Chapter 23
Geometric Structures for Routing Decision in Wireless Sensor Networks

Alok Kumar
Indian Institute of Information Technology, India

Shirshu Varma
Indian Institute of Information Technology, India

ABSTRACT

This chapter surveys routing algorithms in Euclidean, virtual, and hyperbolic space for wireless sensor networks that use geometric structures for route decisions. Wireless sensor networks have a unique geographic nature as the sensor nodes are embedded and designed for employing in the geographic space. Thus, the various geometric abstractions of the network can be used for routing algorithm design, which can provide scalability and efficiency. This chapter starts with the importance and impulse of the geographical routing in wireless sensor networks that exploits location information of the nodes to determine the alternatives of the next hop node on the desired routing path. The scalability of geographical routing encourages more effort on the design of virtual coordinates system, with which geographical routing algorithms are built up and applied to route data packets in the network. The geometry of large sensor network motivates to calculate geometric abstractions in hyperbolic space. Thus the challenge is to embed the network virtually or hyperbolically, which affects the performance and efficiency in the geographical message delivery.

INTRODUCTION

Due to potential applications in the areas such as military, health, environmental, home and other, wireless sensor networks (WSNs) have came forth as a premier research area in current decade. Sensor networks consist of significantly large number of sensor nodes scatter over a geographical terrain (Akyildiz, 2002). These nodes are capable to perform sensing, processing and are additionally able of self-organize to interacting by means of a wireless network. The network will achieve a

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larger sensing task in urban environments as well as inhospitable terrain, with coordination among these sensor nodes. The absolute numbers of these sensors and the varying dynamics in these environmental scenarios present unique challenges and limitations in the design of WSNs. Various research projects have been conduct to study for solve various problems in this new field. This book chapter assumes a WSN comprising of a set V of N nodes scattered over a routing space. Each node is content an omnidirectional antenna for physical connectivity with each other. This is significant as a single transmission of a node, taken to be a disk centered at the node, is hearable by many nodes within its vicinity. The radius of this omnidirectional disk is known as the transmission range of this sensor node. In other words, any node V can get the signal from sensor node u, if receiving node v lies in the transmission range of the sender node u, else, (u,v) nodes interact through multi-hop links while using nodes in between as relays of packet. Each node in the network also works as a router, which can forward data packets for other nodes. Through a proper scaling, all nodes are assumed to have the maximum transmission range, which is equal to unit. With information about the position, computational geometry techniques can be employed to solve some intriguing questions on sensor networks. Most geometric algorithms are formed for studying the structural properties, inclusion, searching or exclusion relations of a set of points or planes, or both. As an example, the structural properties include convex hull, intersections, triangulation, hyperplane arrangement, Voronoi diagram, and so on. In this chapter, the focus is on the use of some geometric structural properties for routing process in WSN.

This chapter surveys geographic routing algorithms which use various geometric structural properties for routing process in routing spaces for wireless sensor networks.

Geographic routing algorithms which are design for the Euclidian space are most common for researchers. Here, some consider the unit disk graph (UDG) as a communication model for the computation of as real network but UDG does not behave like real network. Many proposals also consider other models such as quasi disk graph and cross link detection protocol for model the network. Due to location unavailability and the presence of the localization error in the mechanism of node localization, geographic routing performs inefficiently. To overcome these problems these algorithm can be design on virtual coordinates, but these virtual coordinate assignment approaches affects the performance and efficiency in the geographical message delivery. Geographic routing using the physical coordinates of the sensor nodes has been considered to study due to its scalability and simplicity, and regained popularity in the research community in recent times with the increasing GPS-capable communication devices. Geographic routing based on node locations and distances in Euclidean space, has been proven to have a higher success rate, but fails when a packet reaches at node which is nearer to the location of the destination node than all of its straight neighbors even if a path exists to the destination, but it can provide higher success in hyperbolic space.

This chapter focuses on the design rational and the main theme in each algorithm. Please refer to the original literatures for implementation and experimental details for the validation of each. The typical situation is large homogeneous sensors network with the possibility of communication each other with nearby nodes and communicate with other using multi-hop routing. Since many of the routing protocols use network model and basic geometry for computation, we first survey background knowledge on communication network model and basic heuristics of geographic routing.

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