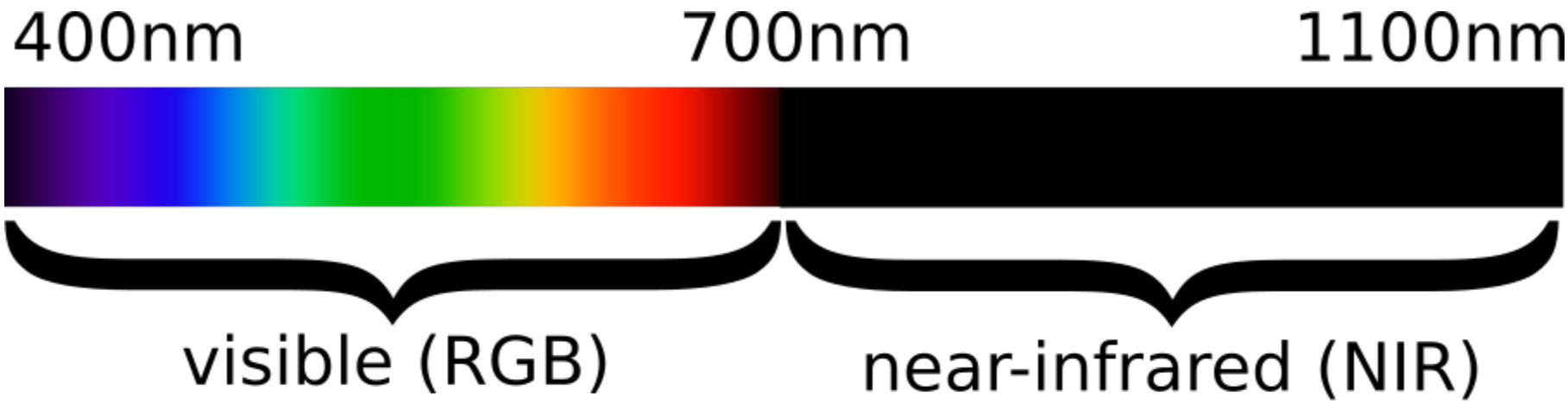
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

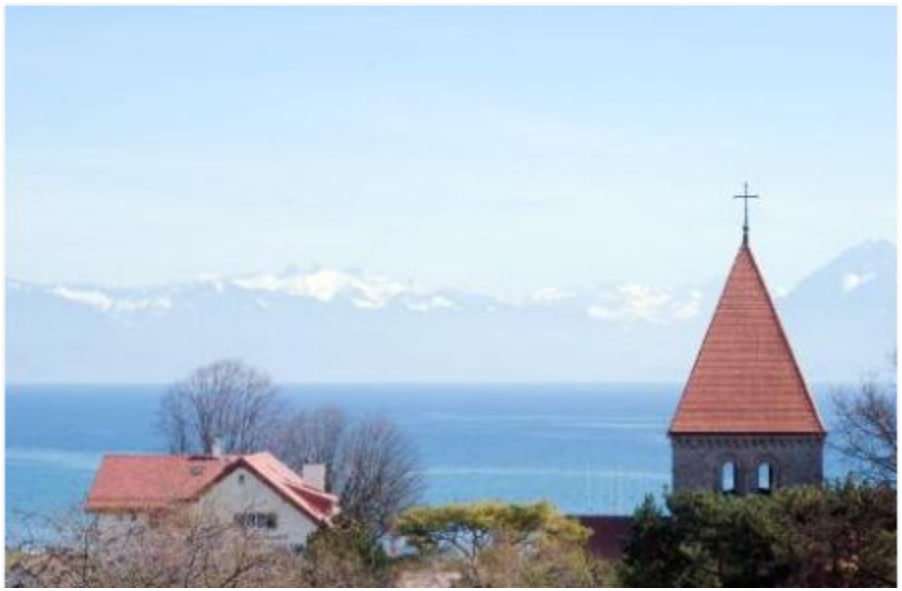
Near-infrared imaging

Computational Photography
CS-413

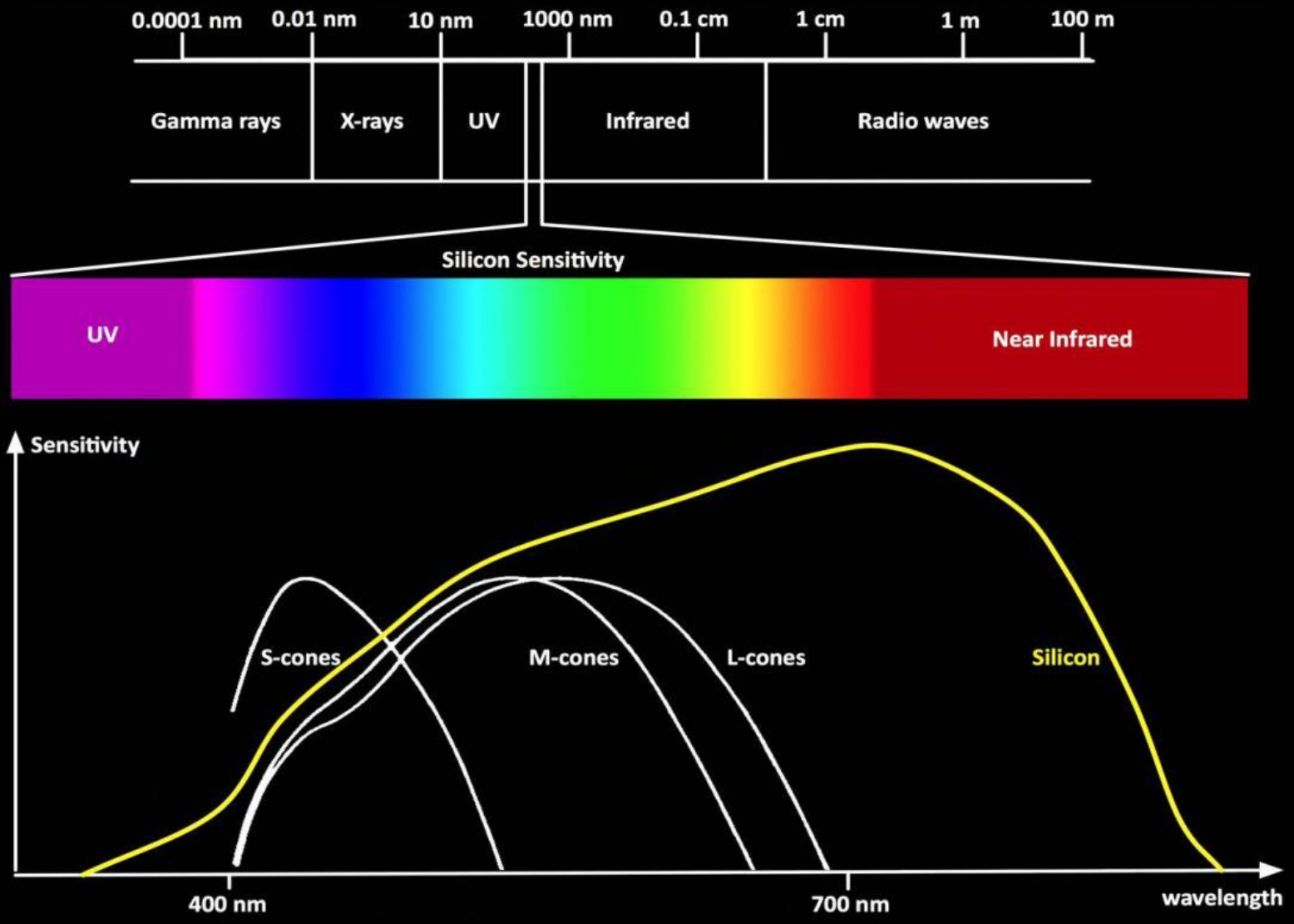
Damien Firmenich

What is Near-infrared ?





Silicon sensitivity to NIR



Benefits of capturing visible + NIR spectrum

We can **exploit** the correlation and decorrelation of visible and NIR image frequencies and intensities to:

- **Enhance** the visual quality of images/videos
- **Extract** more accurate information about the scene

Computer vision applications

- Light source estimation
- Material reflectance
- Shadow detection
- Image segmentation
- Scene recognition
- Haze removal
- Skin smoothing

Skin smoothing

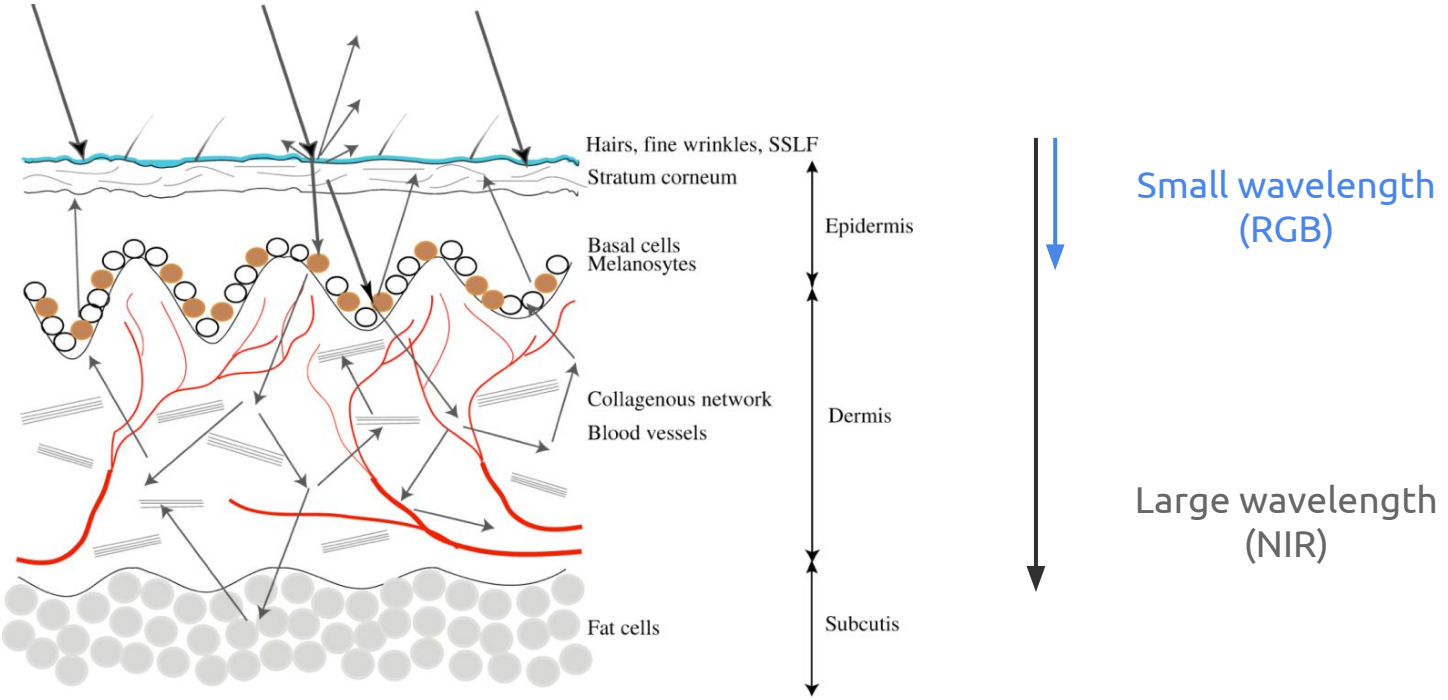
RGB
(visible)

NIR

Reference [1]

Penetration of radiation in skin

Absorption and scattering of light is inversely proportional to its wavelength.

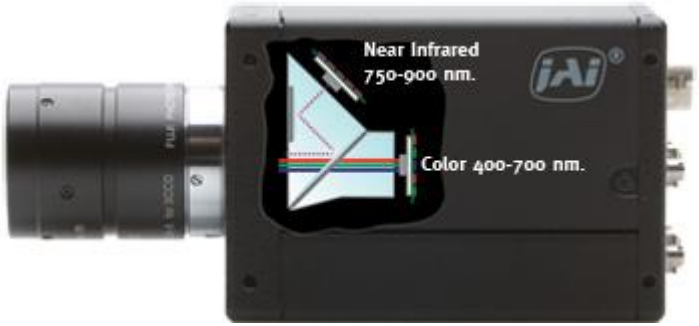


Reference [4]

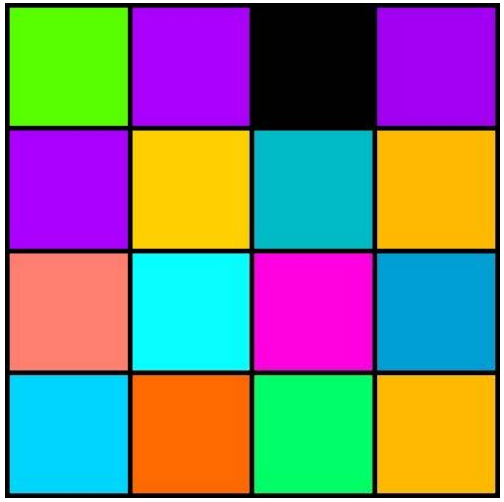
Intuition
If NIR penetrates deeper into skin, then surface imperfections are less visible.

How to capture Near-infrared ?

Joint acquisition of RGB and NIR



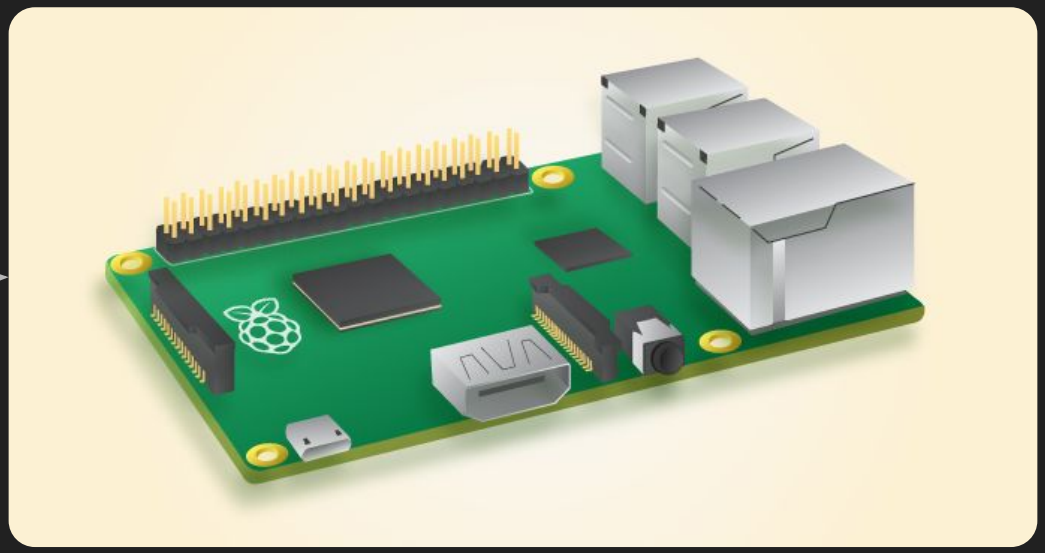
Two sensors acquisition



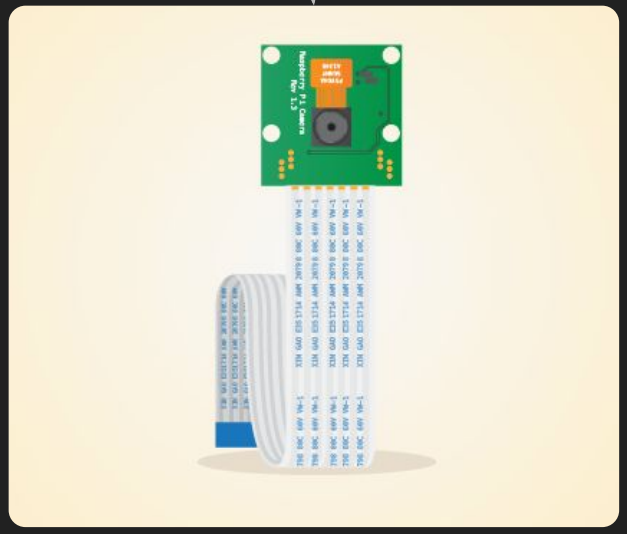
Single sensor acquisition

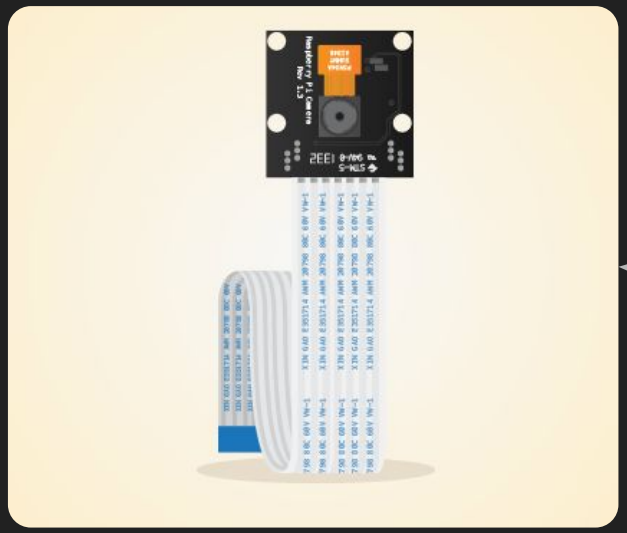
Reference [2]

Two Raspberry Pi 2
(Model B)



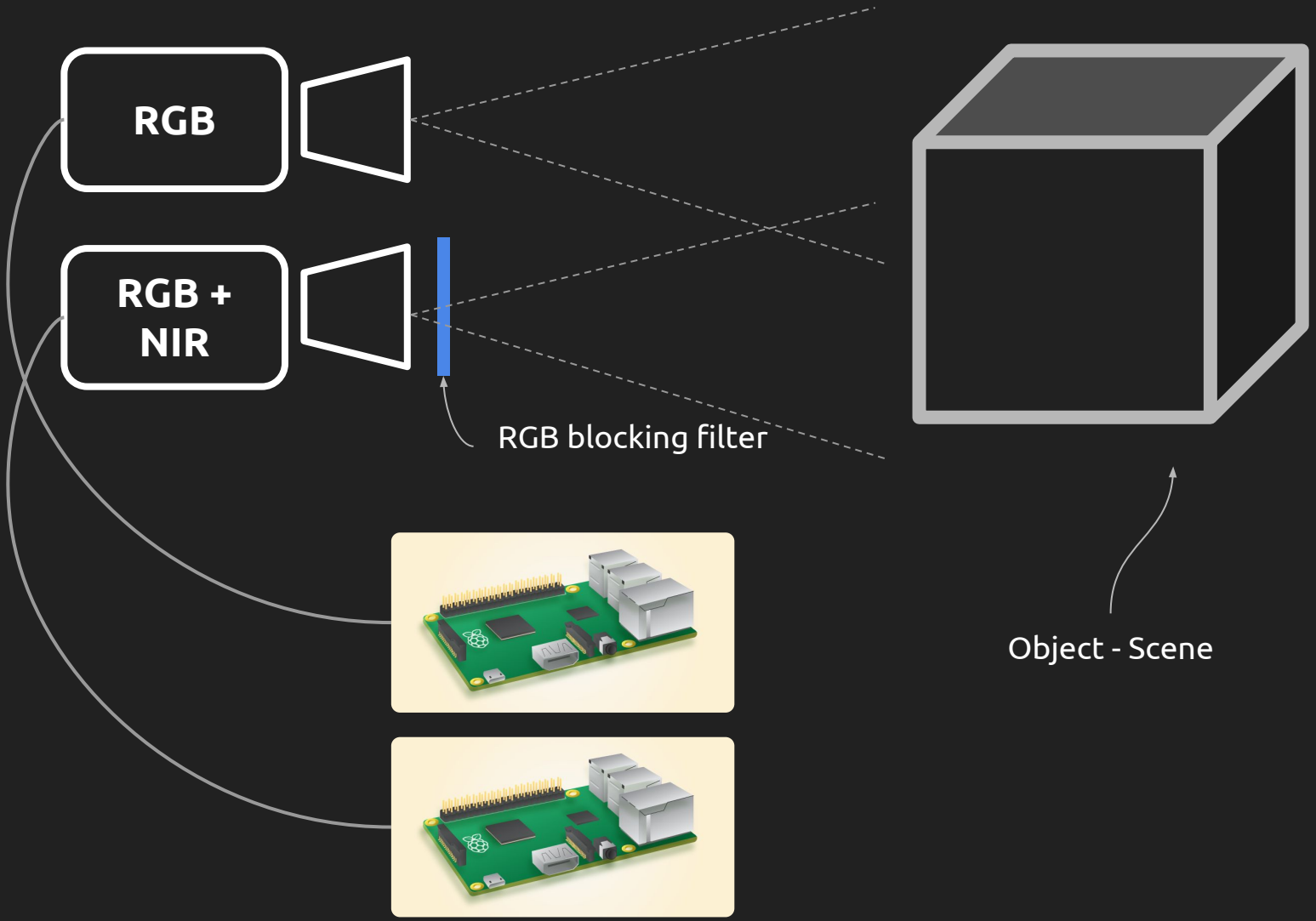
Pi Camera module



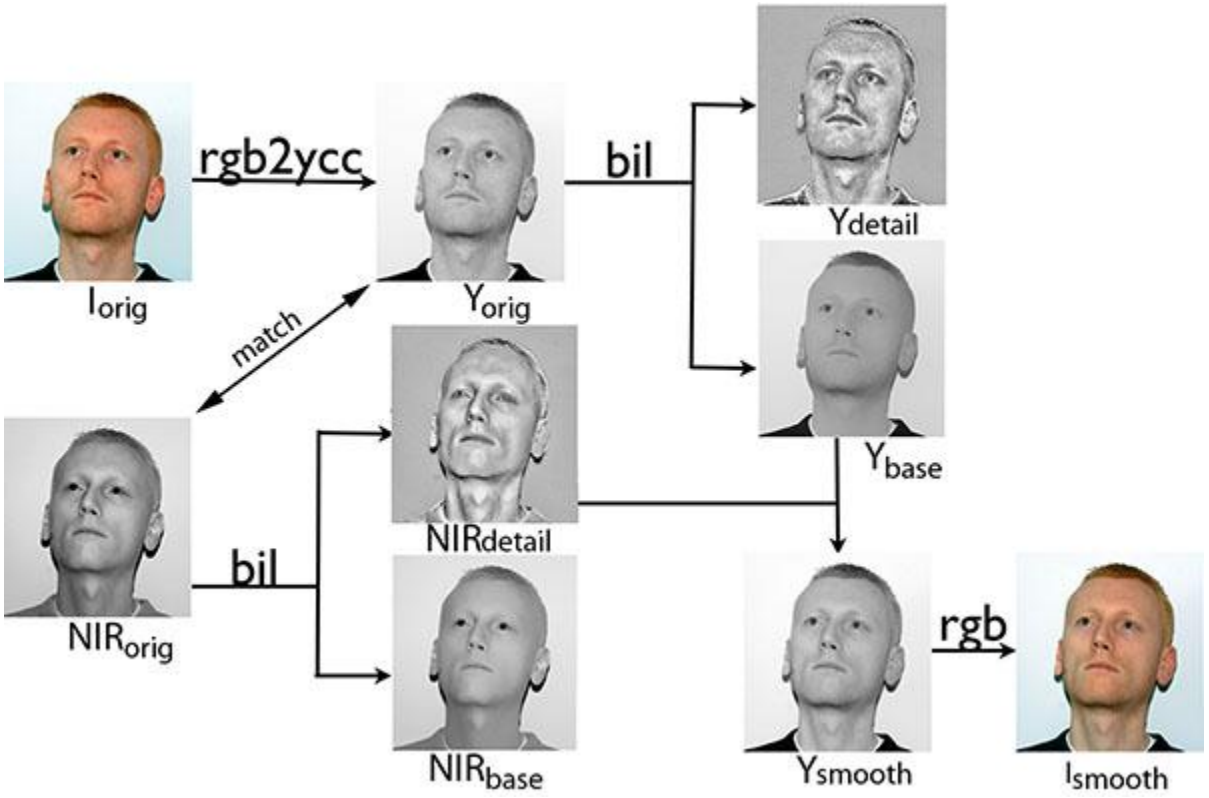


Pi Camera module NoIR (no
infrared filter)

Stereo cameras setup



Merging RGB and NIR



Reference [1]

RGB + NIR pair

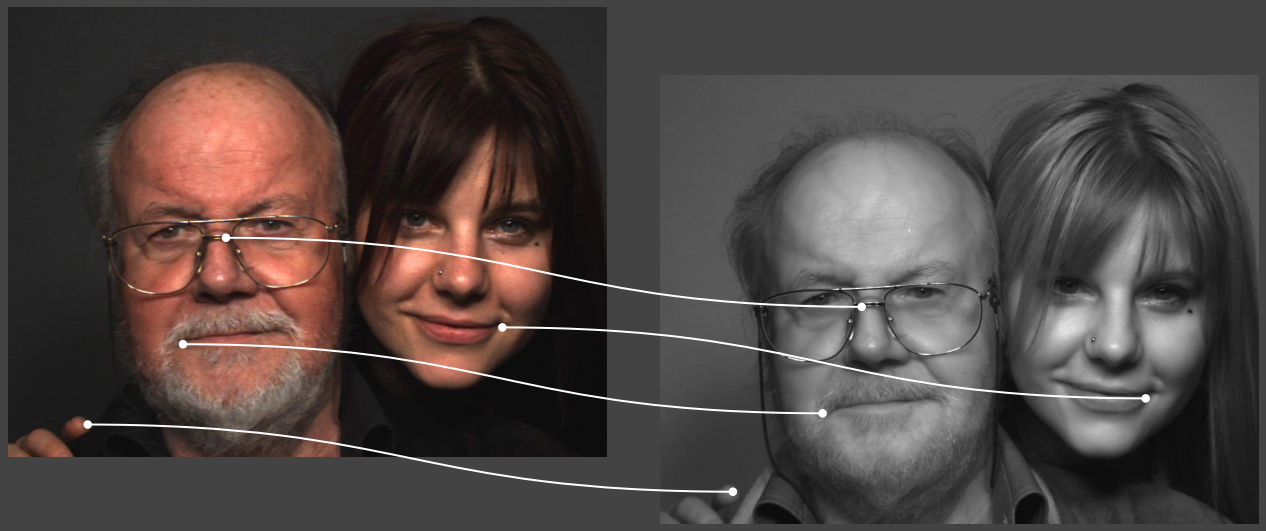
Result

Captured RGB and NIR image pair

Misaligned from stereo capture

Aligned with affine transformation

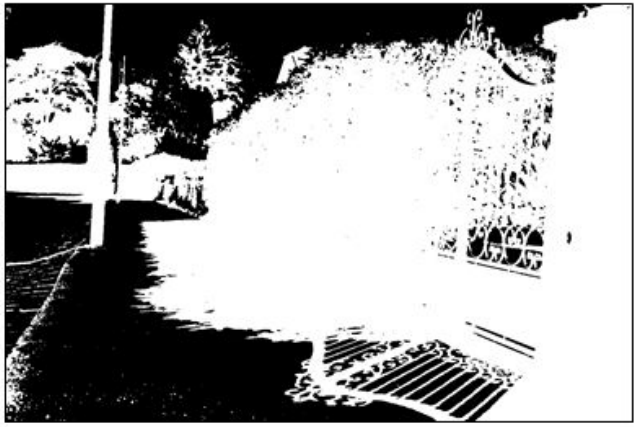
Find matching features in image pair



Reference [3]

Dehazing

Shadow detection & removal



Depth from stereo

Proposed project structure

1. Preparation of the Raspberry Pi (operating system + environment)
2. Preparation of the cameras in stereo setup
3. Registration algorithm to align the captured images
4. Merging algorithm to combine RGB + NIR and smooth skin
5. Extra
    - Dehazing
    - Shadow detection and removal
    - Depth from stereo

References

[1] C. Fredembach, N. Barbuscia and S. Süsstrunk
Combining visible and near-infrared images for realistic skin smoothing,
Proc. IS&T/SID 17th Color Imaging Conference (CIC), 2009

[2] M. Brown, S. Süsstrunk
Multispectral SIFT for Scene Category Recognition
Proc. IEEE International Conference on Computer Vision and Pattern Recognition (CVPR 2011), p. 177-184

[3] D. Firmenich, M. Brown, S. Süsstrunk
Multispectral Interest Points for RGB-NIR Image Registration
Proc. IEEE International Conference on Image Processing (ICIP 2011)

[3] R. Szeliski
Computer vision: algorithms and applications
Springer Science & Business Media, 2010, p. 311-320

[4] T. Igarashi, K. Nishino, and S.K. Nayar
The appearance of human skin.
Technical Report: CUCS-024-05, 2005.