Challenges in the automation of visual harmony control in production lines

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EINES Quality Engineering & Vision Systems
Extensive experience in the automation of quality control systems
who and where

Ford Valencia, Spain
Opel Zaragoza, Spain
Mazda Valencia, Spain
Ford Köln, Germany
Ford Genk, Belgium
Ford Saarlouis, Germany
Visteon Valencia, Spain
Ford Southampton, UK
GM Holden Adelaide, Australia
SAAB Trollhättan, Sweden
Ford Kentucky, USA
Ford Hermosillo, Mexico
NISSAN Smyrna, USA
GM Arlington, USA
Mitsubishi Illinois, USA
Dynamit Nobel Valencia, Spain
HYUNDAI Montgomery, USA
Land Rover Solihull, UK
Faurecia Ourense, Spain
Ford Melbourne, Australia
PSA Peugeot Citroën Vigo, Spain
Ford St Thomas, Canada
Gamesa Valencia, Spain
Volvo Gent, Belgium
Volvo Torslanda, Sweden
GM Rüsselsheim, Germany
Gestamp Cerveira, Portugal
K.S.C Ahwaz, Iran
SAS Automotive Valencia, Spain
Renault Samsung Motors Busan, Korea
Mercedes Benz Vitoria, Spain
VIZA Pilsen, Czech Republic
Casting ROS Utrillas, Spain
Faurecia Scheuerfeld, Germany
Standard Profil Düzce, Turkey
Ford Otosan Kocaeli, Turkey
Ford Craiova, Romania
Voith Coventry, UK
HONDA Swindon, UK
GM Oshawa, Canada
Johnson Controls Valencia, Spain
Ford St. Petersburg, Russia
Main objectives

Color Quality Measured/Controlled
100% production

Perceiving process issues as soon as possible

→ better colour-matching to hang-on parts
→ increasing customer satisfaction
→ being better than competitors
Basic requirements (Paint-Shop)

- 100% production inspected
- Minimum of 4 points on each side
Typical requirements (Paint-Shop)

- 100% production inspected
- Preferable all panels
Basic requirements (Final-Assembly)

- 100% production inspected
- Minimum of 4+ points on each side
Typical requirements (Final-Assembly)

- 100% production inspected
- ALL panels including: doors, fender, molding and door handles, fuel flap cover, mirrors, spoiler.
System requirements

• HMI → Measurement results should be presented to the operators in an easy way
• Easy version of measurement results shall be transferred to the Plant Quality System (green, yellow, red)
• Measurement values shall be stored for process–engineering separately
Technical challenges

• Production complexity (models, sizes, shapes, colors)
• Ambient Light influence
• Positioning Influence
• Temperature influence
• Multiple controls (thickness, orange peel, color harmony)
• Self – Test, verification & calibration
• Automatic Unattended system
• Data collection and reports
• Immediate feedback to process & quality engineering
• Production flow and traceability
Measurement Setup for Step 4

30 measurements of each measuring point without robot movement in combination with alternating on and off ambient light
6-Sigma studies

- Step 1 - Reference values (Gage R&R)
- Step 2 - Comparison data (Master panels)
- Step 3 - Light influence (Master panels)
- Step 4 - Comparison data (Production Parts)
- Step 5 - Light influence (Production Parts)
- Step 6 - Gage R&R data
- Step 7 - Temperature influence (by degrees)
- Step 8 - Temperature influence (by time of day)
6-PANEL

MEASURE CTQ (y) CAPABILITY

Cause & Effect Diagram w/ Ranking:

MSA & Process Capability:
- Engineering Test Requirement
  test name spec
- Gage R&R: see below. For more information, please refer to BB-project

<table>
<thead>
<tr>
<th>Process Elements</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>Element OK</td>
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<tr>
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<tr>
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<tr>
<td>Element Removed</td>
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</tbody>
</table>

CONTAINMENT (state reasoning if not required):
State action
- details
- details

Process Owner Date Before Data After Data
name mm/dd/yy X.XX Cpk X.XX Cpk

Table of Gage R&R results

<table>
<thead>
<tr>
<th>Colour</th>
<th>% contribution</th>
<th>% study total</th>
<th>% study total</th>
<th>% study total</th>
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<td>100</td>
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<tr>
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<td>100</td>
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</tr>
</tbody>
</table>

Gage R&R borderline --> if required more test

• details
• details

Environmental
- Methods
- Machines

Measurement
- measurement spot
- device orientation
- measuring angle
- calibration
- machine
- manual devices
- automatic devices

Environment
- Colour tone
- Surface conditions
- Devices orientation
- Measurement spot

Material
- Colour tone
- Surface conditions
Preliminary conclusions

• BYK-mac ROBOTIC Sensor is capable
• Project is feasible, it can be installed with no major changes in current production lines (paint shop and final assembly)
• 3D robot guidance required
• Cycle time is critical (~10 sec. per point, including movements)
• Estimated number of robots/devices: 2 (one per side)
Process alternatives

- A) 100% production, stop&go
- B) loop for measuring only when cell available
- C) off-line measurement, “on-demand”
Other considerations

• **Offline Cell** for quality check
  – More control points can be added
  – One robot + rotatory table → cost reduction
  – Additional quality controls can be performed: i.e. Thickness, Orange Peel measurement
  – Vehicles can be taken out automatically based on color mix/sequence
Main System Components

- **Robots (2) on 7th axis or Long arm**
- **Color Measurement Device (2)**
- **EINES 3D Guidance System (Vision System)**
- **Conveyor Table with clamping on the skids**
- **Safety Fences and safety devices**
- **Control System**
  - Flow control system
  - QLS reporting
  - Statistical Report capabilities
  - Warning and Trends Analysis
EINES 3D Guidance

• Accurate sensor position reducing positioning cycle time

• Points to inspect are precisely located
EINES 3D Guidance

3D Body Location
BYK-mac ROBOTIC
Future Challenges

- 100% production colour verification, on all parts, on cars on wheels in a moving line at a high speed
Future Challenges
Thanks for your attention!