Cost Savings Through Automated Quality Inspection Using A Smart Camera

Alexander Belanger
Department of Electrical and Computer Engineering, University of New Hampshire

University of New Hampshire

Introduction

Background: Hutchinson Sealing Systems requested an automated inspection system for their production line to prevent bad shipments.

Goal: Design and build an inspection system to identify imperfections for the 2023 Honda Pilot side panel that provides a financial benefit to the company.

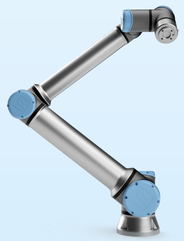
Requirements:

- False negatives (good parts judged as bad) must have <5% occurrence.
- False positives (bad parts judged as good) must have <1% occurrence.
- Inspection cycle time must be <30 seconds.
- Follow safety restrictions set by plant.

Design

Equipment:

- UR10e Collaborative Robot
- Cognex IS-7802P Camera
  - Pre-programmed methods
- Allen-Bradley 5380 PLC
- 2x Keyence Area Scanners
- C-More HMI

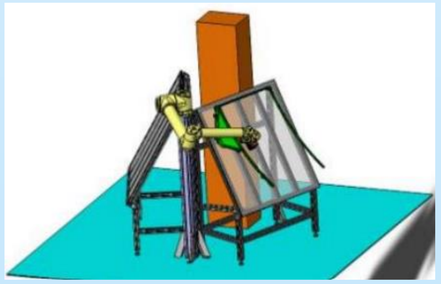


Budget: $60,000

Item	Price
Universal Robots UR10e	$ 26,500.00
Allen Bradley CL 5380 PLC	$ 10,000.00
Cognex IS-7802P	$ 15,000.00
C-More HMI	$ 2,500.00
Keyence Area Scanners (x2)	$ 6,000.00
Total *	***$ 60,000.00***

Strategy:

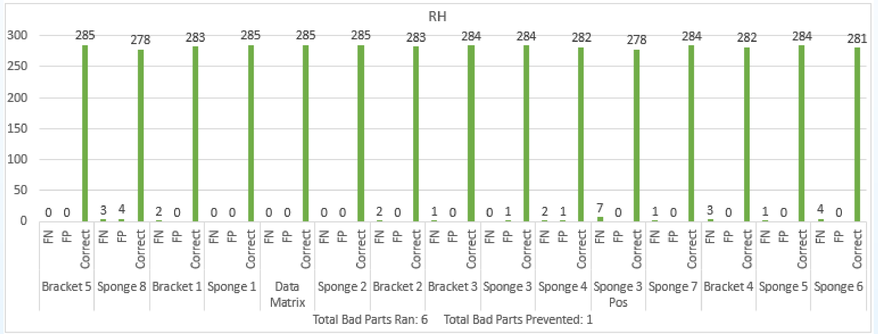
- Create 2 inspection tables with camera-equipped cobot in center pedestal.
- Operators mount prepared parts onto the inspection table.
- Upon request, scan over part to check for 8 sponges, 5 brackets, and 1 data matrix.
- Display information through HMI to operators about part status.
- When area scanners mounted under robot are obstructed, reduce robot speeds in case of collision.

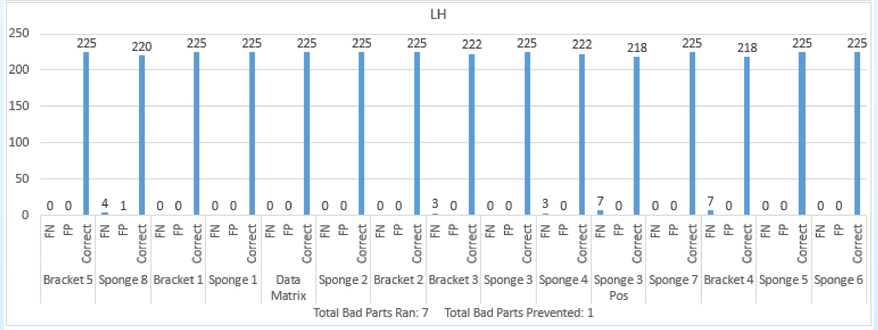


Results

Testing:

- Testing consisted of collecting data on the accuracy of inspections throughout 1st shift of several workdays.





Results:

Met false negative requirements:

- RH: Sponge 3 Position: 2.5% Error Rate.
- LH: Sponge 7/Sponge 3 Position: 3.2% Error Rate.

Failed to meet false positive requirements:

- RH: Sponge 8 67%, Sponge 3/Sponge 4: 16.7% Error Rate.
- LH: Sponge 8 14.3% Error Rate.

Analysis

Causes of false positives:

- Inconsistent part mounting.
- Inconsistent sponge placement.

Based on data, $10,000 savings per month
Estimated ROI: 6 months

- $ROI = \frac{Budget}{\left(\frac{Bad\ Parts\ Prevented}{Months}\right) * (Cost\ of\ Bad\ Shipment)} = \frac{\$60{,}000}{\frac{2}{1} * \$5{,}000}$

Future Work

Address False Positives:

- Redesign bottom mount for better fit.
- Create tighter pass conditions.

Expand on Testing:

- Create more “red rabbit parts” – parts specifically made poorly.
- Gather larger amount of data from different shifts.

Investigate Hardware Optimizations:

Keyence IV-3

- Neural Network Training
- Cheaper: $5,000
- Lacks Data Matrix Reader

Fanuc CRX-10iA

- Fanuc’s cobot
- More familiar interface
- More expensive: $30,000

References

Models : Vision Sensor with Built-in AI - IV3 series | KEYENCE America
Fanuc CRX-10iA/L Collaborative Robot - RobotWorld Automation
Cognex Corporation: Metrología - Laboratorio – DirectIndustry
UR10e Medium-sized, versatile cobot (universal-robots.cn)