



Machine Vision Application Requirements

Global Common

SD-1061

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1 Scope

- 1.1 This specification details general requirements and guidelines for the design, implementation, and validation of Machine Vision Applications included in Nexteer Manufacturing processes. Machine Vision includes part inspection and robot guidance. Part inspections can be categorized as location, counting, measuring, and decoding. Machine Vision Applications shall be specified in the Machine Equipment Purchase Specification (commonly referred to as the Machine T-Spec).
- 1.2 The use of the word "shall" indicates requirements, and the use of the word "should" indicates recommendations. The use of the word "may" indicates permission or allowance and the use of the word "can" indicates a possibility.

2 Process

- 2.1 The goal of machine vision is to fulfill one or several of the following items. Detection and prevention quality related defects identified in the PFMEA. To detect part presence or absence of parts or objects to aid machine controls. To aid in part location for robot guidance.
- 2.2 Camera Selection
 - 2.2.1 Camera Resolution and type Resolution

Selecting the correct resolution is vital for robust detection. The resolution should be based on the feature size and the desired field of view.
 - 2.2.2 Color vs. Monochrome

Monochrome shall be the default camera type. Color shall only be used if it is required by the application.
 - 2.2.3 Severity of Detection

Camera models used for detection of QCL items shall have FTP file transfer capability and variable data output functionality.
- 2.3 Machine MQ Flow

The Nexteer Equipment Engineer shall request support from the Manufacturing Machine Vision Engineer (Vision SME) prior to defining the scope definition within the T-Spec. Vision SME support assignment will be made through TeamCenter Manufacturing (TcM) and MEED indicating Vision is included in the machine design.
- 2.4 Vision and Robotics

The Nexteer Equipment Engineer shall request support from the Core Controls and Automation Group for any robotics application that involves vision. This is accomplished through TcM by indicating Vision and Robotics is included in the machine design. Robotic Engineer assignments will be made in TcM and MEED.

2.5 Vision Guidance Robotics

2.5.1 The Equipment Supplier (OEM) is responsible to develop Robot User Frames-Vision System coordinates configuration procedures. This procedure shall be performed and documented prior MQ2. These procedures are to be used to provide proper training to Plant personnel. Proof of Concept Report and Reliability Study

2.5.2 Machine Vision Inspection (T-Spec)

The Equipment Engineer shall describe the general functionality of the Machine Vision Application to be included in the manufacturing process in the T-Spec.

2.5.3 Scope of the Application

The Equipment Engineer shall clearly define all attributes to inspect and the criteria of acceptance / rejection for the Machine Vision Application.

2.5.4 Proof of Concept

Prior to Machine Design Review, an Application Feasibility and Reliability Report shall be created. The report shall include basic setup information, including, but not limited to camera model, working distance and angle from camera to part, light color, and lighting used.

2.5.5 Feasibility and Reliability Report

A Study of Reliability for the application shall be created. This report shall include proposals of the Machine Vision System that satisfies the requirements specified by the purchasing ME. The report shall include a detailed proof of concept and a detailed Study of Reliability including images representing the criteria of acceptance or rejection.

2.5.6 Samples for testing

Specimens or samples are required for Feasibility and Reliability testing. The Equipment Engineer shall provide GOOD and REJECT samples that clearly represent features or attributes to be inspected by the Machine Vision Application as identified in the PFMEA. It is required that parts represent conditions of regular production. These samples can be utilized to build the OK and NOT OK Masters required in section 4.1.3.

2.6 Additional Resources (Nexteer)

The Nexteer Vision Lab is available to conduct initial feasibility trials for Vision Inspection. Contact the Manufacturing Machine Vision Engineer (Vision SME) for assistance.

2.7 Additional Resources (External)

Vision Equipment Suppliers or Distributor shall be contacted by the Equipment Engineer or OEM to request support during the Machine Vision Application proof of concept. Proof of concept shall include basic setup information, including, but not limited to working distance and angle from camera to part, light color, and lighting used.

2.8 Design Review

Once the Feasibility report and Study of Reliability are submitted, a Design Review meeting shall be conducted by the Equipment Engineer and include the OEM, assigned Controls Engineer, and the

Where applicable, error counting or monitoring should be used and added as an additional condition for pass status. See Figure 2 for example.

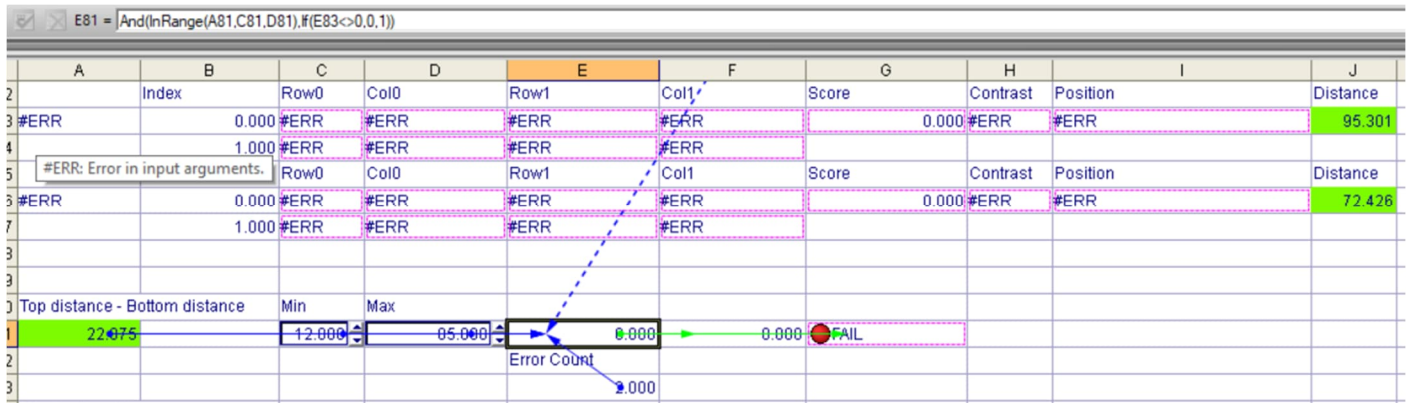


Figure 2: Error monitoring used to prevent retained pass bit.

3.3 Naming Convention

When possible, cameras should be renamed with the following format:

- Machine Asset number (SDxxxxxx)_OP (OPxxx) or station number (STAxixx)_Description
- Example:** SD123456_OP190_Final_Inspection

Camera programs should follow the following naming convention:

- Cognex Program name Example: 01_IS7600_OP140_RTV_13FEB25
- First two characters are program number: 01 – 99
- Camera model: Example: IS7600
- OP or station number: OPxxx or STAxixx
- Description: Example RTV
- Creation or revision date DDMMYY: Example 18JL24
- Keyence Program name Example: CAHX200M_OP140_RTV_13FEB25
- Camera model: Example: CA-HX200M
- OP or station number: OPxxx or STAxixx
- Description: Example RTV
- Creation or revision date DDMMYY: Example 18JL24

3.4 Use of AI vision tools

3.4.1 AI Vision Image Database

When Edge Learning, Deep Learning, or other vision tools commonly referred to as AI tools are used an Image database of all images used to train the tools shall be saved and provided to the Equipment ME and a copy saved in Teamcenter / GMEP. These images should be saved in a secure location so that they can be used to recreate vision program if necessary.

3.4.2 AI Classification tool requirements

When setting the region of interest (ROI) for a classification tool, the area shall include only the area that is different between the different classes. Additional area or background that is included, that is the same or similar between the different classes negatively affects the trained model. This can result in a larger number of trained images required, and lower classification performance. Classification tools shall always be verified with the process described in section 4.2.1 of this document.

AI classification and segmentation models shall not include images of error proofing master parts. All training shall be done with other comparable parts.

3.4.3 AI Segmentation tool requirements

When setting the region of interest (ROI) for a segmentation tool, the area should be small, typically only 512 x512 or less pixels in area, any larger area is usually reduced to a smaller pixel area for processing and will lose resolution. It is better to have several smaller ROIs than one large ROI.

Segmentation AI tools also use the non-classified items in the trained image as a background class. It is very important that the background be consistent. Mechanical part fixturing should be used to reduce part location variation and pattern location tools should be used and very well defined in the camera program to accurately locate the ROI consistently.

4 Qualification / Documentation

4.1 General Requirements for Machine Vision (pre MQ1/MQ2)

4.1.1 Implementation

Reliability of a Machine Vision Application is crucial for a successful and robust Error Proofing Device functionality. Therefore, it is imperative the OEM provides the best and optimal solution to be implemented.

4.1.2 Error Proofing Verification.

4.1.3 The OEM is responsible to include an Error Proofing Verification sequence in the machine function. This function will be used to validate system performance, reliability and any adjustments made to the system once the equipment is released into production. Camera program functionality shall be tested for the following items prior to MQ1. Camera program shall not pass with complete black image, white image, with part not in focus, or part not in image. GOOD and REJECT Part Masters

The OEM is responsible to work with engineer in charge to provide GOOD and REJECT part Master(s) to be used for the Error Proofing Verification (EPV) routine. Master ID is required (2D code) for stations that require 2D code reading. Rust prevention for master(s) is required. If applicable, Masters can be painted Red or Green avoiding features that are inspected.

When a vision system is used with AI (Edge learning, Neural Networking, or Deep Learning) capabilities the REJECT part Master(s) shall not be used to train and setup any AI tools. Other REJECT parts shall be used.

4.1.4 MQ setup Image files

At least 100 GOOD images and 50 REJECT images per model are required in a folder. Images shall be stored electronically in a BMP format. Name of the file shall contain the prefix GOOD or REJECT for each image.

4.2 Machine Qualification 1 (MQ1)

Reliability of a Machine Vision Application is crucial for a successful and robust Error Proofing Device functionality. Therefore, it is imperative that Nexteer Engineer in charge documents functionality of Machine Vision incorporated as Error proofing.

4.2.1 Inspection Repeatability Study

Acceptable Gage R&R for vision measuring applications or gage attribute capability study for vision attributes inspection shall be documented in Runoff Book.

The Repeatability and limit verification study required is the same for all applications and shall follow the steps below. The number of data points required will be based on severity level of failed detection.

4.2.1.1 Repeatability and Limit verification Process

The images used for data points should include all variation in lighting. If operator lights are available, then images should be included with the lights on and off. If the receiving plant will have skylights, then an added external light should be used to simulate a skylight with direct sunlight on the part.

The variable data used for the pass / fail criteria shall be collected from the camera. For camera programs that use many vision tools, more than 10, consult the Nexteer machine vision SME for the required data collection. The average value of all the good parts shall be calculated along with the sample population standard deviation. A six-sigma distribution range shall be calculated.

The average value of each failure mode bad part shall be calculated along with the sample population standard deviation. A six-sigma range of each failure mode shall be calculated and compared to the six-sigma distribution of the good parts. There should be separation between the bad part and good part ranges.

The camera program shall have limits set to fail all six-sigma range values of the reject parts for all failure modes. There should be no good parts rejected by setting the limit in this way, meaning the set limit(s) should not be placed within the good part distribution. The ideal camera application should have separation between good part distribution and bad part distribution(s). See Figure 3 for example of acceptable results in graphical form.

The limits should be set conservatively, meaning that the limit should be closer to the edge of the good part distribution range and further away from the bad part distribution(s).

The set limits shall be used to calculate the Cpk and Ppk and included in the Runoff book. Requirements are per SD-002.

If there is an overlap between good and bad part distribution ranges the camera and lighting setup should be improved to increase contrast between good and bad parts or the camera program changed to improve performance, and the study repeated. If a small amount of overlap cannot be avoided, then the receiving plant ME & QE team will need to sign off on the machine vision application in MQ plan. The overlap should never be more than 3%. Include calculated FTQ in MSD plan. See Figure 4 for example of overlapping distribution example.

4.2.1.2 Part Gauging Applications

In applications where the vision system will be acting in place of a gage a gage R&R shall be performed per SD-002.

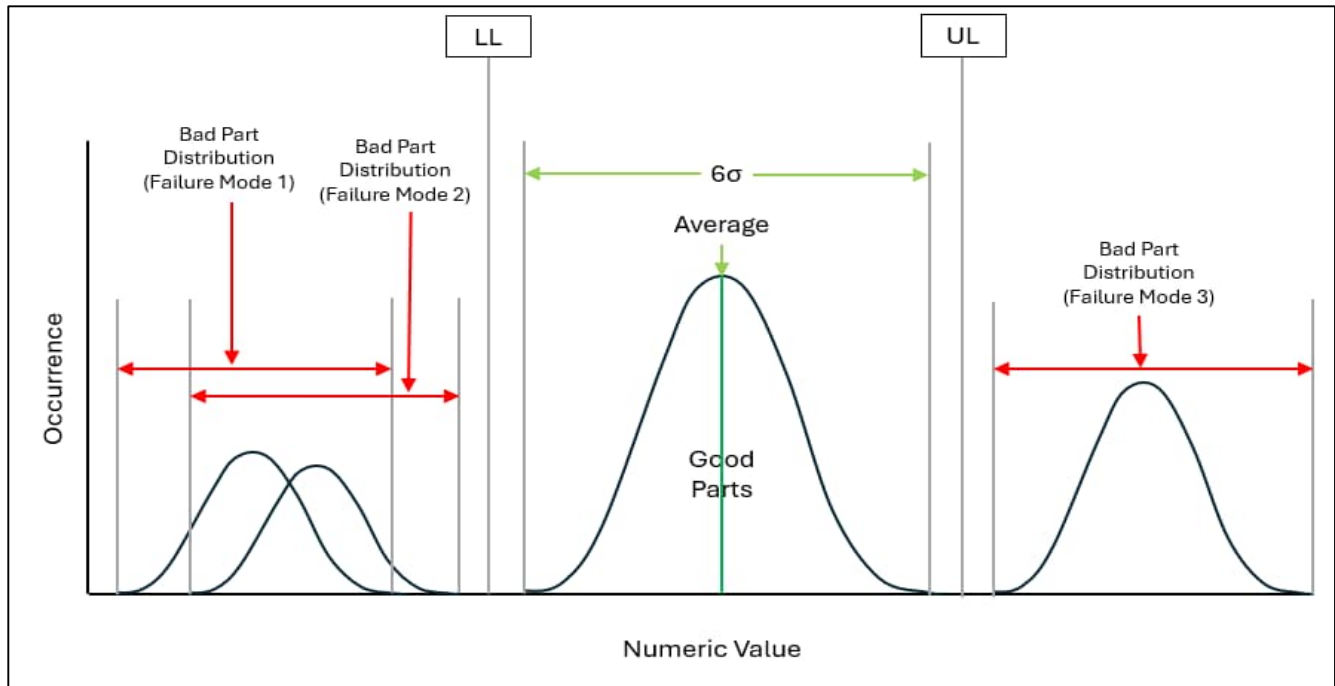


Figure 3: Example of Good and Bad part value distributions.

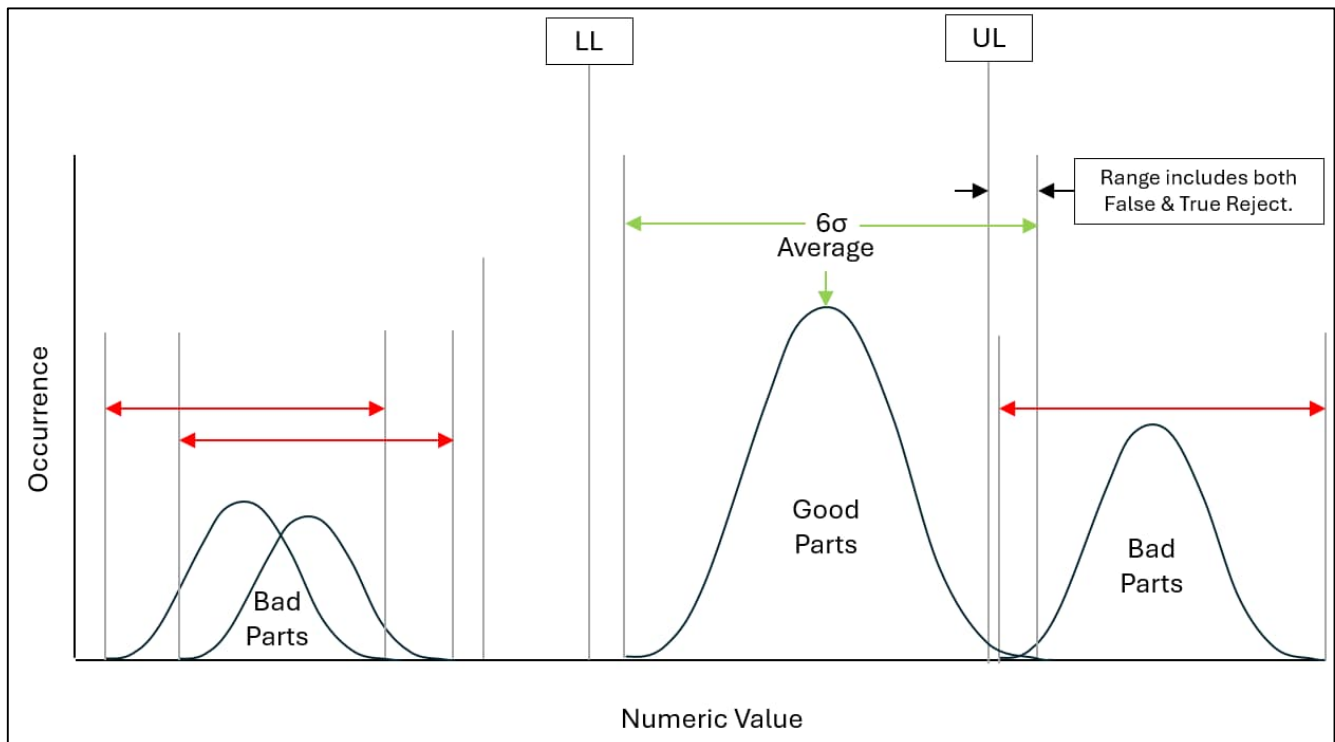


Figure 4: Overlapping Distributions Example.

4.2.1.3 SEV 9/10 items:

A minimum of 45 good part data points and a minimum of 20 data points from each failure mode identified in the PFMEA. If the occurrence of certain failure modes are higher than 3 in the PFMEA, then it is recommended to collect more than the minimum required data for that failure mode.

4.2.1.4 For all other KCC items:

A minimum of 30 good part data points and a minimum of 10 data points from each failure mode identified in the PFMEA. If the occurrence of certain failure modes are higher than 3 in the PFMEA, then it is recommended to collect more than the minimum required data for that failure mode.

4.2.1.5 For all other items:

A minimum of 18 good part data points and a minimum of 6 data points from each failure mode identified in the PFMEA. If the occurrence of certain failure modes are higher than 3 in the PFMEA, then it is recommended to collect more than the minimum required data for that failure mode.

4.2.1.6 The failure modes that are closest to the good parts should be focused on. A limited number of samples can be evaluated to determine which failure modes are closest to the good parts and the failure modes that are furthest from the good parts can be ignored until more sample parts are available.

4.3 Machine Qualification 2 (MQ2)

4.3.1 Installing Machine Vision Application in the plant.

Plant environment and lighting conditions are critical for any Machine Vision Application and its reliable performance. The OEM is responsible for eliminating such lightning variation by design. Image files can be used at this point to replicate MQ1 conditions.

4.3.2 Attributes Inspection Capability Study

An acceptable Gage R&R or Repeatability and limit verification study applied to all inspected features or attributes shall be documented in Runoff Book. This study shall demonstrate system reliability and shall follow the requirements outlined in section 4.2.1 at a minimum.

4.3.3 The OEM is responsible for providing camera system configurations, libraries and application backups to the Equipment Engineer.

4.3.4 The Equipment ME shall share system backups and images libraries to the Plant ME and Controls Engineer. System backups shall also be saved in the MQ workflow as a PRG file. All this information shall be included in the Machine Process Sheet (MPS).

5 Onsite Training

- 5.1 Proper training shall be provided by the OEM to the Plant Team. Training shall include basics on functionality, setup, and system recovery installed in Nexteer Equipment.
- 5.2 Basic Machine vision training material is available from the Vision SME. Hands-On Training can be shared or provided to the teams.
- 5.3 Additional training on Nexteer preferred vision systems (refer to Nexteer Specification SD-007) is available on the Supplier websites. Specific training shall be requested to local Machine Vision representatives.

6 General Requirements for Machine Vision in Production.

6.1 Plant ME

The Plant Receiving ME is responsible to review and approve the MQ2 Runoff Book and additional documentation related to the Machine Vision Application.

6.2 Machine Vision Subject Matter Expert in Plant

The Plant shall designate a Manufacturing Engineer or Controls Engineer as the Subject Matter expert in Machine Vision. This person will be responsible for maintaining and managing machine vision systems in the Plant.

6.3 Preventive Maintenance

The Plant ME is responsible to design and schedule the frequency for the proper PM for the Machine Vision Application. PM shall be designed accordingly to the Machine Vision Application considering machine and plant environment.

6.4 Use of MQ1/MQ2 Image Database as Reference

An Image database can be used as reference in order to maintain Machine Vision Acquisition. Image quality degradation can be identified by comparing images from MQ runs.

6.5 Camera Alignment & Verification.

An additional camera program can be created to aid in re-aligning a camera's position to its original position if required. This program can use a series of edge/ line tools along with graphic display tools that align with distinct background objects or master part features. See Figures 5 & 6.

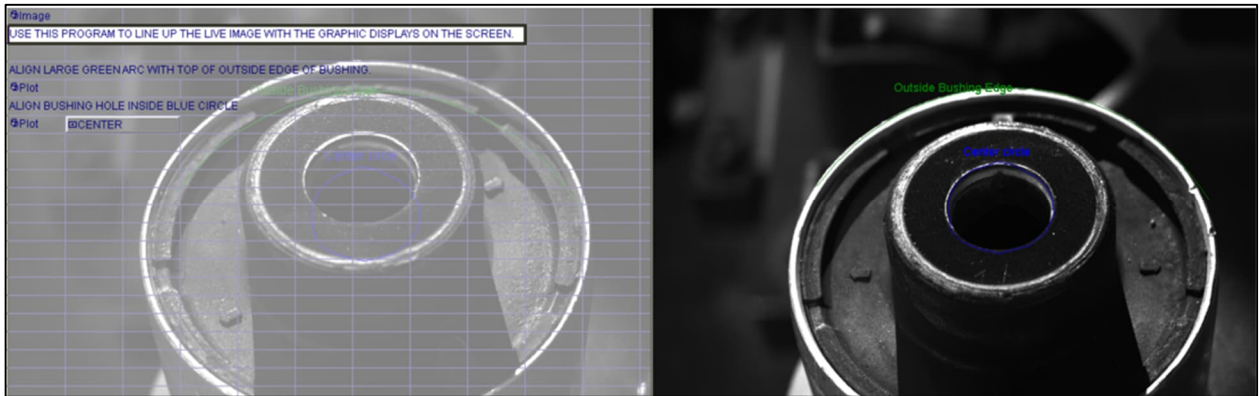


Figure 5: Cognex Alignment Program Example

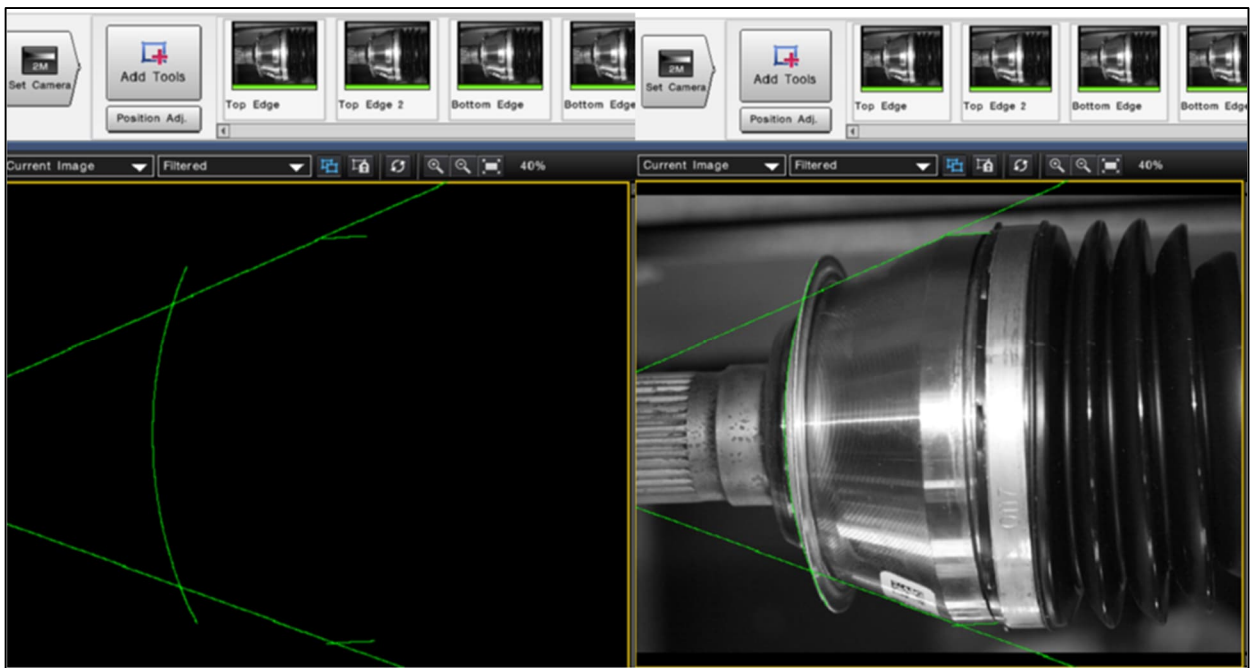


Figure 6: Keyence Alignment Program Example

7 Additional References.

7.1 Machine Process Sheet (MPS) Example:

MPS - Machine Process Sheet

This document to contain the key process parameters/features to assure standardized output for this process
All KCC's Shall be updated for changes per PCN's and documented in tables below identified by green fill. All other settings are as reference
Note: All process controls - gaging, error proofing, calibration and verification on OCP

Form: 07-1-5-F1

Program:	WL	Severity	
Machine / Function:	Machine Vision		
Plt / Dept / Group:	3/44/Saginaw		
SD #(s)	SD803206	Compliance to	SD1061
Rev:	001		
Rev Date:	6/5/23	Yes	

Page: 4

Camera Parameters: Presence/Absence of Continuous RTV bead

Part Numbers:

All

Inspection Description	Brand	Type	Model Number
The vision system shall find the absence or presence of an RTV bead. This bead will be inspected to make sure it is within specification with no breaks or smear of the bead.	Cognex	Vision System	In-Sight 8505P

Vision & Lighting System Installation			
Camera Mounting		Lighting Mounting	
Focal Length (Lenses)	55 mm (Blue Polarized Filter)	Type	Polarized Brick Light
Working Distance	762 mm	Color	Blue
FOV(Field of View) Height	99 mm	Model	S75-470
FOV(Field of View) Width	119 mm	Mounting Distance	762 mm
Angle	90 Deg. (Perpendicular to Part)	Mounting Angle	90 Deg.

Communications	
IP Address	192.168.126.202

PLC Interface (Tag)	
Logic Software: Cognex provided AOP	
- Cognex_Sta30_RTV_Inspect1 - Cognex_Sta30_RTV_Inspect1.Status - Cognex_Sta30_RTV_Inspect1.InspectionResults	- Cognex_Sta30_RTV_Inspect1.O - Cognex_Sta30_RTV_Inspect1.O.Control - Cognex_Sta30_RTV_Inspect1.O.UserData

Pre-MQ Check list			
Check	Complete Y / N	Pass / Fail	Date
Confirm camera program fails with lens covered or with black image.	YES	Pass	6/23/2022
Confirm camera program fails with no part in view.	YES	Pass	6/23/2022
Confirm camera program fails with complete white image.	YES	Pass	6/23/2022
Confirm camera does not retain pass bit from previous image if ERR is present.	YES	Pass	6/23/2022

ALL REFERENCE PROGRAM BACKUPS SHALL BE IN THE NUMBER IN "PROGRAM FILES" FROM MQ2

Backup Program	Rev Date	Saved in TcM	MQ2 Images	
SD803206_STA30_12JUN2023b.job	12/9/22	NO	Good	Bad
			N/A	N/A
Software Version:		6.1.0		
Good Image		Bad Image		

Camera Programming and settings			
Image Acquisition / Capture			
Description	Setting	Unit	Notes
Trigger	Industrial Ethernet		
Trigger Delay	0	msec	Disabled
Trigger Interval	500	msec	
Exposure	C2*N27+C3*N28+C3*N29+C3*N30	msec	SCS4
Star Row	0		
Number of Rows	2048		
Gain	D2*N27+D3*N28+D3*N29+D3*N30		SCS5
Focus Controls	Manual		
Focus Position	0		
Save Focus Position with Job	Enabled		
HDR Mode	Disabled		Disabled
Light Settings	External		
Polarity			
Intensity			
Strobe Star Position			
Red Zone			
Lens focus			

How This Camera Works

A	B	C	D	E	F	G	H	I	J
400	This camera takes four different pictures, designated by "Inspection Number" from the PLC.								
401	Basic Machine Sequence is as follows:								
402	Part indexes into this station								
403	Inspection Number 1, with unpolarized light, verifies three screws are present								
404	Inspection Number 2, with polarized light. No analysis, just captures a pre-RTV picture								
405	RTV is Dispensed								
406	Inspection Number 3, with polarized light Analysis is done on differences between this image and pre-RTV image.								
407									
408	Inspection Number 4, only for RTV EPV, analysis is done on raw picture with polarized light,								
409	since there is no pre-RTV picture								

MPS Example continued.

Part Location / Position Adjustment			
Tool 1 Used:	Pattern Match	Unit	FindPatterns
Description	Setting		Notes
Image	SA\$0		
Fixture	(0,0,0)		
Model Region	(-29.882,-1159.332,150,150,-0.249)		
Model Settings	(Edge model, Medium, Medium, 0,0,0)		
Find Region	(944.057,591.635,305.436,286.998,-0.249)		
Number to Find	1		
Angle Range	15		
Scale Tolerance	Enabled		
Thresh: Accept	50		
Thresh: Confuse	70		
Time out	5000		
Show	hide all		

Inspections / Vision Tools						
# of Tools Needed	10					
#1 Tool Used:	Clocked Data Storage	Unit	Latch Image	Description of Inspection		
Description	Setting		Notes			
Image	SA\$0					
Fixture	(0,0,0)					
Region	(0,0,1944,2448,0)					
Event	SC\$34					
Colorize	Disabled		Enabled			
Show	hide all					

Captures Image before RTV is dispensed in order to compare it later when RTV is present. Latch image was used because the metal, shiny surface made it hard to see the RTV. (May not be needed for other applications).

#2 Tool Used:	Image	Unit	Image Math	Description of Inspection		
Description	Setting		Notes			
Image 1	SA\$36					
Image 2	SA\$0					
Operation	Difference					
Display Row	0					
Display Column	0					
Show	hide all					

Comparing the PreRTV image and the RTV image and output the difference between the two images.

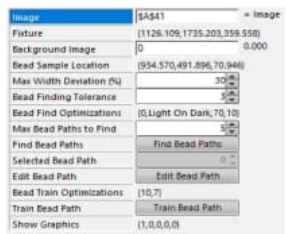
#3 Tool Used:	Image	Unit	Filter	Description of Inspection		
Description	Setting		Notes			
Image	SA\$40					
Fixture	(0,0,0)					
Region	(336.625,293.302,1526.749,1740.049,0)					
Filter Type	Binarize					
Kernel Rows	3		Disabled			
Auto Threshold	Disabled		Enabled			
Min.	128		Disabled			
Max.	128		Disabled			
Gain	1		Disabled			
Smoothness	1		Disabled			
Show	hide all					

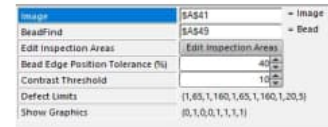
Filter used to make more contrast where there are more defined edges.

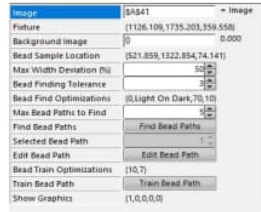
#4 Tool Used:	Image	Unit	Filter	Description of Inspection		
Description	Setting		Notes			
Image	SB\$40					
Fixture	(0,0,0)					
Region	(336.625,293.302,1526.749,1740.049,0)					
Filter Type	Open					
Kernel Rows	11		Disabled			
Auto Threshold	Enabled		Disabled			
Min.	128		Disabled			
Max.	128		Disabled			
Gain	1		Disabled			
Smoothness	1		Disabled			
Show	And(Not(O33),N26=3)					

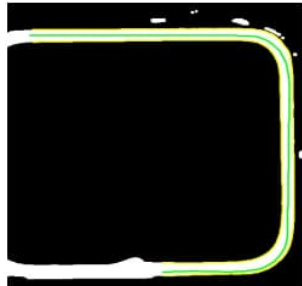
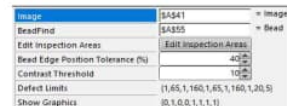
Cleaning up the image so that only the bead of the RTV can be seen. Adds on from previous filter.

MPS Example continued.

#5 Tool Used:	Inspect Edge		Bead Find	Description of Inspection	Uses a POLARIZED light in order to Find and outlines the left side of the RTV bead in order to train the bead inspection.
Description	Setting	Unit	Notes		
Image	SA541				
Fixture	(0,0,0)				
Background image	0				
Bead Sample Location	(934,570,491,896,70,946)				
Max Width Deviation (%)	30				
Bead Finding Tolerance	3				
Bead Find Optimizations	(0,Light On Dark,70,10)				
Max Bead Paths to Find	5				
Find Bead Paths	Enabled				
Selected Bead Path	0		Disabled		
Edit Bead Path	Enabled				
Bead Train Optimizations	(10,7)				
Train Bead Path	Enabled				
Show Graphics	(1,0,0,0,0)				

#6 Tool Used:	Inspect Edge		Bead Inspect	Description of Inspection	Inspects the left side bead to make sure it is continuous and uniform.	
Description	Setting	Unit	Notes			
Image	SA541					
BeadFind	SA547					
Edit Inspection Areas	Disabled					
Bead Edge Position Tolerance (%)	40		Disabled			
Contrast Threshold	10		Disabled			
Defect Limits	(1,65,1,160,1,65,1,160,1,20,5)					
Show	(0,1,0,0,1,1,1,1)					

#7 Tool Used:	Inspect Edge		Bead Find	Description of Inspection	Finds the top and right side of the bead to train the inspection.
Description	Setting	Unit	Notes		
Image	SA541				
Fixture	(0,0,0)				
Background image	0				
Bead Sample Location	(521,859,1322,854,74,141)				
Max Width Deviation (%)	30				
Bead Finding Tolerance	3				
Bead Find Optimizations	(0,Light On Dark,70,10)				
Max Bead Paths to Find	5				
Find Bead Paths	Enabled				
Selected Bead Path	1		Disabled		
Edit Bead Path	Enabled				
Bead Train Optimizations	(10,7)				
Train Bead Path	Enabled				
Show Graphics	(1,0,0,0,0)				

#8 Tool Used:	Inspect Edge		Bead Inspect	Description of Inspection	Inspects the bead top and right side that was trained in bead find to make sure the bead isn't smeared or broke.	
Description	Setting	Unit	Notes			
Image	SA541					
BeadFind	SA555					
Edit Inspection Areas	Disabled					
Bead Edge Position Tolerance (%)	40		Disabled			
Contrast Threshold	10		Disabled			
Defect Limits	(1,65,1,160,1,65,1,160,1,20,5)					
Show	(0,1,0,0,1,1,1,1)					

[illegible][illegible][illegible][illegible]

FTP Folder: Image Directory			
Description	Setting	Unit	Notes
Event			
FTP	WriteImageFTP		

Trigger	Acquisition Job Complete
Manual	☐

Event	SASIS	= Event
Host Name	98S70	= 192.168.254.181
User Name	98S71	= Guest
Password	98S72	= Hds33r
Image	SASD	= Image
File Name	SAS79	= UVR/Dept 44-Line
Max Append Value	1007	
Reset	☐	
Date Format	RJAGT-1 RJN2G-1.D80.D82	= BMP
Save Graphic Overlays	☒	
Resolution	Full	
Disable FTP Quoting	☒	

FTP Image	
Event	9FTF
Pass?	0.000
Setting Up the FTP Settings	
Host	192.168.254.181
Username	Guest
Password	Hds33r
Folder	UVR/Chest 44Line_2ND803208OP30
Serial	1.000
Enable Save?	☒
Show All Images	☒
Complete Diagnostic Images will be Saved in this folder	
UVR/Chest 44Line_2ND803208OP30VAL2023_08_02_FAIL	
Screen Image Pass Format	LIFO
Screen Image Fail Format	LIFO
RTV Image Pass Format	LIFO
RTV Image Fail Format	BMP

MPS Example continued.

Execute Conditions Settings (Sequence)			
Description	Setting	Unit	Notes
Compares before and after RTV			
Filters the image			
Finds RTV bead			
Inspects RTV bead			

Format Output Data			
Description	Setting	Unit	Notes
Buffer	FormatOutputBuffer	bit	
WriteResults	WriteResultBuffer		

Returning Outputs to PLC
Buffer and WriteResults extracts the Data to Send to the PLC

Buffer WriteResults

Cell(s)	Total Size (bytes)	Data Type
\$N531	1	bit
\$N532	1	bit

Event	\$A565	= Event
Buffer	A55	= Buffer
Result Code		
Protocol	EtherNet/IP	
Byte/Word Order	Default	

7.2 Program Logical Sequence Example:

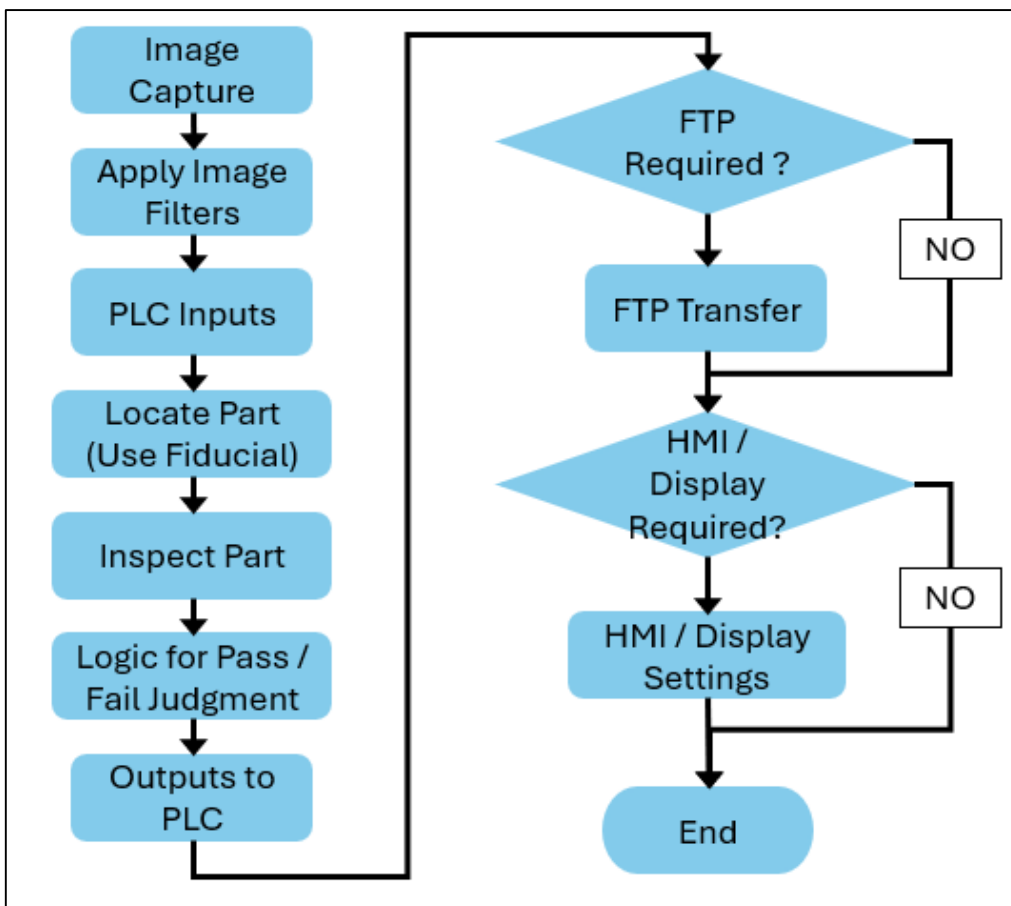


Figure 7: Camera Program Sequence Logic

A. Appendix**A.1 Programming Requirements**

- A.1-1 Lenses and Lighting system shall be documented or commented in the program if the software is capable. Language used shall be in English, or language of receiving country.
- A.1-2 All programs shall be documented with descriptors. Vision tools and their functions shall be clearly documented in the program where the software is capable.
- A.1-3 All program structures shall follow a logical sequence. Image acquisition, part location, part inspection and communications shall be clearly defined in the structure. The program sequence of operation shall be included and documented. The program sequence can be stored in the Images Folder.

A.2 Machine Vision Image Visualization and System Access.

- A.2-1 A vision monitor/panel should be installed in the machine for image visualization and the system performance monitoring.
- A.2-2 The vision monitor/panel shall display the key inspected features including OK or Not-OK status indicators for an easy visualization for the operator.
- A.2-3 For multiple vision systems within a cell or machine, an industrial PC monitor with the most recent Vision Software version shall be provided with the equipment.
- A.2-4 The access to the vision programming software shall be password protected.

A.3 Image Storage

- A.3-1 The OEM and Nexteer Equipment Engineer are responsible to define image storage in the Plant. Unless required by Nexteer's End Customer, images are not to be stored in the Traceability Database and shall follow the Data Retention Policy.

A.4 PM Recommendations

- A.4-1 The OEM is responsible to provide recommendations for cleaning, if required.
- A.4-2 Plant ME is responsible to document PM recommendations.
- A.4-3 MPS shall include setup and a camera machine installation sketch relative to the part.
- A.4-4 Plant ME is responsible to maintain and update the MPS.

A.5 Glossary

- A.5-1 OEM: Original Equipment Manufacturer
- A.5-2 MQ1: Machine Qualification I
- A.5-3 MQ2: Machine Qualification II
- A.5-4 EPV: Error Proofing Verification
- A.5-5 SOP: Start of Production
- A.5-6 SME: Subject Matter Expert
- A.5-7 ME: Manufacturing Engineer
- A.5-8 TcM: Teamcenter Manufacturing
- A.5-9 MPS: Machine Process Sheet
- A.5-10 PM: Preventive Maintenance
- A.5-11 QCL: Quality Control Level

RECORD OF REVISIONS

Revision No	Date	Section	Description
001	07OC21	ALL	Initial Release.
002	15AU25	ALL	Restructured with multiple updates
003	28JL26	2.8, 3.4.2, 4.2.1	Added clarification and AI classification ROI requirement.
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