

A NATIONAL SCIENCE FOUNDATION
ENGINEERING RESEARCH CENTER

Research Goal
Derivation of scene descriptions from Binocular and Multiple View Stereo in terms of:

- Surfaces
- Curves
- Junctions
- Depth and Orientation Discontinuities

Role in IMSC
Inexpensive and reliable model generation for:

- Graphics
- Animation
- Haptics

Models of people objects and environments for:

- tele-conferencing
- Immersipresence
- e-commerce
- cartography

Research Approach

- Initial matching using multiple methods
 - Normalized cross-correlation
 - Interval matching
- Data Representation by second-order symmetric non-negative definite tensors
- *Smoothness* enforcement in the design of the voting fields
- Information propagation by Tensor Voting
- Use of *saliency* to determine correct matches
- Group points into 3-D surfaces to obtain color information for scene surfaces
- Use color information to validate matches and generate matching hypotheses for unmatched pixels

Uniqueness & Related Work

- Global Optimization Approaches
 - Processing in 2-D (even 1-D)
 - High computational complexity
 - Many unable to handle more than two views
- Methods using Image Segmentation
 - Image Segmentation is harder than Stereo in some cases
- Our Approach
 - Processing in 3-D
 - Integration of multiple matching methods
 - Manageable computational cost due to locality of Tensor Voting
 - Linear wrt number of images
 - Grouping based on binocular cues to infer color distributions

5-Year Plan
Short Term:

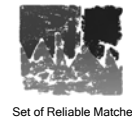
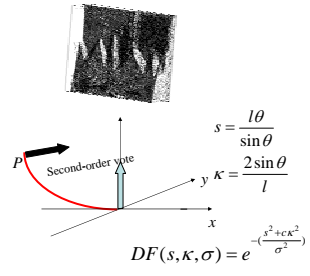
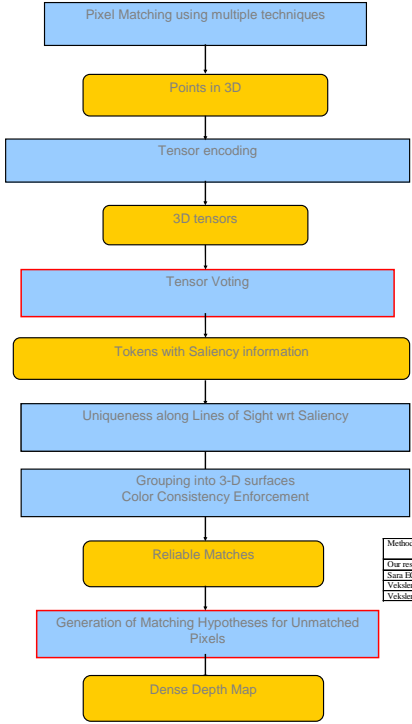
- Integration of curvature

Mid Term:

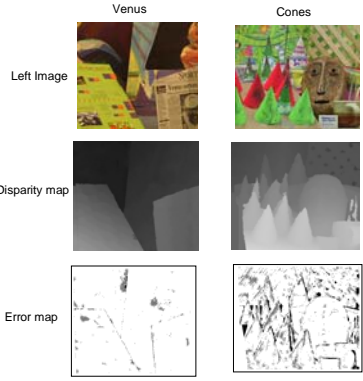
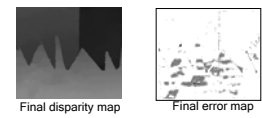
- Multiple-resolution structure extraction
- More efficient data structures

Long Term:

- Multiple-scale Tensor Voting
- Multiple-viewpoint texture-mapping



Method	Tsukuba		Sawtooth		Venus		Map	
	Error	Density	Error	Density	Error	Density	Error	Density
Our result	1.19%	72.5%	0.23%	78.4%	0.20%	74.1%	0.01%	84.2%
Sun ICCV02	1.4%	55%	1.6%	52%	0.3%	40%	0.3%	74%
Vekkar ICCV02	0.38%	66%	1.62%	76%	1.83%	68%	0.22%	87%
Vekkar CVPR03	0.36%	75%	0.54%	87%	0.10%	73%	0.01%	87%



Dataset	Unoccluded		Untextured		Discontinuities	
	Error	Rank	Error	Rank	Error	Rank
Tsukuba	2.19%	10	0.92%	5	11.93%	11
Sawtooth	0.53%	4	0.0%	1	4.91%	6
Venus	0.36%	1	0.16%	2	5.00%	4
Map	0.33%	9	-	-	4.69%	10

Dataset	Our result	SSD	Dynamic Programming	Graph Cuts
	Cones	5.57%	17.8%	17.1%
Teddy	9.10%	26.5%	30.1%	29.3%

Publications

Journals:
M.S. Lee, G. Medioni, and P. Mordohai, "Inference of Segmented Overlapping Surfaces from Binocular Stereo", IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 24, no. 6, pp. 824-837, June 2002.

Conference Proceedings:
P. Mordohai and G. Medioni, "Stereo using Monocular Cues within the Tensor Voting Framework", in Proc. European Conference on Computer Vision, Prague, Czech Republic, 2004.
P. Mordohai and G. Medioni, "Dense Multiple View Stereo with General Camera Placement using Tensor Voting", submitted to the Second International Symposium on 3-D Data Processing, Visualization and Transmission, 2004.
P. Mordohai, G. Medioni, and M.S. Lee, "Inference of Segmented Overlapping Surfaces from Binocular and Multiple-View Stereo", Third Workshop on Perceptual Organization in Computer Vision, 8th IEEE International Conference on Computer Vision, Vancouver, British Columbia, Canada, 2001.
P. Mordohai and G. Medioni, "Perceptual Grouping for Multiple View Stereo using Tensor Voting", in Proc. International Conference on Pattern Recognition, Quebec City, Quebec, Canada, vol. 3, pp. 639-644, 2002.