

YASKAWA

Motosight 2D for welding

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YASKAWA ELECTRIC CORPORATION

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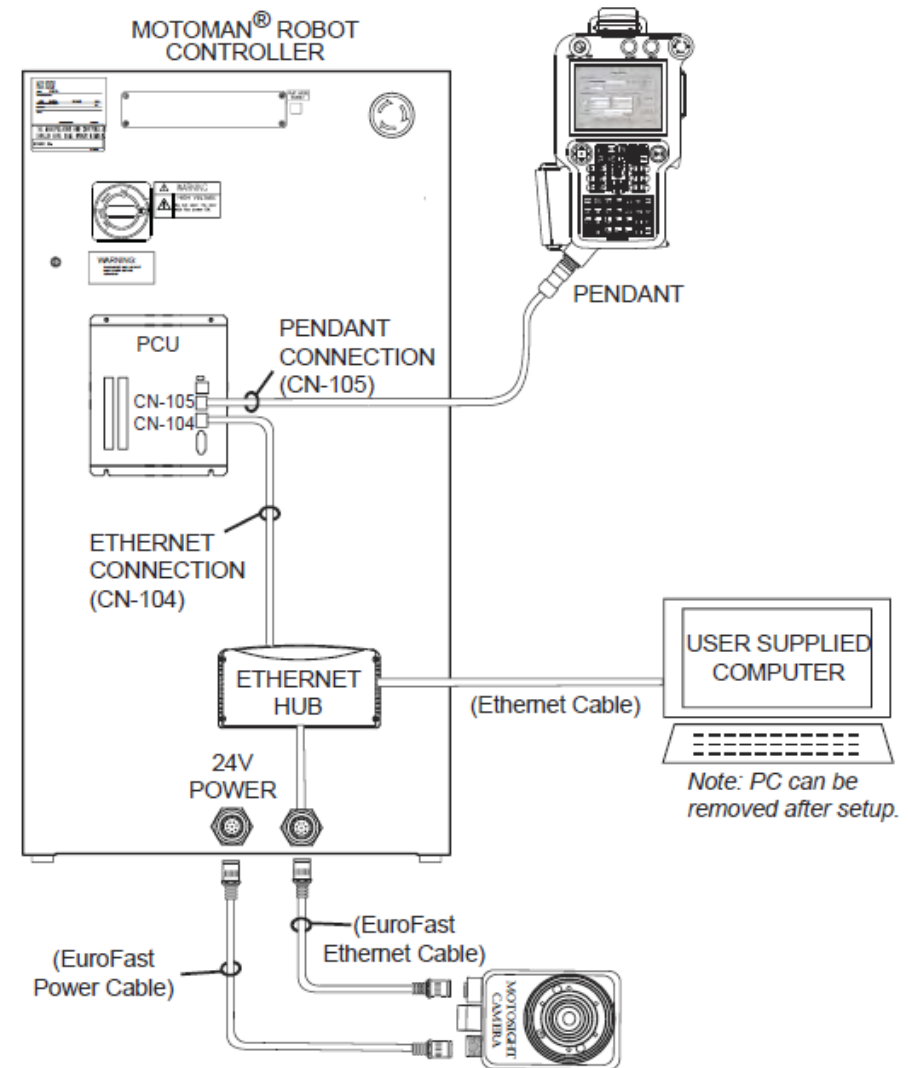
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Motosight 2D for welding

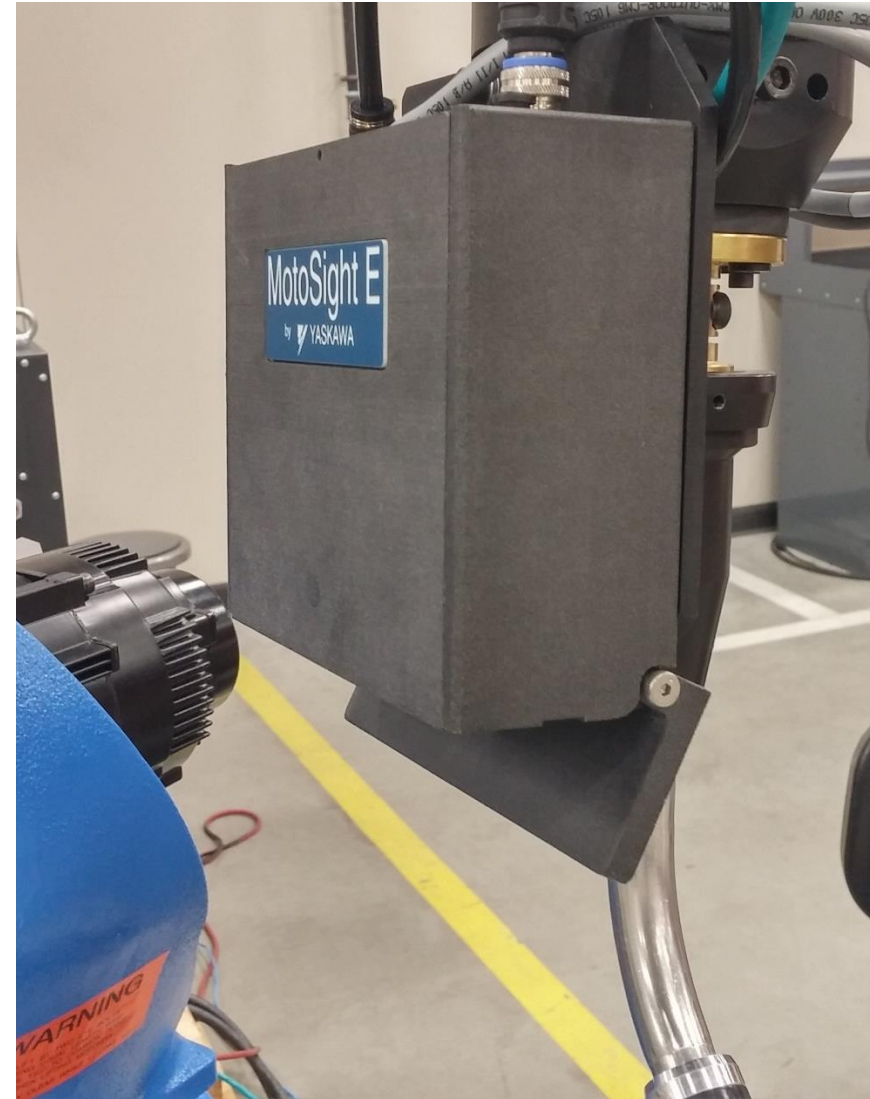
- Can be used to detect lateral weld joint movement
- For certain applications, it can also be used to measure weld line rotation
- Does not detect depth (distance from camera)
- Very quick measurement time (in general, fastest of all sensing technologies)

Motsight 2D for welding: Config

- Preparation
 - Review “[Motsight 2D Global Edition](#)” manual
 - Procure the work instruction [SSGW-429](#)
- Hardware
 - Mount camera. Arrange for lighting (if needed). Consider provisions for protection from weld environment
 - Ensure all connections are made
 - Power + Ethernet / POE to sensor, Ethernet to controller, Ethernet to PC
 - Install In-Sight Explorer to PC
 - Install required camera lens for application



Motosight 2D for welding; Example of Sensor Mounting



Motosight 2D for welding: Setup Sequence of Operations

1. Configuration for: Robot <-> Sensor communication
2. Calibrate sensor for the working distance / stand-off distance
3. Program to application
 1. Move Sensor to weld path to be measured, then move to stand-off distance.
 2. Adjust sensor settings for application
 3. Program macro instructions into robot job
 4. Deploy shift amounts(s) and program weld path

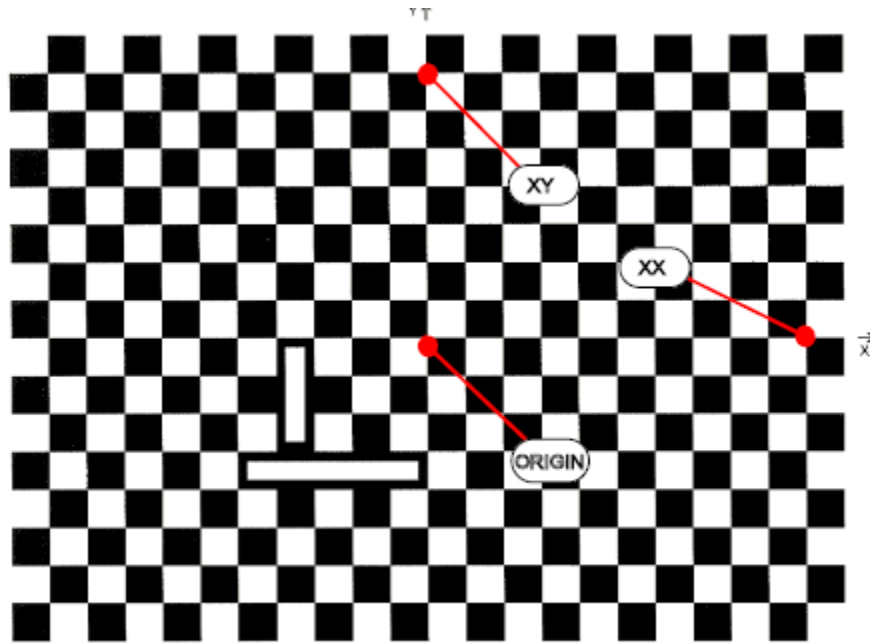
- Set IP address of robot port in the MS2D app
 - On robot PP, open the Pendant Application for Motosight2D (MAIN MENU > APPLICATION > “MS2D *.*.*”)
 - Set the IP address used for the DX controller LAN port (which was configured during MS2D Work Instruction setup) into the “Robot IP Address” field

- Now that the sensor is connected to PC, lets Calibrate! ...

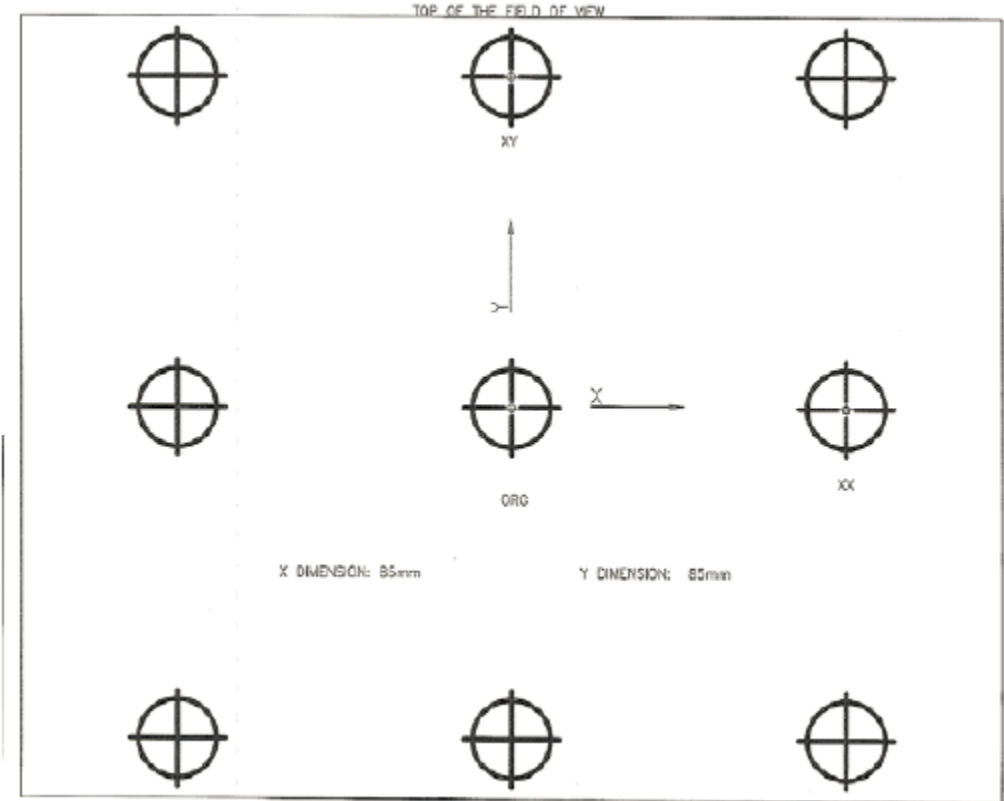
- Calibrate the sensor to the robot based on the camera's distance-to-weld seam (If using multiple camera stand-off distances, repeat the following three (3) steps)
- Overview – Calibrating sensor to robot
 1. Teach User Frame to Calibration Grid/Sheet
Used to attach (orientation) camera measurement to the robot's coordinate system
 2. Move sensor to required height above Calibration Grid. Adjust Focus / Exposure.
Used to scale (1mm in camera = 1mm in robot's frame) the camera measurement to the robot's frame, based on the programmed camera-to-grid distance
 3. Run the TOOL job
Creates a Tool Center Point / Frame. This TCP will be used during weld joint measurement routines to utilize the camera orientation and scaling calculations made above

Motosight 2D for welding: Calibration

1. With a good TCP of the welding torch, teach a User Frame to a printed calibration sheet (use either “9-point target” or “calibration grid” method)



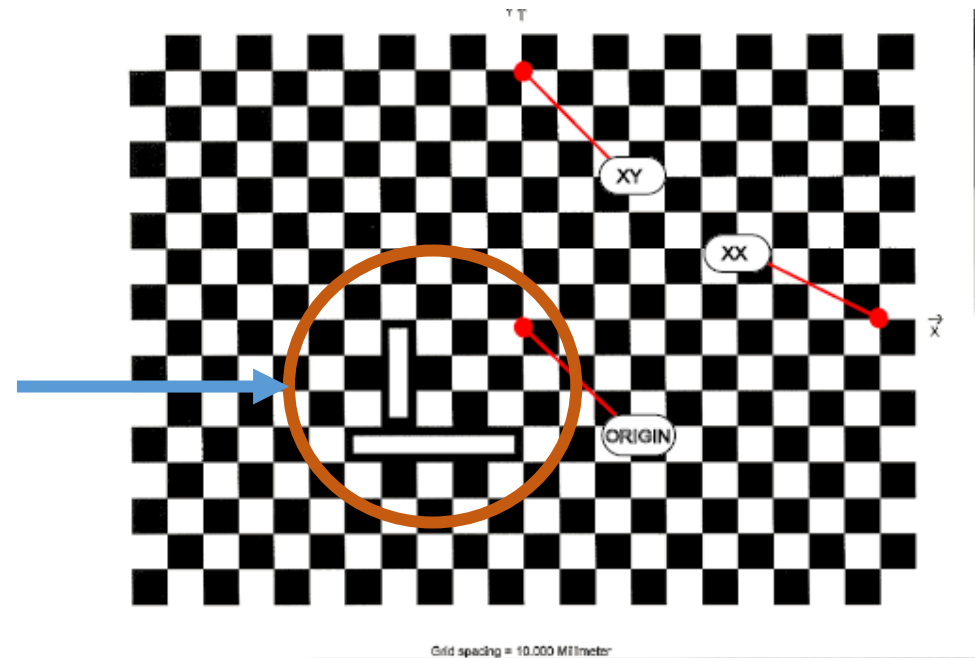
Grid spacing = 10.000 Millimeter



- NOTE: Grid-with-fiducial Calibration: offers adjustable grid size for small camera field of view. Also adjusts for lens distortion

Motosight 2D for welding: Calibration

2. Next, **move sensor** to required height above grid, making sure entire center element is visible (note “IMOV method” discussed later).



■ Motosight 2D for welding: Calibration

• Run “CalibrateGrid” in In-Sight Explorer.

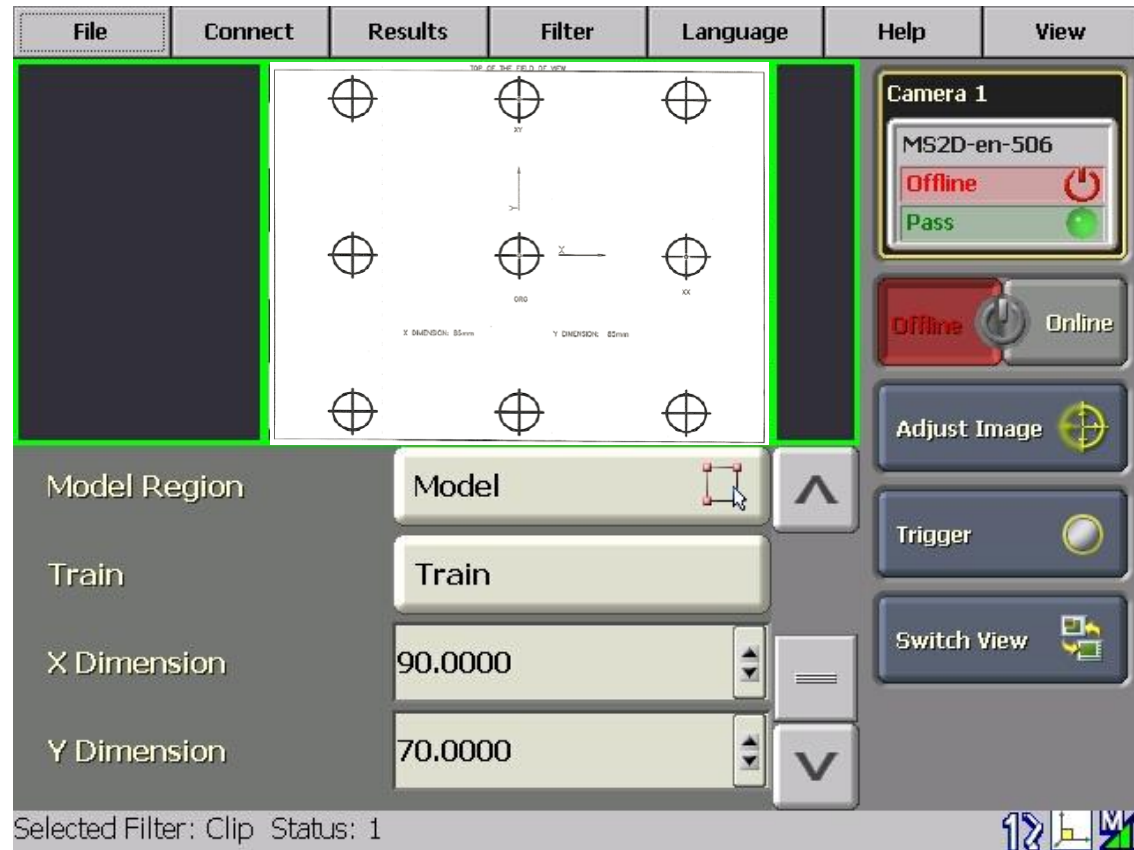
- Note: With calibration grid method, adjust grid size so at least the entire center element (the fiducial) fits into field of view
- Note: pixel size of the sensor is now calibrated to an actual distance in mm.

The screenshot shows the In-Sight Explorer interface during the 'CalibrateGrid' process. The main window displays a checkerboard grid with a green border. A 'PC Sensor' label is visible at the bottom. A 'Results' dialog box is open, showing a color scale from 0 (Excellent) to 5 (Very Poor) and a table of feature points.

Index	Row	Column	World X	World Y
0	208.5	348.2	-19.980	-19.992
1	147.1	347.8	-10.006	-19.987
2	85.6	347.5	0.018	-19.998
3	209.0	286.6	-19.999	-10.019
4	147.4	286.4	-10.007	-10.037

■ Motosight 2D for welding: Calibration

- As an alternative to using the In-Sight Explorer calibration method, you may instead use the Easy Builder programming pendant application.
 - Easy Builder Calibration: requires used of 9-Point Target
 - Model: place box around middle circle
 - X/Y dimensions: distance between sides of rectangle defined by outer circles



Motosight 2D for welding: Calibration

3. Third, **run the TOOL job**, setting the required UF# that was used on the calibration grid and also set the Tool File# you'd like to have the TOOL job create.

Note: the measurement distances of the Cognex camera are now tied to robot coordinate systems via the Tool File# that was just created.

As the sensor is used on different weld seams across the weldment, this same Tool File is used to apply the newly-measured Cognex weld joint location onto robot Base Frame / User Frame coordinate systems

```
J: TOOL S: 0000
CONTROL GROUP: R1 TOOL: **
0000 NOP
0001'*****
0002' this job creates a TCP
0003' for a camera mounted
0004' to the T axis of the robot
0005' user must enter tool to
0006' create, user frame used,
0007' and teach the calibration
0008' position
0009'*****
0010'1)
0011' set LB000 to the
0012' tool number to create
0013 SET LB000 10
0014'*****
0015'2)
0016' set LB001 to the user frame
0017' number used for calibration
0018 SET LB001 10
0019'*****
0020'3)
0021' teach this position as the
0022' camera calibration position
0023' with the same tool as LB000
0024 MOVJ VJ=20.00 PL=0
0025'*****
0026 GETTOOL LP000 TL#(LB000)
0027 SUB LP000 LP000
0028 SETTOOL TL#(LB000) LP000
0029 GETS LPX000 $PX000
0030 CNVRT LPX000 LPX000 UF#(LB001) TL#(LB000)
0031 INVMT LP000 LP000
0032 SETTOOL TL#(LB000) LP000
0033 END
MOVJ VJ=0.78
```

- Setting for Stand-Off Distance

- Configure for the camera's "distance-to-weld seam." For robot-mounted Cognex cameras, for each weld seam the robot needs to position the camera to a certain stand-off distance from the weld seam. This distance should be the same distance used during the previous step's calibration. Two methods exist: (1) User Frame Method and (2) M2D-SFT macro job
 - UF method:
 1. teach a User Frame "A" onto the weld seam to be detected. Use either the 3-point method (manually teaching these points) or Calculated 3-point method (MFRAME instruction)
 2. Move the robot's TCP to User Frame Origin (0,0,0) using the Tool File# taught previously (when the TOOL Job was executed)
 3. Repeat for each location of the weld seam you need to measure.

Motosight 2D for welding

- Setting for Stand-Off Distance
 - M2D-SHFT macro job method:
 - Manually configure a P Variable (ie. P127) for proper camera height. (i.e. -120mm in Z of Tool Frame using Tool # x).
 - Create a P Variable based on TOOL Coordinates. Reference the TOOL FILE number used previously for calibration.
 - Set X, Y, and Z amounts
 1. Move torch TCP to center of grid
 2. Execute IMOV P*** TF V=***
 3. Robot should move camera to stand-off distance from grid and roughly over the center of the grid

The screenshot shows a software interface for configuring a position variable. The title bar reads "POSITION VARIABLE". The main window contains a table with the following data:

#P127	TOOL	NAME	CAMfocal
R1 :X	-37.000		
Y	68.000	TOOL: 00	
Z	-240.000	<TYPE>	
Rx	0.0000	FRONT	S< 180
Ry	0.0000	UP	R< 180
Rz	0.0000	FLIP	T< 180

Motosight 2D for welding

- Setting for Stand-Off Distance

- M2D-SHFT macro job method [con't]:

- Reference this P Variable number in the M2D-SFT macro job's "SETUP" section.
- Create your temporary / test Job, insert M2D-SFT macro instruction, and set "MoveCamera2Focal" argument to a value of 1.
- Move the end of welding wire / torch TCP to center of grid. INT LOCK + TEST START this macro instruction and observe the camera moves to the needed height / location above grid

ARGUMENT SETTING		
JOB NAME : M2D-SHFT		
COMMENT1	TYPE	COMMENT2
Pvar# masterPart	16	
Pvar# DetectPart	9	
Teach PvarMstrPt	1	Teach=1
MoveCamera2Focal	0	MOV=1

M2D-SHFT pMstr:16 pDet:9 Teach:1 move:0

POSITION VARIABLE			
#P127	TOOL	NAME	CAMfocal
R1 :X	-37.000		
Y	88.000	TOOL: 00	
Z	-240.000	<TYPE>	
Rx	0.0000	FRONT	S< 180
Ry	0.0000	UP	R< 180
Rz	0.0000	FLIP	T< 180

- Now to Program the Application! ...
- Open the robot Job to be used for detecting the weld seam location. Move camera over weld seam (using UF or M2D-SHFT).
- From In-sight Explorer
 - **Make an In-Sight Explorer “JOB”** from on an existing JOB. Note: do not create a new job; rather, copy and change from an existing MS2D template.
 - **Add a Tool(s)** to detect weld seam / part geometry. Adjust lighting / lighting angle (robot position) / exposure. Set size of inspection Tool based on expected part movement. Finally, set sensor to ONLINE and then LOG OFF from PC.
 - For most applications, EDGE Tool is satisfactory for welding applications. EDGE is convenient because it is portable (one Cognex Job / 1 Tool can be used for multiple weld joint locations).
 - Ensure the EDGE tool is perpendicular to the edge of the weld seam
 - PatMax may be able to be used for smaller welds
 - If you take care with Cognex settings (Tool size, location, lighting/exposure, etc.), you may be able to use the same Cognex job for multiple weld seam measurements (ie. 10 measurements along a 10' long weld seam might all be able to use the same Cognex Job)

Motosight 2D for Welding

- In-Sight Explorer
 - Tool added via “Locate Part” > “Edge” tool
 - Adjust for “transition”, “contrast”, and “find by” settings
- If poor image stability is observed due to poor contrast, adjust ambient lighting / add external light source
- When completed with sensor and Tool settings, Exit Insight-Explorer.

The screenshot displays the In-Sight Explorer software interface. The main window shows a grayscale image of a weld joint with a green bounding box around it. The interface is divided into several panels:

- Application Steps:** A vertical list of steps including "1. Start" (Get Connected, Set Up Image), "2. Set Up Tools" (Locate Part, Inspect Part), "3. Configure Results" (Inputs, Outputs, Communication), and "4. Finish" (Filmstrip, Save Job, Run Job).
- Results Palette:** A table showing the results of the tool run.

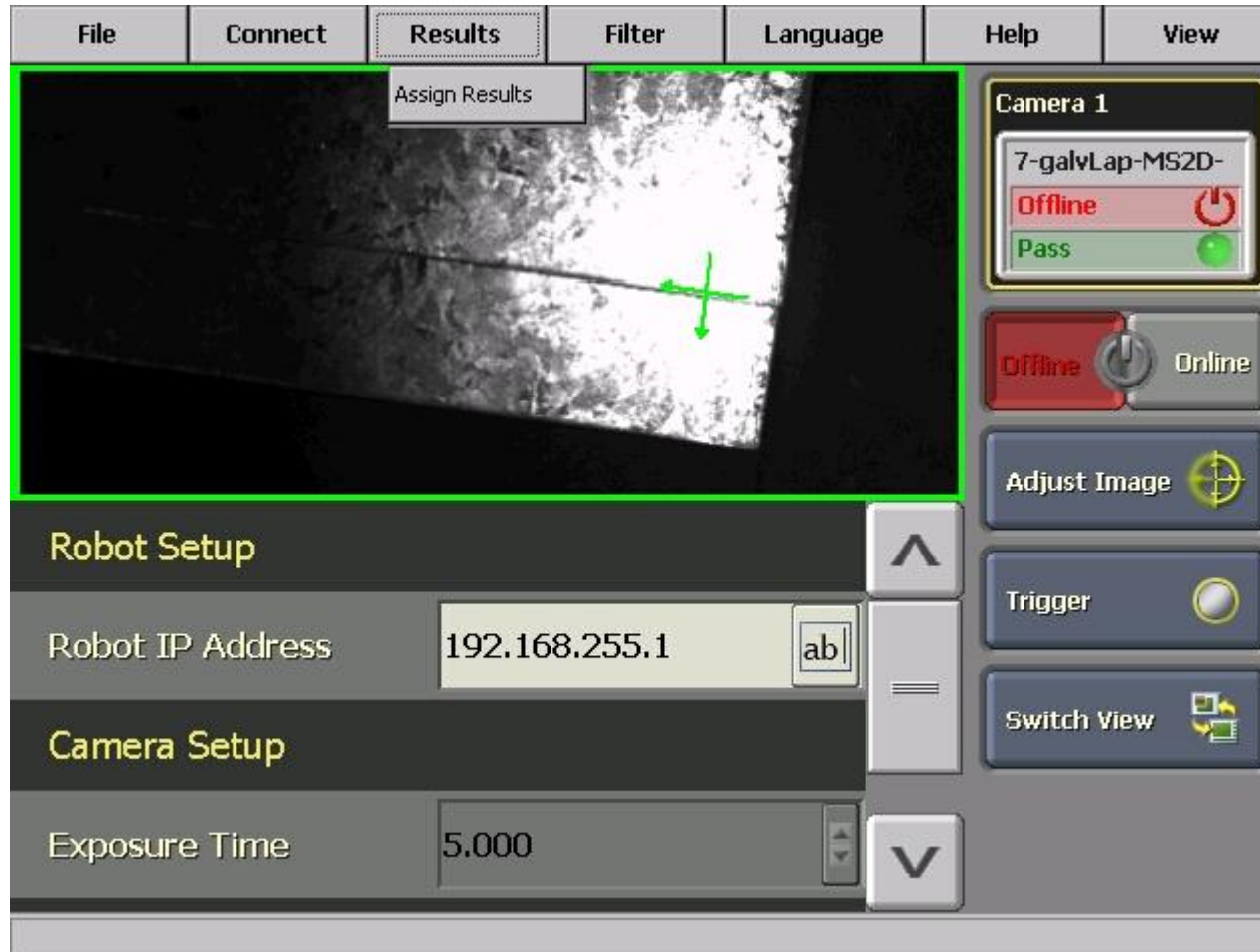
Name	Result
Edge_2m...	(-9.2,17.5) 2.9°
- Add Tool:** A list of tools including Location Tools, PatMax® Pattern, Pattern, PatMax® Patterns (1-10), Patterns (1-10), Edge, Edge Intersection, Blob, Blobs (1-10), Color Blob, and Color Blobs (1-10).
- Edit Tool - Edge_2mmLap:** A settings panel for the Edge_2mmLap tool, showing fields for Tool Name, Tool Fixture, Tool Enabled, Include In Job Pass, Execution Time (ms), and Description.
- Score Graph:** A line graph showing the score of the tool run over an offset range from 0 to 95. The score fluctuates around a mean value, with a peak near the end of the range.

Motosight 2D for Welding

The screenshot displays the Motosight 2D software interface. On the left, two 'Edit Tool - Edge_2mmLap' panels are visible. The top panel shows the 'General' tab with the following settings: Tool Name: Edge_2mmLap, Tool Fixture: None, Tool Enabled: On, Include In Job Pass: checked, Execution Time (ms): 6.501, and a blank Description field. The bottom panel shows the 'Settings' tab with: Edge Contrast: 25, Edge Transition: Light to Dark, Edge Width: 5, Find By: First Edge, Angle Range: 10, and Result: (-92,17.5) 2.9°. The main window shows a grayscale image of a weld joint with a green rectangular box highlighting the edge detection area. A green line with arrows indicates the detected edge path, and a purple 'C' symbol is visible on the right edge of the box.

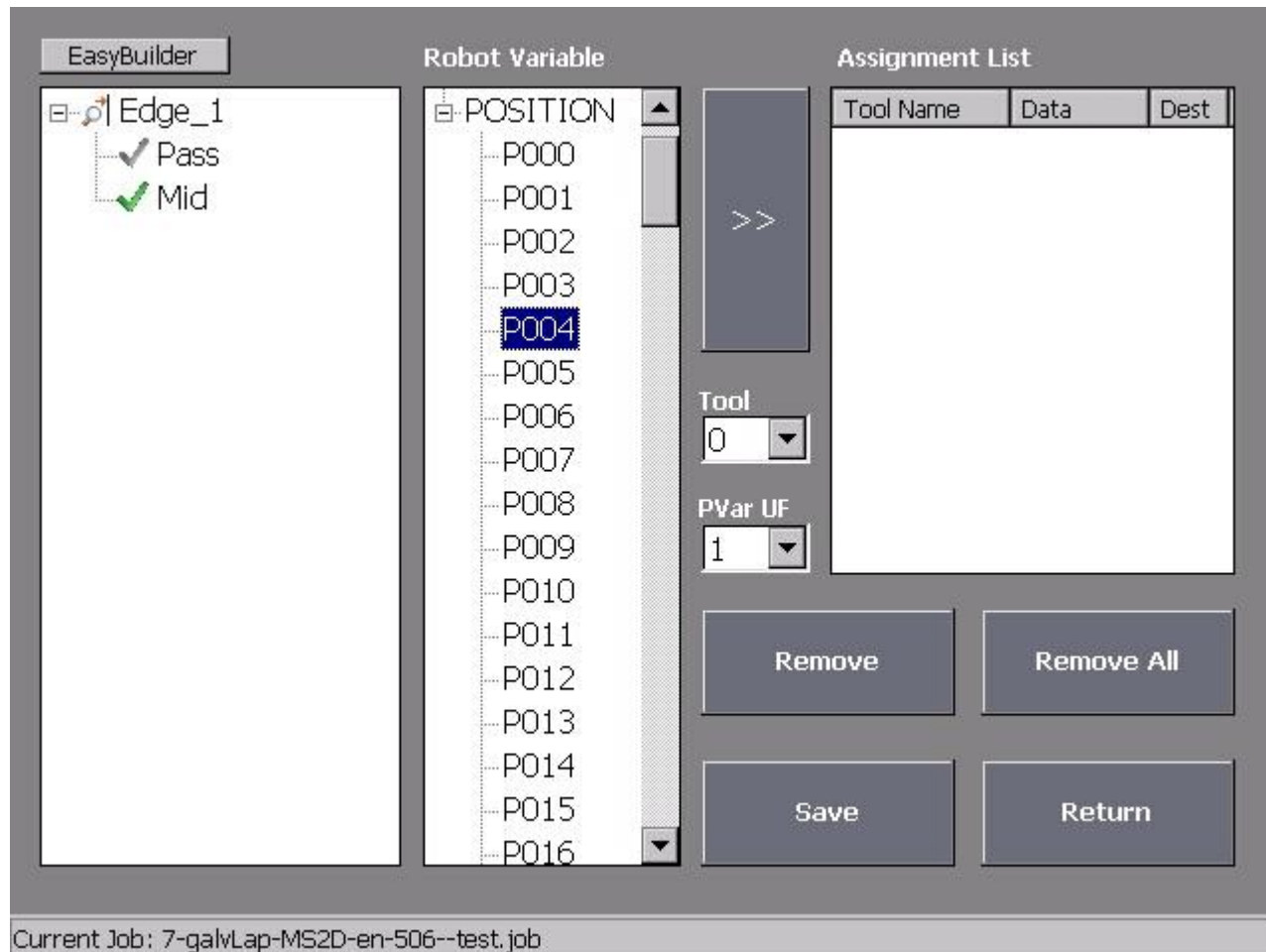
Motosight 2D for welding

- Next, on the DX controller, open the PP Application for EASY BUILDER.



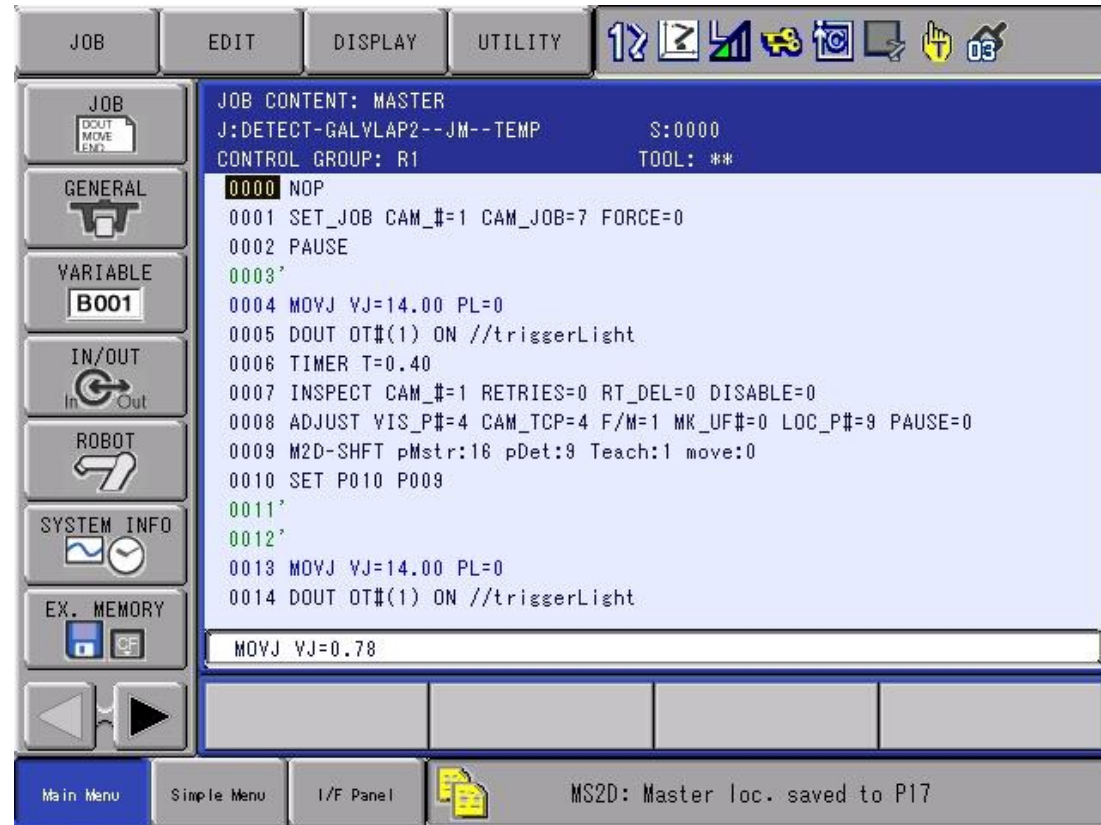
Motosight 2D for welding

- Assign variable(s) to inspection Tool(s) created previously.



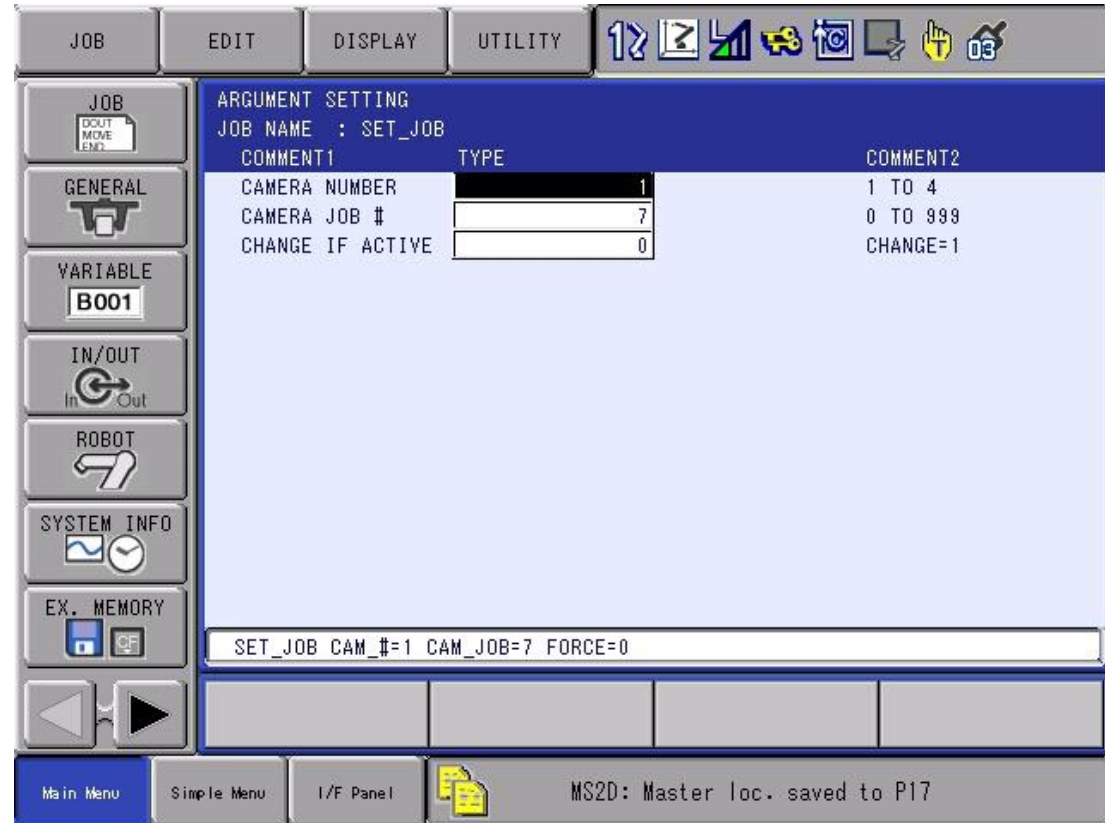
Motosight 2D for welding

- Add INFORM commands to process this inspection
 - SET_JOB
 - INSPECT
 - ADJUST
 - M2D-SHFT (Not part of the Motosight 2D standard macro jobs)



Motosight 2D for welding

- SET_JOB macro
 - Opens a job in the Cognex camera. To be called by this macro, the Job name in the camera must begin with a number, and the CAM_JOB argument references this number.



Motosight 2D for welding

- INSPECT macro
 - allows the Cognex camera to Trigger the measurement
 - handles system errors related to this measurement
 - Configure Re-Try sequences

The screenshot displays the Motosight 2D software interface. At the top, there are menu tabs: JOB, EDIT, DISPLAY, and UTILITY. Below these are several icons for navigation and control. The main window is titled 'ARGUMENT SETTING' and shows the 'JOB NAME : INSPECT'. A table lists the settings for the macro:

COMMENT1	TYPE	COMMENT2
CAMERA NUMBER	1	1 TO 4
# OF RETRIES	0	0 TO 255
RETRY DELAY	0	MILISECS
DISABLE ALARM	0	0=ALARM

Below the table, a status bar shows the current settings: 'INSPECT CAM_#=1 RETRIES=0 RT_DEL=0 DISABLE=0'. At the bottom of the interface, there are buttons for 'Main Menu', 'Simple Menu', and 'I/F Panel', along with a status indicator 'MS2D: Master loc. saved to P17'.

Motosight 2D for welding

- ADJUST macro
 - Configures how the measurement data is configured (which User Frame) and the destination P variable #
 - Saves the measurement location to a 2nd P variable in Base Frame (useful for weld path shifting)

The screenshot displays the 'ARGUMENT SETTING' screen for the 'ADJUST' macro. The interface includes a top menu bar with 'JOB', 'EDIT', 'DISPLAY', and 'UTILITY' options, along with various navigation icons. A left sidebar contains buttons for 'JOB', 'GENERAL', 'VARIABLE' (with 'B001' selected), 'IN/OUT', 'ROBOT', 'SYSTEM INFO', and 'EX. MEMORY'. The main area shows a table of arguments with columns for 'COMMENT1', 'TYPE', and 'COMMENT2'. Below the table, a summary line reads 'ADJUST VIS_P#=4 CAM_TCP=4 F/M=1 MK_UF#=0 LOC_P#=9 PAUSE=0'. The bottom status bar shows 'Main Menu', 'Simple Menu', 'I/F Panel', and the message 'MS2D: Master loc. saved to P17'.

COMMENT1	TYPE	COMMENT2
VISION RESULT(P)	4	0 TO 127
CAMERA TCP #	4	0 TO 15
FIXED/MOBILE CAM	1	FIXED=0
UF# TO CREATE	0	0 TO 16
VIS RESULT BF(P)	9	0 TO 255
PAUSE	0	0 or 1

ADJUST VIS_P#=4 CAM_TCP=4 F/M=1 MK_UF#=0 LOC_P#=9 PAUSE=0

MS2D: Master loc. saved to P17

Motosight 2D for welding

- M2D-SHFT macro
 - Developed for conceptual purposes (not a standard macro job with MS2D)
 - Stores master part location into P var “masterPart” (this is done during teaching)
 - During playback, it compares location of “DetectPart” P var to “masterPart”, and then calculates a shift amount
 - The “MoveCamera2Focal” argument is used to place camera at proper height over weld seam

The screenshot displays the 'ARGUMENT SETTING' screen for the 'M2D-SHFT' macro job. The interface includes a top menu bar with 'JOB', 'EDIT', 'DISPLAY', and 'UTILITY' options, and a toolbar with various icons. A left sidebar contains buttons for 'JOB', 'GENERAL', 'VARIABLE', 'IN/OUT', 'ROBOT', 'SYSTEM INFO', and 'EX. MEMORY'. The main area shows a table of arguments and their values.

COMMENT1	TYPE	COMMENT2
Pvar# masterPart	16	
Pvar# DetectPart	9	
Teach PvarMstrPt	1	Teach=1
MoveCamera2Focal	0	MOV=1

Below the table, a status bar displays the macro parameters: M2D-SHFT pMstr:16 pDet:9 Teach:1 move:0. At the bottom, a footer shows 'MS2D: Master loc. saved to P17'.

Motosight 2D for welding

- Robot Job structure:
 - INSPECT + ADJUST + M2D-SHFT = shift amount
 - Use SFTON instruction as you would with other sensing technologies.

```
0001 SET_JOB CAM_#=1 CAM_JOB=7 FORCE=0
0002 PAUSE
0003'
0004 MOVJ VJ=14.00 PL=0
0005 DOUT OT#(1) ON //triggerLight
0006 TIMER T=0.40
0007 INSPECT CAM_#=1 RETRIES=0 RT_DEL=0 DISABLE=0
0008 ADJUST VIS_P#=4 CAM_TCP=4 F/M=1 MK_UF#=0 LOC_P#=9 PAUSE=0
0009 M2D-SHFT pMstr:16 pDet:9 Teach:1 move:0
0010 SET P010 P009
0011'
0012'
0013 MOVJ VJ=14.00 PL=0
0014 DOUT OT#(1) ON //triggerLight
0015 INSPECT CAM_#=1 RETRIES=0 RT_DEL=0 DISABLE=0
0016 DOUT OT#(1) OFF //triggerLight
0017 ADJUST VIS_P#=4 CAM_TCP=4 F/M=1 MK_UF#=0 LOC_P#=9 PAUSE=0
0018 M2D-SHFT pMstr:17 pDet:9 Teach:0 move:0
0019 SET P011 P009
0020'
0021'
0022 MOVJ VJ=14.00
0023 SFTON P010
0024 MOVL V=222.0
0025 TIMER T=0.20
0026 SFTON P011
0027 MOVL V=60.0
0028 TIMER T=0.20
0029 SFTOF
0030 MOVJ VJ=4.00
0031 END
```

- Closing notes
 - Cognex Tools are available for measuring distances between two objects (ie. two edges). This could be useful for Adaptive Welding where Gap measurement can lead to weld parameter changes.