A4A NDT Forum 2016 - AutoInspect
Innovative Inspection System for Engine Components


Lufthansa Technik
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AutolInspect – Introduction

Lufthansa Technik Group – Facts & figures

- 800 customers worldwide
- 20,289 employees worldwide*
- 5,099 billion € in revenue*
- 3,680 aircraft under exclusive contracts
- 33 subsidiaries and affiliates worldwide

* Lufthansa Technik AG Germany and 23 consolidated companies of Lufthansa Technik Group in 2015; employees as of 31.12.2015
AutoInspect – Introduction

Where to find the combustor in the engine?

Combustion Chamber
Digital MRO requires digital inspection!

Crack inspection is one of the most common MRO processes
AutoInspect – Technical Overview

Goal: Automated engine parts repair

Inspection -> Milling -> Welding

defect data -> repair data
AutoInspect – Technical Overview

System Setup

Automated Inspection System

Handling System
Industrial robot
External axis

Sensor System
WLI with linear axis
Laser triangulation sensor

Image Processing System
Image stitching
3D-processing
Crack detection
Crack classification
Crack post processing
Visualization

Industrial robot
Ethernet
External axis
AutoInspect – Technical Overview

Sensor Technology

White light interferometer

Based on “Michelson Interferometer”
AutoInspect – Technical Overview

Sensor Technology

White light interferometer

Path of beam #1 (reference)

1. IR - SLED
2. Lens
3. Beam splitter
4. Reference mirror
5. Device under test
6. Camera

Motion
AutoInspect – Technical Overview
Sensor Technology

White light interferometer

1. IR - SLED
2. Lens
3. Beam splitter
4. Reference mirror
5. Device under test
6. Camera

Path of beam #2 (object)
AutoInspect – Technical Overview

Sensor Technology

White light interferometer

1. IR - SLED
2. Lens
3. Beam splitter
4. Reference mirror
5. Device under test
6. Camera

Movement in z-direction

Optical path difference < coherence length \(\rightarrow\) Interference
AutoInspect – Technical Overview

Sensor Technology

Demodulation $\rightarrow$ Envelope

Detection of maximum intensity $\rightarrow$ Distance to object

moving through scan range $\rightarrow$ z-distances/intensity for every pixel
AutoInspect – System Qualification

How to compare physical different working NDT systems?

Define:

AUTOINSPECT

equivalent or better than

FPI & VI

Measure:

POD-Study

2

Analyze:

\( S = \frac{a_{90/95;FPI}}{a_{90/95;AI}} \)

if \( S \geq 1 \)

no

yes

equivalent or better

approved

 Improve:

Technical improvements

\( a_{90/95;AI} \)

must be equal or smaller

than \( a_{90/95;FPI} \)
Experimental requirements to produce POD curves

\(a_{90}\): crack length, which is detected with a probability of 90%, i.e. \(P(a_{90}) = 0.9\)

\(a_{90/95}\): crack length, which is detected with a probability of 90% and confidence limit of 95% over all measurements, i.e. \(P_{L}(a_{90/95}) = 0.9\)
Experimental requirements to produce POD curves

90% POD

Crack

With influence of the operator

90% POD

95% confidence limit (over all measurements)

length

\(a_{90}\)

\(a_{90}/95\)
AutoInspect – System Qualification

Watch out for common pitfalls using POD!

- Underestimating the influence of sample geometry on POD performance
- Underestimating the influence of informed/uninformed inspectors on POD performance
- Wrong definition of crack size distribution during POD experiment
- Deleting “outliers” that do not “fit” to other inspection results

Recommendation:
Study POD literature or consult POD experts before conducting any experiments!
AutoInspect – System Qualification

Summary POD

- POD method is the industry standard for qualification of new NDT systems
- POD method is the best way to consider the random nature of inspection processes
- POD method creates transparency of inspection system performance
- POD method allows a comparison of physically different inspection systems (unlike R&R)
- POD method is compatible to DTD and fits nicely into Part Life Management
Any questions?

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