Efficient Tracking of Uncertain Evolving Shapes with Probabilistic Spatio-Temporal Bounds in Sensor Networks

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Abstract
We address the problem of balancing trade-off between the (im)precision of the answer to evolving spatial queries and efficiency of their processing in Wireless Sensor Networks (WSN). Specifically, we focus on scenarios where, in addition to simple measurements one is also interested in the boundaries of a shape in which all the sensors’ readings satisfy a certain criteria. Given the evolution of the underlying phenomenon being tracked/monitored, the changes of the corresponding sensed values imply that the boundaries of the shape(s) will also evolve over time. To avoid sending constant updates of the individual sensor-readings to a dedicated sink (and yet provide certain guarantees on the answer to user's queries posed to the server which stores the spatial data pertaining to the evolving shapes) we propose a methodology where the accuracy of the answer is guaranteed within certain probabilistic bounds. Towards that, we devised both linguistic constructs for the user to express the desired probabilistic guarantees as part of the query's syntax, along with the corresponding algorithmic solutions and system aspects of their implementation. Our experiments demonstrate that the proposed methodology provides over 25% savings in energy spent on communication in the WSN.

Keywords
sensor networks, probabilistic measurements, evolving shapes