Simulation of Radar Profiles for Satellites Using Mercury Method of Moments

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Abstract

A brief survey of characterizing the three dimensional radar cross section of satellites.

Contents

1 Overview

Topa 2020c Working with CAF files, producing output, compressing data. Topa 2020d ibid.

2 Overview

2.1 About

(A) Build a CAD model of the satellite (*.cad)
(B) Seal the CAD mesh
(C) Create geometry file (*.geo)
(D) Irradiate object with Mercury MoM
(E) Harvest backscatter
(F) Construct RCS
(G) Resolve RCS measurements into spherical harmonics

3 Additional Information

3.1 YouTube Videos

YouTube offers useful didactic presentations and simulations.

1. The Radar cross-section of backscattering objects
2. Basic Concepts of Radar Cross Section (RCS)
3. Mie scattering
4. Mie theory (BME51 Lecture 5)
5. Mie Scattering

3.2 Further Reading

Radar rudiments

1. D. K. Barton and H.R. Ward (1969). *Handbook of Radar Measurement*. New York, NY: Penguin Random House
2. Andrei A. Kolosov (1987). *Over the Horizon Radar*. Artech House. ISBN: 9780890062333. URL: https://us.artechhouse.com/Over-the-Horizon-Radar-P254.aspx
3. Peyton Z Peebles (2007). *Radar principles*. John Wiley & Sons

Radar cross section

1. JW Jr Crispin (2013). *Methods of radar cross-section analysis*. Elsevier
2. Allen E Fuhs (1982). *Radar cross section lectures*. Monterey, California, Naval Postgraduate School. URL: https://calhoun.nps.edu/server/api/core/bitstreams/9e69ec48-4628-4243-9f9b-7e879521f7f8/content
3. Eugene F Knott, John F Schaeffer, and Michael T Tulley (2004). *Radar cross section*. SciTech Publishing
4. M Madheswaran and P Suresh Kumar (2012). "Estimation of wide band radar cross section (RCS) of regular shaped objects using method of moments (MOM)". in: *Ictact Journal on Communication Tech-nology* 3.2, pp. 536–541

Method of Moments

1. Walton C Gibson (2021). *The method of moments in electromagnetics*. Chapman and Hall/CRC
2. Roger F Harrington (1987). "The method of moments in electromagnetics". In: *Journal of Electromagnetic waves and Applications* 1.3, pp. 181–200
3. Cai-Cheng Lu and Chong Luo (2003). "Comparison of iteration convergences of SIE and VSIE for solving electromagnetic scattering problems for coated objects". In: *Radio Science* 38.2, pp. 11–1

4. Jiade Yuan, Changqing Gu, and Guodong Han (2009). "Efficient generation of method of moments matrices using equivalent dipole-moment method". In: *IEEE Antennas and Wireless Propagation Letters* 8, pp. 716–719

Mercury MoM

1. Daniel Topa (Mar. 2020c). *Radar Cross Section Models for AFCAP Dashboard: Rapid Report 2020-02: Corrected*. Briefing
2. Daniel Topa (Apr. 2020a). *Mercury Method of Moments Adjunct Visualization Tool: Trials and Tribulations*. Tech. rep. ARFL/RVB
3. Daniel Topa (Apr. 2020d). *Radar Cross Section: Phase 1 Summary Report*. Tech. rep. ARFL/RVB
4. Daniel Topa (2020b). *Mercury Method of Moments: AFRL Quick Start Guide*. Tech. rep. AFRL

A Mercury Method of Moments: Distribution and Rights

A.1 Distribution Letter for Software

The subsequent distribution letter was signed by Randy J. Petyak of the NASA Software Release Authority and describes terms for distribution, Government rights, and the ITAR status of the software.

December 11, 2019

Air Force Research Laboratory
RVB
3550 Aberdeen Ave SE
Kirtland Air Force Base, NM 87117-5776
Attn: Mr. Nelson Bonito

Subject: Transmittal of Mercury MoM version 4.1.12, MM_Viz Code.

This distribution letter details the terms for distribution, the Government rights in the software, and the ITAR status of the software. The software usage agreement you signed covers Mercury MoM and MMViz executable codes on both Linux 64 bit and Windows 64 bit. The Mercury MoM software is copyrighted by Matrix Compression, LLC. of which the Government retains certain rights to the software, and must be controlled as outlined in the signed Software Usage Agreement.

NASA furnishes this software under the condition that no further dissemination of the software shall be made without prior written permission of the NASA Langley Research Center. Additionally, this software has been designated as ITAR and needs appropriate protection while on the DVD or on an installed machine.

Note: The software falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be taken out of the U.S. nor transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violation of these regulations is punishable by fine, imprisonment, or both.

We are interested in your use of this software and the results you obtain. Please include us on your mailing list for any publications that may result from your use of this code.

If you have any additional questions related to your request, please contact me.

Randy J. Petyak
NASA Software Release Authority
(202) 358-4387

A.2 Copyright Statement by the Author

A.3 Legal Statement

MERCURY MOM™
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This software was developed under NASA Contracts NAS1-02057, NAS1-02117, NNL08AA00B, and NNL13AA08B, and the U.S. Government retains certain rights.

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A.4 Obtaining Software and Documentation

For more information regarding this document contact the following:

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jeffrey.allen.miller@nasa.gov

Figure 1: Contact information to request Mercury MoM Software and Documentations

A.5 Distribution Contents

A.5.1 Executables

1. Linux 64-bit
2. Windows 64-bit

A.5.2 Documentation

The distribution includes four documents in PDF which are marked as CUI:

1. User's Guide
2. Pill Tutorial
3. Code Validation Report
4. Benchmark Tests

References

Barton, D. K. and H.R. Ward (1969). *Handbook of Radar Measurement*. New York, NY: Penguin Random House.

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Gibson, Walton C (2021). *The method of moments in electromagnetics*. Chapman and Hall/CRC.

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Madheswaran, M and P Suresh Kumar (2012). "Estimation of wide band radar cross section (RCS) of regular shaped objects using method of moments (MOM)". In: *Ictact Journal on Communication Tech-nology* 3.2, pp. 536–541.

Peebles, Peyton Z (2007). *Radar principles*. John Wiley & Sons.

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Yuan, Jiade, Changqing Gu, and Guodong Han (2009). "Efficient generation of method of moments matrices using equivalent dipole-moment method". In: *IEEE Antennas and Wireless Propagation Letters* 8, pp. 716–719.