Popular Science Summary – Martin Haulund Gæde, DTU Compute

A Fast Direct Solver for Electromagnetic Waves

Electromagnetic waves are everywhere. They enable wireless communication, power radar systems, and help us explore the universe through radio telescopes. But have you ever wondered how scientists and engineers predict how these waves interact with objects, like antennas, aircraft, or even stealth technology? The answer lies in **mathematical simulations**, where computers solve equations that describe how waves scatter when they hit an object. These simulations are essential in designing efficient satellite communication systems, improving radar technology, and even minimizing interference in everyday wireless networks.

However, there's a challenge: these simulations become incredibly **computationally demanding** when the objects involved are electrically large. Traditional methods for solving these problems require massive amounts of memory and computing power, often making them impractical for real-world applications.

In this project, we developed a **fast direct solver,** an advanced numerical method that dramatically speeds up the computations required for solving wave scattering problems. We applied our method to practical engineering problems, such as **phased array antennas** and **radar cross-section analysis**. Our results showed that this new approach **outperforms existing state-of-the-art solvers** and makes previously infeasible simulations possible.