



Making Regional Manufacturing Globally Competitive and Innovative

3D scanning



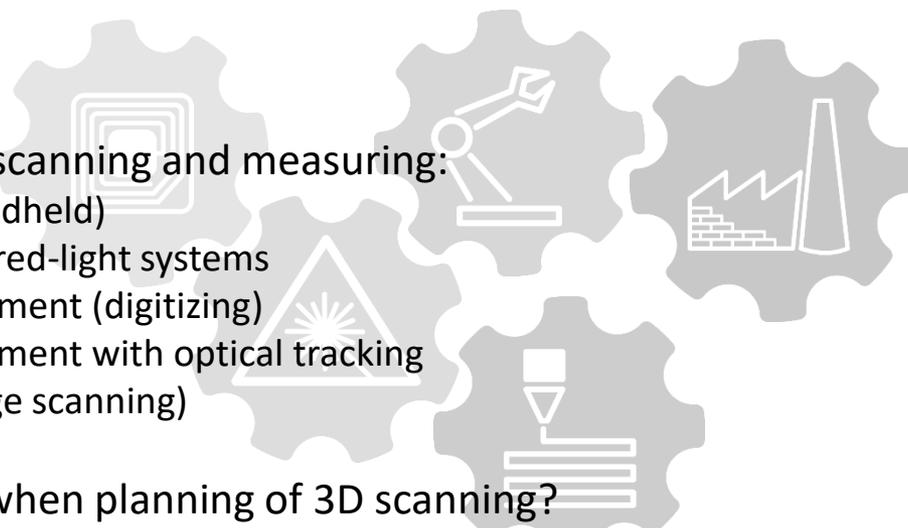
3D scanning / digitizing tool

- The purpose of this tool is to get knowledge how to choose best method to 3D scan or digitize a required object or space.
- It is important to find out if customer has to do scanning or measuring on regular basis or is the scanning just for "one time" – use, for example to reverse engineer existing product, which don't have CAD model yet.
 - If there is need for just one time scanning or even for few object scans then bying scanning service is better idea than to buy own equipment -> software, equipment and training.
 - If there is need for lots of scanned objects and it will be part of production process, such as quality control, then buying own equipment could be the best solution.

3D scanning

- 3D scanning is a method commonly used for reverse engineering and inspection purposes.
 - To validate that required tolerances are met.
 - Scanning existing part, which does not have any CAD files.
 - Scanning buildings and/or equipment for layout planning.
- There are basically two methods used for constructing 3D-model from object.
 - Scanning, which is preferred for organic shapes, large objects or objects which cannot be touched.
 - Digitizing (touch probe), which is preferred for the engineering projects with geometric shapes (defined lines, planes and curved shapes).
- Sometimes there also can be situation where both methods can be used and this could be for example a casted engine block with machined surfaces. This block could be scanned and then bolt holes and some special features could be digitized for more accurate measurements.

3D scanning

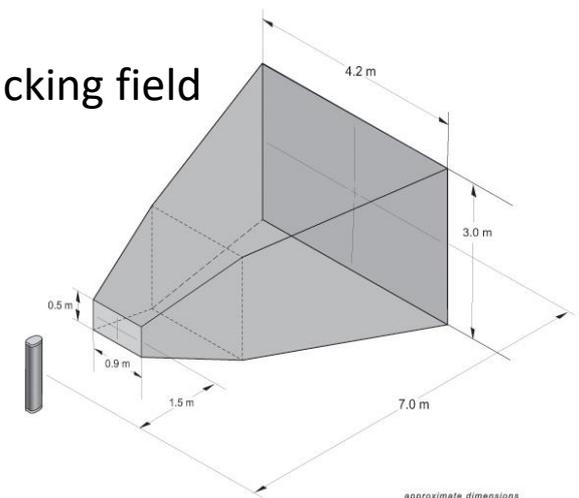
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- A variety of methods for scanning and measuring:
 - Laser triangulation (handheld)
 - White-light and structured-light systems
 - Contact based measurement (digitizing)
 - Contact based measurement with optical tracking
 - Time of flight (long range scanning)
 - What to take in account when planning of 3D scanning?
 - Scanning or measuring itself can be quite fast, but post-processing the point cloud or measurement data can take a (very) long time though measurement data is little more easier to process.
 - Software for post processing -> or choosing which software would best fit for the purpose as there is many different software available and not all will fit for the results you are trying to achieve.
 - Object would preferably have to be stationary as any movements will cause scan results to be inaccurate.
 - One of the important things is to keep in mind with 3D scanning, that it is a very fast developing field and new technology and equipment are coming all the time to market with lots of new features.

Laser triangulation

- Laser triangulation method uses laser beam projected on surface and surface is measured from deformation of the laser ray.
 - Scanner position has to be determined and this can be done by either having adhesive markers on surface of the object or by having separate monitoring device.
 - Data of the scan is saved as point cloud → it needs further editing to make solid 3D-model.
 - These devices are resilient to ambient light, but shiny and transparent surfaces can be troublesome and cause errors or failures on scanning.

Example scanner NDI Optotrak

- NDI Optotrak uses laser triangulation with main camera as object/motion tracker.
- Main camera defines an area as shown in the picture below and handheld device must be kept inside this area.
- This scanner will not allow moving of main camera during scanning without losing location in coordinates, but location tags can be attached to object for combining the scan data from separate scans.
- Picture in bottom corner shows the main camera tracking field shape.



Example case with laser triangulation (optical scanner)

- Car roof and body parts scanning for Oulu University.
- Parts were scanned to design how to mount car body parts for new ultra strength steel car chassis.
 - The point clouds were used to make surfaces of the models
 - Parts was scanned one by one and point clouds of each part were formed.
 - Scanning made it easier to reverse engineer the car body parts and allowed faster design process for mounting options as measuring parts by hand would have taken lot of time to get the parts to fit in the chassis.

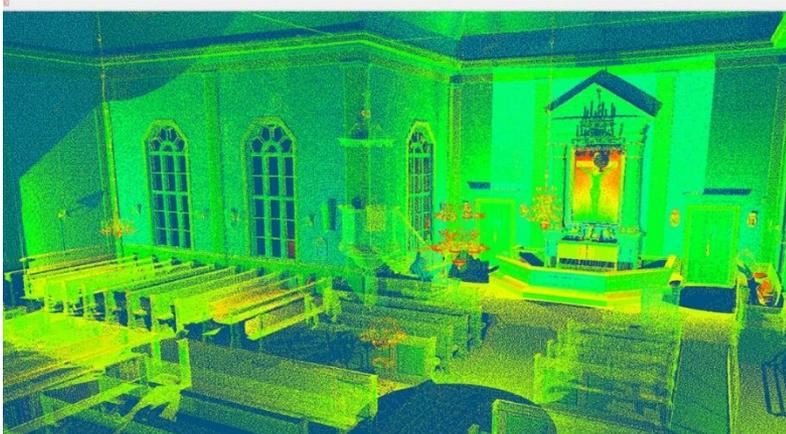
Time of flight (long range)

- Time of flight scanners project a laser beam at the object. By measuring the time it takes for the pulse to reflect back to the sensor, combined with the orientation of the device, a 3D-representation of a point can be made. The end result is a point cloud which needs editing.
- Modern scanners can have ranges up to few kilometers and scan millions of points in a matter of seconds, but a lot of the typical limitations apply
 - Especially good for large areas both indoors and outdoors
 - Vastly superior range than most techniques
 - Scanner needs to be relocated between scan points to cover the whole area
 - Very reflective surfaces can cause problems
 - Not very suitable for scanning small objects
- Example device: Leica Scanstation 2
 - A bit older device, but still valid



Example case with time of flight scanning

- The old wooden church of Ylivieska was scanned with a Leica Scanstation 2 terrestrial scanner as a proof-of-concept project
- A typical example of utilizing laser scanning to acquire accurate measurements of a building that has no blueprints due to its age
- The scan was proved invaluable, as the church burned down in 2016
 - Accurate measurements still possible from the point cloud
 - The scan material was critical in a further project where a virtual version of the church was produced



iSense scanner (optical)

- iSense is more affordable option for starting 3D-scanning as it costs around 400 €, though this means you must own either iPad or Windows PC (or Windows tablet for easier use).
- It is very simple to use and forms a solid 3D-object automatically, so not much postprocessing needed.
- iSense has recommended object size range from 0,2m x 0,2m x 0,2m to 2m x 2m x 2m.
- Accuracy is around 1mm
- In the bottom left corner is picture of iPad with iSense and in bottom right corner picture of iSense for Windows.



Case example with iSense scanner

- Company was interested to find out if some parts of boat hull could be scanned within some degree of accuracy using cheap and portable scanners.
 - iSense with iPad was used to scan the boat hull and customer was shown how to get measurements out of the model to produce parts.
 - This would allow easier manufacturing of parts for company as service. It is not needed to grind parts to fit the boat, but instead parts can be now produced based on the scanning data.



White-light and structure-light systems

- Structured-light scanners project a light pattern on the object and then deformed pattern is "measured" by camera. Method is good and accurate, but has downside of being sensitive for lighting conditions and as with all optical methods it also has issue with reflective or transparent surfaces
 - This system can scan whole view at once -> very fast.
 - More precise than laser triangulation.
 - Not even movement of object causes distortion (or minimal distortion)
- Modulated light scanner projects continually changing light on the object -> linear patterns that camera detects and measures the distance of light traveled.
 - No interference from light of other sources except lasers.

Faro

- Scanning or actually measuring is based on arm that has (in this case 6 joints) that move freely and allow you to use touching probe to touch the measured part surface and record this surface points.
 - This allows very accurate measurements of main features (edges, curves etc.)
 - With enough point data an 3D-model can actually be produced with help of cad software.
 - This method fits best for the geometrical shapes and when very accurate measurements are needed for points in 3D-world.
 - Downside is that arm has specific length and it don't necessarily fit for all the measuring purposes due to the tight spaces or very complex location with lot of equipment wires etc.



Sources

- <https://www.ndigital.com/msci/products/optotrak-certus/>
- <https://www.3dsystems.com/shop/support/isense/videos>
- <https://www.faro.com/products/factory-metrology/faroarm/>

