CPSC 695

Multi-resolution approach in GIS and terrain visualization

Dr. M. Gavrilova
Overview

- Definitions
- Multi-resolution approach
- Applications to image analysis
- Applications in biometrics
- Applications in terrain modeling
Terminology

- Multiresolution Analysis
- Multiscale Analysis
- Multilevel analysis
- Scale-space processing
- Wavelets
The Pyramid

- Traditionally stacks of images:
  - $2^n$ by $2^n$, $2^{n-1}$ by $2^{n-1}$, ..., 2 by 2, 1 by 1
- Does not have to be image data
Simple Pyramid Example

- Lena, the typical example
Methodology

For 1 to number of pyramid levels
  tempImg <- doRowConvolution(inImg)
  outImg <- doColumnConvolution(tempImg)

- Convolution creates a subsample of the image
Divide and Conquer

- Creating a pyramid is a variation of the principle of divide and conquer.
- Any point at a certain level is calculated from a small number of points on the previous level.
Action at a Distance

- Local interaction at higher levels (courtesy of Eric Pattison)
Uses of Multiresolution

- GIS applications (Level of Detail, DEM, real-time rendering)
- Biometric applications (face recognition, image processing algorithms, feature extraction)
- Multiresolution can be used for other types of 1D, 2D, and 3D data (maps, binary images, etc)
Example: Multilevel Views and Mapping

- Usage: Used when a textures screen resolution differs from its original resolution

- Example: OpenGL (courtesy of Eric Pattison)
Multilevel Views con’t
Image Compression

- **Usage:** Smaller images, especially useful for satellite or airphoto’s in GIS.
- **Example:** .ecw (enhanced compressed wavelet)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Uncompressed Size</th>
<th>Compressed Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 8000 x 8000</td>
<td>192 MB</td>
<td>4 MB</td>
</tr>
</tbody>
</table>
GIS LOD (Level of Detail)

Usage: A detail-in-context technique for GIS.

Example: The TerraVision™ System

Figure 11. An example image pyramid. (a) Illustrates four different resolutions of an original image, where each level of the pyramid is segmented into 128 x 128 pixel tiles. (b) Shows how this structure can be used to alter the resolution of an image in different regions.
Modeling and Forecasting Web Traffic

- **Usage:** Understanding the complex web traffic graphs.
- **Examples:** Various papers by Aussem and Murtagh.
Multi-resolution in biometric

- Used for face recognition, hand geometry, iris recognition, etc.
- Methodology allows to remove/reduce noise, thus to improve true identification ratio
- Also useful in extracting features and removing unnecessary details
Multi-resolution in GIS

- Visualization of the wavelet transform provides knowledge about the structure of the data and presents a convenient forum for conducting wavelet-based diagnostics prior to reconstruction.
- The multiresolution aspect of the transform also permits the detection and parsing of objects within an image.
Conclusion

- A powerful technique based on divide-and-conquer that finds applications in GIS, visualization, image processing, compression and biometrics.