Course plan

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Title

Ray-Tracing based channel modeling and its application to mobile communication

Content

The application scenarios and requirements are more diverse in the fifth-generation (5G) era than before. In order to successfully support the system design and deployment, accurate channel modeling is important. Ray-tracing (RT) based deterministic modeling approach is accurate with detailed angular information and is a suitable candidate for predicting time-varying channel and multiple-input multiple-output (MIMO) channel for various frequency bands. The computational complexity and utility are the main concerns of users.

In this course, ray tracing technologies will be introduced with special attention to 5G applications and future prospects. According to the discussed requirements and challenges, a high-performance computing (HPC) cloud-based ray-tracing simulation platform (CloudRT) and the development experiences are presented.

The self-developed 3D ray-tracing (RT) engine is installed on the HPC clusters with 1600 CPUs and 10 NVIDIA Tesla GPUs. With a flexible architecture design, parallel processing, and high storage capability, CloudRT supports massive simulation tasks in both static and moving scenarios, with various antennas and frequencies. A user-friendly interface is designed for managing the whole platform in a browser-server style on http://www.raytracer.cloud/. Based on which, users can access the CloudRT remotely to edit models and trigger simulation tasks. The performance of CloudRT is analyzed for a 3.5 GHz Beijing vehicle-to-infrastructure scenario and a 28 GHz Manhattan outdoor scenario. Experiences are shown on tackling open issues like how to calibrate and validate RT based on measurements, how to apply RT for mobile communications in moving scenarios, and how to evaluate MIMO beamforming technologies.

Objectives

- Let the students know the principle of ray-tracing based channel modeling.
- Let the students know how to use RT to simulate propagation channel for mobile communication scenarios.
- Inspire the students on developing new RT algorithms and doing research on radio propagation.

Schedule

Duration: 20th August- 26th August
5 days with 20 hours of lectures, 10 hours of exercises.

Day1	Morning lecture (8-12)	Background introduction and overview of the course Geometrical Theory of Propagation part I: introduce modeling of direct and reflection paths
	Lunch break	
	Afternoon lecture (13-17)	Geometrical Theory of Propagation part I: introduce modeling of scattering and diffraction paths
Day2	Morning lecture (9-13)	Ray-tracing simulation: the work flow and the CloudRT platform
	Lunch break	
	Afternoon exercise (14-16)	Environment modeling exercise
Day3	Morning exercise (9-13)	RT simulation exercise: SISO simulation
	Lunch break	
	Afternoon lecture (14-16)	RT based radio propagation researches part I: radio propagation modeling and RT calibration
Day4	Morning lecture (9-13)	RT based radio propagation researches part II: influence analysis of the typical objects
	Lunch break	
	Afternoon exercise (14-16)	RT simulation exercise: MIMO simulation and result analysis
Day5	Morning exercise (10-12)	RT simulation exercise: result analysis and demo
	Lunch break	
	Morning lecture (13-15)	Question time and conclusion of the course