

## EE367 Project Proposal

### Survey of Disparity Map Algorithms Intended for Real Time Stereoscopic Depth Estimation

#### *Overview and Motivation*

Stereoscopic imaging systems, inspired by the human visual system, provide a low cost approach for inferring depth information. Though LIDAR and RADAR are traditionally used for ranging, these approaches are extremely expensive and present sparse measurements which must be augmented with video streams for object identification and tracking. Multi-camera arrays for depth estimation have thus been pursued as a potential replacement for LIDAR in commercial autonomous vehicles with recent advances in long range object identification algorithms (Wang et al.).

While deriving depth from the angular position of corresponding pixels in multiple views is simple, establishing this correspondence in real time is difficult and a challenge which must be overcome for feasibility in embedded applications. Our proposed project is to survey four algorithms for inferring disparity maps while comparing memory consumption, runtime on test images from the Middlebury sets, and accuracy compared to an offline “ground truth” approach. If we have time we would like to run these algorithms in real time on a personal computer with the use of a rig made from two web cameras.

#### *Related Work*

In “Modern Stereo Correspondence Algorithms, Investigation and Evaluation” written in 2010 Anders describes a general division of the correspondence algorithms between local (fast) and global (accurate) algorithms with some exploration

The Middlebury site supported by Scharstein et al. provide of algorithms that take advantage of image sequences relevant to video data. Algorithms explored include Pixel Matching, Winner-Take-All, and Plane fitting. DERS was evaluated for image sequences. This work references the efforts of Scharstein et al. in compiling algorithms for dense correspondence algorithms and other surveys.

Several datasets with ground truth depth information for evaluation of 50+ algorithms. The algorithms contained here could provide an interesting pool from which to select candidates and the data provided will be invaluable in evaluating our own algorithms.

In Accurate Real-Time Disparity Map Computation Based on Variable Support Window, Nadia Baha and Slimane Larabi propose a new real time-dense stereo matching algorithm which uses a combination of disparity space image structure and gradient information. They first propose a new method of optimizing the computation time of the initial disparity map. Then they propose to

use the magnitude and orientation of pixel gradients in addition to pixel intensities, to provide a more accurate measure of pixel similarity between the two images.

## *Project Overview*

We plan to implement and compare the performance of four disparity mapping algorithms in the context of a simple stereoscopic depth estimation pipeline on the basis of memory consumption, runtime on the middlebury set, handling of edge cases including partial view occlusion and low texture resolution, and accuracy compared to an offline “ground truth” approach.

## *Project Timeline*

### **Week 0-1:**

- Implementation of the algorithms
- Full stereoscopy pipeline
- Implement above software so that it would be easy to migrate to real-time time permitting

### **Week 1-2:**

- Run algorithms on existing test set
- (Time Permitting) Build and calibrate custom webcam rig using OpenCV (OpenCV)

### **Week 2-3:**

- (Time Permitting) Record test footage with webcam rig for edge case testing
- (Time Permitting) Modify existing disparity mapping algorithms or implement one that takes advantage of previous frame result as prior

### **Week 3-4:**

- (Time Permitting) Finish implementation of new algorithm

## *Works Cited*

1. Wang et al. : Pseudo-LiDAR from Visual Depth Estimation: Bridging the Gap in 3D Object Detection for Autonomous Driving  
(<https://arxiv.org/pdf/1812.07179.pdf>)
2. Olofson Anders: Modern Stereo Correspondence Algorithms, Investigation and Evaluation  
(<http://www.diva-portal.org/smash/get/diva2%3A328101/FULLTEXT02.pdf>)

3. Scharstien et al. : vision.middlebury.edu  
(<https://vision.middlebury.edu/stereo/>)
4. Accurate Real-Time Disparity Map Computation Based on Variable Support Window  
([https://www.researchgate.net/publication/276196169\\_Accurate\\_Real-Time\\_Disparity\\_Map\\_Computation\\_Based\\_on\\_Variable\\_Support\\_Window](https://www.researchgate.net/publication/276196169_Accurate_Real-Time_Disparity_Map_Computation_Based_on_Variable_Support_Window))
5. OpenCV : Camera Calibration  
([https://docs.opencv.org/master/dc/dbb/tutorial\\_py\\_calibration.html](https://docs.opencv.org/master/dc/dbb/tutorial_py_calibration.html))