SM 14/15 – T4
Special Effects

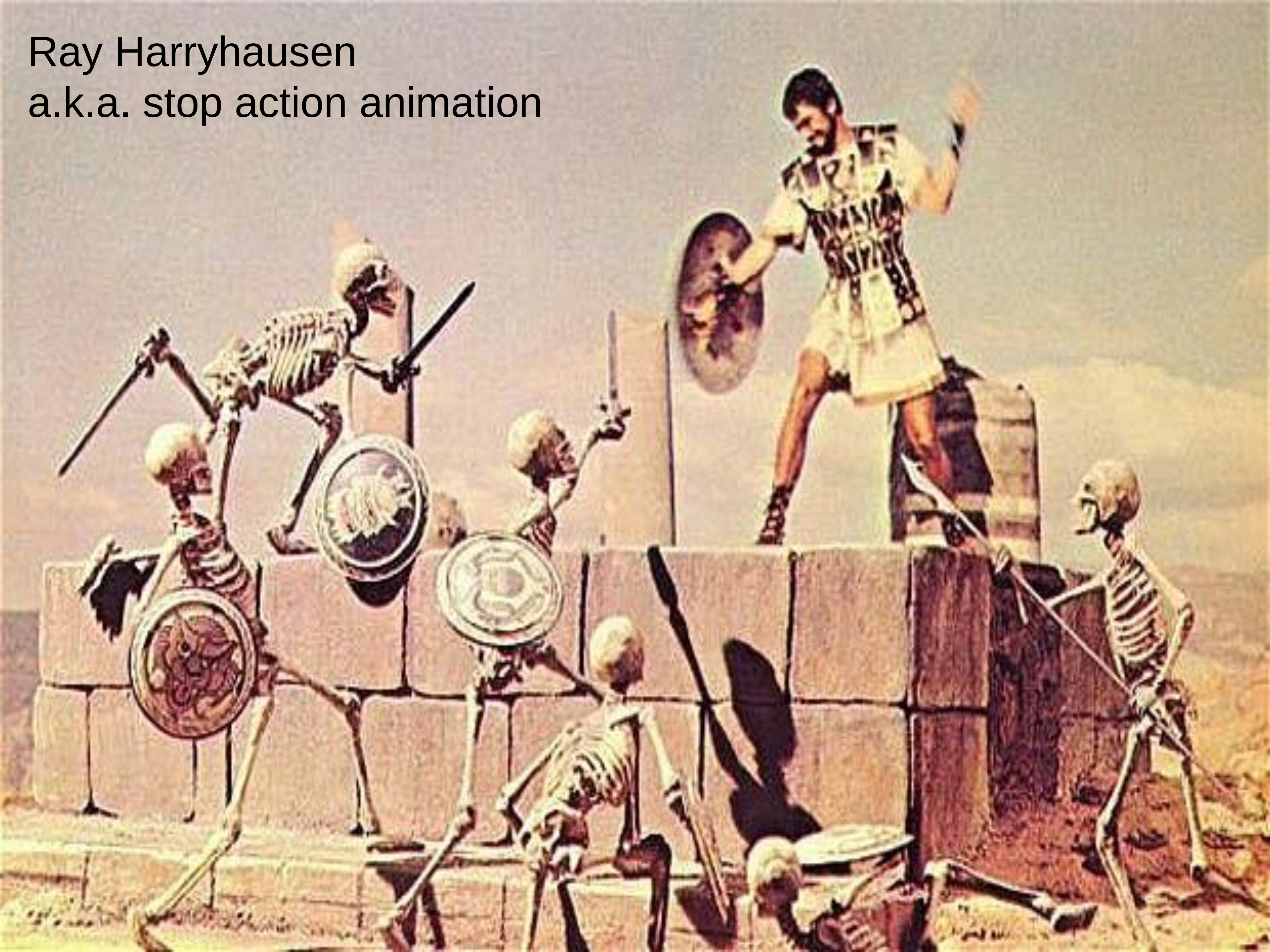
LCC, MIERSI

Miguel Tavares Coimbra

Image Processing

Computer Graphics

Ray Harryhausen
a.k.a. stop action animation



‘Special Effects’ can mean a lot of things

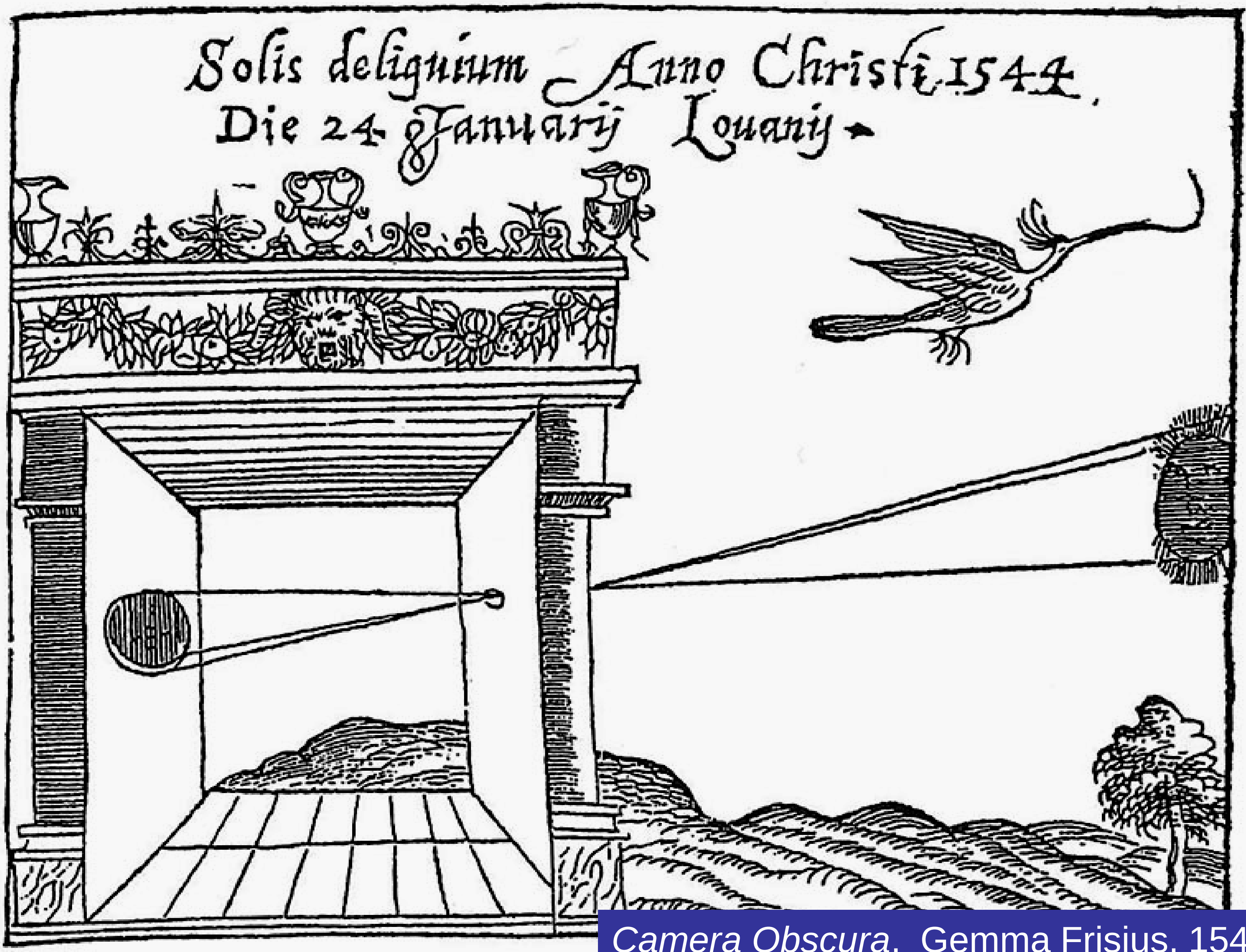
Today

- We will talk about **image processing**
- Computer graphics is in Lecture 8
- We will not talk about stop-action animation
  - But you should go and see “Jason and the Argonauts” anyway
  - http://www.rayharryhausen.com/

(Some) Pieces of the Puzzle

- Image creators (3D -> 2D)
  - – Camera (Today)
  - – Computer Graphics (T8)
- Image manipulators (2D -> 2D)
  - – Image Processing (Today)
- Image displays (2D -> ?)
  - – 2D Screen
  - – 3D Virtual Reality (T7)

How do we get 2D images of a real 3D world?



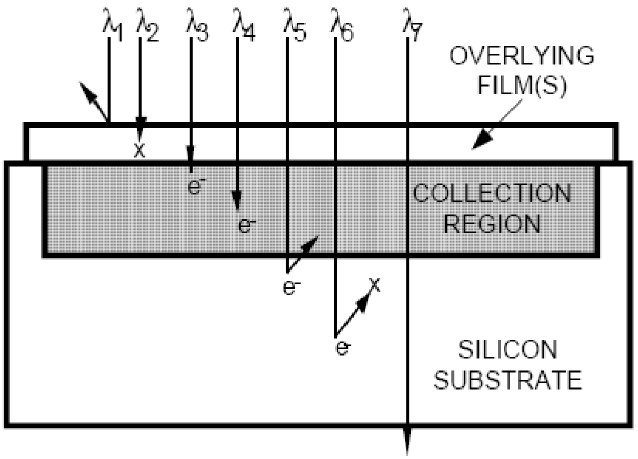
Camera Obscura, Gemma Frisius, 1544

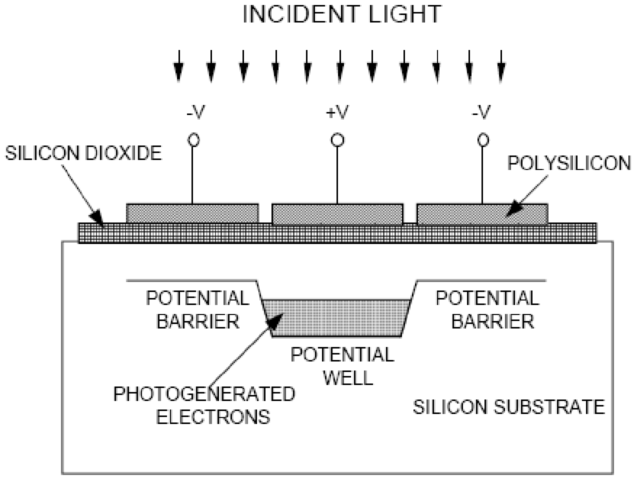
Pinhole Photography

Lenses

Image Sensors

- Convert light into an electric charge



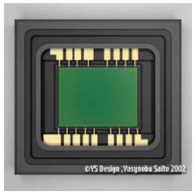


CCD (charge coupled device)

Higher dynamic range

High uniformity

Lower noise

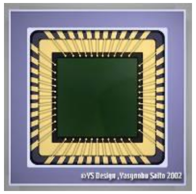


CMOS (complementary metal Oxide semiconductor)

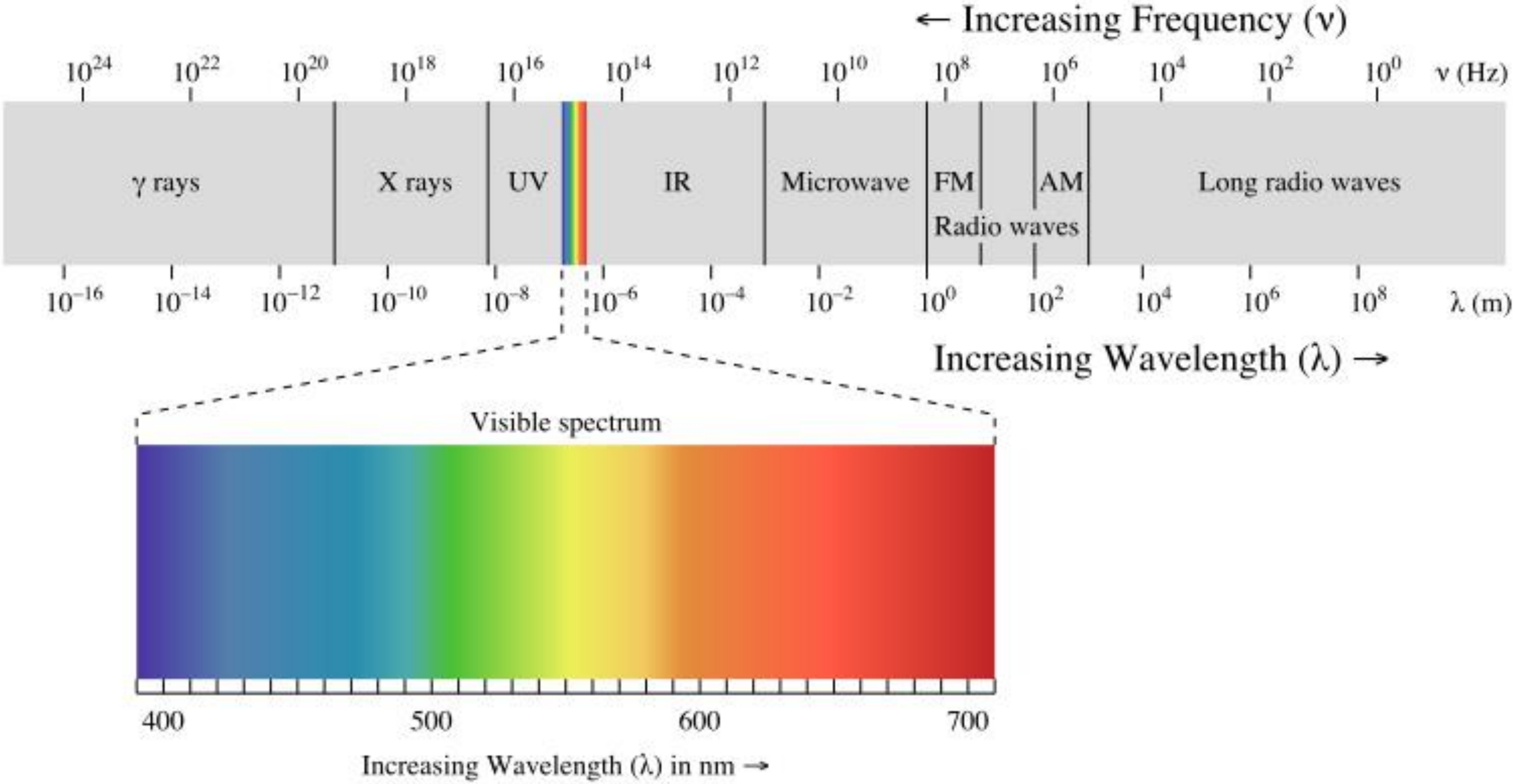
Lower voltage

Higher speed

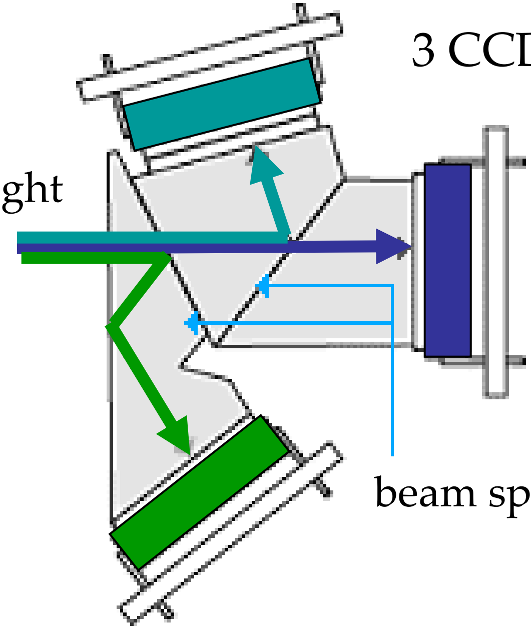
Lower system complexity



What is Colour?



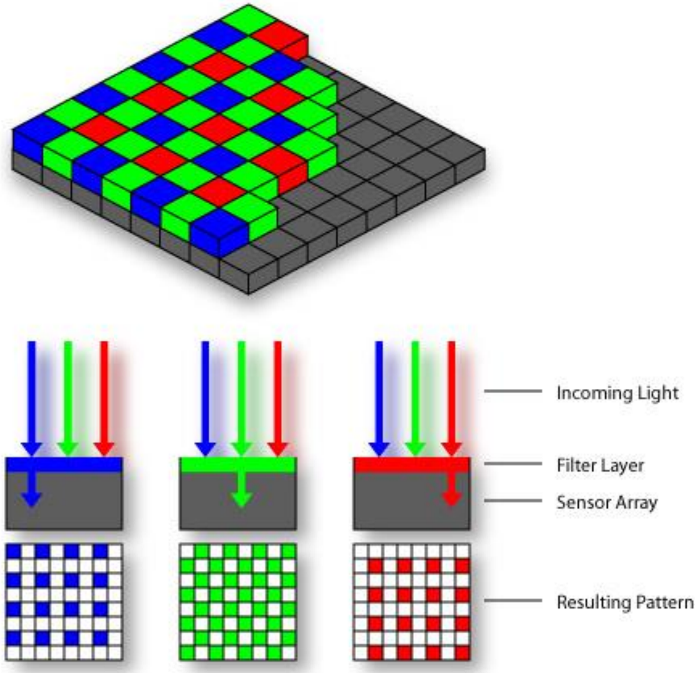
Sensing Colour



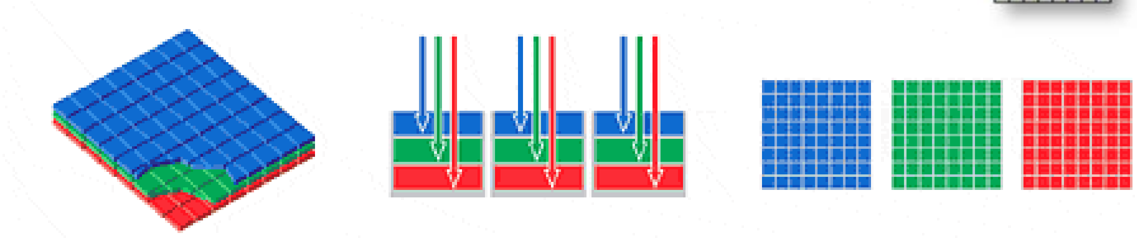
3 CCD

light

beam splitter



Bayer pattern

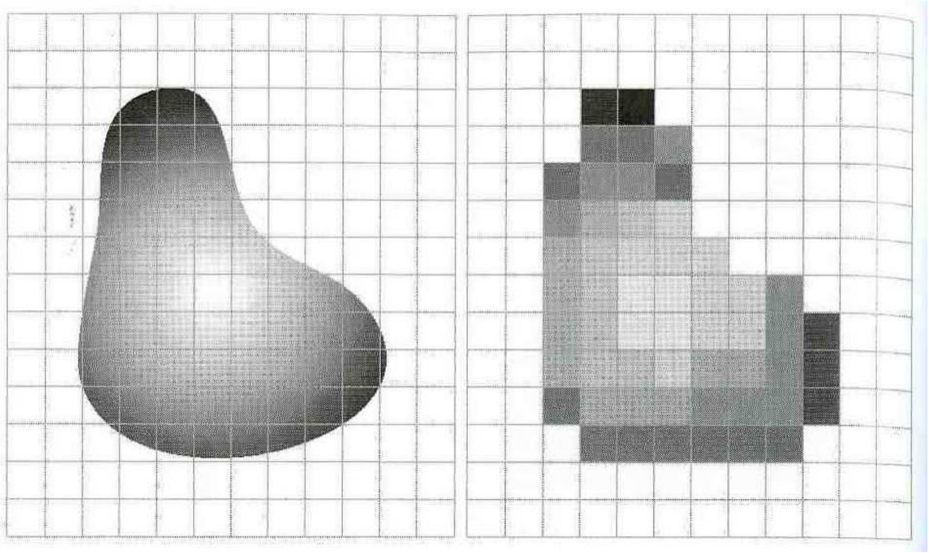


Foveon X3^{TM}

Analog to Digital

The scene is:

- **projected** on a 2D plane,
- **sampled** on a regular grid, and each sample is
- **quantized** (rounded to the nearest integer)



$$f(i, j) = \text{Quantize}\{f(i\Delta, j\Delta)\}$$

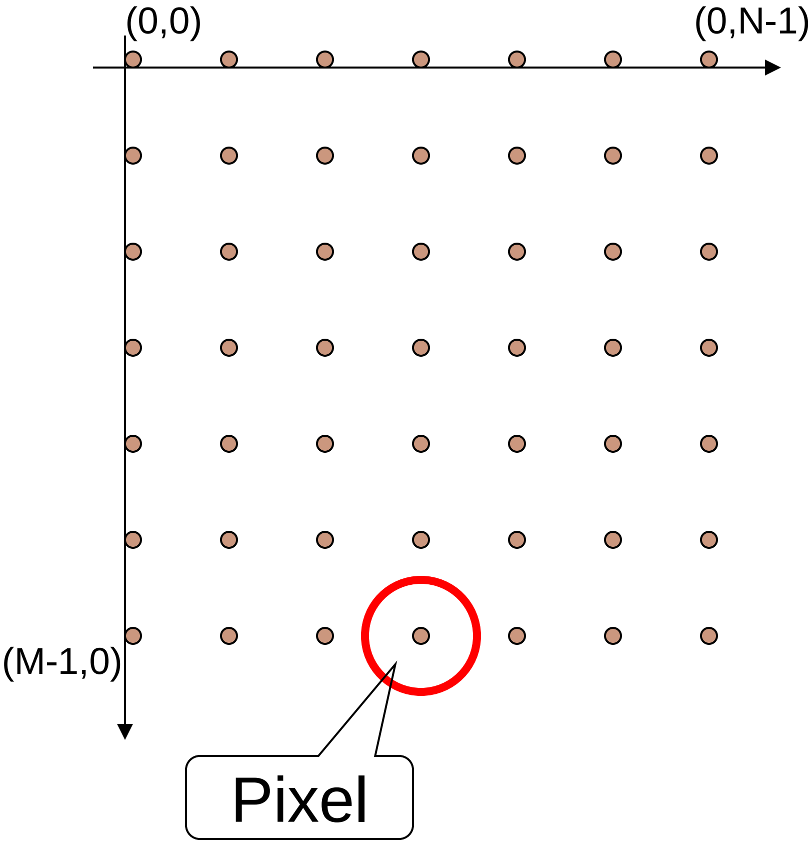
Images as Matrices

- Each point is a pixel with amplitude:
  - f(x,y)
- An image is a matrix with size N x M

M = [(0,0) (0,1) …

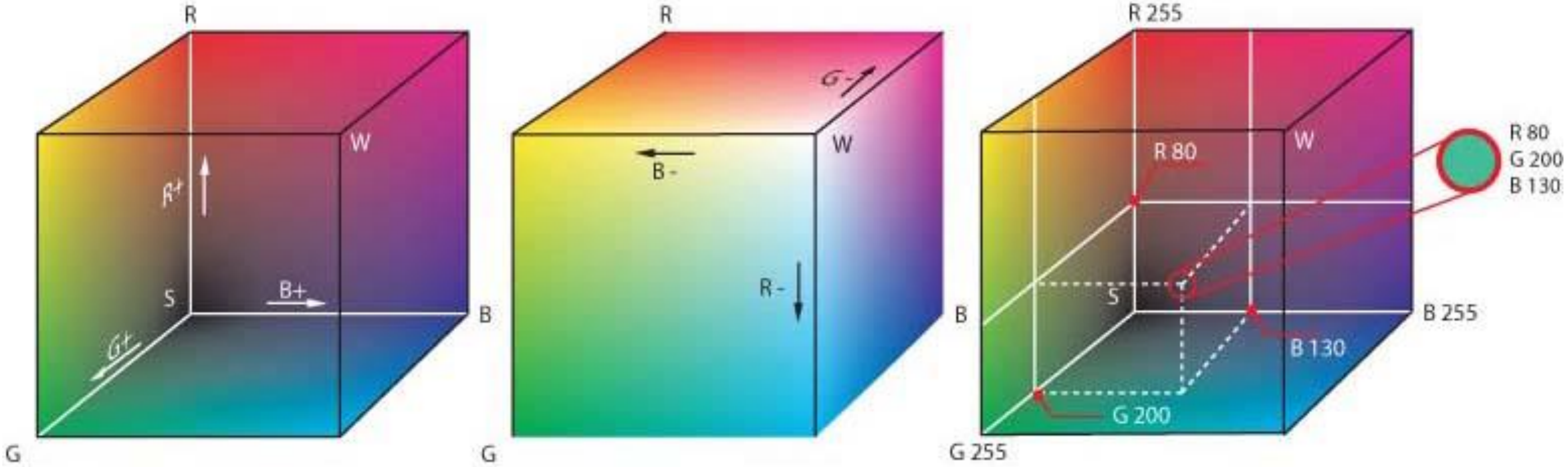
[(1,0) (1,1) …

…



Colour Space

- Colour space
  - Coordinate system
  - Subspace: One colour -> One point
- RGB is very popular



Manipulating Single Pixels

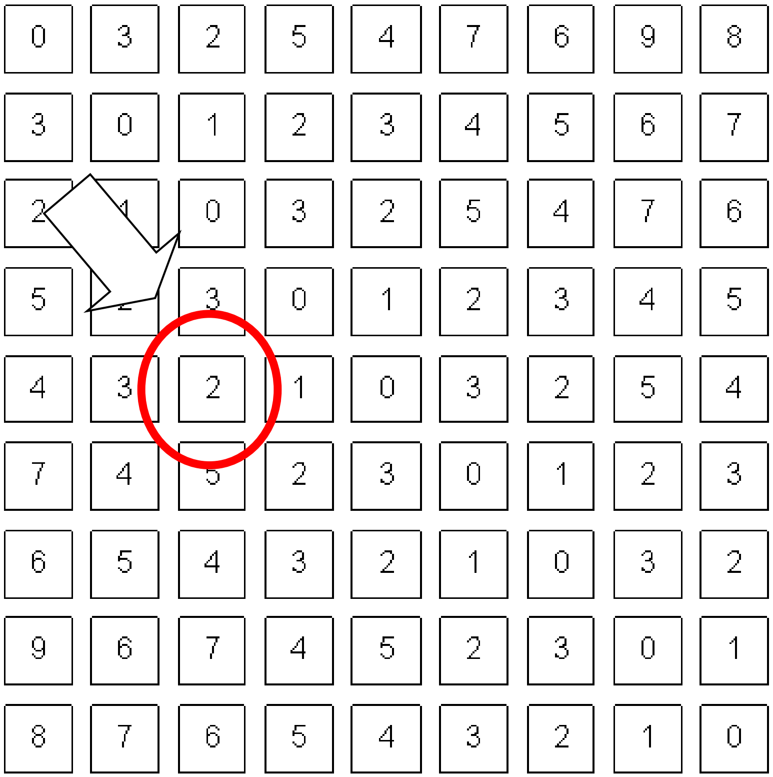
Pixel Manipulation

- Let’s start simple
- I want to change a single Pixel.

$$f(X,Y) = MyNewValue$$

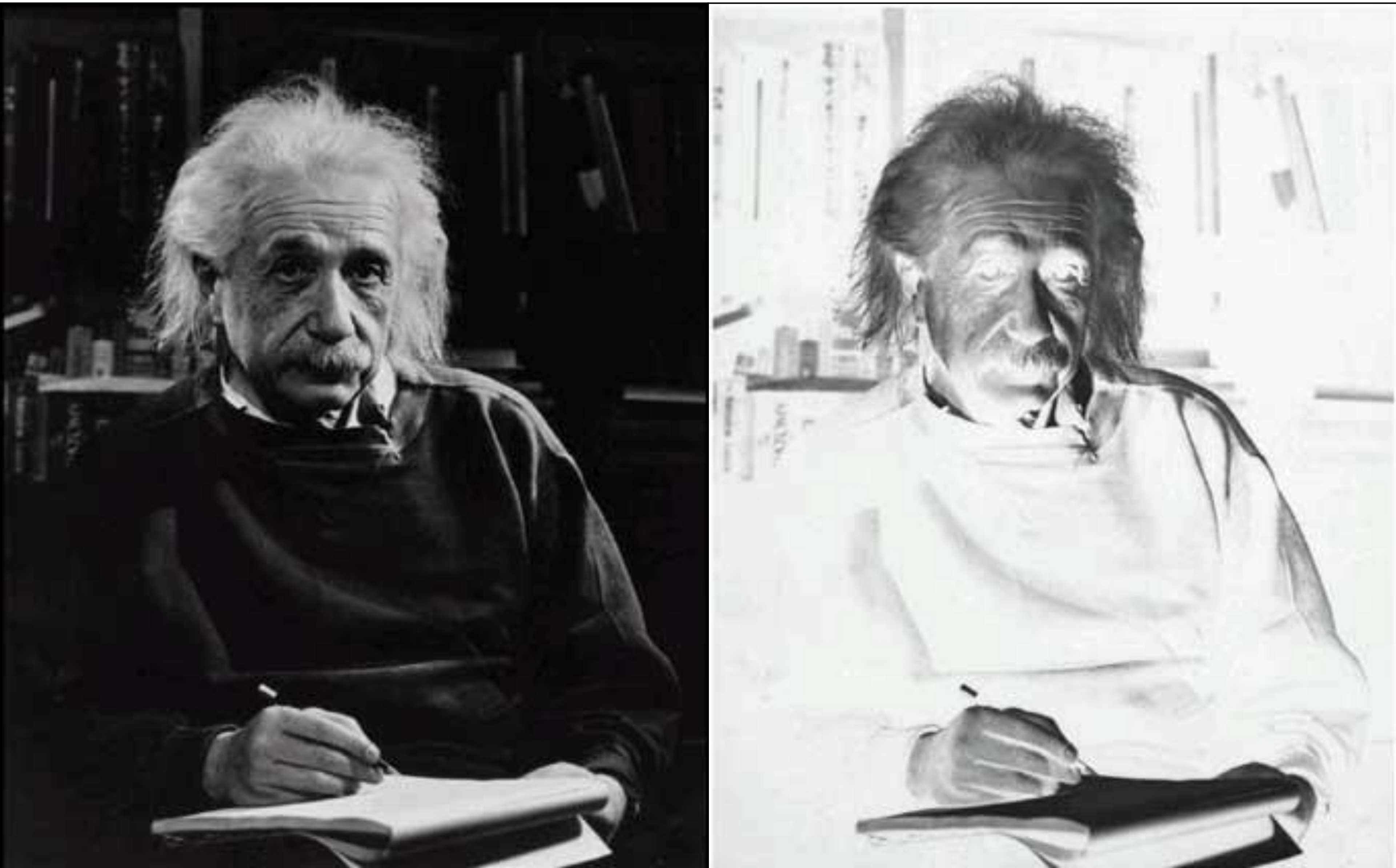
- Or, I can apply a transformation T to all pixels individually.

$$g(x,y) = T\left[f(x,y)\right]$$

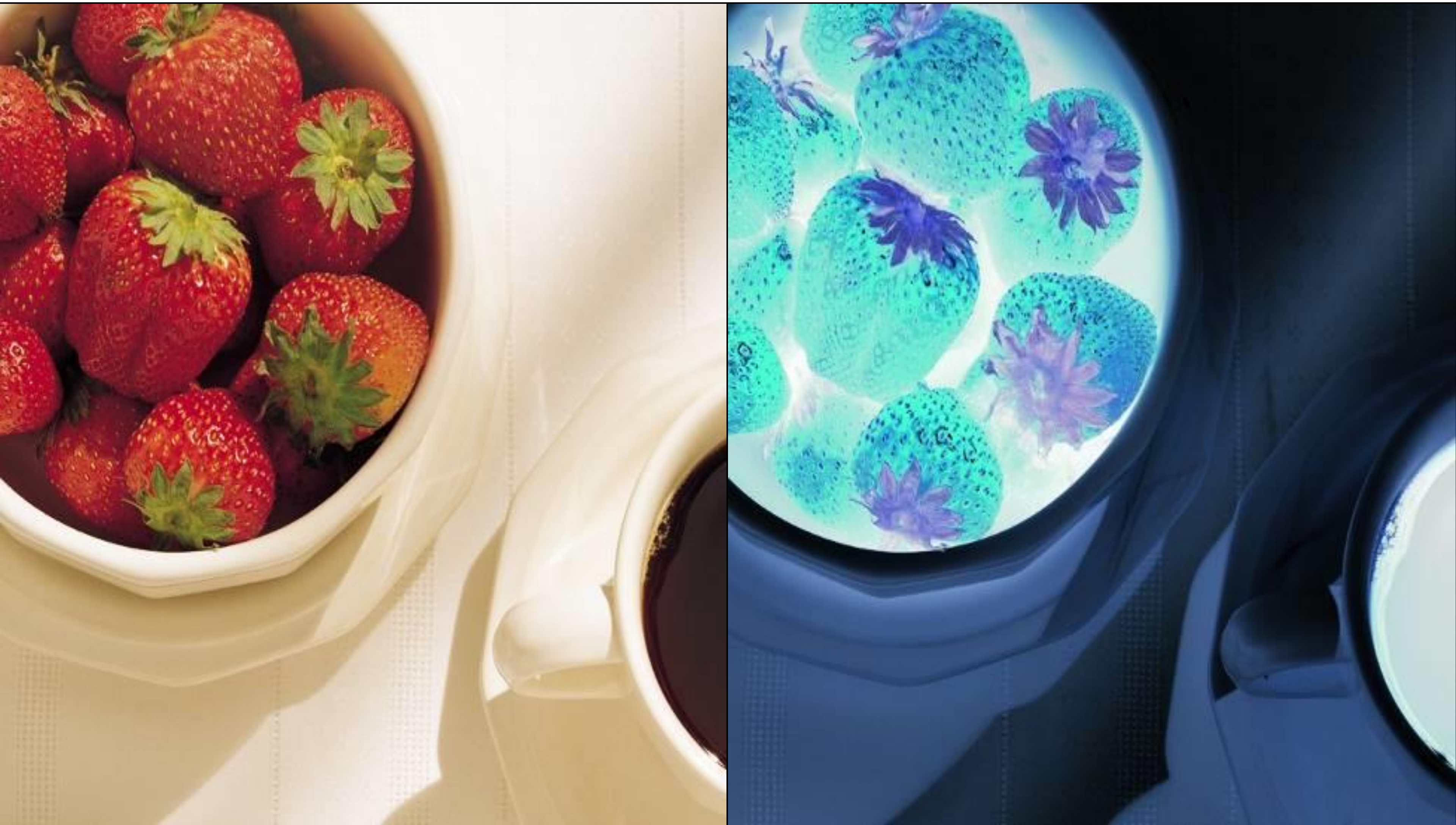


0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

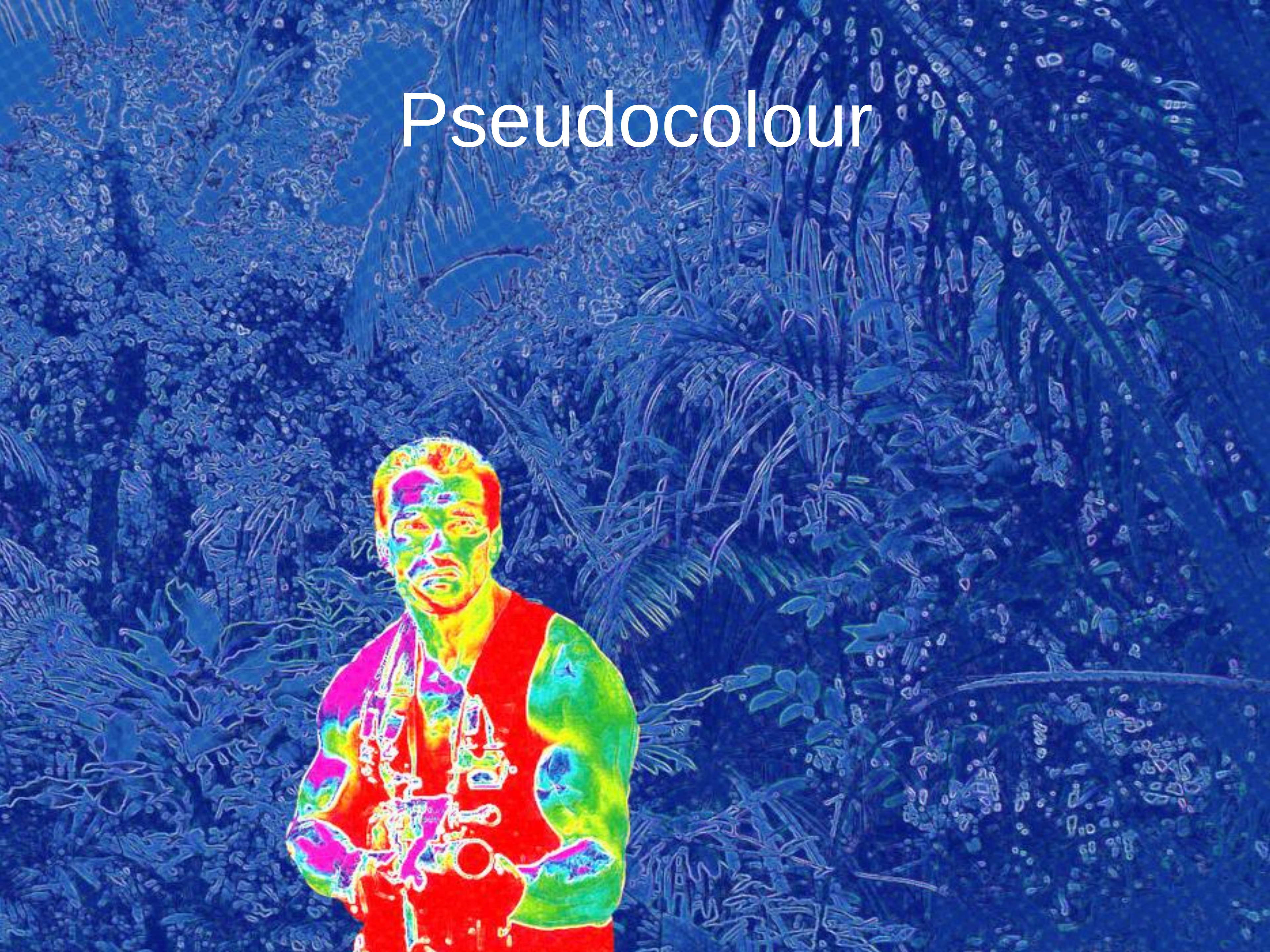
Negative



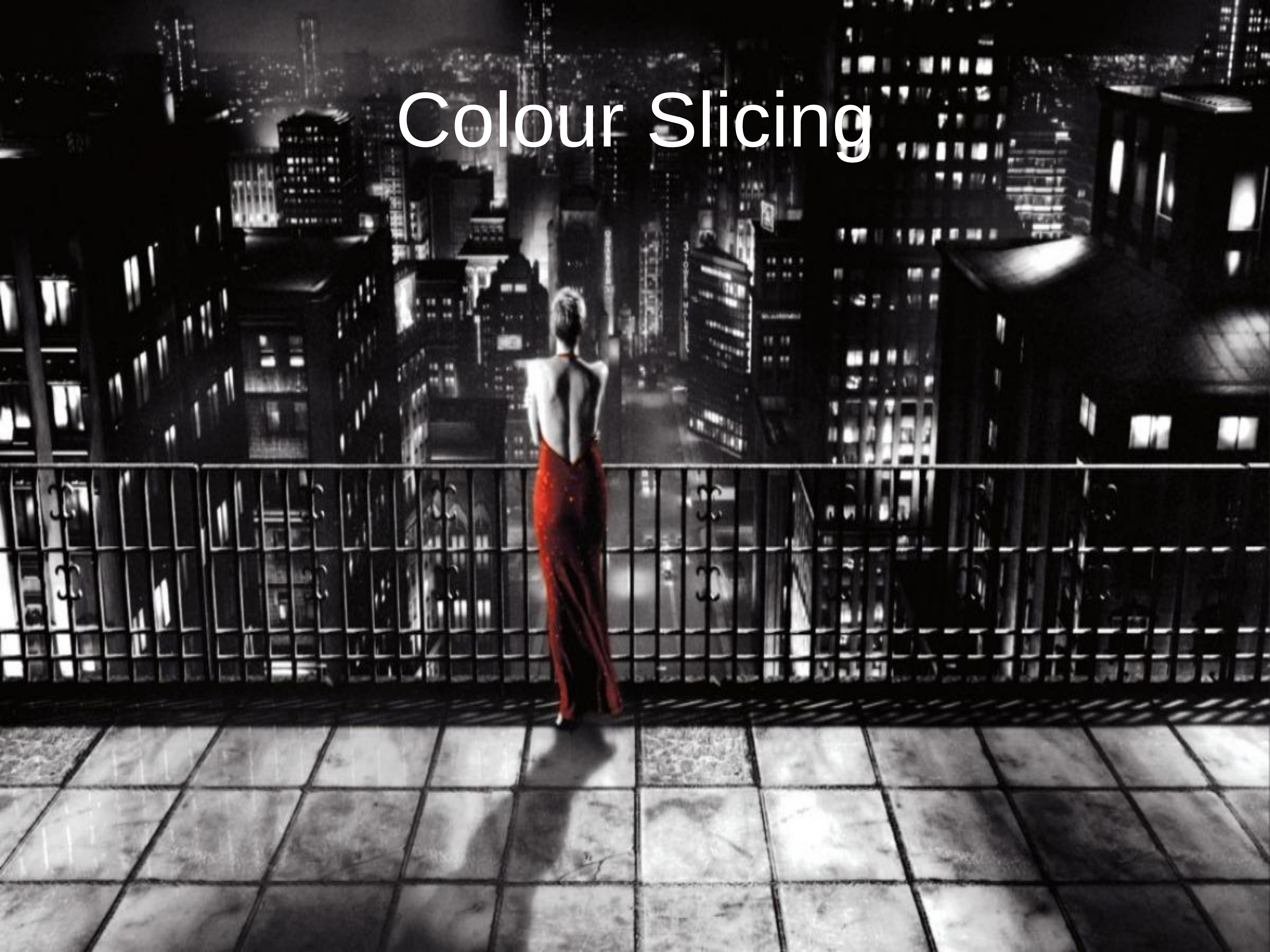
Colour Negative



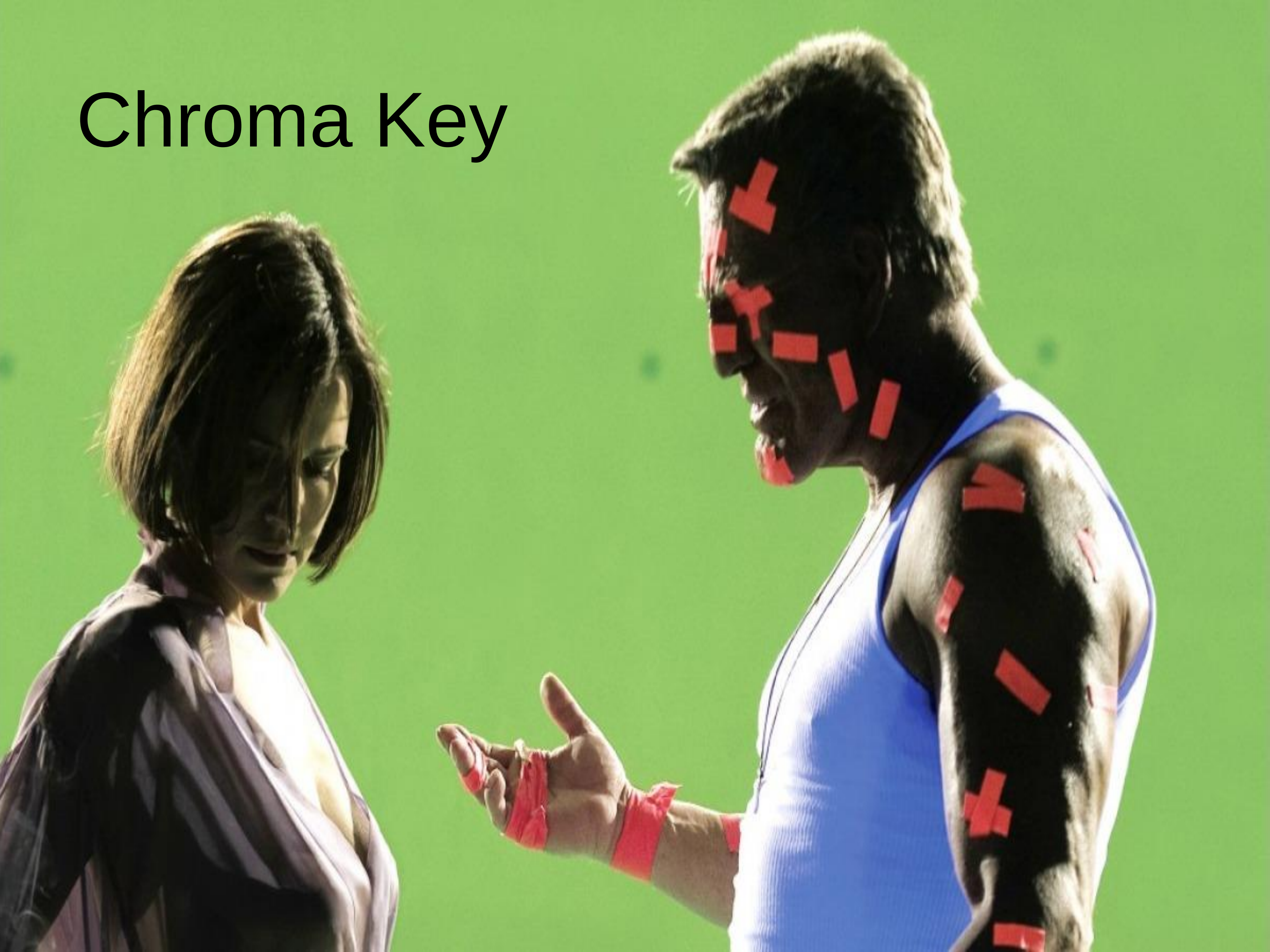
Pseudocolour



Colour Slicing



Chroma Key

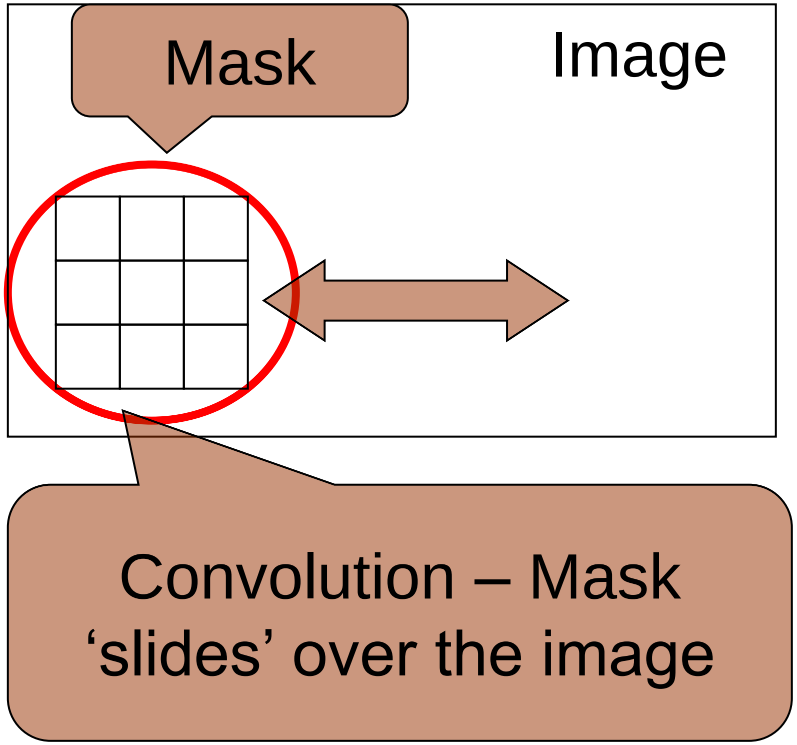


Digital Filters

U. PORTO

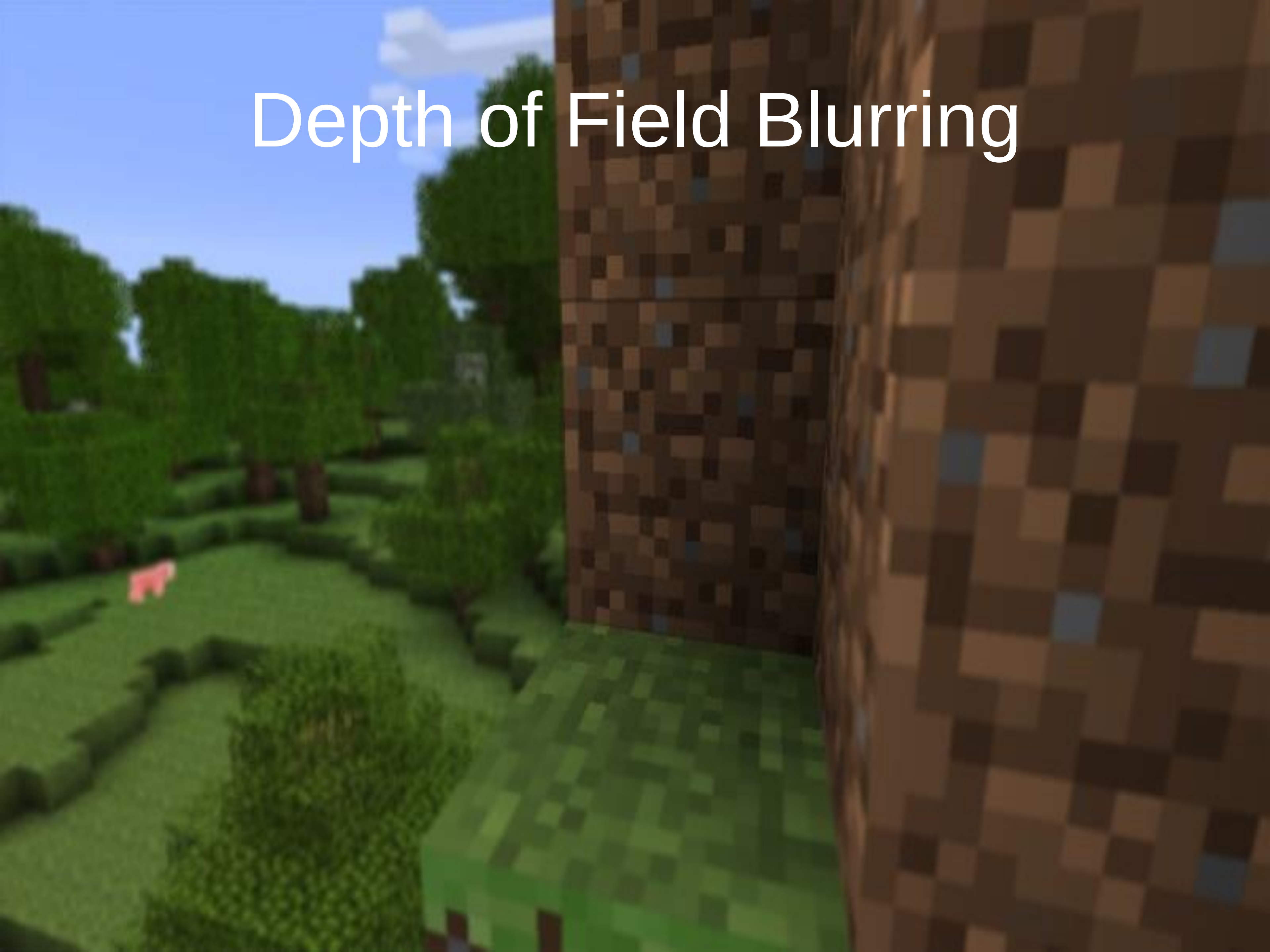
Convolution with a Filter Matrix

- Simple way to process an image.
- Mask defines the processing function.
- Corresponds to a multiplication in frequency domain.

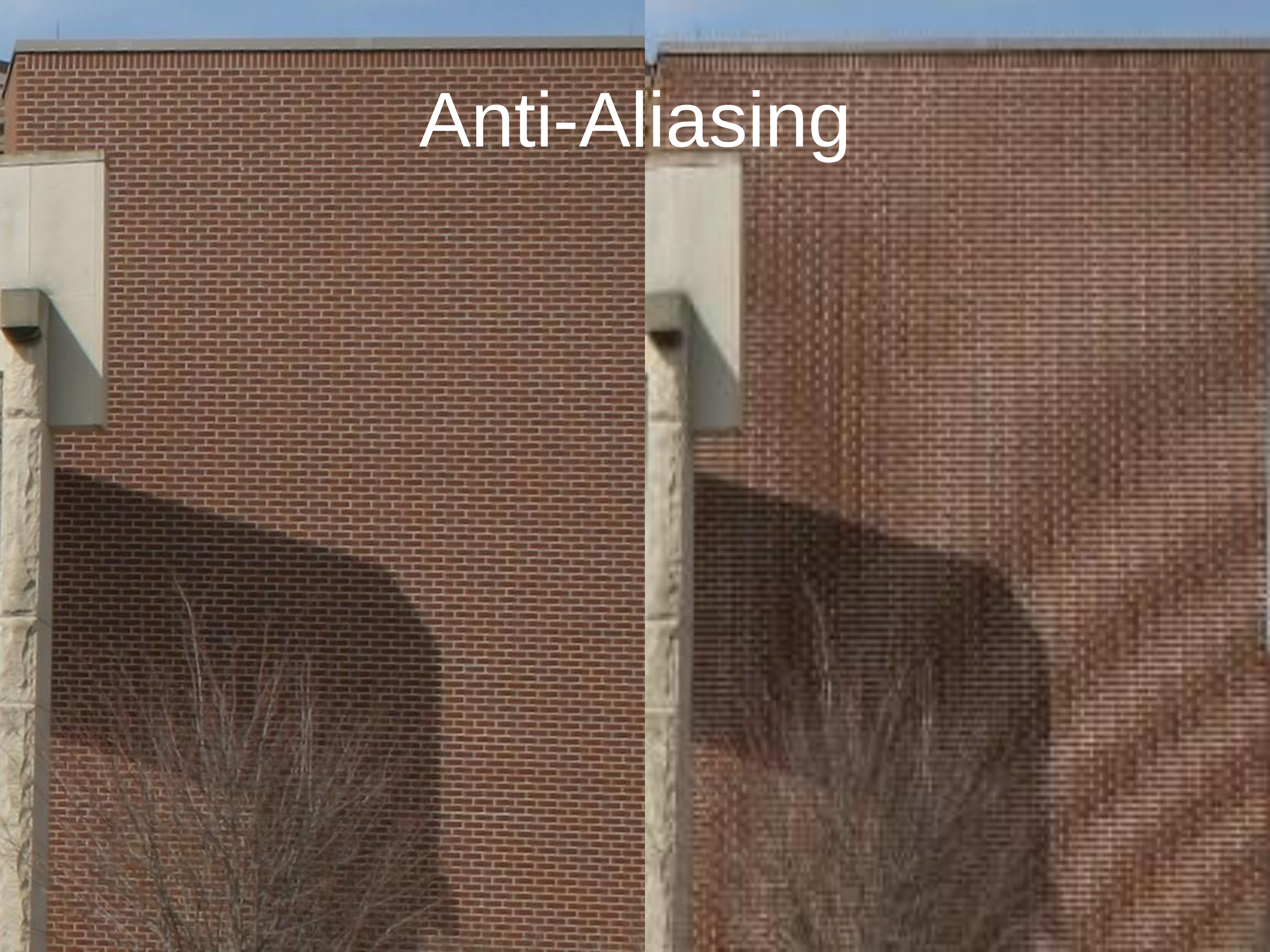


Convolution – Mask ‘slides’ over the image

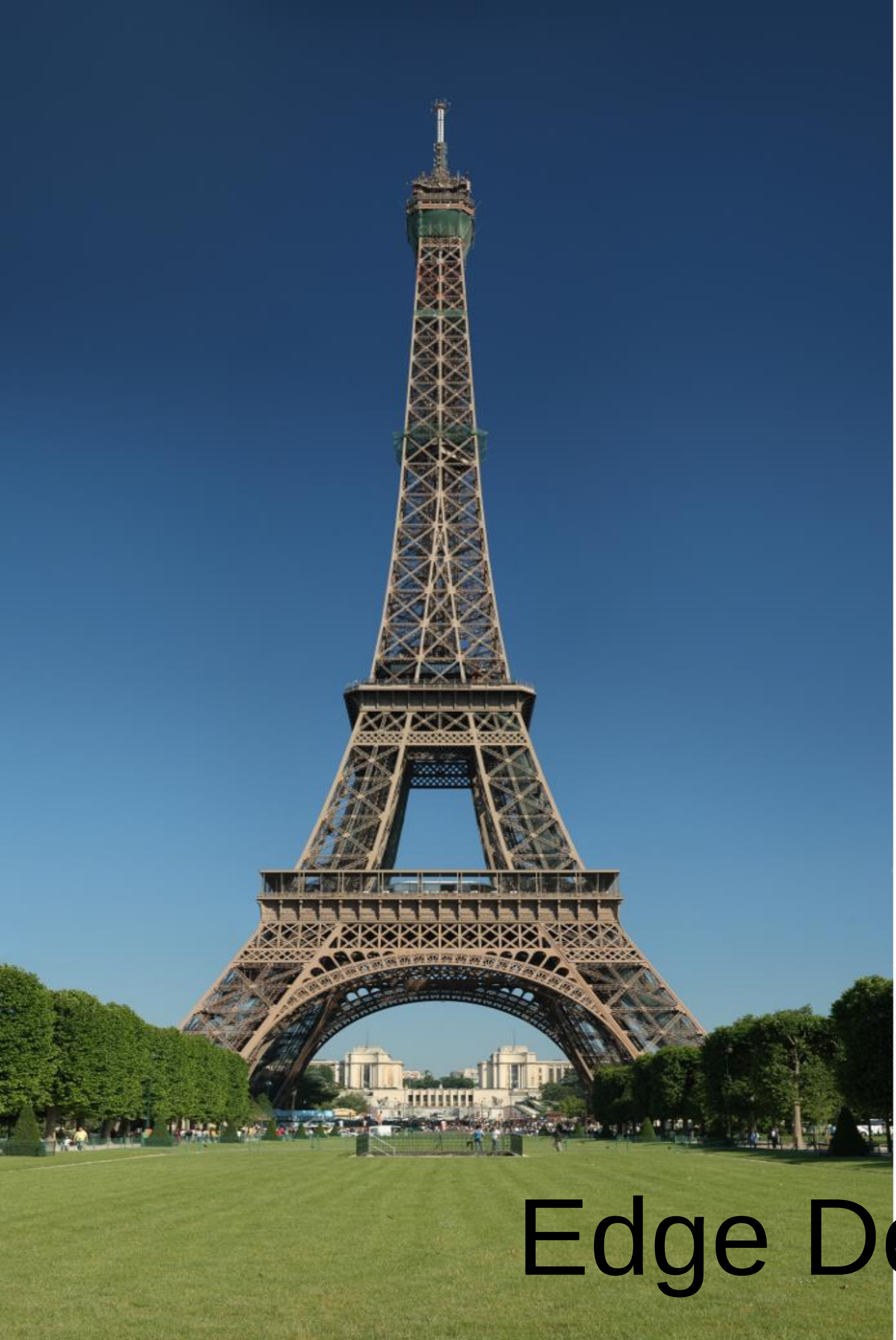
Depth of Field Blurring

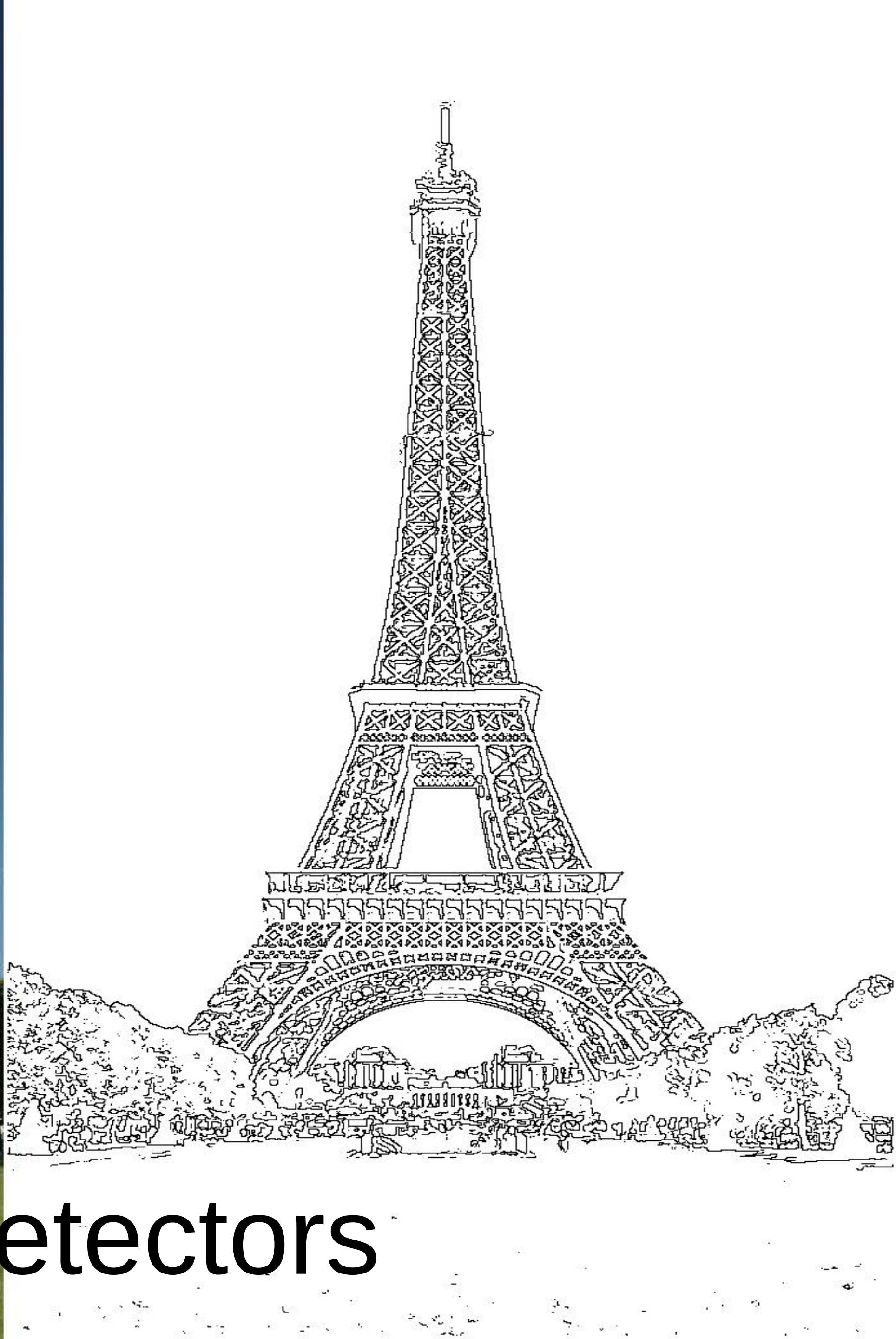


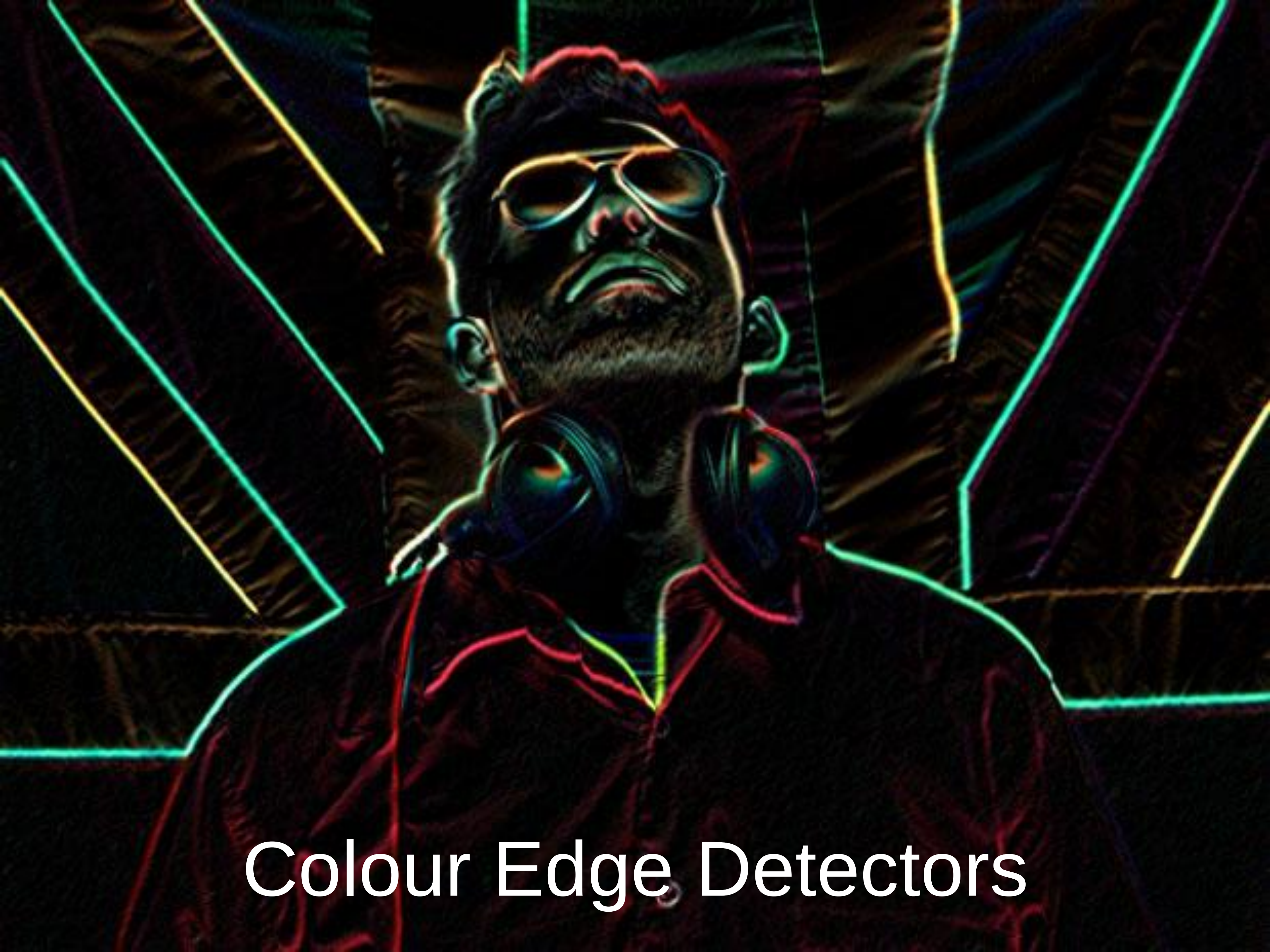
Anti-Aliasing



Edge Detectors



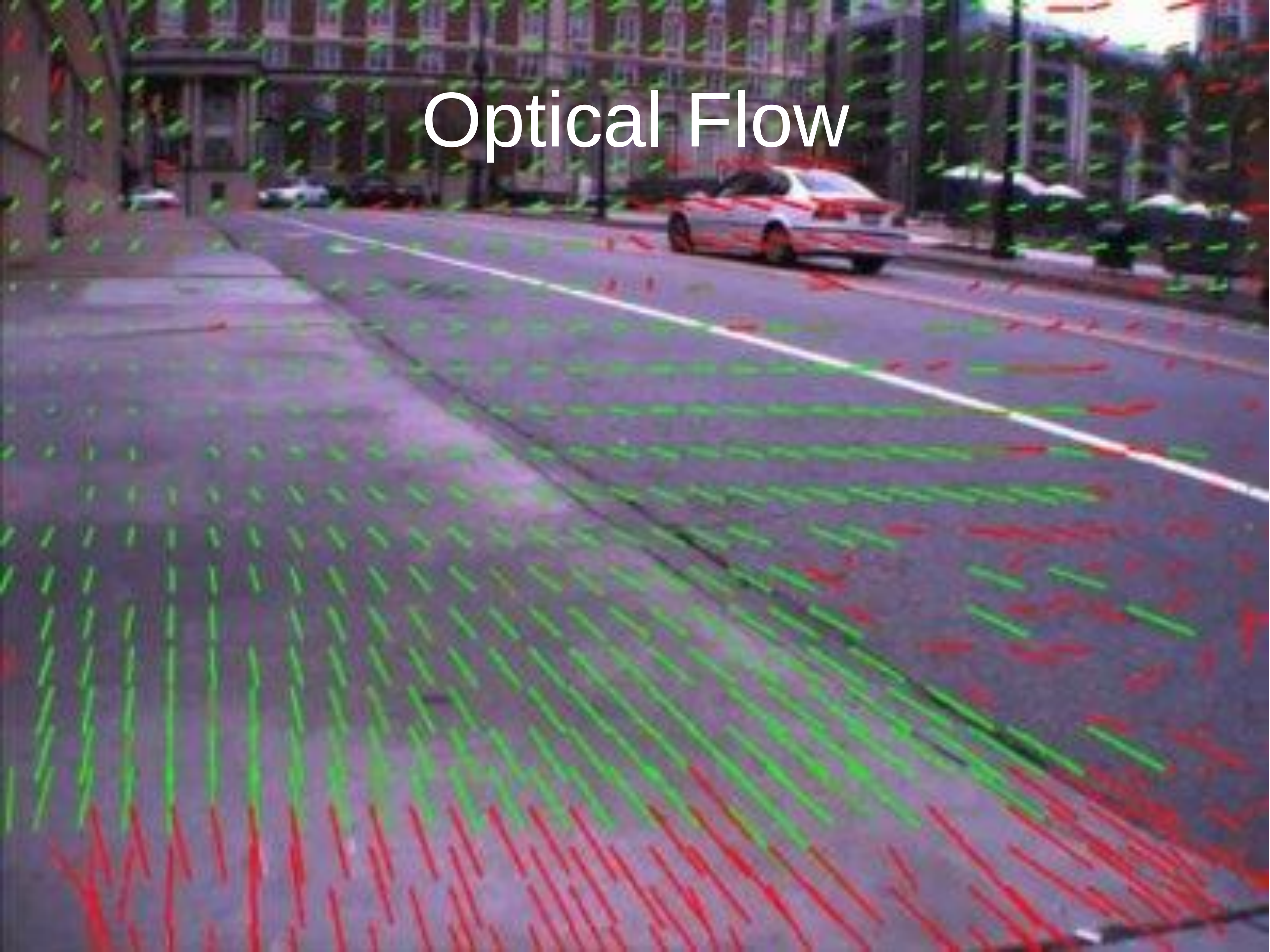




Colour Edge Detectors

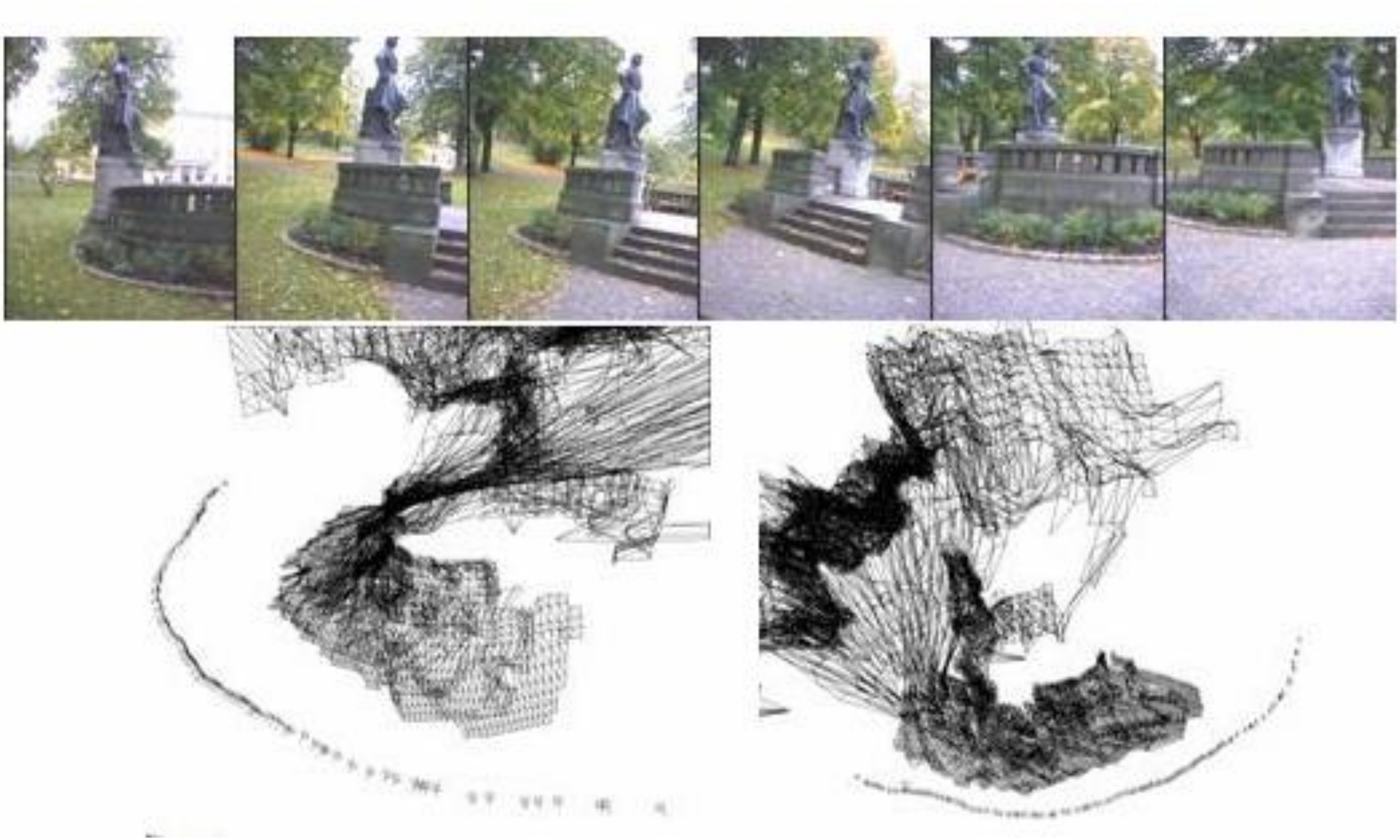
Advanced Processing

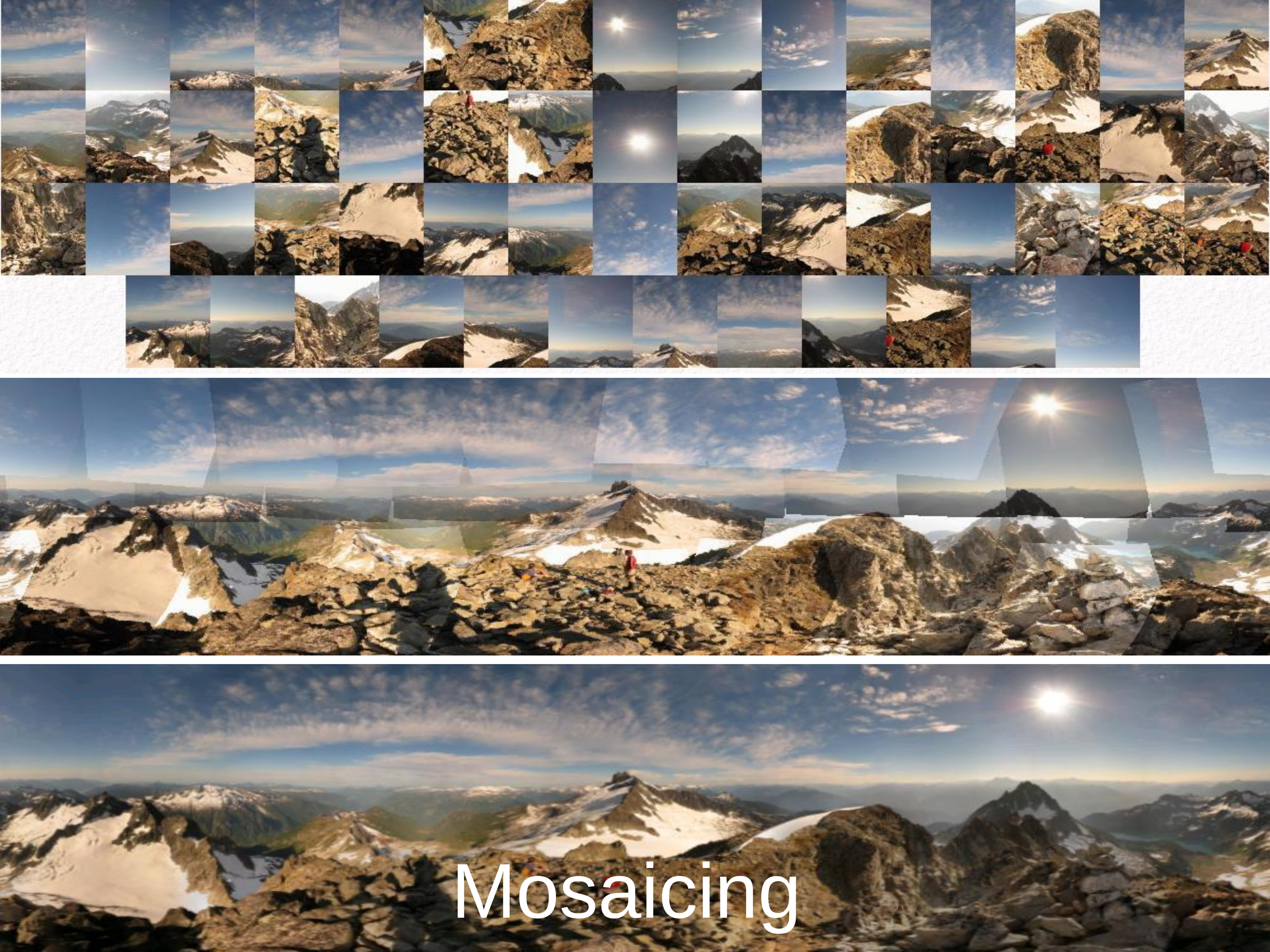
Optical Flow



Motion Quantification

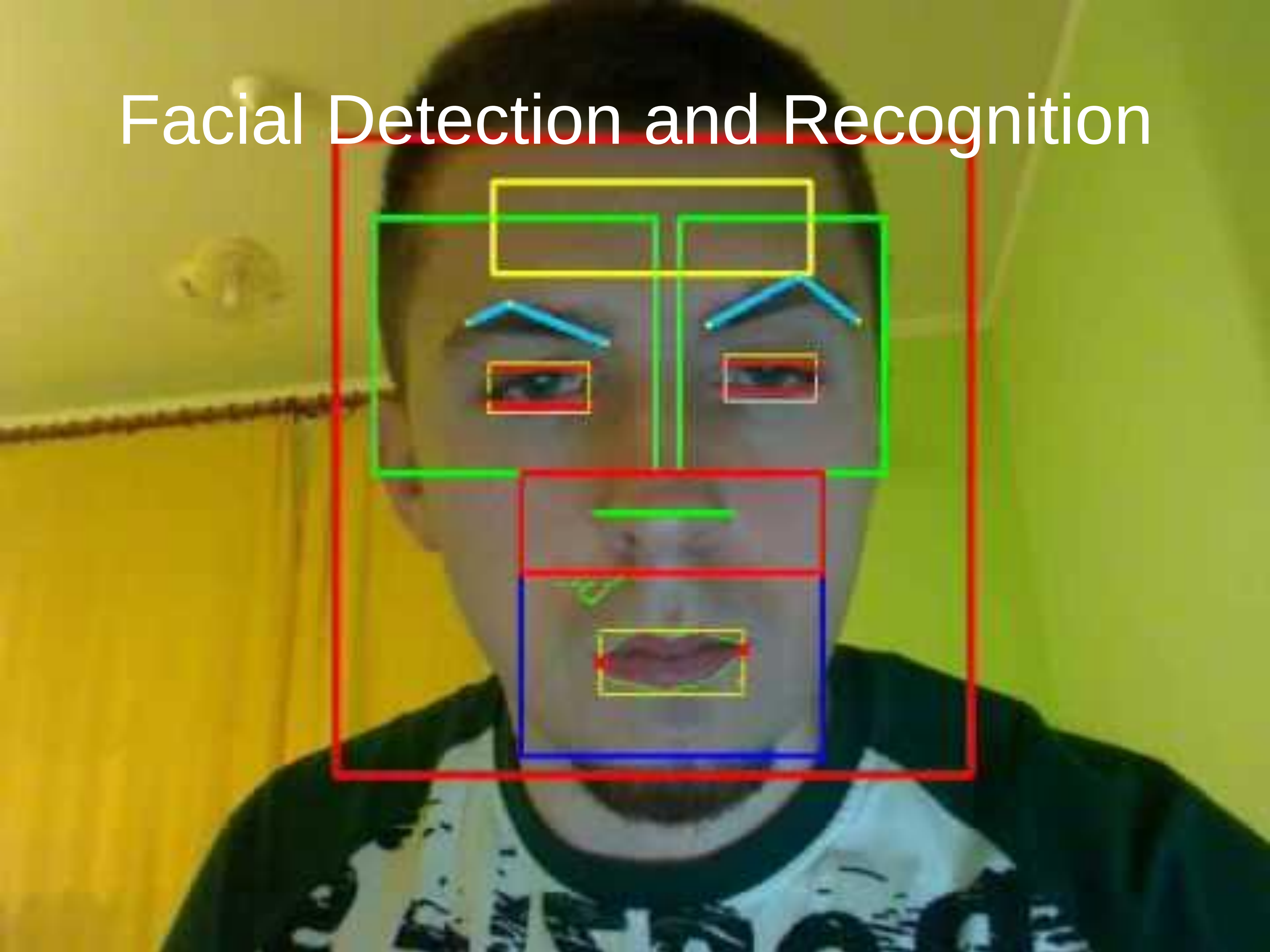
Structure from Motion



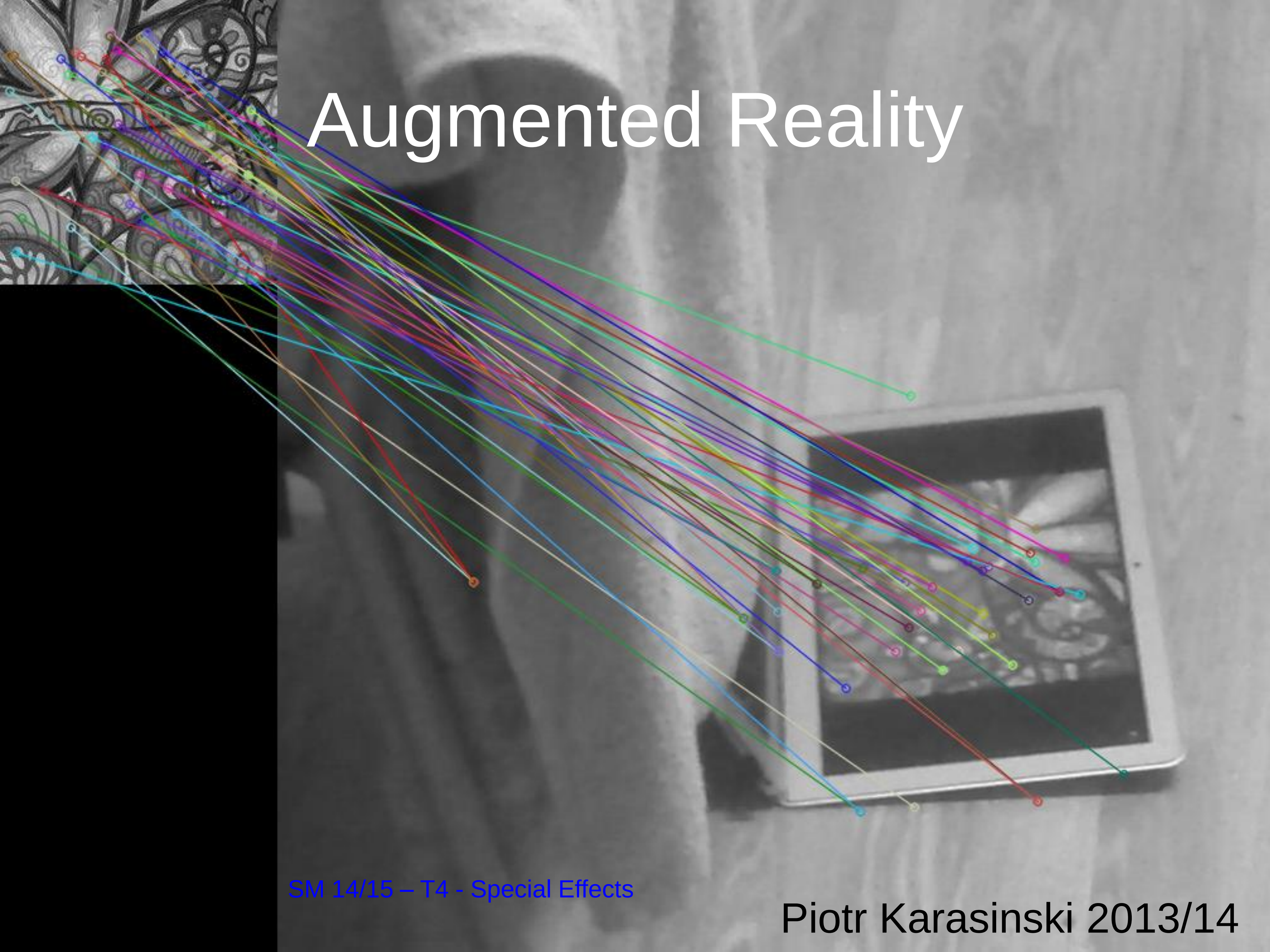


Mosaicing

Facial Detection and Recognition



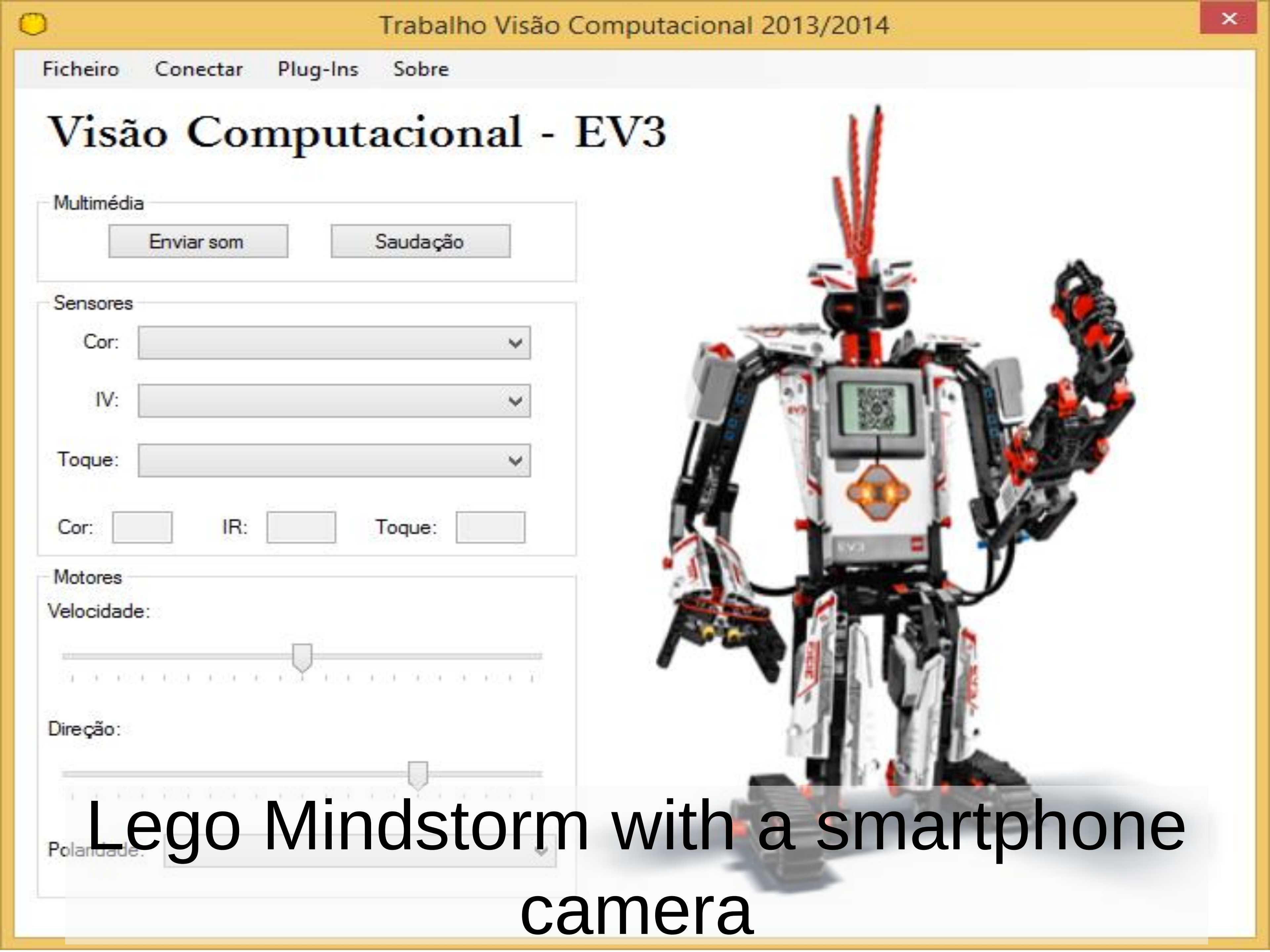
Augmented Reality



Piotr Karasinski 2013/14

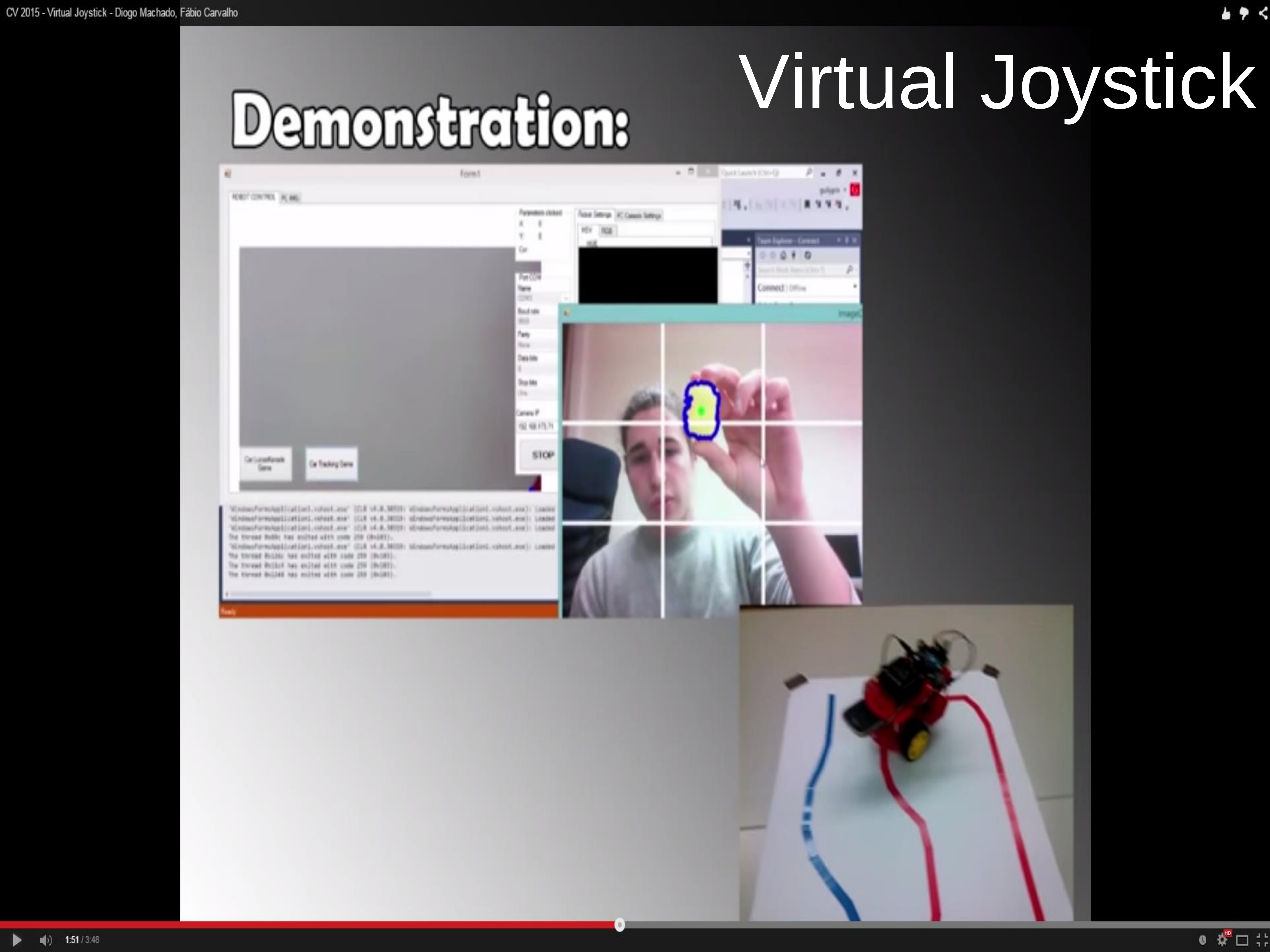
Crazy Stuff

That didn’t really fit anywhere else…



Lego Mindstorm with a smartphone camera

Virtual Joystick



CV 2015 - Virtual Joystick - Diogo Machado, Fábio Carvalho

Demonstration:

```
'WindowsFormsApplication1.vshost.exe' (CLR v4.0.30319: WindowsFormsApplication1.vshost.exe): Loaded
'WindowsFormsApplication1.vshost.exe' (CLR v4.0.30319: WindowsFormsApplication1.vshost.exe): Loaded
'WindowsFormsApplication1.vshost.exe' (CLR v4.0.30319: WindowsFormsApplication1.vshost.exe): Loaded
The thread 0x80c has exited with code 259 (0x103).
'WindowsFormsApplication1.vshost.exe' (CLR v4.0.30319: WindowsFormsApplication1.vshost.exe): Loaded
The thread 0x1b0c has exited with code 259 (0x103).
The thread 0x13c4 has exited with code 259 (0x103).
The thread 0x1248 has exited with code 259 (0x103).
```

How do I do all this?

Platforms and Source Code

- Computer Vision DCC
  - Lecture notes
  - JAVA platform
  - Android platform

  http://www.dcc.fc.up.pt/~mcoimbra/lectures/vc_1415.html
- OpenCV
  - Free to use, lots of algorithms, C

  http://opencv.org/
- Gonzalez & Woods book