Generation of high quality 3D surfaces by Computed Tomography and Optical Scanning Systems

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Abstract

Optical measurement systems are state-of-the-art in industry for 3D digitizing of surfaces. The most common systems are based on the principle of fringe projection. Industrial X-Ray CT systems, classically applied to non-destructive testing applications are capable to digitize 3D surfaces as well, provided that the CT hardware and software is well designed for measurement purposes. Both technologies prove to have a high potential.

In this contribution the technologies are investigated in view of their individual capabilities and limitations as well as their potential to combine both methods. The obvious advantage of the CT technology is the ability to gather information of internal structures without any significant influence of the object surface properties. Its limitation is the ability to penetrate the object with X-Rays which depends on the material properties and the penetration lengths. Therefore, the main limitations of CT scanners are large parts and dense materials.

Optical scanners can be mobile, large surfaces can be scanned by combining data of single scans. Although the scan quality is independent of the bulk material, it highly depends on the surface properties of the object. Certain surfaces need to be treated with sprays to enable scanning. The main limitations of optical scanners are surface properties, undercuts, internal structures and resolution of small parts.

In this investigation typical industrial parts are scanned with different techniques. The surface quality is analyzed and compared to classify parts and applications best suitable for the specific technique.

Since both techniques prove to have their specific limitations, the combination of both data can be helpful to overcome application limitations. It will be demonstrated that for special applications the overall surface data quality can be significantly increased by combining both scanning methods.
Topometric GmbH

Largest European metrology service provider for optical measurement systems

Generation of high quality 3D surfaces

CT Hardware Equipment

The Desktop-CT exaCT® S

The CT-Workstation exaCT® M
CT Hardware Equipment

- Industrial detector from our own development and production
- Integrated metrology software
- Vibration damping
- High-precision mechanics from our own production line

Optical Scanner Equipment

- Fringe projection method
- GOM ATOS III
Operating principles - Comparison

**X-Ray Source**
Detector acquires two-dimensional X-ray images (projections)

**Component rotates in the path of X-Ray beam**

**Computed Tomography:**
Absorption of X-Ray

**Optical Scanner:**
Reflection of visible light on surfaces

Comparison

**Computed Tomography:**

Main Strengths:
- No significant influence of surface properties
- Measure internal and external surfaces

Main Limitations
- Ability to penetrate objects
- Not mobile
- Large objects

**Optical Scanner:**

Main Strengths:
- Large parts can be scanned
- Mobile

Main Limitations
- Surface properties
- No undercuts, no internal surfaces
- Small objects
Software used

WENZEL Volumetrik exaCT Analysis

GOM Inspect Professional

Typical application of fringe projection
Typical application of fringe projection

Generation of high quality 3D surfaces

Typical application of CT

Generation of high quality 3D surfaces
Comparison Optical – CT: Tooth

Surface data size optical: 8 MB
Surface data size CT: 380 MB
Data fusion of optical and CT data

Generation of high quality 3D surfaces
Comparion of 3D surface generation by CT and optical scanner

exaCT® Computed Tomography Systems:
- Metrology: High precision mechanics, proprietary detector technology, metology software package
- Strengths: scanning of internal surfaces, independent of surface properties
- Limitations: large parts and dense materials

Fringe projection optical scanner (GOM):
- Strengths: Mobile, large parts
- Limitations: Surface properties, internal structures, small parts

→ Technologies complement each other, data fusion