MODERN MEASUREMENT TECHNOLOGIES: CONNECTORS AND PINS

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INITIAL SITUATION

- Increasing demands on accuracy
  - housings
  - pins
  - Holes, springs & jacks

- Smallest areas at pin tips

- Narrow pin rows, often sunk into the housing

- Variable materials
  - Galvanized stamping strips for pins
  - Different shape of the pin tips
  - Plastic housing in many colours
CONNECTORS & PINS

- Position of the pin tips in X- and Y-direction (wobble circle of the pin tip)

- But also: Height of the pin tip/ insertion depth:

- Can’t be solved with 2D image processing!

- Dimensional inspection => also 3D!

- Position of the pins to other pin the entire row (valid grid dimensions)

- Distances from pins to characteristics within the connector

- Distances of the connector to the board and other components
3D MEASUREMENTS

Advanced measurement results

- Position
- Height
- Angles
- Volume
- Coplanarity
- Partly also gray scale or colour information
LASER TRIANGULATION

- Angle between laser and camera
- Depending on the component height, the camera image shows an offset of the laser line projection
- Special camera hardware for profile acquisition and calculation
- A 3D point cloud can be generated from many individual profiles (one camera image each!)
- Extremely accurate height measurements (μm range)
LASER TRIANGULATION (2)

Pros:

- High lateral and z resolution (with up to 4096 pixels lateral resolution)

Cons:

- Occlusions between high component edges and narrow placed pins possible
- No measured values on highly reflective surfaces
- Precise linear movement of the component necessary, use of encoder
- Laser light source: speckles, protection classes
STRIP LIGHT PROJECTION

- Stationary object
- LED projector with structured light projection
- Sequence of various fine line patterns with about 12 to 16 images (partly sinusoidal intensity distribution of the stripes)
- Deformation of the light and shadow transitions in accordance with the component contour
- Software: reconstruction to a 3D Point Cloud

Projected grey code:
STRIP LIGHT PROJECTION (2)

Pros:

- LED light source, no laser
- No motion, no encoder needed

Cons:

- Occlusions between high component characteristics and lower or narrow placed pins
- Less flexible geometrical setups possible compared to laser triangulation
- No motion, inspection at standstill
- Capturing multiple images takes about 200 to 500 ms, depending on the exposure time
- No vibrations during complete image sequence
CHALLENGES

- Metal shiny pins
- Housings and PCBs in all colours

Possible solutions:
- Multiple scans with different exposure times
- HDR / multislope image acquisition
- Software optimization of point clouds to remove outliers
CHALLENGES (2)

- Difficulties with occlusion with narrow placed pins, high housing contours and small, deep holes when using the triangulation principle (laser & line strip light)

- Reflections at certain angles & edges

Possible solutions:

- Tilted sensor

- Multi-camera setups with different angles
Dual-head sensors

- Two cameras, must be calibrated to each other for point cloud stitching
- Reduced occlusion, both flanks of the pin can be captured, the area of the pin tip is enlarged
- Slightly increased accuracy and lower noise (doubled number of points of the 3D scan)
- Two different shooting angles of the cameras reduce problems with reflective reflection

Source: Automation Technology: Dual head sensor MCS series
DEPTH FROM FOCUS

Working principle

- Telecentric optics
- Liquid lens
- Diffused lighting

- Depth-from-focus method: Capture several hundred images with different focus settings (focus variation) in about one to two seconds

- Calculating a 3D height image of the object
DEPTH FROM FOCUS (2)

Pros:
- Gray image and 3D information with only one camera (2D sharp image and 3D depth image)
- High lateral resolution
- Monocular solution: No triangulation-based shading or Laser-related reflection artifacts

Cons:
- Capture many images at a standstill without vibration: Cycle time
- Computationally intensive: several gigabytes per second, no smart camera solution possible
SOFTWARE PREPROCESSING

- Point cloud optimization using different filters, e.g.
  - 3 x 3 Median for smoothing
  - Fill holes with flexible size
  - Remove outliers etc.

- Image calibration

- Position correction of all 6 degrees of freedom (intrinsic & extrinsic calibration)
INTRINSIC CALIBRATION

- Ideal image
- Perspective distortion
- Lens distortion

- Ideal image
- Inhomogeneity of laser line
INTRINSIC CALIBRATION

Thermal effects

- Thermal expansion: change of stereo base between light source and camera(s)
- Laser pointing stability: Laser line drift

3D scan enhancements

- Thermal calibration data is determined by using calibration cycles, individually stored in the device by the manufacturer.
- Calibration of the system on calibration targets at runtime
- Heat dissipation thanks to useful mounting
EXTRINSIC CALIBRATION

Sensor coordinate system

Object coordinate system
EXTRINSIC CALIBRATION

- Displacement in X, Y, Z
- 3 degrees of rotation of the axes
- Object coordinates:
  - Measurement related to the reference point of the component (housing)

Animation: https://de.wikipedia.org/wiki/Eulersche_Winkel
SOFTWARE TOOLS

- Search tools: locating the housing, centering studs or pins
- Plane fits
- 3D edges & geometric construction
- 3D blobs
- 3D matching & search tools
SUMMARY

- Full completeness inspection of housings as well as complete pin tip inspection only possible with 3D technologies

- Various acquisition technologies are available that must fit the inspection process

- Pay attention to cycle time and handling!

- Attention: increased costs and requirements compared to 2D solutions

- STEMMER IMAGING provides a wide range of components and solutions for 3D inspection. Ask our technology specialists!
THANK YOU FOR YOUR TIME!

QUESTIONS?

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