شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

بعض الوثائـــــــق الاصليـــــة تالفـــة

بالرسالة صفحات لم ترد بالاصل

EL-Mansoura University
Faculty of Engineering
Electrical Communication Dept.

DETERMINATION OF ANTENNA RADIATION PATTERN FROM NEAR-FIELD MEASUREMENTS

BY
HAMED ABD EL-FATTAH ABD EL-AZIZ EL-SHENAWY
Col. Eng. In Armed Forces

A Thesis
Submitted in Partial Fulfillment for the Requirements
of the Degree of Master of Science in Engineering

In
ELECTRICAL COMMUNICATION ENGINEERING

SUPERVISORS

Prof. Dr.
HAMDI AHMED EL-MIKATI
Electrical Communication Dept.
Faculty of Engineering
EL-Mansoura University

Asst. Prof. Dr.
ROSHDI ABO EL-AZAYAM ABD EL-RASOUL
Electrical Communication Dept.
Faculty of Engineering
EL-Mansoura University

1994

EL-Mansoura University
Faculty of Engineering
Electrical Communication Dept.

DETERMINATION OF ANTENNA RADIATION PATTERN FROM NEAR-FIELD MEASUREMENTS

BY
HAMED ABD EL-FATTAH ABD EL-AZIZ EL-SHENAWY
Col. Eng. In Armed Forces

A Thesis
Submitted in Partial Fulfillment for the Requirements
of the Degree of Master of Science in Engineering

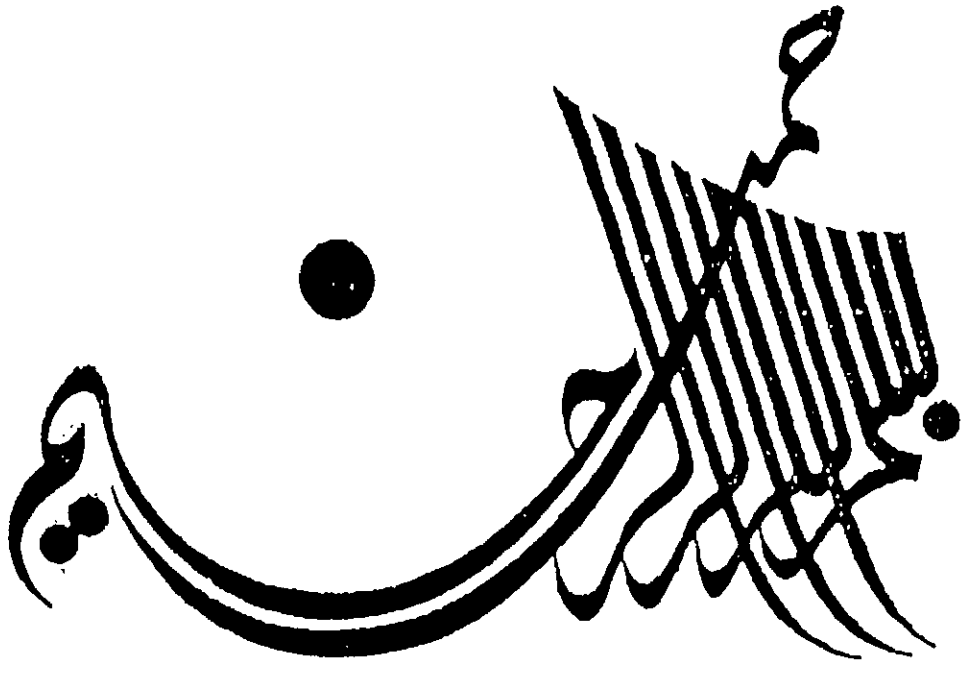
In
ELECTRICAL COMMUNICATION ENGINEERING

SUPERVISORS

Prof. Dr.
HAMDI AHMED EL-MIKATI
Electrical Communication Dept.
Faculty of Engineering
EL-Mansoura University

Asst. Prof. Dr.
ROSHDI ABO EL-AZAYAM ABD EL-RASOUL
Electrical Communication Dept.
Faculty of Engineering
EL-Mansoura University

1994



سبحانك لا علم لنا إلا ما علمتنا
إنك أنت العليم الحكيم

سورة البقرة
(٣٢)

SUPERVISORS

THESIS TITLE : Determination Of antenna Radiation Pattern from near-field measurements

Researcher Name : Hamed Abd El-Fattah Abd El-Aziz El-shenawy

SUPERVISIORS :

	NAME	POSITION	SIGNATURE
1	Prof. Dr. Hamdy Ahmed EL-Mikati	Prof. at ELectrical communication Dept., Faculty Of Engineering El-Mansoura University	
2	Asst. Prof Dr. Roshdi Abo EL- Azayam Abd EL- Rasoul.	Asst. Prof. at ELectrical communication Dept., Faculty Of Engineering EL-Mansoura University	

EXAMINATION COMMITTEE

Thesis Title : Determination of antenna radiation pattern from near-field measurements

Researcher Name Hamed Abd El- Fattah Abd El- Aziz EL-Shenawy

Examination Committee

	NAME	POSITION
	Prof. Dr. Rasheed Mokhtar El-Awady	Head Of Electrical Communication Dept. Faculty Of Engineering El-Mansoura University
	Prof. Dr. El Helaly M Eid	Prof.at Electronics Research Institute , National Research Center
	Prof. Dr. Hamdy Ahmed El-Mikati	Prof.at Electrical Communication Dept. Faculty Of Engineering El-Mansoura University

Examination Date :

Thesis Grade :

Signatures :

	NAME	SIGNATURE
	Prof. Dr. Rasheed Mokhtar El-Awady	prof.Dr Rasheed El-awady 5/3/1994
	Prof. Dr. El-Helaly M Eid	elhelaly eid 5/3/94
	Prof. Dr. Hamdy Ahmed El-Mikati	

Acknowledgement

Thank God for helping me to finish such work in this critical period of my life.

My sincere appreciation and gratitude to my supervisors **Prof.Dr. HAMDI AHMED EL MIKATTI** and **Dr. ROSHDI ABO EL AZAYEM ABD EL RASOUL** for the plenty of time they devoted to this work and for the excellent supervision, valuable guidance and fruitful discussions during all phases of the research.

My gratitude and thanks to **Maj. General eng. Sameh Amin Mahmoud Nohi** of the Egyptian Armed Forces who always encourages and supports me. His encouragement and support gave me the strongest motive to accomplish this work.

Dedicated

To

The spirit of my late father who always encouraged me to acquire as much knowledge as I could

To

My mother, my wife and my sons: **Sameh and Hatim** who gave me much and still do, and whose blessings are giving me the required strength to achieve every success.

Abstract

This thesis presents a study of two fundamental problems in antenna theory: determination of antenna far-field radiation properties from near-field measurements, and computation of the near-field mutual coupling between two antennas arbitrarily oriented and separated in free space, given the complex electric far-field pattern of each antenna and the geometrical factors that describe the relative orientation of each antenna. Both problems are based on plane-wave scattering-matrix (PWSM) theory of antennas.

Plane-wave scattering-matrix theory was introduced by D.M Kerns. It is a good basis for advanced antenna theory. Its formulation is obtained by enclosing the antenna between two planes and considering the incident and scattered plane-waves on both planes. It specifies the linear transformation from the incident part of the field to the scattered part of the field. It considers the antenna as a multiport transducer which can be fully described using the scattering parameters.

The far-field radiation properties (such as far-field pattern, power gain, effective receiving area and polarization parameters) can be determined from near-field measurements. Near-field measurements may be either probe-corrected or non probe-corrected. Near-field measurments may be planar (plane-rectangular or plane-polar) or spherical or cylindrical.

This thesis is concerned with planar near-field measurements. Planar near-field measurements range consists of anechoic chamber, control room, measuring probe, receiving system, antenna under test, transmitting system, recording system and data processing system. The near-field data acquired are (relative amplitude and phase) at either rectangular grid in plane-rectangular or at concentric rings centered about the antenna under test in plane-polar. The following processing methods and data minimization techniques are used to determine the far-field radiation characteristics from the measured near-field data: two-dimensional sampling theorem, two-dimensional fast Fourier transform algorithm, two-dimensional spatial filtering technique and equilizer algorithm.

When verifying the algorithms of computation of near-field mutual coupling between two antennas using PWSM theory of antennas, three cases have been investigated: First, the near-field mutual coupling between two antennas versus transverse displacement is analyzed, assuming separation distance between them is fixed, and an algorithm for its computation is developed. The analysis starts with Kerns coupling equation that expresses the coupling quotient in terms of the plane-wave transmitting and receiving coefficients. This equation is expressed in terms of the normalized complex electric far-field patterns of both

antennas. The coupling quotient is the scalar product of the complex normalized electric far-field patterns of both antennas. The computation is performed using two-dimensional fast Fourier transform (FFT) algorithm and sampling theorem. The following transformations are used: normalization of the far-field pattern of each antenna, spherical-to-rectangular transformation, Eulerian transformation, and transformation of the integration variables to azimuth and elevation angles.

Second, the near-field mutual coupling between two antennas versus separation distance is analyzed, assuming that the transverse displacement between them vanishes, and an algorithm for its computation is developed. The analysis starts with Kerns coupling equation that expresses the normalized coupling quotient. The normalized coupling quotient is expanded in a series of outgoing scalar spherical wave functions. The spherical wave coefficients are given in terms of the scalar product of the normalized complex electric far-field patterns of the two antennas and Legendre polynomial. The normalized coupling quotient is expressed in terms of the spherical wave coefficients and Hankel function of the first kind. Legendre polynomial and Hankel function of the first kind are generated using recurrence relations and Miller algorithm is used to ensure their stability.