Elektrotechnisches Kolloquium

der Bergischen Universität Wuppertal

Die Fakultät für Elektrotechnik, Informationstechnik und Medientechnik lädt zur Teilnahme an folgender Vortragsveranstaltung mit anschließender Diskussion ein:

Es spricht

Mohannad Saifo

Lehrstuhl für Theoretische Elektrotechnik
Prof. Dr. rer. nat. Markus Clemens

über das Thema

Development of a Ray-Tracing Tool with Curvature Extraction Method to perform Electromagnetic Simulations to Generate Synthetic Radar Data for Machine Learning.

Inhalt:

This PhD research explores the use of radar simulation for machine learning applications in automotive environments, with a focus on generating synthetic data for training models to infer object height based on multi-path radar signals. Radar is critical for modern cars due to its robustness in poor visibility and ability to measure range and velocity accurately. With the rise of AI, machine learning is increasingly used for tasks such as object classification, cognitive radar behavior, and ghost target detection.

A major challenge in training these models is obtaining large, accurate datasets. To address this, the work investigates using electromagnetic (EM) simulations to generate synthetic radar data. Commercial simulation tools like HFSS, FEKO, and Wavefarer were tested and compared with a mathematical model that is developed for this purpose, but they proved too slow or inaccurate for large-scale data generation. To overcome this, I developed a custom ray-tracing simulation tool based on a modified physical optics approach (MECA), capable of handling multi-path effects efficiently.

The tool uses triangular meshes to model objects and a kd-tree to accelerate ray-triangle intersections. A novel method was developed to reconstruct curvature information from coarse meshes, significantly improving accuracy. Validation was done using spheres, cylinders, and corner reflectors, with comparisons against theoretical models, commercial tools, and real-world measurements showing high agreement.

To enable real-time simulations in large automotive scenarios, the far-field radiation pattern of the car is commonly used as a simplified representation. In this work, the traditional one-dimensional angle-dependent pattern is extended to a two-dimensional angle–range-dependent map, enhancing realism. Furthermore, instead of relying solely on far-field approximations, antenna-based simulations are employed, which significantly improve accuracy, especially at close ranges.

Additionally, a dedicated simulation approach is developed to analyze and estimate ghost targets—false detections caused by internal reflections within the vehicle structure—helping to better understand and mitigate their impact on radar systems.

T e r m i n: **16.07.2025, 16:10 Uhr**

O r t: Bergische Universität Wuppertal
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