High-quality Kinect Data Filtering

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Outline

- Problem & Motivation
- Related Work
- Main Idea
- The Computational Method
- Preliminary Results
Kinect Sensor
Noisy Kinect Data

\[ \sigma_z = \sigma_d \left( \frac{m}{f_0} \right) Z^2 \]

\[ \delta_z = \left( \frac{m}{f_0} \right) Z^2 \]
Questions Raised

• What are the characteristics of the Kinect data, especially of the noise?
• Are normal filtering methods the best?
• How to develop better filtering & denoising method?
Experiment on Wall

- Planar
- Monochromatic
- Uniform illumination

Input: Depth Image

Plane Fitting

Visualization of Deviation

positive
relatively largest
negative

20 0

Z [mm]
Look into the data

- Highly quantified with very limited resolution on the depth range
- Error caused by quantization could produce irregular-shaped patches and gaps
- Error caused by quantization is directional
- Some data are more ‘credible’ than others when filtering

Flood Fill of the Raw Depth
Problem & Motivation

• Reduce the error of raw Kinect depth data, typically considering the effect of depth quantization
• Filter the large smooth surface and the small feature differently
Related Work

• Bilateral Filter [1]

Limitation: it can also interpret impulse noise spikes as forming an edge.

Related Work

• Joint-Bilateral Filter [2]
  – Additional one dimension to bilateral filter from color or temporal info

• Mean/Median/Gaussian Filter
  – All could be used to smooth and reduce noise

• Limitation of all the filters
  – Identical filtering for all data without considering the different saliency

Main Idea:
Multi-Scale Anisotropic Filter

Multi-Scale

Anisotropic
Multi-Scale Anisotropic Filter
Computational Method

1. Multi-scale analysis for scale selection
   - Initialize a set of scales
   - Multiple Gaussians with different scales for each pixel
   - Automatically label the pixels as region/boundary/quantization edge/noise
   - Automatically choose optimal scale

2. Structure tensor for orientation selection
   - Tensor conversion
   - Orientation extraction

3. Tensor voting for filtering
Preliminary Results
Preliminary Results
Further Work

• Well formulated weighting strategy for filtering
• Qualitative Evaluation of the algorithm
Thank You!

Any Questions?