Welcome to CIVIL-510
“Quantitative Imaging for Engineers”

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Lecture Two: 2021-09-27

Lesson One

Definitions

- Number of pixels, megapixels

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- Measuring lengths in pixels

This lesson: Optics and Hardware

Learning objectives

- Where do images actually come from?

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- Where do images actually come from?
- How does your eye work?
- What are the consequences on our images of the image capture?

We're capturing light

Light is a wave, with a given amplitude and frequency.

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Double slit experiment – light behaving as a wave...

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Light is a wave, with a given amplitude and frequency.

Double slit experiment – light behaving as a wave... and a discretely (*i.e.*, as a particle).

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Introducing the star of the show, a CCD or CMOS sensor – it is **one pixel**.

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- Exposure time (Min, Max)

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- Fill factor

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- Angle and colour sensitivity
- Number of pixels *vs* pixels in a colour picture

Variation in time

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Time profile of the readout value *vs* time $\Rightarrow$ Histogram of values

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Many sources – in many cases *Additive Gaussian Noise* is a good model.

How to characterise noise?

Forming an image

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- 1D detector projection geometry explanation...

Space for drawing

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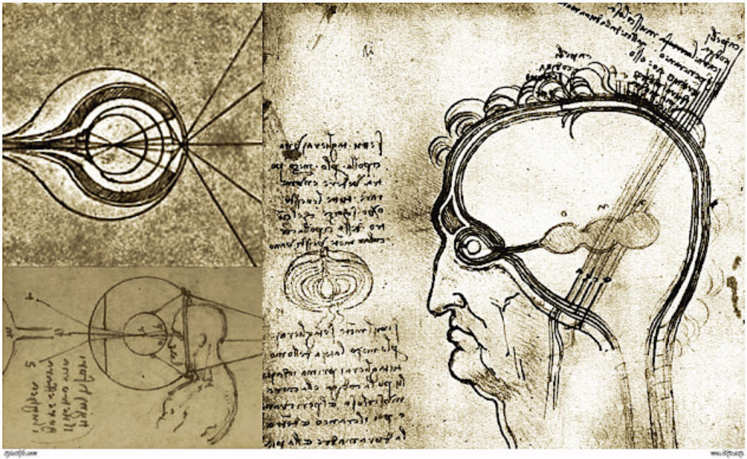
Let's draw an example with a 1D detector – geometry is all angular!

Space for drawing



Much to learn

Key elements to discuss

- Pixel size definition

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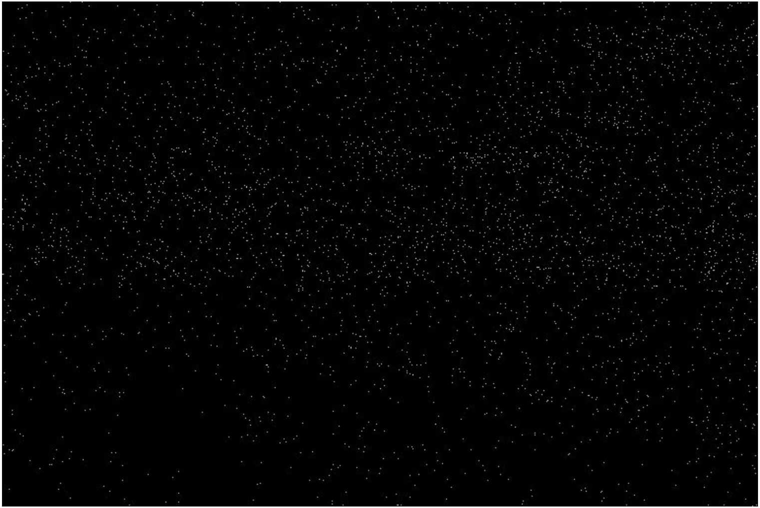

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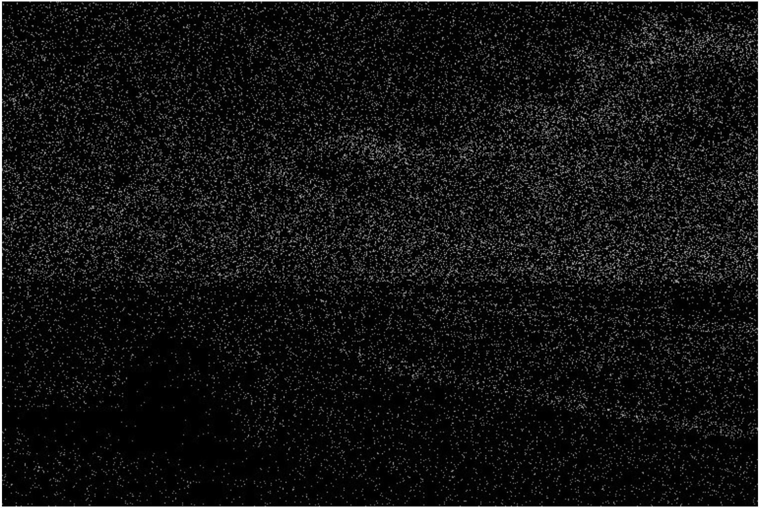

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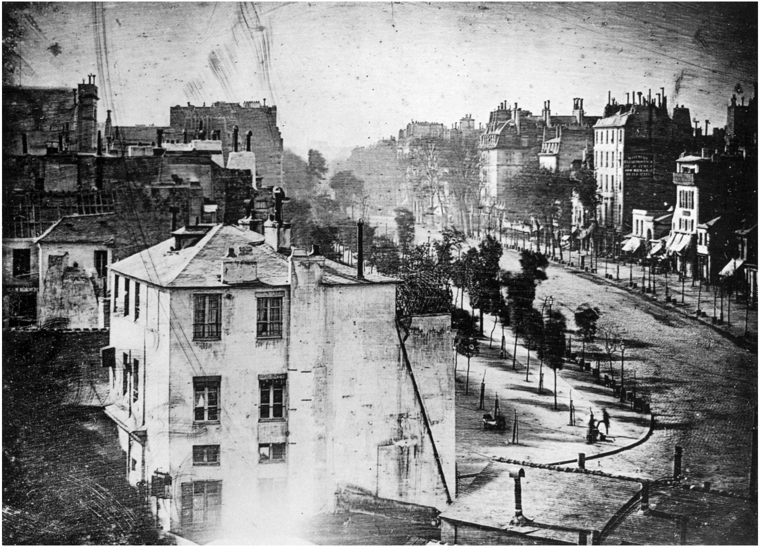
Early photo



Real example with camera

1. Dark image

Real example with camera

1. Dark image
2. Direct image

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3. Pinhole example

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4. Optics

Optics basics

Crash course in optics

DOF

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DOF (No, not degree of freedom, Depth Of Field)

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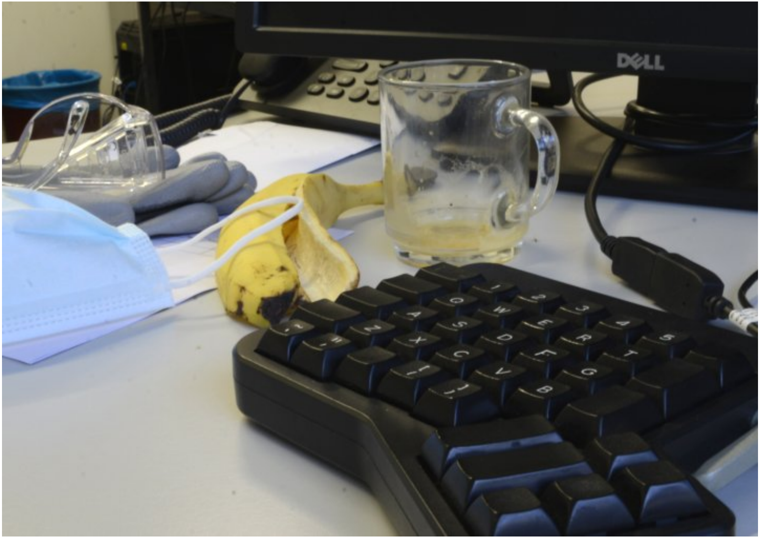
DOF example

Rough autofocus algorithm

DOF example

aperture f/22; exposure 2 sec Rough autofocus algorithm

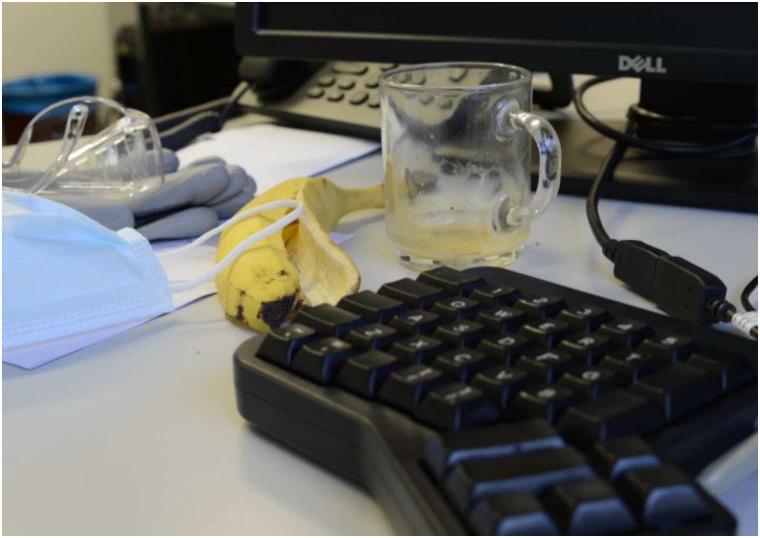


DOF example

aperture f/10; exposure 1/2 sec Rough autofocus algorithm

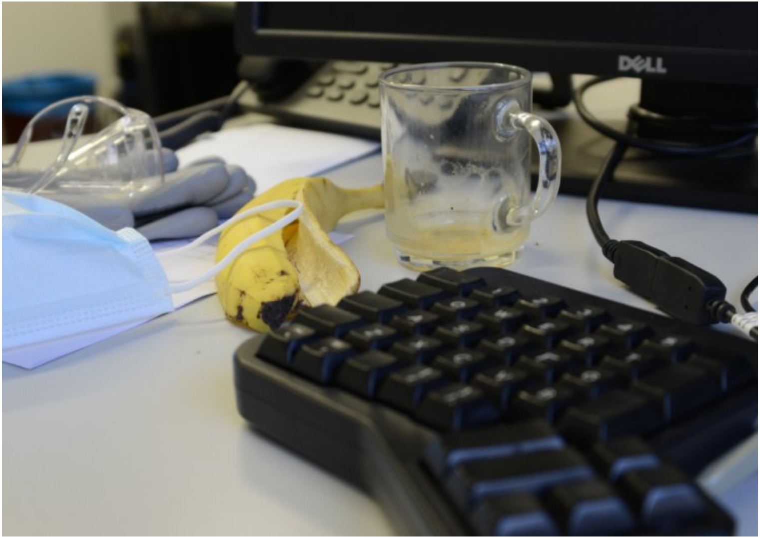
DOF example

Rough autofocus algorithm aperture f/5.6; exposure 1/6 sec



DOF example

Rough autofocus algorithm aperture f/4; exposure 1/13 sec



Sources of blur:

- Spatial/geometric

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- tracking