THE UNIVERSITY OF MEMPHIS
Computer Science

Coverage and Connectivity in Wireless Networks – the Journey from Percolation to Reliable Density Estimates

Dr. Santosh Kumar
Assistant Professor
University of Memphis

ABSTRACT: Since the advent of wireless ad hoc networks, especially sensor networks, the issue of coverage and connectivity has been a fertile area of research. Coverage pertains to ensuring certain quality of monitoring, whereas connectivity pertains to ensuring that sensed data reaches base station(s). If sensors can't be deployed deterministically either due to excessive time and expense incurred in such a deployment, due to inaccessibility of the terrain, or for other reasons, sensor deployment is often considered random (with some known probability distributions). How many sensors should then be deployed to achieve a desired level of coverage/connectivity?

Percolation theory can be used to derive asymptotic density estimates to ensure that a majority of sensors are connected to each other. Numerous sensors may remain isolated though. Asymptotic probabilistic analysis is the next level of analysis which is used to derive critical density (or, equivalently critical power/radius), a density above which (with high probability) no sensors remain isolated. Although such analyses are useful in predicting network behavior at a high-level, they can't be used by a practitioner to compute the appropriate number of sensors needed in a finite deployment region.

In this talk, I will introduce a novel mathematical technique (proposed in our MobiCom 2007 paper) that can be used to derive probabilistic estimates for density that are quite reliable even for small finite regions. We envision this work to be a first step towards closing the gap between theory and practice. As this new approach of deriving reliable probabilistic estimates is applied to newer problems, theoretical research done in this area will become increasingly useful to the practitioner community. Using barrier coverage (MobiCom 2005) as an example, I will present the key steps involved in such a derivation.

About the Speaker: Santosh Kumar is an Assistant Professor in the department of Computer Science at the University of Memphis. He works both on theoretical and systems research. The current focus of his theoretical research is on fundamentals of coverage and connectivity with an emphasis on provable optimality, localized design, and energy-efficiency. In systems research, he is building novel systems such as AutoWitness and AutoSense. AutoWitness will help law enforcement agencies in recovering lost/stolen objects, while AutoSense is aimed at revolutionizing behavioral sciences research by enabling reliable and real-time quantification of personal exposure to addictive substances and psychosocial stress as experienced by individuals in their natural living environments.

Santosh received his Ph.D. from the Ohio State University in Computer Science and Engineering in 2006 where he was awarded SBC Presidential Dissertation Fellowship for his fundamental contributions to the issue of coverage in wireless sensor networks.