Robotics and
Embedded Systems

Applied Computer Vision for Robotics

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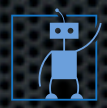
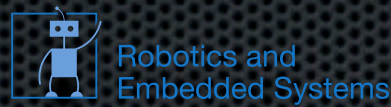
GitHub



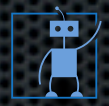
- Find together in groups of 3 people
- Everyone needs to create a GitHub account http://github.com
- Write a mail to jensen@in.tum.de containing:
  - team name (be creative here)
  - real name, GitHub account name and e-mail address for each team member

Syllabus



- New sheet every 2 weeks
- **Mandatory** meeting every week
- Short presentation of the sheet results by the teams
- Everyone will be registered to a RVC mailing list - ask questions here
- You can also ask us questions or write mails

ROS



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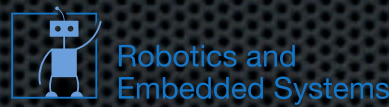
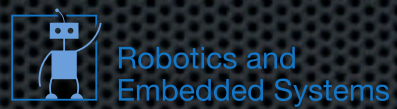
- We are going to use ROS - Robot Operating System (www.ros.org)
- We'll introduce it on the fly and give hints which packages you might need
- Check out the tutorials and wiki on ros.org for more details

Cameras



- If you don’t have an own camera working in ROS, you can borrow one from us
- PSEye Camera - 640x480 @60Hz
- **Deposit: 10 €**

Harris



- Detect image corners
- Calculate structure tensor

$$M = \sum_{u,v} w(u,v) \begin{pmatrix} \nabla_x I & \nabla_x I \nabla_y I \\ \nabla_x I \nabla_y I & \nabla_y I \end{pmatrix}$$

- Be careful about the image data types
- Use the eigenvalues λ_1, λ_2 to calculate the "corneress"

Harris

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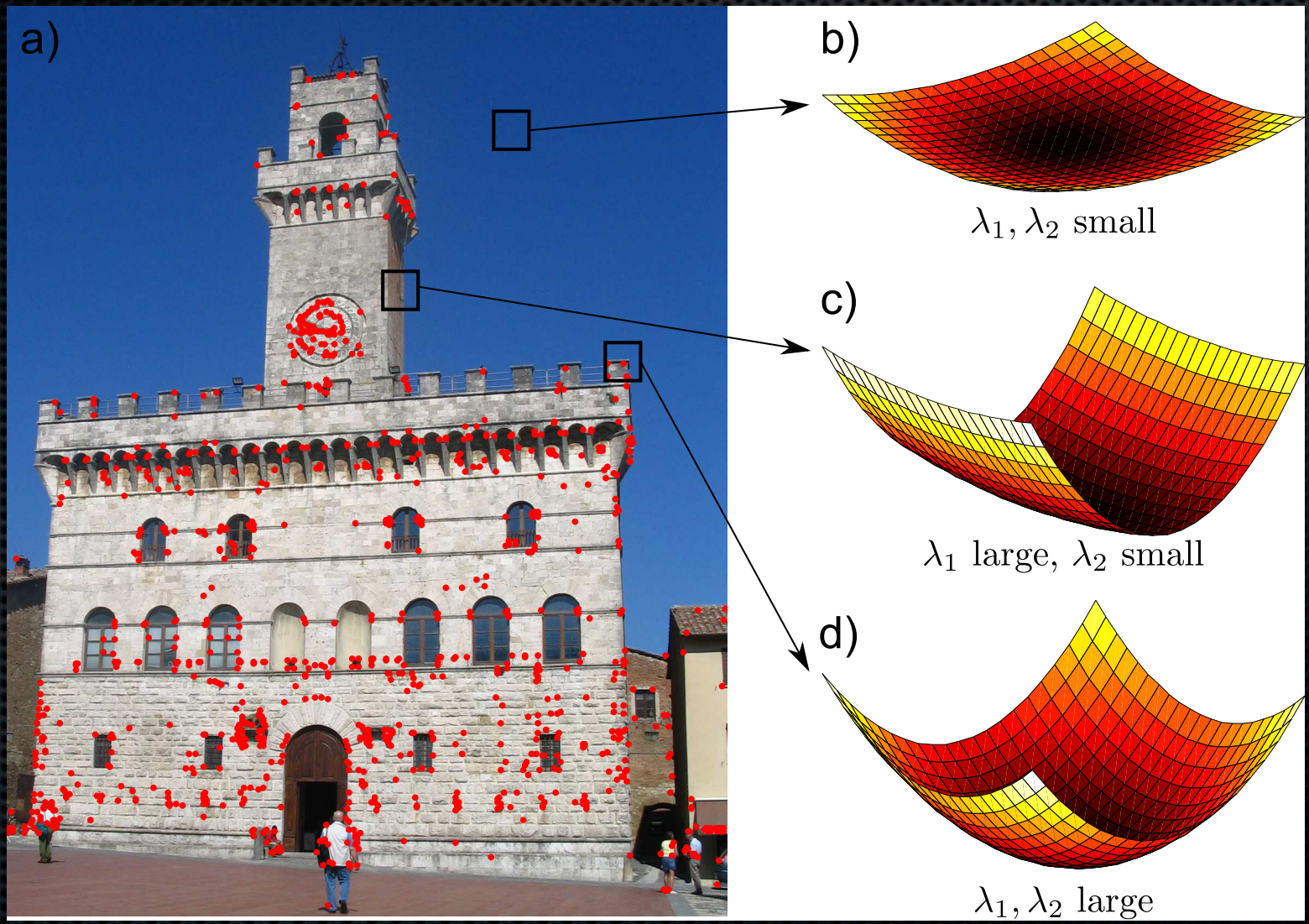
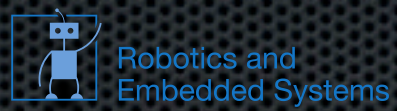


Harris



- Use the Harris-Stephens formula to avoid the exact computation of the eigenvalues

$$M_c = \lambda_1 \lambda_2 - \kappa(\lambda_1 + \lambda_2)^2$$
$$= \det(M) - \kappa \, \mathrm{trace}^2(M)$$

- Kappa is a parameter and can be tuned to get reasonable results
- Threshold to get corners and perform non-maximum suppression

Scale Space

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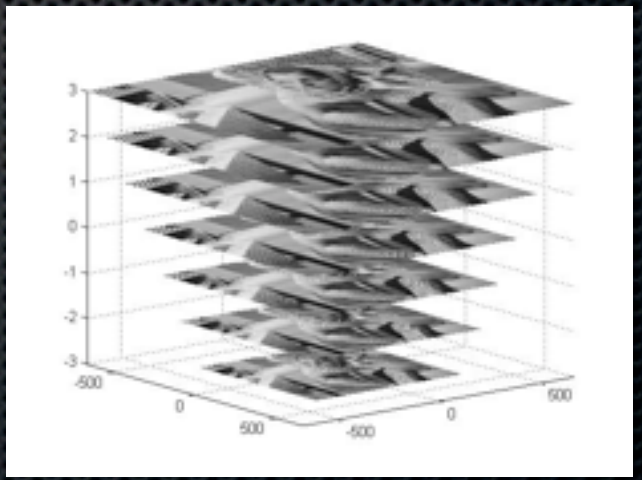
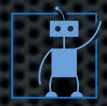
- Perform Harris corner detection on different scales
  - Create an image pyramid with a scale factor (<1) and a fixed number of octaves
  - Detect the corners in each octave



Orientation



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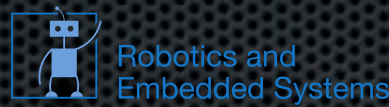
- Find the orientation of each corner
- Compute the angle using

$$\theta = \operatorname{atan2}\left(\sum_{u,v} w(u,v)\begin{pmatrix}\nabla_x I\\ \nabla_y I\end{pmatrix}\right)$$

ANMS



- Very often the detected features are not well distributed over the image
- Instead of using a fixed threshold ANMS uses only non maximum suppression within a certain radius