Reconstructing Near Fields of Antennas via Dipole Approximation

A Heuristic Approach Using Far-Field Data and Antenna Geometry

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Motivation

Why Near Fields?

- Due to safety considerations with electromagnetic field exposure assessments
- Commonly unavailable in datasheets (Which focus on far field)

How?

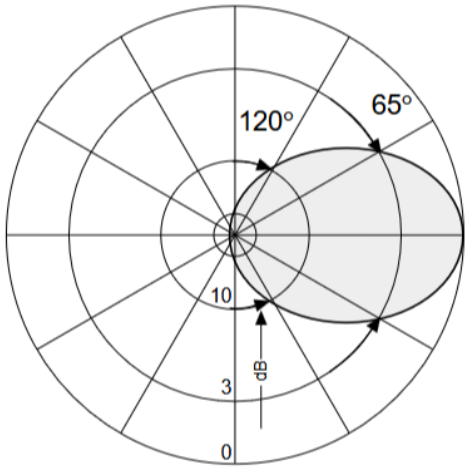
- Develop a program to approximate near fields using only datasheet information

Key Question:

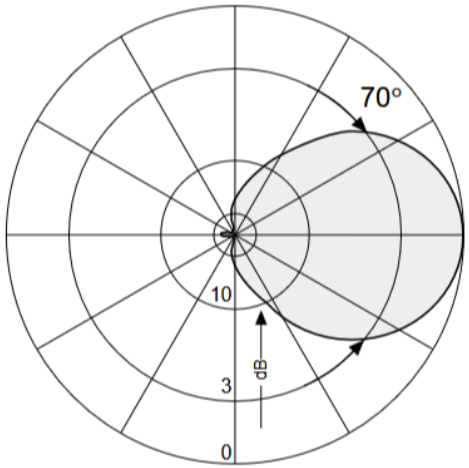
- Can near fields be accurately reconstructed from typical datasheet data?

Typical datasheet:

Type No.	730 676	730 677
Frequency range	860 – 960 MHz	
Polarization	Vertical	
Gain	9 dBi	
Half-power beam width	H-plane: 65° E-plane: 70°	
Front-to-back ratio	> 25 dB (890 – 960 MHz) > 20 dB (860 – 890 MHz)	
Impedance	50 Ω	
VSWR	< 1.3	
Intermodulation IM3 (2 x 43 dBm carrier)	< –150 dBc	
Max. power	350 Watt (at 50 °C ambient temperature)	
Input	7-16 female	N female
Connector position	Bottom or top	
Weight	1.2 kg	
Wind load (at 150 km/h)	Frontal / Lateral / Rearside: 40 N / 25 N / 90 N	
Max. wind velocity	230 km/h	
Height/width/depth	264 / 258 / 103 mm	



Horizontal Pattern



Vertical Pattern

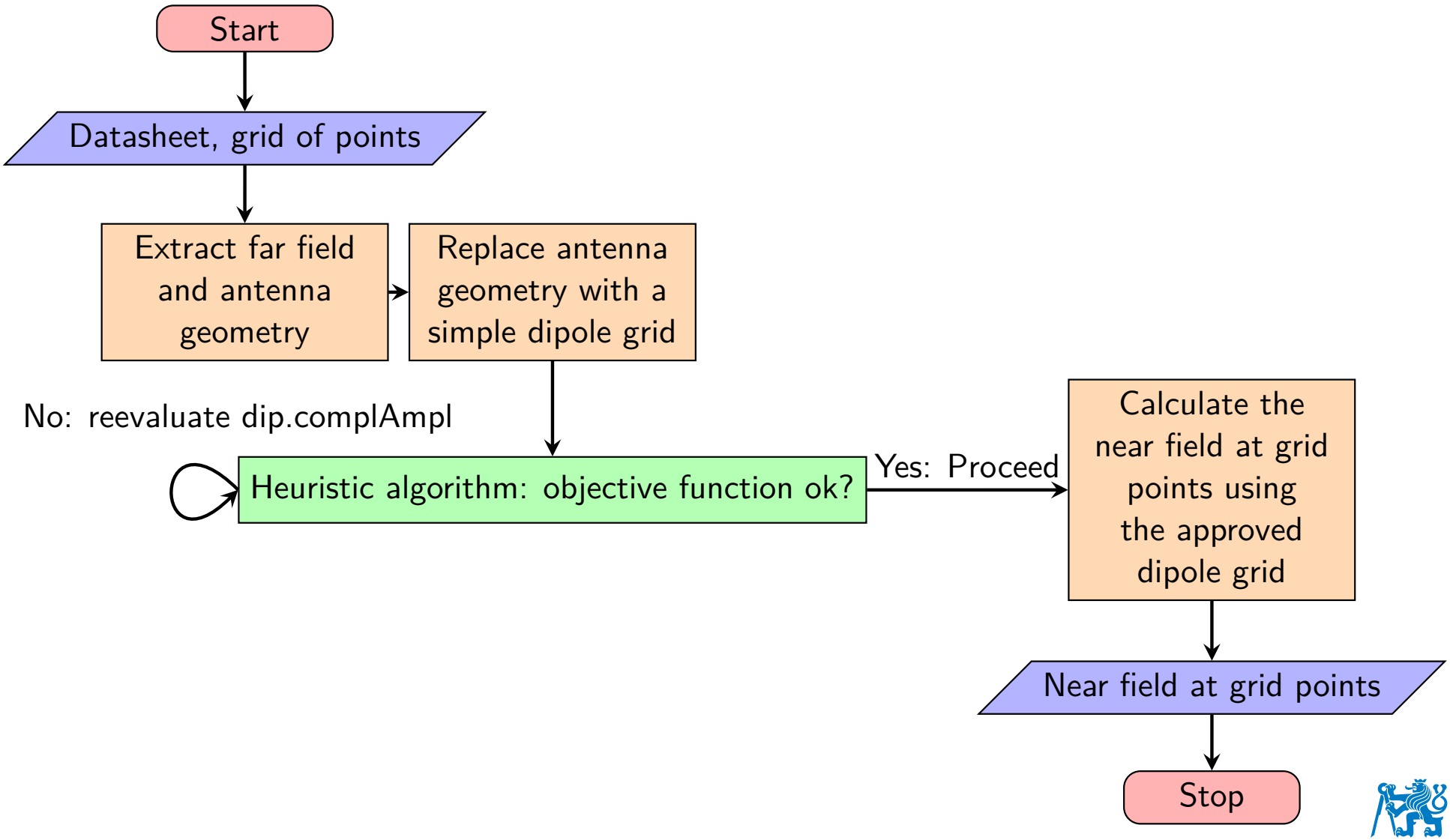
Background

- Antenna Basics:
  - Far fields: Radiated pattern at a distance
  - Near fields: Complex and influenced by antenna geometry
- Dipole Approximation:
  - Antennas are modeled as a grid of elementary dipoles where each dipole is defined by
    - Position
    - Orientation
    - Complex amplitude
- Heuristic Optimization
  - Iteratively optimizes the objective function:

$$\min_{\mathbf{p}} \int_0^{2\pi} \int_0^{\pi} \left| \boldsymbol{F}_{\mathrm{sim}}(\theta, \phi, \mathbf{p}) - \boldsymbol{F}_{\mathrm{true}}(\theta, \phi) \right|^2 \sin\theta \, \mathrm{d}\theta \, \mathrm{d}\phi, \tag{1}$$

until the difference between the simulated and true far field meets a predefined threshold.

Program flowchart



Progress

Main points

- Coded near and far field computation functions.
- Tested against other such computation function.

Some details

- Coded utility functions.
- Initial tests for near field and far field matching.
- Reducing computation time for near field and far field functions.

Next steps

- Optimization of objective function:
  - Test PSO algorithm
  - Test PSO + DE algorithm
  - Test GA algorithm
  - Test GA + Newton algorithm
- Validation:
  - Compare results with full-wave antenna simulation using commercial packages.
  - Test against experimental data from real measurements
- Challenges:
  - Handling data extraction from datasheets (The user input on the geometry of antenna will be necessary)

Thank You for Your Attention!

- Thank you for your time and attention!
- For further questions or follow-ups, please feel free to contact me:
- Email: `hrazskil@fel.cvut.cz`