Advanced Ray-Tracing Techniques in Radio Environment Characterization

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In the concluded project the radio ray-tracing method was revisited from the algorithmic point of view with the aim to use it for the characterisation of dynamic radio environments. Ray tracing is a deterministic radio channel modelling tool belonging to the computational EM family of algorithms. We introduced new concepts, such as radio ray-tracing pipeline architecture and rasterization-like discretization, in order to allow near interactive rates of computation. Further, we solved a number of specific problems, including efficient wavefront double counting avoidance in brute force approach and double refraction modelling error for visibility trees in the method of images.

We implemented ray tracing as a remote service, where the computation of radio environment is accessible to broad range of potential users from the developers of various web and mobile applications to wireless network planers and network operators.

Low cost sensor node localization problem based on a cooperative decision making process is a perfect example of a problem that could benefit from the advanced ray-tracing techniques but cannot accommodate them on a performance constrained hardware. In this respect we investigated the possibilities of enhancing the accuracy and robustness of the location estimation by integration of the precise deterministic channel model into the localization procedures.

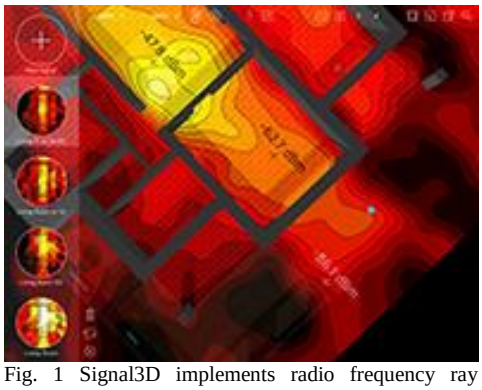

Fig. 1 Signal3D implements radio frequency ray tracing for indoor environments. It offers a 3D user interface to define environment geometry and visualize signal prediction.

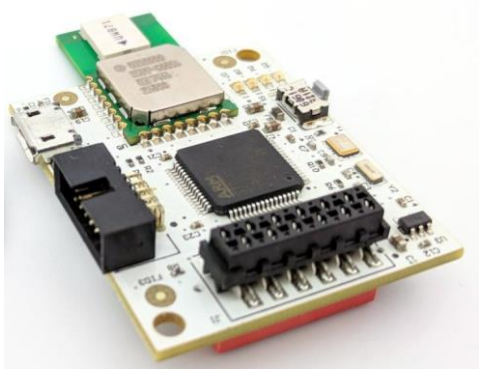

Fig. 2 IR-UWB board with DWM1000 was developed in order to address low cost sensor node localization problem.

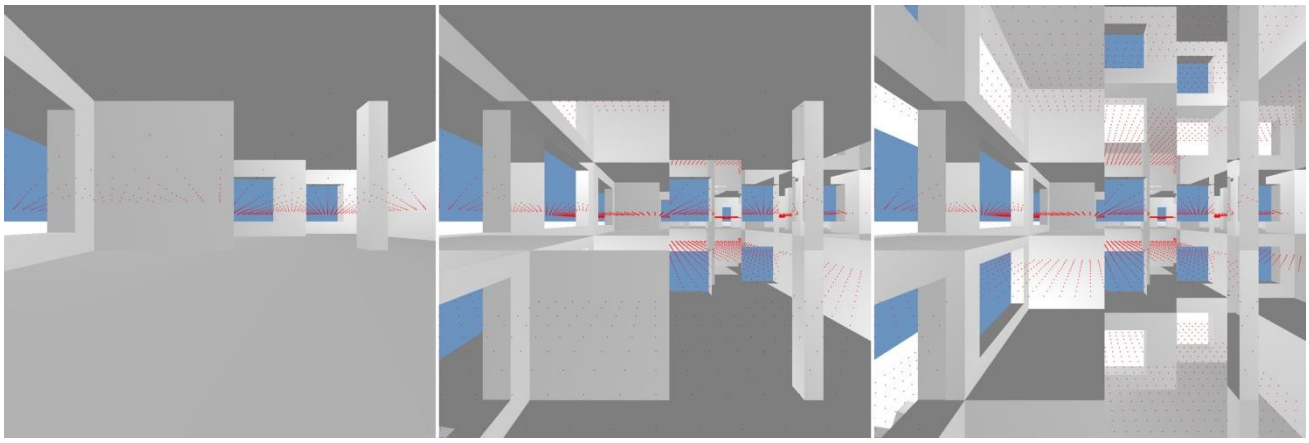

Fig. 3 Radio signal reflections and double refractions are recursively traversed using graphic primitives. The illustration shows three snapshots of a framebuffer object at increasing tree depths. Color-coded surfaces are replaced by black-and-white rendering of scene objects with visible reception points superimposed as red dots.