



Example Applications at Le2i – Le Creusot

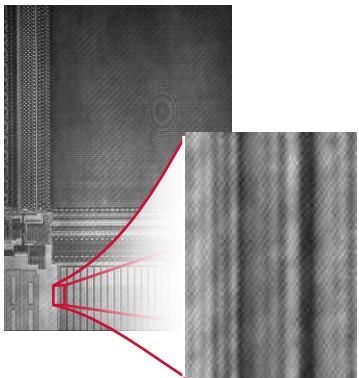


Examples at Le2i

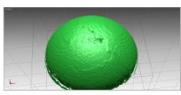


Application Areas

3D INSPECTION



- Scanner Laser.
- adding opaque coating



- Polarization system.
- reconstruction by normals field integration



- Deviation.
- $\pm 1.5 \text{ mm}$

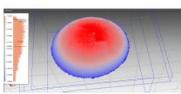
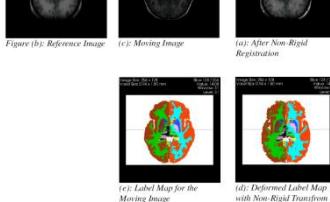
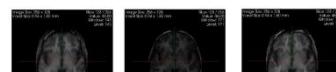
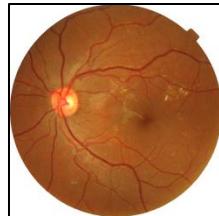


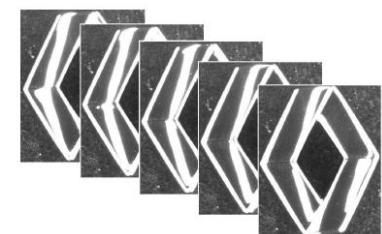
IMAGE COMPRESSION



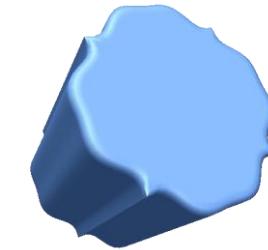
MEDICAL



MACHINE VISION



3D Visualization





14

23

3

1

Professors

- 10 PU
- 3 PU-PH
- 1 PU collaborator

Profs

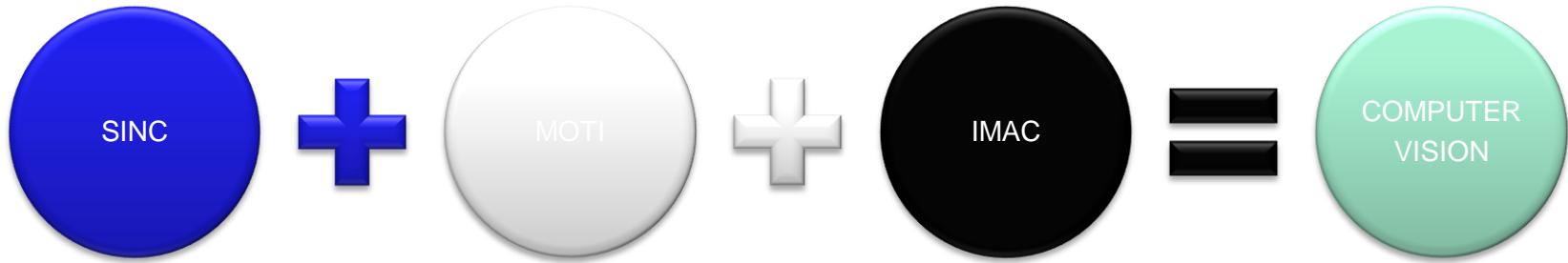
- 1 MCF-HDR
- 1 MCF Chaire CNRS
- 18 MCF
- 3 MCF collaborators

CNRS

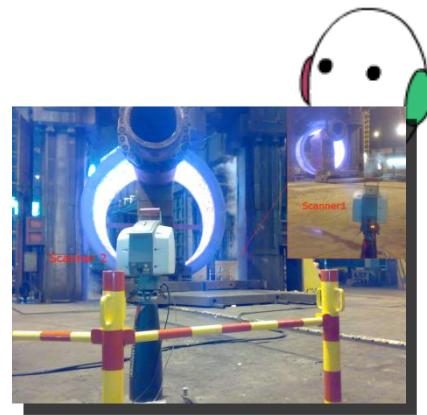
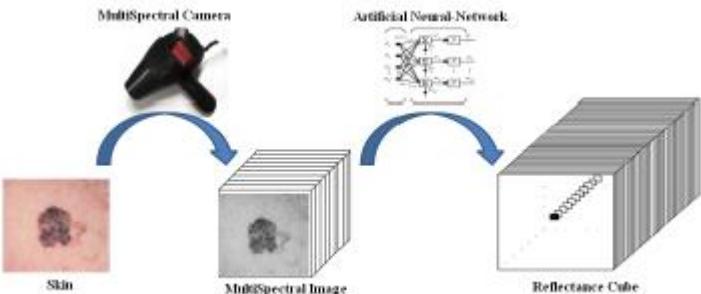
- 1 IR
- 1 IE
- 1 TR

uB

- ½ ASI



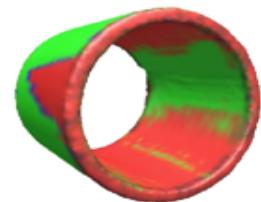
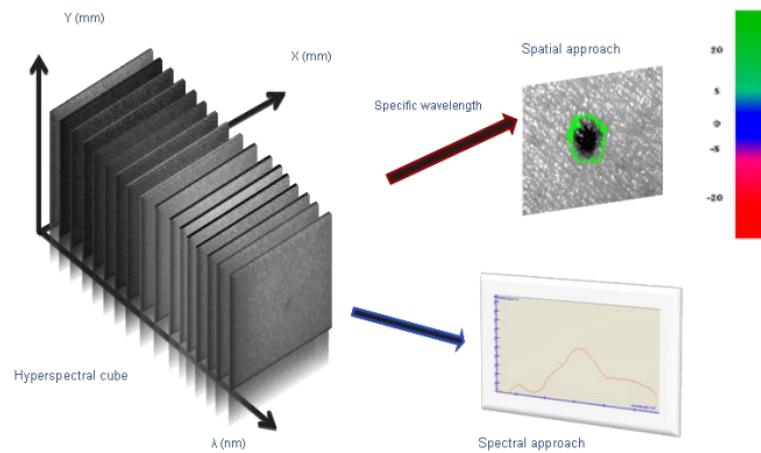
Computer Vision



Non Conventional
Imaging systems
(SINC)

Tools and
Methods for Image
processing (MOTI)

Medical imaging
and Clinical
Applications
(IMAC)



Computer Vision

Non Conventional Imaging systems
(SINC)

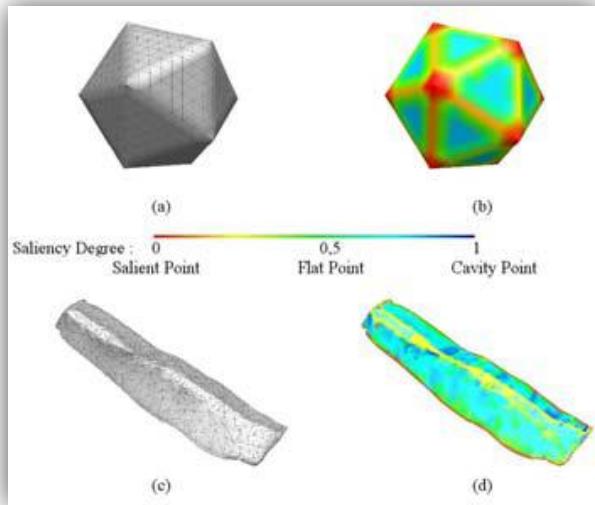
Tools and
Methods for Image
processing **(MOTI)**

Medical imaging
and Clinical
Applications
(IMAC)

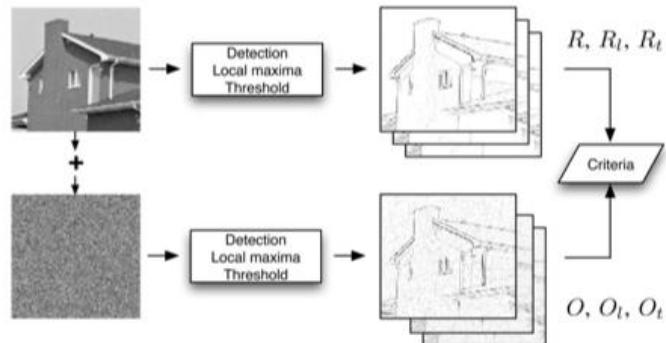


Computer Vision

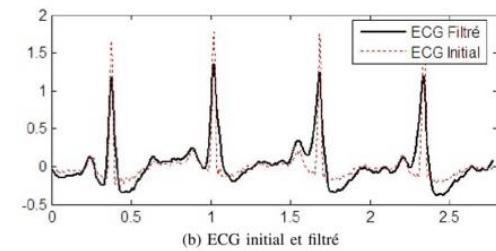
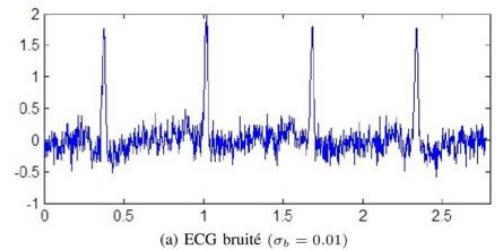
Non Conventional
Imaging systems
(SINC)



Tools and
Methods for Image
processing
(MOTI)



Imagerie Médicale
et Applications
Cliniques
(IMAC)

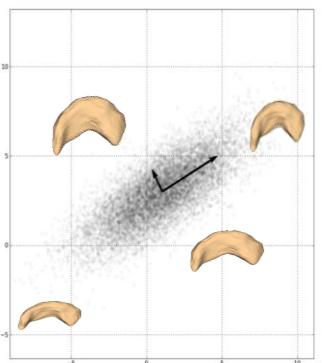


"A nonlinear derivative scheme applied to edge detection", Olivier LALIGANT, Frédéric TRUCHETET, **IEEE TPAMI**, 32 (2), pp. 242-257, February 2010

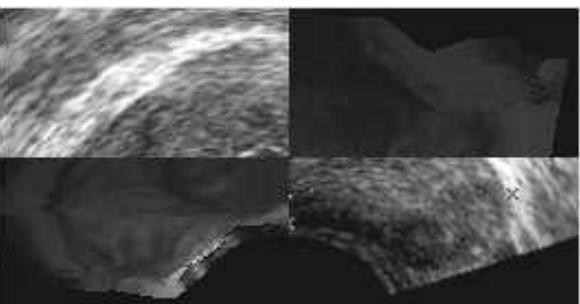
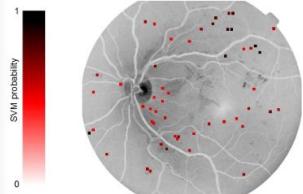
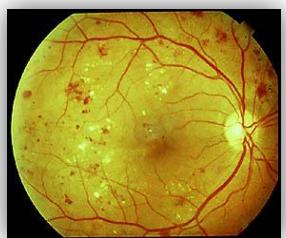


Computer Vision

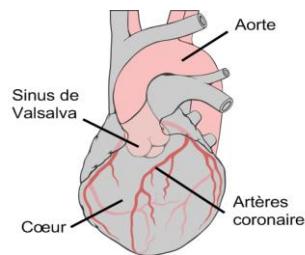
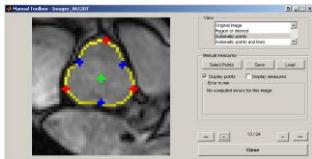
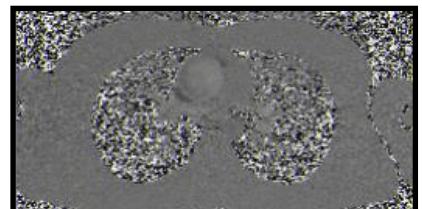
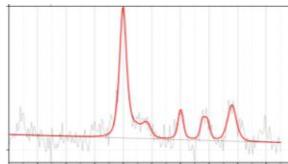
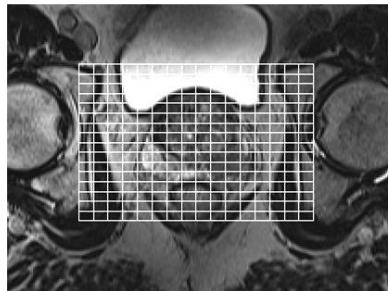
Non Conventional Imaging systems (SINC)



Tools and Methods for Image processing (MOTI)



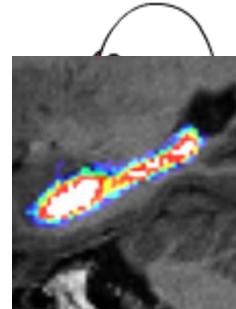
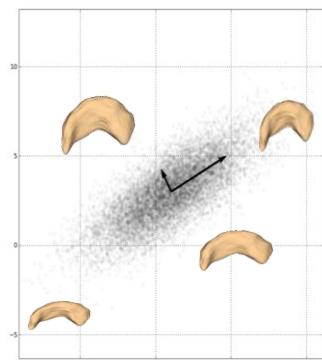
Medical Imaging and Clinical Applications (IMAC)



Mériaudeau

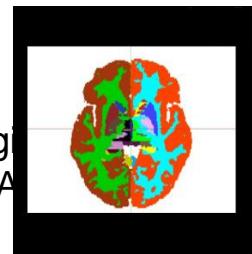


Computer Vision



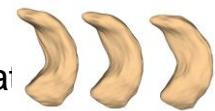
Non Conventional Imaging systems
(SINC)

- Atlas based segmentation of deep gray matter structures
 - Multi-atlas based segmentation propagation
 - Atlas construction using a supervised method
 - Atlas selection strategies based on Maximal Margin relevance (MMR) and Least Angle Regression (LAR)



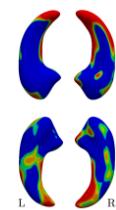
Tools and Methods
for Image processing
(MOTI)

- Statistical shape model (SSM) of hippocampus
 - Building hippocampal SSM
 - Extrapolation of SSM and shape parameter estimation



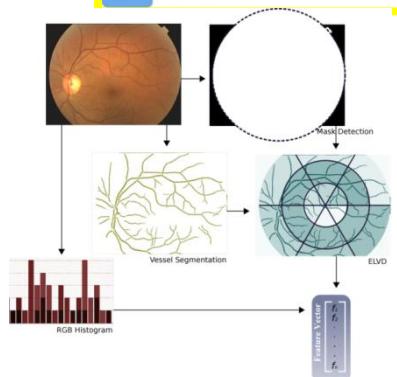
Medical Imaging
and Clinical Applications
(IMAC)

- Shape analysis of hippocampus in Alzheimer's disease
 - Localization of SSM to hippocampal subregions affected by the atrophy
 - Shape analysis on the localized hippocampal subregions





L. Giancardo, et al, "Elliptical Local Vessel Density: a Fast and Robust Quality Metric for Fundus Images," in 30th Annual International Conf. of the IEEE EMBS Vancouver, Canada, 2008.

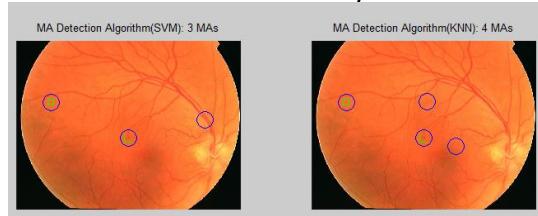
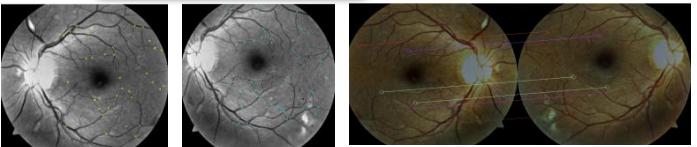


Computer Vision

Non Conventional Imaging systems (SINC)

Tools and Methods for Image processing (MOTI)

Medical Imaging and Clinical Applications(IMAC)



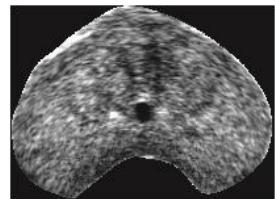
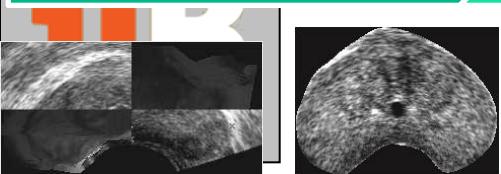
CBIR database

Sample report:

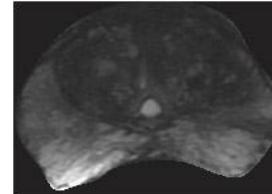


Giancardo, L., et. al, (2010), Microaneurysms detection with the Radon Cliff operator in retinal fundus images, Proc. SPIE Medical Imaging, San Diego CA, 7623:7623

Giancardo et al. MIA, 2012



$$\varphi(\cdot) \neq \varphi^{-1}(\cdot)$$



Computer Vision

Non Conventional Imaging systems
(SINC)

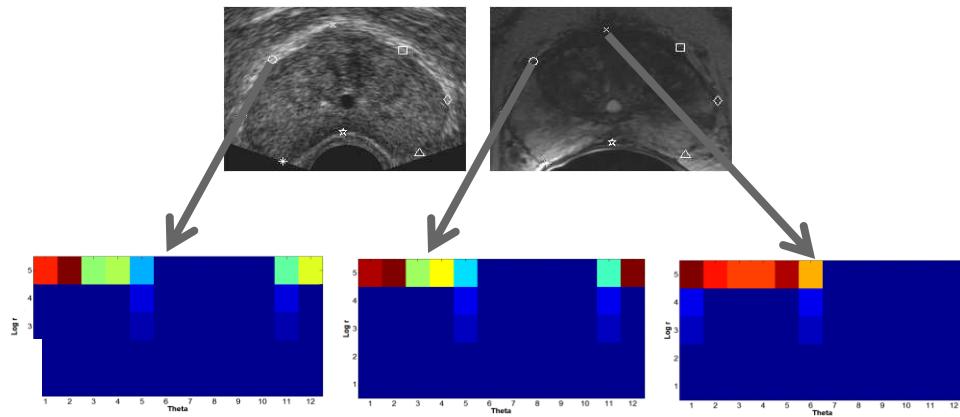
$$\int \omega(\text{Brain Image}) = \int \omega(\varphi(\text{Brain Image}))$$

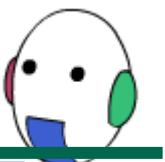
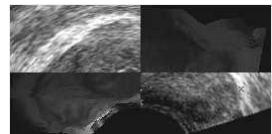
Thin-plate spline function

Domokos et al. 2012, IEEE TPAMI

Tools and Methods
for Image
processing (**MOTI**)

Medical Imaging
and Clinical
Applications(**IMAC**)





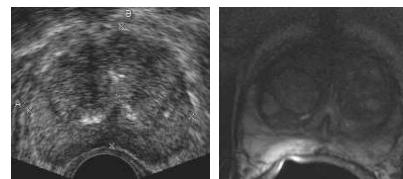
Computer Vision

Non Conventional Imaging systems
(SINC)

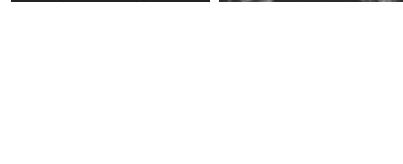
Tools and Methods
for Image
processing (**MOTI**)

Medical Imaging
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Applications(**IMAC**)

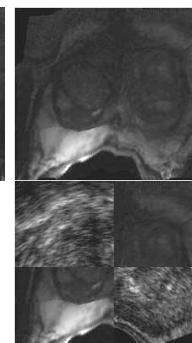
TRUS



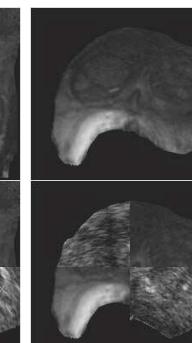
MRI



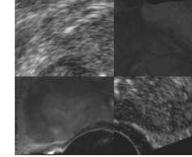
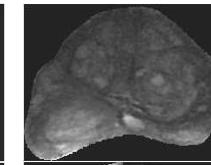
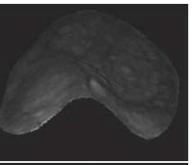
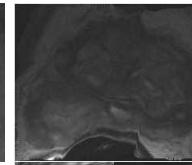
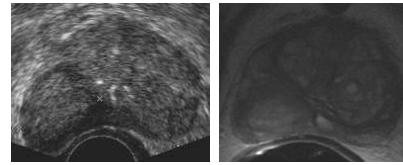
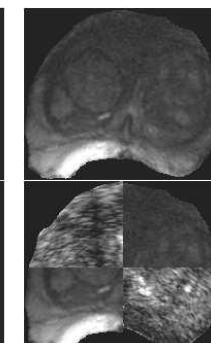
TPS



B-splines



NLTPS-
REGCORR



Mitra et al. MIA, 2012



Computer Vision

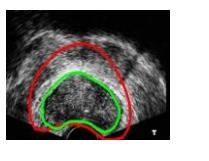
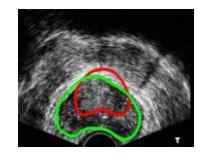
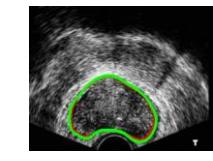
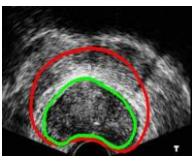
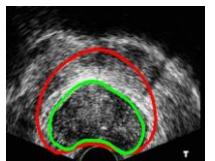
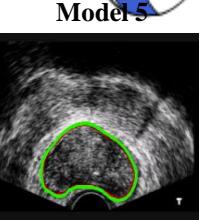
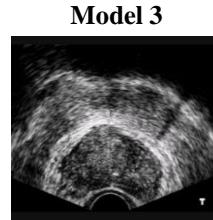
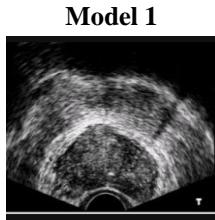
Non Conventional Imaging systems
(SINC)

Tools and Methods
for Image
processing (MOTI)

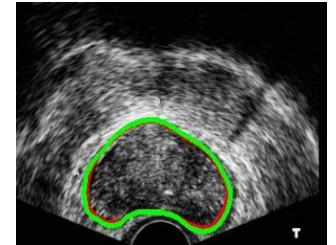
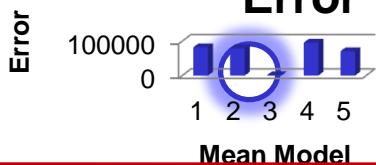
Medical Imaging
and Clinical
Applications (IMAC)

Ground Truth

Segmentation



Registration Error





Computer Vision

Non Conventional
Imaging systems
(SINC)

*IEEE TIM, Optics Express, Applied Optics, Optical
Engineering, IEEE ICPR.....*

Tools and
Methods for Image
processing
(MOTI)

*IEEE PAMI, IEEE Signal Processing Letters, IEEE
Visualisation and graphics, Optical Engineering....
IEEE ICIP....*

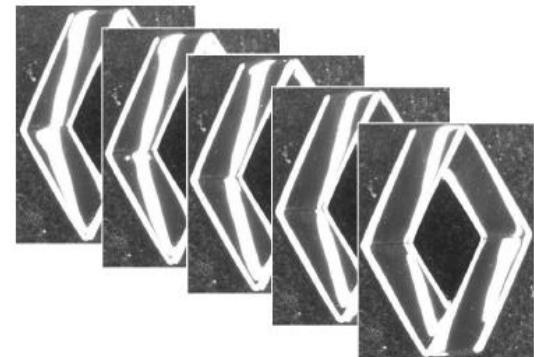
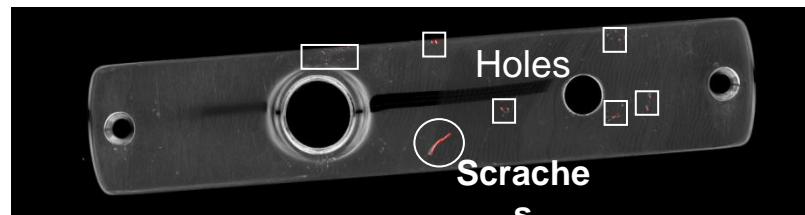
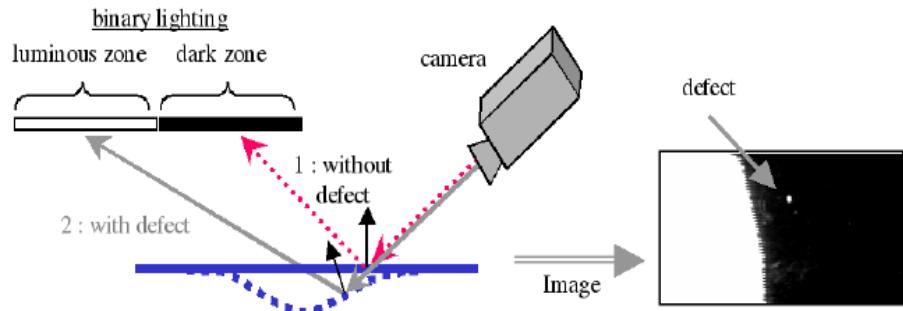
Imagerie Médicale
et Applications
Cliniques **(IMAC)**

*Neuroimaging, Medical Imaging Analysis, MAGMA,
European Journal of Oncology....
MICCAI.....*

Some more Examples at Le2i



Reflective product inspection: Cosmetic lid, Silverware, Automotive parts.....

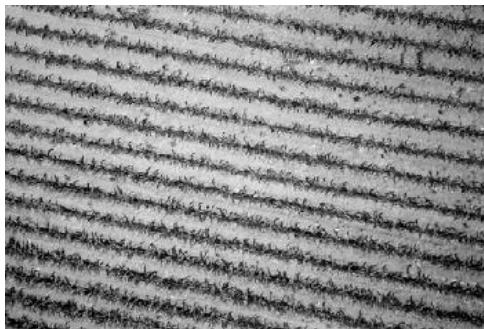


Machine Vision and Applications (2008) 19:35–42
Characterization of surface deformation with the Edge of Light™ technique, Z. Liu · M. Genest · A. Marincak · D. S. Forsyth

➡ Crop/Weed discrimination from image processing



Aerial image



Line detection for images with perspective effects ?

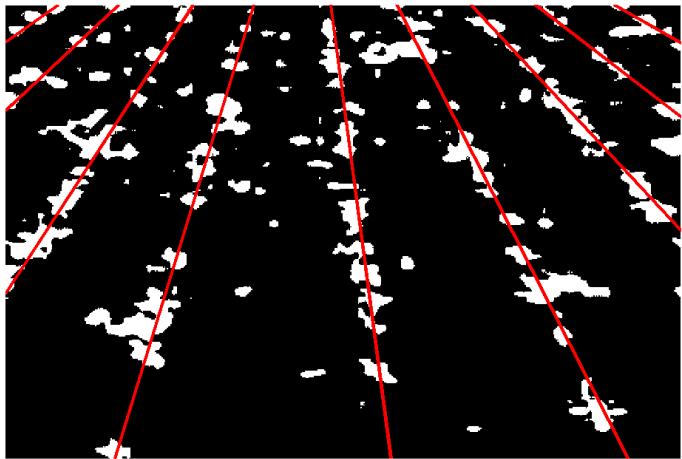
Pass-band filter : 2D oriented Gabor

$$g(x, y) = e^{-\frac{1}{2}[-\frac{x_\theta^2}{\sigma_x^2} + \frac{y_\theta^2}{\sigma_y^2}]}. \cos(2\pi f_\theta x)$$

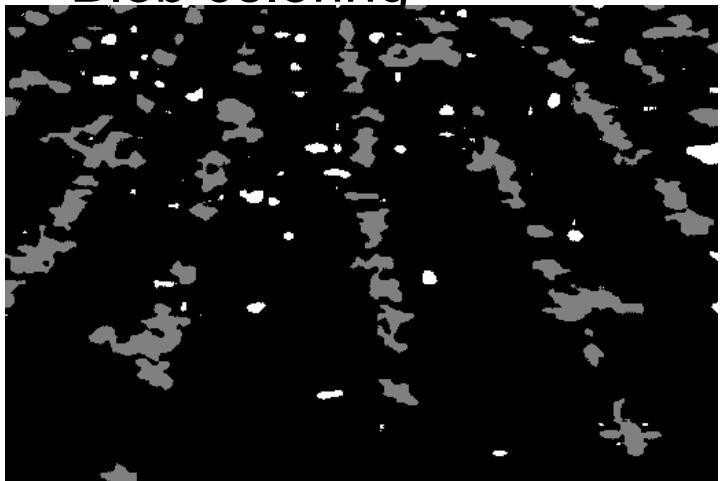
In-field image



■ Line detection

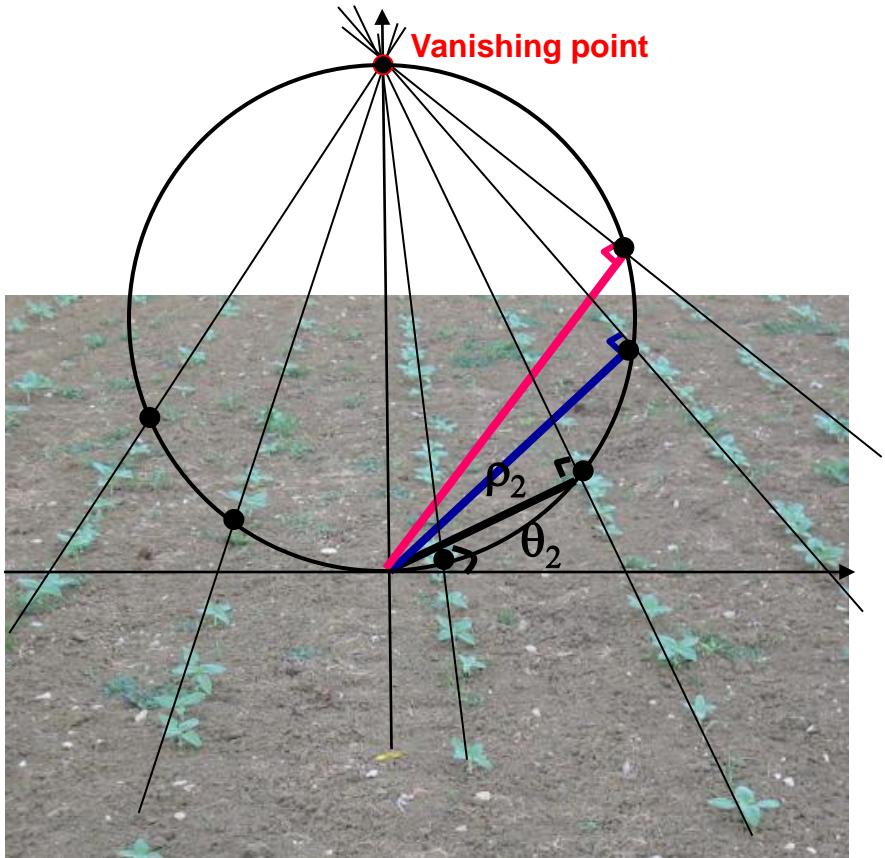


■ Blob coloring





■ 1st Method: standard detection



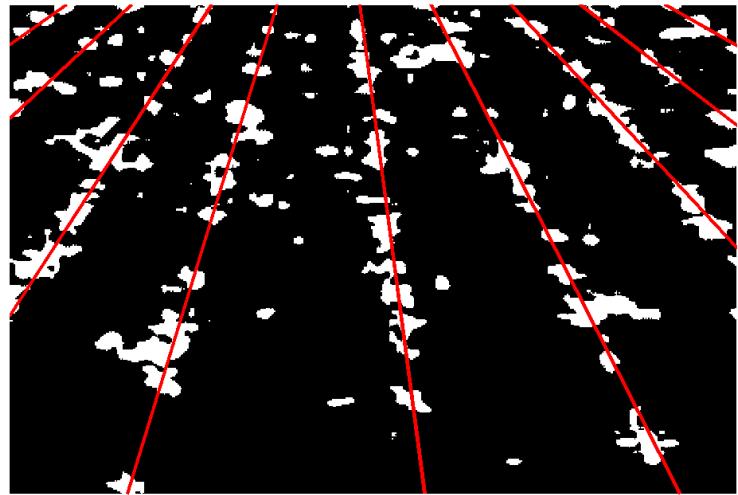
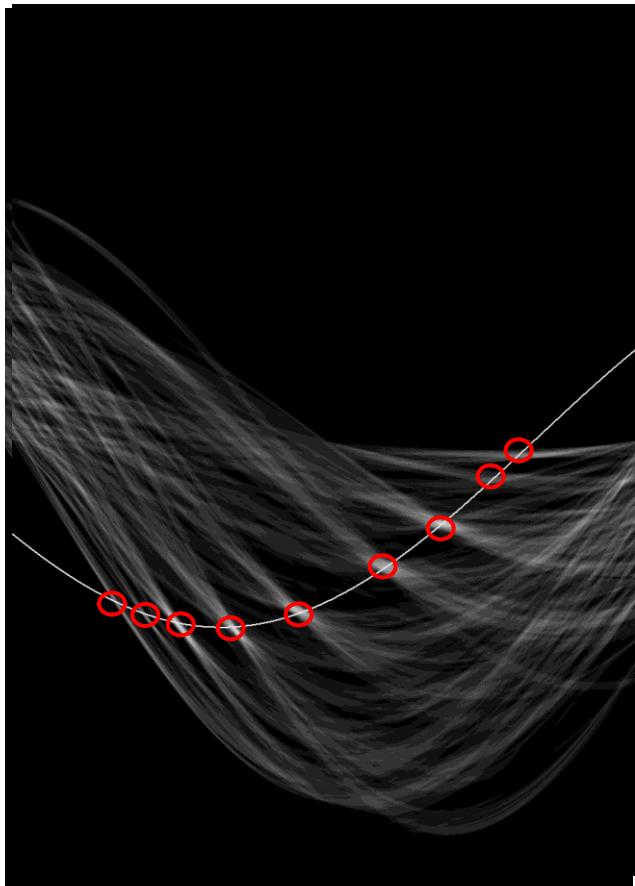
■ Line detection

Hough Transform :
Accumulator (ρ, θ)

$$\rho = x \cos \theta + y \sin \theta$$

Spatial space Hough space
one point \longleftrightarrow **one sinusoid**

one line \longleftrightarrow **one point (ρ, θ)**

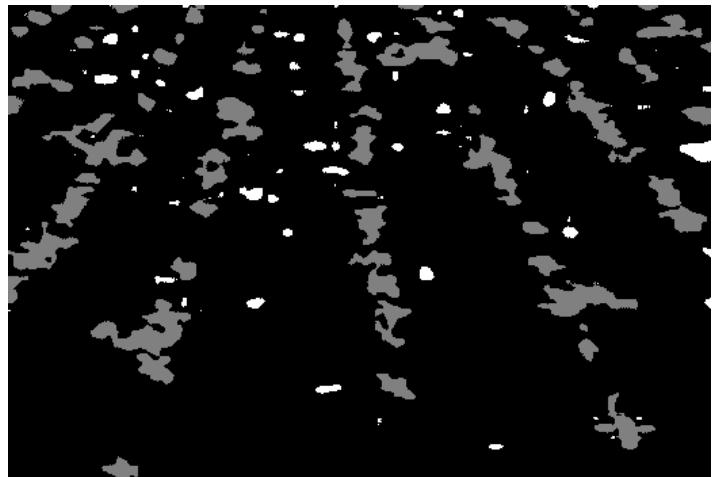




■ Blob coloring: region-based segmentation

Pixel state

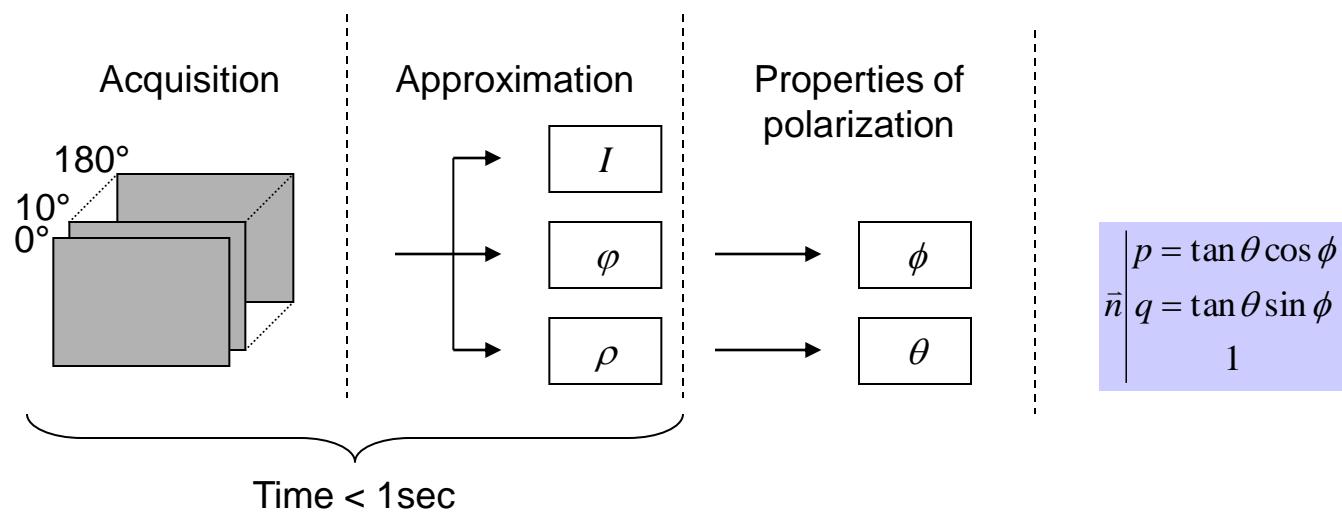
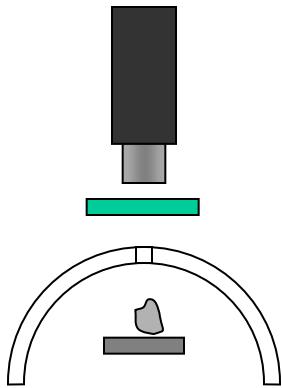
If Region \in line \Rightarrow crop
else \Rightarrow weed



WIR (Weed Infestation Rate) = 11.6%

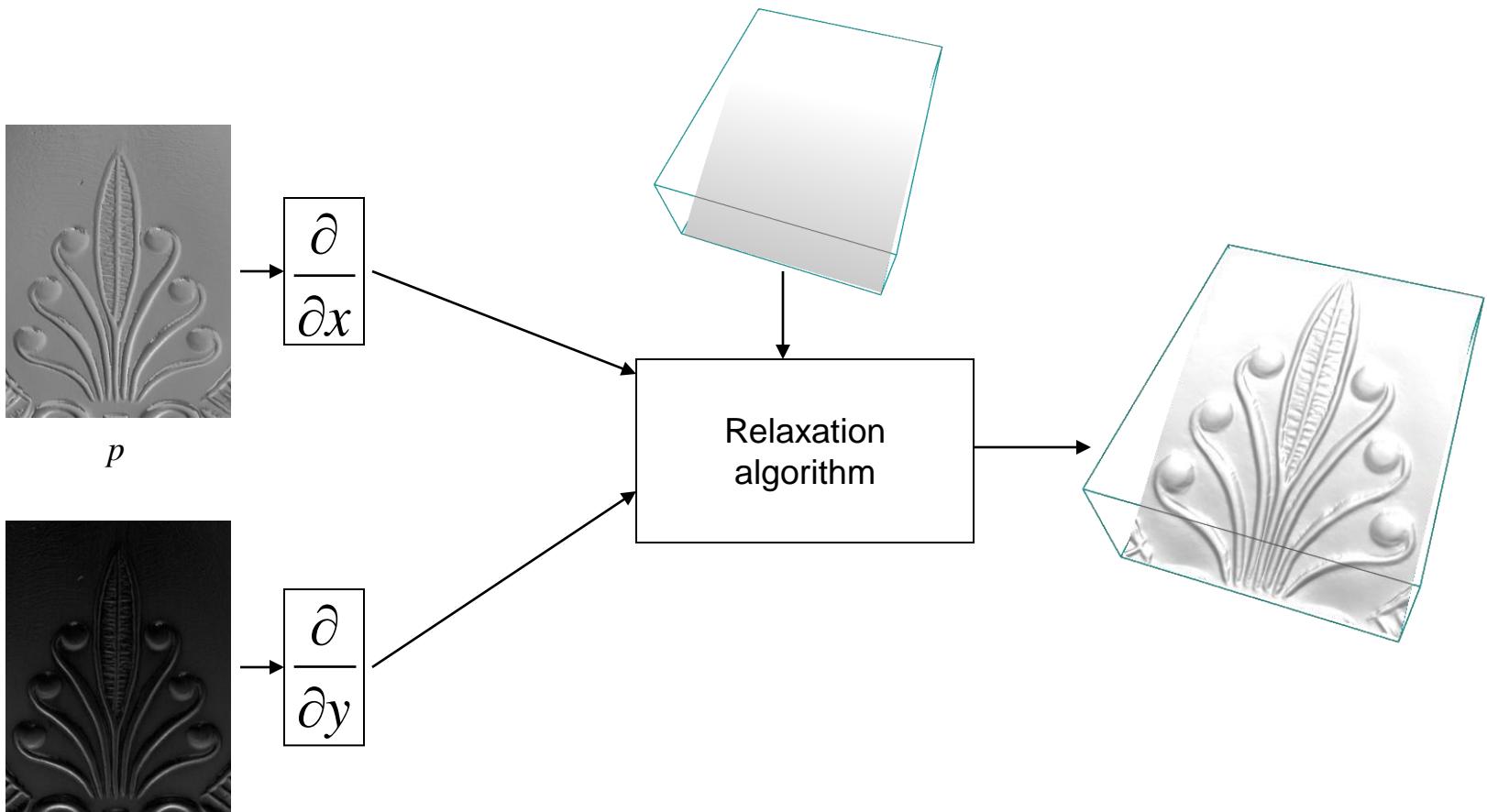


- Polarization images computing:



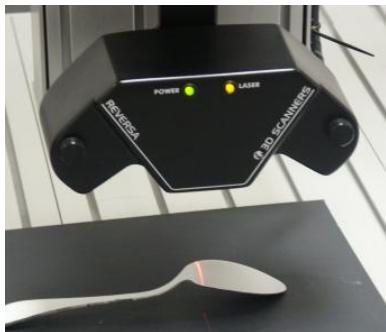


- 3D surface reconstruction:

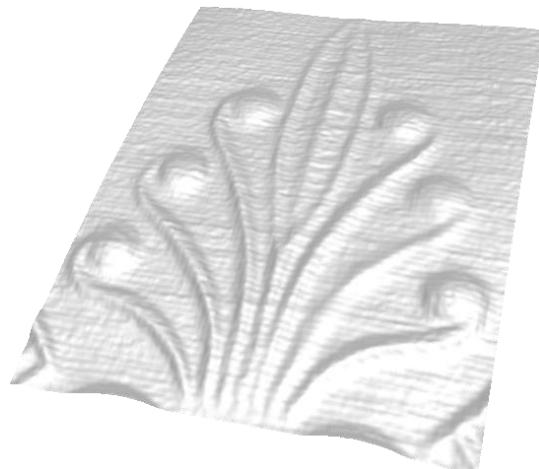




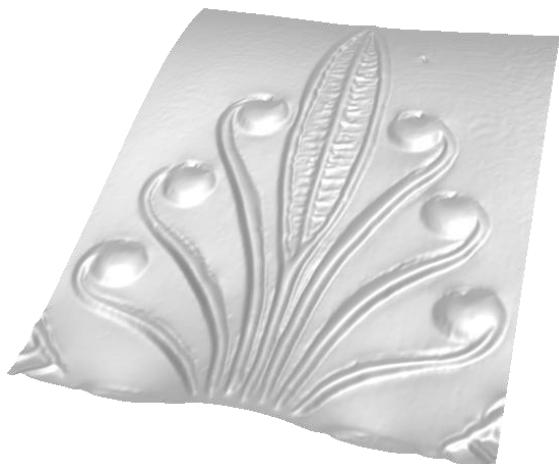
- Results:



Scanner Replica, x - y resolution: $50\mu m$ and z precision: $20\mu m$



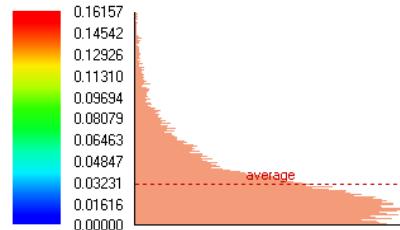
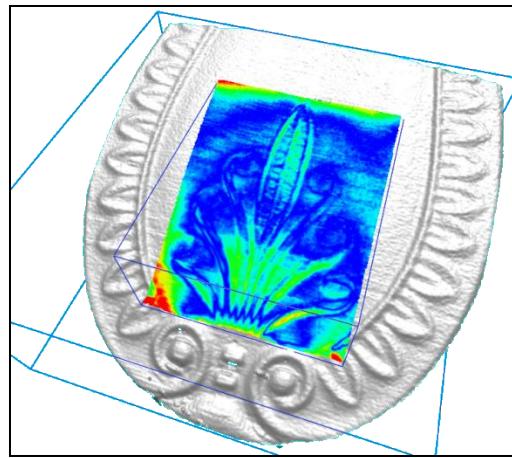
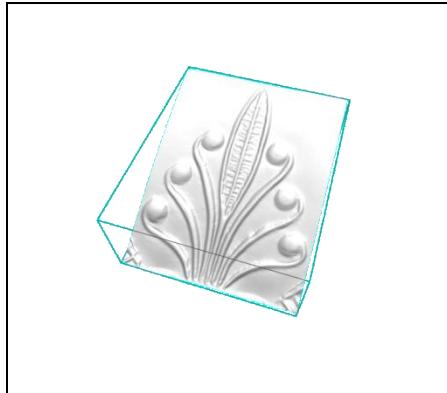
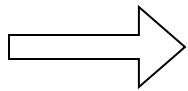
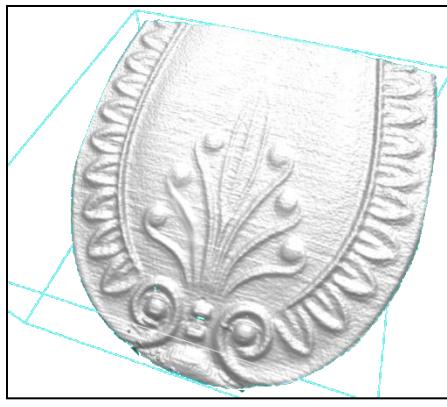
Surface from the 3D
Image Processing I/ F. Mériaudeau
Scanner



Surface from our
method

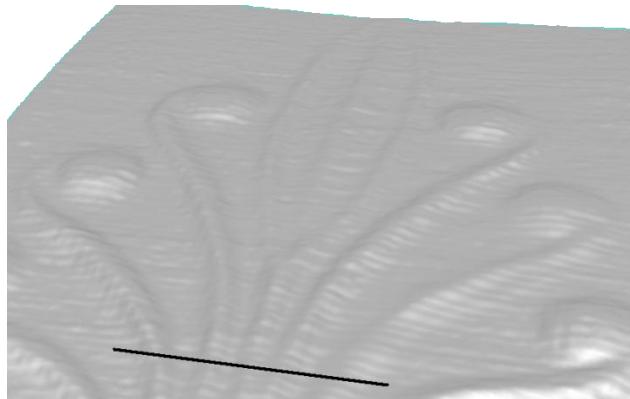


- Mean deviation:

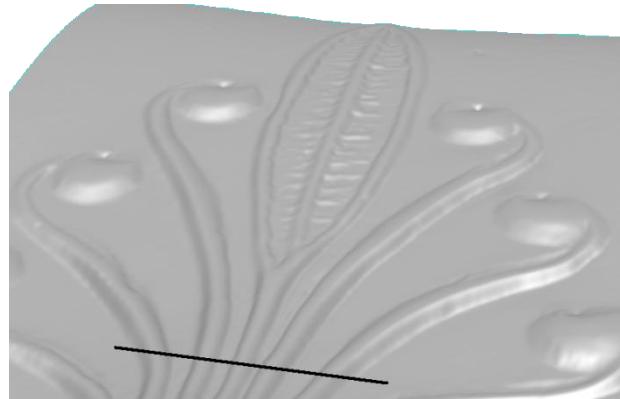




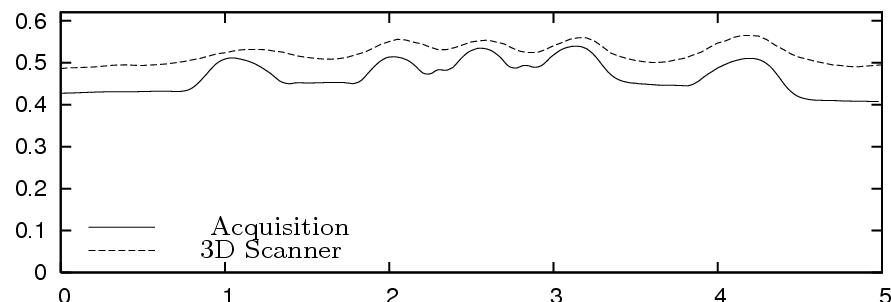
- Cross-section:



3D Scanner

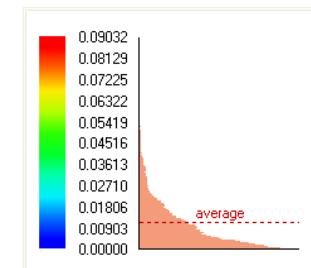
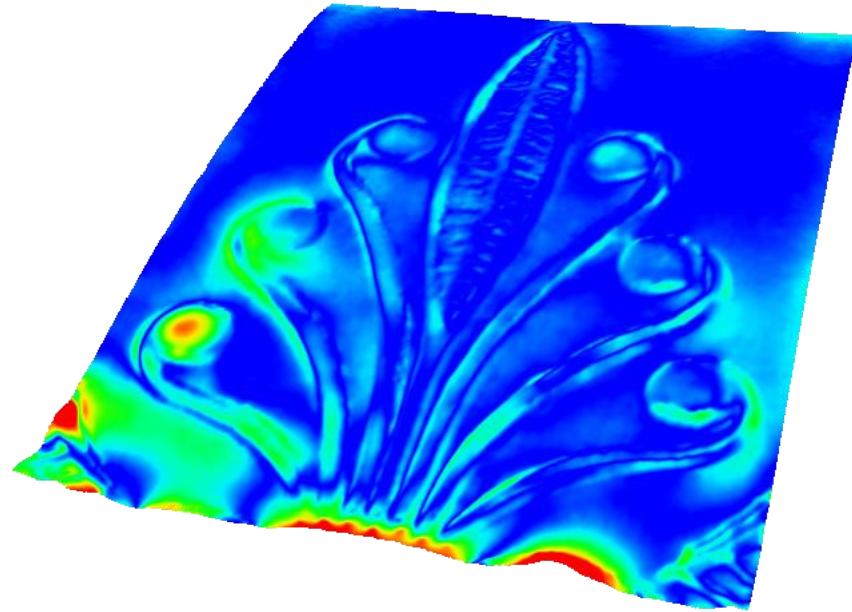


Acquisition





- Shape defect detection



Quantitative Imaging of Subcutaneous Veins with Multispectral Illumination and 3D Modeling



Vincent C. Paquit

Ph.D. Student

Le2i - University of Burgundy, France

&

Image Science and Machine Vision group

Measurement Science and Systems Engineering Division

Oak Ridge National Laboratory, Oak Ridge TN, USA

Prof. Fabrice Mériadeau

Le2i - University of Burgundy, France

Prof. Thomas L. Ferrell

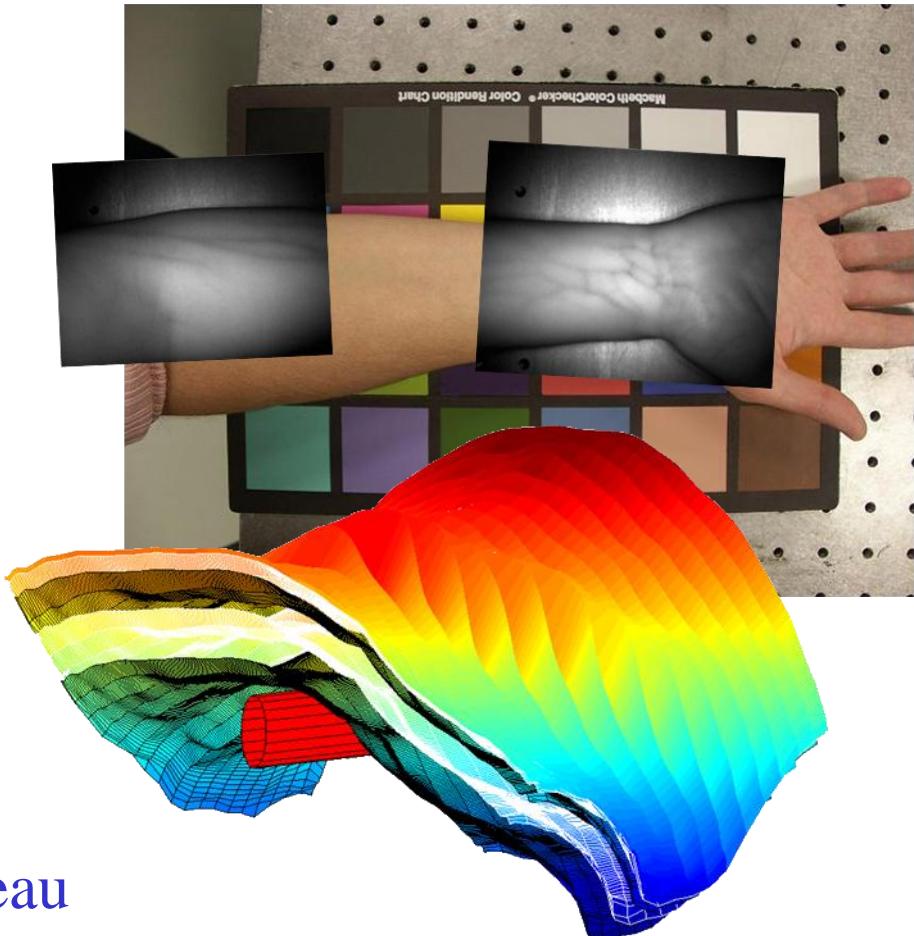
University of Tennessee - Knoxville TN, USA

Jeffery R. Price, PhD.

Oak Ridge National Laboratory, Oak Ridge TN, USA

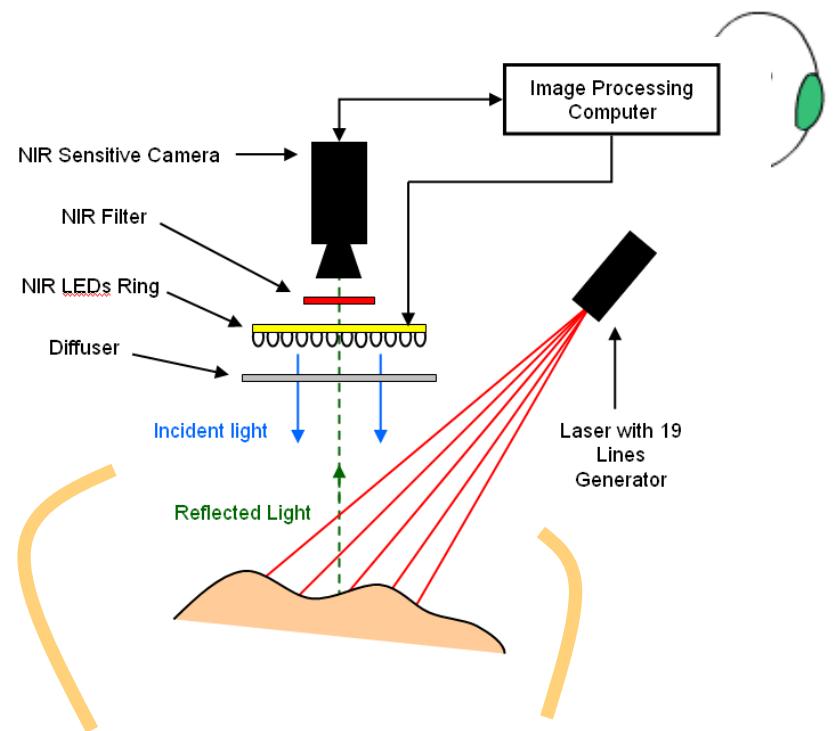
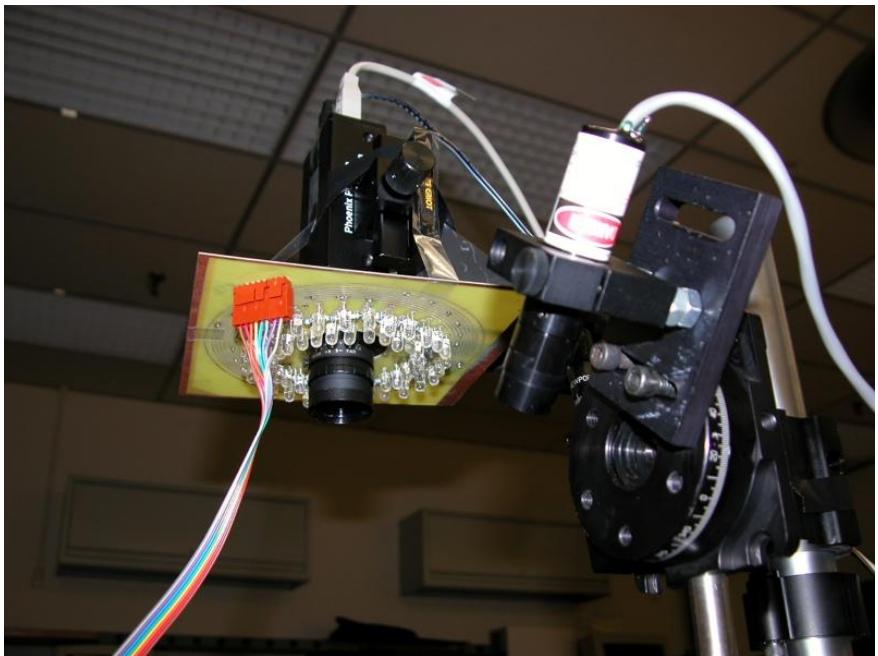
Kenneth W. Tobin, PhD.

Oak Ridge National Laboratory, Oak Ridge TN, USA



Hardware:

- NIR sensitive CMOS camera + NIR high pass filter
- NIR ring of LEDs at 740nm
- Laser and line generator module for 3D triangulation



NIR image of the surface



Topology measured w/
structured light



☐ Calibration

☐ Distortion correction

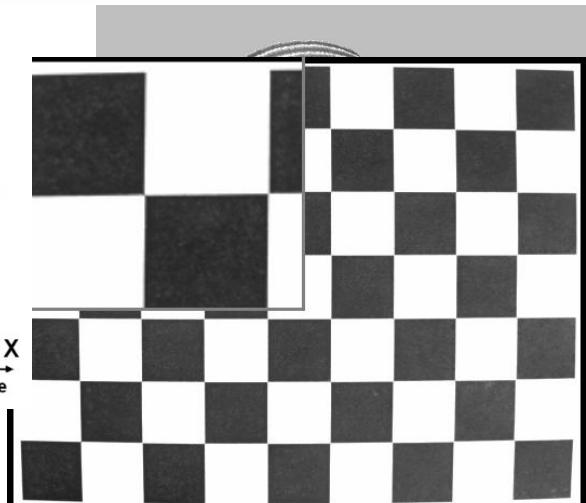
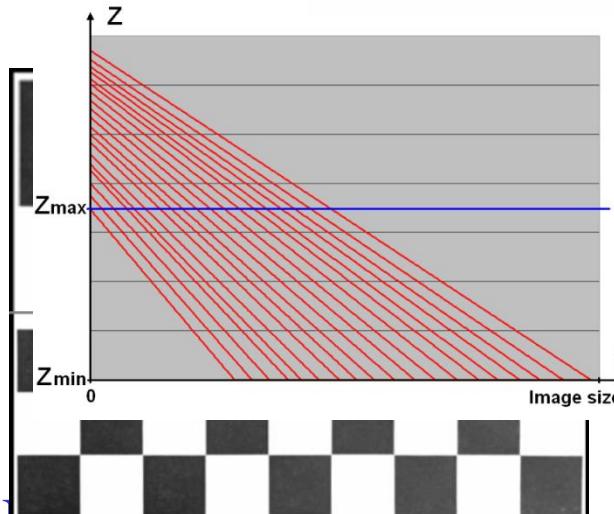
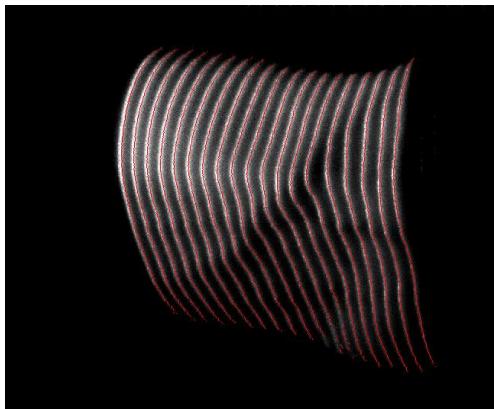
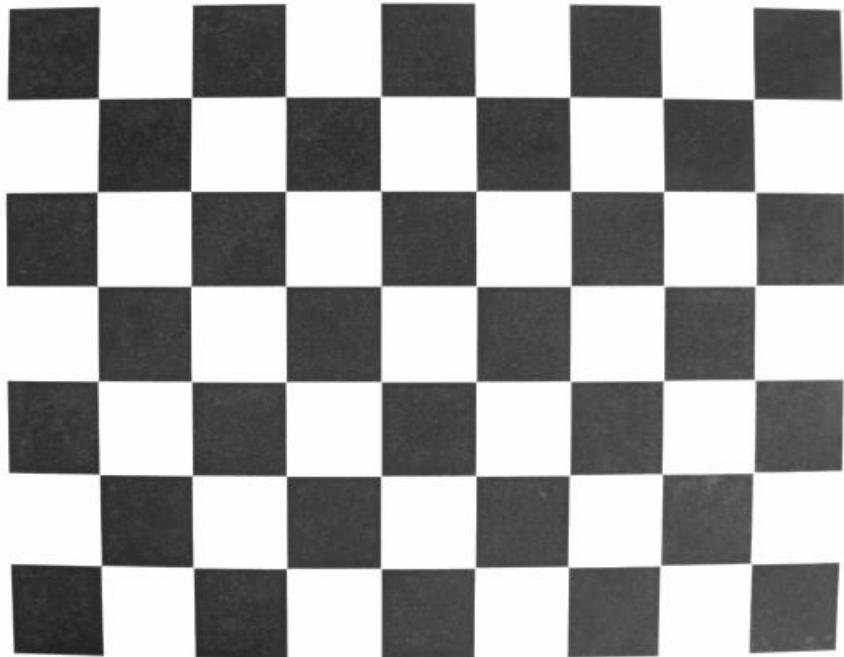
- Bouguet (2008), Matlab Toolbox
- OpenCV (2008)

☐ 3D modeling

- Besl (1989)

☐ Reflectance

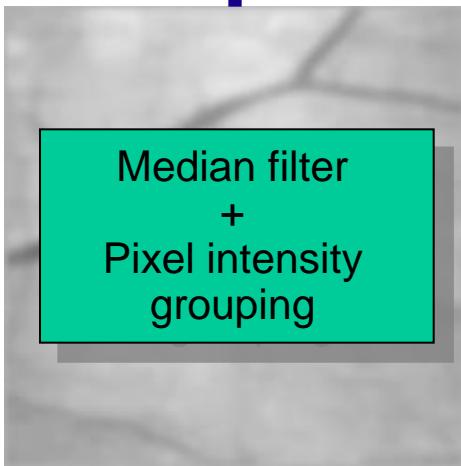
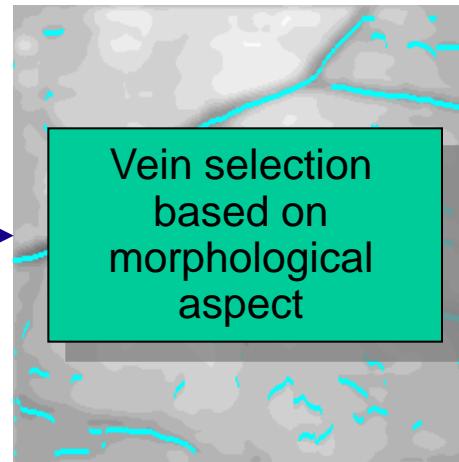
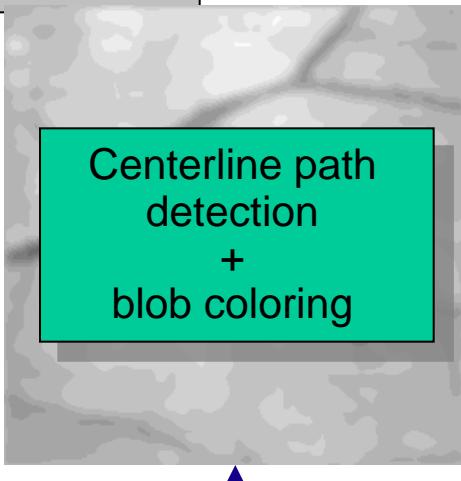
- Pan (2003)



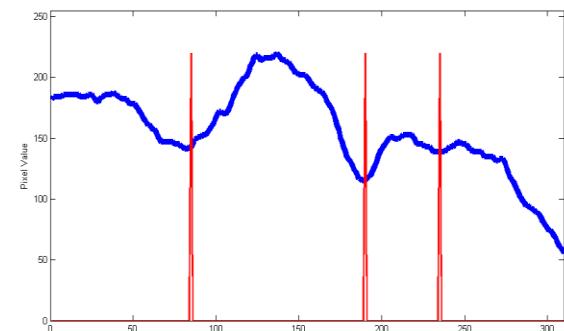
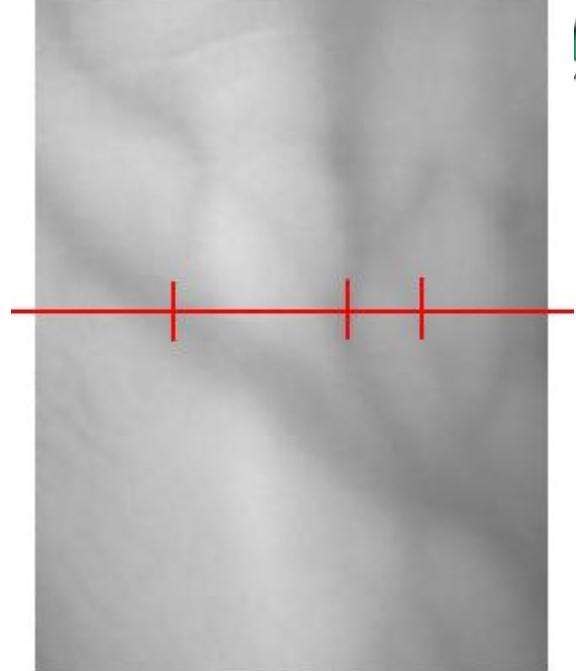
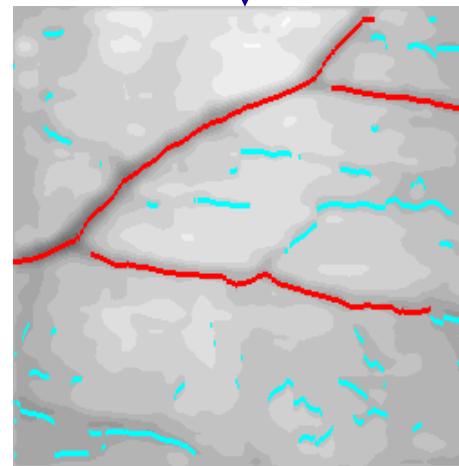


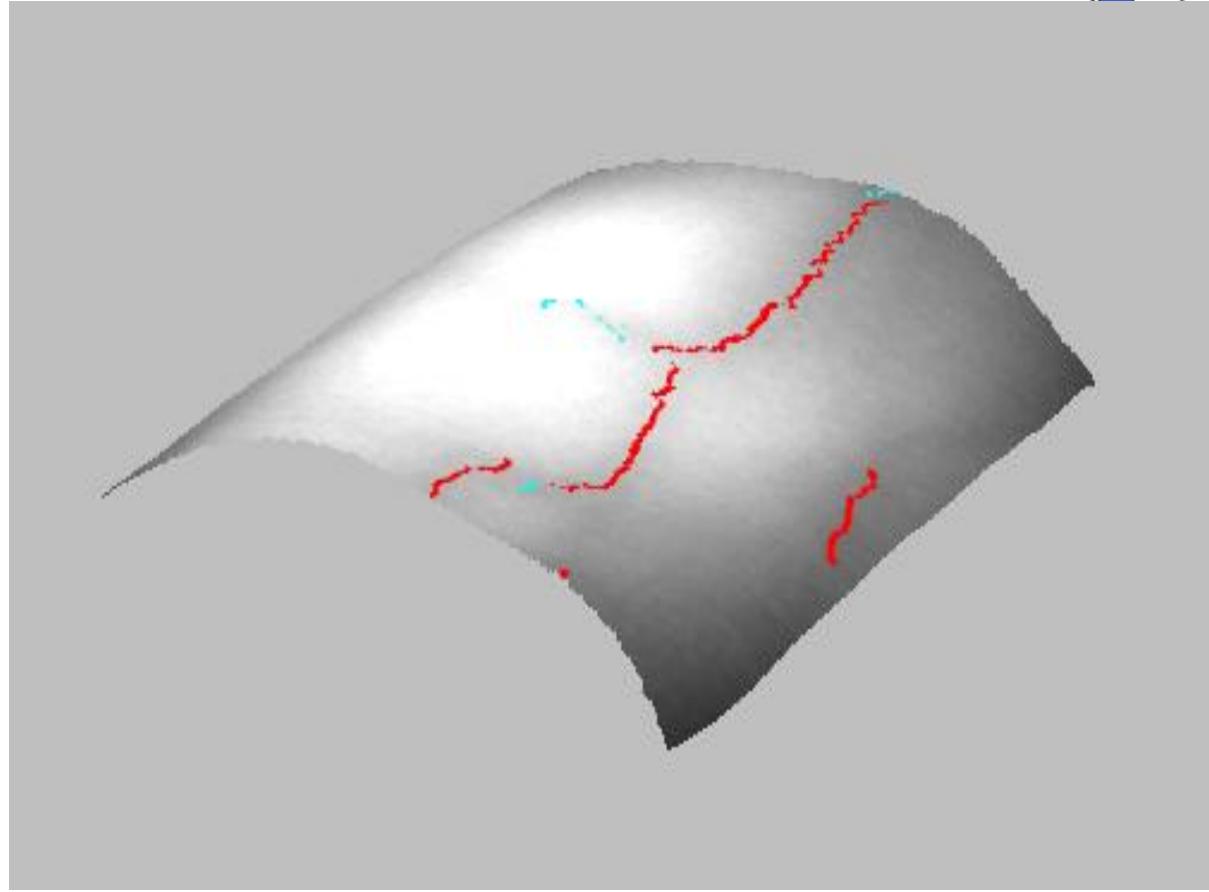
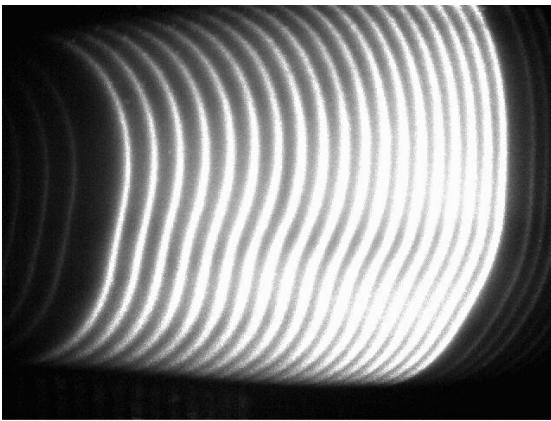
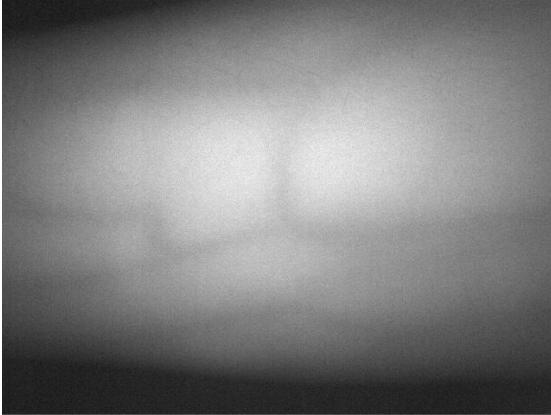
Videos of what can be seen in the visible range of light (left) and in the near infrared range (right). Example of a Caucasian male.

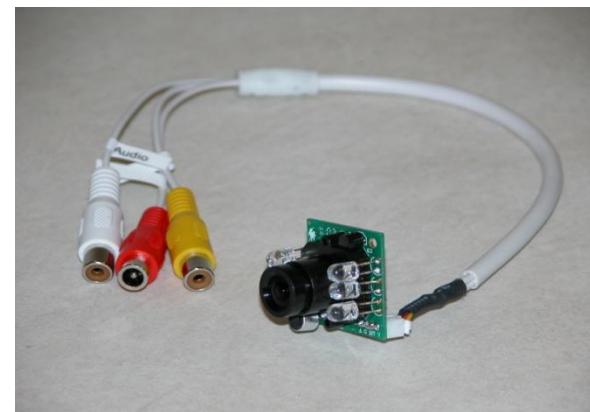
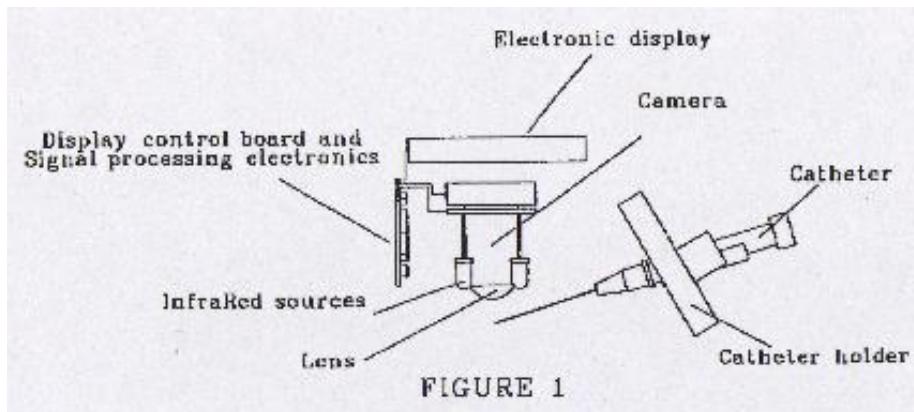
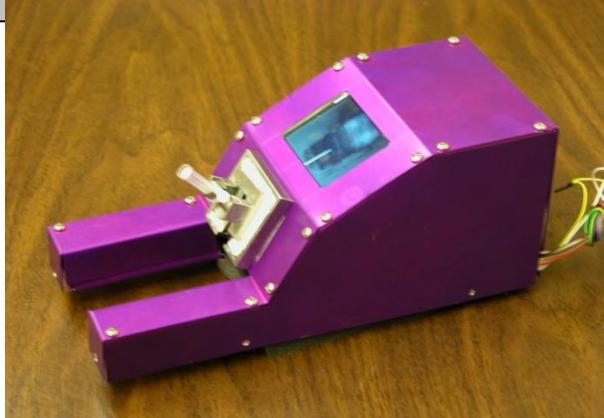
Vein Detection and Selection



Median filter
+
Pixel intensity grouping







"Invention disclosure: Self-contained Compact Venous Imager for Catheter Insertion", Thomas FERRELL, David HEDDEN, Rubye H. FARAH, Vincent PAQUIT, Fabrice MERIAUDEAU, University of Tennessee - Knoxville, USA, 22 December 2005.