Software for automated image-to-image co-registration

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This presentation represents an *interim status report*. Our SBIR Phase II project is in its second year, and is scheduled for completion at the end of 2006.

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Basic Premise

In spite of excellent quality in state of the art orthorectification software, camera models, and digital elevation models, two orthorectified images of the same area often exhibit minor errors relative to each other.

Although the absolute geometric accuracy is typically excellent, the relative accuracy of the image-to-image co-registration can be improved. For automated change detection at the scale of one pixel, the relative accuracy of two independently created orthophotos is often inadequate.

The fundamental goal of this SBIR Project is to develop software that applies multiple techniques to achieve subpixel precision in the co-registration of image pairs.
Project Objectives

• Develop software to fine-tune image-to-image co-registration, presuming images are orthorectified prior to input.

• Create a reusable software development kit (SDK) to enable incorporation of these tools into other software.

• Provide automated testing for quantitative analysis.
Project Deliverables

• Software development kit (SDK), developed in C++ (ANSI standard)

• Windows application
  – For automated testing (.NET framework)
  – Example application for SDK implementation
Features & Benefits of image co-registration tools

Features

• Will provide for very accurate (sub-pixel) image-to-image co-registration, assuming input image data is already well registered.

• SDK will allow incorporation of these tools into other software.

• Test system (Windows .NET compliant) will provide ability to compare effectiveness of alternative methods.

Benefits

• Improves the accuracy of automated change detection.

• Enables a User with a need for these tools to customize them for their application.

• Enables user to add new technology and determine if it improves the results in their application.
Software Architecture

- **VB.NET Windows Application**
  - Setup/Reporting/Output Interfaces
  - Recipe Run Engine
  - SDK Interface

- **R & D Tools Extension to VB.NET Application**
  - Recipe Builder
  - Recipe Development Engine
  - Development Reporting/Analysis/QC Tools

- **SDK**
  - Co-Registration Process Tools
  - Rectification Tools
  - Re-Sampling Tools
  - Other Useful Utilities
  - Image I/O Tools

- **Projects**

- **Co-Registration Recipe Libraries**

- **Raw Images**

- **Rectified Images**
Primary Functions – SDK & Windows Application

• Change Detection
• Identification of tie points
  – (a.k.a. matching points, landmarks, pass points)
• Automatic measurement of initial and final accuracy
• QC tools
Basic Software Flowchart

1. Begin coregistration process
2. Configure software and read image pair
3. Identify areas of significant change
4. Conduct tie point tests, select passing points
5. Calculate local warp coefficients
6. Repeat co-registration accuracy test
7. Apply co-registration accuracy test
   - Accuracy "BEFORE"
8. Co-registration accuracy improved?
    - Yes: Rectify Image A to match B
    - No: TBD!
9. Accuracy "AFTER"
10. Process Complete
Image Pair QC tools

Side by side tie point view
Image Pair QC tools

Residual tie point error view
Image Pair QC tools

Overlay view
Reporting Functions
Added Functions – Development & Validation Tools

• Recipe Builder
  – For algorithm development
  – Intuitive GUI for linking core processes together into complex algorithms
  – User can query & modify process data

• Recipe Validation
  – Batch processing of recipes against multiple input datasets, for statistical analysis
“Recipe Builder”

Each process can be queried (input & output data, configuration data) for testing, and data may be modified to alter the results of subsequent processes.

Note the “look and feel” of this UI are preliminary…
Recipe Validation

“Recipes” (integrated algorithms) may be executed with multiple input pairs to compare results and validate the recipe.
Preliminary Results

- Example #1:
  - Subset of orthorectified air photo pair (Source: USDA APFO).
  - Relative Error (RMS): 2.95 meters
  - After processing? TBD
Target markets
for software and/or services

• Industries:
  – Defense
  – Agriculture
  – Environment
  – Urban planning/Local Government
  – Medical imaging?
  – Machine vision/automated inspection?
Project Collaborators

- Dr. Doug Stow (San Diego State University)
- Dr. Ardeshir Goshtasby (Wright State University)
- Dr. John Dwyer (USGS LP-DAAC)

- Seeking more... (See next slide)
Goals for JACIE workshop
March 14-16, 2006

• Identify agencies interested in using image co-registration tools:
  – Validate software requirements.
  – Provide image data for testing.
  – Assist with BETA testing.
  – Utilize software when complete.
References


References - continued

• Goshtasby, A. Ardeshir, “2-D and 3-D Image Registration : for Medical, Remote Sensing, and Industrial Applications (Hardcover)"
References - continued

Contact information

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