Identification_Information:
Citation:
Citation_Information:
Originator: NOAA Coastal Services Center (CSC)
Originator: U.S. Geological Survey (USGS)
Publication_Date: 20041223
Title: Connecticut Coastal ADS40 Digital Imagery Acquisition and Natural Color and Color Infrared Orthophoto Production
Geospatial_Data_Presentation_Form: remote-sensing image
Description:
Abstract:
An orthoimage is remotely sensed image data in which displacement of features in the image caused by terrain relief and sensor orientation have been mathematically removed. Orthoimagery combines the image characteristics of a photograph with the geometric qualities of a map.
This task consists of two primary components, ADS40 digital image acquisition and natural color and color infrared digital orthophoto production. In addition to the orthophotos a reflective surface digital elevation data set covering the project area was produced.
Purpose:
These data have been created as a result of the need for having geospatial data immediately available and easily accessible in order to enhance the capability of the NOAA Coastal Services Center (CSC) and the USGS.
Supplemental_Information:
The bounding coordinates provided within the Spatial Domain section represent a rectangle covering the total area in which the project is located. The actual project boundary located within this area is comprised of areas delimited by areas along the coast of the state of Connecticut.
The Coastal Connecticut project area is comprised of approximately 930 square miles. A total of 244 orthos (122 natural color and 122 color infrared) were produced to cover this area.
Aerial imagery was collected in panchromatic, Red, Green, Blue and Near Infrared which yielded a natural color and false color infrared version of the completed digital orthophotography. In addition to producing the

digital ortho imagery a first surface (reflective surface) elevation data set was produced. Imagery was collected at an approximate altitude of 15,750 feet above mean terrain.
The ADS40 digital camera system used in this project incorporates the latest in sensor technology, optics, electronics, data transfer, and storage. The ADS40 imagery is generated from seven parallel sensor lines in the focal plane of a single lens system, three panchromatic (forward, nadir, backward), red, green, and blue lines placed next to each other, and one infrared. Each panchromatic channel consists of two lines, each with 12,000 pixels, staggered (shifted with respect to each other) by 0.5 pixels. The viewing angles and characteristics of the sensor are as follows -
- Focal length 62.5mm
- Pixel size 6.5mm
- PAN 2 arrays 12,000 pixels each
- R,G,B and NIR,R,G 12,000 pixels
- Backward to nadir stereo angle -14.1 degrees
- Near infrared to nadir stereo angle -2.05 degrees
- Dynamic Range of CCD - 12-bits for all arrays

For this dataset, the natural color and color infrared orthoimages were produced at 0.50-meter pixel resolution. Each digital orthorectified quarter quad provides imagery for a nominal 3.75 by 3.75 minute area corresponding to the USGS quarter quad boundaries. The projected coordinate system is UTM (Zone 18) with a NAD83 datum. The naming convention is based on the National Grid.
Deliverables include -
- 24-Bit Natural Color in GeoTIFF format
- 24-Bit False Color Infrared in GeoTIFF format
- Reflective surface digital elevation data set in .flt format

Time_Period_of_Content:
  Time_Period_Information:
    Range_of_Dates/Times:
      Beginning_Date: 20040920
      Ending_Date: 20040922
  Currentness_Reference: Ground Condition
Status:
  Progress: Complete

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            Maintenance_and_Update_Frequency: Unknown
      Spatial_Domain:
            Bounding_Coordinates:
                  West_Bounding_Coordinate: -073.811097
                  East_Bounding_Coordinate: -071.755583
                  North_Bounding_Coordinate: +41.658672
                  South_Bounding_Coordinate: +40.911606
      Keywords:
            Theme:
                  Theme_Keyword_Thesaurus: None
                  Theme_Keyword: rectified imagery
                  Theme_Keyword: rectified image
                  Theme_Keyword: orthophoto
                  Theme_Keyword: Digital Orthophoto Quarter Quad (DOQQ)
                  Theme_Keyword: image map
                  Theme_Keyword: Natural Color DOQQ
                  Theme_Keyword: Color Infrared DOQQ
                  Theme_Keyword: False Color Infrared DOQQ
            Place:
                  Place_Keyword_Thesaurus: Geographic Names Information System
                  Place_Keyword: United States of America
                  Place_Keyword: Connecticut
                  Place_Keyword: CT
                  Place_Keyword: US
      Access_Constraints: None
      Use_Constraints: None
      Data_Set_Credit: EarthData International,  LLC
      Native_Data_Set_Environment:
            Leica ADS40 Digital Camera System
            ISTAR Digital Image Processing Software
            Z/I Imaging Orthopro 4.0
            Windows NT/2000 Systems
Data_Quality_Information:
      Attribute_Accuracy:
            Attribute_Accuracy_Report:
                  The digital imagery for each acquisition sortie is
                  differentially rectified to produce orthophotography for the
                  Red, Green, and Blue and near infrared channels at a
                  resolution of 0.50-meter per pixel.  The orthophoto
                  mosaics are inspected for accuracy issues that fall in the
                  following categories -
                  - Aerotriangulation related
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- DSM related
Accuracy issues will be investigated through review an correction of the DSM or triangulation adjustment. Once the imagery has passed quality control review, final radiometric adjustments are performed to create a uniform overall appearance.

Logical_Consistency_Report:

Compliance with the accuracy standard was ensured by the placement of photo identifiable ground control points and the collection of airborne GPS data. Using several tools that are part of the ISTAR workflow, a digital surface model (DSM) was correlated at a post spacing of 2 meters depending on terrain and land cover. The ISTAR correlation algorithm computes the X,Y,Z value for each DSM post utilizing every stereo angle that is available. A series of DSM files were created for each acquisition block, one for each stereo look angle. A mosaic was then created from the separate DSM files where the best vertical value for each posting was selected from all look anglescompared against the aerotriangulation adjustment which is incorporated into the mosaic. EarthData then edited the surface to the level required to support the orthophoto production. An RMS value was calculated based on the imagery utilized in the production of the tile by comparing the AT X and Y coordinates. This value represents an estimate of the accuracy of the horizontal coordinate measurements in the tile expressed in meters.

Completeness_Report:

Compliance with the accuracy standard was ensured by the placement of photo identifiable ground control points and the collection of airborne GPS data.

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

The horizontal accuracy of the orthorectified images is mainly determined by the accuracy of the aerotriangulation and digital surface model (DSM). For each rectified image (lift), an RMSE value for all of the standard errors of the tie/pass/control points located in that image (lift) and computed by the aerotriangulation solution was calculated.

The DSM accuracy assessment was achieved by

comparing the aerotriangulation-derived elevation with the
elevation of the DSM. In addition, visual examination was
employed to assess all tiles and its relative edge match.
All results were examined for consistency and its
compliance with the NMAS accuracy standard.
Quantitative_Horizontal_Positional_Accuracy_Assessment:
Horizontal_Positional_Accuracy_Value: 0.273256
Horizontal_Positional_Accuracy_Explanation: Accuracy assessment determined by evaluating the horizontal accuracy obtained during the aerotriangulation process for each lift.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
CheckDEM is a program designed to compare a list of
controls against DEM file(s) and therefore to check the
accuracy of the DEM file(s). For each control point, first,
the program selects all the DEM points that fall into a
given radius from the position of the control point. Second,
the program calculates a weighted average of the DEM
points to interpolate an elevation at the position of the
control point. And last, the program computes the
difference between the elevation of the control point and
the interpolated elevation. After all the control points have
been checked, the program computes several statistics
on the differences between controls and interpolated DEM
elevations. The statistics include RMSE, Standard
Deviation, Minimum Difference, Maximum Difference, and
Mean Difference. In the output report, the program prints
out elevation differences for every control points and the
statistics.
Raw elevation measurements have been determined to
be vertically accurate to within 0.328 meters.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Terrasurv Inc.
Publication_Date: 20041223
Publication_Time: Unknown
Title: Ground Control Survey of Coastal Connecticut
Geospatial_Data_Presentation_Form: model
Type_of_Source_Media: digital
Source_Time_Period_of_Content:
Time_Period_Information:

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                  Range_of_Dates/Times:
                        Beginning_Date: 20040927
                        Ending_Date: 20040928
            Source_Currentness_Reference: Ground Condition
      Source_Citation_Abbreviation: GPS ground control
      Source_Contribution:
            Terrasurv  Inc.  established ground control to support the
            aerotriangulation process.  A total of 16 points were
            surveyed to support the AT process.
Source_Information:
      Source_Citation:
            Citation_Information:
                  Originator: EarthData International
                  Publication_Date: 20041223
                  Publication_Time: Unknown
                  Title: Coastal Connecticut Digital Surface Model
                  Geospatial_Data_Presentation_Form: model
      Type_of_Source_Media: digital
      Source_Time_Period_of_Content:
            Time_Period_Information:
                  Single_Date/Time:
                        Calendar_Date: 20041223
            Source_Currentness_Reference: Publication Date
      Source_Citation_Abbreviation: digital surface model
      Source_Contribution:
            Used to provide ground elevations for the
            orthorectification process.
Source_Information:
      Source_Citation:
            Citation_Information:
                  Originator: EarthData International, LLC
                  Publication_Date: 20041223
                  Publication_Time: Unknown
                  Title: ADS40 Digital Imagery
                  Geospatial_Data_Presentation_Form: remote-sensing image
      Type_of_Source_Media: digital
      Source_Time_Period_of_Content:
            Time_Period_Information:
                  Range_of_Dates/Times:
                        Beginning_Date: 20040920
                        Ending_Date: 20040922
            Source_Currentness_Reference: Ground Condition
```

Source_Citation_Abbreviation: imagery
Source_Contribution:
The digital imagery mission was composed of a total of
2 lifts. Imagery was obtained at an altitude of 15,750 feet
above mean terrain. The mission was flown with a Leica
ADS40 digital camera with ABGPS and IMU.
Imagery was acquired on the following dates -

Lift	Date
26404B	09/20/2004
26604A	09/22/2004

Process_Step:
Process_Description:
Source Imagery - ADS40 Digital Camera Imagery.
Control - Airborne GPS/IMU supplemented with photo
identifiable field control
Aerotriangulation - ISTAR software package
Elevation Model - ISTAR software package
Radiometric Balancing - ISTAR software package and
COTS Software (PhotoShop).
Orthorectification - ISTAR software package.
Mosaic - ISTAR software package and Z/I Imaging
OrthoPro software package.
The following section describes the ISTAR digital image
production sequence. This is a mature, stable workflow
and incorporates all production components into an
integrated series of tools to accomplish photogrammetric
mensuration, aerotriangulation, elevation model
development, ortho production and finishing. Production
processes are fully documented in accordance with
ISO9001 mandates.
The following is a step-by-step description of the ISTAR
workflow to develop digital orthophoto quarter quads to
Step 1
The unprocessed ADS40 data and accompanying GPS
and IMU data for one or more sorties was downloaded
from the portable hard disks and checked to verify that no
files were corrupted and that all data could be
downloaded. Digital aerial imagery that was used for this
project includes the Red, Green, Blue, Near Infrared
channels as well as the S1 pan, S2 pan and nadir green
channels. Sample segments of the imagery were
inspected in an uncorrected state to verify the integrity of

each data sortie.
Step 2
The GPS/IMU parameters for each sortie were optimized using the ground control points and the error calibration map. The horizontal and vertical positions of all ground control points in the block were observed in each channel (R,G,B, IR, R, G, S1 Pan, S2 Pan).
Step 3
Aerotriangulation was accomplished using the CLB tool that is a component of the ISTAR process. The ground control, GPS and IMU information were ingested and tie points between strips were identified. Normally, only 3 tie points are needed between adjacent flight lines.
Step 4
CLB produces a bundle adjustment for each data sortie. The results of the adjustment were verified through the development of a sub-sampled panchromatic mosaic for the data sortie. The mosaic was corrected using the aerotriangulation points only. This mosaic was inspected by the photogrammetric technician to identify any gross errors in the adjustment as well as the identification of any voids or image quality problems.
Step 5
Using several tools that are part of the ISTAR workflow, a digital surface model (DSM) is correlated at a post spacing of 2 meters depending on terrain and land cover. The ISTAR correlation algorithm computes the X,Y,Z value for each DSM post utilizing every stereo angle that is available. A series of DSM files are created for acquisition block, one for each stereo look angle. A mosaic is then created from the separate DSM files where the best vertical value for each posting is selected from all look angles compared against the aerotriangulation adjustment which is incorporated into the mosaic. EarthData will then edit the surface to the level required to support the orthophoto production.
Step 6
The digital imagery for each acquisition sortie was differentially rectified to produce digital orthophoto mosaics in natural color and false color infrared renditions at a resolution of 0.50-meter per pixel. The orthophoto mosaics were inspected for accuracy issues that fall in the

following categories -
- Aerotriangulation related
- DSM related
Accuracy issues were investigated through review and correction of the DEM or triangulation adjustment. Once the imagery passed quality control review, final radiometric adjustments were performed to create a uniform overall appearance. The final DOQQ tiles were organized for nominal 3.75 by 3.75 minute areas corresponding to the USGS quarter quad boundaries and were clipped out with the specified overage of a minimum of 30 meters beyond the quarter quad boundaries.
Imagery was output in the folowing formats -
24-bit natural color GeoTIFF images
24-bit false color infrared GeoTIFF images
Step 7
The completed digital orthophotos were checked for image quality. Minor artifacts were corrected using Adobe Photoshop in an interactive editing session. Digital files were assigned final names based on the National Grid.
Step 8
Project level metadata describing the orthophoto production process was developed to support the task.
Source_Used_Citation_Abbreviation: imagery, digital surface model, GPS ground control
Process_Date: 20041223
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 18
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.9996
Longitude_of_Central_Meridian: -075.000000
Latitude_of_Projection_Origin: +00.000000
False_Easting: 500000.0
False_Northing: 0.0
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: row and column
Coordinate_Representation:
Abscissa_Resolution: 0.50

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                        Ordinate_Resolution: 0.50
                  Planar_Distance_Units: Meters
            Geodetic_Model:
                  Horizontal_Datum_Name: North American Datum of 1983
                  Ellipsoid_Name: Geodetic Reference System 80
                  Semi-major_Axis: 6378137
                  Denominator_of_Flattening_Ratio: 298.2572221
Distribution_Information:
      Distributor:
            Contact_Information:
                  Contact_Organization_Primary:
                        Contact_Organization: NOAA Coastal Services Center
                  Contact_Position: Clearinghouse Manager
                  Contact_Address:
                        Address_Type: mailing address
                        Address: 2234 Hobson Avenue
                        City: Charleston
                        State_or_Province: SC
                        Postal_Code: 29405-2413
                        Country: US
                  Contact_Voice_Telephone: 1-843-740-1227
                  Contact_Electronic_Mail_Address: custserv@usgs.gov
                  Hours_of_Service: Monday  -  Friday,  8:00 AM  -  5:00 PM (Eastern Time)
      Distribution_Liability:
            Users must assume responsibility to determine the
            usability of these data.
Metadata_Reference_Information:
      Metadata_Date: 20041223
      Metadata_Contact:
            Contact_Information:
                  Contact_Organization_Primary:
                        Contact_Organization: NOAA Coastal Services Center
                  Contact_Address:
                        Address_Type: mailing and physical address
                        Address: 2234 South Hobson Avenue
                        City: Charleston
                        State_or_Province: SC
                        Postal_Code: 29405
                        Country: US
                  Contact_Voice_Telephone: 1-843-740-1227
                  Hours_of_Service: Monday  -  Friday, 8:00AM  -  5:00PM (Eastern Time)
      Metadata_Standard_Name: FGDC Content Standard for Digital Geospatial Metadata
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Metadata_Standard_Version: FGDC-STD-001-1998