

# Disparity Determination in Stereo Vision

Lu Sang, Michael Haberl, Raphael Ullmann

14.06.2017

# Overview

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# Problem description

## Problem

What is the distance to an object?

How to determine the distance by 2D images?

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How to determine the distance by 2D images?

## Applications

- Autonomous driving
- Robotics

# Problem description



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Disparity

Pixel distance of related pixels.



# Overview

# Preprocessing

- Undistortion
- Rectification
- Normalisation

# Preprocessing

- Undistortion



Figure: Distorted Image



Figure: Undistorted Image

# Preprocessing

- Rectification



Figure: Left Image



Figure: Right Image

# Preprocessing

- Rectification



Figure: Left Image



Figure: Right Image

# Modelling: Energy Function

## Energy Function

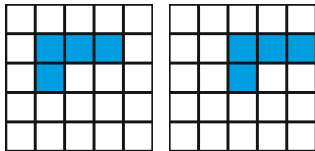
$$\operatorname{argmin}_d C(x, y, d) + S(x, y, d)$$

- Cost  $C(x, y, d)$
- Regularization  $S(x, y, d)$ 
  - E.g. penalty for deviation of neighbouring pixels

# Cost Calculation: Comparing Windows

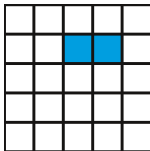
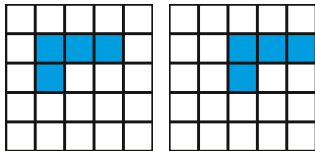
- Use surrounding information of the current pixel
- Compare windows instead of only one pixel
- Windows of size e.g. 5x5

# Cost Calculation: Cross Correlation

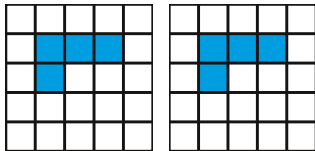




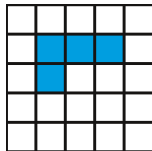
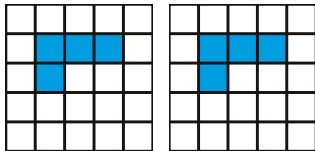
# Cost Calculation: Cross Correlation



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# Current Results



Figure: Left Image



Figure: Right Image

# Current Results

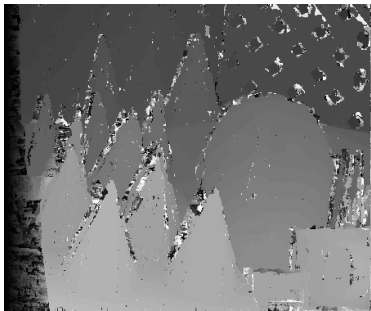


Figure: Cross Correlation

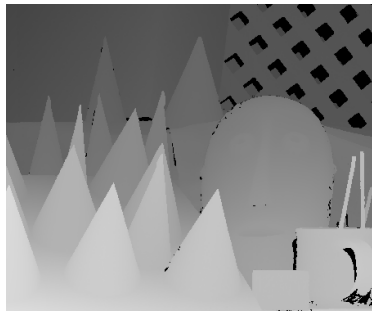


Figure: Ground Truth

# Current Results

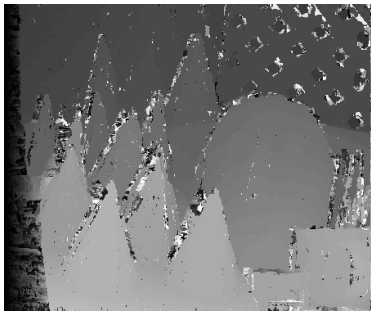


Figure: Cross Correlation

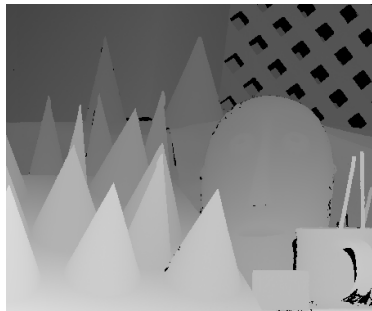


Figure: Ground Truth

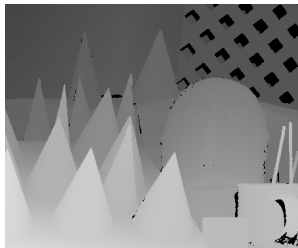
- Current Error Rate: 40 %

# Test Data

- Middlebury Dataset
- Ground Truth
- Leaderboard

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# Algorithm Defect

- Error on the boundary
- Ignores depth discontinuities

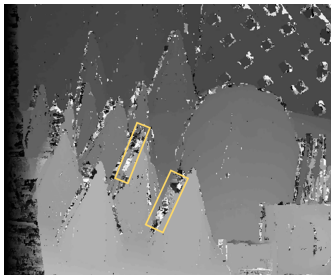


Figure: Error on Boundary



Figure: Discontinuity on Boundary

# Overview

# Further Improvement: Smooth Penalty

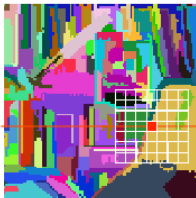
## Assumption

- same object belongs to the same segment
- same segment has the same disparity
- the depth within each segment varies smoothly

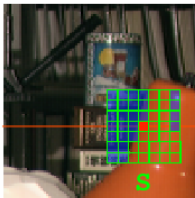
# Smooth Penalty

## Penalty

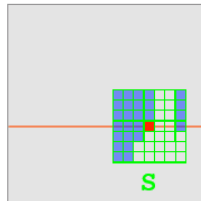
For those pixel with different disparity add a penalty term



R (Seg)



R



R

# Overview

# Summary

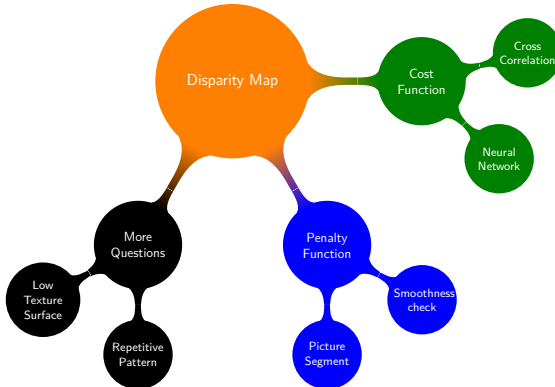
## What we have already done

- Image Preprocessing
- Cost function: Cross Correlation
- Cost function minimization

## Things we want to do after

- Implement penalty function
- Lower error rate
- Increase speed of the algorithm

# Summary & Expectation



Thanks!