

Image and Video Compression

EE368b

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Bernd Girod: EE368 Digital Image Processing

Introduction no. 1

Introduction

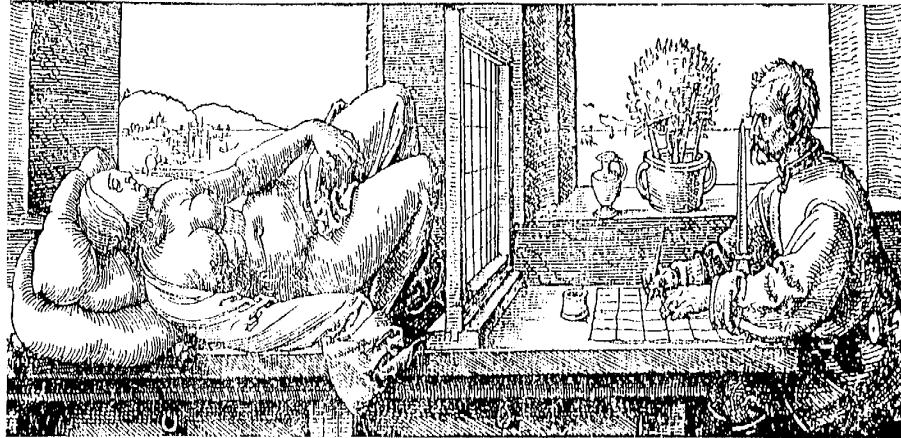
- A brief history of (electronic) image communication
 - Invention of photography and cinema
 - Invention of television
 - Introduction of television broadcasting
- Current technological challenges
- Technological key problems
- What will be covered in this course?
- Organisation



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Introduction no. 2

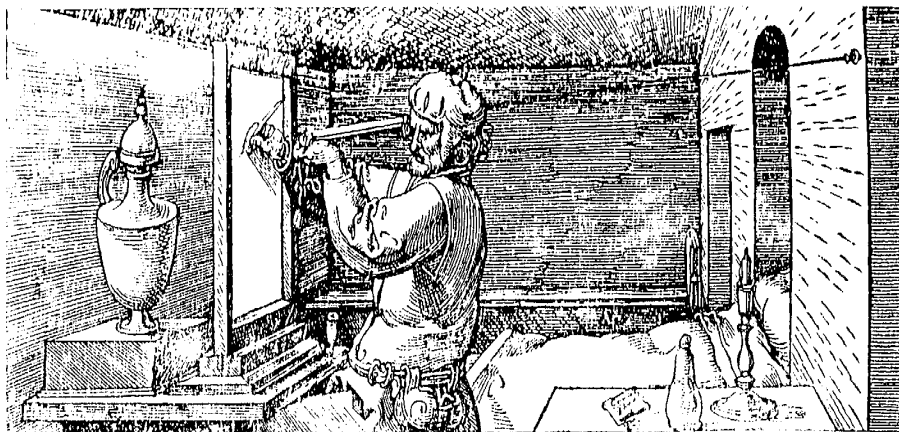
Perspective Projection



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Introduction no. 3

Perspective Projection II



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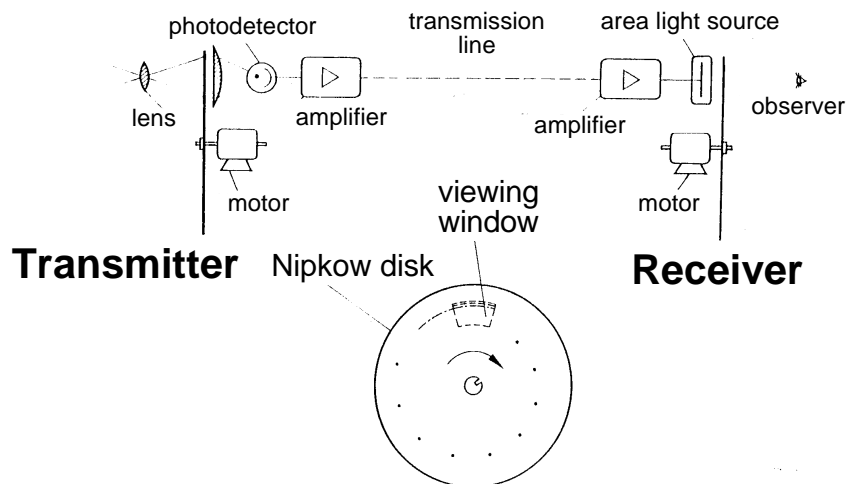
Introduction no. 4

Photography and Cinema

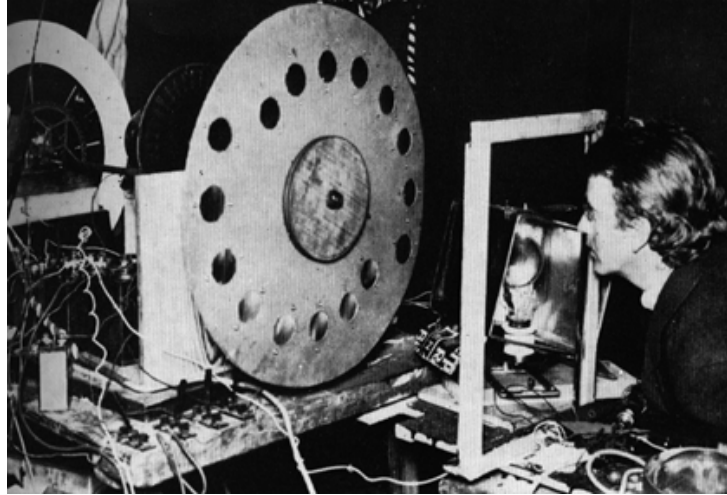
- 1840 Louis J. M. Daguerre, France
William Henry Fox Talbot, USA
photographic film
- 1895 First public motion picture presentation
(Lumière brothers, France)
- End 1920s Sound motion pictures: „talkies“
- 1930s Color movies



Nipkow Disk I



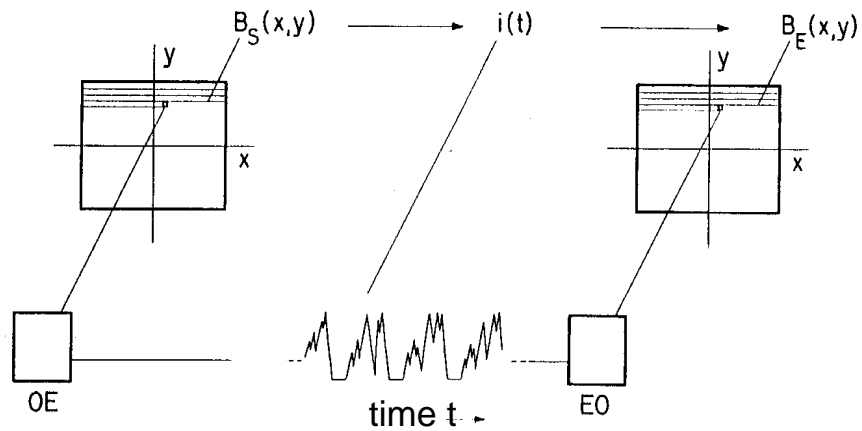
Nipkow Disk II



British TV pioneer J.L. Baird with Nipkow disk (around 1926)



Image Transmission by Line Scanning



Cathode Ray Tube (Braun)

12. Ueber ein Verfahren zur Demonstration und zum Studium des zeitlichen Verlaufes variabler Ströme; von Ferdinand Braun.

1. Die im Folgenden beschriebene Methode benutzt die Ablenkbarkeit der Kathodenstrahlen durch magnetische Kräfte. Diese Strahlen wurden in Röhren erzeugt, von deren einer ich die Maasse angebe, da mir diese die im allgemeinen günstigsten zu sein scheinen (Fig. 1). *K* ist die Kathode aus Aluminiumblech, *A* Anode, *C* ein Aluminiumdiaphragma; Oeffnung des Loches = 2 mm. *D* ein mit phosphorescirender Farbe überzogener Glimmerschirm. Die Glaswand *E* muss möglichst gleichmässig und ohne Knoten, der phosphorescirende Schirm

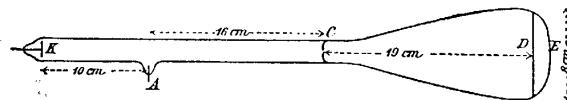


Fig. 1.



History of Electronic Image Communication I

- 1920s **First television experiments**
- 1930-32 First experimental television broadcasting (New York City)
- 1935 **First German television broadcasting in Berlin**

TV transmission during the Berlin summer olympics 1936 using an iconoscope camera



History of Electronic Image Communication II

- 1939 Regular monochrome TV service in the US
- 19__ First regular TV service in _____
- 1952 First regular TV service in Germany
- 1954 Introduction of NTSC color television in US
- 19__ Introduction of _____ color television in ___
- 1967 PAL color television in Germany
- 1970s Consumer video cassette recorder (VCR)
- late 70s Fax machines
- 1980s Digital TV studios (ITU-R Rec. 601)



*Dr.-Ing. h.c. Walter Bruch,
inventor of the PAL system*



Recent Developments: 1990s

- JPEG and MPEG standards
- Digital still cameras
- Digital TV broadcasting
- Digital video/versatile disk (DVD)
- Integration of computers and video
- World Wide Web
- Internet video streaming

***Each “recent development” depends on
efficient compression of images or video!***



Motivating Image Compression

- Binary image (fax)
 - 8.5 x 11 in document scanned at 7.7 lines/mm with 1 bit/pixel
 - 4.1 Mbits for 1 page = 7 minutes over 9600 baud connection
- Photos on 35 mm film
 - Scanned at 12 μ resolution (3656x2664 pixels) with 8 bits per color and 3 colors
 - 233 Mbits for 1 photo, 2/3 of 48 Mbyte compact flash card



Motivating Video Compression

- Digital video studio standard ITU-R Rec. 601

	Y	Cr	Cb
Sampling rate	13.5 MHz	6.75 MHz	6.75 MHz
Quantization	8 bit	8 bit	8 bit
Raw bit rate		216 Mbps	
W/o blanking intervals		166 Mbps	

- Some interesting bit-rates
 - Terrestrial TV broadcasting channel ~20 Mbps
 - Computer hard disk 20...40 Mbps
 - DVD (max. 17 GB/length of movie) 10...20 Mbps
 - Ethernet/Fast Ethernet <10/100 Mbps
 - DSL downlink 384...2048 kbps
 - V.34 modem 28.8 kbps
 - Wireless cellular data 9.6...112 kbps



Outline EE368b

- Some fundamental results of information theory
- Scalar quantization and vector quantization
- Human visual perception
- Predictive coding
- Transform coding
- Resolution pyramids and subband coding
- Interframe coding
- Motion estimation
- Motion compensated coding
- Coding standards JPEG, H.261, H.263 and MPEG



Prerequisites EE368b

- Required
 - Signals and systems, e.g., EE261
 - Statistical signal processing, e.g., EE278
- NOT required
 - Information theory, will be reviewed in class
 - EE368a (Digital Image Processing)



EE368b Organisation

- Regularly check class home page:
<http://www.stanford.edu/class/ee368b>
- Mailing list:
*Send mail to majordomo@lists.stanford.edu
subscribe ee368b*
- Assistants
 - General TA: Markus Flierl
 - ISE lab TA: Sung-Won Yoon
 - Course assistant: Kelly Yilmaz



EE368b Organisation (cont.)

- Homeworks
 - 3-4 problem sets, require computer + Matlab
 - Term project
 - Individually or in groups, 40-50 hours per person
 - Project approval required, deadline: October 31
 - Class-room presentations of projects: Dec. 1-8
 - Web submission of project report: deadline Dec. 1, **no extensions!**
- Grading
 - Homeworks: 25%
 - Mid-term: 25%
 - Term project: 50%
 - No final.



ISEP laboratory

- Created by an equipment grant from Hewlett-Packard Corporation and Xerox Corporation.
- Exclusively a teaching laboratory
- Location: Packard room 066
- 11 HP Workstations, 2 PCs, scanners, printers etc.
- Access:
 - door combination for lab entry will be provided to subscribers to ee368b mailing list
 - Stanford ID chip card for after-hour entry of Packard building
 - Account on ise machine will be provided to subscribers to ee368 mailing list



Further reading

- Slides available as hand-outs and as pdf files on the web
- Reference books on image and video compression
 - A. N. Netravali, B.G. Haskell, "Digital Pictures - Representation and Compression", 2nd edit., New York, London: Plenum Press, 1995. *Comprehensive standard book covering television standards and digital image compression. Has been augmented compared to the 1st edition from 1988, particularly to discuss the more recent standards, the greater part of the book, however, reflects the state-of-the-art of the mid-80s. Nevertheless, a must-have for image system engineers.*
 - W. Pennebaker, J. Mitchell, "JPEG Still Image Data Compression Standard", Van Nostrand Reinhold, New York, 1993. *THE source to read about JPEG, but also a nice presentation of basic material you need to understand the rationale behind it.*
 - J. Mitchell, W. Pennebaker, C. Fogg, D. LeGall, "MPEG Video Compression Standard," Chapman & Hall, New York, 1996. *Discusses MPEG-2 in detail, and some of the source coding principles, but those rather briefly. A book for practitioners.*
 - B. Haskell, A. Puri, A. Netravali, "Digital Video: An Introduction to MPEG-2," Chapman & Hall, New York, 1996. *Comprehensive coverage of MPEG-2, and also includes a chapter about MPEG-4. Some sections from Netravali & Haskell's "Digital Pictures" are included to provide background.*
 - V. Bhaskaran, K. Konstantinides, "Image and Video Compression Standards," Kluwer Academic Publishers, 1995. *Introduction to standards JPEG, MPEG-1 and MPEG-2, H.261. Emphasizes the foundations of the standards, rather than details. Predictive coding, transform coding, motion estimation and compensation, entropy coding.*
 - A. K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, 1989. *Very readable and sound book that is popular as a text book for image processing classes. A lot of image processing material beyond compression.*
- Fundamental books that are not image/video specific:
 - A. Gersho and R.M. Gray, "Vector Quantization and Signal Compression," Kluwer Academic Press, 1992. *Principles and algorithms for digital source coding, with applications to images, speech, and audio. The most comprehensive and substantial source coding reference, but very readable nevertheless. State-of-the-art.*
 - N. S. Jayant, P. Noll, "Digital Coding of Waveforms," Prentice-Hall, 1984. *In-depth coverage of algorithms for digital source coding, with emphasis on principles. Specific applications mostly to speech, but also to image. Scalar quantization, predictive coding, subband coding, transform coding. 15 years old, but nevertheless a valuable addition to the source coder's library.*

