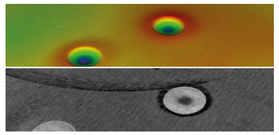
INLINE COMPUTATIONAL IMAGING CAN BE USED FOR ...

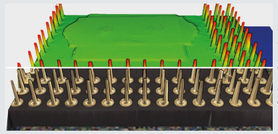

Metal surface

METAL PARTS

- Robust solution for metallic surfaces due to several viewing angles
- Simultaneous 3D measurement and surface quality inspection
- Crack, pore and scratch detection
- Distinguish between machining traces and scratches, cracks, etc.

ELECTRONIC PARTS & PCB INSPECTION

- Inspection of glossy and dark matt materials at the same time
- Solder inspection, detection of bad solder spots
- Assembly control including 3D inspection for pin heights
- Wafer inspection (e.g. cracks)


Chip with pins

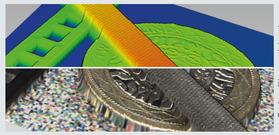

10 € banknote

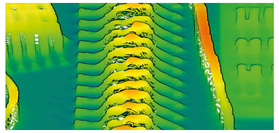
SECURITY PRINT INSPECTION

- Inline hologram inspection, including to check for the correct color shifting effects
- Quality inspection of intaglio print and tactile elements (3D depth)
- Inspection of embossing, braille writing, seals, etc.
- Inspection of decor elements

INSPECTION OF CHALLENGING MATERIALS

- Robust solution for challenging objects, like highly glossy, unstructured and even dark materials
- High quality 2D and 3D inspection with one system
- Flexible parametrization for inspection speed and accuracy
- Works well with challenging reflectance properties


Coin, file, cable tie

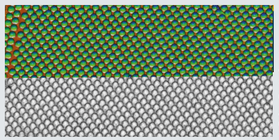

Wirebond

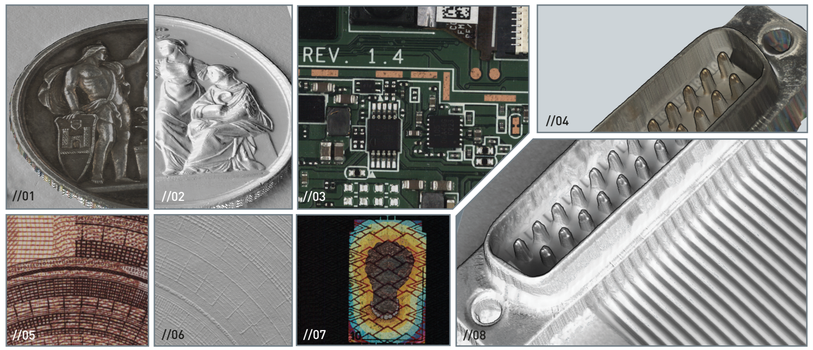
INSPECTION OF COMPLEX GEOMETRIES

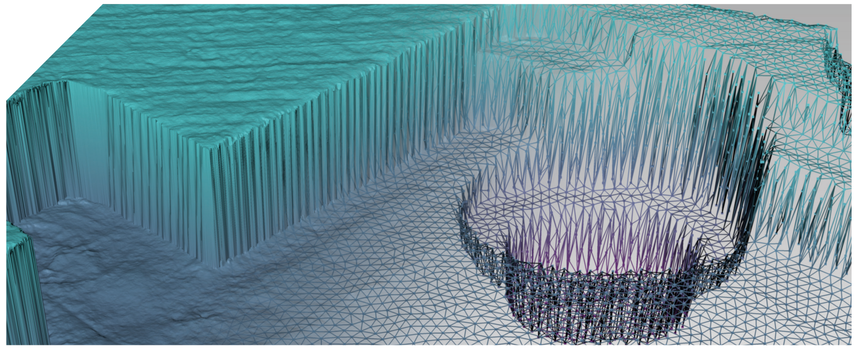
- Inspection of complex geometries and thin/repetitive structures
- Wire bond inspection
- Connector pin inspection

INSPECTION OF MICRO-STRUCTURES

- Ball grid arrays
- PCB traces
- Solder spots


BGA Ball Grid Array





ICI:INSPECT IN A NUTSHELL

- Easy - to install, use and maintain.
- Flexible - to changing requirements in speed and accuracy.
- Robust - against variations within the production process.
- Reliable - for high system availability.
- Multi modal - for simultaneous 2D and 3D inspection plus enhanced 2D imaging.
- Universal – works with different materials, no matter if matt, glossy, bright or dark.

METAL

//01 Coin 3D + texture
//02 Coin 3D

ELECTRONIC

//03 PCB all-in-focus image
//04 Connector 3D + texture
//08 Connector 2.5D

SECURITY PRINT

//05 10 € banknote detail
//06 10 € banknote intaglio print
//07 10 € banknote Hologram

INLINE COMPUTATIONAL IMAGING
PRICE-WINNING TECHNOLOGY

inVISION TOP INNOVATION 2019

inspect award 2020 nominee

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH
Petra Thanner
Tel +43(0)664 8839 0002
petra.thanner@ait.ac.at

Giefinggasse 4, 1210 Wien
www.ait.ac.at/hvs

INLINE COMPUTATIONAL IMAGING

AIT Inline Computational Imaging (ICI) is a novel single sensor technology for simultaneous 2D and 3D inline inspection for challenging inspection tasks.

OPPORTUNITIES

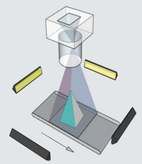
- Combined 2D and 3D inspection
- Enhanced 2D imaging, e.g. gloss / shadow reduction, all-in-focus, high-dynamic range, etc.
- 3D measurements down to µm range
- Advanced inline inspection for 2D and 3D features for materials with challenging surface properties
- Inspection of optically variable devices and holograms
- Detection of defects and fine surfaces structures

ADVANTAGES

- Reliable, fast and accurate
- Simple and compact, using only one camera
- Works for objects with different surfaces (matt / glossy, structured / unstructured) at the same time
- Inspection in motion (no stop-and-go required)
- Dynamic adaptable to changing requirements in terms of speed, accuracy and surface quality
- Patented technology

ICI SENSOR SYSTEM

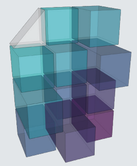
Single Sensor Technology for Simultaneous Light Field and Photometric Stereo Capture



+

ICI SOFTWARE

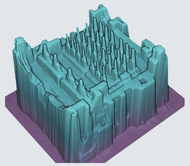
Generic Computational Imaging Library for 2D/3D Tasks



=

ICI SOLUTION (2D & 3D)

3D Point Cloud
2.5D Depth Map
Enhanced 2D Images

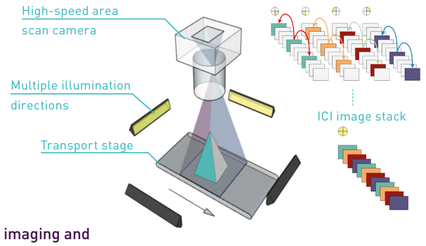


INLINE COMPUTATIONAL IMAGING

Inline Computational Imaging (ICI) is a novel single sensor technology capable for simultaneous 2D and 3D inline inspection. It combines the advantages of light field imaging and photometric stereo into one compact solution. ICI technology is a new type of image acquisition system combined with smart algorithms for high resolution and high speed 2D and 3D inspection.

AIT ICI SENSOR SYSTEM

The ICI sensor system consists of a high-speed area scan camera fitted with a standard endocentric lens, light sources and a moving sample part. While the object moves, the camera sequentially aquires images of the object. A different illumination direction is used for every image frame. This results in an ICI image stack consisting of multiple images each seeing the object under a slightly different viewing and illumination angle.



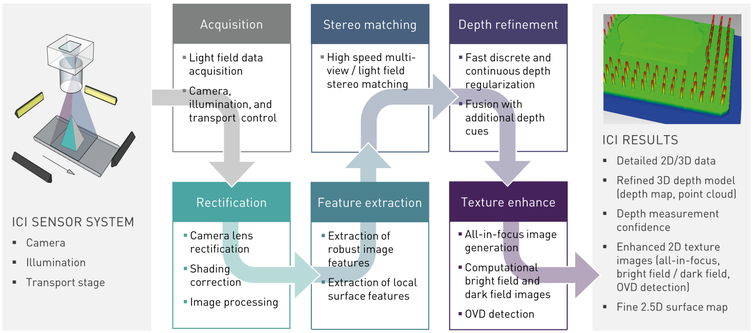
AIT ICI is a smart combination of light field imaging and photometric stereo.

AIT ICI SOFTWARE

The AIT ICI algorithms have been designed specifically to work with the ICI sensor system and provide enhanced 2D images together with a high definition 3D reconstruction. All algorithms are highly optimized for high processing speed and best results quality. They are largely independent from computer and imaging platforms and support decentralized processing and reporting.

AIT ICI is a new technology for high resolution and high speed 2D and 3D inspection.

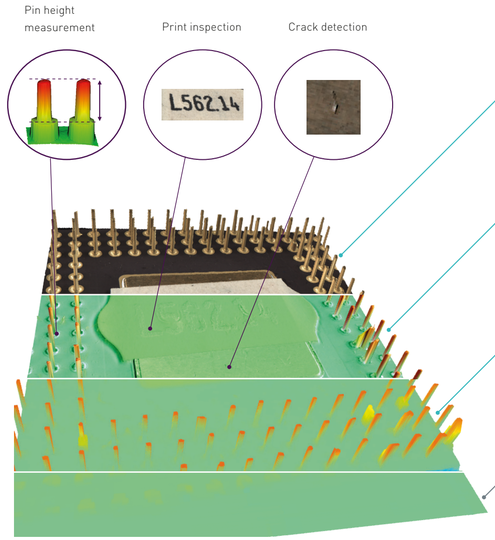
AIT ICI PROCESSING PIPELINE



INLINE COMPUTATIONAL IMAGING – BETTER, FASTER, STRONGER, ...

Inline Computational Imaging makes use of multiple viewing and illumination angles simultaneously. By using Inline Computational Imaging, it is possible to solve problems and tasks where traditional industrial imaging systems fail.

HIGH DEFINITION 3D RECONSTRUCTION



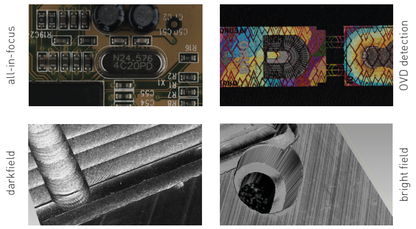
INLINE COMPUTATIONAL IMAGING
- Increased signal-to-noise ratio
- Enhanced 2D imaging
- Flexible dark / bright field imaging

LIGHT FIELD & PHOTOMETRY
- 3D from multiple viewing and illumination angles
- Globally correct and high details
- Robust for all material types

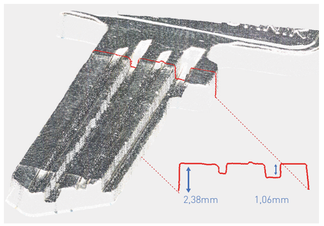
LIGHT FIELD ONLY
- 3D from multiple viewing angles
- Globally correct but low details
- Robust for many material types

State-of-the-Art Stereo
- 3D from 2 viewing angles
- Error prone and low detail
- Difficulties with dark and reflective materials

COMPUTATIONAL IMAGE ENHANCEMENT



PRECISE 3D MEASUREMENT



FLEXIBLE AND SCALABLE FOR INDUSTRIAL NEEDS

The AIT ICI technology can be tailored to fit various applications and meet their specific requirements concerning optical and depth resolution, working distance and acquisition speed and result quality. The optical configurations listed below provide possible examples for micro, standard and large scale 2D & 3D inspection with AIT ICI.

journal publication

TECHNICAL SPECIFICATIONS[1] – CONFIGURATION EXAMPLES

	MICRO SCALE	STANDARD SCALE	LARGE SCALE
Measuring and reconstruction principle	Inline lightfield and photometric stereo acquisition Patented 3D reconstruction[2] and calibration[3] algorithms		
Image sensor	Configuration examples with Alexima AM41 2336 x 1728 px can be adapted to fit any high-speed area sensor		
Measuring point spacing	700 nm / pixel	20 µm / pixel	50 µm / pixel
Optical configuration	Patented hypercentric projection[4]	Schneider Kreuznach APO-Componon	Schneider Kreuznach APO-Componon
FOV normal to transport	1.6 mm	46 mm	116 mm
Working distance	34 mm	108 mm	176 mm
Vertical measuring range (depth range)	160 µm	7.2 mm	38 mm
Transport speed	12 mm/s	400 mm/s	1000 mm/s
Volumetric acquisition speed	3 mm³/s	130 cm³/s	4,4 dm³/s
Acquisition speed points/s	39M 3D points/s	46M 3D points/s	48M 3D points/s
Lateral optical resolution	4 µm	56 µm	140 µm
Temporal noise (depth)	1 µm	4 µm	5 µm
Flatness deviation[5]	2 µm	20 µm	50 µm
Number of light sources	6	4	4

1 Specifications according to recommendations by the "Initiative Fair datasheet" whenever applicable. Our test procedures are published open access: Traxler et al. 2021 "Experimental Comparison of Optical Inline 3D Measurement and Inspection Systems" IEEE Access 10.1109/ACCESS.2021.3070381 Electronic ISSN: 2169-3536

2 Blaschitz et al. 2021 "High-speed inline computational imaging for area scan cameras" Electronic Imaging https://doi.org/10.2352/ISSN.2470-1173.2021.6.IRIACV-301

3 "Method for calibrating an linescanning image recording unit" AT520426B1, EP3561772A1

4 "Microscopy device for creating three-dimensional images" AT521620B1, EP3647851A1 pending

5 Measurment procedure as defined for the parameter "calibration accuracy" in (1)

... SMART INSPECTION WITH ICI:INSPECT