Chapter 0
Organization and Introduction

Variational Methods for Computer Vision
WS 16/17

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Organizational Stuff

Requirements, or “is this something for me?”

Necessary

- Interest in mathematical theory
- Solid background in analysis and linear algebra
- Numerics (Matlab)

Nice to know

- Image processing and computer vision
- Optimization
- Functional analysis

Formalities

Exercises

- Exercise sheets covering the content of the lecture will be passed out every Monday
- Exercises contain theoretical as well as programming problems
- You have one week for the exercise sheets and can turn in your solution in the following week during Monday's lecture
- You may work on the exercises in groups of two
- **Reaching at least** 50% **of the total exercise points is a requirement for being admitted to the examination**
- If solutions have obviously been copied, both groups will get 0 points
- You will discuss the solution to the exercises with Jonas Geiping on Wednessday (14-16 o'clock, H-C 7326).

Formalities

Questions within the lecture

The more we discuss in the lecture, the more interesting the course will be! Please don't be shy to say something!

Examination

- The final exam will be oral
- The lecture is worth 10 credits

Formalities

Miscellaneous

- My office: H-A 7106
- Jonas' office: H-A 7116
- Office hours: Please write an email.
- Lecture: Starts at 16:oo sharp. Short break in between.
- Course website:
  `http://www.vsa.informatik.uni-siegen.de/en/variational-methods-computer-vision`
- To access the course material: username "student" password "100%brain"

Overview

Lecture overview

Chapter 1: Basics and necessary Tools

Topics:

- Types of images and signals
- Discrete vs. continuous representations
- How simple things can fail - ill-posedness
- The general idea of variational methods
- A simple optimization method

Goals:

- Establish a common ground
- Understand the motivation for variational methods
- Know a first way to implement them numerically

Lecture overview

Chapter 2: Linear inverse imaging problems

- Denoising
- TV-Regularization
- MAP-estimates and different data terms
- Non-local regularization
- Deblurring
- Super resolution
- Demosaicking
- Inpainting
- Patch-based regularization
- Non-convex regularizations

Goals:

- A thourough understanding of how to formulate energy minimization problems
- Get to know different regularization methods

Lecture overview

Chapter 3: Non-linear and non-convex problems

- Image segmentation
- Stereo depth reconstruction
- Optical flow estimation
- 3D reconstruction
- Blind hyperspectral unmixing and matrix factorization

Goals:

- Learn different ways to ”fight” non-linearities
- Study several exciting problems

An overview in images

Denoising

An overview in images

Denoising

An overview in images

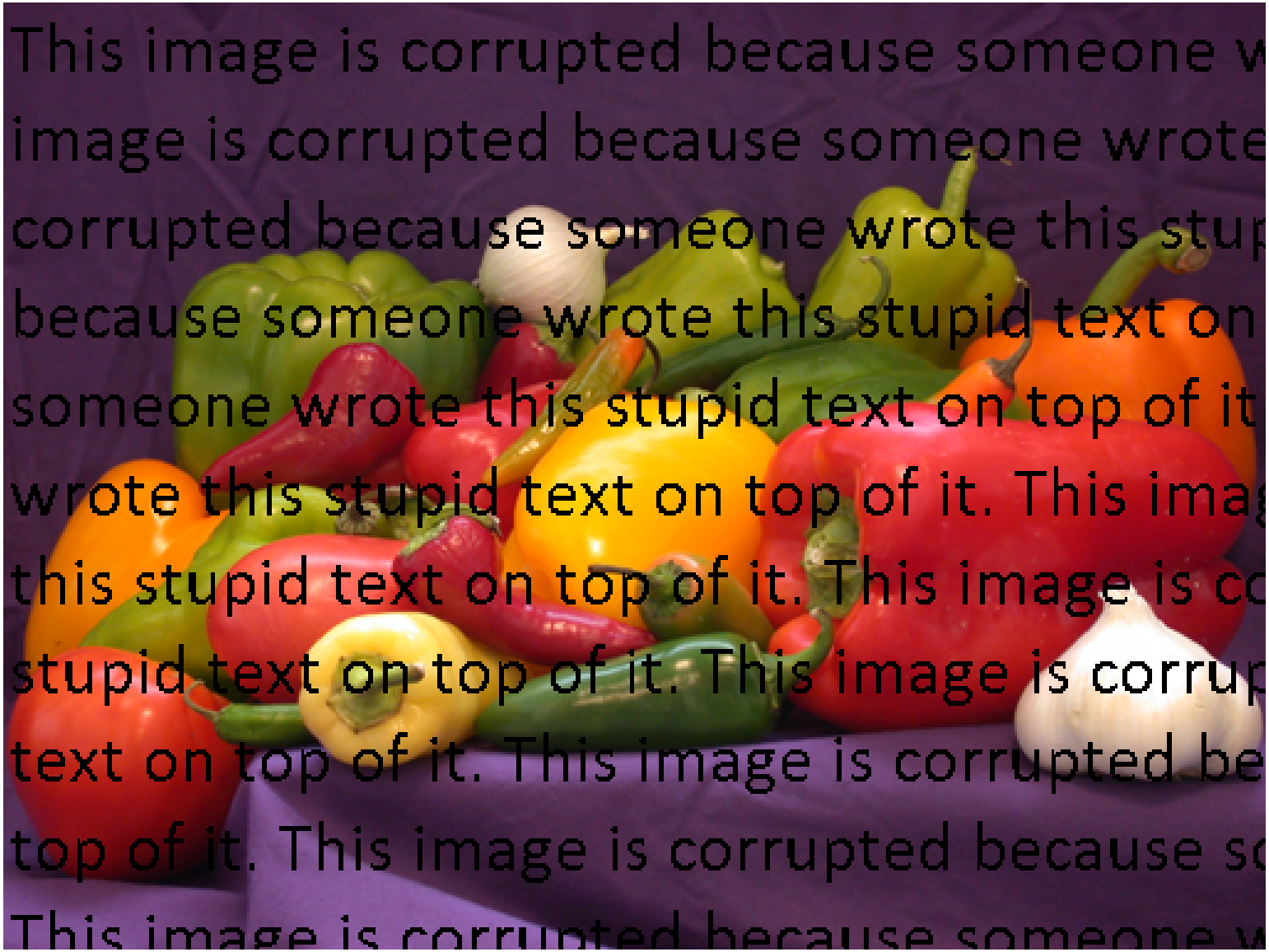
Deblurring

An overview in images

Deblurring

An overview in images

Inpainting



An overview in images

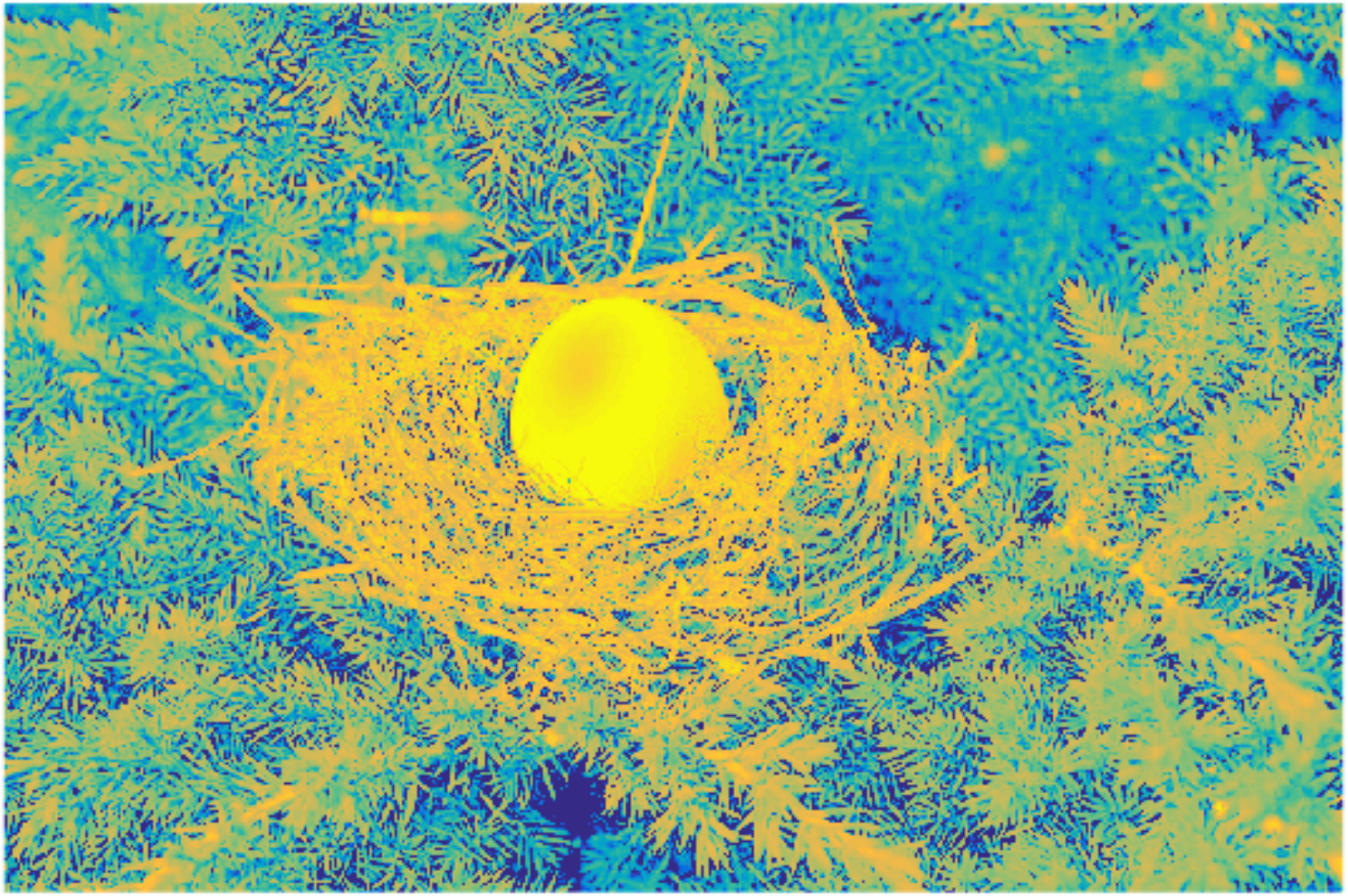
Inpainting

An overview in images

Segmentation

An overview in images

Segmentation



An overview in images

Segmentation

An overview in images

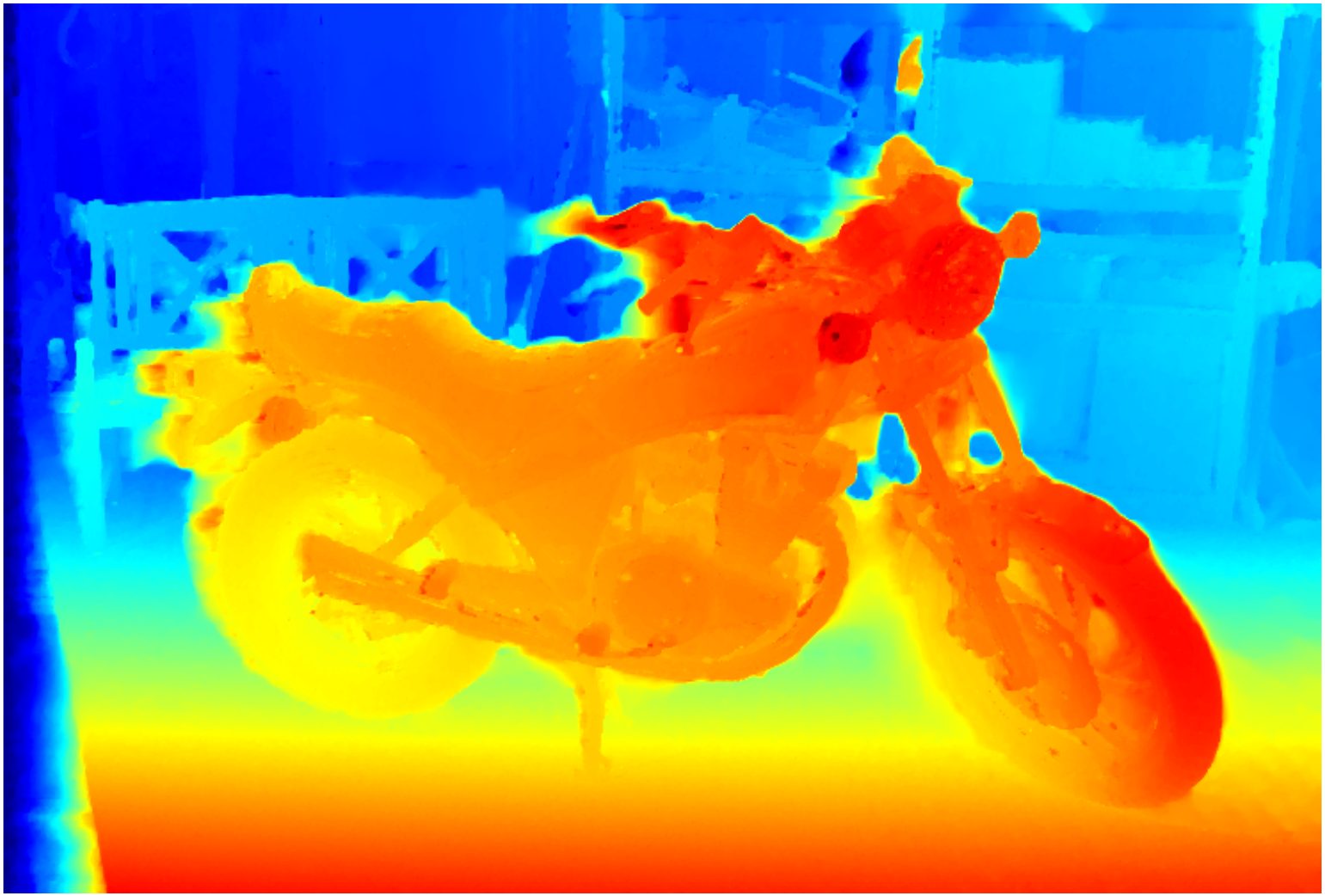
Stereo imaging

An overview in images

Stereo imaging

An overview in images

Stereo imaging

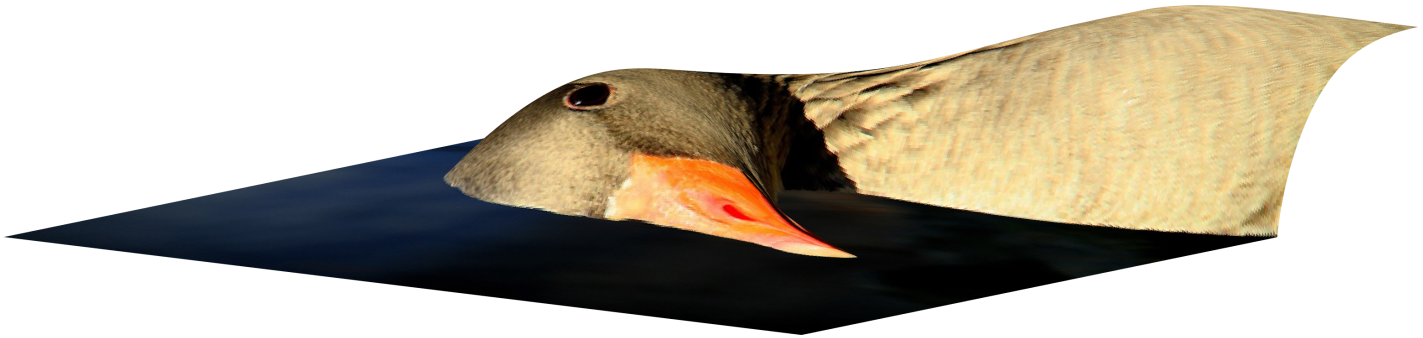


An overview in images

3D reconstruction

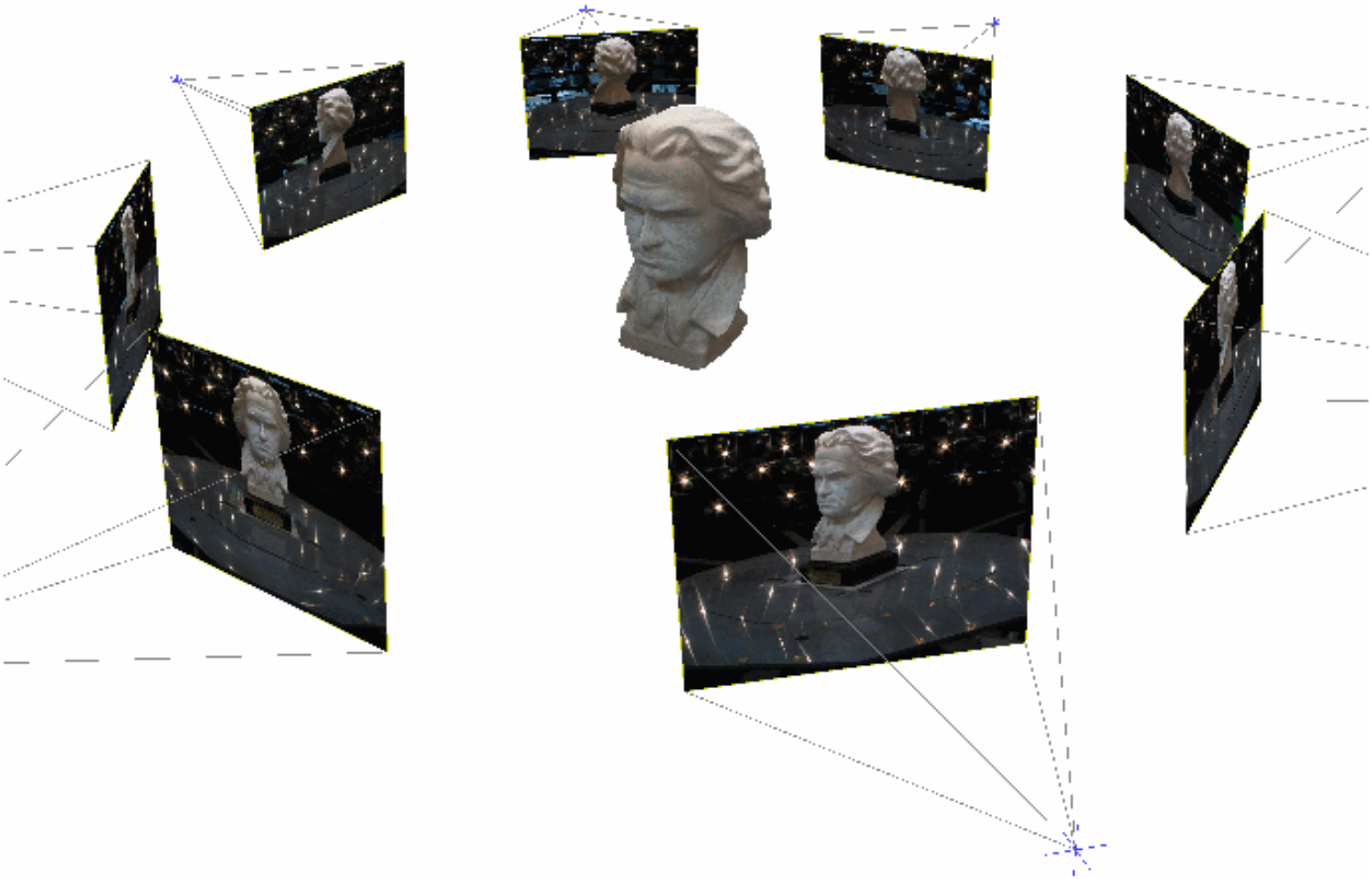
An overview in images

3D reconstruction



An overview in images

3D reconstruction



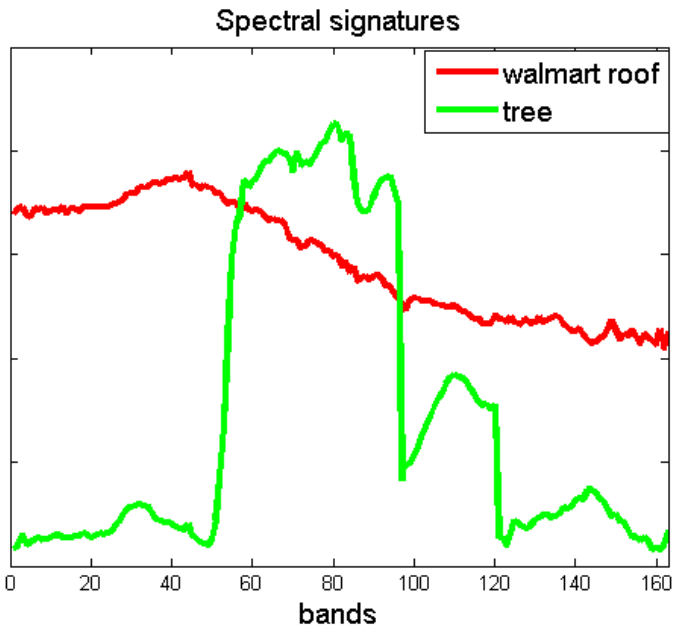
From

http://vision.in.tum.de/research/image-based_3d_reconstruction/multiviewreconstruction

An overview in images

Hyperspectral imaging

Hyperspectral cube with 163 bands

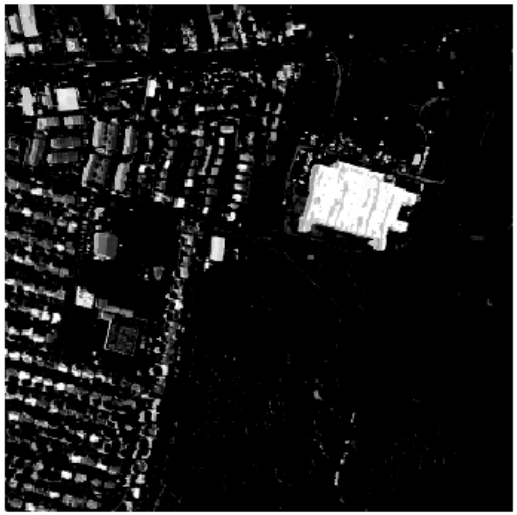


An overview in images

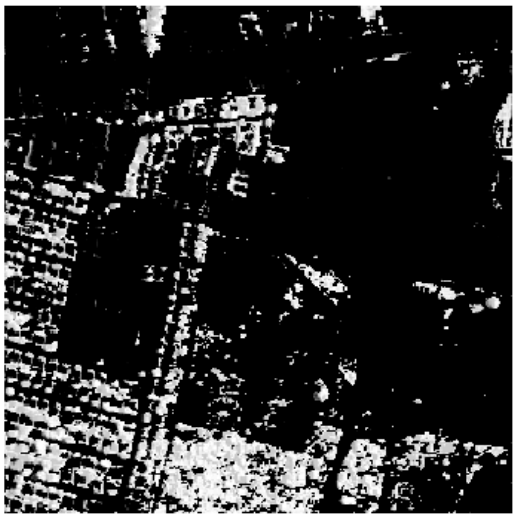
Hyperspectral imaging

color image illustration

endmember "road"



endmember "roof"



endmember "trees"

Remarks

- The lecture covers many different aspects
- This means we sometimes cannot go into many details
- This will be difficult for me!
- If you have the feeling I am covering more content by increasing the speed to an unreasonable level, stop me!

Let's start!