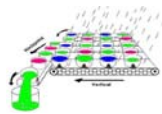
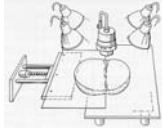


Fracture Exercise

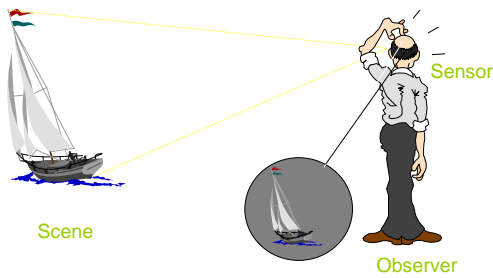
- Laboratory experiments
- Digital Imaging



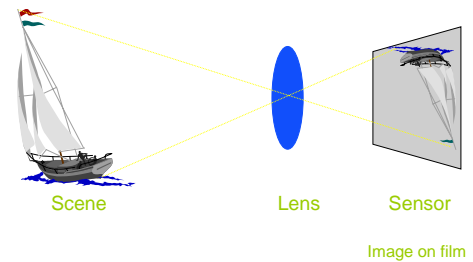
Exercise (PBL-based)

- Compare images from different digital cameras and "video" cameras.
- Demonstrate blooming/glare, low light conditions and at least one more noise problem.
- Compare cameras and demonstrate at least one limitation with a particular technology.
- Explain the physical reasons for the differences you observe.

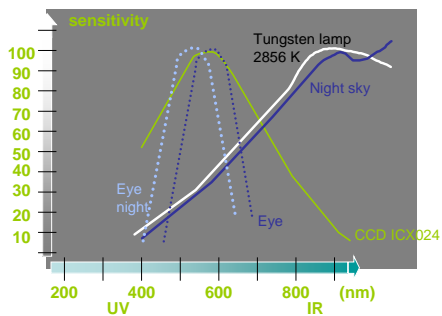
Imaging principles



Imaging principles

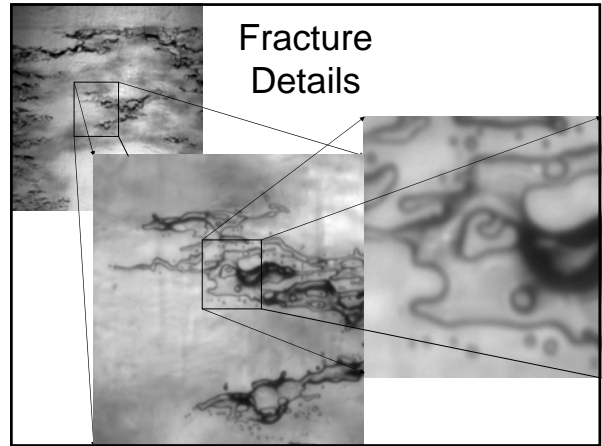
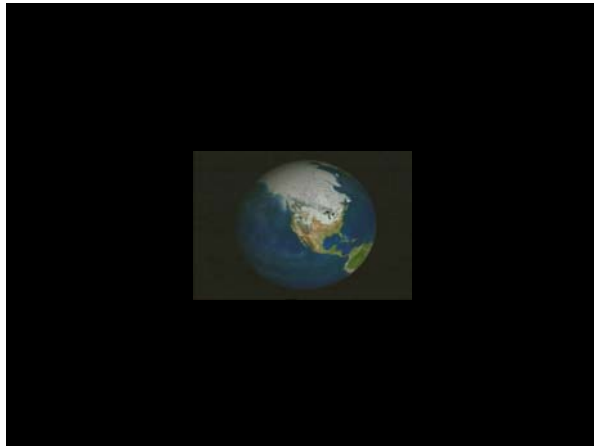


Imaging principles




Digital Imaging





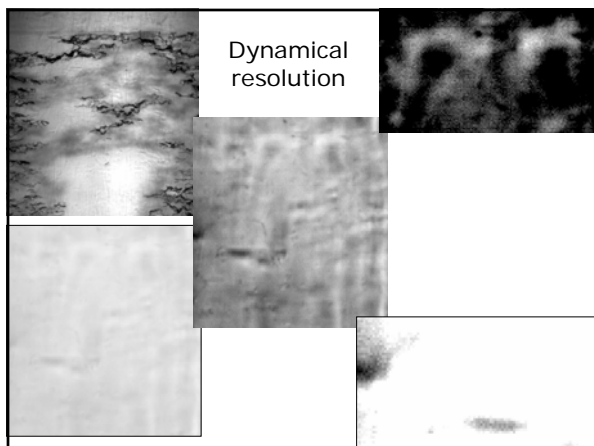
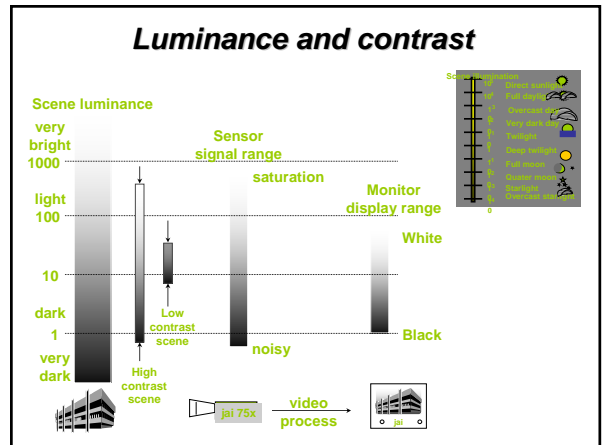
High Resolution Digital Camera



3120x2064
Pixels

14-bit (16384)
resolution

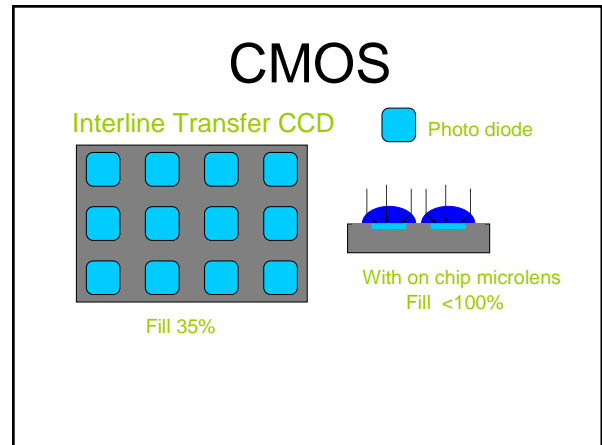
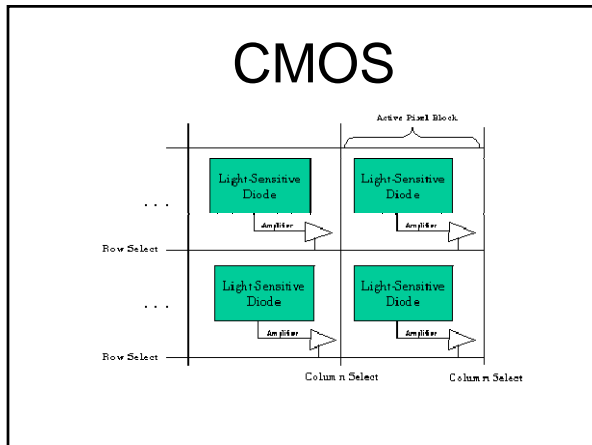
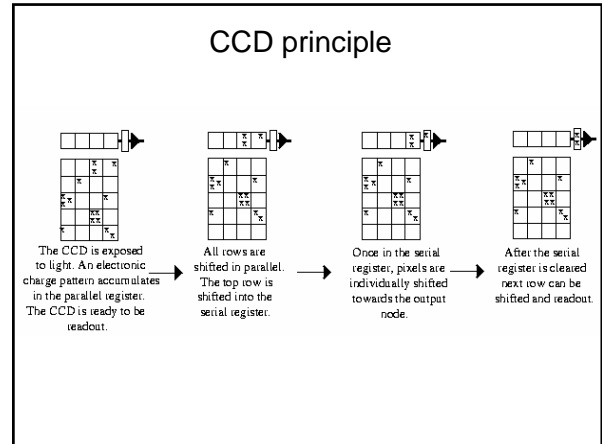
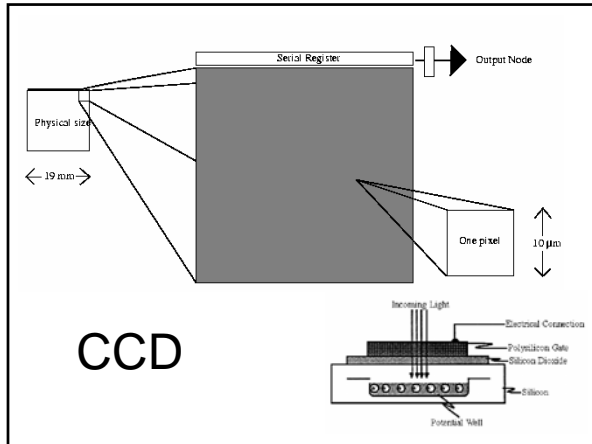
8Mz readout
700x500
16-bit (32768)
XMHz



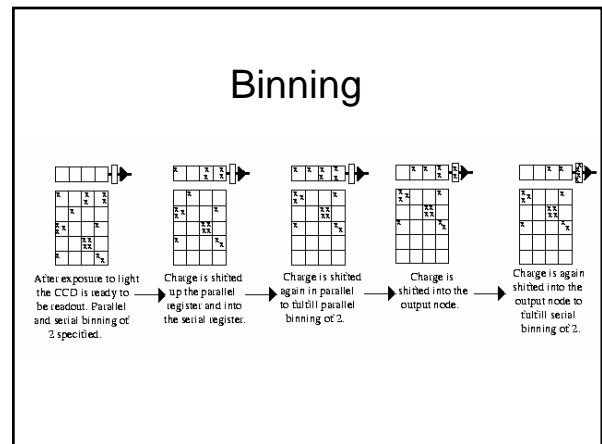
High Resolution Digital Cameras

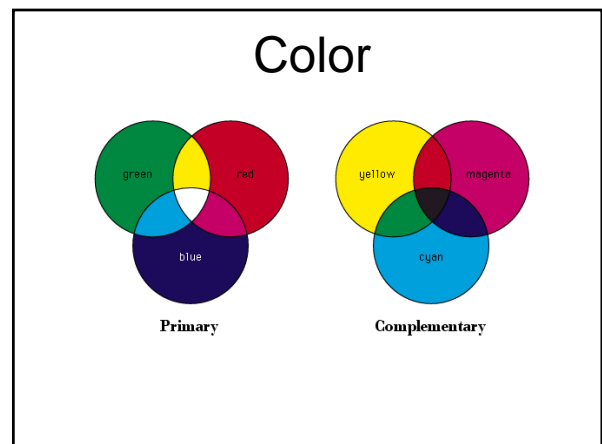
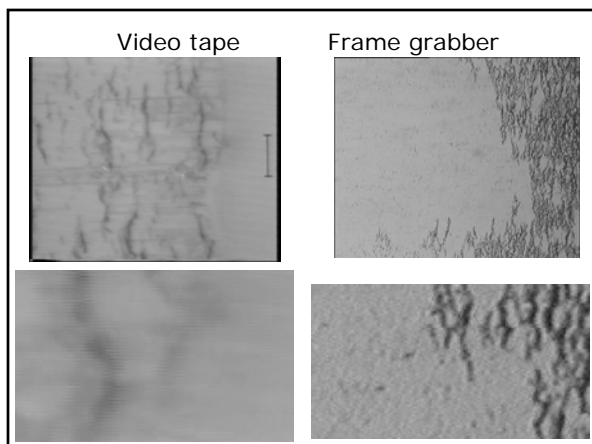
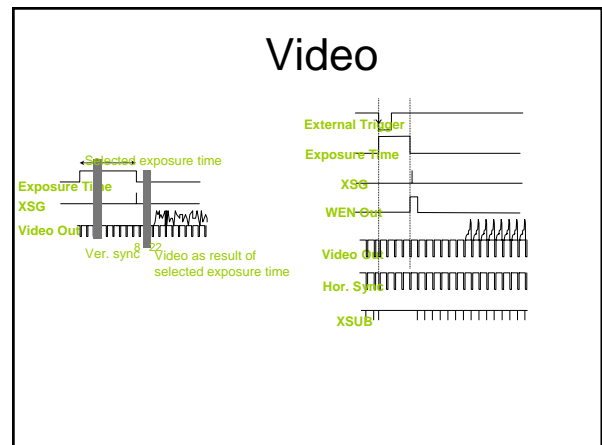
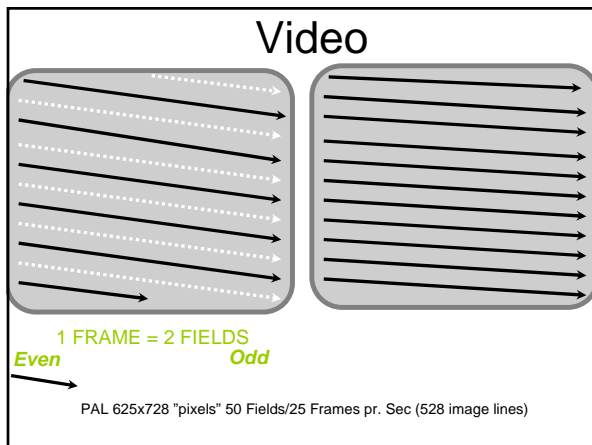
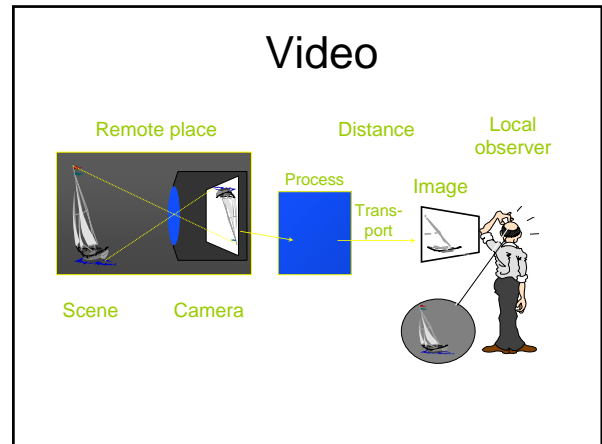
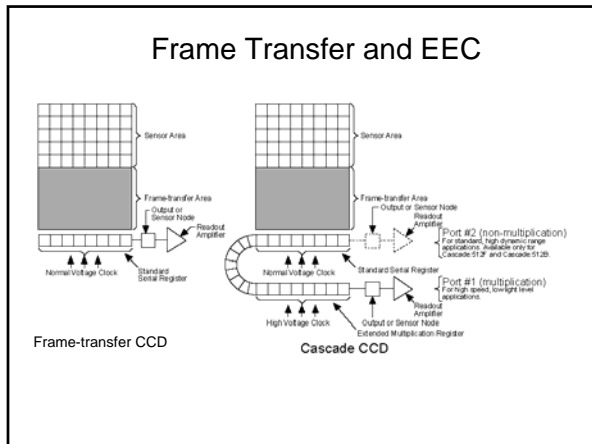
Advantages	Drawbacks
<ul style="list-style-type: none"> • Light sensitive • High spatial and <u>dynamical</u> resolution • Low noise 	<ul style="list-style-type: none"> • Slow data transfer • Produces much data • Requires custom made software • Not user friendly • Expensive

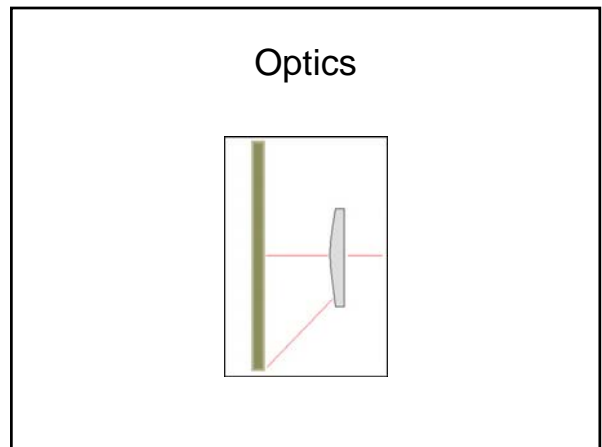
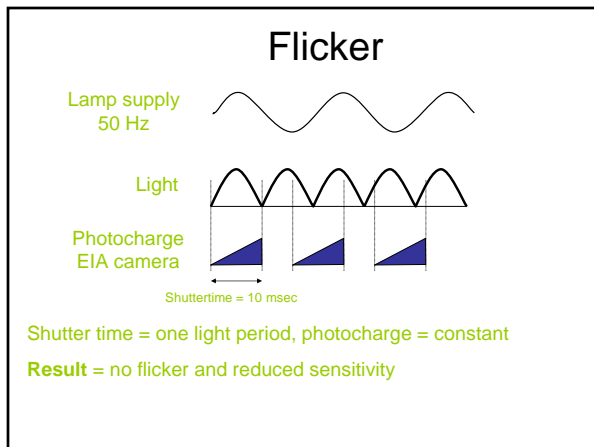
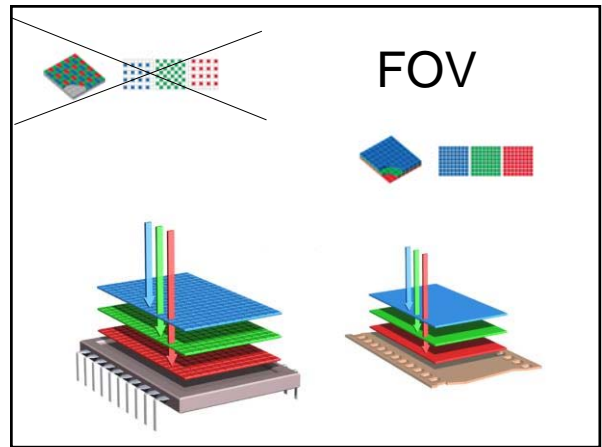
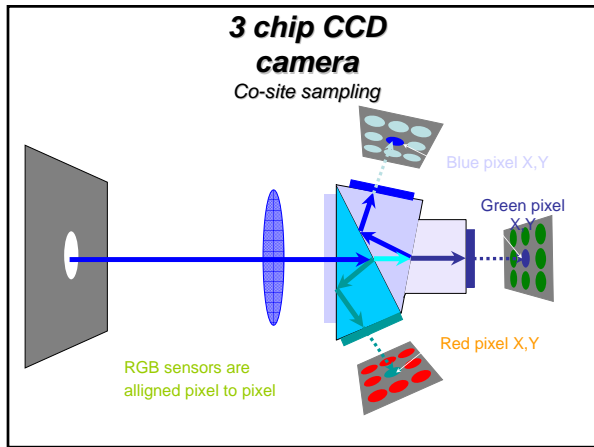
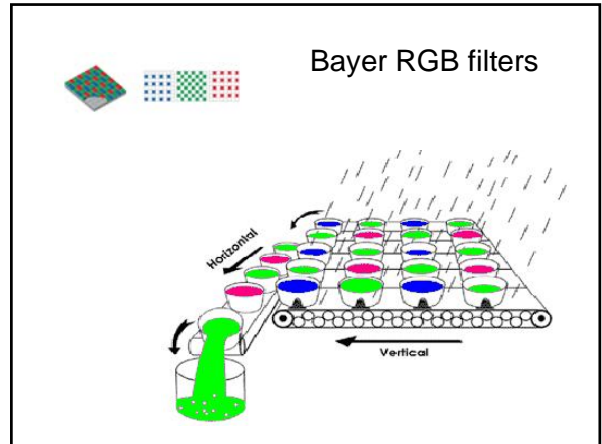
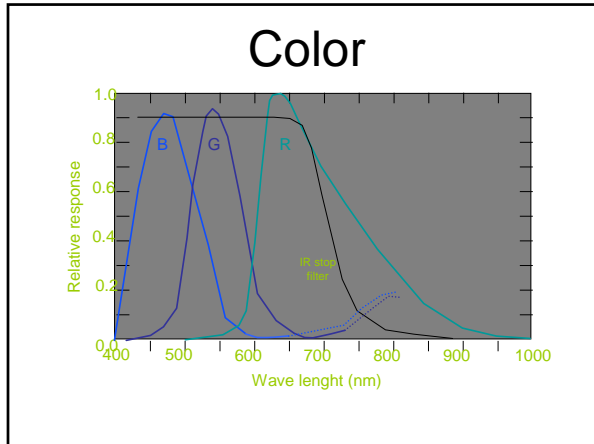
MORE SENSITIVE THAN THE EYE



- # Noise
- Shot noise / thermal / dark current
 - Read-out noise
 - Saturation / Glare / Blooming
 - High energetic "cosmic" rays
 - "Digital noise" / Moirè patterns







Test targets

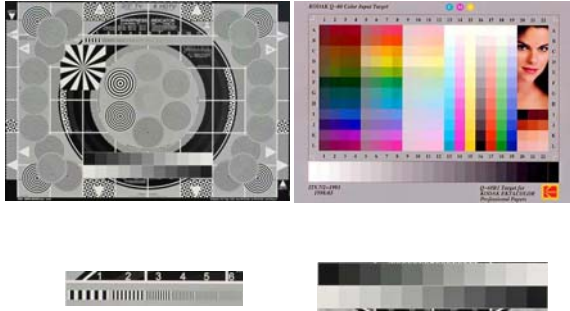
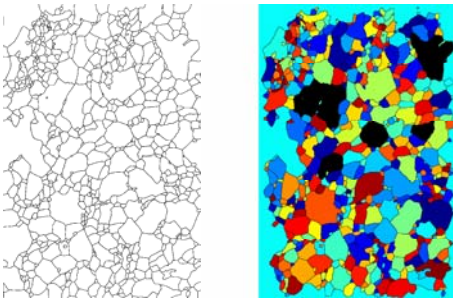


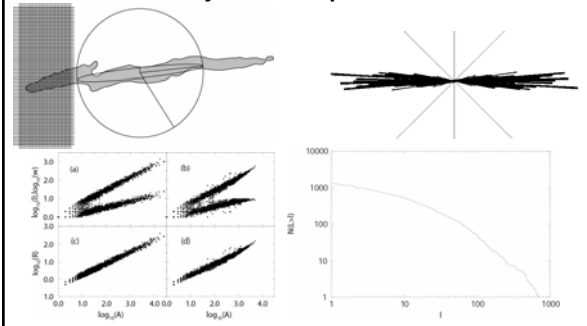
Image analysis

- Object properties
- Feature tracking / pattern matching
- Differences
- Transformations

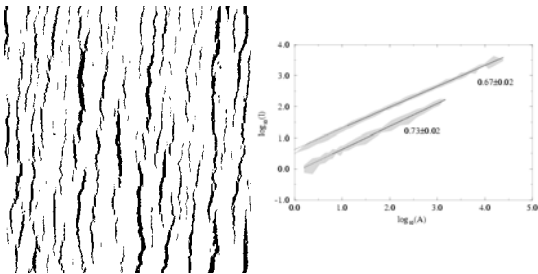
Object Properties



Object Properties



Object Properties



Sub pixel measurement

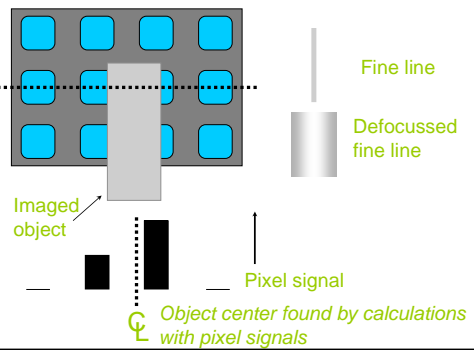
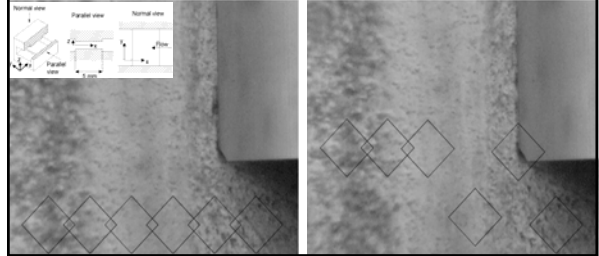


Image analysis

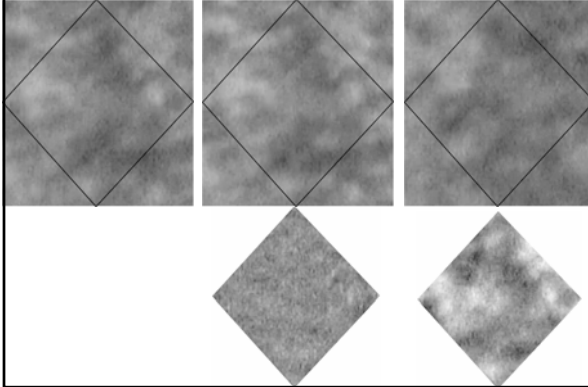
- Object properties
- **Feature tracking / pattern matching**
- Differences
- Transformations

Velocity measurements

DV-images, 40ms apart, 1/16000 s exposure time
128x128 diamond shaped region tracking scheme



Tracking Scheme Explained



Pixel Comparison Algorithms

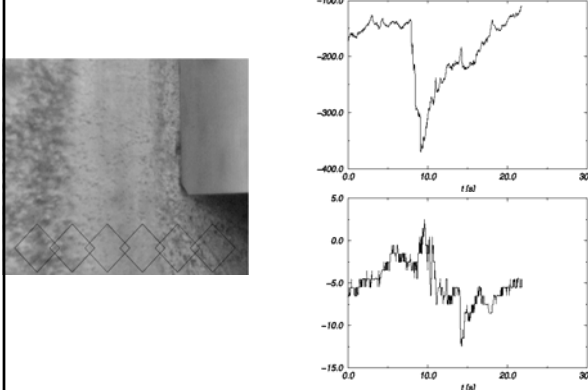
$$S_1 = \sum_T |I_f - I_0|$$

$$S_2 = \sum_T (I_f - I_0)^2$$

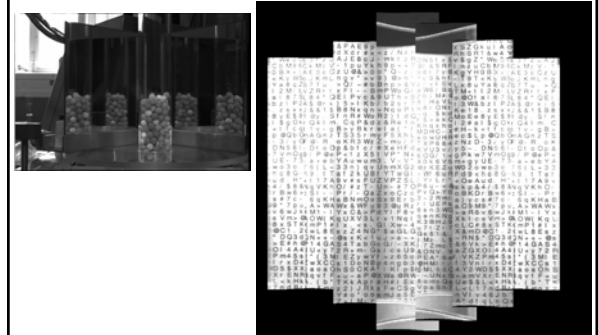
$$S_3 = \frac{\sum_T (I_f * I_0)}{(\sum_T I_f^2 \sum_T I_0^2)^{\frac{1}{2}}}$$

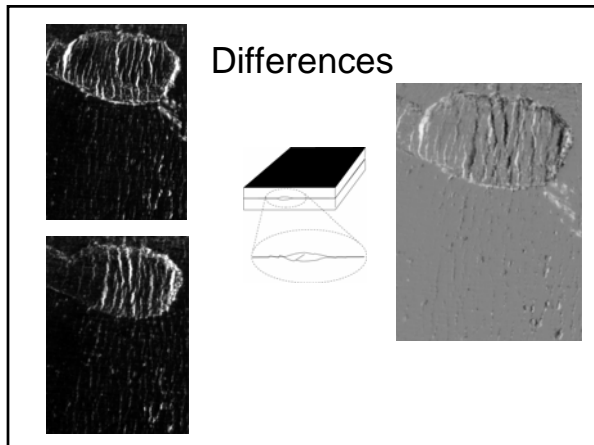
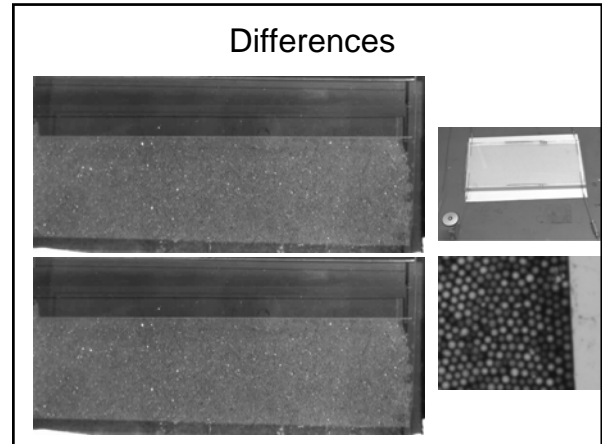
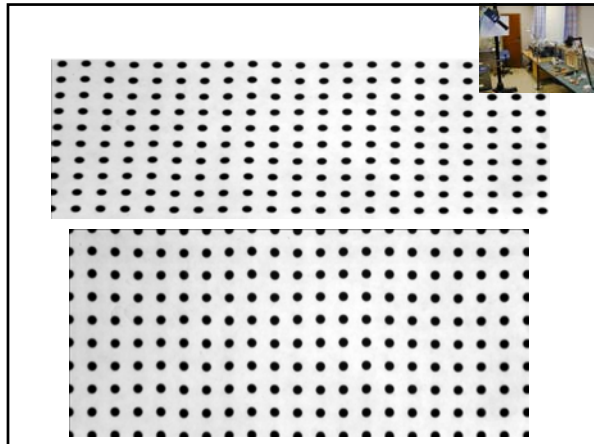
$$S_4 = \frac{\sum_T [(I_f - \bar{I}_f) * (I_0 - \bar{I}_0)]}{(\sum_T (I_f - \bar{I}_f)^2 \sum_T (I_0 - \bar{I}_0)^2)^{\frac{1}{2}}}$$

Velocity fluctuations



Transformation





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