

# Indoor Location Detection for Calculating In-Home Exposures in clinical trials of air purifiers

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## Abstract

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**BACKGROUND AND AIM:** Microscale pollution variation in space and time by some pollutants, notably ultrafine particles near high volume traffic, present a problem for precise exposure assignment for epidemiology. While it is possible to track time activity patterns for outdoor locations, error in GPS data when indoors renders that approach ineffective at determining location within a home.

We are conducting a double blinded, randomized trial of air purifiers in homes next to a highway and sought to develop a method to track when study participants were and were not in the room with the air purifier.

**METHOD:** Several technologies were evaluated before choosing Bluetooth Low Energy Beacons in combination with Apple iPhones for our approach. The design of the system is low-cost, non-disruptive to inhabitants, and easy to deploy and to remove. Software and hardware innovations that delivered higher accuracy will be described. Our method was pilot tested in a small number of homes.

**RESULTS:** Our system was able to create a complete picture of minute-by-minute location without need for participant journals. For a typical Boston-area wood structure home and 30 minutes of setup and calibration, our method achieved nearly 100% accuracy detecting the participant spending at least 8 minutes in either room. Even better results may be obtained with additional initial calibration to the test home. Techniques to achieve similar results in homes with different construction and layouts will be described and demonstrated. Total equipment cost for the system is less than \$1000 and is reusable across multiple homes.

**CONCLUSIONS:** We have proof of principle of a method that can document time study participants spent in specific rooms in a home, specifically those outfitted with air purifiers. Our method holds promise for reducing exposure error for clinical trials of air purifiers.