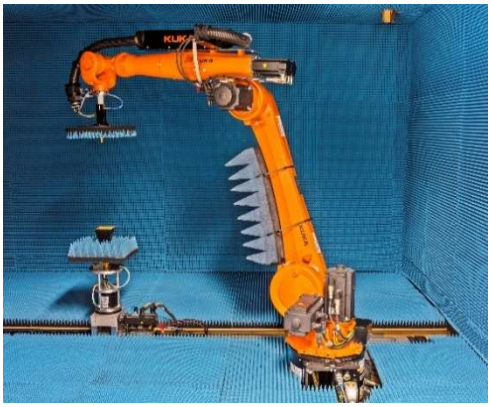
Path Optimization Algorithms for Robotic Near-Field Antenna Measurements

Bachelor/Master Thesis

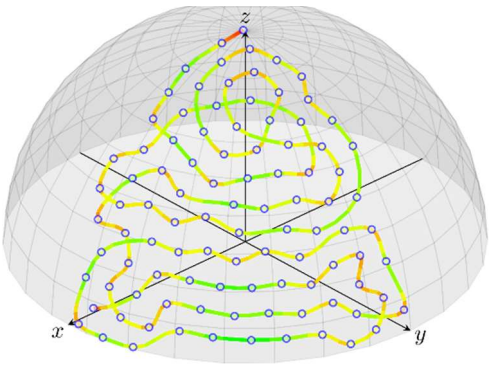
Motivation:

Near-field measurements are a widely used method for antenna characterization. In this approach, the electromagnetic field radiated by the antenna under test (AUT) is sampled on a surface in close proximity to the antenna. Since performance metrics are typically related to the far-field region, a mathematical transformation is applied to the measured near-field data to reconstruct the far-field radiation pattern.



Robotic antenna measurement chamber at IHF

This transformation requires a sufficiently dense sampling on the measurement sphere to ensure a well-conditioned transformation matrix. Traditional sampling grids were designed to work with simple mechanical motions and therefore rely on significant oversampling to achieve numerical stability. In recent years, robot-based positioners have gained increasing attention due to their versatility and cost effectiveness, enabling the realization of more flexible and optimized sampling strategies. Although robotic systems allow for the acquisition of nearly arbitrary sampling grids, the overall measurement time strongly depends on the sequence in which sampling points are scanned. Previous approaches have employed a traveling-salesman-based optimization to minimize the path length; however, this strategy is not optimal with respect to measurement time, as sharp turns in the trajectory require the robot to decelerate.



Exemplary sampling grid and measurement path

A possible solution to this problem is to take into account both the Cartesian positions of the robot's end effector and the motions of the individual robot joints. This, in turn, requires the development of an accurate kinematic model of the robotic system.

Tasks

- Conduct a literature review on path-optimization algorithms for robotic manipulators.
- Develop a kinematic model of the robotic arm and analyze the robot's workspace.
- Implement and optimize path-planning algorithms in MATLAB for near-field antenna measurements with arbitrary sampling grids.
- Test and evaluate different algorithms using the robotic measurement system at IHF and compare their performance with existing solutions.

M.Sc. Henrik Jansen.

2nd floor, Room No. 521a
Telephone: +49 241 80-27939
jansen@ihf.rwth-aachen.de

Institute of High Frequency Technology
RWTH Aachen University
Melatener Straße 25 | 52074 Aachen
GERMANY
http://www.ihf.rwth-aachen.de/
Telephone: +49 241 80-27932
Fax: +49 241 80-22641