

**ANALYSIS OF APERTURE RADIATION USING  
COMPUTER VISUALIZATION AND  
IMAGE-PROCESSING TECHNIQUES**

by

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## **ABSTRACT**

In order to accurately describe the behavior of an antenna, one needs to understand the radiation mechanisms that govern its operation. One way to gain such an insight is to view the fields and currents present on a radiating structure. Unfortunately, in close proximity to an antenna empirical techniques fail because the measurement probe alters the operation of the radiating structure. Computational methods offer a solution to this problem. By simulating the operation of an antenna, one can obtain electromagnetic field data near (or even internal to) a radiating structure. However, these computationally intense techniques often generate extremely large data sets that cannot be adequately interpreted using traditional graphical approaches.

A visualization capability is developed that allows an analysis of the above-mentioned data sets. With this technique, the data is viewed from a unique, global perspective. This format is well suited for analytical investigations as well as debugging during modeling and simulation. An illustrative example is provided in the context of a rectangular microstrip patch antenna. A comparison is performed between the visualized data and the theory of operation for the microstrip patch in order to demonstrate that radiation mechanisms can be obtained visually.

An additional analysis tool is developed using Gabor filters and image-processing techniques. This tool allows one to detect and filter electromagnetic waves propagating with different velocities (both speed and direction). By doing so, each mode of an antenna can be analyzed independently. The fields of a multi-moded, open-ended rectangular waveguide are analyzed in order to demonstrate the effectiveness of these techniques.

*“Not in the clamor of the crowded street,  
Not in the shouts and plaudits of the throng,  
But in ourselves are triumph and defeat.”*

Longfellow

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## TABLE OF CONTENTS

<b>ABSTRACT.....</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>iii</b>
<b>LIST OF FIGURES.....</b>	<b>v</b>
<b>1. INTRODUCTION.....</b>	<b>1</b>
<b>1.1 Motivation .....</b>	<b>2</b>
<b>1.2 Organization.....</b>	<b>3</b>
<b>2. VISUALIZATION TECHNIQUES.....</b>	<b>5</b>
<b>2.1 Post-Processing Routine.....</b>	<b>7</b>
<b>2.2 Overview of Visualization Package.....</b>	<b>12</b>
<b>2.3 Shading Techniques used by AVS .....</b>	<b>17</b>
<b>2.4 Visualized Data.....</b>	<b>20</b>
<b>3. EXAMPLE OF A VISUALIZATION TECHNIQUE.....</b>	<b>23</b>
<b>3.1 Geometry of a Rectangular Microstrip Patch Antenna.....</b>	<b>24</b>
<b>3.2 Theory of Operation.....</b>	<b>28</b>
3.2.1 Transmission Line Model .....	28
3.2.2 Cavity Model .....	30
3.2.3 Full-Wave Numerical Models .....	34
<b>3.3 Geometry of Computational Model.....</b>	<b>37</b>
<b>3.4 Application of Visualization Technique .....</b>	<b>39</b>
<b>4. IMAGE-PROCESSING TECHNIQUES.....</b>	<b>44</b>
<b>4.1 Discrete Fourier Techniques .....</b>	<b>45</b>
<b>4.2 Gabor Filters.....</b>	<b>51</b>
<b>4.3 Topological Understanding of the Process.....</b>	<b>54</b>
<b>4.4 Strategies for Determining Wave Properties.....</b>	<b>57</b>
<b>5. DEMONSTRATION OF IMAGE-PROCESSING TECHNIQUES.....</b>	<b>61</b>
<b>5.1 Waveguide Theory .....</b>	<b>62</b>
<b>5.2 Description of Computational Model .....</b>	<b>66</b>
<b>5.3 Discrimination of Modes .....</b>	<b>69</b>
<b>6. CONCLUDING REMARKS AND FUTURE WORK .....</b>	<b>76</b>
<b>REFERENCES.....</b>	<b>80</b>
<b>VITA .....</b>	<b>82</b>

## LIST OF FIGURES

Figure 2-1.	Flow chart showing the essential components of visualization capability.	(6)
Figure 2-2.	Two-dimensional data set with (a) columnar structure and (b) matrix structure.	(10)
Figure 2-3.	AVS operating environment.	(15)
Figure 2-4.	AVS Module library.	(16)
Figure 2-5.	Simple visualization network in AVS.	(16)
Figure 2-6.	Illustration of data locations and polygons.	(18)
Figure 2-7.	Intensity interpolation along polygon edges and scan lines.	(19)
Figure 3-1.	Geometry of a rectangular microstrip patch antenna (not to scale).	(24)
Figure 3-2.	Feed configurations for microstrip antennas [13].	(26)
Figure 3-3.	Transmission-line model of microstrip antenna [13].	(29)
Figure 3-4.	Geometry of cavity model.	(30)
Figure 3-5.	Field configurations and current densities for microstrip patch [13].	(33)
Figure 3-6.	Example Yee cell with field calculation points.	(37)
Figure 3-7.	FDTD computational space.	(38)
Figure 3-8.	AVS visualization network used to generate examples.	(40)
Figure 3-9.	$M_y$ equivalent magnetic current density.	(42)
Figure 3-10.	$M_x$ equivalent magnetic current density.	(42)
Figure 3-11.	$J_x$ equivalent electric current density.	(43)
Figure 3-12.	$J_y$ equivalent electric current density.	(43)
Figure 4-1.	(a) Time domain data, (b) frequency-domain data, and (c) repeated windows for 2 cycles of a 1 Hz cosine wave sampled with $\Delta t=0.0625$ (N=32).	(48)

Figure 4-2.	(a) Time domain data, (b) frequency-domain data, and (c) repeated windows for 2.5 cycles of a 1.25 Hz cosine wave sampled with $\Delta t=0.0625$ (N=32).	(49)
Figure 4-3.	Flow chart showing the essential components of visualization capability.	(55)
Figure 4-4.	Data on the x-y plane (a) and $k_x$ - $k_y$ plane (b).	(56)
Figure 4-5.	Spatial and k-space data for a uniform plane wave traveling along the x-axis.	(58)
Figure 4-6.	Spatial, k-space, and filtered data for a superposition of uniform plane waves given by (4-12).	(59)
Figure 4-7.	Spatial and k-space data for a uniform plane wave given by (4-13).	(60)
Figure 5-1.	Geometry of rectangular waveguide.	(62)
Figure 5-2.	Field patterns for the first 18 modes in a rectangular waveguide [24].	(65)
Figure 5-3.	Spectral domain distribution of various propagating modes.	(66)
Figure 5-4.	X-Y plane of FDTD computational space.	(67)
Figure 5-5.	Y-Z plane of FDTD computational space.	(67)
Figure 5-6.	X-Y plane, dominant mode (f=3.0 GHz) electric field distribution.	(70)
Figure 5-7.	Y-Z plane, dominant mode (f=3.0 GHz) electric field distribution.	(70)
Figure 5-8.	X-Y plane, mixed-mode (f=4.7 GHz) electric field distribution.	(71)
Figure 5-9.	Example of imaging method used in waveguide problem.	(72)
Figure 5-10.	Spectral domain content of mixed-mode data.	(73)
Figure 5-11.	X-Y plane, $TE_{10}$ filter applied to mixed-mode data.	(74)
Figure 5-12.	X-Y plane, $TE_{20}$ filter applied to mixed-mode data.	(74)