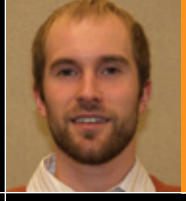


Reliable Location Estimation from Unreliable Signal Strength Measurements

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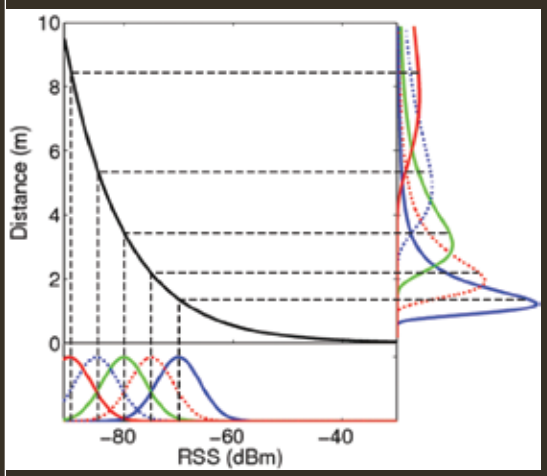
Location estimation, or localization, is becoming increasingly important in wireless networks as device location often plays a critical role in network operations and services.

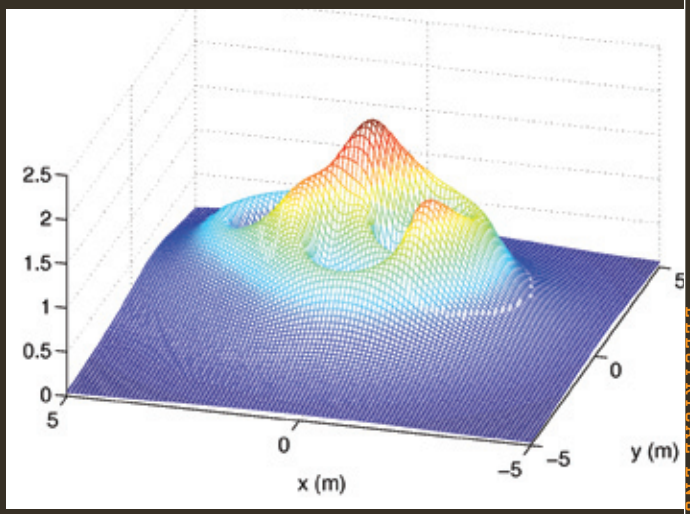
Received signal strength (RSS) provides a readily available and cost-effective solution for localization in wireless networks. Typically, RSS measurements are taken from neighboring devices with known location, referred to as beacons. Distance estimates are computed from these RSS measurements using an environment-specific path-loss model. These distance estimates are then passed to the localization algorithm along with the corresponding beacons' locations and used to estimate a location. This leads to a two step estimation problem where the estimated distances are used in the location estimate. This two step estimation would be a suitable method if each distance estimate had the same level of accuracy, but this is not the case.



The mapping from RSS measurements to distance estimates can be used to map the Gaussian distribution of RSS measurement error to a distribution of the beacon distance. Note that RSS measurements from distant beacons have high estimation variance illustrated by the wide distribution whereas RSS measurements from nearby beacons have low estimation variance as illustrated by the narrow distribution.

The uncertainty in the distance estimate increases with distance, suggesting that distance estimates become increasingly unreliable as distance increases. This work compensates for this fact by modeling each beacon distance probabilistically, using a probability distribution instead of a distance estimate. This approach allows for the execution of a single estimation step using all of the available information about the RSS measurements. An algorithm called ReLoc is presented which uses the set of RSS-derived distance distributions to compute a reliable location estimate.

In ReLoc, a probability distribution of the distance to a beacon is mapped to a three-dimensional surface centered at the beacon's given coordinates. The height of the surface at each coordinate is proportional to the probability that the localizing device is the corresponding distance away from the beacon.



The surface represents the aggregation of RSS measurements from three beacons to indicate the device's probable location.

The proposed ReLoc algorithm provides a way of accounting for the variable accuracy of RSS-derived distance estimates thereby improving the accuracy of the localization. In future work, algorithms will be developed to estimate the confidence of a location estimate, and the issue of inaccuracies in reported beacon location will be addressed. eek09

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