Localization of Wireless Devices in Agricultural Fields

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Localization algorithms that can be easily integrated into deployed wireless sensor networks (WSNs) and which run seamlessly with proprietary lower layer communication protocols running on off-the-shelf modules can help operators of large farms avoid the difficulty, cost and/or time involved with manual or satellite-based localization techniques. Particular challenges include excessive path loss due to densely vegetated environments, limited transmit power level, and proprietary media access control (MAC) and routing specifications deployed on commercial-off-the-shelf RF modules. A distributed localization algorithm that is able to run recursively and divide the calculations between time steps will help to reduce complexity and communication overhead. Further, precision agriculture applications have a need for localization algorithms that could seamlessly integrate into off the shelf WSNs and run with scalable communication and computational complexity.

Here we propose a distributed localization algorithm based on Bayesian model for information aggregation. We update location the probability mass function (pmf) conditioned on communicated path loss samples in real time manner rather than performing marginalization when all distance estimations are provided. Assuming that WSN field is composed of a finite number of grid cells, conditional pmf at each time step is interpreted as probability of the node being located at the centroid of the corresponding grid cell given all the packets that have so far been communicated packets between pairs of sensors. We prove that in order to update the conditional location pmf given all available inter-node path loss information, only the most recent conditional pmf updates, so called priors of the transmitting and receiving nodes, most recent received path loss samples and path loss model are required. The algorithm has communication and computational complexity of O(1) and O(n) per node which renders the algorithm scalable and highly desirable for WSNs in large environments such as precision agriculture applications.