Optical measurement with structured light scanner based on automated search for the best measurement positions from CAD data of the measured part

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Small minds are concerned with the extraordinary, great minds with the ordinary.

Blaise Pascal
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This presentation was created as a part of the project: "Complex System for Attracting, Education and Continuing Involvement of Talented Individuals to Research Centers of AS CR and FME BUT", reg. no. CZ.1.07/2.3.00/09.0228
INTRODUCTION - THEME

Supervisor specialist: Ing. David Paloušek, Ph.D.

Automation of 3D optical photogrammetry measurement.
INTRODUCTION

• Inspection – verification of prescribed specifications

• Traditional methods – contact instruments $\leftrightarrow$ automation not possible

• Recent methods – CMM, Laser scanner, Structured light scanner

• Automation of particular phases of inspection – measurement, registration, evaluation

• Drawing-less documentation – CAD-based inspection

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MOTIVATION

• CMM measurement is slow with few acquired points
• Increasing adoption of optical systems in industrial applications
• Time savings employing automation
LITERATURE REVIEW

• Automation in CMM inspection
• Automation in Laser scanner inspection
• Automation in Structured light scanner inspection
LITERATURE REVIEW - CMM


• Registration of CAD and CMM coordinate system
• Offset NURBS surfaces
• More accurate registration than with conventional method
• Surface sampling – measurement points
• Uniform, curvature based, minimum sample density, parameterisation-based

Conclusion: Better description of free-form surfaces in inspection
LITERATURE REVIEW - CMM


- Sampling of the surface for the measuring points
- 4 sampling algorithms + genetic algorithm
- Equi-parametric, patch size based, curvature based, hybrid
- Best results with genetic algorithm but with long computing time

Conclusion: Robust solution for free-form surfaces measurements with CMM
LITERATURE REVIEW – Laser scanner


• Laser scanner best positions (based on CAD data)
• Best results with: 170 to 240 mm distance
  -35 to 35 ° angle (α)
  -15 to 35 ° angle (β)
• Collisions avoidance (voxel model)
• Strategy improved accuracy of measurement

**Conclusion:** Optimal positioning increases the accuracy
Viewpoints projection strategy

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LITERATURE REVIEW – Laser scanner


• Manual measurement with poor positions → lower accuracy
• Voxel model – viewpoint set & scanning path generation

Conclusion: Voxel model vs. NURBS surfaces in other publications
LITERATURE REVIEW – Structured light scanner


- Complet inspection system with 6 DOF robot
- CAD-based possition computation
- Surface Nomal and Visibility Map methods
- Sphere strategy, Patch sliding strategy
- Time savings 25 – 45 %

Conclusion: Presented strategies and methods useful for own utilization

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LITERATURE REVIEW – Structured light scanner


- Extension to previous work
- 5 strategies – GD&T, Trims and cutouts, Large multifaces surfaces, Global coverage, Specific target points
- Iterative view planning
- Registration – RPM or ICP method
- Suitable for complex parts (e.g. car door)

Conclusion: Methodology of view planning process; strategies for inspection tasks
CRITICAL ANALYSIS

• **CMM** – registration and sampling problems using different algorithms
  – continuous improvements in free-form surfaces measurements

• **Laser scanner** – registration problems (ICP or assisted)
  – optimal viewpoints problems
  – viewpoints projection strategy & voxel model

• **Structured light scanner** – optimal viewpoints algorithms based on different inspection tasks
  – virtual simulation of measurement
  – methodology of view planning process
GOALS OF RESEARCH AND METHODOLOGY

• Algorithms for optimal viewpoint placement for two cameras structured light scanners considering models for illumination and reflection

Methodology

1. Viewpoints placement calculation – recursive, genetic or neural algorithms
2. Illumination and reflection model – ray tracing, ray casting, Z-buffer methods
3. Robot positions accessibility – reverse kinematics
4. Verification on various objects
CURRENT STAGE OF PROJECT

Theoretical part:
- Literature review
- Formulation of objectives
- Known algorithms selection

Practical part:
- Robot positioning skills
- Parameters and algorithms for optimal positions
- Employment of reflection model
- Robot position accessibility
- Verification measurements

Final part:
- Formulation of conclusion
- Publishing the dissertation

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BIBLIOGRAPHY


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Thank you for your attention

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