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Accuracy of Homology Based Coverage Hole Detection for Wireless Sensor Networks on Sphere

Abstract:

Homology theory has attracted great attention because it can provide novel and powerful solutions to address coverage problems in wireless sensor networks. They usually use an easily computable algebraic object, Rips complex, to detect coverage holes. But Rips complex may miss some coverage holes in some cases. In this paper, we investigate homology-based coverage hole detection for wireless sensor networks on sphere. The case when Rips complex may miss coverage holes is first identified. Then we choose the proportion of the area of coverage holes missed by Rips complex as a metric to evaluate the accuracy of homology-based coverage hole detection approaches. Closed-form expressions for lower and upper bounds of the accuracy are derived. Asymptotic lower and upper bounds are also investigated when the radius of sphere tends to infinity. Simulation results are well consistent with the analytical lower and upper bounds, with maximum differences of 0.5% and 3% respectively. Furthermore, it is shown that the radius of sphere has little impact on the accuracy if it is much larger than communication and sensing radii of each sensor.