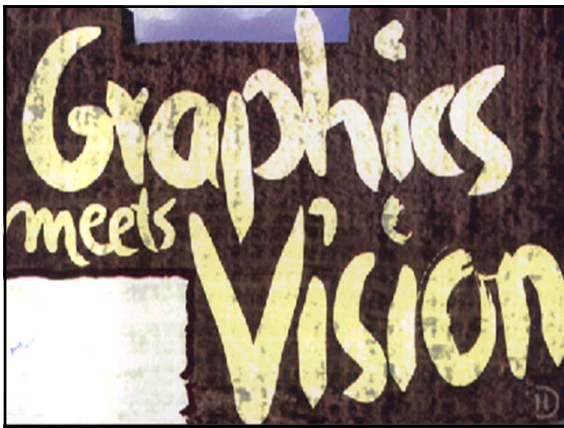


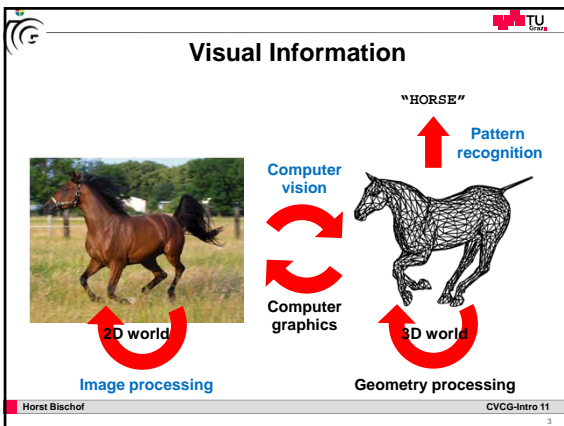
Computer Vision 1&2
SS 2011

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

Prof. Horst Bischof
Institut für maschinelles Sehen und Darstellen

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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**

GPU Model	GFlops	GB/s
GeForce FX 5600 (2002)	~10	~10
GeForce FX 5900 (2003)	~20	~20
GeForce 6800 (2004)	~50	~50
GeForce 7900 (2005)	~200	~100
GeForce 8800 (2006)	~500	~150

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Integration of Cameras in Mobile Phones

Year	Mobile phones	Camera phones
2000	~400	0
2001	~400	0
2002	~400	0
2003	~450	~100
2004	~550	~200
2005	~800	~400
2006	~1000	~600
2007	~1100	~800
2008	~1200	~900
2009	~1250	~1000
2010	~1300	~1100
2011	~1350	~1200

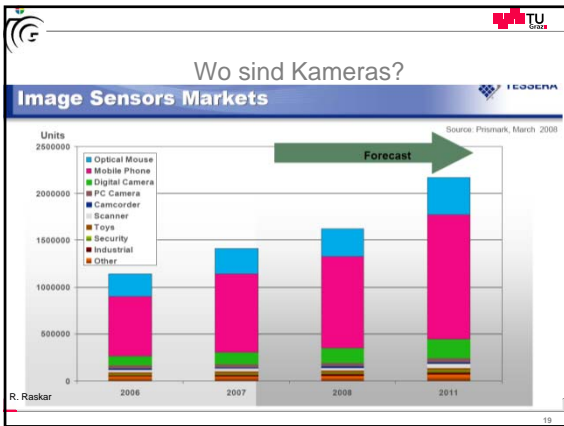
R. Raskar Horst Bischof CVCG-Intro 11 17

Wo sind Kameras?

Image Sensors Markets

Year	Units
2006	~1,200,000
2007	~1,400,000
2008	~1,600,000
2011 (Forecast)	~2,200,000

R. Raskar Source: Prismark, March 2008 CVCG-Intro 11 18



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, 1925

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

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Can computers match (or beat) human vision?



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

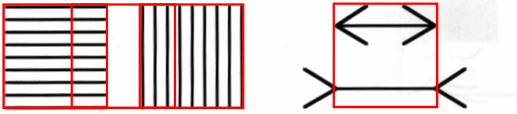
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Human perception has its shortcomings...

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"Optical" Illusions

Classical "optical" Illusions:



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

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TU
Eberhard-Karls-Universität
Tübingen

"Optical" Illusions

Hering Illusion (1861) Wundt Illusion (1896)

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Horst Bischof Copyright [A. Kitaoka](#) 2003 CVCG-Intro 11 26

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Current state of the art

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

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


Original Variational Bayes

Horst Bischof Fergus et al., 2006 CVCG-Intro 11



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/Automatic_number_plate_recognition

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Face detection

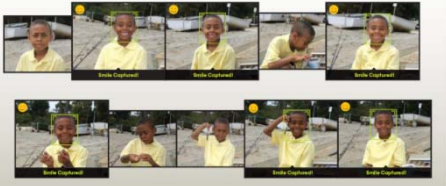


- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

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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 flip 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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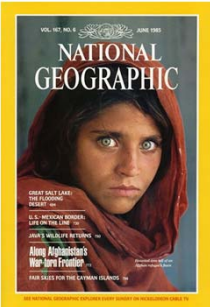
Object recognition (in supermarkets)



[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?

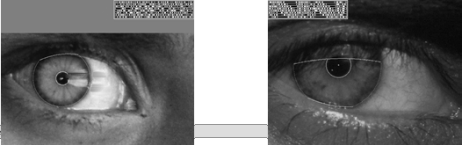
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Vision-based biometrics



"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](http://www.howstuffworks.com) on www.howstuffworks.com

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Robotics



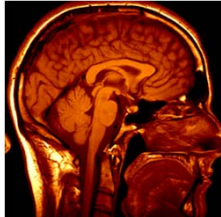
NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover



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

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Medical imaging



3D imaging
MRI, CT

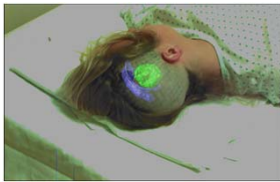


Image guided surgery
[Grimson et al., MIT](#)

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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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