Intelligent Scanning with Robot-Tacheometer and Image Processing

A Low Cost Alternative to 3D Laser Scanning?

1. How to record geometry using an intelligent tacheometer
2. Integration of robot-tacheometry and photogrammetry

Comparison between laserscanner and intelligent tacheometer

	topic	laserscanner	intelligent tacheometer / robot-totalstation
general	measuring frequency	high (+)	low (-)
	importance of a single point	low, point cloud (-)	high characteristic points (+)
recording	time of selection	a posteriori	a priori
		single point not measurable	measurement of single points
	connection of different locations	expensive	simple
	supplementary network	in most cases necessary	not applicable
	hidden points	not measurable	partly automatic recording with extrapolation rod
	manual measurement	hardly to be inserted	often avoidable, simple to insert
	remote control	not possible in general	+
	working mode	automatic	half automatic / manual
processing	finishing work	expensive when extracting corners and edges, simple describing complex surfaces	not necessary concerning simply formed surfaces
	stitching	automatic	recording of complex structures possible, it is a question of time
visualization	connection between image and geometry	high degree of automation possible, often much manual work for complex structures	fully automatic directing of the instrument with external images
	rendering	differential rectification nearly automatic automatic rend ering	parametric, differential rectification possible, also automatic rendering on si te
costs	investment	100%	20% - 10%
	universal application	special equipment	universal common equipment
	handling	comparatively expensive	simple
	proportion of work on site / domestic	1 / 10	1 / 1

Intelligent Totalstation
= Robot-Tacheometer

↓

Totalstation, computer-controlled, motorized, measuring without reflector

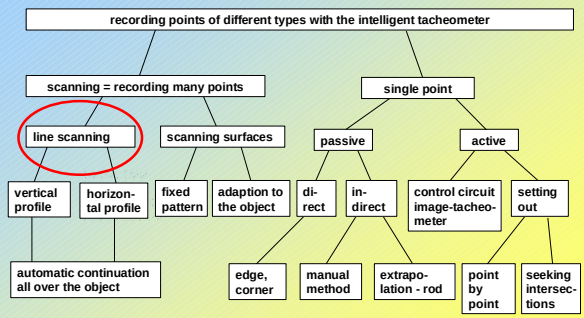
Intelligent Totalstation → Intelligent Scanning - Intelligent Instrument control

a) Exact motorized pointing of the Totalstation (horizontal and vertical direction) to precalculated points of the object. This enables surveying technologies based on iteration and control circuit mechanisms

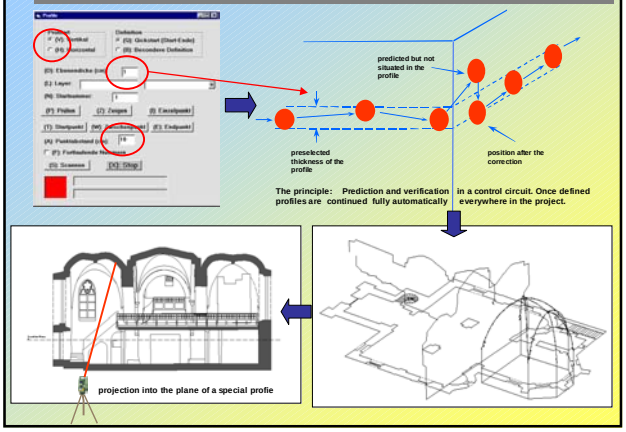
b) This ability to give feedbacks distinguishes the active, object-oriented robot-totalstation fundamentally from the passive, not object-oriented laser scanner.

The circuit-steps are: measurement – calculation – automatic pointing - measurement ...

What laser-scanners and „normal“ tacheometers are not able to do



Automatic measurement of vertical und horizontal profiles



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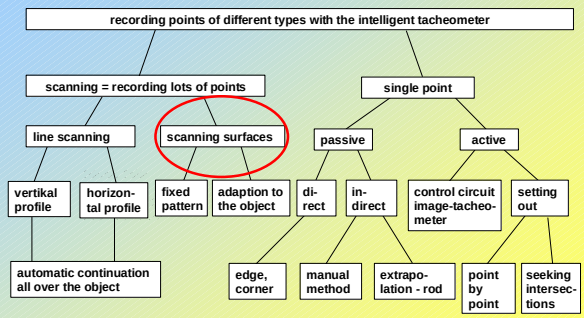
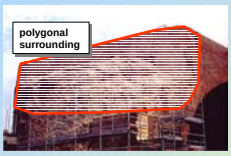
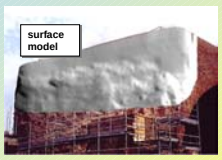
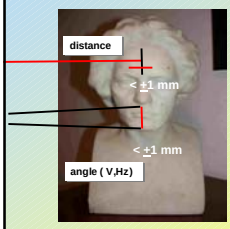


Modelling areas







resolution depending on the diameter of the footprint

with standard diameter of 6 mm to 12 mm → not better than 3-5 mm

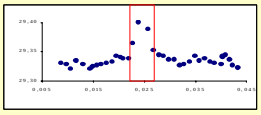
Improvement of the resolution

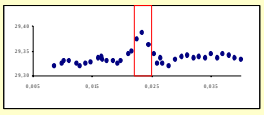
Leica-TCRM normal condition

Leica-TCRM with stop

scan in mm-steps over a horizontal stair

recording a gap



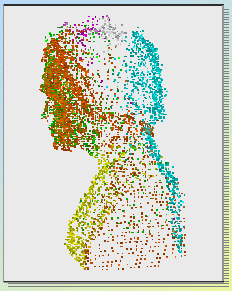


2 mm gap width

1 mm gap width

depth 6 mm

Scanning small structures



set of single points

photo

surface model (via programm surfer)

What laser-scanners and „normal“ tacheometers are not able to do

recording points of different types with the intelligent tacheometer

- scanning = recording lots of points
  - line scanning
    - vertikal profile
    - horizon-tal profile
    - automatic continuation all over the object
  - scanning surfaces
    - fixed pattern
    - adaption to the object
- single point
  - passive
    - di-rect
    - in-direct
      - edge, corner
      - manual method
      - extrapo-lation - rod
  - active
    - control circuit image-tacheo-meter
    - setting out
      - point by point
      - seeking intersec-tions

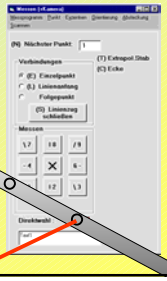
Exact detection of edges

direct method

rays from the totalstation

one sight, followed by an automatic measurement of distances

indirect method



specially coded extrapolation-rod ® to measure hidden points

two arbitray sights, automatic computation

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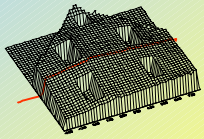
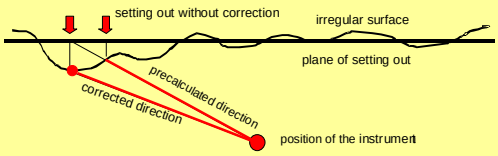
Setting out rectangular to a vertical plane

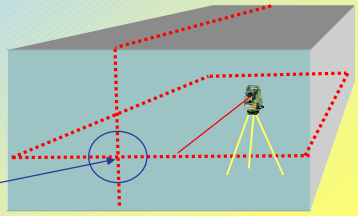




Setting out of lines

- horizontal, plane
- vertical plane
- plane slanting in space

- setting out single points in special relations to a given plane or line
- i.e. to find the exact position of an edge in a profile



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A Low Cost Alternative to 3D Laser Scanning?

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Mean tools

1. Hardware :
Totalstation plus
Notebook plus
digital camera

2. Software :
Programmsystem TOTAL

- general surveying functions
- graphic functions and image processing
- special tools for architectural surveying

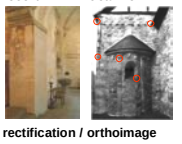
TOTAL = Tachymetrische Objektorientierte TeilAutomatische Laservermessung

3. Methods :
Development of new procedures

Roles of the camera module

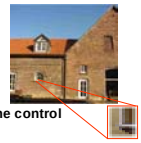
documentation | measurement control | visualization

photo / data base
archive/ record
base for practical work



rectification / orthoimage

automatic / manual
coarse control



fine control

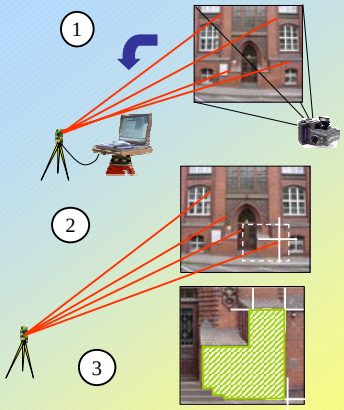
direct interaction of image and measurement

rectified photo of a fresco

forms of 3D-models

panorama

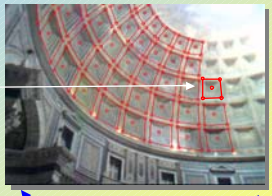
„Photo-tacheometry“ : intelligent control via external photos

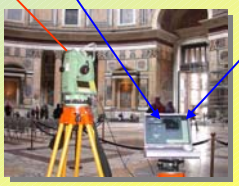


On-line-Steps

1. Make the photo, save it to the laptop and orient the image using control points to be measured in the course of the process. This delivers the position and camera orientation at the time of recording.
2. Click on a point of a surface in the image; automatic steering of the distance measuring laser dot to the corresponding point on the object.
3. Click the corners of the surface in the image, connect them, cut out image planes resp. triangles for visualization software.

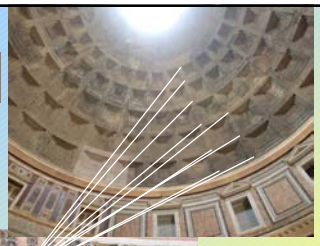
Dynamic measuring protocol

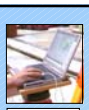




continuous documentation of the measuring progress by automatic connection of coordinates and image background

Monitoring with the intelligent control





2001

2002

1995

?

1997

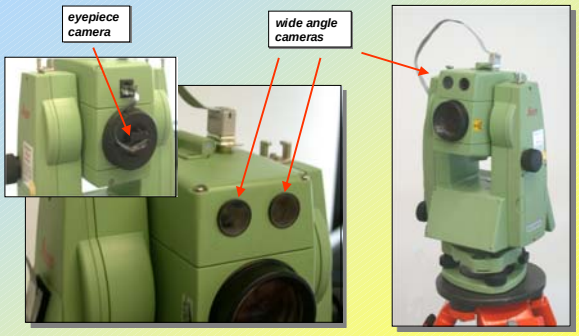
prototype built at Bochum using an Ibeo-Pulsar for range measurement

modified totalstation Geodimeter DR 486

From the Robot-Totalstation to the Video-Totalstation: two wide-angle cameras and one ocular-camera, automatically focused by a gearing in the tube of the telescope

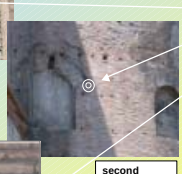
eyepiece camera

wide angle cameras



Working with the integrated cameras

first coarse aiming



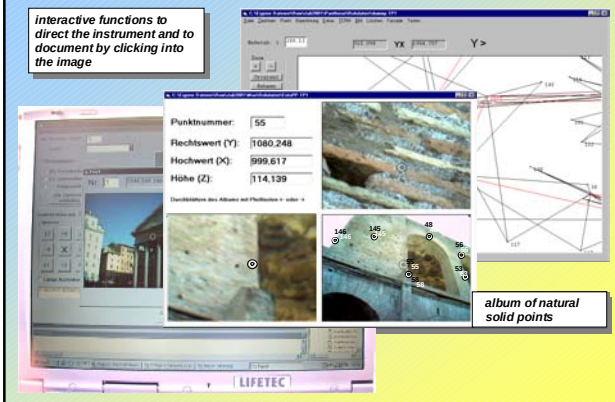
fine aiming

second coarse aiming

eyepiece picture

Practical work

interactive functions to direct the instrument and to document by clicking into the image



album of natural solid points

Intelligent Tacheometer and Image Processing

A Low Cost Alternative to 3D Laser Scanning?

1. All work happens on site, results are generally on site.
2. It is a low cost alternative, using the totalstation.
3. Intelligent tacheometry is predestined for setting out.
4. Monitoring is easily possible.
5. It is a great advantage to work with exactly definable natural points.
6. Easy to combine the intelligent tacheometer and the laserscanner.
7. The technology, the know-how und the software for the rarely used intelligent tacheometry are tried and tested.