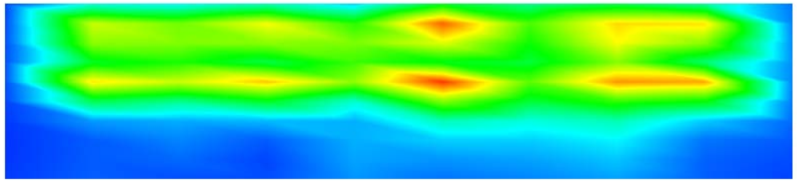
ISAP2020 Student Design Contest

Instructions for final design submission and online competition

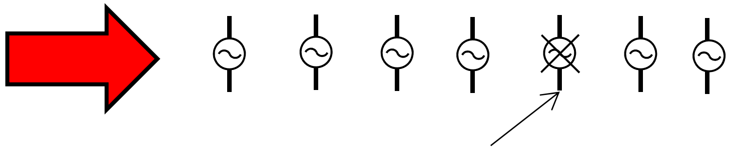
Category C. Inverse Problem

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

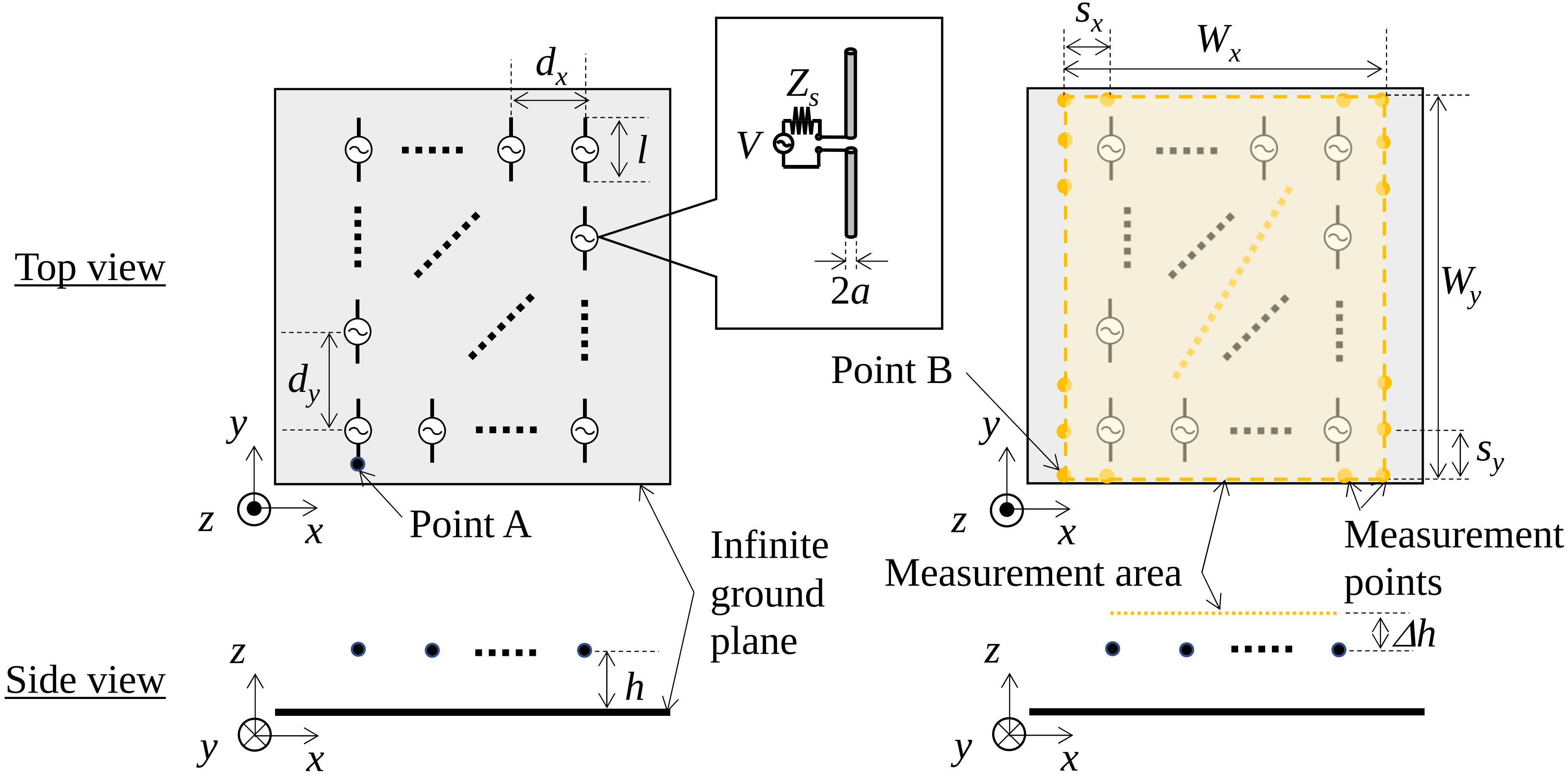
- All antennas are made of PEC (no conductor loss, no dielectric/magnetic medium).
- All antennas are identical except for defective elements.
- Feeding port is center of wire elements.
- Given near-field distribution is calculated using Method of Moments (MoM) for wire antenna.
- Geometry of antennas 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://...

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)

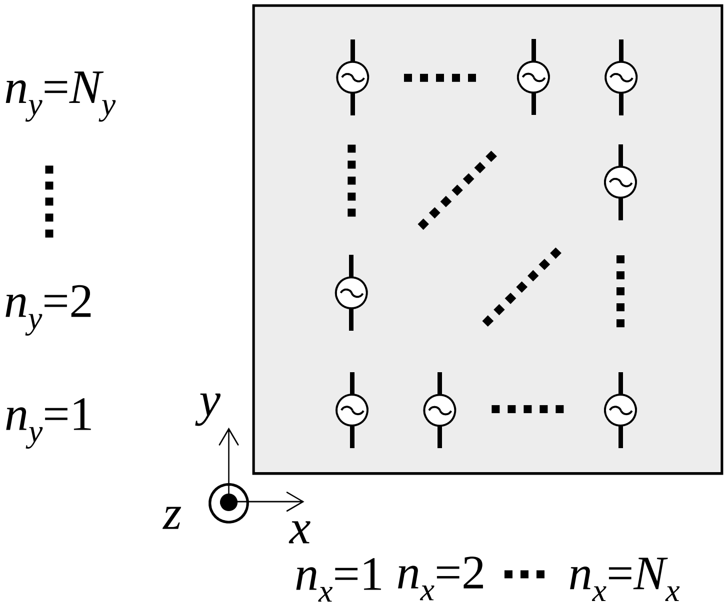
A $N_x \times N_y$ periodic dipole array antenna over infinite PEC ground



- 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 $(x, y, z)=(-0.2, -0.2, h+\Delta h)$

<u>Antenna under study (AUT)</u>

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.

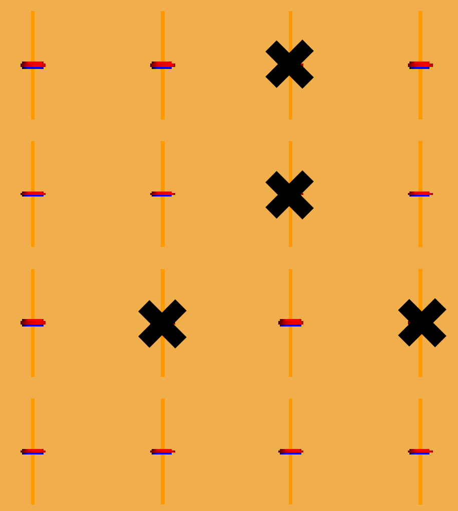
Two Examples for Debug

Parameters and Geometries

Problem example 1: Short circuited defective elements

Array size	$N_x \times N_y$=4 × 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	$W_x \times W_y$= $(M_x$-1$)s_x \times (M_y$-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

<u>Problem example 1 Answer</u>



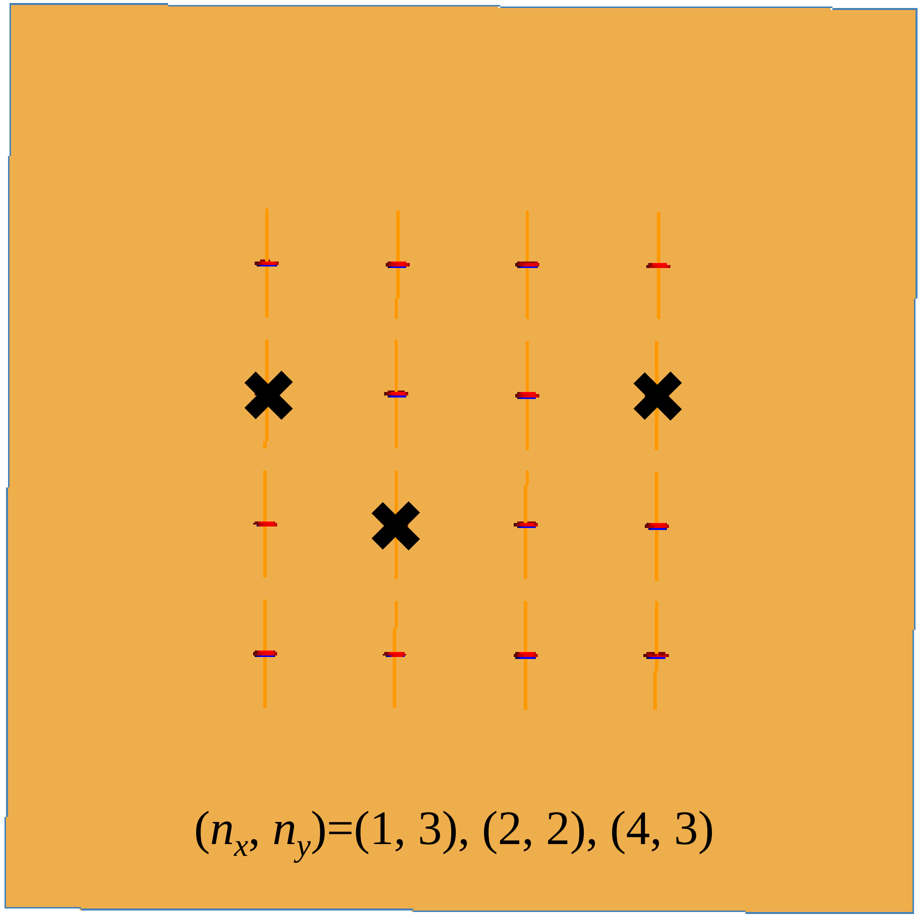
(n_x, n_y)=(2, 2), (3, 3), (3, 4), (4, 2)

<u>Parameters and Geometries</u>

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	$Z_s = 50\ \Omega$
Defective elements	Open circuited (V=1 V and Z_s=100,000 Ω)
Measurement points	$M_x \times M_y = 23 \times 28$
Measurement intervals in x and y direction	$s_x = s_y = 0.1$ m
Measurement area of near field distribution	$W_x \times W_y = (M_x - 1)s_x \times (M_y - 1)s_y = 2.2 \times 2.7\ m^2$
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

<u>Parameters and Geometries</u>

Problem 1: Abnormal excitation

Array size	$N_x \times N_y$**=8 × 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	$M_x \times M_y = 47 \times 66$
Measurement intervals in x and y direction	$s_x=s_y$=0.1 m
Measurement area of near field distribution	$W_x \times W_y = (M_x-1)s_x \times (M_y-1)s_y = 4.6 \times 6.5$ 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 × 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$)s_x \times (M_y$-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	$M_x \times M_y = 61 \times 66$
Measurement intervals in *x* and *y* direction	$s_x = s_y = 0.1$ m
Measurement area of near field distribution	$W_x \times W_y = (M_x - 1)s_x \times (M_y - 1)s_y = 6 \times 6.5$ 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 form and confirmation letter.

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. $(n_x, n_y)=(2, 4)$, $\Delta x=0.02$ m, $\Delta y=-0.075$ 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

According to reviewer's comments and advancements from the first submission, finalists must revise their application forms.
Answers of problems 1~3 in the original application form can be updated in the revised application form, if necessary.
Revised parts including updated answers should be indicated clearly in order to find differences from the first submission.
(Colored characters or Italic fonts are recommended.)

Submission deadline for the revised application form is Dec. 25th, 2020.
(Confirmation letter is unnecessary for resubmission)

Online competition

Finalists must be ready for online oral presentation during ISAP2020.
All finalists must give their presentation within 20 minutes including Q&A.

The student contest committee will score each oral presentation and the revised application form based on

- Accuracy of estimation (evaluated by revised application forms)
- Originality of the proposed method
- Contribution of the students in the total work
- Completeness of description
- Quality of the oral presentation

According to the score of oral presentation and the revised application form, one team getting the best score will be prized.