Millimetre Wave Coverage Improvement Using Convex Passive Reflectors In Indoor Environments

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Spectral congestion in wireless systems is of growing concern, with a need for increased bandwidth. The millimetre wave band is becoming of increasing interest for use in next generation communication systems. Clutter in indoor environments presents challenges with increased shadowing, as diffraction can no longer be relied upon to provide coverage behind obstacles at these high frequencies [1, 2]. Use of active solutions are power-intensive and are costly to manufacture and operate. This study presents a low-cost, alternative solution using passive reflectors.

Previous studies have demonstrated the advantages of using passive reflectors to provide coverage to non-line-of-sight (LOS) regions around clutter [1-3]. Planar reflectors have been found to be limited in their angular spread of coverage [1], but may not be appropriate in environments such as indoor offices where multiple devices are distributed across a broad volume. To date, large curved reflectors (typically ranging from 0.5m to 0.83m) have been investigated but are impractical for use in indoor environments [1, 2], due to their obtrusive nature.

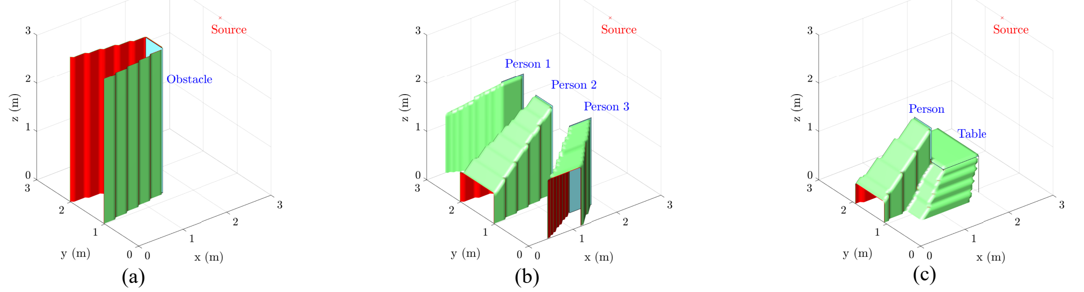

Fig. 1: Shadows created by obstacles in Environments A-C, represented by isosurfaces where the red side indicates no LOS coverage and green side indicates LOS coverage. User locations were sampled at 0.05m apart.

In this study, three small office environments have been considered consisting of single and multiple shadowing obstacles, representative of people and commonly encountered office clutter:

- Environment A – Single, generic shadow-causing obstacle (fig. 1(a)).
- Environment B – Three obstacles, representative of three standing people (fig. 1(b)).
- Environment C – Two obstacles, representative of a person sitting behind a desk (fig. 1(c)).

Placement of 1/8th sphere (octant) reflectors (of 0.3m radius) in the top corners of the offices was determined to be an unobtrusive location while maintaining LOS to the ceiling-mounted source, and allows for variable reflector protrusion. These octant reflectors were found to provide wall-to-wall coverage when placed in the office corners.

Reflectors were varied in radius, corner location, and quantity within each of the three environments. In all cases considered, use of at least one reflector improved coverage to user locations, due to the additional reflected fields, and eliminated shadow regions completely in Environments A and B. Placement of reflectors in opposing corners from the source provided more effective coverage (up to 100% coverage in Environment A), compared to placement in corners on the same side as the source (97.41% in Environment A). While using 2 reflectors provided coverage to more user locations in densely cluttered environments (Environments B and C) compared to single reflector deployment, orientation of clutter may still limit the reflected field from being able to cover all user locations. Reducing the curvature of the reflector increased the reflected power, however, required a larger reflector, which may not be suitable in a small office.

This study demonstrates the use of octant-shaped reflectors as a low-cost solution for providing additional ray paths for coverage to shadowed user locations in a small office. While coverage to all user locations may not always be possible, coverage may not be required in all locations. Further work is being done to investigate prioritisation of regions of importance to ensure coverage is provided for user locations with the highest likelihood of device presence.

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