Construction and Maintenance of Connected Dominating Set as Virtual Backbone in Wireless Network

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Abstract

A virtual backbone plays an important role in routing packets in a Wireless Sensor Network where a predefined infrastructure is absent. Some nodes of the network takes on additional responsibilities in an algorithmic framework to form the virtual backbone. A connected dominating set (CDS) can work as a virtual backbone in a wireless network. A dominating set of a graph is a subset of its vertices such that each node is either within that set or adjacent to one of the nodes present in that set. If the nodes within the dominating set are connected, then the dominating set is known as a connected dominating set. As the routing responsibilities lie only on the CDS nodes, researchers are interested in minimizing the CDS size. However, the construction of minimum CDS is an NP-Complete problem. In this dissertation, first a new centralized degree-based greedy approximation algorithm is designed which constructs CDSs of smaller sizes in comparison to other existing algorithms. The proposed algorithm retains the current best approximation ratio and is also the most time efficient CDS construction algorithm. In the second work, a novel distributed greedy approximation algorithm for CDS construction is developed which reduces the CDS size effectively. The simulation shows that this is the most size optimal distributed CDS construction algorithm with linear message complexity. The algorithm constructs the CDSs in lesser number of rounds in comparison to other degree-based algorithms. In a CDS, a node may fail or downgrade due to lack of its battery power or some other reason. In this situation, it is advantageous to repair the current CDS rather than reconstructing a fresh CDS. In the third work, a distributed CDS maintenance algorithm is developed which repairs the CDS by changing the role of only a few nodes. The proposed algorithm has linear time and message complexity. This CDS maintenance scheme handles the failure of both CDS and non-CDS nodes. To use the proposed distributed CDS construction and maintenance algorithms each node needs its two-hop neighbours' information.

Keywords: Connected Dominating Set, Steiner Tree, Unit Disk Graph, Virtual Backbone, CDS maintenance.