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MEDICAL IMAGE ANALYSIS, HUMAN MOTION AND BODY MEASUREMENT

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Medical applications of 3D surface scanning technologies


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Contents of presentation

Overview of the different methods and technologies for optical 3-D surface digitization (commercial)

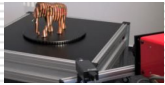




Overview and state of technology of systems for human body digitization (commercial)

Laser scanning

Coded light projection

Modeling / image processing

Exploitation for medical applications

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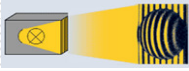


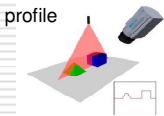

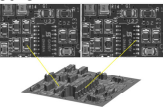


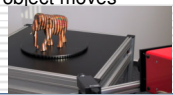
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Optical 3D surface digitization

Technology	Measurement	System
laser scan 	surface 	fix 
structured light 	profile 	moves 
other 	point 	hand held 
		object moves 

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Products exploitable for medical applications

- (1) Portable coded light projection systems

- (2) Desktop solutions, multi-axial platforms


- (3) Hand operated / hand held laser profilers

- (4) Dedicated systems


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(1) Portable structured light projection systems

Technology: structured light projection
Measurement type: surface
System: fix, ev. object on rotating platform


Single or multiple cameras and projector


Digitization of large areas in short time

Acquisition of texture


Post processing, merging/alignment

Variations:
variable basis lengths
rotation platform
multiple synchronized units






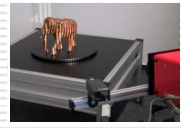
nub3d (Spain)
Triple



GOM (Germany)
ATOS III



Steinbichler (Germany)
Comet IV
variable basis



Polygon Techn. (Germany)
QTSculptor
rotating platform

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(2) Desktop solutions, multi-axial platform

Technology: laser scan. / struc. light.
Measurement type: surface / profile
System: object/system move

Desktop solution for the measurement of small objects

Full automatic acquisition process

High accuracy: range of micron

Variations:
from 2-axis up to 7-axis
mirror systems



IVB-Jena (Germany)
HSDig Volume



3D Shape (Germany)
Scan3D
st.light., 5-axis platform



3D Alliance (Gemmay)
DigiScope
laser, 2-axis sensor mov.

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(3) Hand operated laser profilers


Technology: laser triangulation
Measurement type: profiles
System: moves by hand

Laser profiler operated by hand
Manual control of the scan process
Real-time view of acquired data



Variations:
mounted on mechanical arm
hand held (tracked)
fix, hand operated



Romer (France)
G-Scan
on mechanical arm



Metris (Belgium)
K-scan
hand-held, tracked
by photogrammetry

3D-Alliance (Germany)
Hexman
desktop, 7 axis
hand operated

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(4) Dedicated systems


Systems specifically designed for acquisition tasks
Different technologies
Multiple sensors, acquisition units
Predefined (sensor, object) movements
Adequate system dimensions (fix, movable, portable)



Scanny 3D (Italy)
Scanny3D Base
shoe last scanner
desktop, laser point m.
1-axis sensor mov. and rot platform




RSI (Germany)
DigiScan Dental
dental cast scanner
structured light
2-axis platform



Wick and Wilson (UK)
TriForm BodyScanner
full body scanner
structured light
4 units (2 cameras, 1 projector)


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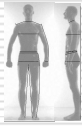
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Technologies

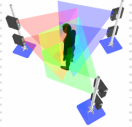


Laser Scanning

- Full body
- Head/face
- Foot

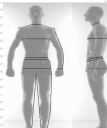


White light projection

- Full body
- Face
- Skin

Modeling

- Body sizes
- Face
- Hand

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Laser scanning

Method:

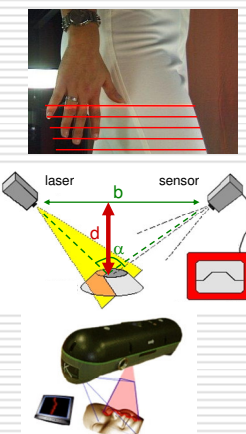
- Laser stripe projected onto the human body
- Light sensor acquire the scene
- Triangulation: distance projected line - sensor
- To scan surface parts: displacement of line

Laser scanning system:

- Laser beam
- Optics
- Light sensor

Scanning head

Displacement mechanism:
optical, electromechanical, mechanical, free



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Laser scanning - Setup (examples)

Full body scanner (VITRONIC GmbH)
4 scanner units moves vertically along 4 pillars

Head scanner (Cyberware Inc.)
1 scanner unit moves horizontally around a person

Foot scanner (Vorum Research Corp.)
3 scanner units moves horizontally along the foot

Hand-held scanner (Polhemus)
Freely movable scanner unit



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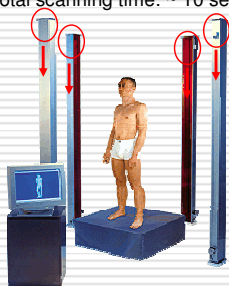
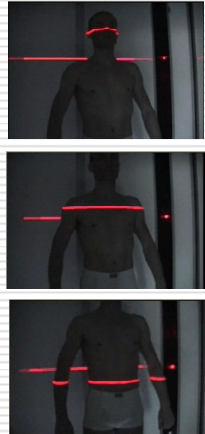
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Laser scanning - Setup (examples)

Full body scanner (VITRONIC GmbH)
4 scanner units moves vertically along 4 pillars
Total scanning time: ~ 10 seconds

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Laser scanning - Setup (examples)

Head scanner (Cyberware Inc.)
1 scanner unit moves horizontally in circle around a person
Total scanning time: ~ 17 seconds

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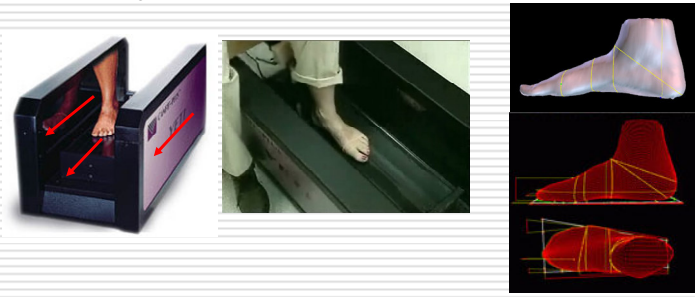
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Laser scanning - Setup (examples)

Foot scanner (Vorum Research Corp.)
3 scanner units moves horizontally along the foot
Total scanning time: ~ 4 seconds



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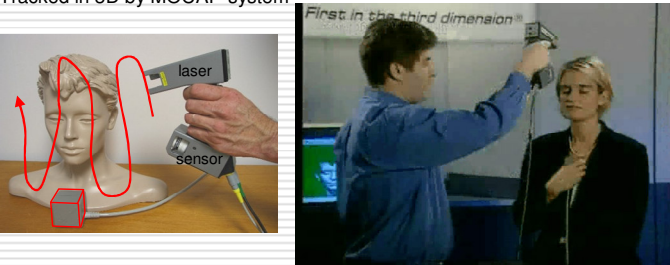
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Laser scanning - Setup (examples)

Hand-held scanner (Polhemus)
Freely movable scanner unit
Tracked in 3D by MOCAP-system



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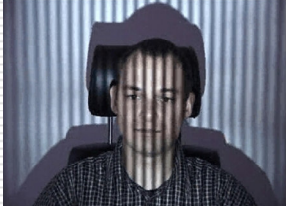
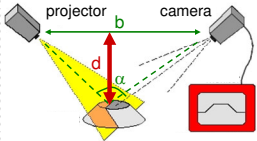
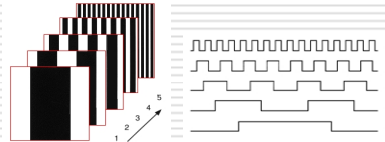
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Coded light projection

Method:

- Coded light projected onto the human body
- Camera(s) acquire the scene
- Triangulation: distance projected lines - sensor
- Coding system to determine position of source:
 - binary code, color code, sinus code
 - shifted, 90 degrees rotated, square ...

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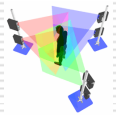

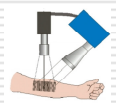

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Coded light projection - Setup (examples)


- Fullbody Scanner (InSpeck Inc.)**
3 pillars placed around a person
- Face scanner (Breuckman GmbH)**
1 projector and 2 cameras
- Skin scanner (GFMesstechnik GmbH)**
1 scanner unit: projector and camera
- Hand-held scanner (Eyetrionics NV)**
Hand-held scanner unit: projector and camera

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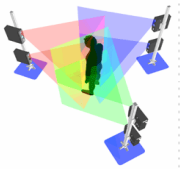
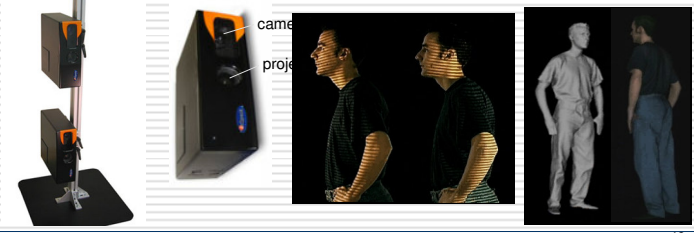
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Coded light projection - Setup (examples)

Fullbody Scanner (InSpeck Inc.)


- 3 pillars placed around a person
- Each pillar has 2 sensor units
- Sensor unit: projector and camera
- Total scanning time: ~ 4 seconds

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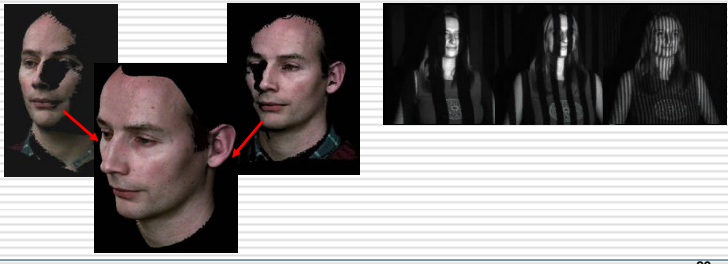
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Coded light projection - Setup (examples)

Face scanner (Breuckman GmbH)

- 1 projector and 2 cameras
- 2 independent acquisitions
- Total scanning time: ~ 2 seconds

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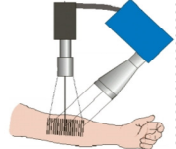
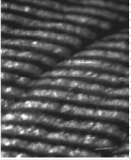

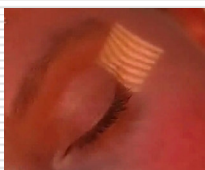
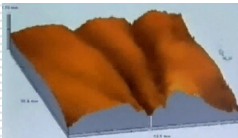
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Coded light projection - Setup (examples)

Skin scanner (GFMesstechnik GmbH)
1 scanner unit: projector and camera
Movable system
Total scanning time: <1 second

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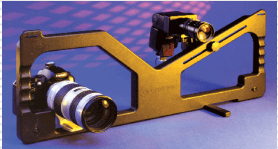
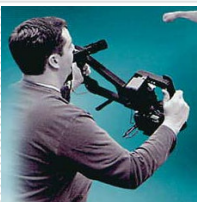


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Coded light projection - Setup (examples)


Handheld scanner (Eyetrionics NV)
Scanner: projector and camera
Handheld system
Projection of square pattern
1 acquisition scanning time: <1 second

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Modeling / image processing

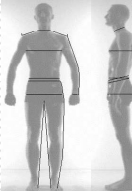

Method:

Real 3D measurement is not performed

Image processing / modeling techniques are used to gain 3D information from 2D images

Examples:


- Body sizes measurement from two images
- Realistic 3D face models from anthropometrical database and two photographs
- Simple hand and foot scanner

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Modeling / image processing - Examples

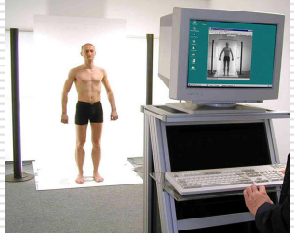
2D Full Body Scanner (Human-Solutions GmbH)

Setup: 1 camera, 2 lights, calibration panel

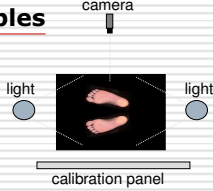
Two acquisitions: front and side

From silhouettes: extraction of body sizes

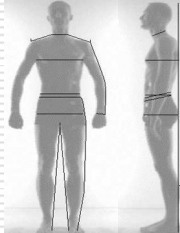
Accuracy: < 1mm



camera




calibration panel



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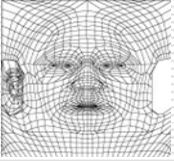





Modeling / image processing - Examples

3D Face Modeler (Singular Inversions)


- Modeling software (anthropometric database)
- Predefined, parameterized 3D face model
- 3D shape can be easily modeled to fit photographs (+ texture mapping)




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Modeling / image processing - Examples

2D Hand and Foot Scanner (VisImage Systems Inc.)


- Setup: desktop scanner (consumer market)
- Acquisition of foot and/or hand images
- Automatic extraction of foot/hand sizes




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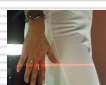


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Exploitation for medical applications - Examples

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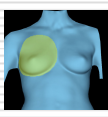

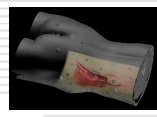
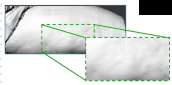


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Exploitation in medicine - Examples

- Ortho-prosthetics**
Back, limb measurement
 
- Plastic surgery**
Chest, full body, face measurement
 
- Orthodontics**
Dental cast measurement
 
- Forensic medicine**
Full body, details measurement
 
- Dermatology**
Skin measurement
 

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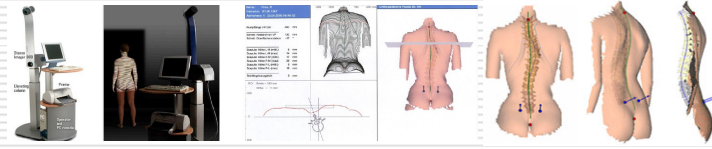
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Ortho-prosthetics

Human back measurement (Diers GmbH)
3D dynamic measurement of the human back
Analysis, diagnosis of back diseases (e.g. scoliosis)
Prosthetics: customized corsets/tutors, perfect fit/comfort



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Ortho-prosthetics


Limbs measurement (Vorum Research Corp.)
3D measurement of limbs and prosthesis
Perfect fit/comfort



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Plastic surgery


Human chest measurement (InSpeck Inc.)

3D measurement of the human chest

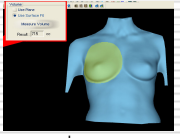
Planning, analysis of plastic surgical interventions

Better interface between patient and surgeon





distance measurement




volume measurement and comparison

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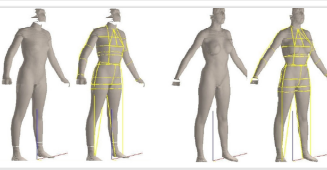
Plastic surgery

Full human body scanning (Novaptus Systems Inc.)

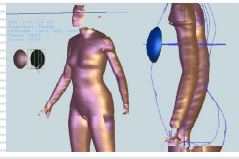
Aid in planning body contouring surgery

Comparison of pre- and post-operative body measurements

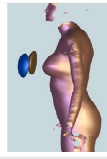
Virtual planning and forecasting of results



3D scans and measurement extraction
left: pre-operative, right: post-operative



Placing a virtual breast implants



forecasted model

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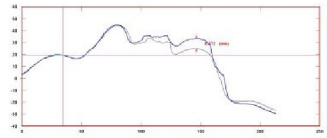
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Plastic surgery

Human face measurement (GFMesstechnik GmbH)

3D measurement of the human face
Planning, analysis of plastic surgery interventions
Better interface between patient and surgeon

Pre- and post-operative profiles

Pre- and post-operative comparison

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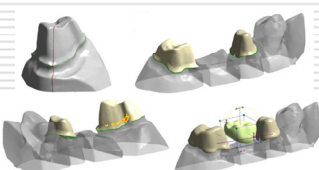
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Orthodontics

Dental cast scanning (3Shape A/S)

3D measurement of dental cast impression
Digital archiving
Analysis, diagnosis
Digital planning and design of orthodontical intervention

3D scans of single parts or full dental cast impressions

planning of orthodontical intervention

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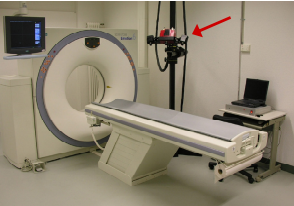
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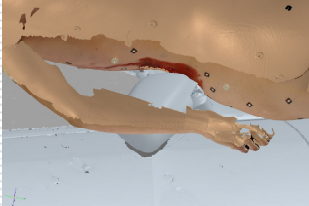
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Forensic medicine

Virtual autopsy (Inst. Forensic Medicine, Univ. of Bern)
Documentation of internal and external body morphology
CT and MRI for internal body structures
3D scanning (structured light) for external surface
Analysis and study of injuries to determine causes



CT and 3D scanner (arrow)



3D model of vehicle and injured pedestrian

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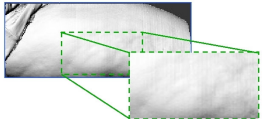
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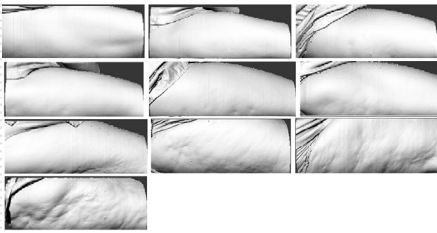
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Dermatology

Cellulite measurement (Cyberware Inc.)
3D laser scanning of the thighs
Analysis of 3D topology of skin surface
Quantification of cellulite severity grade

3D laser scanning and results




3D scans arranged with cellulite severity grade

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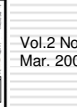


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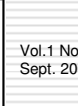
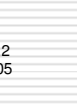
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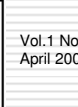

Human Body Measurement Newsletter

Vol.2 No.1
Mar. 2006

Vol.1 No.2
Sept. 2005


Vol.1 No.1
April 2005

Available at: www.homometrica.ch

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Thank you for the attention!

For any questions regarding
3D digitization of the human body:

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