The Radar Image Generation (RIG) Model

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ABSTRACT

RIG is a modeling system which creates synthetic aperture radar (SAR) and inverse SAR images from 3-D faceted data bases. RIG is based on a physical optics model and includes the effects of multiple reflections. Both conducting and dielectric surfaces can be modeled; each surface is labeled with a material code which is an index into a data base of electromagnetic properties. The inputs to the program include the radar processing parameters, the target orientation, the sensor velocity, and (for inverse SAR) the target angle rates.

The current version of RIG can be run on any workstation, however, it is not a real-time model. We are considering several approaches to enable the program to generate real-time radar imagery.

In addition to its image generation function, RIG can also generate radar cross-section (RCS) plots as well as range and doppler radar return profiles.

RADAR IMAGERY GENERATOR (RIG)

The Radar Imagery Generator (RIG) simulates the image from a synthetic aperture radar (SAR) or an inverse SAR (ISAR). The target model for RIG is a 3-D geometric data base. RIG uses a physical optics model to calculate the radar return from conductive and dielectric surfaces. RIG uses a ray tracing method to calculate the coherent path to each surface. Multiple bounces from non-contiguous objects as well as dihedral and monostatic returns are modeled.

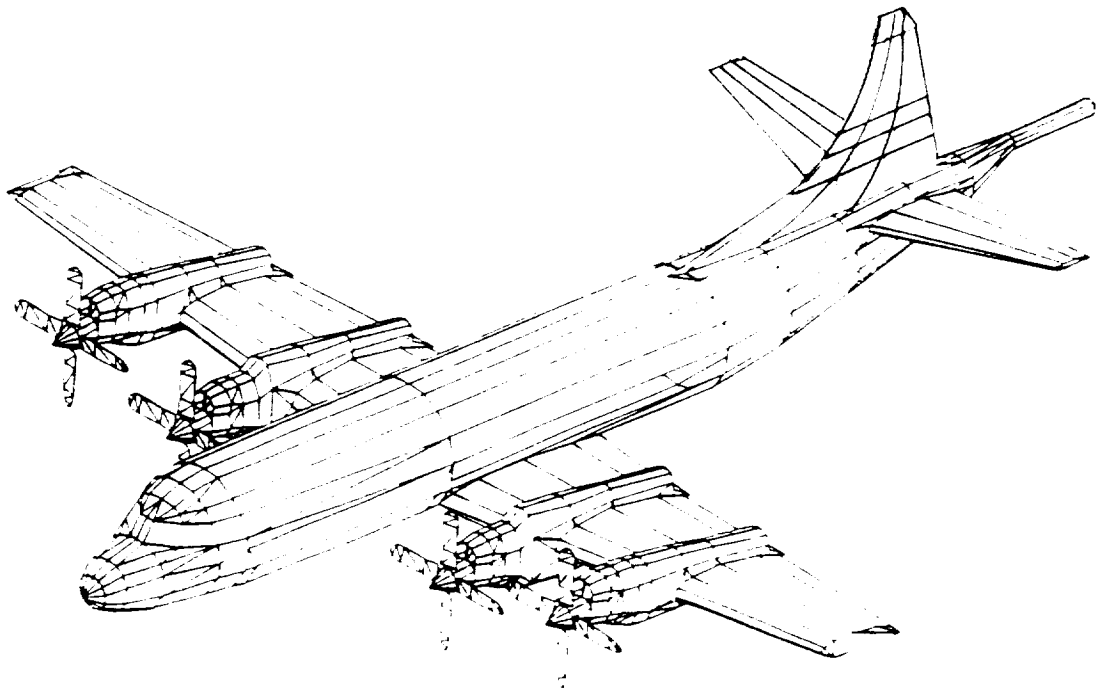
The user can define the radar parameters, e.g. wavelength, polarization, range resolution and doppler bandwidth. The target is defined by its orientation and speed, or in more detail, by its complete motion cycle in roll, pitch and yaw.

RIG

RADAR IMAGERY GENERATOR

- INTEGRATED TOOL FOR CREATING SYNTHETIC APERTURE RADAR (SAR) AND INVERSE SAR (ISAR) IMAGERY
- PHYSICAL OPTICS MODELING OF CONDUCTIVE AND COATED MATERIALS
- MONOSTATIC AND DIHEDRAL BOUNCE MODELING
- 3-D FACETED DATA BASES OF AIRBORNE, LAND, AND SEA BASED TARGETS
- CONTROL OF RADAR PLATFORM AND TARGET POSITIONS
- USER-DEFINED DIFFUSE GROUND TOPOGRAPHY

P-3C "ORION" TARGET MODEL



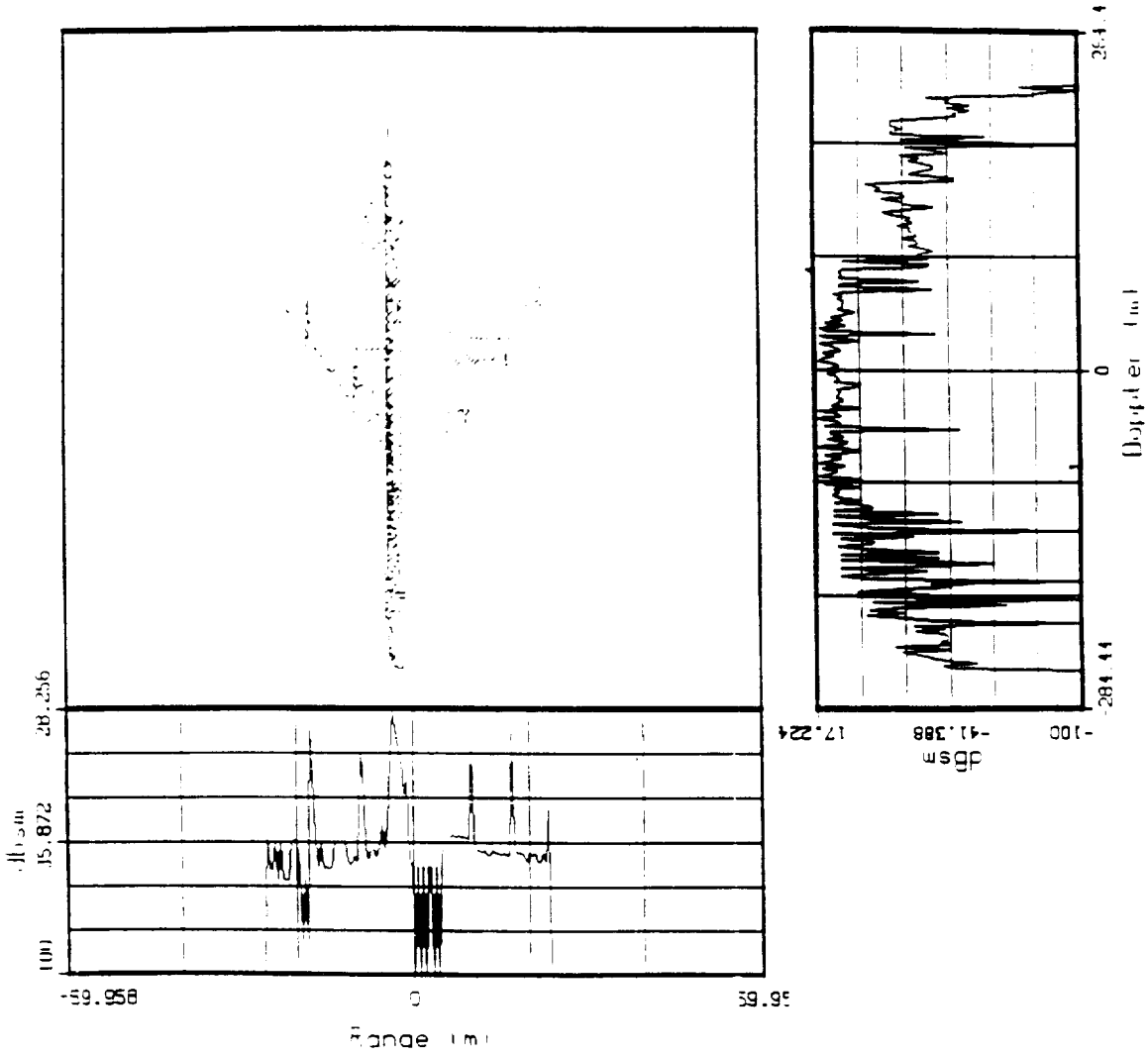
- 1344 POLYGONS
- NO LANDING GEAR
- ALL FLAPS, SLATS IN CLEAN POSITIONS
- PROPELLERS ORTHOGONALLY ORIENTED

SIMULATED IMAGERY

The returns from several surfaces that appear in a given range/doppler cell are coherently integrated to generate the SAR or ISAR image. The RCS profile as a function of range (doppler) is generated by summing in the doppler (range) dimension.

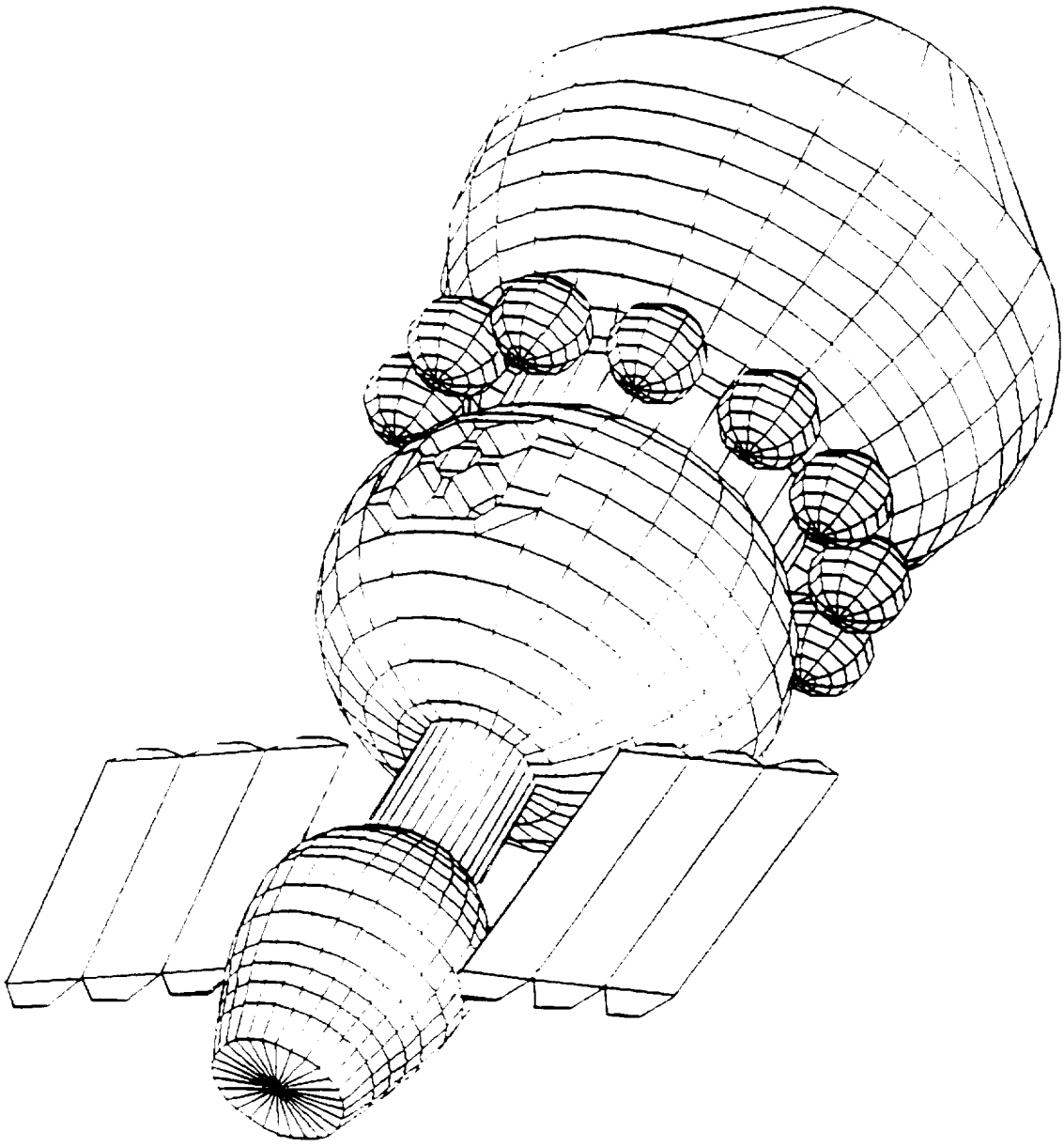
The final step of RIG is to convolve the radar response function (that models the antenna, range and doppler response characteristics) with the ideal RCS image. The images and profiles provided in the Figure are the ideal RCS and do not show the results of the convolution.

IMAGERY WITH RCS SIMULATION



- **RCS PROFILES ARE COHERENTLY SUMMED WITHIN EACH RANGE BIN AND EACH DOPPLER FILTER.**

RECONNAISSANCE SATELLITE

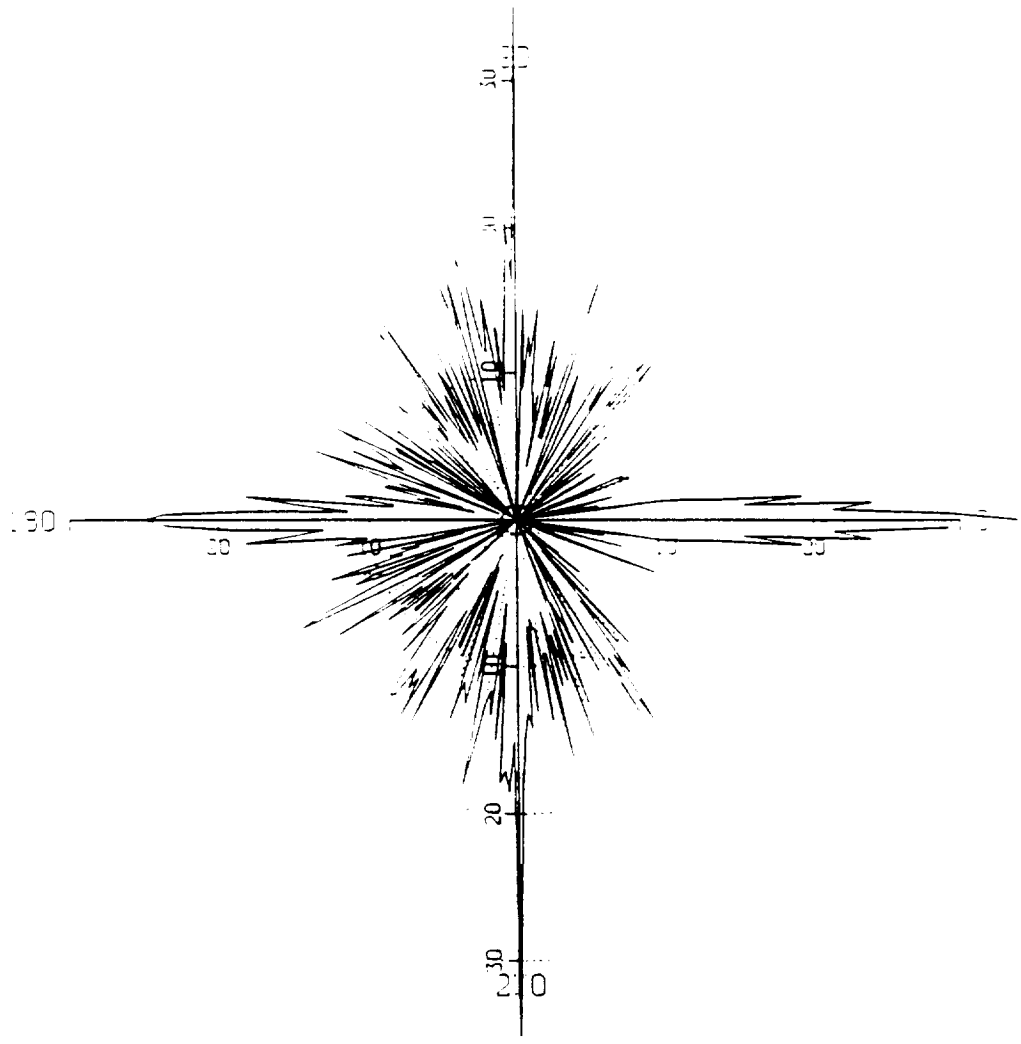


TOTAL RCS

RIG also generates the total RCS of the target by coherently summing over all range and doppler cells. The RCS of a satellite is given in the Figure as a function of aspect. Angle is defined in a plane perpendicular to the solar panels, with 0° looking toward the panels. The RCS without convolution with the radar response is provided.

TOTAL RCS OF SPACECRAFT

RCS(dBsm) vs Aspect Angle (deg)



MULTISPECTRAL SIMULATION

RIG is the radar equivalent of IRGen that is described in a companion paper. Together both programs can generate multispectral imagery from the same geometric data base. The combined system would simulate the visible, infrared and radar image of the same scene for the same viewing and atmospheric conditions.

MULTISPECTRAL SIMULATION