HS 2009 Prof. Dr. Roger Wattenhofer, Philipp Sommer, Johannes Schneider

Ad Hoc And Sensor Networks
Exercise 3

Assigned: October 5, 2009
Due: October 12, 2009

1 Degree of Euclidean Graphs

In the lecture the four Euclidean graphs Minimum Spanning Tree (MST)[1], Relative Neighborhood Graph (RNG), Gabriel Graph (GG), and Delaunay Triangulation (DT) have been introduced. Which of these four graphs has/have a degree bounded by a constant in the UDG model? Give a reasoning if you think a graph has bounded degree or draw a counterexample if you believe a graph can have unbounded degree.

2 Face Routing continued

We consider again the quasi unit disk graphs (QUDG) with parameter $d \in]0, 1]$. In a QUDG, two nodes u and v are always connected if $\overline{uv} \leq d$. If $1 \geq \overline{uv} > d$, the two nodes may be connected or not. Assume symmetric links, i.e. if node u sees node v, then v sees u as well.

a) Show that the Gabriel Graph cannot be used directly to planarize a d-QUDG for $d < 1$.

As another type of network, we now consider spanning disk graphs (SDG). The connectivity of a SDG fulfills the following property: Whenever two nodes u and v are connected, they are connected to all nodes contained in the disk spanned by u and v, i.e. the smallest disk that touches u and v. Again, assume symmetric links.

b) Show that face routing algorithms succeed on the Gabriel Graph of any SDG.

3 Gabriel Graph Spanner Property

The energy consumption of an edge with Euclidean distance d is often defined as d^α, with $\alpha \geq 2$. The Gabriel Graph (GG) contains the energy-minimal paths and is therefore a power-spanner with spanning factor 1. Do you think the GG is also a geometric spanner, with respect to the Euclidean length of edges? If you think so, give a reasoning; if not, provide a counterexample.

4 Topology Control

In the lecture, you have seen multiple ways to conserve energy by managing a node's neighborhood, e.g. we have seen how the XTC algorithm connects only to selected neighbors.

a) Discuss in which circumstances topology control is useful and when it may be inappropriate. For example, does it make sense to have topology control in dense networks or is it more suitable in sparse topologies? Does the traffic pattern influence your decision for or against topology control?

b) It was stated, that XTC produces a topology with maximal node degree of 6 if the underlying network graph is a UDG. Why does XTC result in a bounded degree topology if the given graph is a UDG? Does XTC still produce bounded degree topologies when considering a more practical environment including non-ideal radio propagation and obstacles?

[1] with respect to the Euclidean length of edges