




Together
To think differently ...

QUANTITATIVE IMAGING OF THE SKIN

ORION Concept
Jean Christophe PITTET
26 rue Pasteur - 37000 TOURS - France

MEMBRE DE LA COSMETIC VALLEY



INTRODUCTION

Photographs : Easy ?...

- ✓ Light and the vision of colors (for clinical observation too)
- ✓ White balance
- ✓ Lighting modalities (directionnal, diffused, polarised, ...)
- ✓ Other lighting (U.V.)

Quantitative Imaging

- ✓ Quantification : Repetability / reproducibility. A compromise between « the best and the more reliable (Lighting, colors, centering, expressions...)

Other images of the skin (Confocal Microscopy, ultrasound Imaging...)

All that is valid for photography, is also for clinical perception !!!

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

PLAN

Photography

LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS – Acquisitions / Analysis

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - fixed or variables (zoom) & Automatic/manual settings
- ✓ Aperture/speed – Depth of field
- ✓ Configurations for acquisitions

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

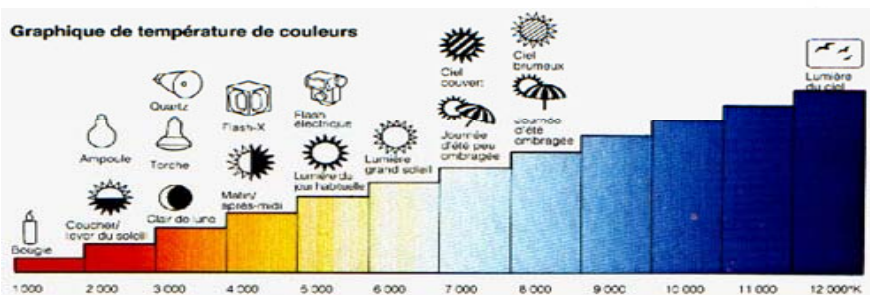
Lighting and colors

The lighting reveals the color...

1/5

Color temperature : « Black Body / Corps Noir » color emitted by an element heated at a precise temperature (ex : Carbon)

- ✓ Low Temperatures $< 3000^{\circ}\text{K}$: Hot colors (ex : Sun light, incandescent)
- ✓ High temperature $> 6000^{\circ}\text{K}$: Cold colors (ex : D65)



MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Lighting and colors

The lighting reveals the color...

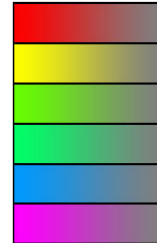
2/5

Color Rendering Index / Indice de Rendu des Couleurs : The quality of lighting determines the perception of the color dynamic

IRC or Ra : From 0 to 100 – Reference « Black Body»

Rendu des couleurs	très bon		bon		moins bon	mauvais	non défini
	90-100	80-89	70-79	60-69	40-59	20-39	<20
Indice de rendu des couleurs Ra							
Lampes à incandescence et lampes halogènes à incandescence		X					
Tubes fluo	X	X	X	X	X		
Lampes fluocompactes	X	X					
Lampes à vapeur de mercure haute pression				X	X		
Lampes aux iodures métalliques	X	X	X	X			
Lampes à vapeur de sodium haute pression		X		X	X	X	
Lampes à vapeur de sodium basse pression							X

IRC
100 50 0



(Norme DIN5035, Fascicule 1)

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Lighting and colors

The lighting reveals the color...

3/5

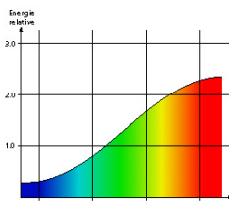
Continuity of the light Spectrum :

✓ Continuous spectrum

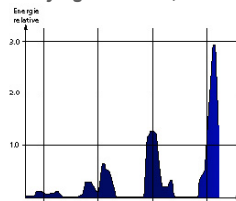
- Representation of all visible wavelengths
= Well rendering of colors

Ex : Natural Sun light - Artificial : Tungsten & Halogen – 2500-4000 K (New : « Continuous » fluorescent lights)

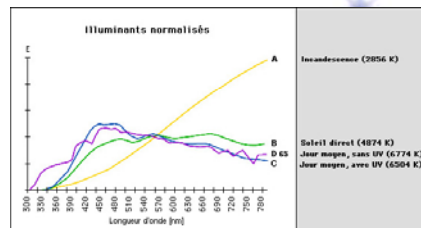
- « Day light » : Fluo, Xenon, Diodes...6500 K



Incandescent



Fluorescent



MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Lighting and colors

Lighting for Photography

4/5

Photography: Visualisation of colors depends on the type of lightings

X (Too much blue)

✓ (but bad acquisition)

X (Too much yellow)

✓ (Good conditions)



Standard
Fluorescent



Fluorescent 965
(D65)



Halogen



Xenon Flash

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Lighting and colors

White Balance of Camera

5/5

Photography: Visualisation of colors depends on the type White Balance of camera

X (Too much blue)

X (Too much yellow)

✓ (Good acquisition conditions)



WB for Fluorescent
Light



WB for Incandescent
or Halogen Light



WB for Xenon Flash

MEMBRE DE LA COSMETIC VALLEY



ORION Concept



PLAN



LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe Balance
- ✓ Lighting modalities
- ✓ Other lightings

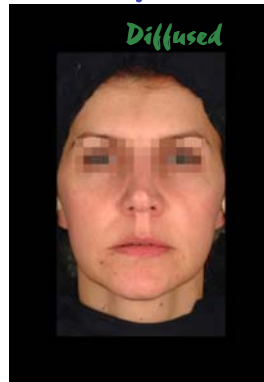


DIGITAL PHOTOGRAPHS – Acquisitions / Analysis

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - fixed or variables (zoom) & Automatic/manual settings
- ✓ Aperture/speed – Depth of field
- ✓ Configurations for acquisitions



Lighting Modalities & Acquisitions



Directe : accentuation of relief & « details » of the skin texture

- « Hard & contrasted image

- Very dependente on the lighting incidence – Photographs for the visualisation of the relief, wrinkles, grain of skin... » - No reliable image analysis

Diffused = More soft image - Illustration



Lighting Modalities & Acquisitions

Directional = Brightness/ Matity / Relief

Ex: **Crow's feet** (Same subject - Same lighting - Same skin color - 3D acquisition)



35° / average plane

Specular surface or
Diffused Lighting
(High brightness)
=
Good visualisation of
relief and wrinkles
(« Hard » image)



Vertical lighting



Mat surface or
Diffused Lighting
=
perception (all of contrast,
the relief and texture
(More soft))



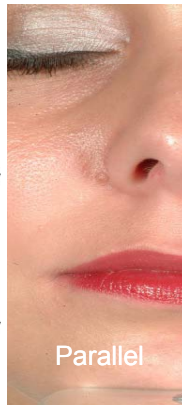
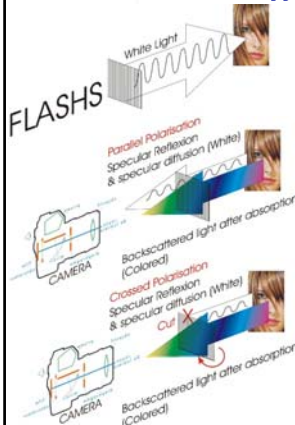
Remark : modification of the perceived clearness of the skin

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Lighting Modalities & Acquisitions

Crossed & Parallel Polarised Light



Parallel



Crossed

Principle :

- Linear polarisation of light emitted by flashes (filters)
- Linear filter (front the objective of the camera)
- Specular reflexion keeps its polarisation
- Cut of specular reflexion (brightness)

Parallel : Closely similar than direct light = Brightness (white) + color

Specular reflexion hides the colors & accentuates the relief

Crossed : Cuts the brightness and reveals colors (specular reflexion & specular diffusion due to the relief)

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Lighting Modalities & Acquisitions

Crossed & Parallel Polarised = BRIGHTNESS calculation



Calculation of the brightness (specular reflexion)
! That requires a perfect superposition of these 2 acquisitions !

MEMBRE DE LA COSMETIC VALLEY



ORION Concept



PLAN

LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe Balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS – Acquisitions / Analysis

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - (fixed or variables (zoom) & Automatic/manual settings
- ✓ Aperture/speed – Depth of field
- ✓ Configurations for acquisitions

MEMBRE DE LA COSMETIC VALLEY



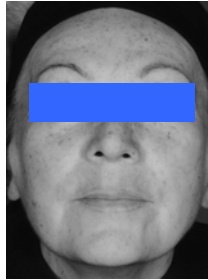
ORION Concept

Other lighting

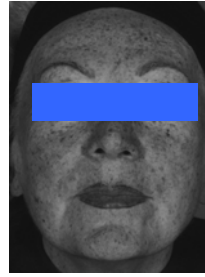
UV or « Bleu Channel of digital images»



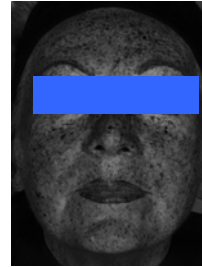
Crossed Polarized
Light
(color acquisition)



Red Channel



Green Channel



Bleu Channel

Crossed Polarised Light - Bleu channel : High contrast on pigmentation (spots) and vascular elements (capillary vessels)

MEMBRE DE LA COSMETIC VALLEY



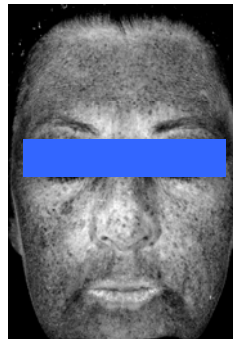
ORION Concept

Other lighting

UV



UV



Grey levels

Digital cameras & CCD captors = Low sensibility to UV (increase of noise)
High contrast on pigmentation (spots) and vascular elements (capillary vessels)

- But ...**
- Interest for Protoporphyrin of the sebaceous glands
 - Very low depth of field (problem of focusing)
 - Poor quality of images - (Problem for good images analysis)
 - Historical interest (silver film)

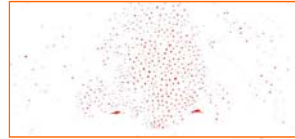
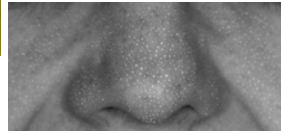
MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Other lighting

UV for Protoporphyrin



UV
+

Yellow filter (550nm)

Grey levels

Image analysis

Detection of sebaceous glands

- Fluorescence (secreted by protoporphyrin at 650nm (secreted by bacteria))
- No direct relationship with the secretory activity of sebaceous glands
- Interest for acne study

But ...

- Very low depth of field (problem of focusing)
- Poor quality of images - (Problem for good images analysis)
- Historical interest (silver film)

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

PLAN

LIGHTING - Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe Balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS - Acquisitions

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - fixed or variables - Automatic/manual settings
- ✓ Aperture/speed - Depth of field
- ✓ Configurations for acquisitions



MEMBRE DE LA COSMETIC VALLEY



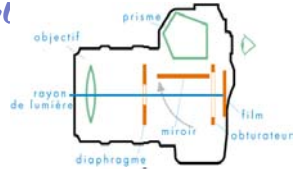
ORION Concept

Cameras



Reflex camera :

- ✓ For quality of photographs – Precise centering & framing
- ✓ High resolution matrix (min 6 to 16 Mpixels)
- ✓ Various objectives and focals (same distance = stable resolution)
- ✓ Used only as a « captor » with an objective
- ✓ !! No equivalent captors – Variation of the col rendering (pre-filtering and low level data processing)



MEMBRE DE LA COSMETIC VALLEY

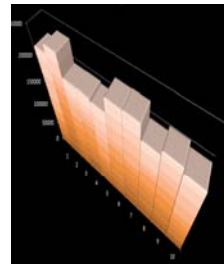
ORION Concept

Digital Images

A matrix of square pixels



- ✓ Matrix determines the resolution (Nb of rows and columns)
- ✓ Nombre couleurs par pixel (NdG, 8bits (256 couleurs), 16(65000), 24(16M)...))
- ✓ Raw data (RAW – NEF..) and conversion in standard file formats (Tif, Bmp, Jpeg...)
- ✓ Standard file formats :
 - TIFF – RVB (No compression – 24 bits – for colorimetry)
 - BMP (No compression – 24 bits – for colorimetry)
 - JPEG (Irreversible & variable compression (Spatial & color – Low size– Filing – Illustration – Electronic exchanges - WWW)
 - GIF (256 colors– Low size – Animations – WWWW)



1 line of pixels

Resolution :

- ✓ Size of one pixel (in mm or μm) :
- Width of field of view / Number of the matrix pixels

MEMBRE DE LA COSMETIC VALLEY

ORION Concept



PLAN

LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ White Balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS – Acquisitions

- ✓ Devices : Cameras & Numerical images
- ✓ Focals - fixed or variables - Automatic/manual settings
- ✓ Aperture/speed – Depth of field
- ✓ Configurations for acquisitions

Objectives focals

Focales fixes

- ✓ Determine the images resolution : for a same distance and a same matrix = same spatial resolution
- ✓ Focal : from 40 to 60 mm : No geometrical deformation s – Constant growth ratio – Good aperture - Macro)
- ✓ <40 mm : Great Angle (deformation of lignes – « Fish Eye » - Good depth of field)
- ✓ >60 mm : Teleobjective (Low depth of field – Low aperture - No macro)

Zoom :

- ✓ No possibility to insure a reproducible field of view = variations of resolution

Adjustments of the camera : « A simple captor with an objective »

- ✓ MANUEL adjustments
- ✓ Speed, aperture, sensibility, white balance, automatic improvement of images must be **DEACTIVATED** (filtering, correction, increase sharpness...)
- ✓ Idem for flashes (constant values)

REMARKS : - The adjustments on the objectives are not reproducible (focus & zoom)
- To work at constant distances (same resolution)
- Adjustment of the focusing on a calibration card



PLAN

LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe Balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS – Acquisitions

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - fixed or variables - Automatic/manual settings
- ✓ Aperture/speed – Depth of field - Calibration
- ✓ Configurations for acquisitions



Périsesco – Avril 2007

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Sensibility/Speed/Aperture

CCD captor = « a bottle »

Sensibility : « Volume of the bottle »

- ✓ In ISO (ou ASA) – 50, 100, 200 ... sensibility of the captor to the light
 - Low valeur : Large « volume of bottle » requires much light
(long exposition time – Low noise)
 - High value : Small « volume » requires a small quantity of light
(short exposition time – High noise (high gain))

Speed : « time to fill the bottle »

- ✓ In seconds : 1/8sec, 1/15, 1/30 ... 1/250, 1/500sec..
 - High speed = low risk of mouvement
- ✓ For such a photograph it is necessary to privilege the small aperture.

Aperture : « Opening of the tap »

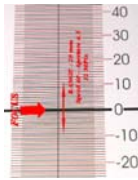
- ✓ Opening of the diaphragm = 2.8, 4, 4.5, 5.6, 8, 11, 16, 22, 32
 - Highvalue : Large depth of field (Image will be sharp for a Large depth \approx 20 cm)
 - Low value: Small depth of field (Image will be sharp for a small depth \approx 2 cm)

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Depth of field



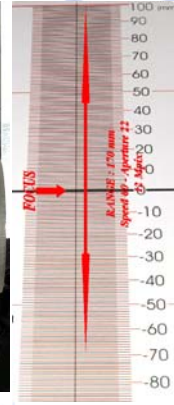
Test card



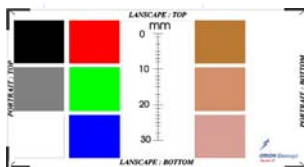
High aperture: 4
Low depth of field
(60 mm)



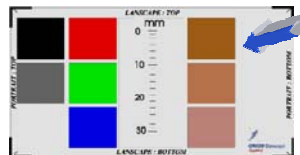
Low aperture: 22
Large depth of field
(180 mm)



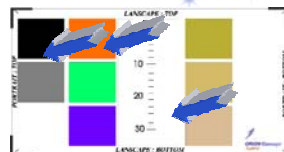
Test card



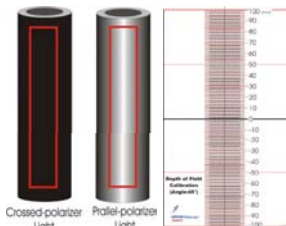
Reference – Baseline
Good exposition and color



Underexposed or Overexposed
(Speed/Aperture/Flashes)
Possible correction (small range)



Color variations
(White balance/lighting)
No possible correction!



Polarisation and depth of field adjustments

- Visual control of photographs balance (luminosity & color at different times of the kinetics)
 - Focusing at each times of the study
 - Calculation of the resolution (mm/pixel)
 - Polarisation & depth of field checking
- ABSOLUTLY necessary for an image analysis !**



PLAN

LIGHTING – Perceive with lighting shows...

- ✓ Vision of colors
- ✓ Withe Balance
- ✓ Lighting modalities
- ✓ Other lighting

DIGITAL PHOTOGRAPHS – Acquisitions

- ✓ Devices : Caméras & Numerical images
- ✓ Focals - fixed or variables - Automatic/manual settings
- ✓ Aperture/speed – Depth of field
- ✓ Configurations for acquisitions

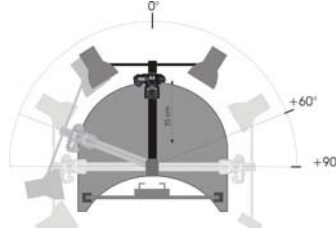


MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Acquisition system

HeadScan® V02



Face, Profile & ¼ photographs
Flash coupled with Camera



- ✓ Reproducible positioning of the head and body, hands & chest at different times of a study kinetics
- ✓ Incorporated lighting (Flashes, standardized lighting DS6...) to standardize the lighting incidence for all acquisition angles (face, profiles, crow's feet, hands, low-neck...)
- ✓ Coupling between Captor, Object and lightings (No modification of the adjustments of camera and lighting for different fields of view (excepted focusing))
- ✓ Modular system
- ✓ To improve the reliability of your acquisitions...

MEMBRE DE LA COSMETIC VALLEY

ORION Concept



IMAGES ANALYSIS

No possible images analysis with no-controlled acquisitions...

Colorimetric images analysis - Data contained in the image pixels

Morphological image analysis – Detection of « objects » - Shape, size, number...

Same processing for different applications : Make-up, skin care product efficacy...

3D used as « model » for photographic acquisitions

2D image analysis used for 3D reconstruction (Ultrasound imaging, Confocal microscopy...) – Segmentation of images

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Some possible analyses on Photographs (2D imaging)

Brightness of the skin

- ✓ Matifying products, Make-up, nail-varnish...

Color of the skin - Distribution of color - Heterogeneity (entropy)

- ✓ Colorimetry $L^*a^*b^*$, Redness, inflammation, self-tanning, (foundation cream, homogeneity of complexion, ...)

Color & Morphology of pigmentary spots or Rosacea

- ✓ Bleu Channel or UV, whitening products)

Color follow-up

- ✓ Stability of make-up (Eye-liner, eye-shadow, lipsticks, (foundation...))

Dimensional measurements

- ✓ Length of lashes (mascara, care products...)

MEMBRE DE LA COSMETIC VALLEY



ORION Concept



Dedicated Software

FrameScan® V02

- ✓ *Dedicated for analysis of an sample of images (panel – kinetics)*
- ✓ *Creation of specific images (brightness images, RGB channels, Grey levels, Pigmentation, Vascularization...)*
- ✓ *Both for "routine" & "advanced" analysis*
- ✓ *Measurements of colorimetry, brightness, vascularization, pigmentation, homogeneity... on several Regions Of Interest (ROI)*
- ✓ *Morphology analysis (pigmentary spots, lashes, wrinkles...)*
- ✓ *For skin care product and make-up...*

MEMBRE DE LA COSMETIC VALLEY



ORION Concept



Software Interface

FrameScan® V02

The screenshot shows the software interface with a central window displaying a face with several red boxes indicating Regions of Interest (ROIs). To the left is a file list, and to the right is a color calibration chart. Surrounding the interface are several callout boxes with descriptive text:

- Definition of multi Region Of Interest (ROI) on images
- Perfect reproducibility of ROIs positioning at different times
- ROIs storing and transfers on other images
- Files Coding (Subject, Site, Time...)
- Tracability
- Protection of raw data
- Kinetics analysis
- All Parameter setting adjustable & protected by password
- Color Calibration
- Calculation of color variations
- Correction of small shifts
- Creation and storage of images for analysis (R, G, B channels, grey level, brightness...)
- Multi-formats : TIFF, RAW, JPEG
- Management of images modalities crossed and parallel polarized light acquisitions...
- Processing « Step by Step »
- User guide
- Compilation and recording (file txt) for all individual results (Excel)

On the right side of the interface, there is a vertical stack of four face images, each with a different ROI configuration, labeled 'ROI 1', 'ROI 2', 'ROI 3', and 'ROI 4'.

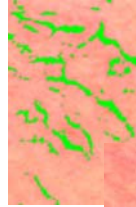
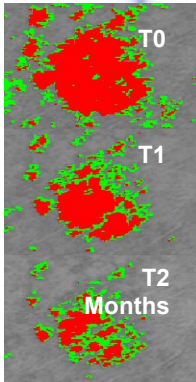
MEMBRE DE LA COSMETIC VALLEY



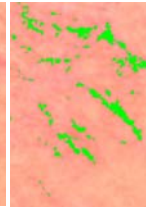
ORION Concept

Pigmentary spots

Rosacea



ROSACEA



SPOTS

- Color of spot pixel ($L^*a^*b^*$) versus skin color
- Morphology of spots (surface, perimeter, regularity of contour, cleanness...)
- Heterogeneity (entropic)

- Surface
- Color
- Specific recognition of capillaries

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

Brightness



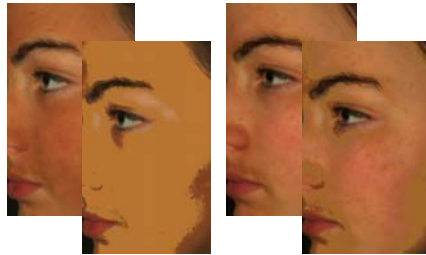
- Measurement of brightness of surface (skin, hair, nails...)
- Evaluation of make-up, hair or skin care products (Nail varnish, matifying products, sheathing shampoo, foundation cream, anti-selossheic...)

MEMBRE DE LA COSMETIC VALLEY



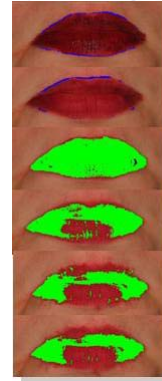
ORION Concept

Stability of Make-up



T0

T8h



- Measurement of the stability of make-up products with a high sensibility (discriminative sorting of « product pixels/skin pixels »)
- Foundation cream, eye liner, mascara, lipstick, eye-shadow ...



Lashes Make-up

« Mascara... »



Acquired Image
(Crossed polarized image)

Red Channel

Perceived Length Without product

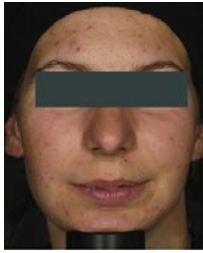
Real length Without product

Real length WITH product

- Real & perceived increase of lashes length correlated to the clinical assessment.
(resolution : 10µm)



Intensity & Heterogeneity of Pigmentation & Vasculazisation



Acquired Image
(Crossed polarized image)



Pigmentation
Image



Vascularization
Image



ITA°
Image

- Reconstruction of Pigmentation, vascular and ITA° cartography (from color photographs (based on a^* and b^* & L^* measurements)
- Calculation of intensity, homogeneity, distribution... - Multi-areas measurements
- Whithening products, acne, inflammation, photoageing, skin complexion...

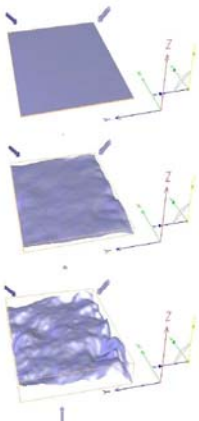
MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Photographs from 3D acquisitions...

Controlled acquisitions for evaluation of the relief

- Photographs obtained from 3D acquisition (Fringe projection)
- Determination of the COLOR (skin-like) & CHARACTERISTICS of the surface (Brightness-Satin-Mat), LIGHT, INCIDENCE of lighting (virtual scene)
- Only one variable parameter = the RELIEF..



- Obtaining a photorealistic image
- All parameters are imposed & stable
- Relief perceived via shadows...
- Comparison with roughness parameters (R_a , R_z , ...)
- A quantification of perception by image analysis (quantification of "shadows")

For evaluation of wrinkles, cellulite...

For the establishment of qualified clinical scales...

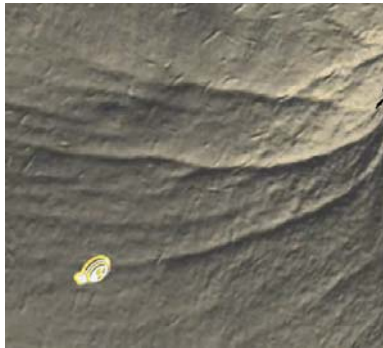
MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Dynamic Acquisitions

Serial photographs (video) acquired at different angles of lighting

Crow's feet



+50°



-50°

Variations Calculation of :

- SPECULAR and DIFFUSE light emitted by the skin
 - COLOR for various directions
 - Simultaneous Multi-areas calculations (FrameScan software)
- Skin complexion & radiance – Make-up – Texture of the skin...

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Images analysis of other 2D images

Ultrasound imaging

EchoScan® V02

Hypodermis (7.5MHz - acq/analysis) and skin ultrasound

scans (20-50MHz - Analysis)

Dedicated for analysis of an sample (panel -kinetics)

Same interface than FrameScan)

Measurements of :

- ✓ Thickness (average)
- ✓ Hypo-echogenicity of superficial dermis (SENEB)
- ✓ Texture of the tissue (dermis & hypodermis)

MEMBRE DE LA COSMETIC VALLEY

ORION Concept

Images analysis of other 2D images

Ultrasound imaging EchoScan® V02



Acquired image



Segmented image



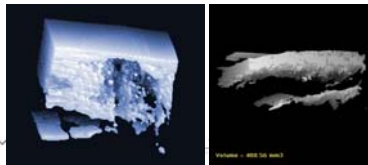
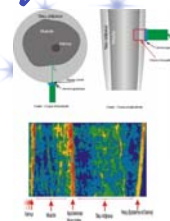
Diffuser detection



Development of a 3D
version (interfaces and
dermis structures) in
progress



- **THICKNESS** : Average between surface of the skin & Dermis/Hypodermis interface
- **SENEB** : differential echogenicity between superficial (■) dermis & deep dermis (□) – Relationship with ageing
- **TEXTURE** : N° of diffusers (collagen network), size, density, distribution (entropy in transversal & axial planes)
- Based on a data base, software can give the "age of the skin"



LUSSE Laboratory – Tours
IODP Compagny



Images analysis of other 2D images

Confocal Microscopy Vivo

High quality images containing differents levels of information :

- Cellular informations : keratinocytes, melanocytes ...
- Tissue information : granular dermis, reticular dermis...
- Structural information : Papillae...

Development of a specific tool for quantification on 2D images...and 3D reconstructions :

- Cells : Number, volume, "intensity" & distribution of cells
- Tissue : regularity & "morphology" of different layers in the skin...
- Structure : Volume, circumference and heigh of papillae...

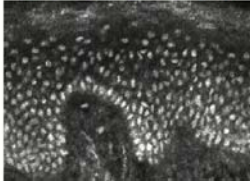
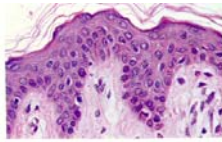


3D for a best repairing in the skin and a reliable comparison of quantification at different times of

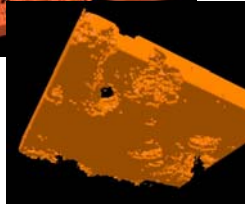
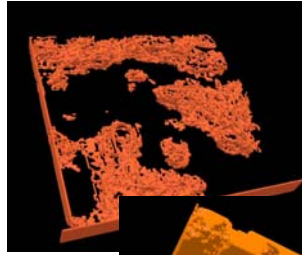


Images analysis of other 2D images

Confocal Microscopy Vivo



Vivacscope® image of a Mohs section showing the epidermal margin. Similar well-stained histology image. Notice the well-differentiated pattern of cell nuclei.



3D reconstructions



Histology Image Taken from Wharton's Functional Histology, 10th Edition, J. Young, J. W. Heath, Philadelphia: Elsevier, 1996. © by W. B. Saunders, J. Mackinnon, T. Fisher and Fawcett.

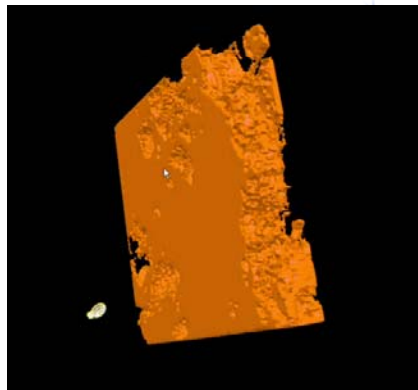
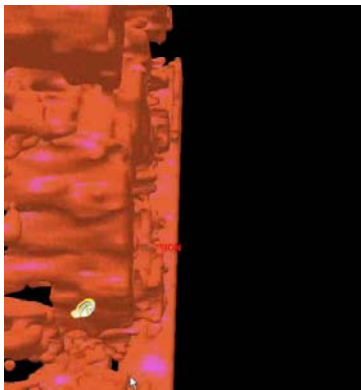
3D for a best repairing in the skin and a reliable comparison of quantifications at different times

MEMBRE DE LA COSMETIC VALLEY



ORION Concept

For tomorrow...together...



Thank you for your attention

MEMBRE DE LA COSMETIC VALLEY



ORION Concept