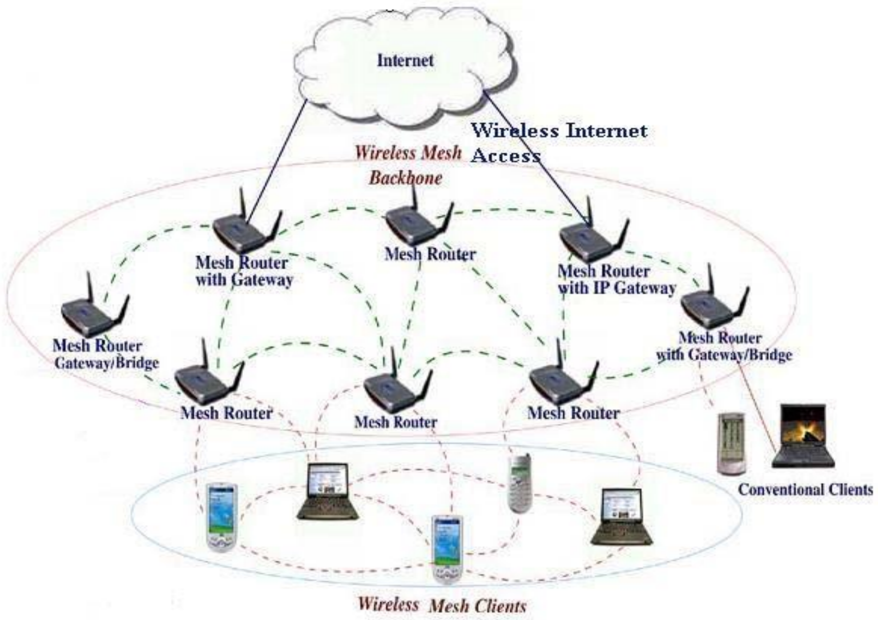

Figure 1. Architecture/Backbone of WMNS

The existing localization algorithms have proposed for nodes tracking. Due to the limited processing and memory capabilities, it is not realistic to take the sensor nodes equipped with specialized hardware components such as global position system (GPS) into mass production. There are two kinds of localization algorithms: range-free and range-based. Range-based protocols compute the absolute point to point distance estimates or angle estimates between neighboring nodes. The parameters can be collected by ranging techniques, including angle-of-arrival (AOA), received signal strength indicator (RSSI), time-of-arrival (TOA) or time difference of arrival (TDOA). The localization accuracy implemented by range-based measurement offers a better result, however, it needs special hardware for computing the parameters. Contrast with Range-based algorithms, Range-free methods need less device constrains in order to attract enough focuses despite of the level of low accuracy related to range-based algorithms.

Location-Allocation Problems (LAP) are important issue in the optimization of emergency systems [4, 5, 6, 7], which are related with the path problems and they affected and depended each other. From the perspective of system optimization, it is necessary to research the Location-Routing Problem (LRP). Currently, lots of approaches have been conducted on LAP or LPN of general logistics Systems [8,9,10] while very few has been conducted on LAP or LPN of response systems. [11] investigated the coordinate optimization problem of materials distribution and injured transportation in emergency rescue of natural disasters. The location of temporary medical nodes, assignment of medical staffs, distribution of emergency supply and decision-making of vehicle transport route are considered. Then a determined mixed integer network flow model of multi-species material has been established and solved by some application software. For the LRP of emergency logistics system, to consider the congestion of post-disaster network, a LRP model maximizing the total satisfaction of time consumption has been built and a two-stage heuristic algorithm has been proposed to solve it.

This paper discusses the requirement of emergency service, emergency service time and total system cost on each demand point based on the wireless sensor networks (WSNs), and then introduces the Gaussian convolution of urgent demands. A cover algorithm is discussed for the location problem. Based on it, a more efficient distribution of dispatching nodes can be obtained with the considering of sorted demands.

The rest of the paper is organized as follows: In Section 2, the location problem was define and a general optimization problem was given with a fixed condition. The Gaussian convolution is introduced in

Section 3 and a unsorted cover algorithm with fixed radius is given in emergency systems. A sorted cover algorithm is proposed for the location problem and several numerical examples are presented in Section 4. The conclusions are given in the last section.

2. Related Works

Most the existing research focuses on static sensor networks. Relatively less is known about localization in mobile sensor networks, and very few algorithms work in situations where the sensors may be static or mobile. Relevant papers in this section were surveyed in this section. and refer the user to the surveys by Bachrach and Taylor [1] and by Savvides et al. Bahl et al. [2] and Bischo et al. [4] used received signal strength (RSS) to estimate distances. Ward et al. [7] presented a range-based algorithm relied on the Monte Carlo approach. Range-free localization: He et al. [12] proposed a range -free algorithm called APIT in which all possible riangles of the seeds are constructed. The location of a node is the center of intersection region of all triangles. Sextant [11] proposed a distributed algorithm that uses Beziercurves for estimating the possible locations of the nodes. The nodes estimate their locations by using the location information of their neighbors. Bergamo and Mazzimi [3] presented a range-based algorithm for mobile sensor networks which uses only two static seeds that are located at a specific location in the network and their radio ranges cover the whole network. Recently, we proposed a range-free localization algorithm [6] that works in both static and mobile networks. The primary problem associated with the algorithm in [6] is that it cannot estimate locations well when the radio ranges of sensors are not perfect circles.

3. The Location Problem

The service system should promptly respond when service requirements occurred, and it can reflect the emergency system capabilities. System capacity is decided by the quantities of available facilities and maximum effectiveness of these facilities[12]. System management is reflected in early warning, evacuation, public safety and protection such as [13]. Thus, valid management capabilities by managing the quality and scope of facilities and the effective ability play the most effective use of limited facilities.System facilities should be prepared in some selected deploying points, and if service requirements occur, nodes must quickly select a deploying point, and transport limited emergency facilities to demand points in a limited time. Proper location of emergency dispatch points will greatly reduce transport costs, improve efficiency of emergency facilities utilization and reduce the losses, called Location Problem (LP) of emergency system.

Assumed that there are many service requirements occurred in the past time. The demands distributes on the points $P_i(x_i, y_i)(i=1,2,\ldots n)$ in the urban. The demand amount on the points are Q_i $(i=1,2,\ldots n)$. Then the amount and the positions of the distributed points should be determined.

Obviously, the design should satisfy the future requirements. In terms of the past requirements, we can suppose that future distribution be the same as past. If the number of emergency deploying nodes is constant, it is convenient to set-up and solve the common programming model. Suppose the number of required deploying nodes for the k, a total of m candidate deploying nodes $N_j(x_j, y_j)(j=1,2,\ldots m)$. The cost of unit facility is transferred from dispatching nodes to required ones is defined by C_{ij}. The cost of unit facility to be prepared on distributed nodes are set to be D_j ($j = 1, 2, ..., m$) . With the constraint condition of service cost T on each requisite node, then a relative optimization issue can be built as following.

$$\min S(I, X, V) = \sum_{j=1}^{m}(D_j \cdot X_j \cdot I_j) + \sum_{j=1}^{m}\sum_{i=1}^{n}(C_{ij} \cdot I_j \cdot V_{ij}) \tag{1}$$

$$
\begin{aligned}
s.t.\quad & I_j \in \{0,1\} \\
& \sum_{j=1}^{m} = k \\
& \sum_{j=1}^{m} (I_j \cdot X_j) = \sum_{j=1}^{m} Q_i \\
& \sum_{j=1}^{m} (I_j \cdot C_{ij}) = I_j \cdot X_j,\ j = 1,2\cdots m \\
& I_j \cdot C_{ij} \le T,\ i = 1,2\cdots n,\ j = 1,2\cdots m.
\end{aligned}
$$

where I_j denotes point whether to adopt the dispatching point N_j , X_j denotes the quantity of facilities on dispatching point N_j , V_{ij} is the amount of facilities derived from dispatch point N_j to demand point P_i . Figure.2 gives WMNs under assumptions, where solid arrows denote the traffic flows loaded to mesh router nodes from mesh clients within their coverage, and dashed arrows represent direction of flows in the WMNs. The first number of the footnote in each node denotes its hop count.

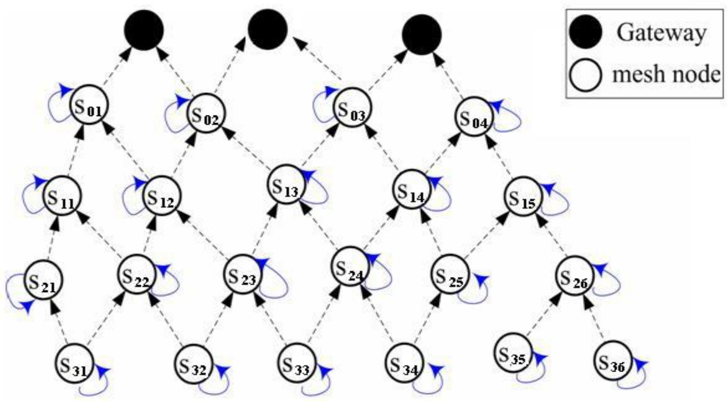

Figure 2. Case of Forward streams in WMNS

As shown in Figure.2, traffic loads of (s+1)-hop (0≤s<S) nodes affect the packets arrival rate of s-hop nodes. Assume that Gateways do not communicate with mobile users directly. Traffic loads of Gateways (s=0) equal to that of 1- hop nodes. Recall that S-hop mesh nodes are the farthest nodes from the gateways. S-hop nodes do not relay packets for any other mesh node. Suppose that there is no packet loss in the WMNs. Let λ and λ(s) be the ideal number of packets loaded to every mesh node from its mesh clients and the total number of packets arriving at s-hop nodes. λ(s) is also called the ideal input of s-hop nodes. Assume that the traffic loads generated by mesh clients within the coverage of every mesh node are equal.

4. D-Cover Algorithm

This section proposed a cover algorithm based on the partial demand level. A set of circles with the radius d is composed to a cover of the demand region. Efficiency and applicability of algorithm are illustrated by several numerical results.

d-Cover Algorithm

The algorithm is stated as the following

step1. Calculate the convolution of original demands f (x) and Gaussian kernel k(x) , it refers to the local demand level;

step2. Sorted the demand points according the local demand level by descending;

step3. In terms of the constraint condition of supply time, set a proper radius d;

step4. According the sorted points, generate a set of circles covering the demand region Ω as following procedure.

DO For the first node P in the sorted nodes set PSET
If it is not in anyone of the circles
Then generate a new circle with the center P and erase it from PSET
WHILE PSET is not null

5. Conclusion

In this paper, we have presented a cover algorithm for location problem. First we discusses the requirement of emergency facilities, service supply time and total system cost in the system, and then introduces the Gaussian convolution of requirements distributions. Eventually, a sorted set of circles with radius d is generated to cover the needed region. Simulated results show that the presented method and algorithm can solve the location problem for optimizing the system.

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