

Computer Vision 1&2
SS 2011

<http://www.icg.tu-graz.ac.at/courses/cgcv>

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Visual Information

Image processing Geometry processing

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Plan für heute

- Organisation der Vorlesung
- Überblick über behandelte Themen
- Etwas Inhalt (Bildentstehung)
- Organisation des Übungsteiles+Bsp

➤ DI Andreas Wendel
➤ Dr. Denis Kalkofen

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LVA-Module Überblick

	DO 8:15-9:45 HS i13 Bischof	DO 10:15-11:45 HS i13 Reitmayr
März April	Computer Vision 1	Computer- Graphik 1
Mai Juni	Computer Vision 2	Computer- Graphik 2

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LVA-Module: CG1-CV1 (Telematik,SE-Wi)

BACG = VIS =	Computer Vision 1	Computer- Graphik 1
	Computer Vision 2	Computer- Graphik 2

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LVA-Module: CG + CV (Informatik)

	Computer Vision =	Computer-Graphik =
	Computer Vision 1 +	Computer-Graphik 1 +
	Computer Vision 2	Computer-Graphik 2

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LVA-Module: Leistungsfeststellung

	Computer Vision 1 = CV-Beispiel 1a + CV-Beispiel 1b + Prüfung (45') am 26.5.	Computer-Graphik 1 = CG-Beispiel 1a + CG-Beispiel 1b + Prüfung (45') am 26.5.
	Computer Vision 2 = CV-Beispiel 2 + Prüfung (45') am 30.6.	Computer-Graphik 2 = CG-Beispiel 2 + Prüfung (45') am 30.6.

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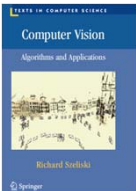
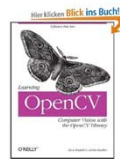
- Modus
- Beurteilung der inskribierten LV:
Summe der erreichten Punkte
 - Siehe auch:
– <http://www.icg.tu-graz.ac.at/courses/cgcv>
 - 1 x Prüfungs-Nachtermin im Oktober
 - **CG2 und CV2 als Freifächer empfohlen (Telematik, SE-Wi)**
→ Für aufbauende Lehrveranstaltungen am ICG
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UNTERLAGEN

FOLIEN
<http://www.icg.tu-graz.ac.at/courses/cgcv>
Folien ersetzen NICHT Vorlesungsbesuch und/oder Lektüre der Bücher!

BÜCHER (einzelne Kapitel)
Rick Szeliski, Computer Vision:
<http://szeliski.org/Book/>

Übungen verwenden OpenCV
<http://opencv.willowgarage.com/wiki/>

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- Warnung!**
- Dies ist eine Einzel-Übung!
 - Keine Code-Plagiate bei Übungsbeispielen!
 - Automatische UND händische Überprüfung
 - 2005: 20% (!) Plagiatsversuche entdeckt
 - **0 (Null) Punkte** auf das kopierte Beispiel
 - Für den **Urheber** und den **Empfänger**
 - **Datensicherheit** ist Aufgabe der Studierenden
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**CV1 & CV2
VORLESUNGSTHEMEN**

Readings:

Szeliski: Chapter 1 (Introduction)

Some Slides adapted from Univ. of Washington
<http://www.cs.washington.edu/education/courses/cse576/08sp/>

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Vorlesungstermine

CV1

- 3.3. Einführung/ Image Formation
- 10.3. Image Processing I
- 17.3. Image Processing II
- 24.3. Feature Detection
- 31.3. Segmentation
- 7.4. 3D Vision-Stereo

CV2

- 14.4. Image Features
- 12.5. Classification+Recognition
- 19.5. Motion OF
- 26.5. Prüfung CV1
- 9.6. Tracking
- 16.6. Texture
- 30.6. Prüfung CV2

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The importance of images

Some images are more important than others



"Dora Maar au Chat"
Pablo Picasso, 1941

100 million \$

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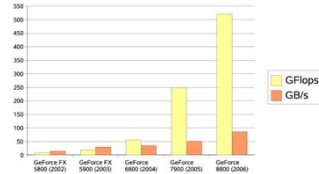
Visuelle Information geht von Bildern aus

- > Ein Bild sagt mehr als tausend Worte **und genau das ist das Problem!**
- > Ist ein Lösung **berechenbar** mit den vorhandenen **Ressourcen** (Rechner und Zeit)?
- > Challenges
 - > Riesige Datenmengen
 - > Echtzeitanforderungen (Grafik & Vision)
 - > Effiziente Algorithmen
 - > Zusammenspiel mit der Hardware

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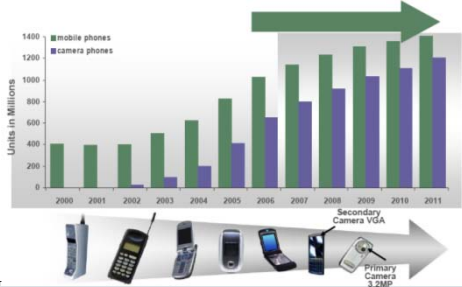
Was sind die Technologietreiber?

- Moore Law → **Schnelle Rechner**
 - Smart Phones
- Computer Spiele → **Schnelle Grafik Hardware**
- **Digitale Photos**
 - Digital Kameras
 - Handy
- **WWW**



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Integration of Cameras in Mobile Phones



Units in Millions

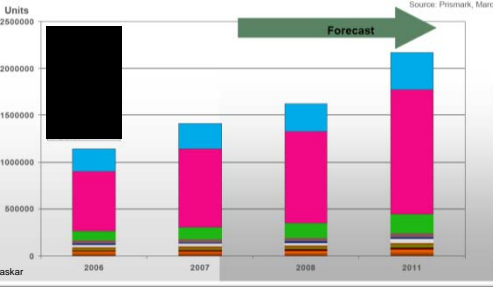
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Primary Camera 3.2MP
Secondary Camera VGA

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Wo sind Kameras?

Image Sensors Markets

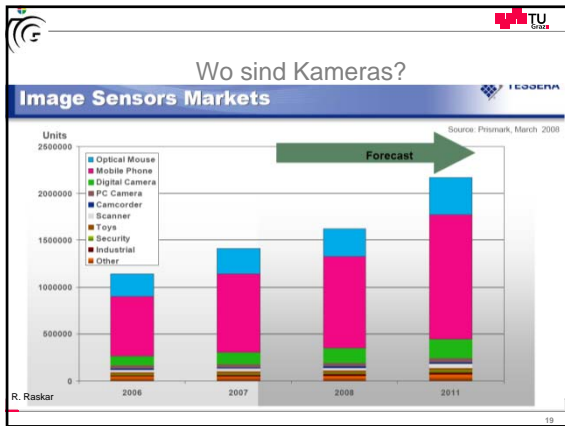


Units

2006 2007 2008 2011

Source: Prismark, March 2008

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Resolution

Ever growing resolution:

- 1975: $100 \times 100 = 0.01$ MP
- 2008: $9216 \times 9216 = 85$ MP (BAE)
- UltraCam_x: 216 MP

1900 Chicago & Alton Railroad Train (photograph a train), \$5000

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Every picture tells a story

La Gare Montparnasse, 1900

- Goal of computer vision is to write computer programs that can interpret images

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Can computers match (or beat) human vision?

La Gare Montparnasse, 1900

- Yes and no (but mostly no!)
 - humans are much better at "hard" things
 - computers can be better at "easy" things

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Human perception has its shortcomings...

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"Optical" Illusions

Classical "optical" Illusions:

Helmholtz Squares (1866) Müller-Lyer Illusion (1860)

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"Optical" Illusions

Hering Illusion (1861)
Wundt Illusion (1896)

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Copyright A. Kitaoka 2003
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Current state of the art

- The next slides show some examples of what current vision systems can do

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Application of statistical image model, and variational Bayesian inference: removing motion blur

Original

Variational Bayes

Fergus et al., 2006

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Close-up

Original Naïve Sharpening Variational Bayes

Fergus et al, 2006

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Earth viewers (3D modeling)

Image from Microsoft's BING
(see also: [Google Earth](#))

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Optical character recognition (OCR)

Technology to convert scanned docs to text

- If you have a scanner, it probably came with OCR software

Digit recognition, AT&T labs
<http://www.research.att.com/~yann/>

License plate readers
http://en.wikipedia.org/wiki/Automotive_number_plate_recognition

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Face detection

- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

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Smile detection?

The Smile Shutter flow

Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically tip the shutter at just the right instant to catch the perfect expression.

[Sony Cyber-shot® T70 Digital Still Camera](#)

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Everyone is laughing

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Object recognition (in supermarkets)

LaneHawk by EvolutionRobotics
 "A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it..."

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Face recognition

Who is she?

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Vision-based biometrics

"How the Afghan Girl was Identified by Her Iris Patterns" Read the [story](#)

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Login without a password...

Fingerprint scanners on many new laptops, other devices

Face recognition systems now beginning to appear more widely
<http://www.sensiblevision.com/>

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Object recognition (in mobile phones)

- This is becoming real:
 - [Lincoln](#) Microsoft Research
 - [Point & Find](#), [Nokia](#)

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Special effects: shape capture

The Matrix movies, ESC Entertainment, XYZRGB, NRC

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Special effects: motion capture

Pirates of the Caribbean, Industrial Light and Magic

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Sports

Sportvision first down line
Nice [explanation](#) on [www.howstuffworks.com](#)

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Slide content courtesy of Amnon Shashua

- [Mobileye](#)
 - Vision systems currently in high-end BMW, GM, Volvo models
 - By 2010: 70% of car manufacturers.

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Vision-based interaction (and games)

Digimask: put your face on a 3D avatar.

Nintendo Wii has camera-based IR tracking built in. See [Lee's work at CMU](#) on clever tricks on using it to create a [multi-touch display!](#)

"Game turns moviegoers into Human Joysticks". CNET
Camera tracking a crowd, based on [this work](#)

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Vision in space


NASA's Mars Exploration Rover Spirit captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

Vision systems (JPL) used for several tasks


- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read "[Computer Vision on Mars](#)" by Matthies et al.

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Robotics



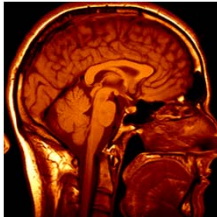
NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover



<http://www.robocup.org/>

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Medical imaging



3D imaging
MRI, CT

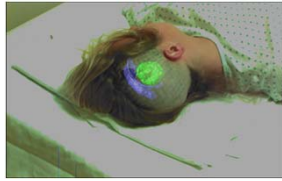


Image guided surgery
[Grimson et al., MIT](#)

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Current state of the art

- You just saw examples of current systems.
 - Many of these are less than 5 years old
- This is a very active research area, and rapidly changing
 - Many new apps in the next 5 years
- To learn more about vision applications and companies
 - [David Lowe](#) maintains an excellent overview of vision companies
 - <http://www.cs.ubc.ca/spider/lowe/vision.html>

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