IG

Gretsi

7ème école d'été de Peyresq
en traitement du signal et des images

Peyresq, du 24 au 30 juin 2012

Numérisation 3D :

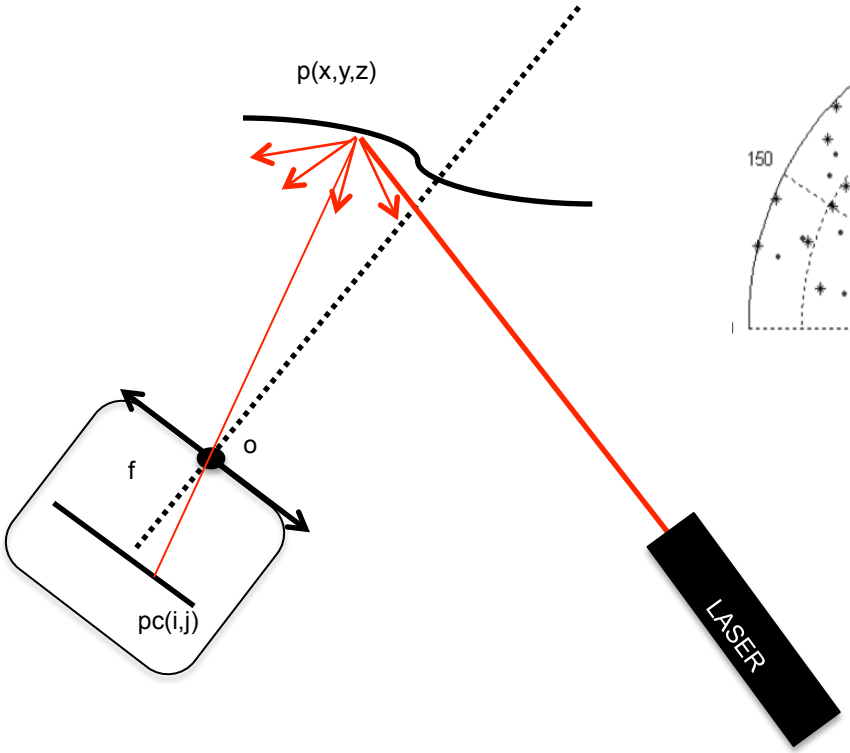
Triangulation Active et Techniques

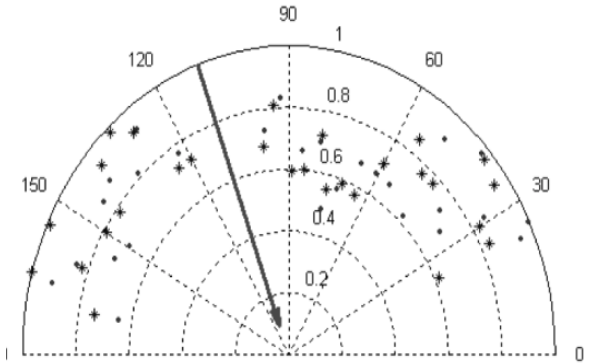
Non Conventionnelles

NON CONVENTIONNEL

PROBLEMATIQUE

Dans le chapitre précédent, nous avons toujours considéré que la surface de l'objet réfléchissait la lumière de telle sorte que le motif est visible dans l'image fournie par la caméra

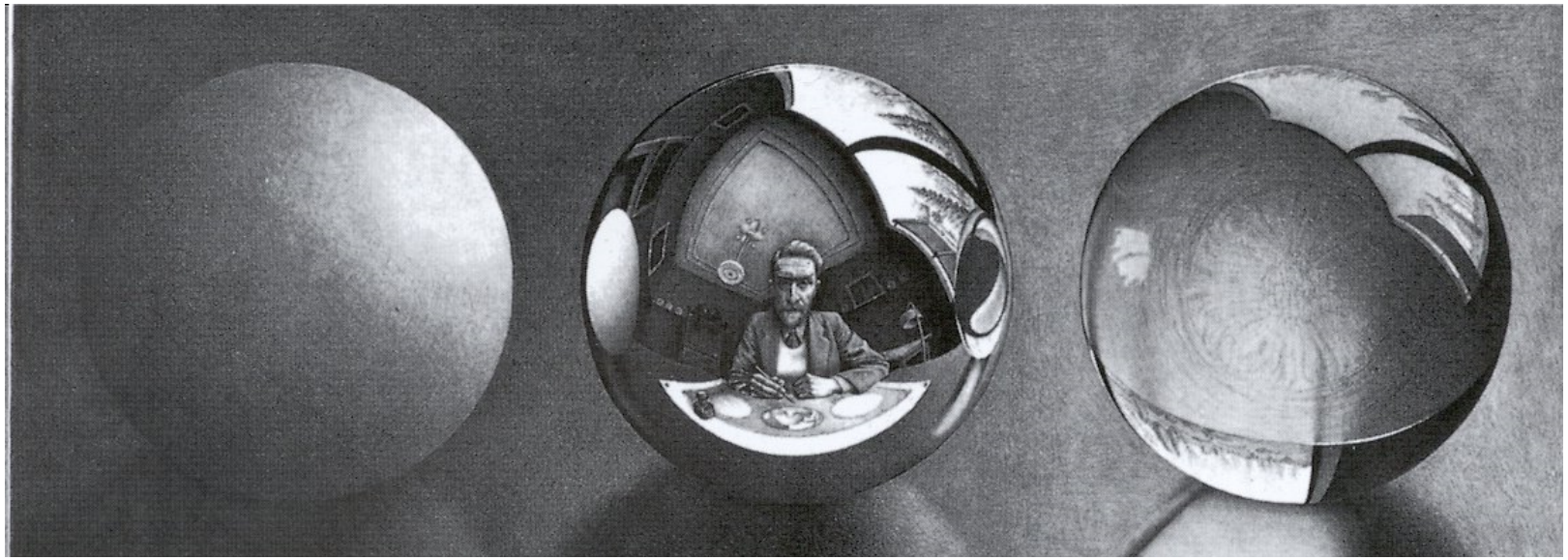


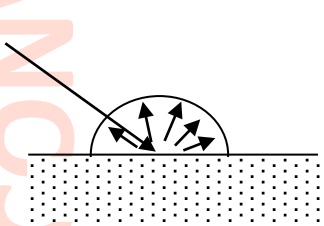


(b)

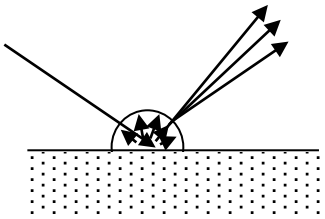
SURFACE DIFFUSE

NON CONVENTIONNEL

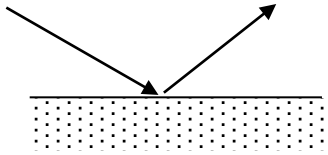




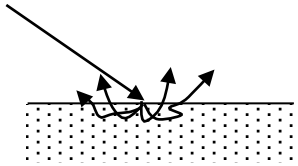
SURFACE DIFFUSE



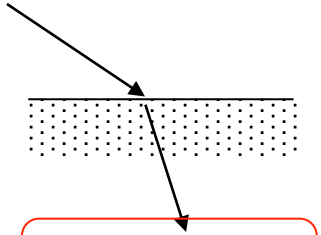
SURFACE « GLOSSY »



SURFACE SPECULAIRE



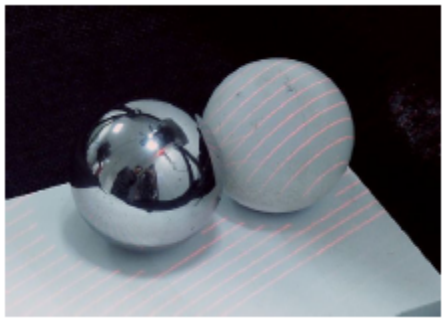
SURFACE TRANSLUCIDES

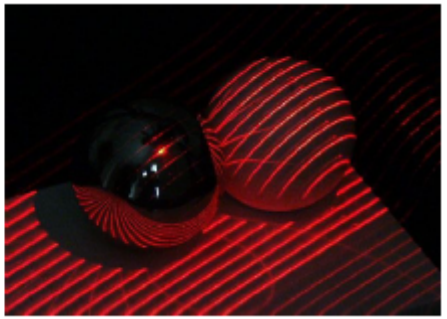


SURFACE TRANSPARENTE

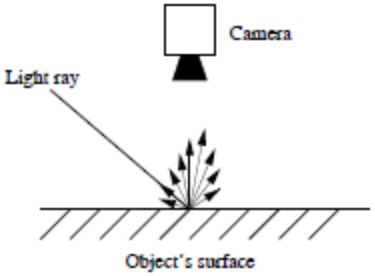
PROBLEMATIQUE DES SURFACES SPECULAIRES

NON CONVENTIONNEL

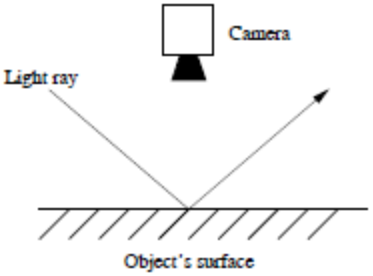




EXEMPLE DE PROJECTION DE MOTIF



Surface diffuse

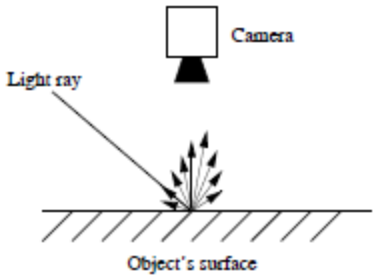


Surface spéculaire

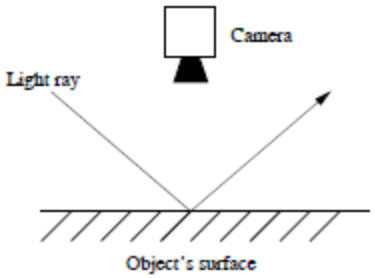
NON CONVENTIONNEL

(a) (b) (c)

ESSAIS DE SCANNING



Surface diffuse



Surface spéculaire

NON CONVENTIONNEL

EXEMPLE D'OBJETS A SURFACE POLI-MIROIR






TYPE DE MATERIAUX :

aluminium, inox, cuivre …

PROCESSUS :

usinage, emboutissage, laminage, polissage…

SECTEURS D'ACTIVITE :

agroalimentaire, automobile, de la bijouterie, de l'horlogerie…

NON CONVENTIONNEL

APPROCHES :

Shape from Distortion (Déflectométrie)

Idée directrice : étudier la déformation de l'image réfléchie d'un motif (une mire par exemple)

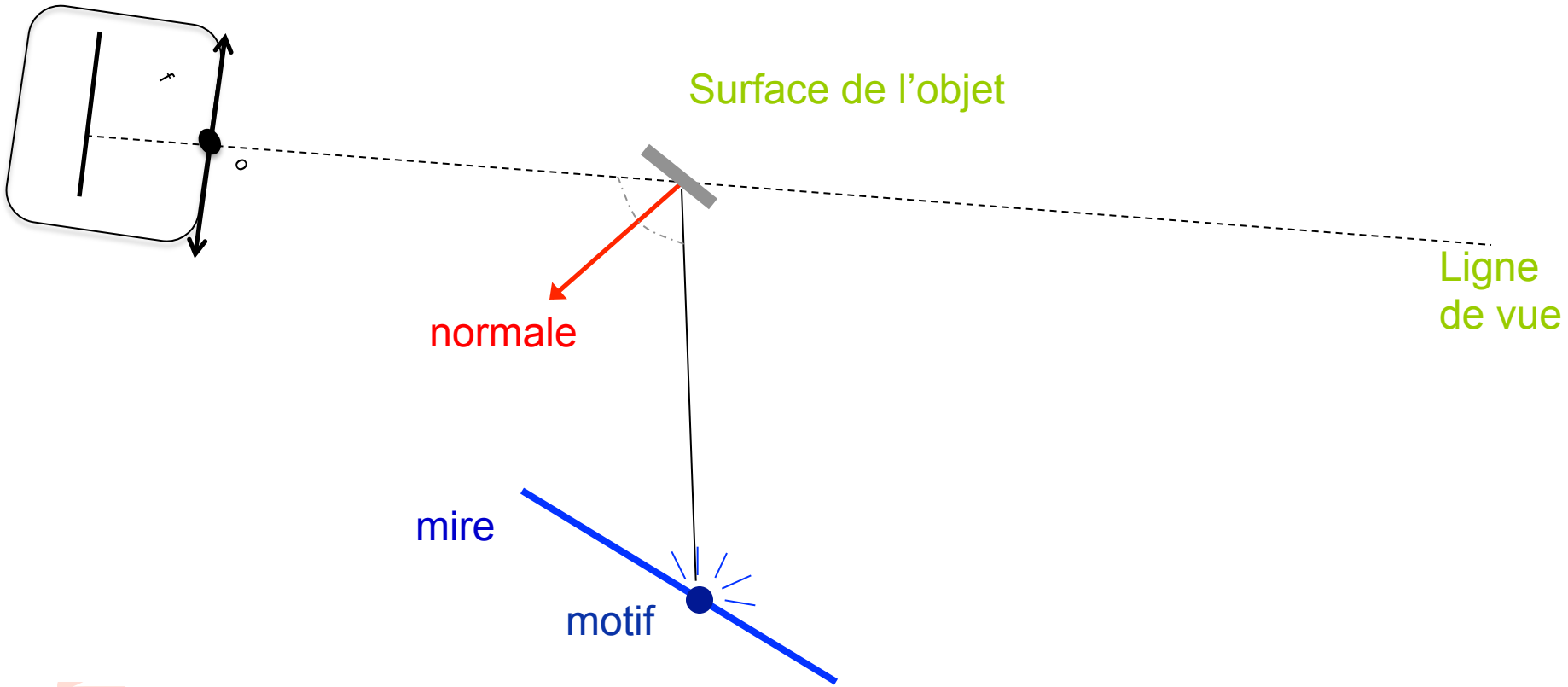
Shape from Specularity / Shape from Polarization

Idée directrice : étudier les propriétés de la lumière réfléchie à la surface de l'objet

Imagerie Confocale

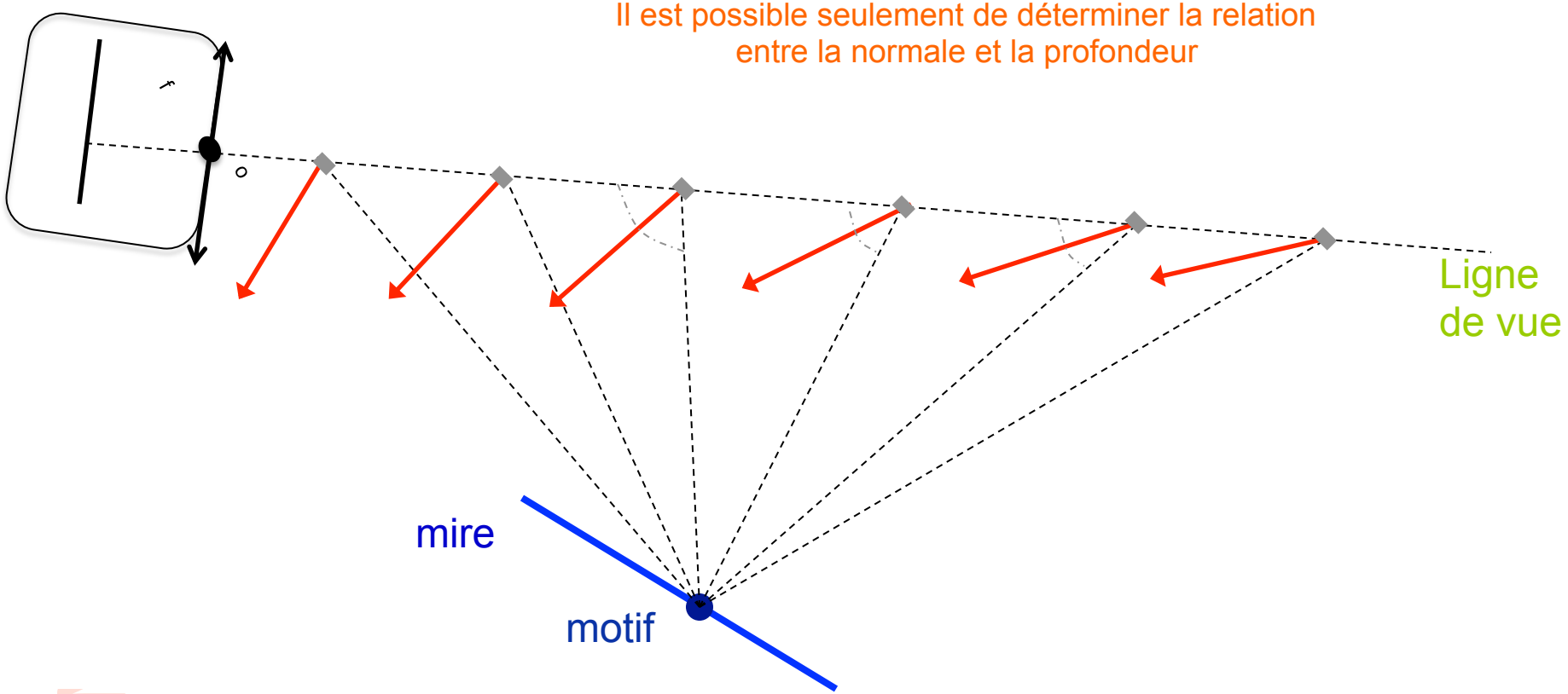
Triangulation laser / surface « glossy »

Shape from Distortion : principe



Shape from Distortion : problématique

Il est possible seulement de déterminer la relation entre la normale et la profondeur



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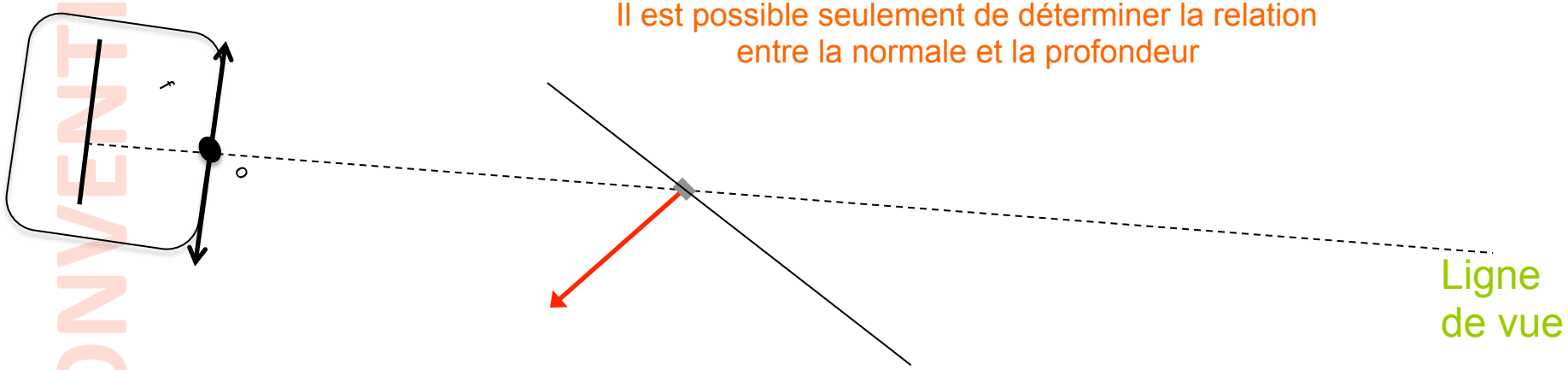
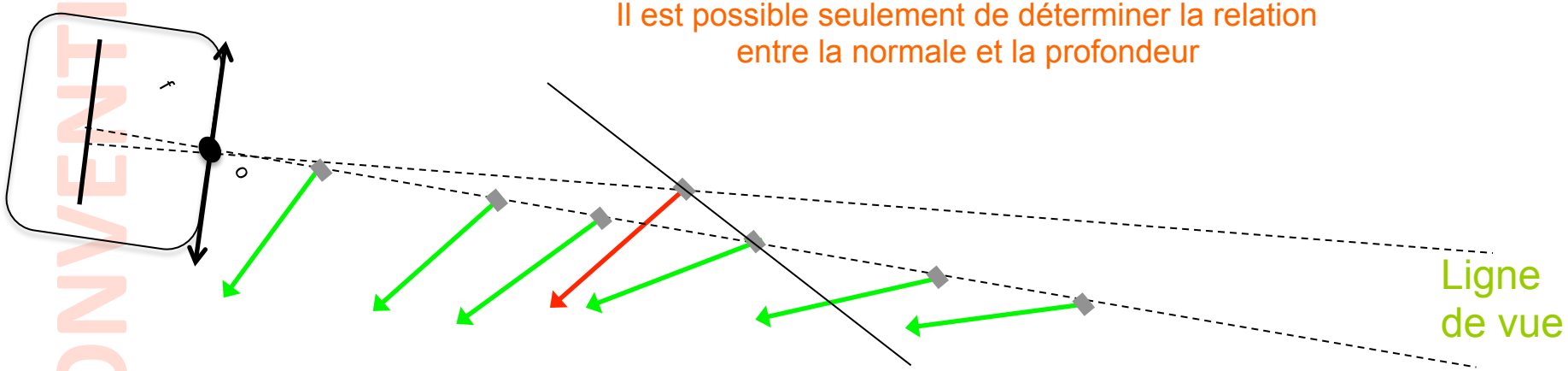


Shape from Distortion : problématique

Il est possible seulement de déterminer la relation entre la normale et la profondeur

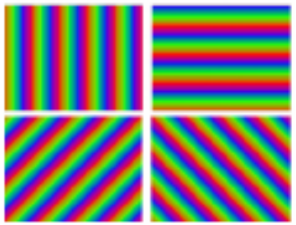


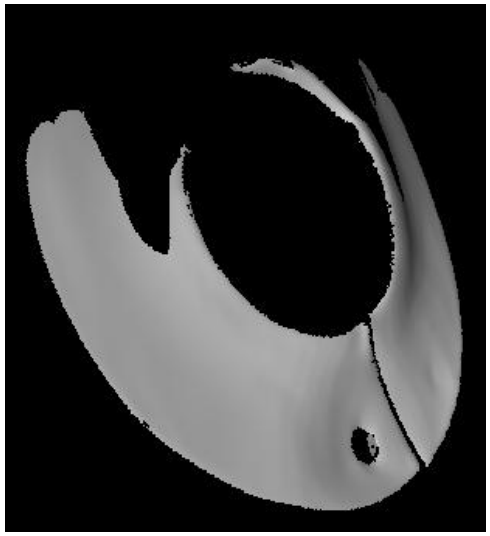
NON CONVENTIONNEL

Shape from Distortion : problématique

Il est possible seulement de déterminer la relation entre la normale et la profondeur

Tarini & al:
la reconstruction est possible à partir de la connaissance ou de l'approximation de la normale ou de la profondeur



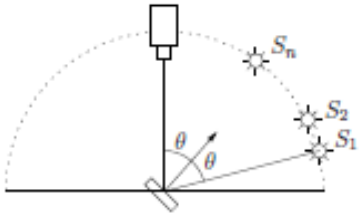


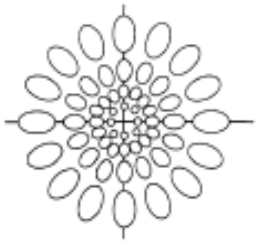
Système par éclairage structuré

NON CONVENTIONNEL

Shape from Specularity : Principe

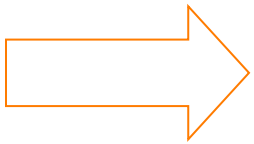
étudier les propriétés de la lumière réfléchie à la surface de l'objet





Système « Shiny » [Sanderson et al., 1988]

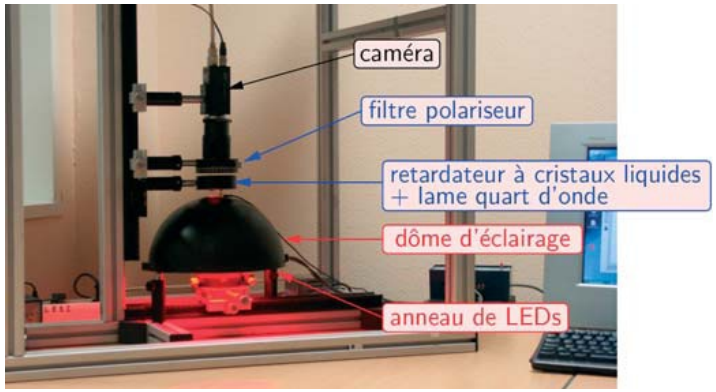
[Nayar et al., 1990]



- Le système permet d'obtenir un champ de normales non dense et non régulière
- Le système est adapté aux surfaces convexes

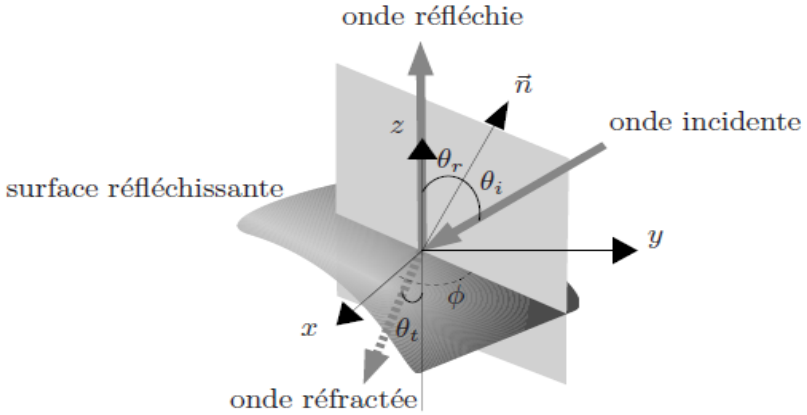
NON CONVENTIONNEL

Shape from Polarization



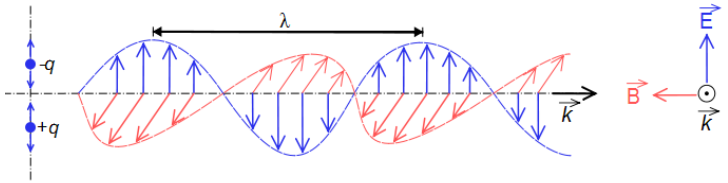
[Rahmann & Canterakis, 2001]

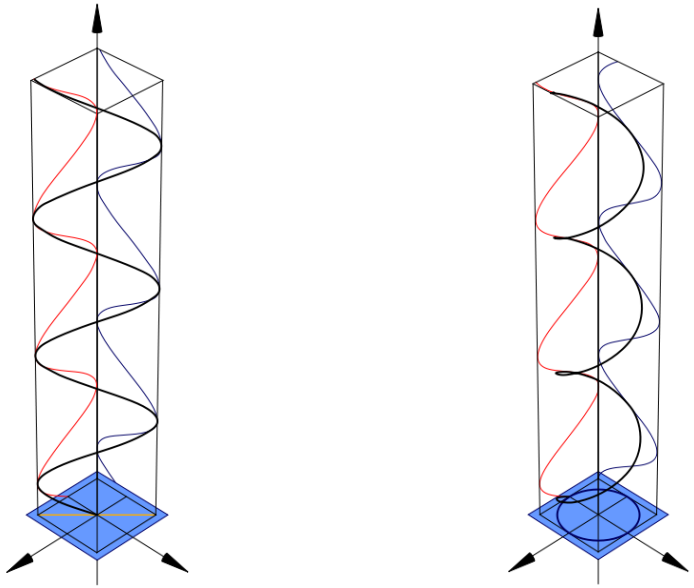
Système par imagerie polarimétrique



Shape from Polarization

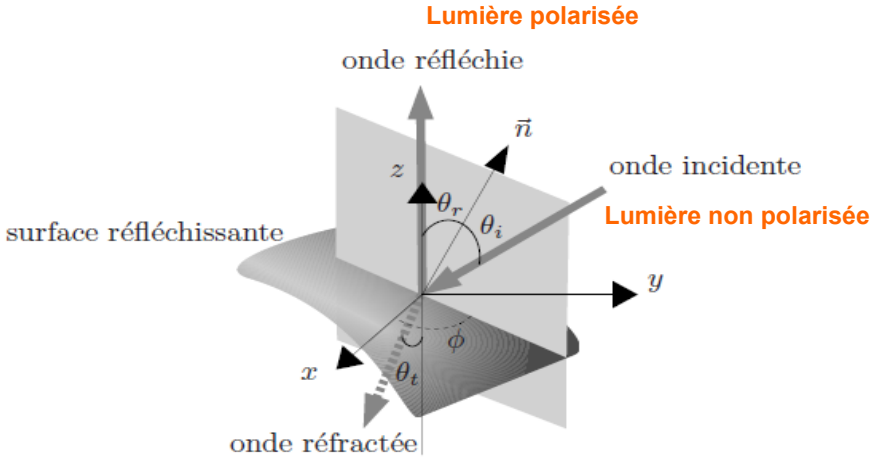
Rapide rappel de la polarisation de la lumière

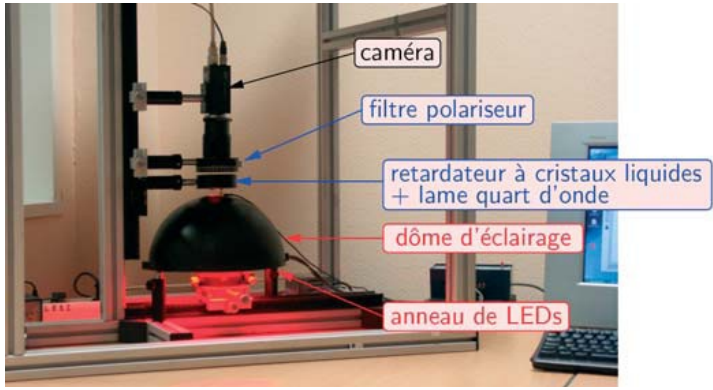




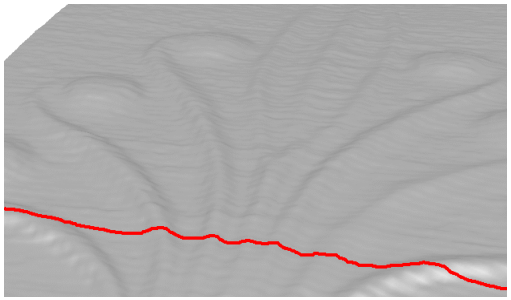
NON CONVENTIONNEL

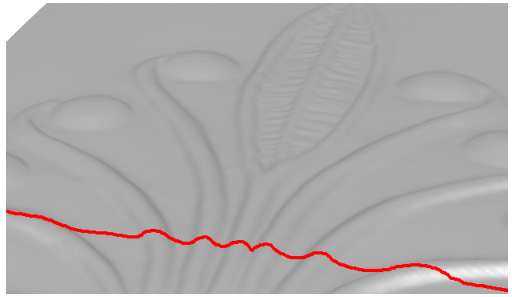
Shape from Polarization





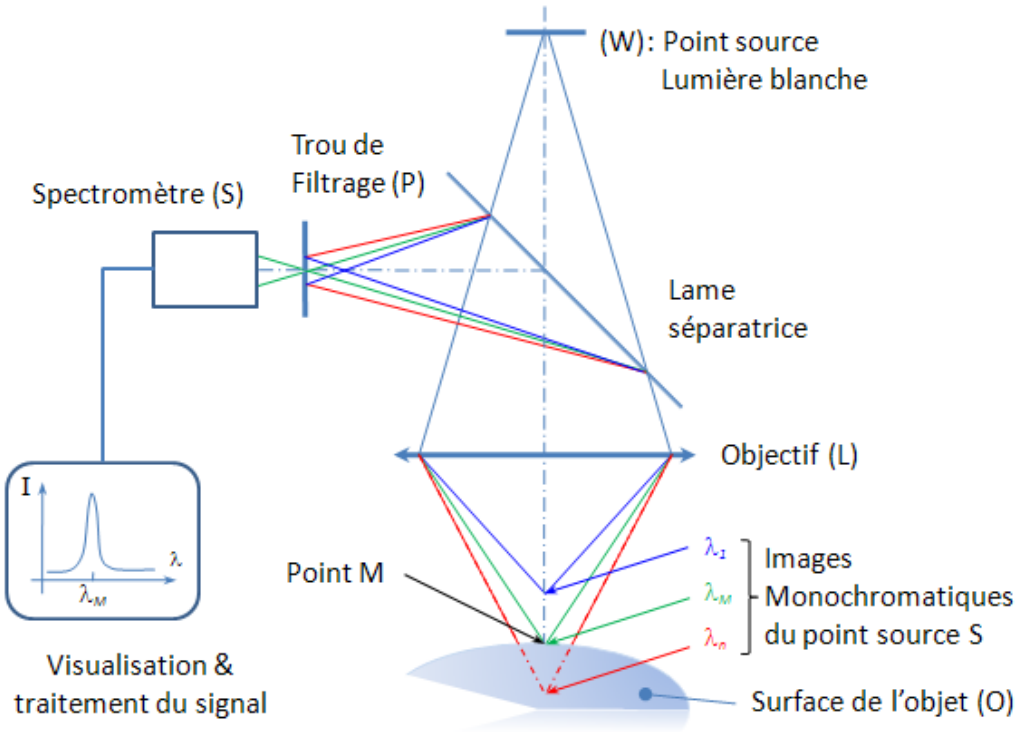
La mesure des paramètres de polarisation permet la détermination des normales





NEL

Imagerie Confocale Chromatique



STIL
Sciences et Techniques
Industrielles de la Lumière

1: source
2 : tête de mesure
3: fibre optique

NON

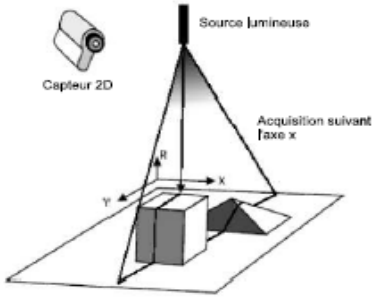
Approche limitée par :

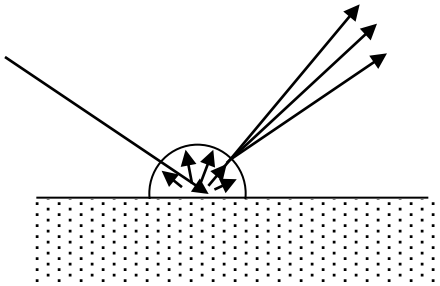
la distance surface – tête de mesure

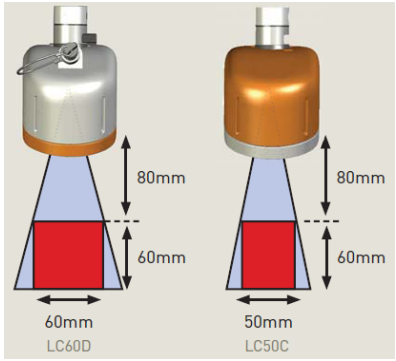
l'orientation de la surface par rapport à l'axe otique

NON CONVENTIONNEL

APPROCHE A BALAYAGE LASER



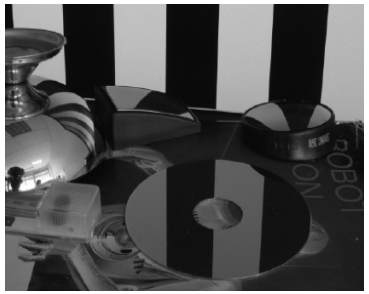




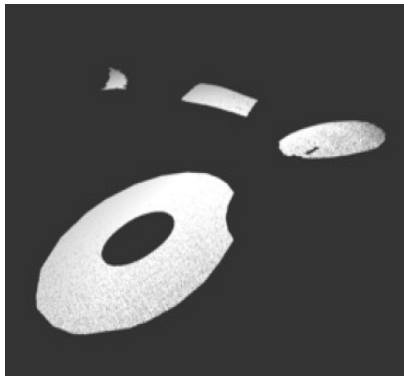
Approche limitée par :

la distance surface – tête de mesure

NON CONVENTIONNEL



[Bonfort & al.,2003]



Les approches utilisent les propriétés optiques spécifiques de la surface

Elles sont souvent dédiées aux surfaces spéculaires

Très souvent c'est la normale ou la relation profondeur/normale qui sont déterminées : problème dans le cas de surfaces discontinues

Une façon de contourner le problème est de diminuer la distance capteur - surface

NON CONVENTIONNEL

PLUS DELICAT : LES OBJETS TRANSPARENTS

[Miyazaki et al., 2004] :

la principale problématique dans le cas surfaces transparentes c'est qu'en plus d'être transparentes elles ont un caractère spéculaire

NON CONVENTIONNEL

EXEMPLE D'OBJETS A SURFACE TRANSPARENTES OU TRANSLUCIDES

TYPE DE MATERIAUX :

verres, plastiques, certains liquides…

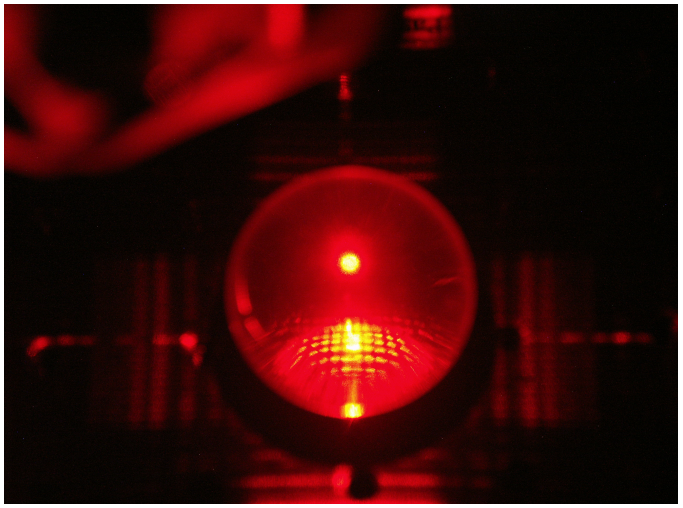
PROCESSUS :

injection, moulage, laminage…

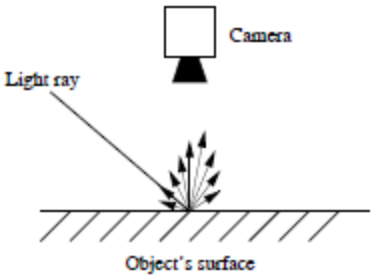
SECTEURS D'ACTIVITE :

agroalimentaire, automobile, de la bijouterie, de l'optique…

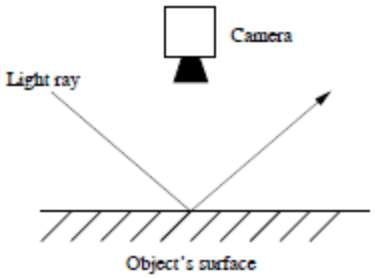
NON CONVENTIONNEL



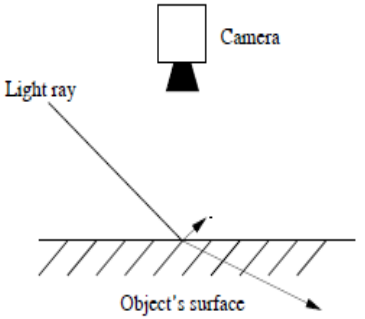
EXEMPLE DE PROJECTION DE MOTIF



Surface diffuse

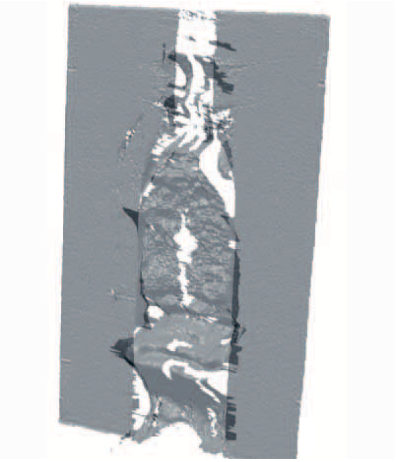


Surface spéculaire

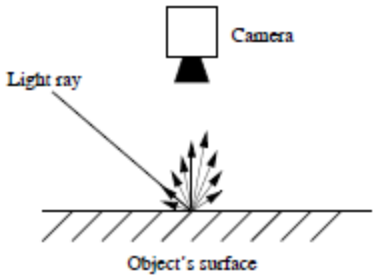


Surface transparente

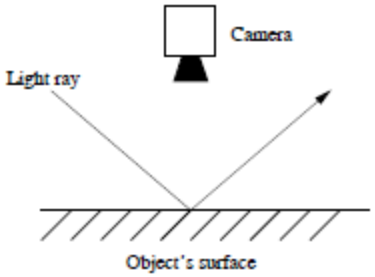
NON CONVENTIONNEL



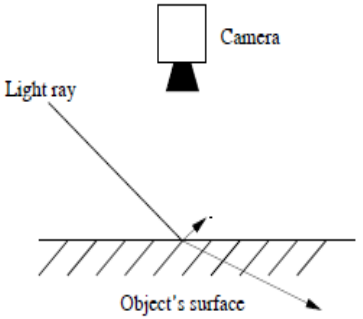
RESULTAT DE SCAN



Surface diffuse



Surface spéculaire



Surface transparente

NON CONVENTIONNEL

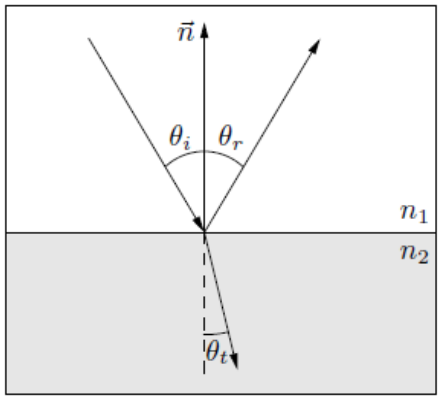
Shape from Distortion

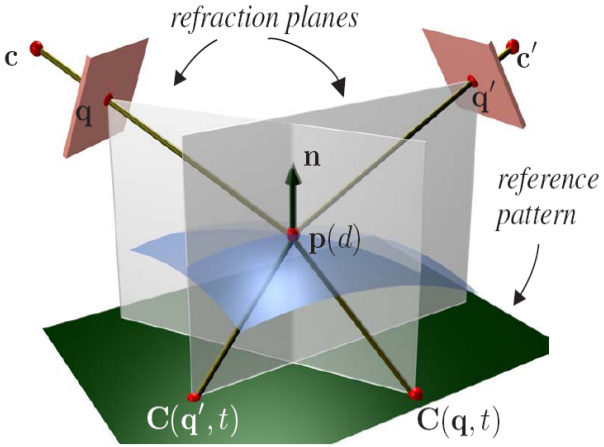
Shape from Polarization

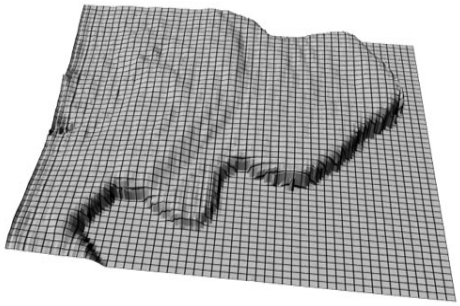
Reduction to Tomography

Imagerie Confocale Chromatique

Shape from Distortion



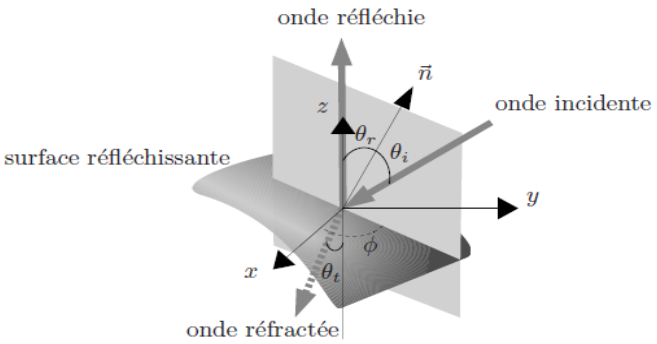




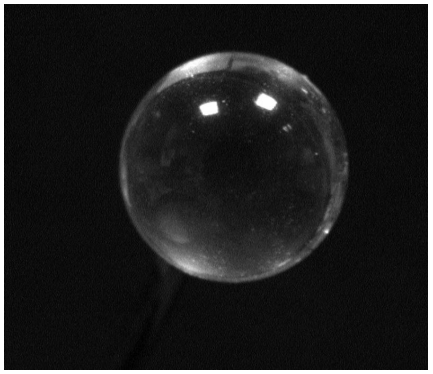
Morris and Kutulakos 2005

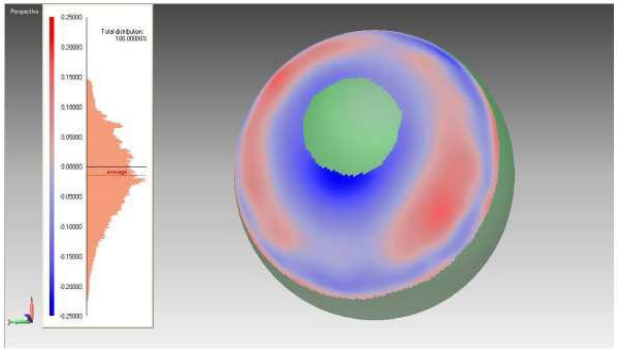
NON CONVENTIONNEL

Shape from Polarization



Miyazaki & al. 2003



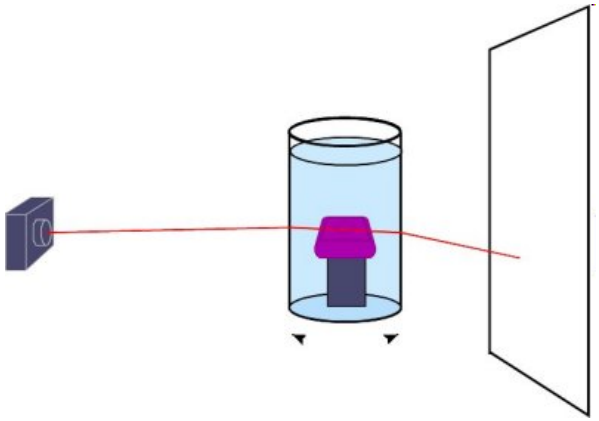


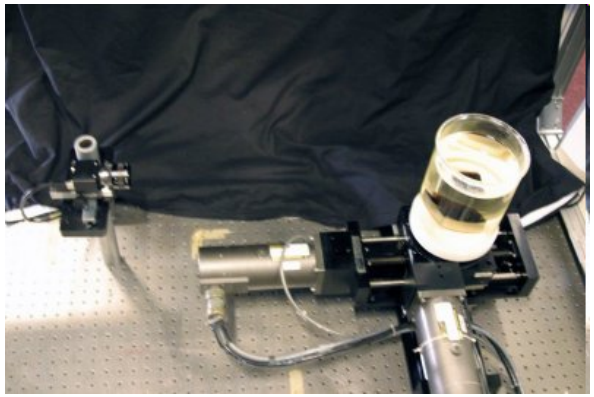
Ferraton & al. 2009

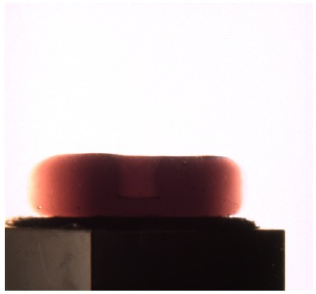
NON CONVENTIONNEL

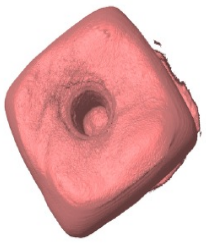
Reduction to Tomography

B. Trifonov, D. Bradley, W. Heidrich, 2006





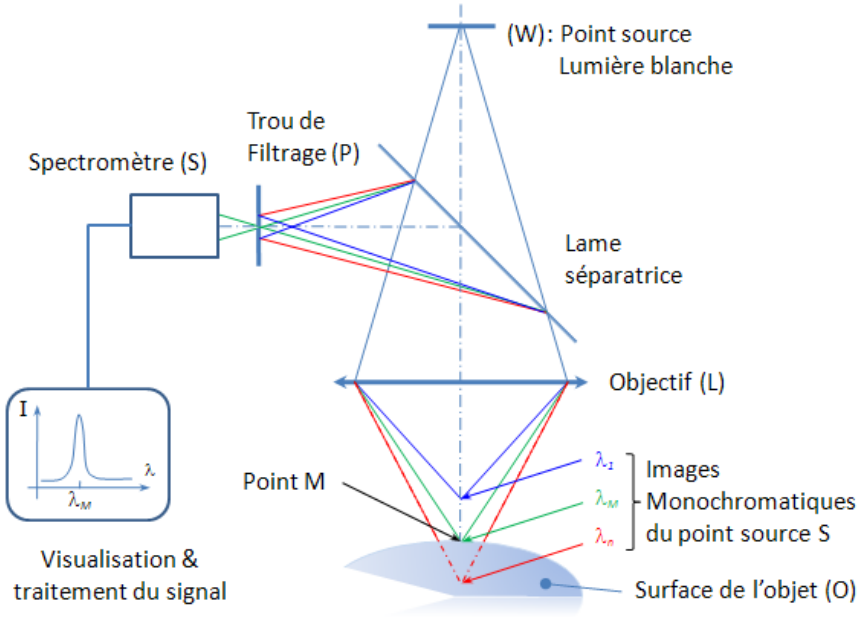


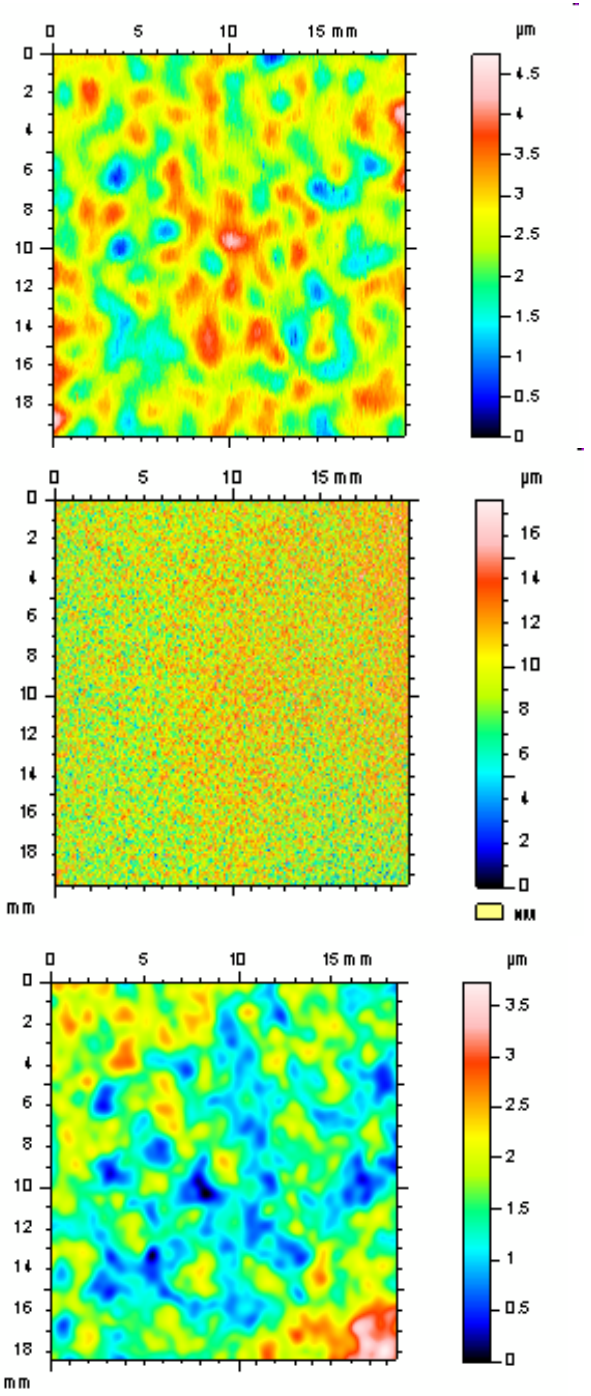


SOLUTION COMMERCIALE

NON CONVENTIONNEL

Imagerie Confocale Chromatique





Permet la mesure 3D de la surface et de l'épaisseur

NON CONVENTIONNEL

Certaines approches sont issues des techniques développées pour les surfaces spéculaires

Elles utilisent les propriétés optiques spécifiques du matériau (spécularité, absorption…)

Très souvent c'est la normale ou la relation profondeur/normale qui sont déterminées : problème dans le cas de surfaces discontinues

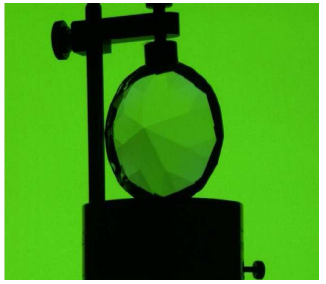
L'information d'épaisseur peut aussi être déterminée

Surface :	Triangulation active	Shape from distorsion	Shape from Polarization	Tomographie	Imagerie confocale
Diffuse	X				X
Spéculaire	X	X	X		X
Transparente		X	X	X	X

NON CONVENTIONNEL

AUCUN POINT COMMUN ENTRE CES TECHNIQUES ?

TOUTES CES APPROCHES SONT BASEES SUR L' EXPLOITATION D' INFORMATIONS OBTENUES PAR ANALYSE DE LA REFLEXION OU DE LA TRANSMISSION D' UN RAYONNEMENT LUMINEUX PROJETE SUR LA SURFACE A NUMERISER



NON CONVENTIONNEL

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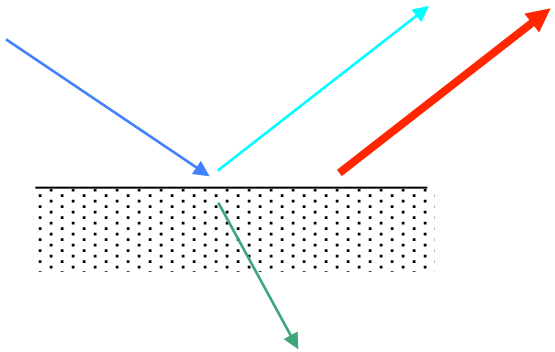
TOUTES CES APPROCHES SONT BASEES SUR L' EXPLOITATION D' INFORMATIONS OBTENUES PAR ANALYSE DE LA REFLEXION OU DE LA TRANSMISSION D' UN RAYONNEMENT LUMINEUX PROJETE SUR LA SURFACE A NUMERISER

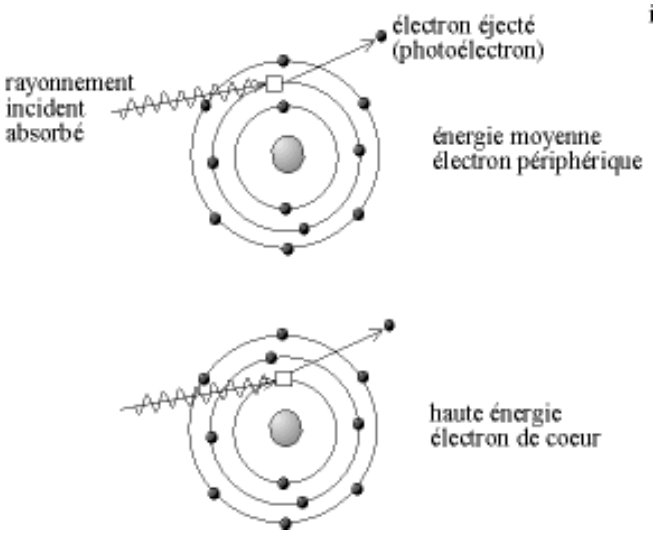
PROBLEME :
TOUTES CES SURFACES N' ONT PAS LES MÊMES PROPRIETES OPTIQUES DONC IL EST IMPOSSIBLE D' OBTENIR UNE METHODE GENERIQUE

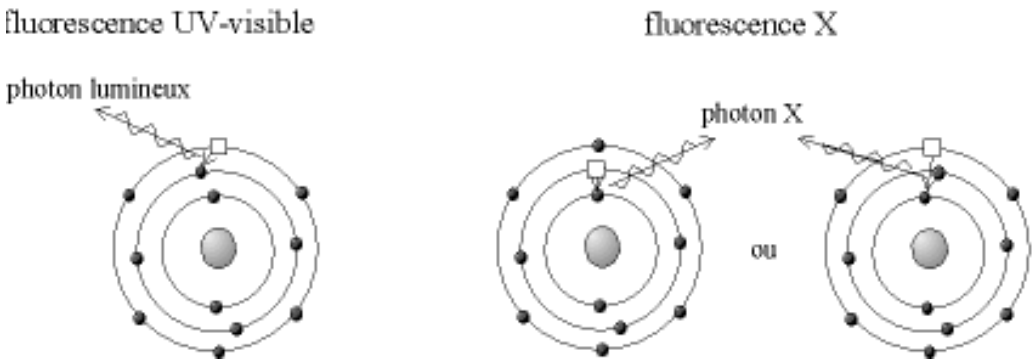
ALTERNATIVE :
LE RAYONNEMENT EMIS PAR LA SURFACE ELLE-MÊME N' EST PAS PRIS EN COMPTE



NON CONVENTIONNEL

UTILISATION DE LA FLUORESCENCE

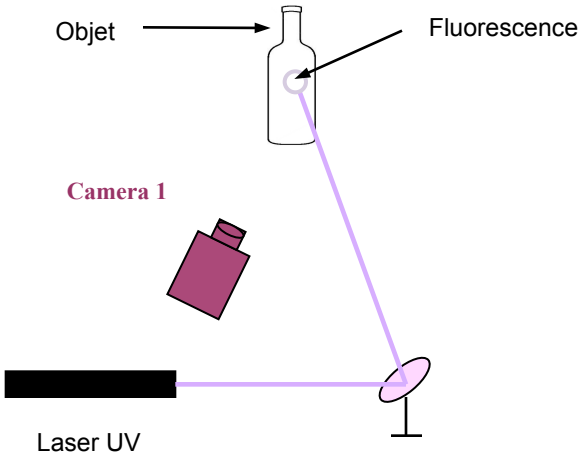


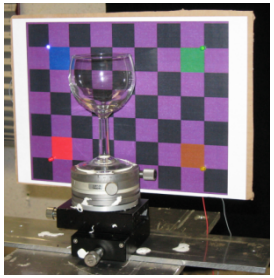


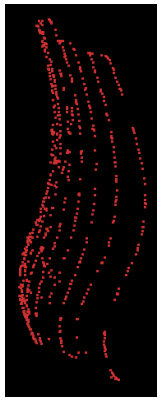
NON CONVENTIONNEL

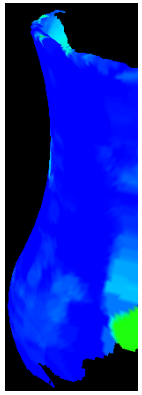
TECHNIQUE DU SHAPE FROM UV

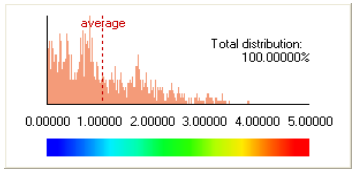
Rantonson & al. 2009







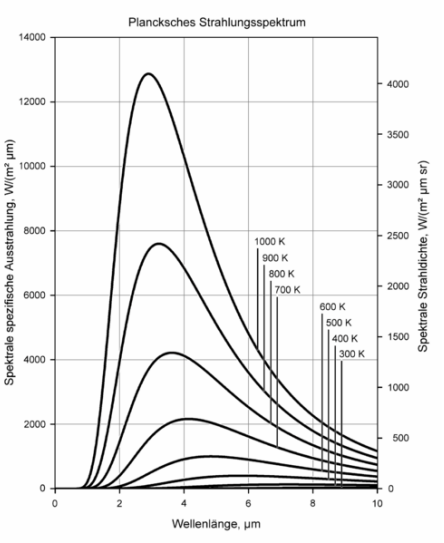


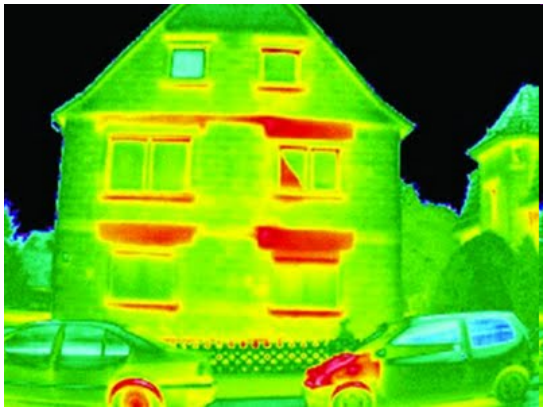


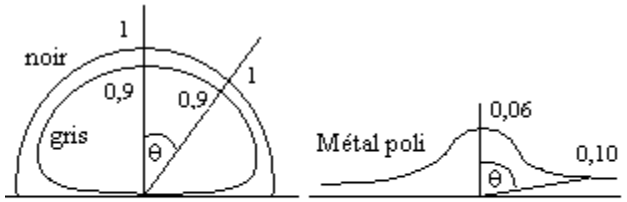
LE RAYONNEMENT EMIS EST DIFFUS

NON CONVENTIONNEL

UTILISATION DU RAYONNEMENT IR



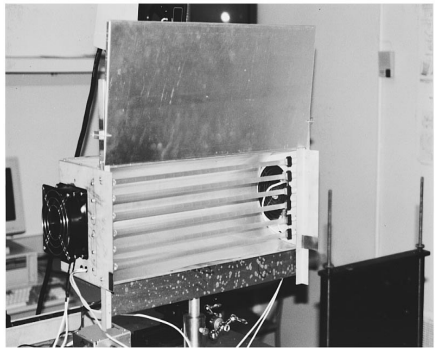


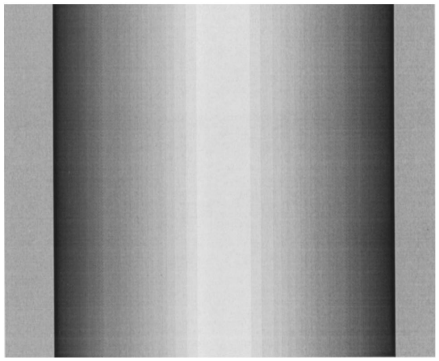


Emissivité directionnelle

SHAPE FROM HEATING

Pelletier & Maldague. 2002

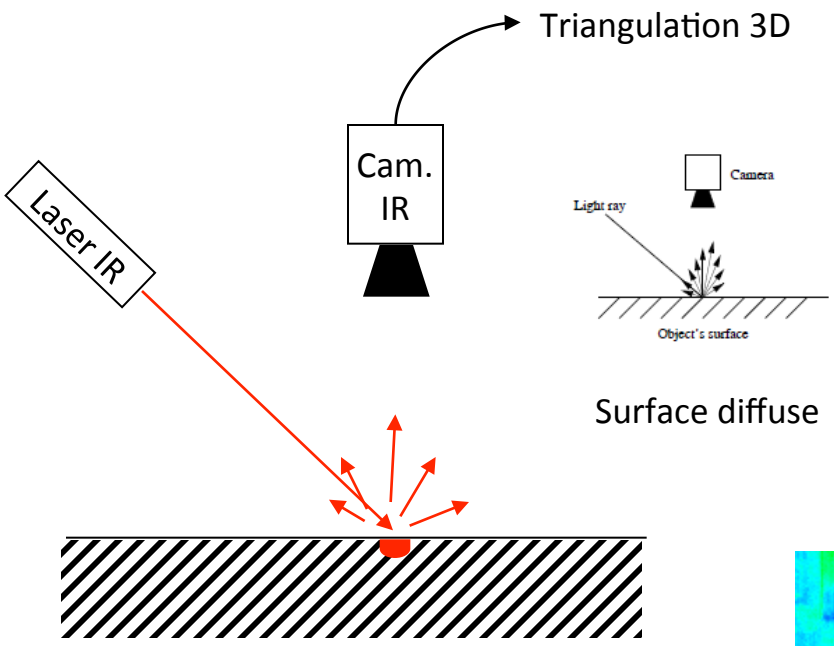




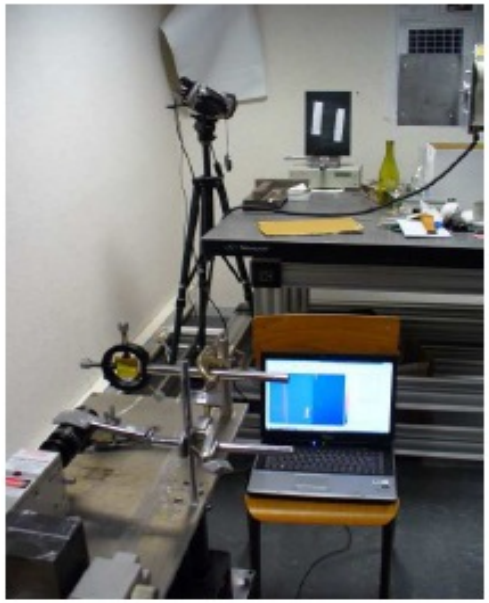
NON CONVENTIONNEL

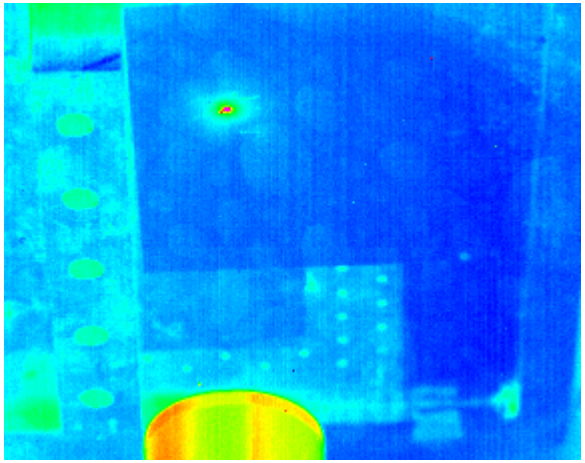
TECHNIQUE DU SCANNING FROM HEATING

Eren et al. 2009



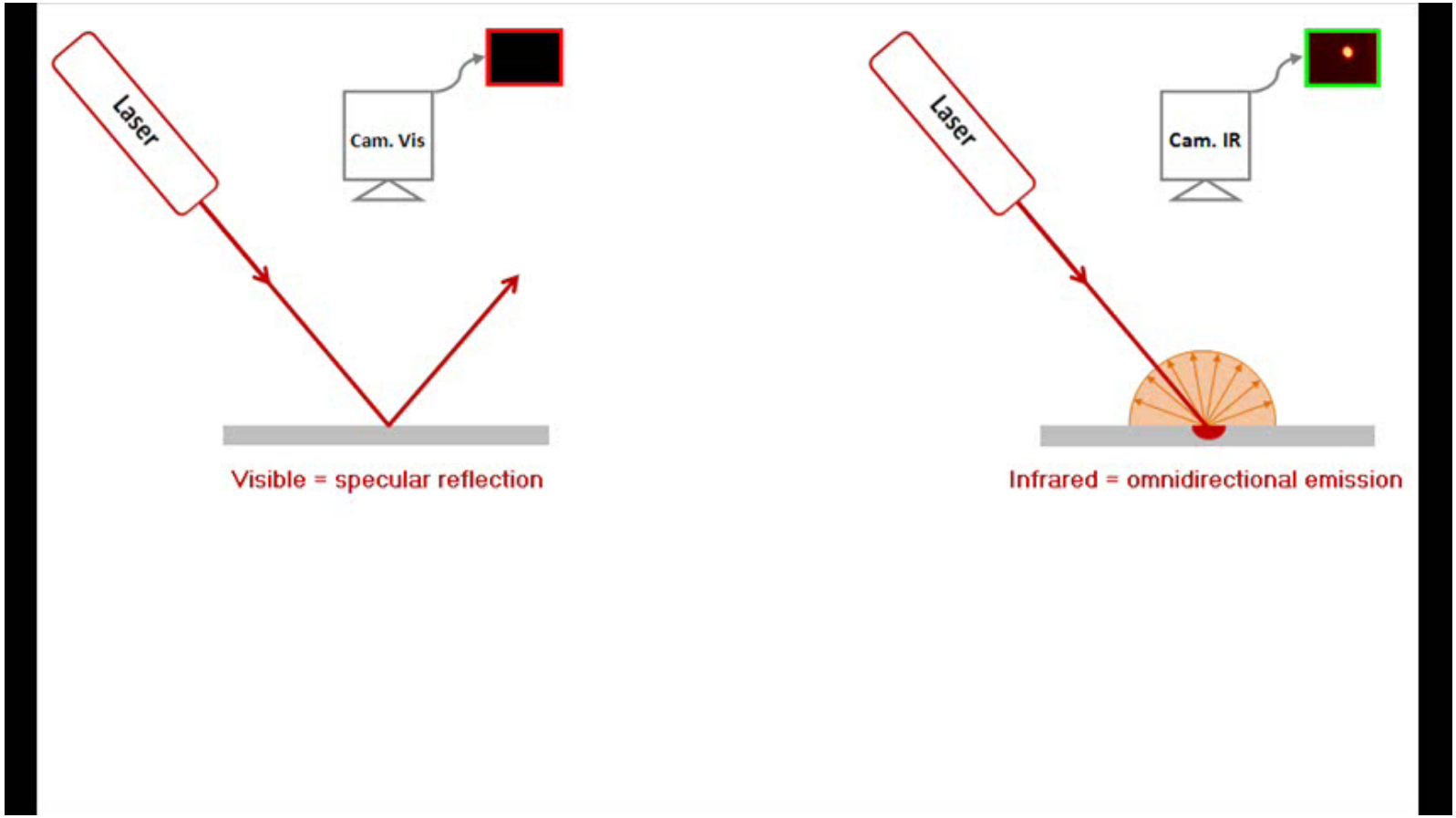
Surface diffuse





TECHNIQUE DU SCANNING FROM HEATING

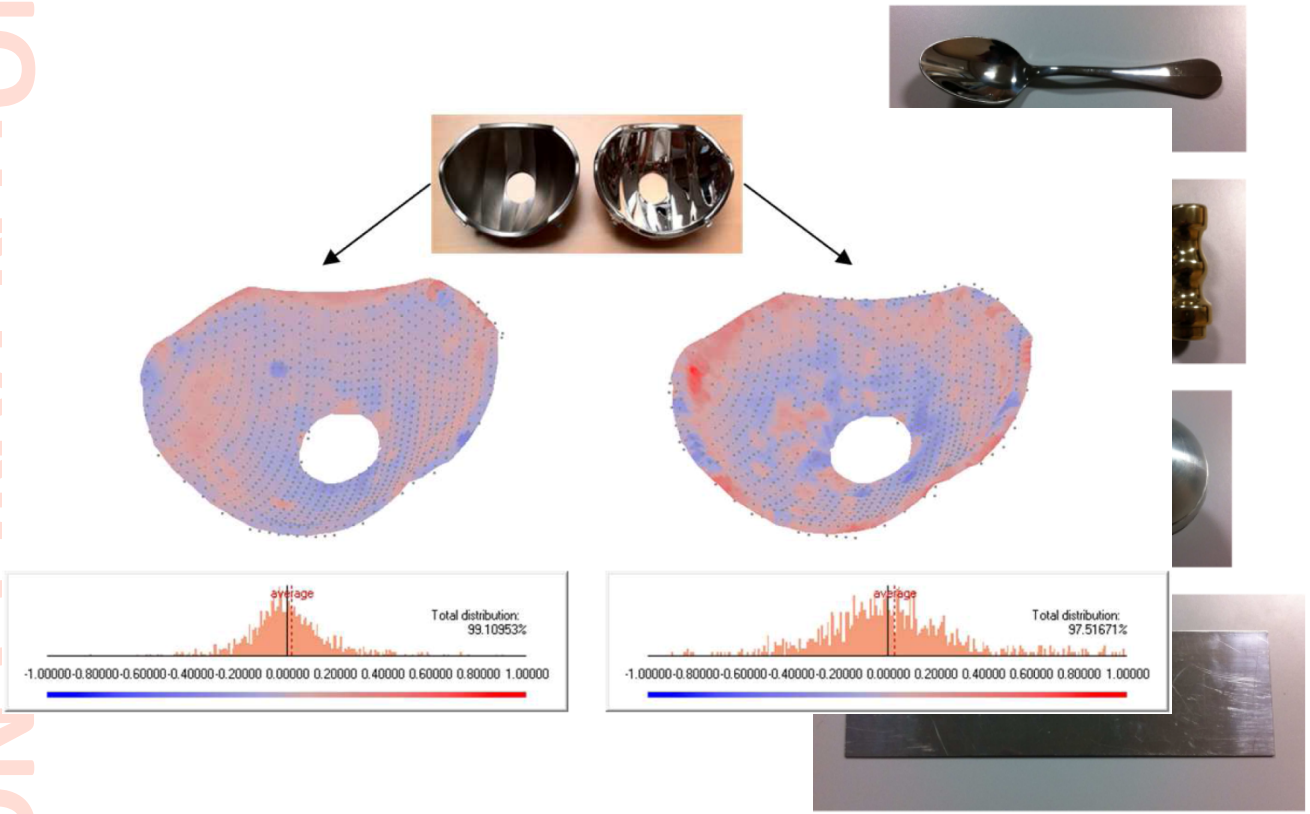
Bajard et al.

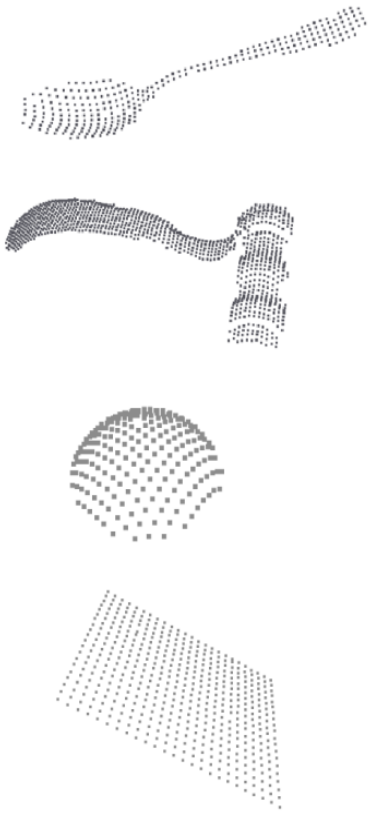


NON CONVENTIONNEL

TECHNIQUE DU SCANNING FROM HEATING

Résultats de numérisation d'objets en métal

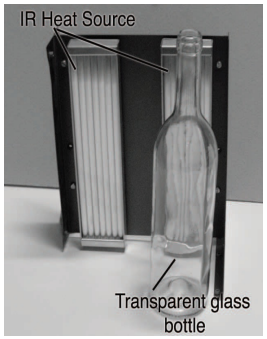


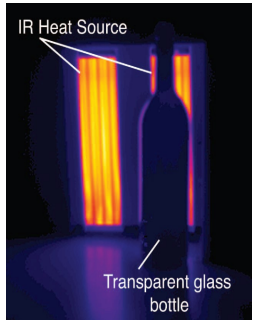


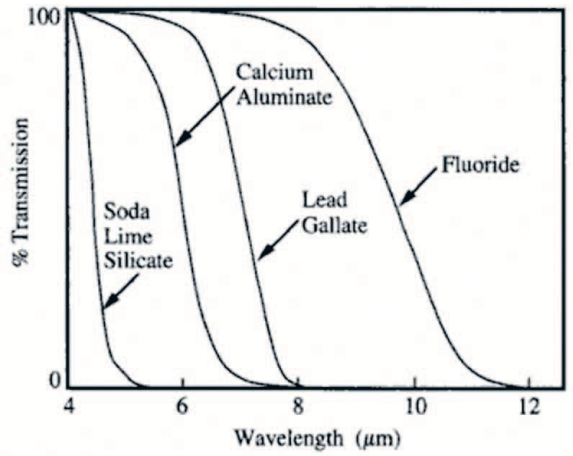
NON CONVENTIONNEL

TECHNIQUE DU SCANNING FROM HEATING

Résultats de numérisation d'objets en verre







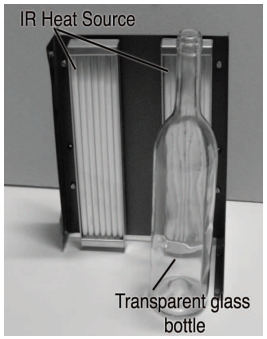
Laser CO^2 (10µm)

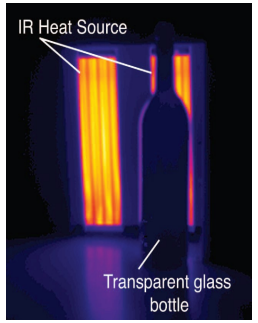
Camera Middle Wave (3-5µm)

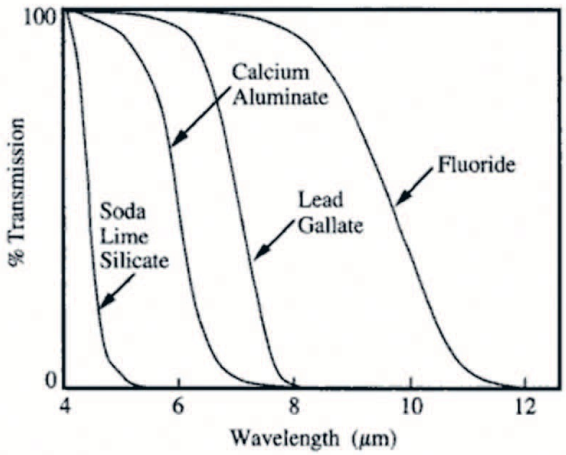
NON CONVENTIONNEL

TECHNIQUE DU SCANNING FROM HEATING

Résultats de numérisation d'objets en verre



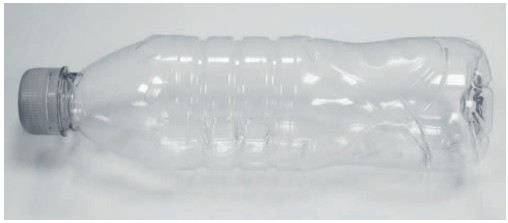


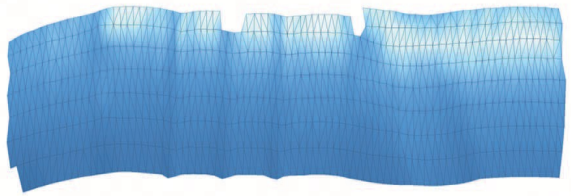


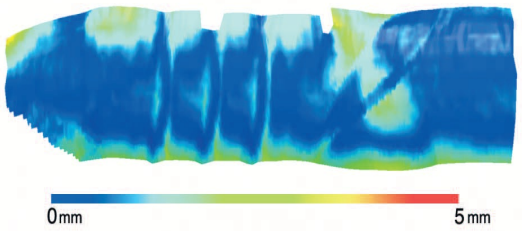
Laser CO^2 (10µm)

Camera Middle Wave (3-5µm)

TECHNIQUE DU SCANNING FROM HEATING : EXEMPLE SUR UN OBJET PLASTIQUE







Surface :	Triangulation active	Shape from distorsion	Shape from Polarization	Tomographie	Imagerie confocale	Émission
Diffuse	X				X	X
Spéculaire	X	X	X		X	X
Transparente		X	X	X	X	X

Ce qui va limiter la technique ce sont les caractéristiques du matériau

IG

CONCLUSION

CONCLUSION

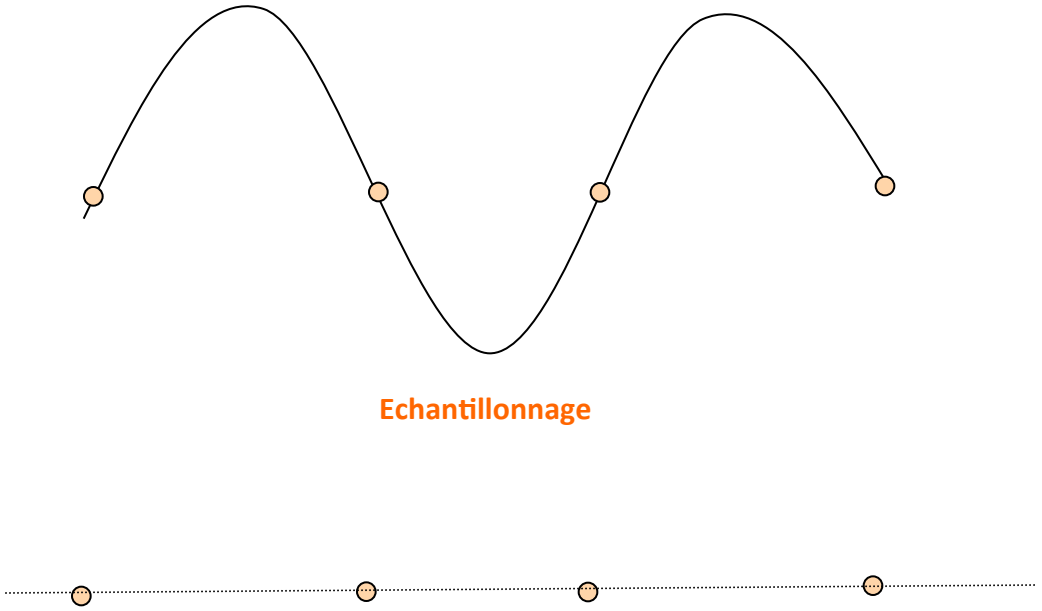
CONCLUSION

CONCLUSION

EXTRAIRE LA NORMALE A LA SURFACE

CONCLUSION

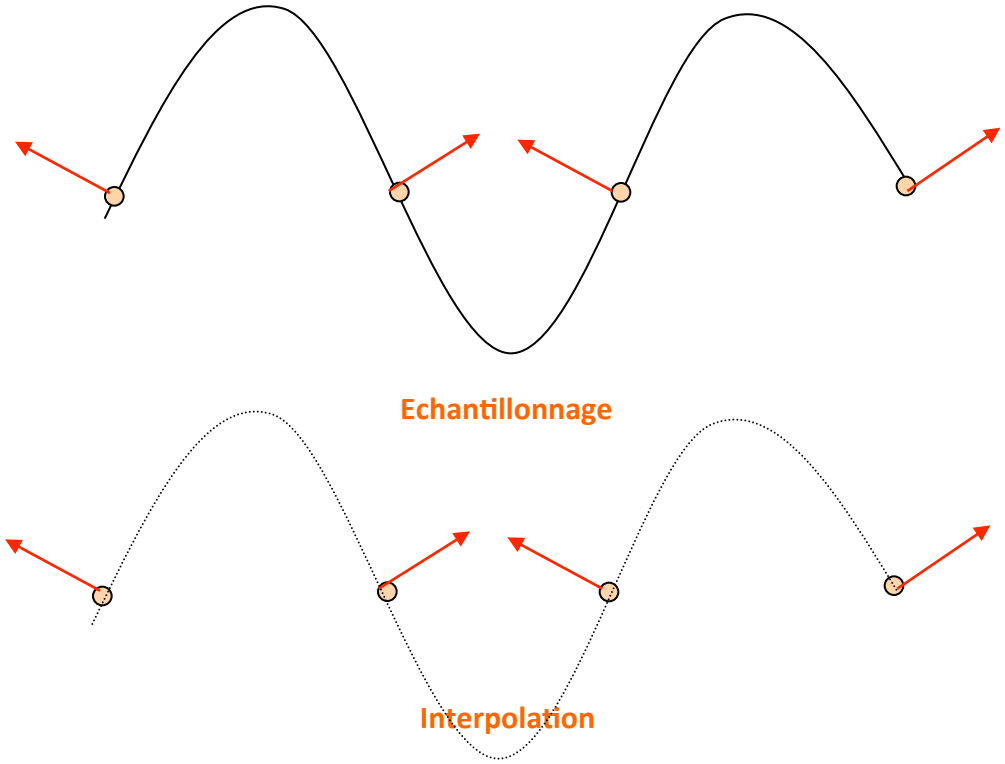
INTERÊT



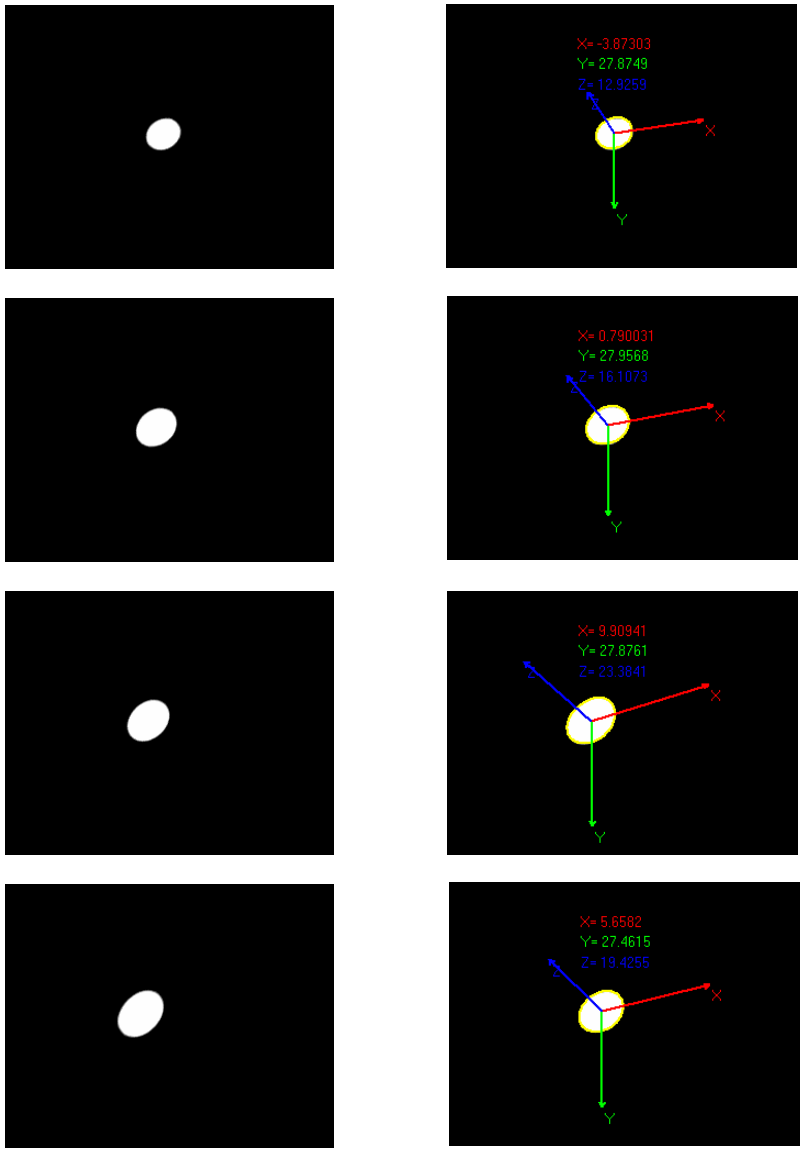
EXTRAIRE LA NORMALE A LA SURFACE

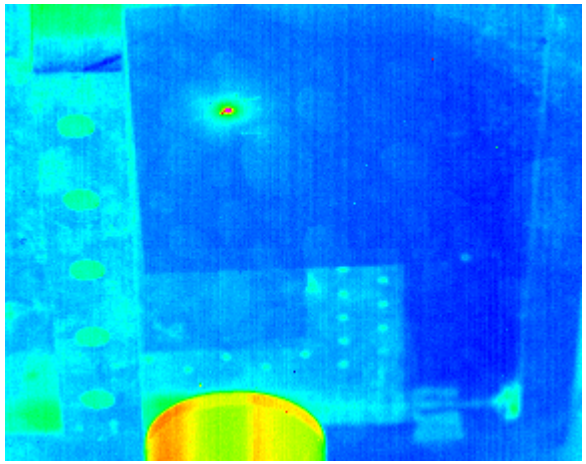
CONCLUSION

INTERÊT

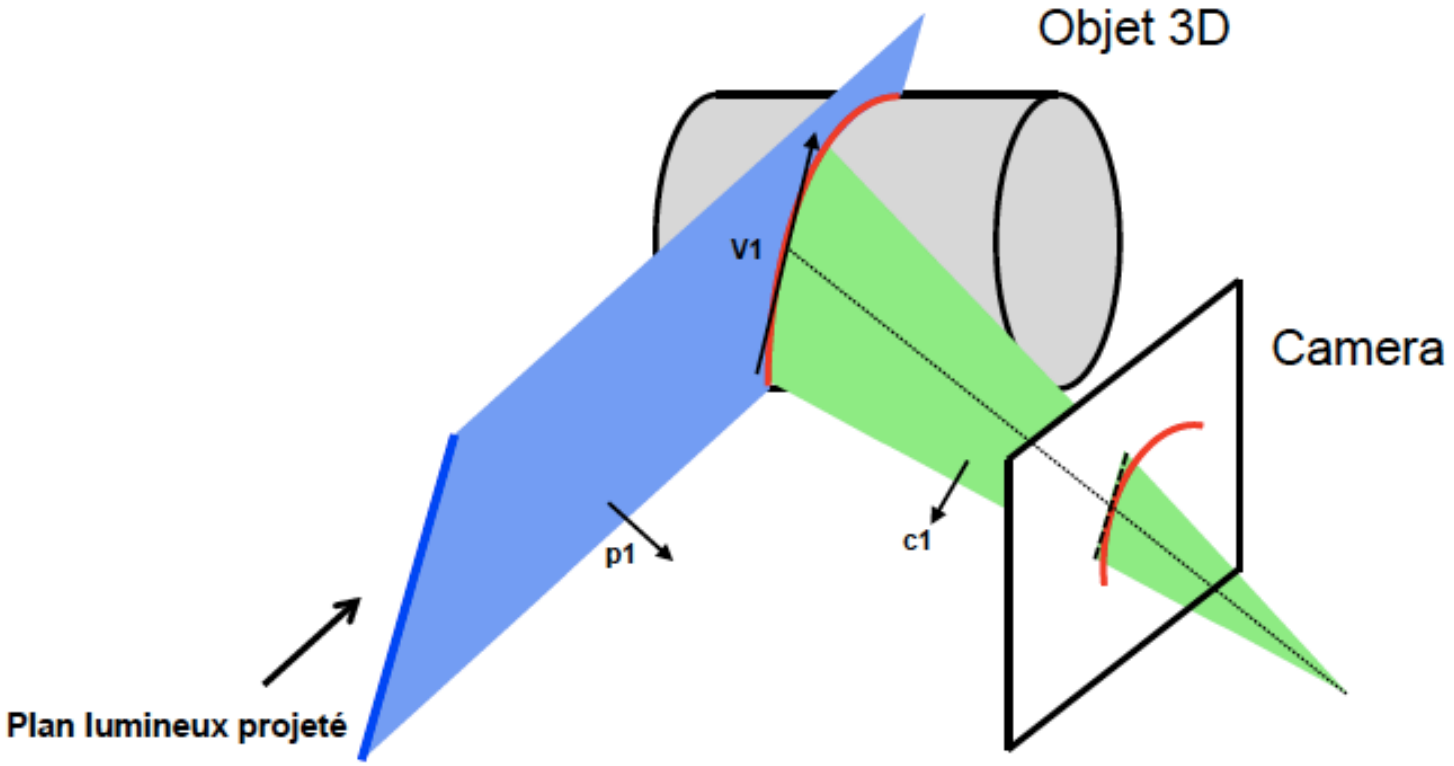


EXTRAIRE LA NORMALE A LA SURFACE



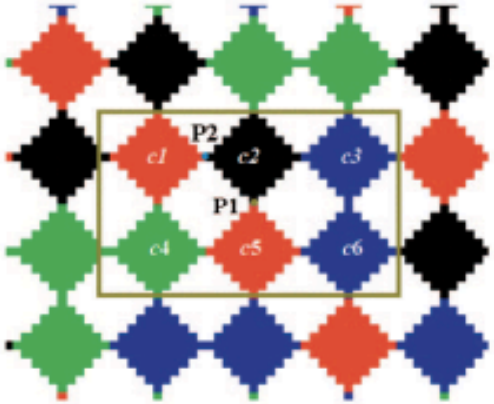


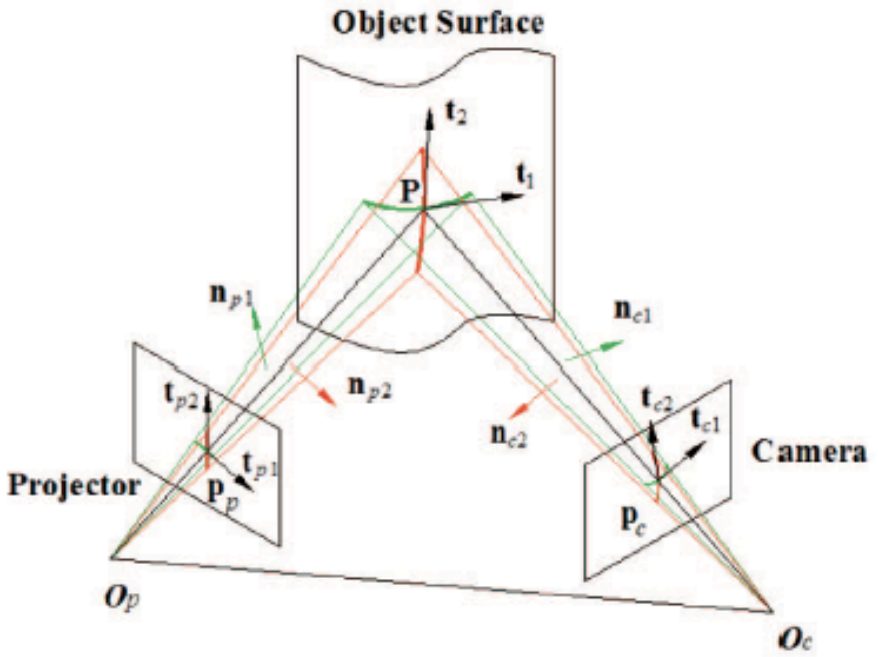
EXTRAIRE LA NORMALE A LA SURFACE



EXTRAIRE LA NORMALE A LA SURFACE

CONCLUSION





$$\mathbf{n}(x, y) = \mathbf{t}_1 \times \mathbf{t}_2$$

EXTRAIRE LA NORMALE A LA SURFACE

CONCLUSION