Numerical and experimental assessment of a phase retrieval technique applied to planar near field distribution for wide band application
Nicolas Ribière-Tharaud, Aronne Casagranda, Marc Lambert, François Jouvie

To cite this version:
Nicolas Ribière-Tharaud, Aronne Casagranda, Marc Lambert, François Jouvie. Numerical and experimental assessment of a phase retrieval technique applied to planar near field distribution for wide band application. ICONIC’07, Jun 2007, Saint-Louis, United States. hal-01107471

HAL Id: hal-01107471
https://hal-supelec.archives-ouvertes.fr/hal-01107471
Submitted on 20 Jan 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
NUMERICAL AND EXPERIMENTAL ASSESSMENT OF A PHASE RETRIEVAL TECHNIQUE APPLIED TO PLANAR NEAR FIELD DISTRIBUTIONS FOR WIDE BAND APPLICATIONS

Nicolas Ribiére-Tharaud, A. Caagnerda, M. Lambert, F. Jouvie

Saint-Louis - USA

THE PHASE RETRIEVAL TECHNIQUE

HISTORICAL BACKGROUND
- Gerchberg-Saxton [1972]: electron microscopy (1 plane)
- Misell > variant [1973]: electron microscopy (2 deformed planes)
- Anderson & Ali [1984]: microwave applications

PRINCIPLE
- Algorithm initialization:
  - Electric field magnitude known in two planes P1 & P2 in front of the source

NUMERICAL ASSESSMENTS (1/3)

MODELS
- MoM (Feko)
- Classical horn antenna (same used for experimental approach)
- Frequency: 8 GHz

PURPOSES
- Validation tool
  - Agreement Models/Measurements
  - Exact phase calculation
  - Exact far field calculation
- Sets of data for parametric study
  - dplane-source and dplane-plane
  - Planes sampling
  - Planes sizes
• Parametric Study
  ✓ Criterion
  \[ \Delta_{\text{comp}} = \sum_{i=1}^{N_{j}} \sum_{j=1}^{N_{i}} \left| E_i (x_i, y_i, z_i) - \tilde{E}_i (x_i, y_i, z_i) \right|^2 \]
  \[ \sum_{i=1}^{N_{j}} \sum_{j=1}^{N_{i}} \left| \tilde{E}_i (x_i, y_i, z_i) \right|^2 \]
  ✓ planes positions
  • Fields calculated in magnitude and phase using Feko
  • distances : 11 values \[x_j = 2\lambda, ..., x_{11} = 1 \text{ m}]\n  • 55 phase reconstructions

• Sampling parameter : \( \delta_x \)
  ✓ Far field from using the reconstructed phase
  • \( \delta_x = \lambda_0/6 \) \( \Delta_{\text{comp}} = 7.94 \% \)
  • \( \delta_x = \lambda_0/3 \) \( \Delta_{\text{comp}} = 6.07 \% \)
  • \( \delta_x = \lambda_0/2 \) \( \Delta_{\text{comp}} = 29.53 \% \)

• Planes positions parameter : \( x_j \) and \( x_2 \)
  ✓ Far field from using the reconstructed phase
  • Worst case : \( \Delta_{\text{comp}} = 222.54 \% \)
  • Best case : \( \Delta_{\text{comp}} = 7.94 \% \)

• Planes dimensions parameter : \( L \)
  ✓ \( L_{\text{min}} = 20\lambda_0 \)

\[
\begin{align*}
|E_\theta| (\text{dB}) \\
\theta (\text{°}) (\phi = 0 \text{ °}) \\
\# \\
|E_\phi| (\text{dB}) \\
\phi (\text{°}) (\theta = 90 \text{ °}) \\
\#
\end{align*}
\]
Phase reconstructions
- ~1000 to 10000 iterations
- Less than 1 or 2 hours on a standard PC

Results at 8 GHz: phase on the first plane

Results at 8 GHz: reconstructed far field

Experimental validation: planar near field measurement setup
- AUT = Horn, Probe = Dipole, open end waveguide
- Frequencies = 2 GHz, 8 GHz and 18 GHz
- Distance AUT/Probe: 2λ, 3λ, ..., 1m
EXPERIMENTAL VALIDATION: $f = 8 \text{ GHz}$

Validation of reconstructed far field

Exact, reconstructed from simulated magnitudes and from measured magnitudes

$|E_{\theta}| (\text{dB})$

$\phi (\degree)$ ($\theta = 90 \degree$)

$\theta (\degree)$ ($\phi = 0 \degree$)

CONCLUSION & FUTURE WORKS

- Conclusions on the phase reconstruction algorithm
  - Validation on numerical and experimental data
  - Parametric study for optimal use
  - Wide band validation

- Future tasks
  - Adding information to increase performances
  - Expanding the parametric study
  - Towards pulsed sources …