

3D high Speed high accurate Laser Measurement on shiny surfaces without spraying

Karl J. Lenz¹

1 OGP Messtechnik GmbH, 65719 Hofheim, Nassaustr. 11, Germany, kjl@ogpnet.com

Based on technologies from PHicom, Kotem, OGP

Abstract:

The majority of industrial surfaces is optically not cooperative and is difficult or not possible to be measured optically. This forces customers to use slow tactile measurement methods. Today surfaces are made optically cooperative by spraying some powder. This method is not economical (takes additional preparation time) and is not accurate (the sprayed layer thickness is unknown). The presentation will explain how optically non cooperative industrial parts can be conditioned for optical high accurate, high speed measurements. The presentation will explain the conditions for the expected substantial increase of optical high speed sensors for dimensional inspection

Keywords: shiny surfaces, laser, high speed, accurate

1. INTRODUCTION

Industry demands continuous improved mechanical functionality with reduced cost. Future dimensional process control will therefore

- Require more CAD comparison of all areas of the part surfaces
- Demand a much higher number of measured points in a much shorter time
- Look for substantially easier usage if inspection equipment

All these requests can only be fulfilled by high speed, high accurate optical sensor.

2. WHAT INSPECTION SENSORS ARE IN USE TODAY?

2.1 Traditional sensors

Today's accurate, but slow sensors are mainly tactile, single laser point, video edge detection and autofocus

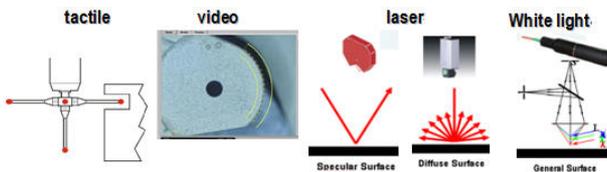


Fig. 1: Traditional sensors [1]

2.2 Emerging high speed area sensors
 These sensors are highly dependant of the surface property – optically cooperative or optically non cooperative

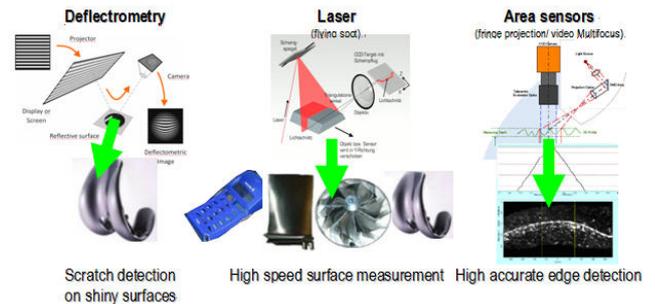


Fig. 2: Area sensors [2], [3]

3. OPTICAL PROPERTIES OF SURFACES

3.1 Part surfaces

Surfaces of industrial manufactured parts often have a complex multilayer surface structure

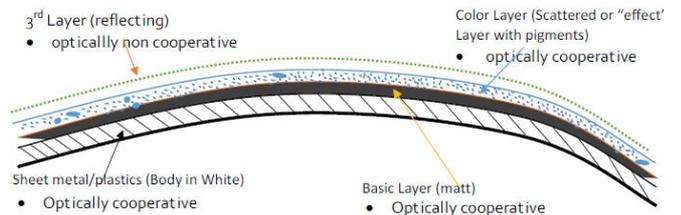


Fig. 3: Example - Layers of car body surface

3.2 Optical sensor interaction with surfaces

The interaction of optical sensors (laser, fringe projection, etc.) are difficult to predict and very seldom to be controlled. As a consequence – measuring results may not reflect the physical surface and are unusable

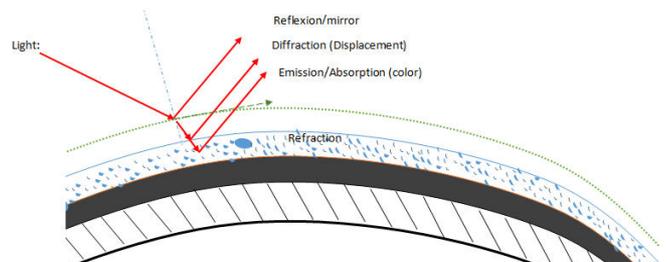


Fig. 4: Laser interacts with surface

4. WHAT PART SURFACES HAVE TO BE MEASURED?

4.1 Surface properties of parts to be measured

The far majority of to be measured parts are optically not cooperative

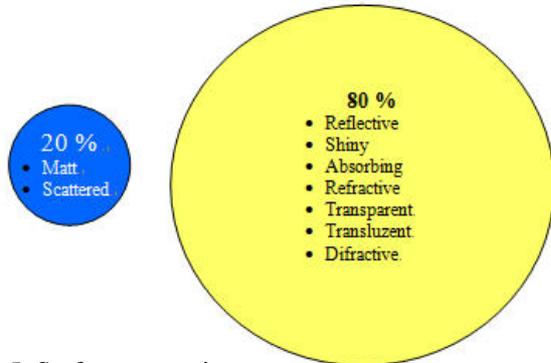


Fig. 5: Surface properties

4.2 Accuracies required for parts to be measured

(Example: consumer parts. Survey's show that more than 80% of parts have tolerances > 50micron – which lead to about 10 micron accuracy)

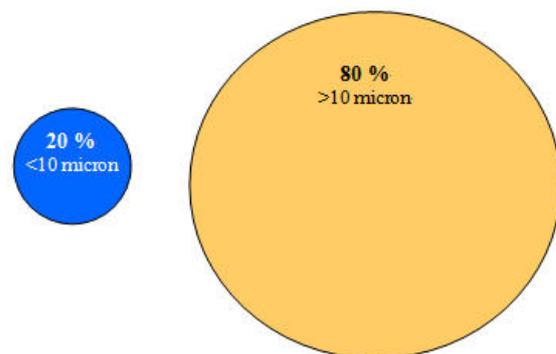


Fig. 6: required measuring system accuracies

4.1 and 4.2 demand high speed optical data acquisition systems

- which can work with optically non cooperative surfaces
- which achieves < 10 micron accuracy

5. REALISED SOLUTION

5.1 used and developed components

- small bench top 5 axis OGP SmartScope system
- With enhanced standard OGP dual rotaries (3'' of arc)
- Red laser from PHicom [2] [4] with
 - Flying spot technology for lateral speckle reduction
 - Gauss curve of line intensity allows interpolation

- Sub-pixel interpolation allows resolutions of 1/20 of pixel size
- Full synchronization to camera shutter
- no smearing of laser during shutter time of camera
- coating system from PHicom [2]
 - does not require any surface preparation before the measurement process starts
 - creates automatically surface coating on the fly just at the area where the measurement is performed
 - temporarily added surface coating is non toxic and disappears automatically a few seconds after measurement
 - the specific coating method creates laser measurement nearly on the surface
 - the computer controlled coating process does not affect any target properties (no thermal impact, no mechanical force)
- Advanced point cloud noise reduction filtering with SmartFit 3D from Kotem Technologies [5]

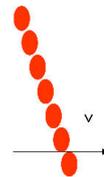


Fig. 7: no smearing of laser spot

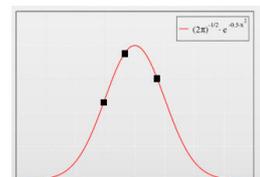


Fig. 8: laser spot inter pixel interpolation

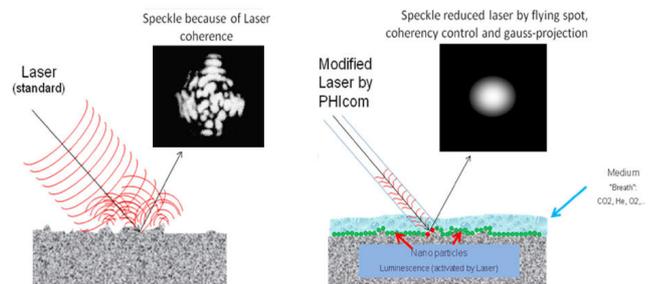


Fig. 9: Left: standard laser with speckle. Right: speckle reduced laser with PHicom nano particle surface coating

5.2 realized system

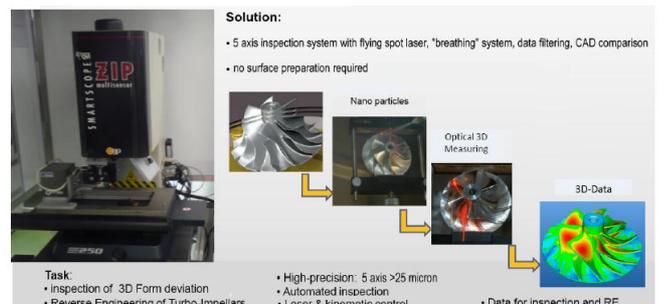


Fig. 10: realized system with all process steps

5.3 video of working system

http://engineering.ogpmbh.de/femur/femur.htm

5.4 accuracies achieved

Smooth shaped parts which require x, y system table movement mainly -> about 10 micron traceable accuracy

3D parts which require 5 axis movement of system -> about 25 micron traceable accuracy (example femur, impeller)

6. MARKETS

- Medical: Form measurements of any kind of shiny, reflecting implants
- Automotive: inspection of varnished and/colored car surfaces, car glass
- Glass: Form measuring of surfaces defects, thickness of coatings,
- Jewelry: shiny, reflecting, translucent, absorbing
- Plastic molded parts: shiny, reflecting, translucent, absorbing
- General purpose machining: any kind of shiny, reflecting parts

7. SENSOR MARKET TREND

7.1 Data acquisition methods

- tactile CMM's are in use since about 50 years
- video based systems are in use since about 35 years
- optical area sensors are relatively new (early laboratory solutions are not counted here)

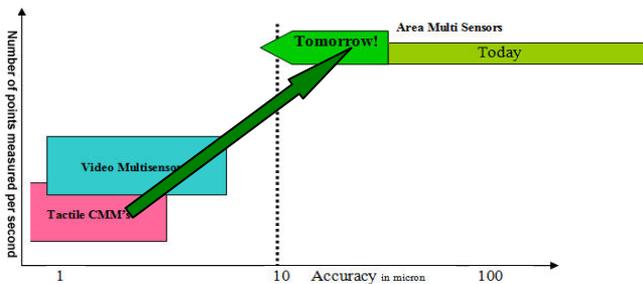


Fig. 11: Accuracies of sensors and data acquisition speed

7.2 Sensor system market today

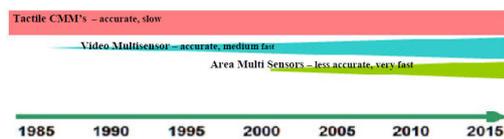


Fig. 12: Sensor market until today

7.3 Potential future sensor system market

With increasing accuracy of high speed area sensor and new ways of dealing with optically non cooperative surfaces – the dimensional inspection market will largely change



Fig. 13: Potential future market development

8. CONCLUSIONS

When high speed area sensors (laser, multifocus, fringe projection, deflectometry) will achieve an accuracy of < 10 micron – or better

- market demanded high accurate traceable surface point accuracy is achieved
- Market acceptance for optical sensors will largely increase
- Tactile CMM's and Video Multisensor systems will be used for high accuracy inspection mainly -> tactile market may shrink
- A combination of different Area Sensors and optical measuring technologies will be the Inspection systems of the future (example: Deflectometry + Laser sensor + temporarily coating can complement their sensor advantages)

REFERENCES

- [1] OGP Messtechnik GmbH
Nassaustr. 11, 65719 Hofheim-Wallau, Germany
<http://www.OGPmesstechnik.de>
- [2] PHIcon GmbH
Managing Director: Hubert Kammer
An der Waage 2, 35560 Ehringshausen, Germany
<http://www.saica-systems.ch>
- [3] GFMesstechnik GmbH
Warthestrasse 21, D-14513 Teltow/Berlin
<http://www.gfm3d.com>
- [4] IOSB, Abt. Mess-, Regelungs- und Diagnosesysteme (MRD)
Fraunhoferstraße 1, 76131 Karlsruhe Germany
- [5] KOTEM Hungary Ltd
2 Gyár str., Budaörs H-2040, Hungary
<http://www.kotem.com>