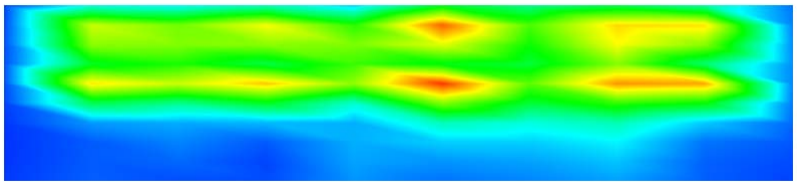
ISAP2020
Student Design Contest

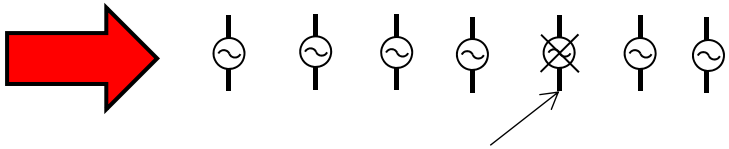
Category C. Inverse Problem

Problem overview

Diagnosis of defective elements in array antennas



Near field distribution



Defective element

- Students develop an algorithm to find defective elements in array antennas.
- The number of defective elements and their positions are expected to be found.
- Near-field data and geometry of the array antennas are given in advance of diagnosis of defective elements.

Problem overview

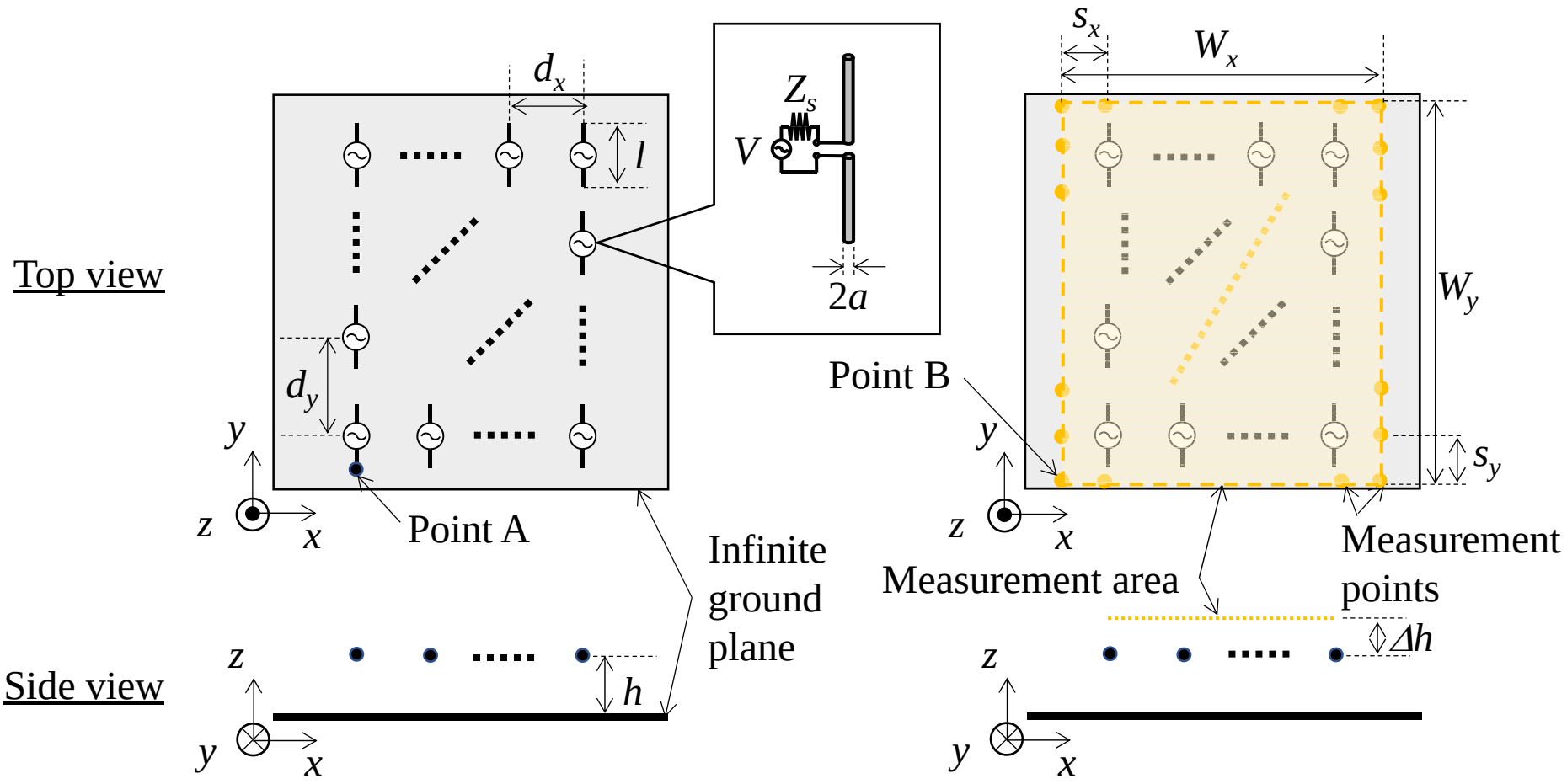
- All antennas are made of PEC (no conductor loss, no dielectric/magnetic medium).
- All antennas are identical except for defective elements.
- Feeding port is center of wire elements.
- Given near-field distribution is calculated using Method of Moments (MoM) for wire antenna.
- Geometry of antennas is given.
- Noise may be added to near field distribution.
- A couple of examples are given in order to test or debug of developed algorithm.
- Format of given near-field data is x [m], y [m], $|E_y|$ [V/m], Phase of E_y [deg.].
- Near-field data is available from following URL,
  http://www.isap2020.org/sdc.html

Data Example

0.0000000000000000E+00	0.0000000000000000E+00	0.1302006185941529E+01	-0.1692766225040980E+03
0.1000000000000000E+00	0.0000000000000000E+00	0.1374331330790637E+01	0.1531028072949372E+03
0.2000000000000000E+00	0.0000000000000000E+00	0.1775542007371312E+01	0.1301743586261456E+03
0.3000000000000000E+00	0.0000000000000000E+00	0.1959338622957370E+01	0.1258114875634234E+03
0.4000000000000000E+00	0.0000000000000000E+00	0.1824603973189982E+01	0.1328872736433964E+03

Antenna under study (AUT)

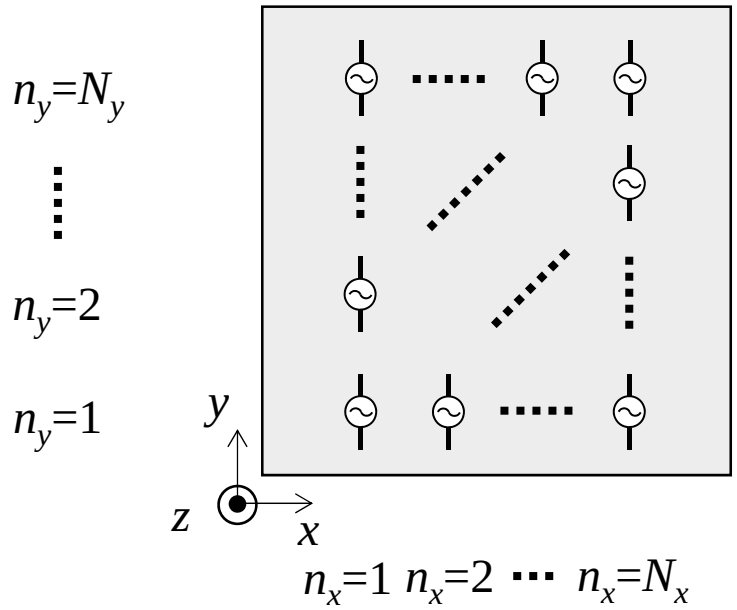
A $N_x \times N_y$ periodic dipole array antenna over infinite PEC ground



- The number of array elements in x and y direction is N_x and N_y, respectively.
- The number of measurement points in x and y direction is M_x and M_y, respectively.
- Point A of antenna geometry (Edge of a dipole antenna) is $(x, y, z)=(0, 0, h)$
- Point B of measurement area (A corner of the area) is $(x, y, z)=(-0.2, -0.2, h+\Delta h)$

Antenna under study (AUT)

A $N_x \times N_y$ periodic dipole array antenna over infinite PEC ground



➢Element position is uniquely indicated by (n_x, n_y).

For example,

(n_x, n_y)=(1, 1) indicates an array element at left below corner.

(n_x, n_y)=(1, N_y) indicates an array element at left top corner.

(n_x, n_y)=(N_x, N_y) indicates an array element at right top corner.

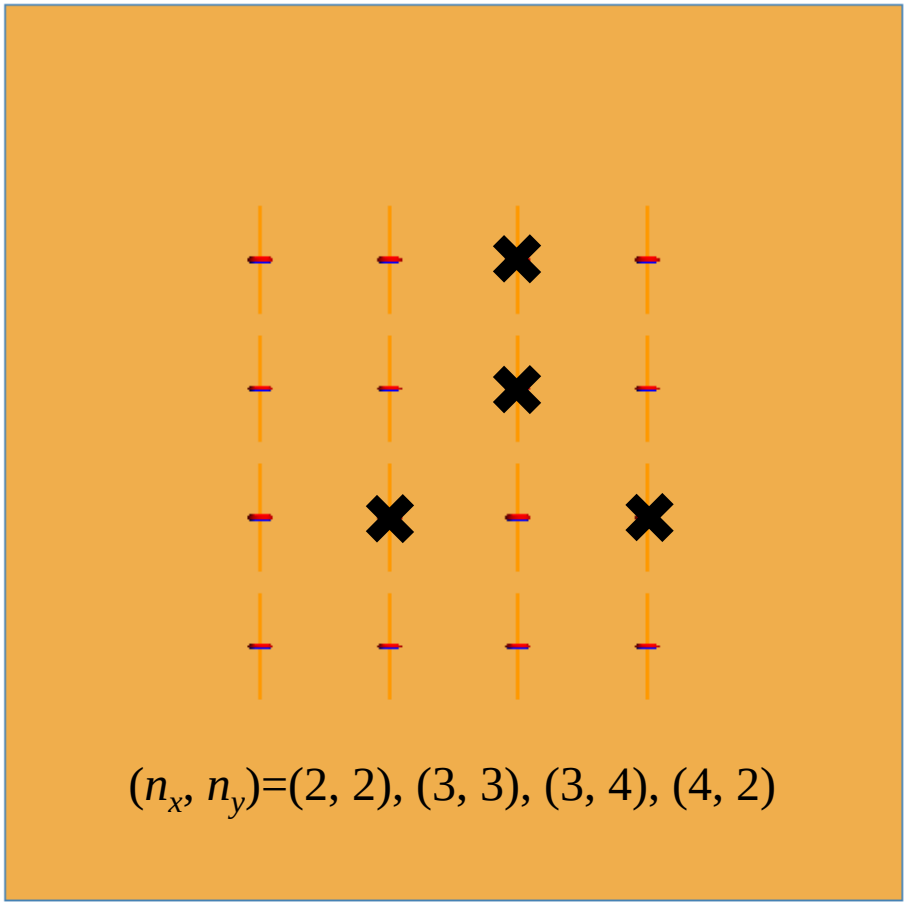
Two Examples for Debug

Parameters and Geometries

Problem example 1: Short circuited defective elements

Array size	$N_x \times N_y = 4 \times 4$
Frequency	300 MHz
Length of dipole antenna	l=0.5 m
Radius of dipole antenna	a=0.001 m
Height of dipole antenna	h=0.25 m
Array spacing in x and y direction	$d_x=d_y$=0.6 m
Excitations	Uniform and in-phase (V=1 V)
Load impedance at feeding port	Z_s=50 Ω
Defective elements	Short circuited (V=0 V and Z_s=0 Ω)
Measurement points	$M_x \times M_y$=23×28
Measurement intervals in x and y direction	$s_x=s_y$=0.1 m
Measurement area of near field distribution	$W_x \times W_y = (M_x\text{-}1)s_x \times (M_y\text{-}1)s_y$=2.2×2.7 m^2
Height of measurement plane from the array	Δh=0.1 m
Measured data	y-components of complex electric field
Number of defective elements	Unknowns to be obtained
Position of defective elements	Unknowns to be obtained

Problem example 1 Answer

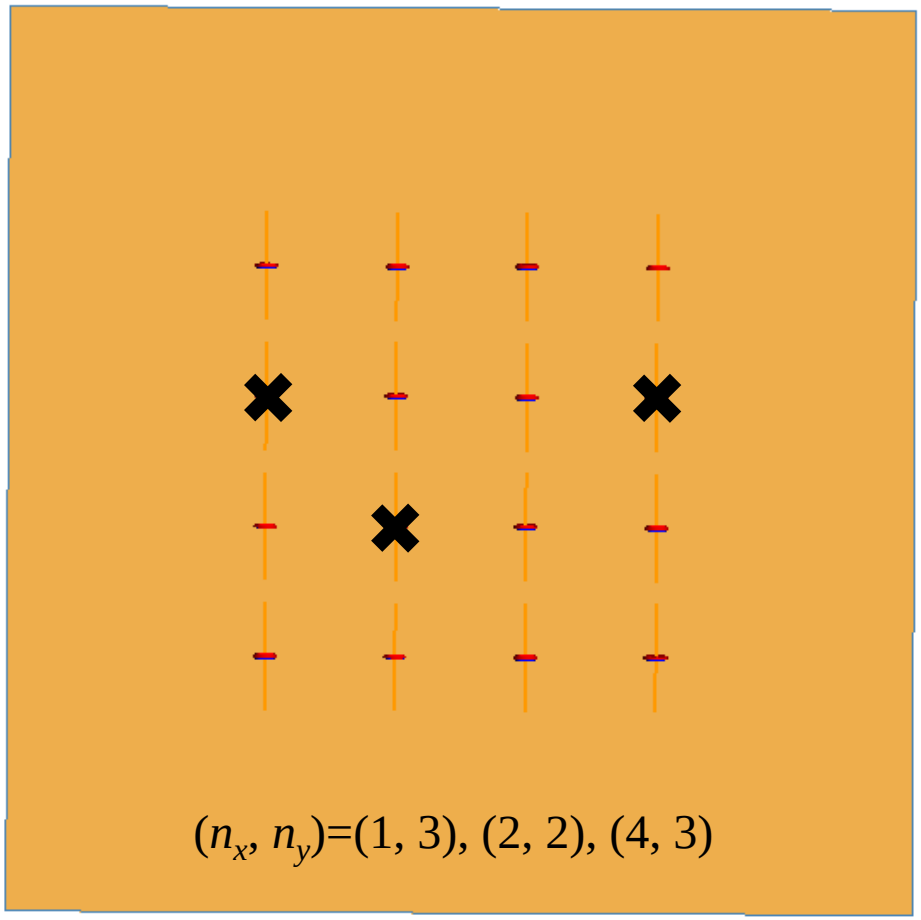


Parameters and Geometries

Problem example 2: Open circuited defective elements

Array size	$N_x \times N_y = 4 \times 4$
Frequency	300 MHz
Length of dipole antenna	l=0.5 m
Radius of dipole antenna	a=0.001 m
Height of dipole antenna	h=0.25 m
Array spacing in x and y direction	$d_x=d_y$=0.6 m
Excitations	Uniform and in-phase (V=1 V)
Load impedance at feeding port	Z_s=50 Ω
Defective elements	Open circuited (V=1 V and Z_s=100,000 Ω)
Measurement points	$M_x \times M_y$=23×28
Measurement intervals in x and y direction	$s_x=s_y$=0.1 m
Measurement area of near field distribution	$W_x \times W_y = (M_x\text{-}1)s_x \times (M_y\text{-}1)s_y$=2.2×2.7 m^2
Height of measurement plane from the array	Δh=0.1 m
Measured data	y-components of complex electric field
Number of defective elements	Unknowns to be obtained
Position of defective elements	Unknowns to be obtained

Problem example 2 Answer



Contest Problems

Parameters and Geometries

Problem 1: Abnormal excitation

Array size	$N_x \times N_y = 8 \times 8$
Frequency	300 MHz
Length of dipole antenna	l=0.5 m
Radius of dipole antenna	a=0.001 m
Height of dipole antenna	h=0.25 m
Array spacing in x and y direction	d_x=0.6 m, d_y=0.8 m
Excitations	Uniform and in-phase (V=1 V)
Load impedance at feeding port	Z_s=50 Ω
Defective elements	Abnormal excitation ($V=e^{j\pi/6}$ V)
Measurement points	$M_x \times M_y$=47×66
Measurement intervals in x and y direction	s_x=s_y=0.1 m
Measurement area of near field distribution	$W_x \times W_y = (M_x\text{-}1)s_x \times (M_y\text{-}1)s_y$=4.6×6.5 m^2
Height of measurement plane from the array	Δh=0.1 m
Measured data	y-components of complex electric field
Number of defective elements	Unknowns to be obtained
Position of defective elements	Unknowns to be obtained

Parameters and Geometries

Problem 2: Impedance mismatching + noise

Array size	**$N_x \times N_y = 8 \times 8$**
Frequency	300 MHz
Length of dipole antenna	l=0.5 m
Radius of dipole antenna	a=0.001 m
Height of dipole antenna	h=0.25 m
Array spacing in x and y direction	d_x=0.7 m, d_y=0.7 m
Excitations	Uniform and in-phase (V=1 V)
Load impedance at feeding port	Z_s=50 Ω
Defective elements	Impedance mismatching (Z_s=50 + j1000 Ω)
Measurement points	$M_x \times M_y$=54×59
Measurement intervals in x and y direction	s_x=s_y=0.1 m
Measurement area of near field distribution	$W_x \times W_y$= (M_x-1)s_x×(M_y-1)s_y=5.3×5.8 m^2
Height of measurement plane from the array	Δh=0.1 m
Measured data	y-components of complex electric field SNR =10 dB
Number of defective elements	Unknowns to be obtained
Position of defective elements	Unknowns to be obtained

Parameters and Geometries

Problem 3: Misalignment + noise

Array size	**$N_x \times N_y = 8 \times 8$**
Frequency	300 MHz
Length of dipole antenna	l=0.5 m
Radius of dipole antenna	a=0.001 m
Height of dipole antenna	h=0.25 m
Array spacing in x and y direction	d_x=0.8 m, d_y=0.8 m
Excitations	Uniform and in-phase (V=1 V)
Load impedance at feeding port	Z_s=50 Ω
Defective elements	Misalignment in xy direction ($-0.1 \leqq \Delta x \leqq 0.1$ m, $-0.1 \leqq \Delta y \leqq 0.1$ m, or their combination)
Measurement points	$M_x \times M_y$=61×66
Measurement intervals in x and y direction	s_x=s_y=0.1 m
Measurement area of near field distribution	$W_x \times W_y = (M_x\text{-}1)s_x \times (M_y\text{-}1)s_y$=6×6.5 m^2
Height of measurement plane from the array	Δh=0.1 m
Measured data	y-components of complex electric field SNR =10 dB
Number of defective elements	Unknowns to be obtained
Position of defective elements	Unknowns to be obtained

Application form

- Each team must submit an application. The application form must include
  - Description of the proposed algorithm
  - Answers of problems[*1, *2]

  [*1]An application form including answers of all problems is preferable but an application form is acceptable if it includes answer of one problem at least.)

  [*2] For problems 1 and 2, element numbers of defective elements must be answered, e.g. $(n_x, n_y) = (2, 4), (1, 5)$.
  For problem 3, element numbers and misalignment of defective elements must be answered,
  e.g. $(n_x, n_y)=(2, 4)$, Δx=0.02 m, Δy=-0.075 m.

- The SDC committee will score each application form based on following points.
  - Accuracy of estimation
  - Originality of the proposed method
  - Contribution
  - Completeness of description
- According to the score of each application form, a number of teams will be nominated as finalists.
  Authors are recommended to highlight above points in their application form.

Final solution submission

- Finalists must be ready for poster presentation during ISAP2020 and must submit a poster data as an final solution submission in advance.
- The poster data should include
  - Description of the proposed algorithm
  - Answers of problems[*]

  [*]It is preferable to show answers of problems using graphs as shown in problem examples.
- The poster should be submitted in PDF format (less than 5 MB file size), and should be ready to be displayed on an A0 portrait poster panel.

On-site competition

The finalists are requested to make a poster presentation on-site.

Evaluation

- The SDC committee will score each poster based on
    - Accuracy of estimation
    - Originality of the proposed method
    - Contribution
    - Completeness of description
    - Quality of the poster presentation
- According to the score of each application form and poster, a couple of teams will be awarded.