REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

AD-A230 696

Report Date.
1990

3. Report Type and Dates Covered.
Abstract

4. Title and Subtitle.

Geometric Rectification of High Resolution Airborne Multispectral Data

5. Funding Numbers.

Program Element No. 0602435N
Project No. 3585
Task No. MOG
Accession No. DN255031

6. Author(s).

Stephen C. Lingsch, Maria T. Kalcic, and H. C. Mesick

7. Performing Organization Name(s) and Address(es).

Naval Oceanographic and Atmospheric Research Laboratory
Stennis Space Center, MS 39529-5004

8. Performing Organization Report Number.

AB 90:351:043

9. Sponsoring/Monitoring Agency Name(s) and Address(es).

Naval Oceanographic and Atmospheric Research Laboratory
Stennis Space Center, MS 39529-5004

10. Sponsoring/Monitoring Agency Report Number.

AB 90:351:043

11. Supplementary Notes.

IGARSS

12a. Distribution/Availability Statement.

Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract *(Maximum 200 words)*.

The Naval Oceanographic and Atmospheric Laboratory (NOARL) is developing techniques to map water depths in clear, shallow waters from multispectral imagery. The Airborne Multispectral System (ABS) consists of a suite of sensors including the NOARL Multispectral Scanner (MSS), Hydrographic Airborne Laser Sounder (HALS), Litton 72 Inertial Navigation System (INS), Rockwell Collins Global Positioning System (GPS), and a radar altimeter on board a Navy P-3 aircraft. Using an airborne multispectral scanner as an bathymetry sensor requires an accurate geometric registration of measured depth points to image pixels. The absolute depth is derived from a source external to the multispectral sensor (i.e., laser sounder or ship derived depths). In order to accurately model the correlation between the depth and multispectral reflectance these depths must be mapped precisely to the multispectral imagery. Following the mapping procedure, regression techniques are employed to compute a depth for each pixel. Once depths are computed for the entire image, accurate positioning is required for merging independent flightlines to produce accurate high resolution bathymetric charts.

14. Subject Terms.

(U) Hydrography; (U) Bathymetry; (U) Optical Properties; (U) Remote Sensing; (U) Reverberation

15. Number of Pages.
1

16. Price Code.

17. Security Classification of Report.	18. Security Classification of This Page.	19. Security Classification of Abstract.	20. Limitation of Abstract.
Unclassified	Unclassified	Unclassified	SAR

GEOMETRIC RECTIFICATION OF HIGH RESOLUTION AIRBORNE MULTISPECTRAL DATA

Stephen C. Lingsch
Maria T. Kalcic
H. C. Mesick

Naval Oceanographic and Atmospheric Research Laboratory (NOARL)
Stennis Space Center, MS. 39529-5004

The Naval Oceanographic and Atmospheric Laboratory (NOARL) is developing techniques to map water depths in clear, shallow waters from multispectral imagery. The Airborne Multispectral System (ABS) consists of a suite of sensors including the NOARL Multispectral Scanner (MSS), Hydrographic Airborne Laser Sounder (HALS), Litton 72 Inertial Navigation System (INS), Rockwell Collins Global Positioning System (GPS), and a radar altimeter on board a Navy P-3 aircraft. Using an airborne multispectral scanner as an bathymetry sensor requires accurate geometric registration of measured depth points to image pixels. The absolute depth is derived from a source external to the multispectral sensor (i.e. laser sounder or ship derived depths). In order to accurately model the correlation between the depth and multispectral reflectance these depths must be mapped precisely to the multispectral imagery. Following the mapping procedure, regression techniques are employed to compute a depth for each pixel. Once depths are computed for the entire image, accurate positioning is required for merging independent flightlines to produce accurate high resolution bathymetric charts.

Errors and distortions in the imagery are caused by aircraft dynamics (ie. roll, pitch and drift), tangential distortions, aircraft speed and along track sampling rate. Standard methods for the rectification and attitude correction of airborne multispectral imagery require the location of control points from an external source to map the image pixels to a common grid. Implementation of this method over water requires the placement of markers or buoys prior to the flight. This is time consuming and expensive. As part of the post processing procedure control point markers must be manually located within the image. The complete set of attitude and positioning sensors allow image rectification for aircraft dynamics with minimal user intervention. A rectified image is produced where each pixel can be geographically referenced. The method implemented in the Multispectral Image Depth Analysis System (MIDAS) software package developed at NOARL. The system uses as input raw multispectral scanner, navigation and attitude data and absolute depths derived from either the laser sounder or boat and outputs depth charts at a 1 m resolution.

Roll and pitch are received from the Litton 72 inertial navigation system. These parameters are updated at the rate of 10 per second. With the scan rate at approximately 100 Hz an update in the aircraft's attitude occurs every 10 scanlines. The GPS parameters including latitude, longitude and drift are updated once a second or an update every 100 scan lines. Five GPS fixes are linearly interpolated giving a position, at nadir for each scanline.

A standard approach for setting up a data structure would be to store the position of the lower left corner in a file header, set up a rectangular region and compute offsets from the lower left corner and placing each pixel in it's proper cell. Since the flight lines are not oriented true N-S or E-W this method would leave large areas in the file empty. The method developed minimizes the 'dead space' in the file and allows the data to be in both 'line - element' and geographic coordinate space. Each flight line is divided into .6 X .5 km subareas. Each subarea is then rectified independently, each having it's own set of mapping coefficients allowing each pixel to be geographically referenced. The aircraft is typically flown at an altitude of 500 m. Given a .002 radian instantaneous field of view the pixel size at nadir is 1 m, increasing in size to 1.7 m at the furthest off nadir pixel. The grid resolution chosen is 1 m.

Land data was collected over Slidell, Louisiana to verify the attitude correction algorithms. Numerous driveway and sidewalk intersections were located within the image for use as ground stations. Geographic positions at the these stations were collected using a Motorola Mini Ranger Eagle GPS receiver. The pixel location of the ground station was found on the multispectral image. The corresponding latitude and longitude were computed using the set of mapping coefficients computed for the image. For 19 stations the RMS error between the image computed position and the ground station GPS reading was 25.7 m for 19 locations. Many sources of error are inherent in this value, therefore this RMS is not a true measurement of the model error. A factor in the accuracy of the GPS positions is based on the Position Dilution of Precision (PDOP). The PDOP is a measure which relates the configuration geometry of the GPS satellites to the positioning accuracy. Since the PDOP was not available for the aircraft data and was not recorded in the field experiments, the actual positioning accuracy could not be measured for this experiment. The orientation of the INS three rotational axis and the true orientation within the aircraft was not known. The magnitude of error for a one degree offset in each of the three axes is 20 m.

The algorithms were implemented on a VAX 8800 with a processor speed of 12 mips. For a .6 X .5 km area the processing time was 1 min, 10 sec.

The complete set of navigation and attitude data allow rectification without picking control points, minimizing user intervention.

CH2825-8/90/0000-0657/$01.00