Antenna Height Compensation for an Indoor to Outdoor Channel Model Based on a 2D Finite Difference Model

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Abstract— It has been recently shown that a finite difference model (e.g., based on an approach similar to FDTD) combined with a ray optical approach (e.g., based on ray launching) can be efficient to compute the simulation of Outdoor to Indoor radio wave propagation [1]. Such model was based on 2D Finite Difference for the indoor part, which efficiently takes into account the propagation into the floors of the buildings since they can be well approximated with a 2D model, combined with a ray launching model for the outdoor part.

However, for the Indoor to Outdoor case [2] and depending on the height where the antenna is located inside the building, it is important to be able to launch the outdoor rays in the correct directions. Therefore, this paper proposes a new approach where the vertical cut of the building is simulated, in order to extract the directions of the outdoor rays to be computed.

The new method we proposed works as follows:

- The horizontal indoor radio coverage is simulated inside the building with the finite difference model (see Figure 1).
- The vertical indoor radio coverage is simulated inside the building with the finite difference model (see Figure 2).
- From these two radio coverage predictions, the directions of the rays to be launched outside are extracted based on the SAGE algorithm. In this approach, the electrical fields on the border of the building are used in order to estimate the angles of arrival.
- The outdoor rays are launched using the ray optical based model, and the reflections/diffractions on the neighbouring buildings are computed.

A measurement campaign was performed in order to evaluate the performance of the new combined model. For this purpose an emitter is deployed inside a building and radio measurements are performed both indoors and outdoors.

The indoor scenario, where the MRFDPF (Multi Resolution Frequency Domain ParFlow) method is used, is the CITI building whose size is approximately 110×100 meters. The outdoor rays are launched in the whole outdoor scenario (800×560 meters).

It is shown that, compared to [2] where only the horizontal indoor field is taken into account, this approach is efficient to take into account the height of the antenna in the building.

Future work include the realization of more measurements in order to validate this combined model in other scenarios and frequency bands.

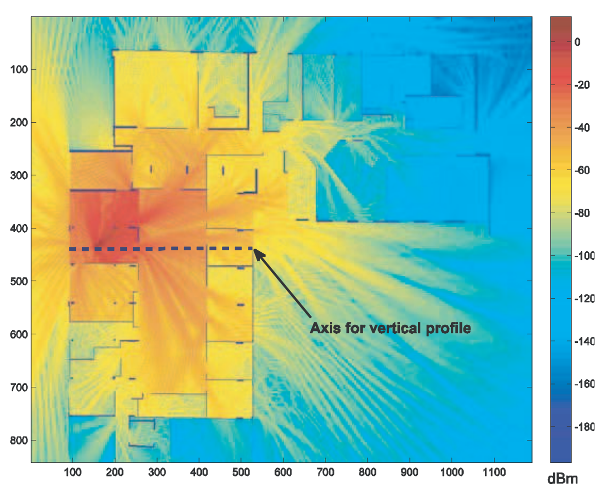

Figure 1: Horizontal indoor radio coverage (with line for vertical cut), from red (−40 dBm to blue (−100 dBm).

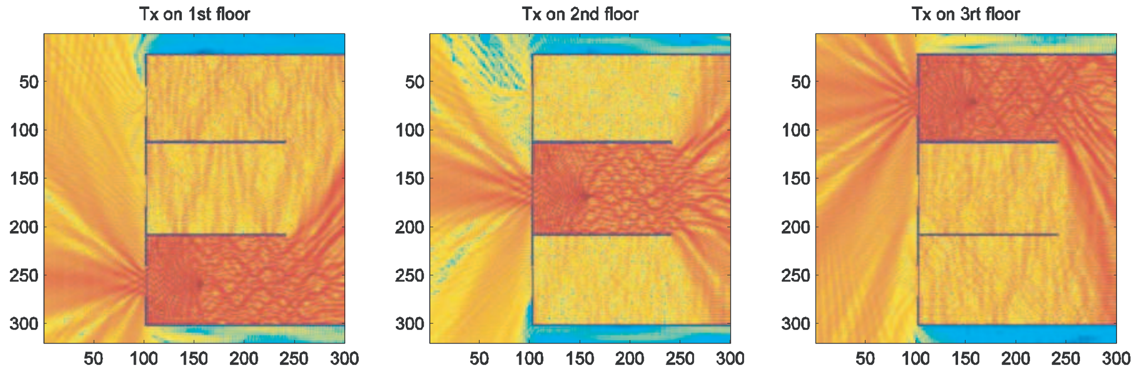

Figure 2: Vertical indoor radio coverage (for antennas located at 3 different floors), from red (−40 dBm to blue (−100 dBm).

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REFERENCES

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