Wireless Sensor Networks Consisting of Directional Antennae

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There has been a lot of interest in the last few years on the performance of Wireless Sensor Networks (WSN) consisting of sensors of directional as opposed to ones consisting of omnidirectional antennae. Applications range from improving energy consumption to security of the resulting sensor network. A fundamental problem concerns comparing the connectivity and spanning characteristics of sensor networks when individual sensors consist of omnidirectional and directional antennae, respectively [1]. More specifically, we look at the following problem.

> How do the network topology characteristics change when we substitute omnidirectional with directional antennae and which antenna orientation algorithm accomplishes the best results?

As opposed to standard WSNs consisting of omnidirectional antennae (usually modelled as Unit Disk Graphs), the resulting network of directional antennae is a far more complicated directed graph. Moreover, when each sensor is equipped with a fixed number, say k, of such directional antennae (modelled as circular sectors) with a given spread (or angle) and range (or radius) the spanning properties of the resulting graph depend on these parameters in several complex ways. Our main concern will be to examine tradeoffs among these parameters and investigate the following specific problems.

1. What spanning properties does the graph of directional sensors have for a given number k of antennae per sensor, sensor angle and "finite" range?
2. What is a performance comparison (stretch factor and energy consumption) between omnidirectional and directional antenna graphs so as to attain connectivity?
3. Find antenna orientation algorithms for more realistic settings, like sensors in $3D$ space as well as as for other metric spaces.
4. Study the orientation problem in more realistic antenna models, like dipole antennae.

Understanding the behaviour of new and emerging wireless networks (ad hoc, sensor, actuator, delay-tolerant, etc.) requires research methods from and interdisciplinary interaction among diverse disciplines including distributed computing, graph theory, probability theory, computational geometry and network analysis. In addition, conjectures and proposals may be investigated and evaluated in an experimental, simulation environment.

References

[1] E. Kranakis, D. Krizanc, and O. Morales. Maintaining connectivity in sensor networks using directional antennae. *Theoretical Aspects of Distributed Computing in Sensor Networks*, pages 59–84, 2011.