Rapid Processing of Unmanned Aerial Vehicles Imagery for Disaster Management

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Presentation Outline:

- Unmanned Aerial Vehicles.
- SIFT Feature Extraction And Matching.
- Automatic Processing Workflow.

Key Words:
- Aerial Mapping,
- Unmanned Aerial Vehicles,
- Automatic Image Matching,
- Natural Disaster Management.
Unmanned Aerial Vehicles

- UAVs are increasing in popularity
- Low cost, high resolution, multi-temporal
- Close range aerial photogrammetry
Post Disaster Risk Management

• Planning and execution of response action

• Role of geospatial information

• Disaster Mapping

Natural Disaster Mapping Requirements

• Real time/Rapid processing

• High Temporal Resolution

• High Detail/Spatial Resolution

• Automated Processes
UAV Trajectory Challenges

- Flight
  - Instability (Wind and thermals)

UAV Imagery Challenges

- Images
  - Large scale differences
  - Illumination changes
  - Occlusions
  - Convergent images
  - Larger number of high resolution images
Sample UAV Images

MAVinci Unamnned Aerial Systems (www.mavinci.eu)

SIFT Based Feature Extraction And Matching
Traditional matching

• Correlation Based Template Matching
  ▫ Computationally expensive
  ▫ Sensitive to variance

• Feature Based Matching
  ▫ More robust
  ▫ Sparse features

SIFT

• Scale Invariant Feature Transform
• Localized scale invariant features
• Invariant to scale, rotations and partially invariant to illumination changes and camera perspectives
• Image pyramid approach
Scale Space Extrema Detection

- Detect features invariant of scale

- Construction of scale space $L(x,y,\sigma)$

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y),$$

where $*$ is the convolution operation in $x$ and $y$, and

$$G(x, y, \sigma) = \frac{1}{2\pi \sigma^2} e^{-\frac{(x^2 + y^2)}{2\sigma^2}}$$
Local Extrema Detection

Keypoint Localization

- Candidates fitted to a detailed model to determine their scale and location

- The Taylor expansion is used to determine the interpolated location of the keypoints

- Edge and Low contrast point reduction
Orientation Assignment

- Consistent orientation at each keypoint
- $L(x,y)$ at the selected scale, the gradient magnitude, $m(x,y)$, and orientation, $\theta(x,y)$, are calculated

\[
m(x, y) = \sqrt{(L(x + 1, y) - L(x - 1, y))^2 + (L(x, y + 1) - L(x, y - 1))^2}
\]

\[
\theta(x, y) = \tan^{-1}((L(x, y + 1) - L(x, y - 1))/(L(x + 1, y) - L(x - 1, y)))
\]

Keypoint Description

- Parameters are then assigned to a distinctive feature descriptor
- Local image gradients at selected scale
- Gradients are then distributed into orientation histograms composed of 8 bins over a 4x4 region
• Transformation to 128 element vector
• Normalized to reduce the effects of illumination variance
Sample Processing
VLFeat: An Open and Portable Library of Computer Vision Algorithms (www.vlfeat.org)
Proposed Workflow

The workflow will be implemented and subsequent experiments will be performed using UAV imagery.

Further expansion of the workflow will include the measurement of control points and the bundle adjustment process required to generate numerical products such as DSM or DEM.

Conclusion

- Rapid Processing
- Computer Vision techniques
- Future Work
References


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