The Ohio State University

ElectroScience Laboratory
Department of Electrical Engineering
Columbus, Ohio 43212

Final Report 710816-19
Contract N00014-78-C-0049
December 1985

Department of the Navy
Office of Naval Research
800 Quincy Street
Arlington, Virginia

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OVERVIEW

1. Time Domain Studies and Slope Diffraction Techniques Studies initiated on JSEP have been combined into the creation of OSU's compact reflector/antenna range system (developed using other funding). This is the best system of its type currently available but it is expected that industry using concepts originated at OSU will soon surpass our current state of the art. These systems will have a large impact on stealth technology.

2. The Hybrid Studies focused attention on the scattering from small inlet structures. Solutions have been developed which far exceed our original expectations. Funding from other sources has also become available. We can now treat very large rectangular or circular inlets using surprisingly simple solutions. The scattering from cracks using the hybrid approach has also been analyzed and indeed we have pointed out to several agencies that they may become dominant scatterers for stealth vehicles. These solutions also should be very useful to the researchers involved in the penetration (coupling) problem as discussed at the recent workshop at the Naval Post Doctoral School.

3. The Diffraction Studies have provided a rigorous solution for a wave propagating along a conducting edge. This has a serious impact in the stealth technology in that for vehicles shaped to provide a low frontal RCS, these edge waves become a dominant contributor as has been confirmed by experiment. They represent the missing component in our analysis of the RCS of such vehicles and we are incorporating their contribution in the appropriate computer codes. All of the analysis developed in our diffraction studies will be incorporated in such codes. Earlier versions for reflector antennas, antennas mounted on aircraft, etc., have been widely distributed to industry for costs corresponding to cost of materials. The requests for these codes continually increase and they make a remarkable mechanism for transferring the technology to industry.

4. The Time Domain or Transient Studies under JSEP have been used to develop, among other uses, target identification techniques which have proven to be very successful. Some of them have been applied (on other programs) to correctly identify a naval vessel using scattered field data provided by the Navy. Most of this work has been transferred to other ONR programs during the last year.

The high resolution capabilities of the compact range radar system was also originated under this JSEP program and we can resolve scattering centers that are separated by less than an inch. Using this same system, we have also very
accurately measured the impulse response of a spherically capped cylinder. This has been compared successfully with the computed impulse response.

Even though the K-pulse has been a subject of interest to us as a potential electromagnetic tool, it has not been the subject of much attention until very recently primarily because the study of the above transient techniques have required most of our attention. Last year as these others were transferred to other funding sources, this changed and we have successfully completed the generation of the K-pulse directly in time domain without first finding the natural resonance. This technique is applicable to the low Q types of targets. In fact, all of the major tools required for applying the K-pulse concept to tasks in target identification, antenna development and resonant cross section control now appear to be in hand. In addition to the above solution for the K-pulse, a pole elimination concept has been used to treat a circular loop and should be applicable to other resonant scatterers. It is noted that most of these successes have been achieved in the last year of this program.

5. The Integral Equation Studies have provided a vast simplification of the analysis of penetrable bodies using two different approaches. One of these used the Green's function of a conducting half plane and treats the scattering of penetrable materials placed on that half-plane.

In the second approach, the physical basis concept (with only three unknowns) was developed for certain large penetrable scatterers with a vast saving of computation time and an equally vast understanding of the scattering mechanisms involved.

An integral equation solution has been obtained for conducting polygonal plates. This solution has been used to generate a computer code for the low frequency electromagnetic scattering from shapes such as aircraft and missiles. The results have been successfully compared to experimental data.

6. Microstrip antennas have been treated in several work units included in the Hybrid Studies and the Integral Equation studies. The case of a microstrip antenna on a dielectric coated cylinder yielded an exact eigenfunction solution and an asymptotic solution. A simple approximation for the surface Green's function has been obtained for a 2-D planar and convexly curved conducting surface with a thin dielectric coating. This should be very useful in the study of such microstrip antennas.
LISTING OF PRINCIPAL INVESTIGATORS
1983-1985

1. Professor R.G. Kouyoumjian
2. Professor D.L. Moffatt
3. Dr. E.H. Newman
4. Professor P.H. Pathak
5. Professor J.H. Richmond
6. Dr. N. Wang
7. Dr. J.D. Young
8. Dr. C.D. Chuang
DEGREES AWARDED

Over the past 3 years with the support of JSEP 5 students have been granted M.Sc. degrees in Electrical Engineering and 8 students have been granted the Ph.D. degree at the Ohio State University. The following lists tabulates these students and gives the quarter of their graduation.

Master of Science Degrees

William J. Leeper, Spring 1983
Photios A. Alexandroupoulos, Summer 1983
Sivasankaran Srikanth, Winter 1984
Richard Kautz, Summer 1984
Akio Nagamune, Spring 1985

Ph.D. degree

Jamaledin Izadian, Winter 1983
Mark R. Schrote, Summer 1983
Ted. C. Lee, Winter 1984
Osman M. Buyukdura, Autumn 1984
Bing W. Kwan, Autumn 1984
Robert J. Paknys, Winter 1985
Roberto G. Rojas, Winter 1985
William J. Kent, Spring 1985


JSEP PAPERS ACCEPTED FOR PUBLICATION


JSEP PAPERS SUBMITTED FOR PUBLICATION


1. O.M. Buyukdura, S. Goad, and R.G. Kouyoumjian, "A New Dyadic Green's Function for a Perfectly-Conducting Wedge".

2. O.M. Buyukdura and R.G. Kouyoumjian, "The Radiation from Scatterers at the Edge of a Wedge".

3. O.M. Buyukdura and R.G. Kouyoumjian, "An Improved UTD Solution for Wedge Diffraction".

4. R. Paknys and N. Wang, "High Frequency Surface Field by a Magnetic Line Source on an Impedance Cylinder-Uniform Solution".


7. B.W. Kwan, R.G. Kouyoumjian and E.H. Newman, "Asymptotic Solution for Mutual Coupling Between Strips on a Dielectric Coated Cylinder".

8. J.H. Richmond, "The Variational Property of the Moment Method".


10. C.W. Chuang, P.H. Pathak, and C.C. Huang, "Ray Analysis of Reflection from Open-end Circular and Rectangular Waveguides".
JSEP DISSERTATIONS AND THESIS

1. Jamaledin Izadian, "Two Dimensional EM-Scattering by Buried Penetrable Non-Circular Cylinders Using the Method of Moments", The Ohio State University, Columbus, Ohio Winter 1983.


4. Mark R. Schrote, "An Open Surface Integral Formulation for Electromagnetic Scattering by a Material Plate", The Ohio State University, Columbus, Ohio, Summer 1983.


8. O.M. Buyukdura, "Radiation from Sources and Scatterers Near the Edge of a Perfectly Conducting Wedge", Ph.D. Dissertation, The Ohio State University, Columbus, Ohio, Fall 1984.


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