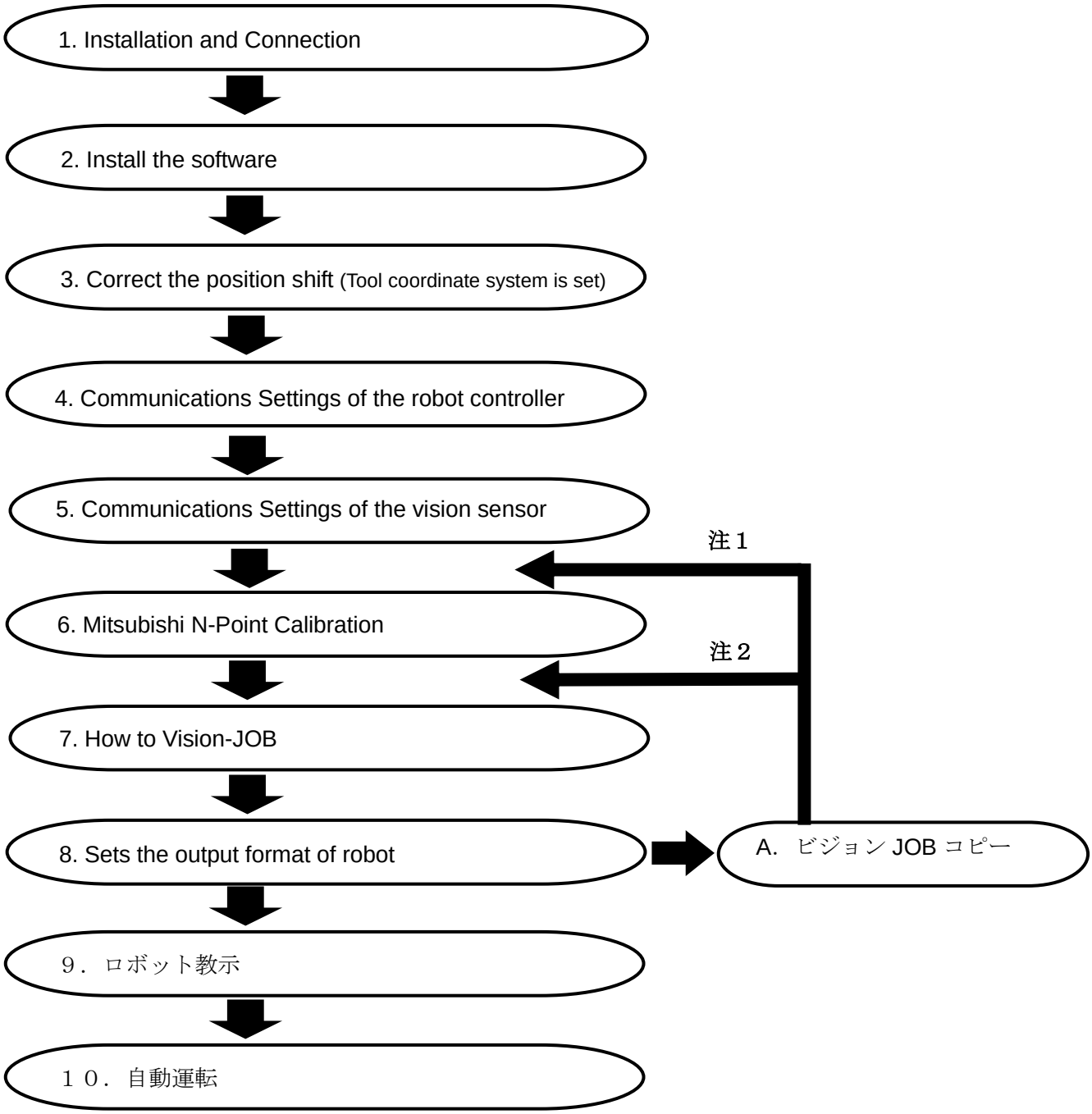
Training-Manual

In-sight & EasyBuilder Startup manual

The procedure of the start-up



＊ 注１：キャリブレーションをやり直す場合

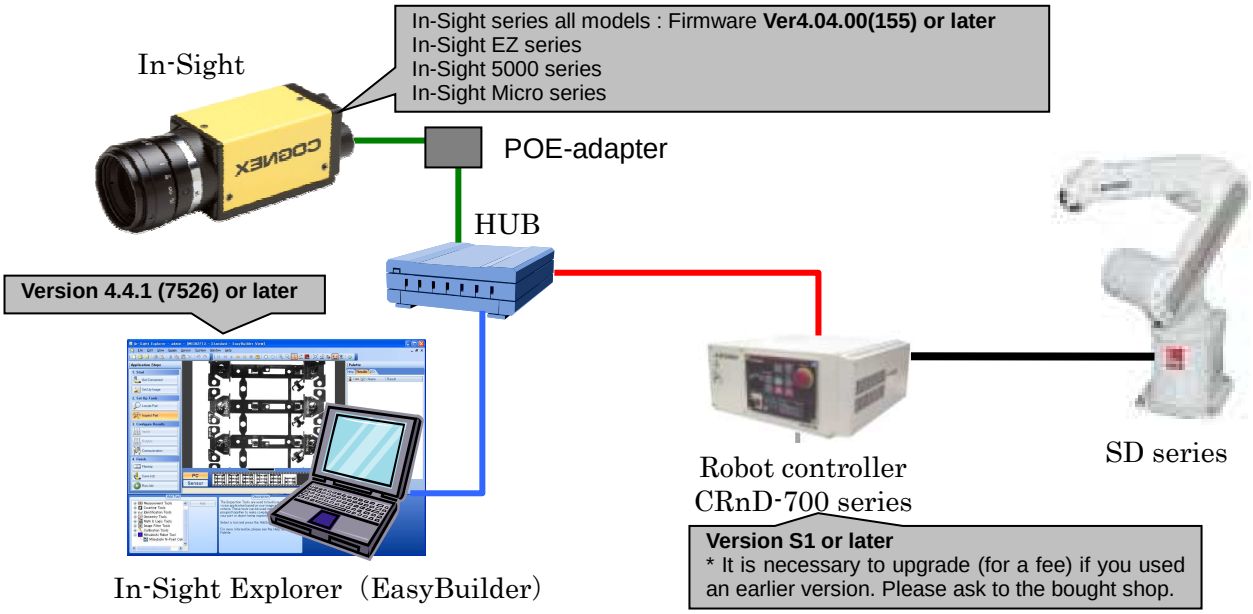
＊ 注２：キャリブレーションをやり直さない場合

1. Installation and Connection

Example of connecting each controller

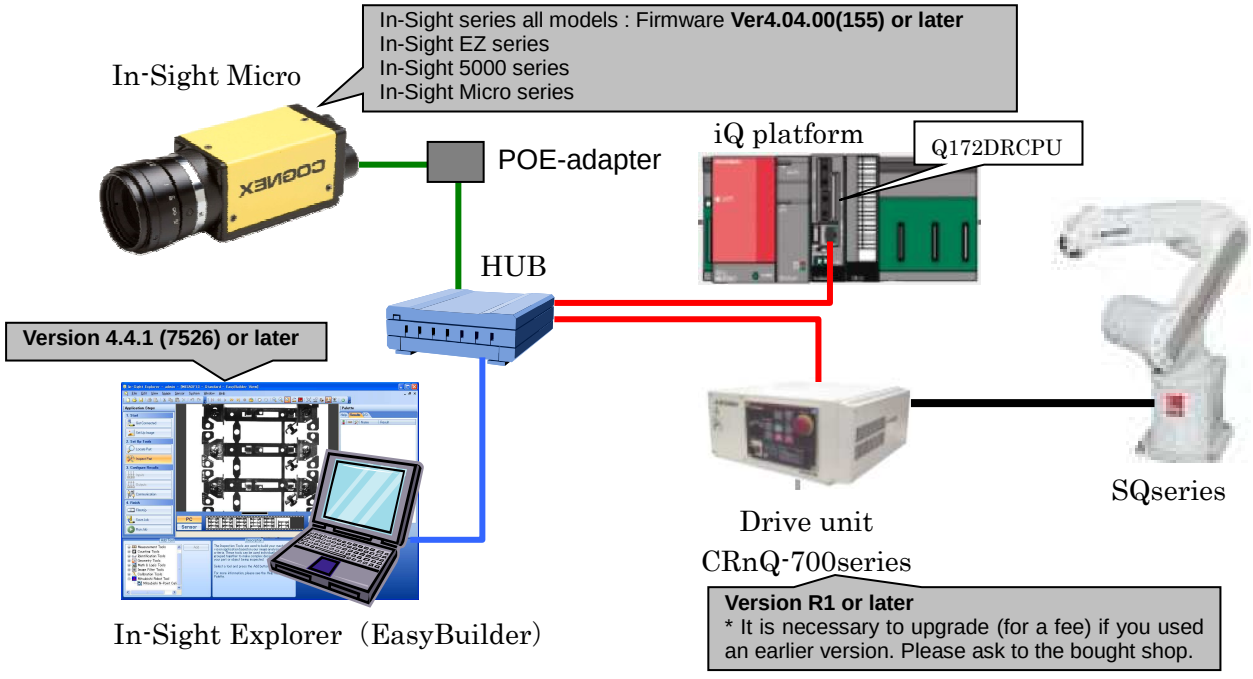
SD series

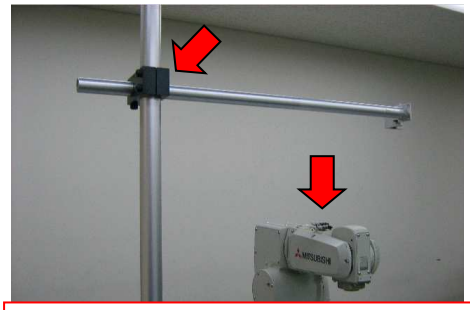
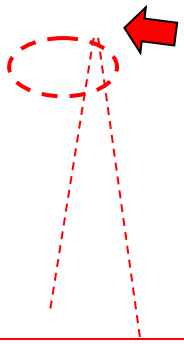
The robot controller and the In-Sight Micro model are connected with the Ethernet hub. Please connect the personal computer with the Ethernet hub when you edit the jobs (Image processing programs) by using In-Sight Explorer (EasyBuilder).

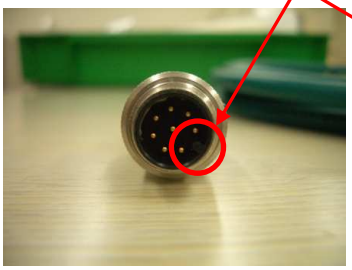
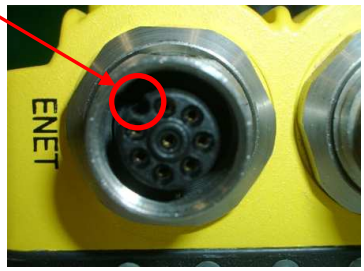
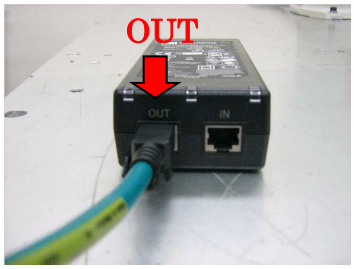
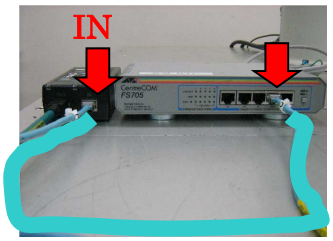
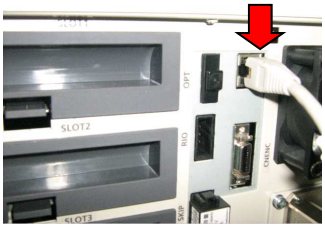
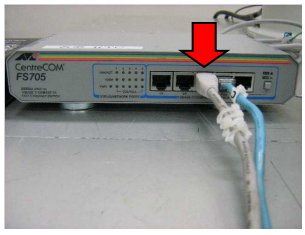
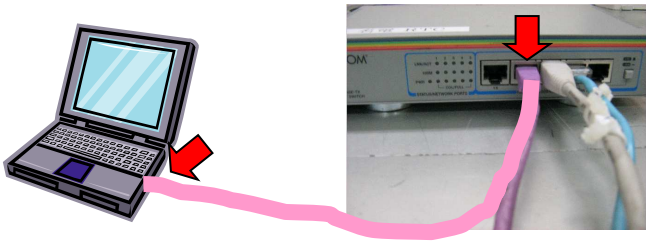


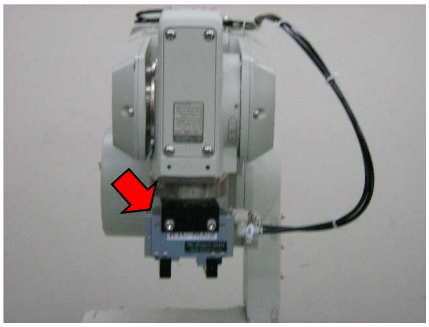
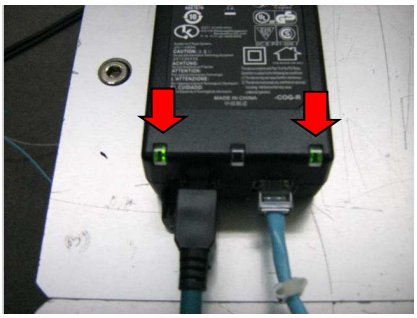
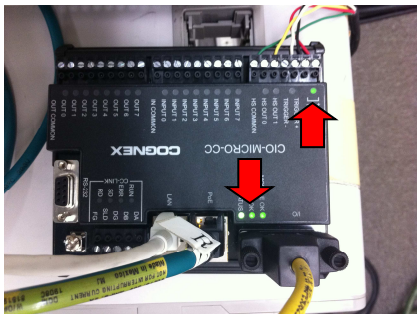
SQ series

The robot CPU unit(Q172DRCPU) and the In-Sight Micro model are connected with the Ethernet hub. Please connect the personal computer with the Ethernet hub when you edit the jobs (Image processing programs) by using In-Sight Explorer (EasyBuilder).



No	Procedure (and Caution)
1-1	The robot and the camera-stand installation are set up.  Please fix camera-stand so as not to move. It causes the position to change.  Camera-stand don't collide with Robot. (Caution: move area of Robot)
1-2	The camera and the bracket are assembled.  In-Sight EZ(Micro) series  In-Sight 5400 series
1-3	The camera and the lens are assembled.  In-Sight EZ(Micro) series  In-Sight 5400 series
1-4	The camera and the bracket are assembled.  Camera is horizontally setting in Robot-Base.

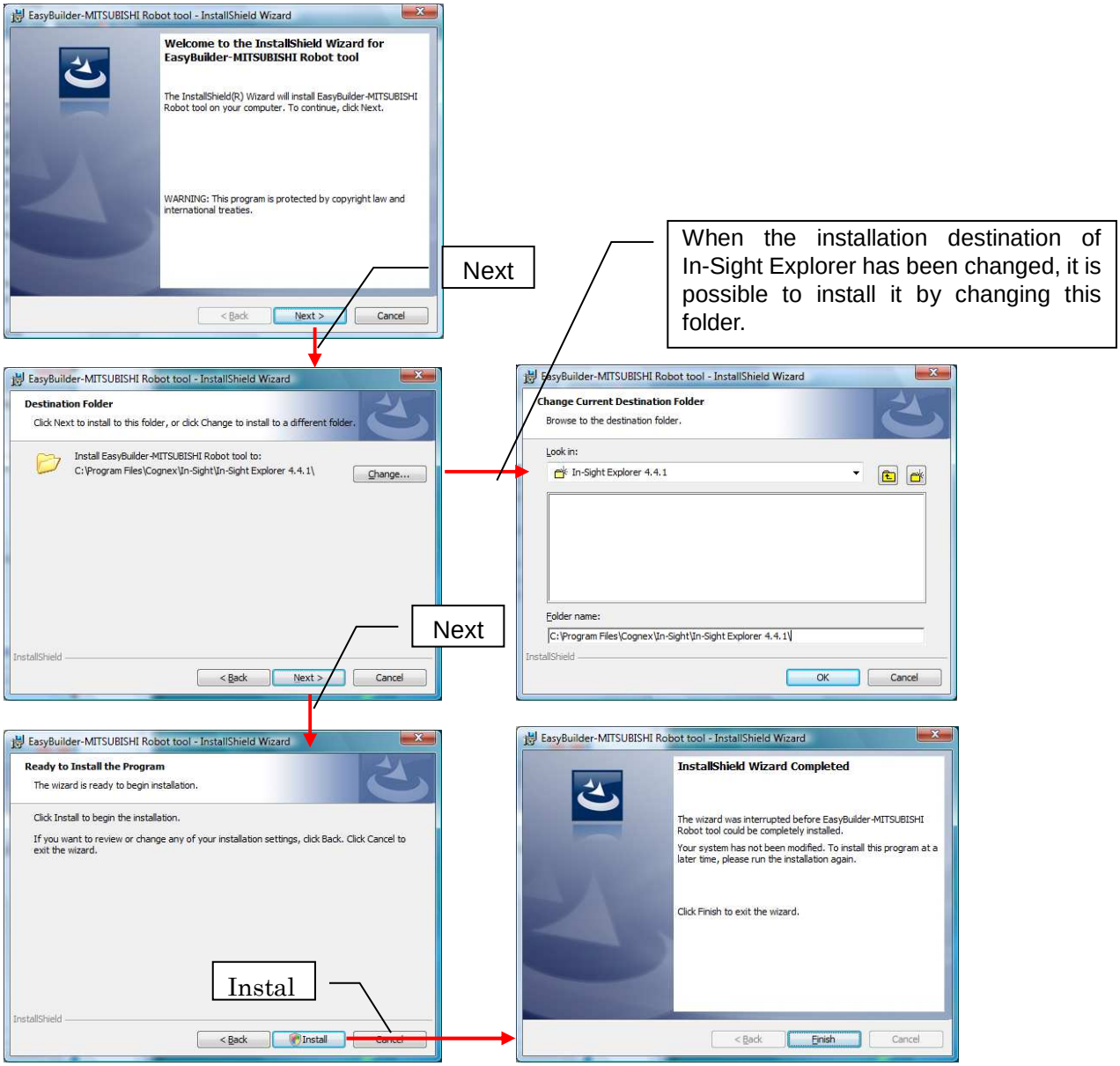
1-5	The Ethernet cable is connected with the camera.    The ditch is matched and connected.
1-6	The Ethernet cable connected with the camera is connected with POE-adapter (I/O unit).   POE-adapter CIO-Micro-CC (I/O unit) Connect it with the **OUT** side. The Ethernet cable is a straight type.
1-7	The HUB and the POE-adapter connected with Ethernet cable.  POE-adapter HUB Connect it with the **IN** side. The Ethernet cable is a straight type.
1-8	The Robot controller and The HUB connected with Ethernet cable.   Robot controller HUB The Ethernet cable is a straight type.
1-9	The HUB and The PC (RT-ToolBox2 must be installed) connected with Ethernet cable.  PC HUB

1-10	The robot and the hand are assembled. 
1-11	Power on robot controller. 
1-12	Power on camera.  POE-adapter  CIO-Micro-CC (I/O unit) OK : All LED is on by green. NG : LED is turn off or red.

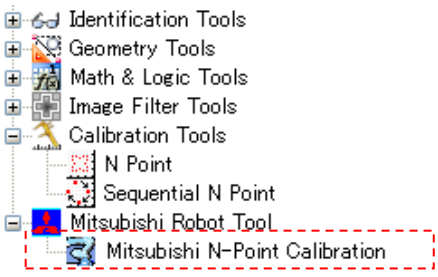
2. Install the software

(1) Obtain the installer. (Please inquire the obtaining method of the purchase shop.)

(2) Execute the installer.



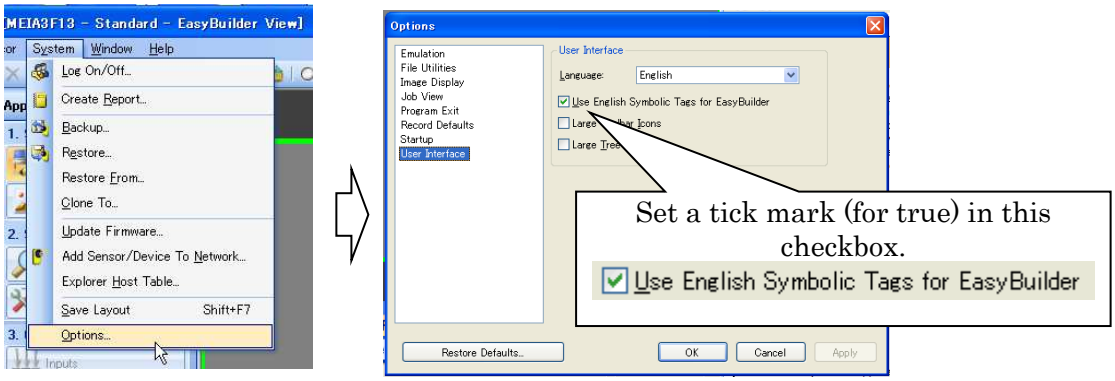
(3) Please start In-Sight Explorer, and confirm the result of the installation.
When succeeding in the installation, "Mitsubishi Robot Tool" and "Mitsubishi N-point calibration" are added to "Add tool" tree in EasyBuilder.



Caution

Please use "English symbolic tag" in the EasyBuilder.

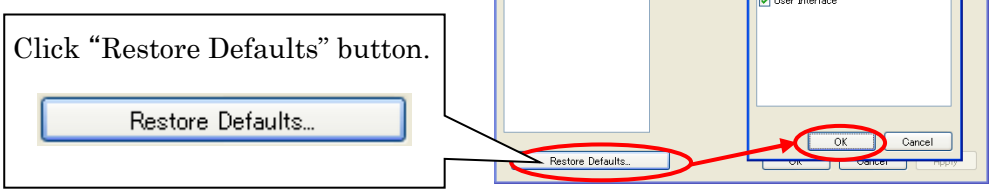
Please set optional information on EasyBuilder according to the following procedures to improve the compatibility between the robot controller and the vision sensor. As a result, it is possible to acquire the information from the vision sensor by using the value of robot parameter "EBRDTAG".



Caution

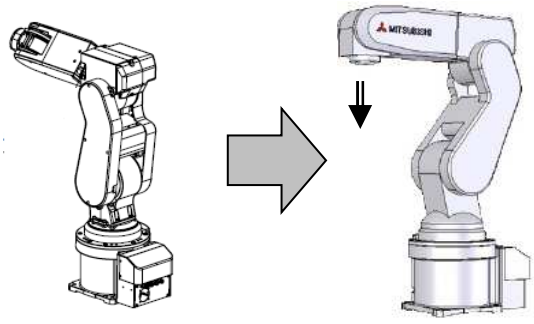
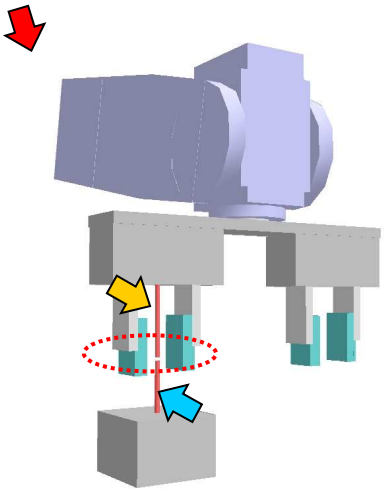
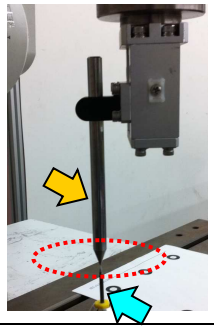
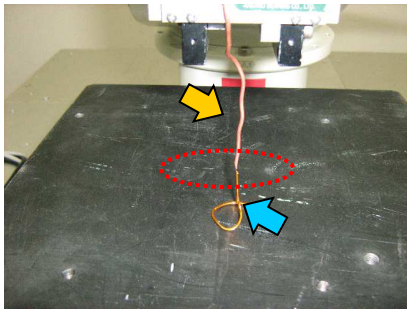
If the error occurs when the value is changed, please execute "Restore Defaults".

When this error occurred, please set a tick mark in the checkbox "Use English Symbolic Tags for EasyBuilder" after executing "Restore Defaults".

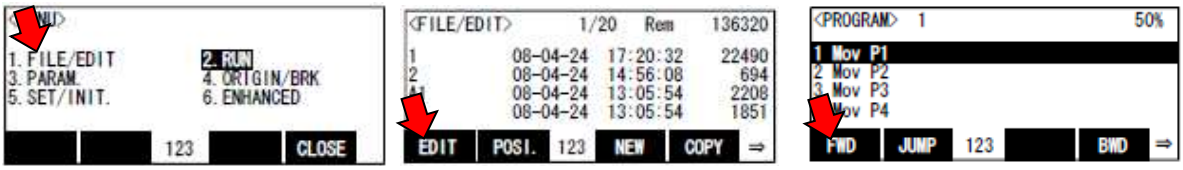


3. Correct the position shift (Tool coordinate system is set)

Holding (adsorption) position is set. If this is not set, it causes misregistration.

No	Procedure (and Caution)
3-1	The additional program (”TL.prg” and ”KHNE.prg”) is copied to the robot controller. TL.prg : Detection for holding position (adsorption position) . KHNE. Prg : Sample program.
3-2	The robot flange is made downward, and it is moved to the position with which it doesn’t interfere in the surrounding. 
3-3	Afterwards, align the hand is done. Execution of hand alignment [Align] 
3-4	The mark is installed on the position where work is held. (The mark use wire or Sharp treatment device.) It similarly installs on the trestle. Afterwards, each position is matched.  **Holding position (Adsorption position)** **Mark of hand (Wire or sharp treatment device)** **Mark of trestle (Wire or sharp treatment device)**  

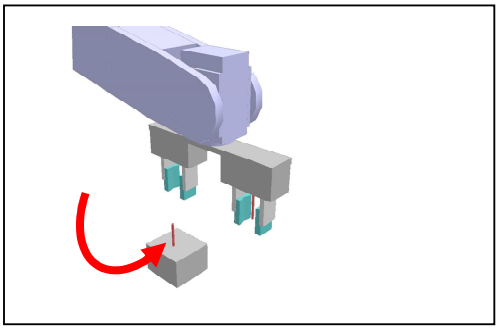
3-5	Robot program “TL.prg” open and "Step feed" from 1 to 10. (Don’t execute from 11 to 20.)




```
1 '###############
2 'Tool set program
3 '###############
4 '
5 Tool P_NTool
6 'Robot moving to first position.
7 P0=P_Fbc
8 P91=P0*(+0.00,+0.00,+0.00,+0.00,+0.00
9 Mvs P91
10 PTL=P_Zero
11 'Only X axis and Y axis of the robot are moved, and the
12 P90=P_Fbc
13 PT=Inv(P90)*P0
14 PTL.X=(PT.X+PT.Y)/2
15 PTL.Y=(-PT.X+PT.Y)/2
16 Tool PTL
17 P_01=PTL
18 'Only C axis is operated in JOG-Moving (XYZ jog) with the mark matched and it is confirmed not to cause the gap.
19 Hlt
20 End
```

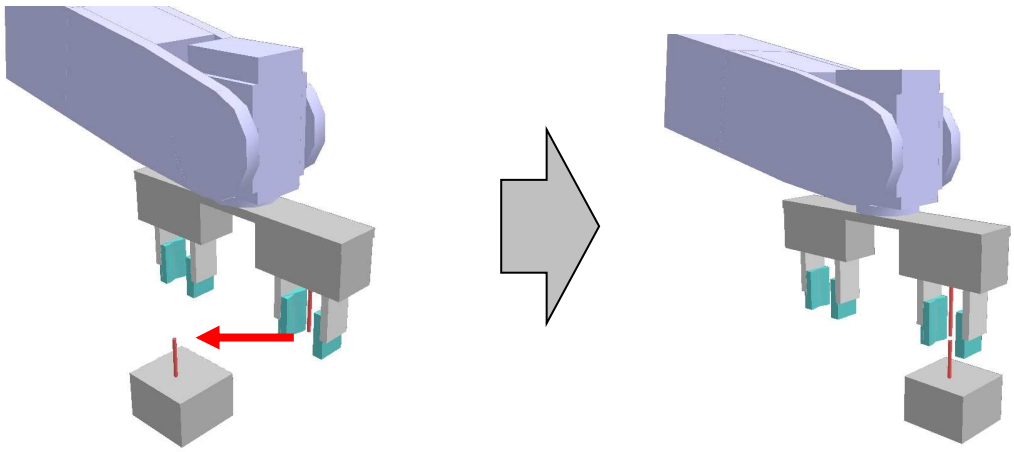
Only C axis moved by +90 degrees.

Do not interfere in the surrounding.



Do not execute these!

3-6	Only **X axis and Y axis** of the robot are moved, and the mark is matched. Execute it from clause 2-2 again when you operate other axes by mistake.



3-7

Execute “Step feed” from 11 to 20.

Afterward, tool coordinate system is set.

```
1 '###################
2 'Tool set program
3 '###################
4 '
5 Tool P_NTool
6 'Robot moving to first position.
7 P0=P_Fbc
8 P91=P0*(+0.00,+0.00,+0.00,+0.00,+0.00,+90.00)
9 Mvs P91
10 PTL=P_Zero
```

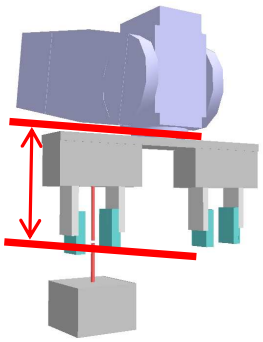
Don’t execute these!

```
11 'Only X axis and Y axis of the robot are moved, and the mark is matched.
12 P90=P_Fbc
13 PT=Inv(P90)*P0
14 PTL.X=(PT.X+PT.Y)/2
15 PTL.Y=(-PT.X+PT.Y)/2
16 Tool PTL
17 P_01=PTL
18 'Only C axis is operated in JOG-Moving (XYZ jog) with the mark matched and it is confirmed not to cause the gap.
19 Hlt
20 End
```

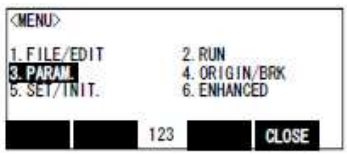
3-8

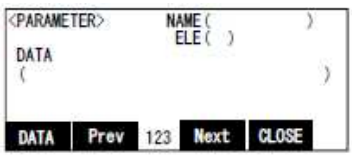
Tool coordinate system of Z axis is set.

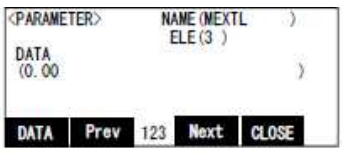
The distance from robot flange to holding p
measured.



Please set It to Parameter “MEXTL”.

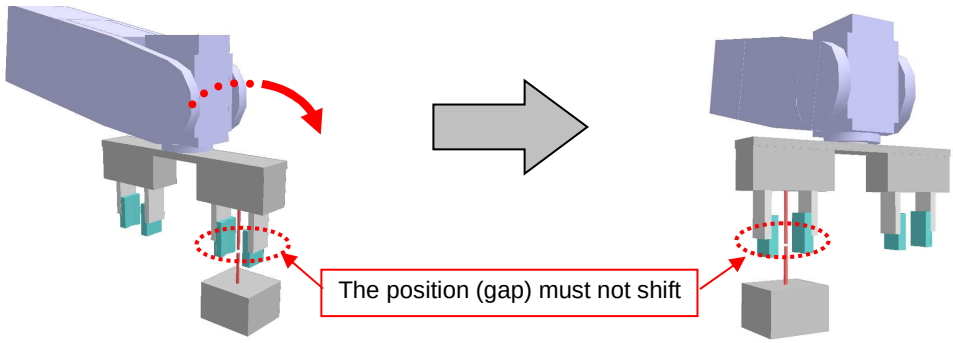






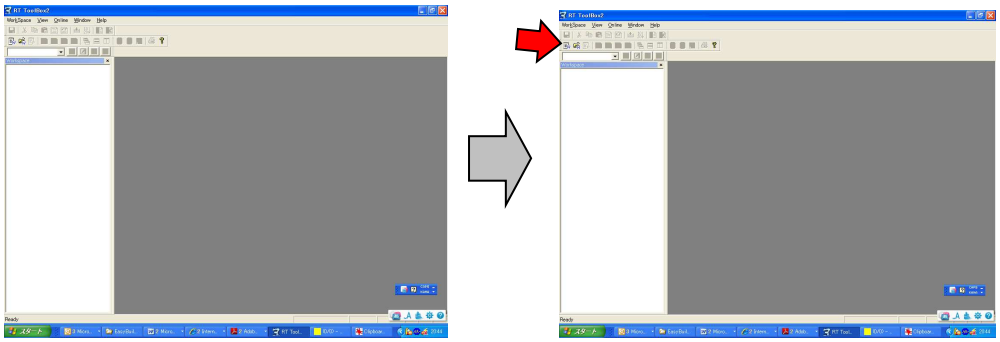
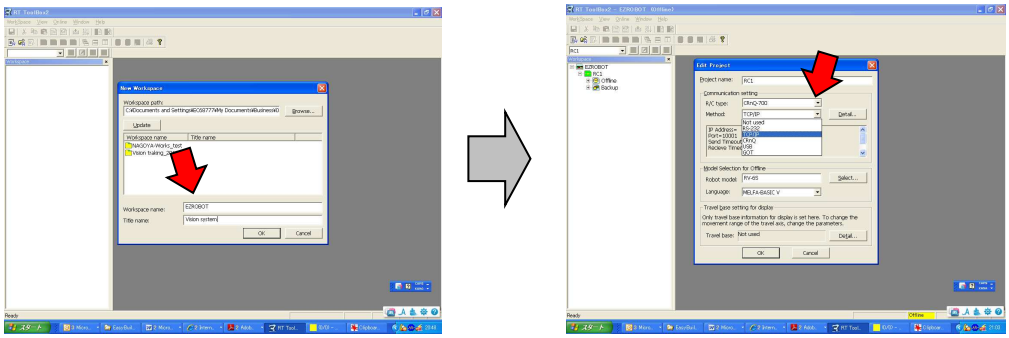
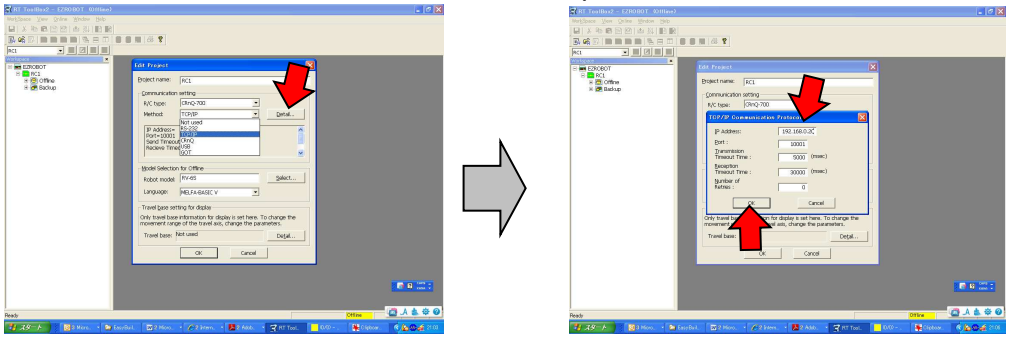
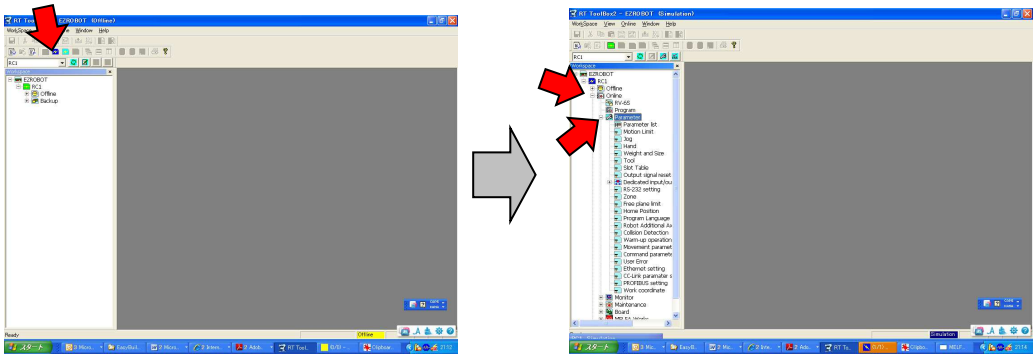
3-9

Please tool coordinate system confirm. Only C axis is operated in JOG-Moving (XYZ jog) with the mark matched and it is confirmed not to cause the gap.



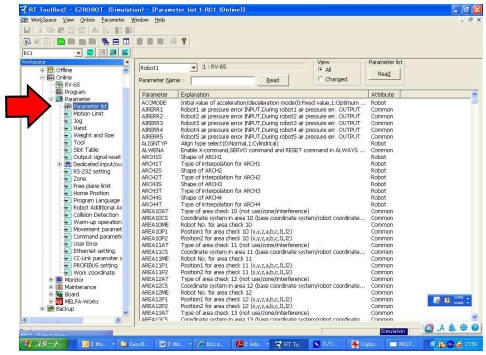
4. Communications Settings of the robot controller

It is necessary to set up the communication method of Ethernet for communicating between the robot and the vision sensor. Set up the following parameter by using “RT ToolBox2”.

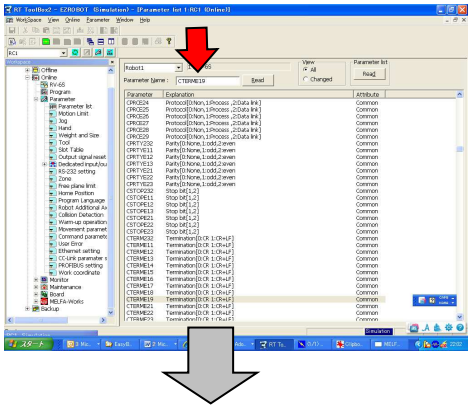
No	Procedure (and Caution)
4-1	Starts “RT ToolBox2”. > Selects “Workspace”. Selects “New Workspace” 
4-2	The name of “Workspace” is input. (Ex. EZROBOT) “R/C type” selects “CR-nQ-700” or “CR-nD-700”. “Method” selects “TCP/IP”. 
4-3	Selects “Detail…” Input “IP address” -> Selects “OK” -> Selects “OK”  IP address of Robot is parameter “NETIP”. Initial value : 192.168.0.20
4-4	Selects “Online”. Selects “Online” -> Selects “Parameter”. 

4-5

Selects “Parameter list”



Input parameter name. (as follows)



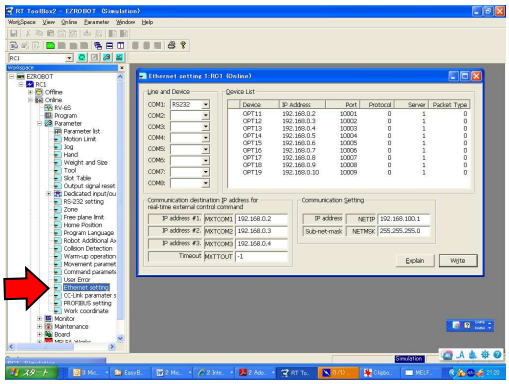
The Parameter is changed as follows.

	Parameter name	Value	Details explanation
1	NETIP	xxx.xxx.xxx.xxx	IP address of robot controller
2	NETTERM(9)	1 (Default value : 0)	The end code is added with communicating by Ethernet.
3	CTERME19	1 (Default value : 0)	The End code of port 10009 is changed to "CR+LF".
4	NETPORT(10)	10009 (Default value : 10009)	Port number allocated to device OPT19
5	CPRCE19	0 (Default value : 0)	The protocol used is "Non-procedure"
6	NETMODE(9)	1 (Default value : 1)	Opens as "Server".
7	NETHSTIP(9)	unused	

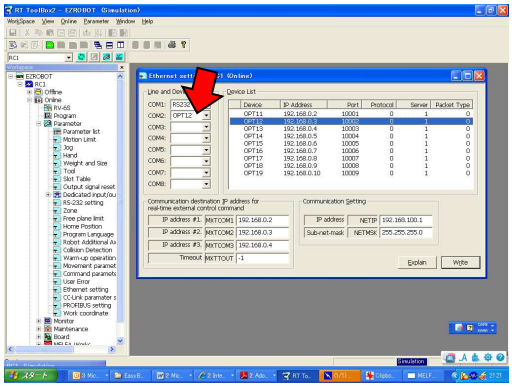
* No.1, 2, and 3 in above list should be changed from an initial value. No.4, 5, and 6 should be same as the above mentioned.

4-6

Selects “Ethernet setting”.

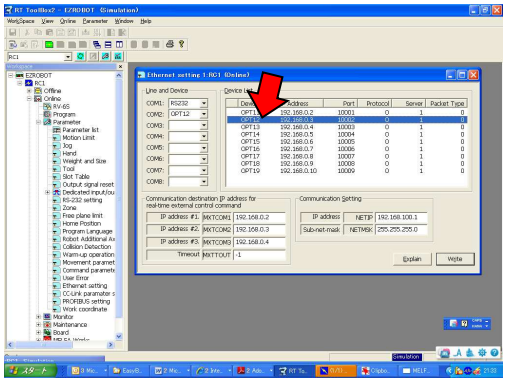


COM2 is selects from "OPT11" to "OPT19". (Ex.OPT12)

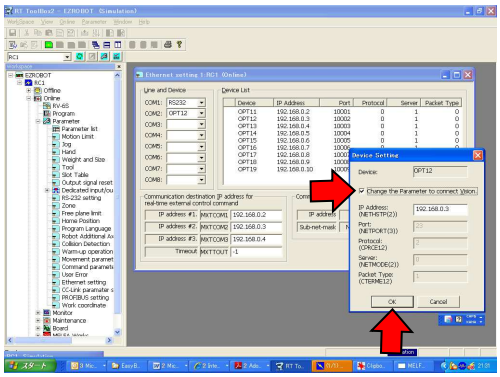


4-7

“OPT12” is double-clicked.



Selects “change the parameter to connect vision”.
-> Input “IP address”. (Don’t overlap with R/C.)
-> Selects “OK”



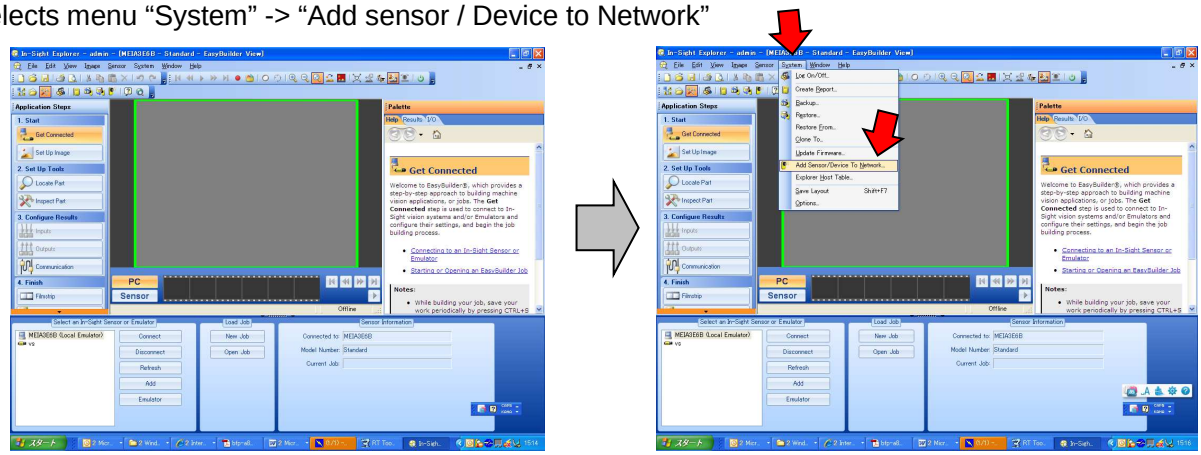
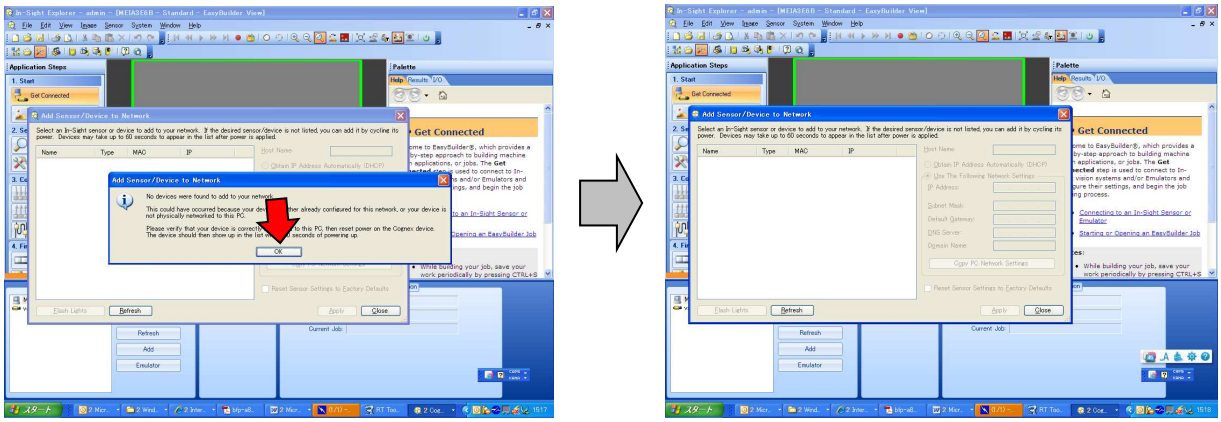
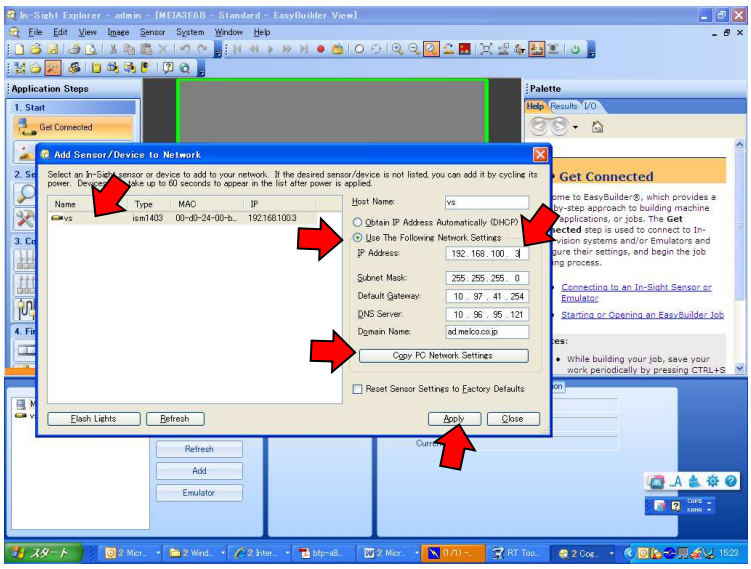
When the operation is executed, the parameter is changed as follows.

	Parameter name	Value	Details explanation
1	NETIP	xxx.xxx.xxx.xxx	IP address of robot controller
2	NETTERM(9)	1 (Default value : 0)	The end code is added with communicating by Ethernet.
3	CTERME12	1 (Default value : 0)	Changing the end code of Port 10009 to "CR+LF".
4	NETPORT(3)	23 (Default value :10003)	Port number allocated to device OPT12.
5	CPRCE12	2(Default value :0)	The protocol used is "data link".
6	NETMODE(2)	0(Default value :1)	Opens as "Client".
7	NETHSTIP(2)	xxx.xxx.xxx.xxx	Internet Protocol address of vision sensor to receive result

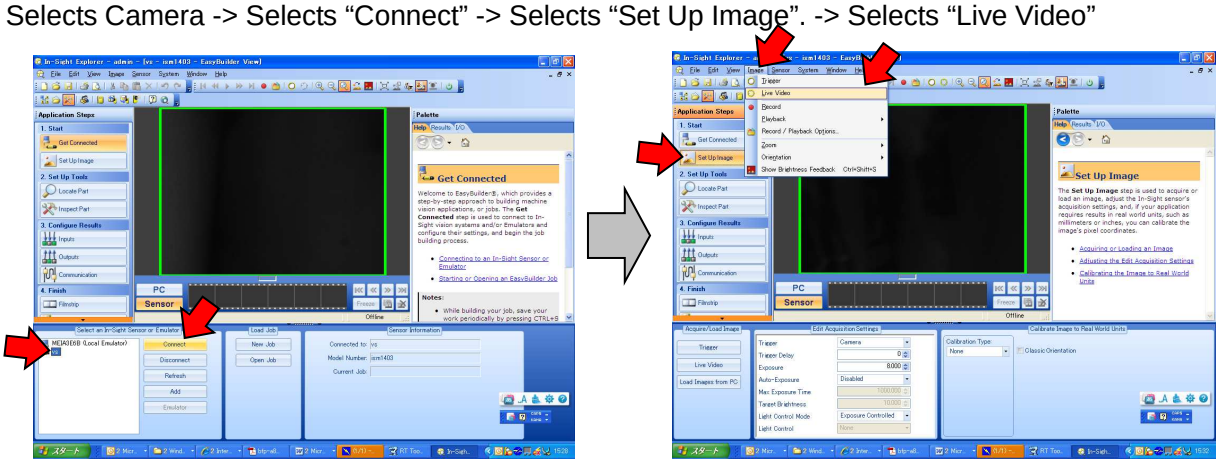
* No.3, 4, 5, 6 and 7 in above list should be changed from an initial value.

5. Communications Settings of the vision sensor

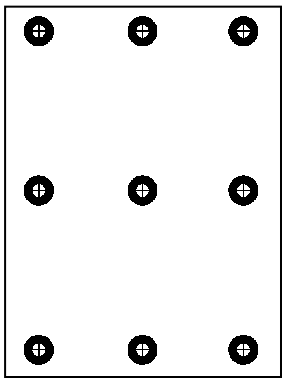
Please set up the Internet Protocol address of the vision sensor according to the following procedures.

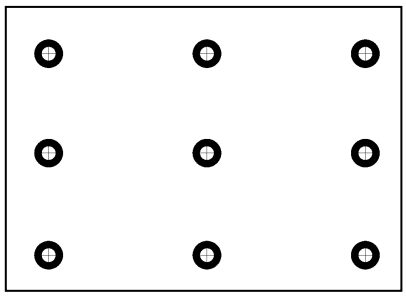
No	Procedure (and Caution)
5-1	Starts “In-Sight Explorer **(Ver 4.4.1(7526) or later)**”. Selects menu “System” -> “Add sensor / Device to Network” 
5-2	Selects “OK” -> Camera Power OFF→ON 
5-3	Clicks “Copy PC Network Settings” button after selecting the icon of vision sensor. Afterwards, set up the **Internet Protocol address** of vision sensor. Clicks “Connect” button after selecting the target camera in “Get Connected” tab. The firmware needs **4.04.00(155) or later**. -> Selects “OK” 

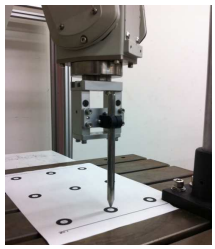
5-4 Selects Camera -> Selects “Connect” -> Selects “Set Up Image”. -> Selects “Live Video”



5-5 Calibration seat is printed out and setting as follows. (It is on the final page of this document.)

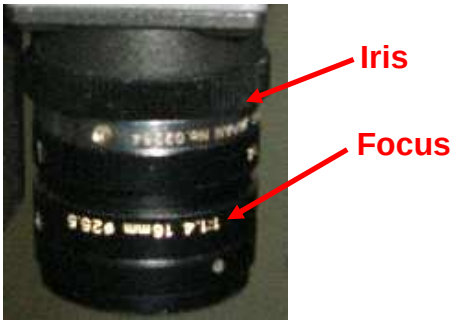






このときロボットを JOG で動かし、認識エリア内すべてにロボットがアクセスできることを確認しておく。特にアプローチ動作（上空位置への移動）までも問題なく行えることを確認しておくこと。動けない場合はカメラかロボットの位置を動かす。

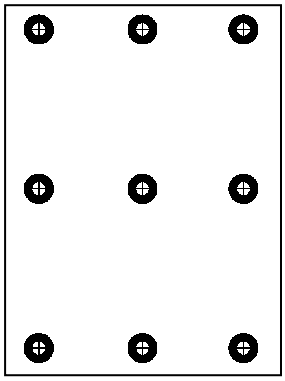
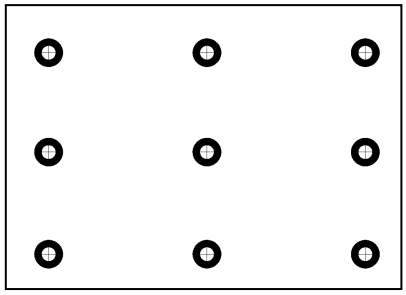
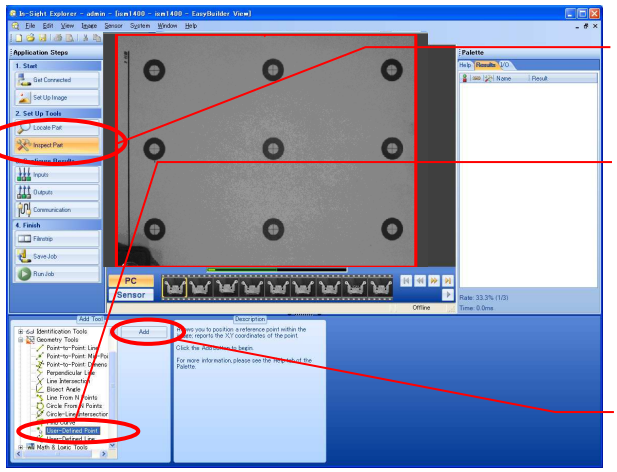
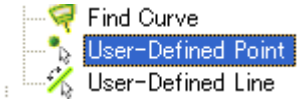
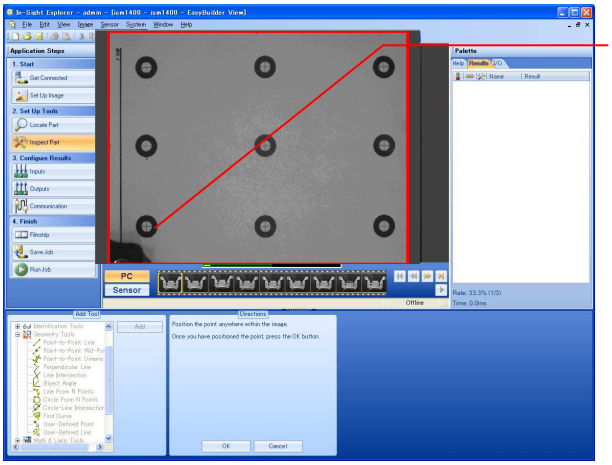
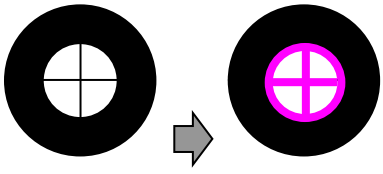
5-6 Adjustment Iris and focus.

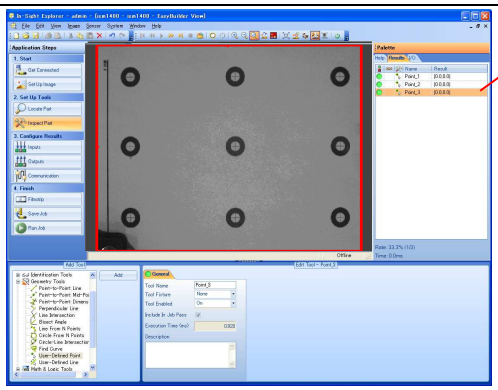


6. Mitsubishi N-Point Calibration

It is necessary to define the target points in the image to do the calibration.
It is possible to use the abundant positioning and the inspection tools prepared in EasyBuilder for the method of defining the point. The preparation method is as follows.

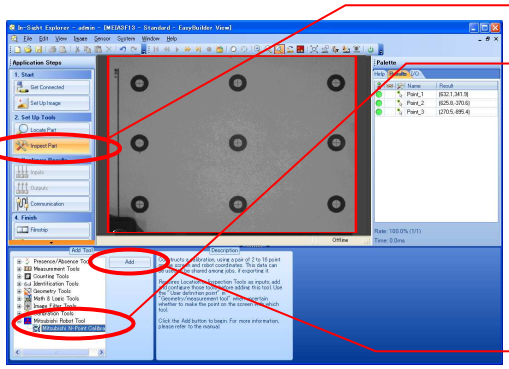
- "User definition point" : Specifies an arbitrary point on the screen.
- "Pattern matching" : Positions the registered template.
- Center of a circle and straight line intersection,
- etc.

No	Procedure (and Caution)
6-1	Calibration seat is printed out. (It is on the final page of this document.)   There is a calibration seat in the appendix. Please use it. The figure below is an example of taking the calibration seat. When the calibration is added, a round object on the screen is automatically recognized because the EasyBuilder has the smart feature function. Therefore, the calibration work only of the selection of the point on the screen can begin.
6-2	Adds the teaching position in image.  (1) Selects “Inspect Part”. (2) Selects “User-Defined Point”in “Geometry Tools”.  (3) Clicks “Add” button.  (4) click "OK" button, after setting the cursor to the position to be taught easily. 



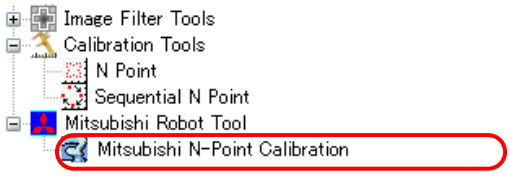
(5) Please teach in **two positions or more** according to a similar procedure.
(It is possible to calculate of the calibration by two positions. However, to improve accuracy, two or more positions are recommended to be taught on the entire screen.)

6-3 Adds “Mitsubishi N-Point Calibration”

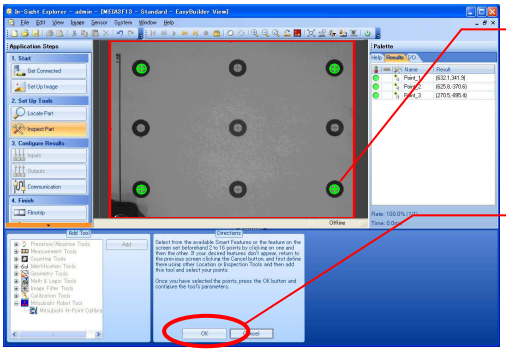


(1) Selects “Inspect Part”.

(2) Selects “Mitsubishi N-Point Calibration”.

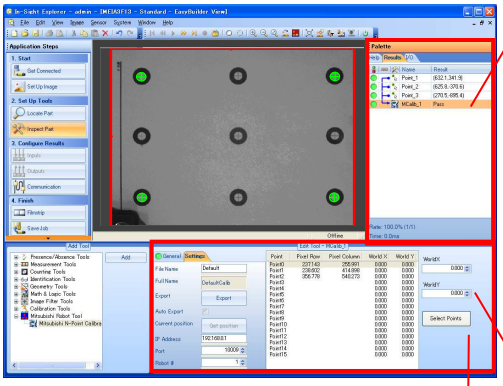


(3) Clicks “Add” button.

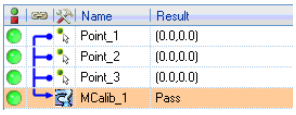


(4) Please select **two positions or more** in the vision sensor coordinates to use for calibration. The color of selected item is changed. It is possible that the point selected here will be changed later.

(5) The calibration is added to the palette when "OK" button is clicked, and the calibration screen is displayed.



Palette
The relation between the tool of the calibration etc. and the recognition points is shown.

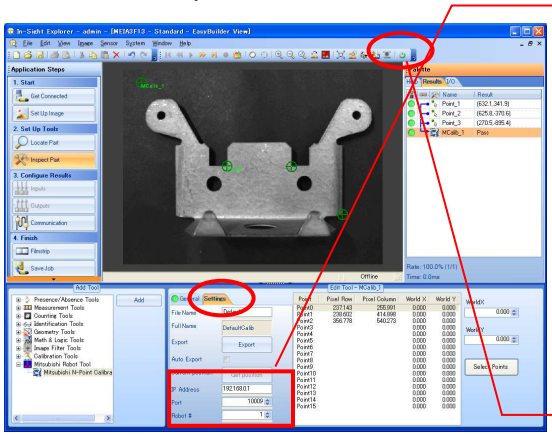


* Note that the calibration is deleted when the point is deleted after adding the calibration.

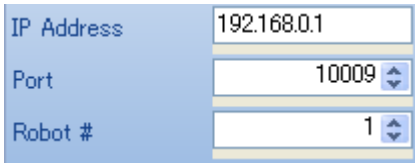
Re-select the points
Clicks "Select Points" button in the calibration screen to re-select the points used.

Edit Tool
Edits the details of the tool of the calibration etc. For "Mitsubishi N point calibration", the following information can be edited.
- The communication setting of the robot controller.
- The coordinates of the camera.
- The coordinates of the robot.

6-4 Gets the current position of the robot.



(1) Sets the following communication method of the robot in a "Settings" tab.

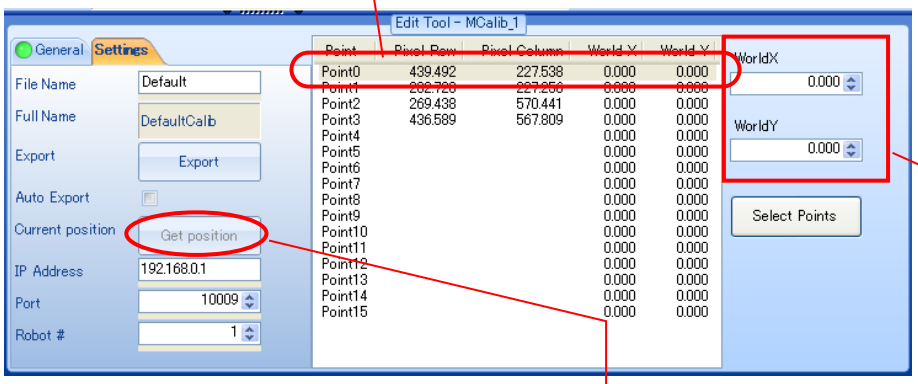


* The address of the robot set in Chapter 4.3 is set to Internet Protocol address. It is possible to use the initial value to the communication port and the robot number.

(2) Switches the In-Sight Explorer to "Online".


(Switching of online/offline)

(3) Selects the camera coordinates related to the robot coordinates.



(4) When "Get position" button is clicked after selecting the point in the list and moving the robot to the position, the current position of the robot is set into "World X/World Y". Getting the current position of the robot is possible only at online mode.

(5) When the point is selected (is clicked) in the list, the current position of the robot is displayed here.
It is possible to change the value by clicking the spin button, by getting the current position of the robot or by inputting directly.

(6) The calibration is possible by two points. (3)-(5) is repeatedly executed. However, It is possible to improve the recognition accuracy by selecting many points in the distance.

⚠ Caution

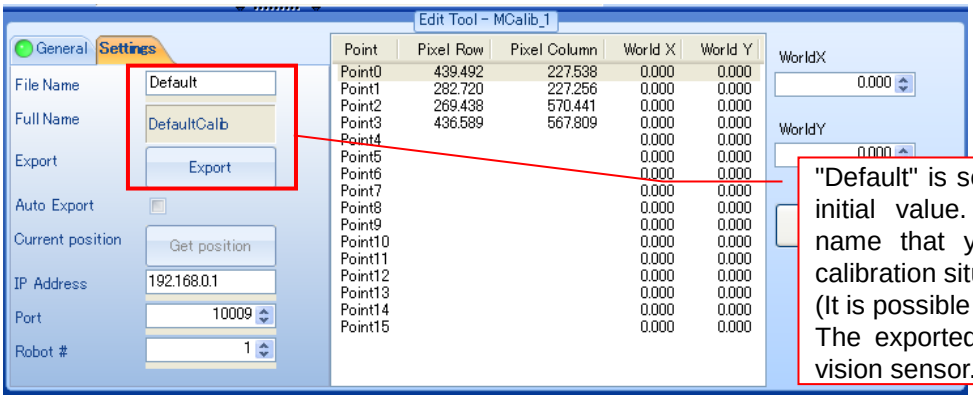
Please switch to online mode,
when getting the current position of the robot.

Please switch In-Sight Explorer to online mode to get the current position of the robot.

If this were operated in an off-line mode, the robot current location acquisition operation is repeated when switching to an online mode. In that case, please get the current position of the robot again.

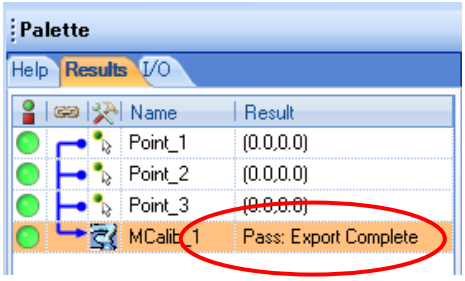
6-7

To export the calibration data, click "Export" button after specifying the file name in the calibration screen.



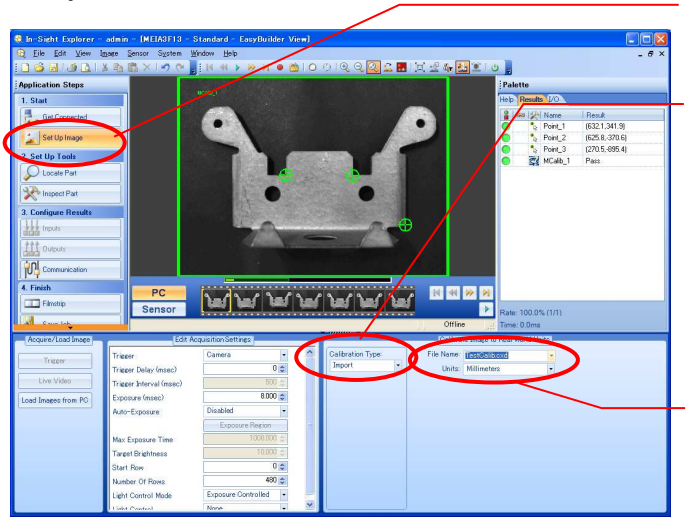
"Default" is set to the file name as the initial value. Please change to the name that you can understand the calibration situation.
(It is possible to use the initial name.)
The exported file is preserved in the vision sensor.

The information is displayed in the palette after the export is completed normally.



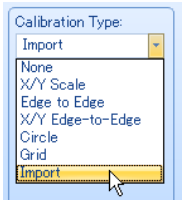
6-8

Data on the vision sensor is used by pixel units. Therefore, it is necessary to convert these to data on the robot coordinate system. Please get the calibration data by the following procedure when you make a new job.

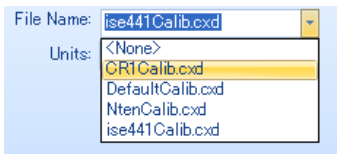


(1) Click “Set Up Image” button.

(2) Select “Import.

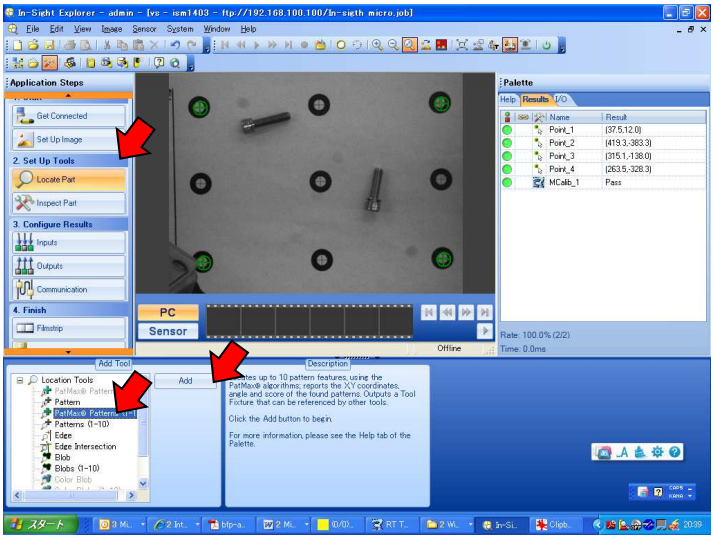
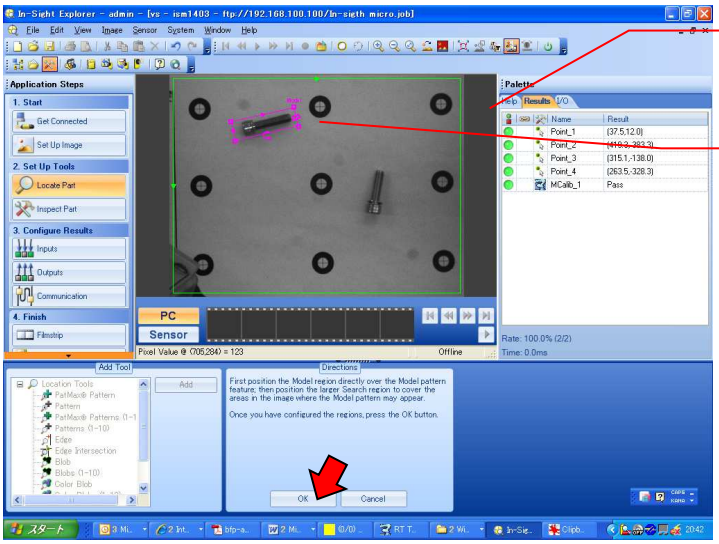
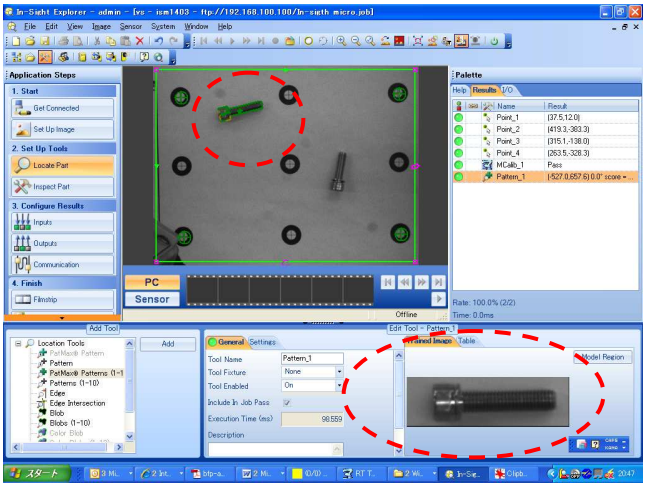


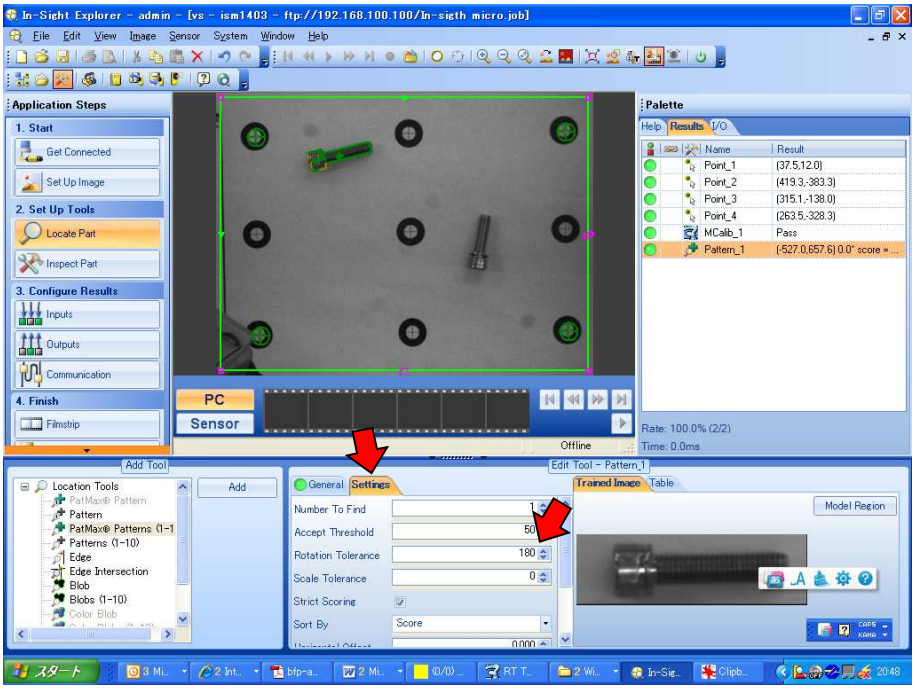
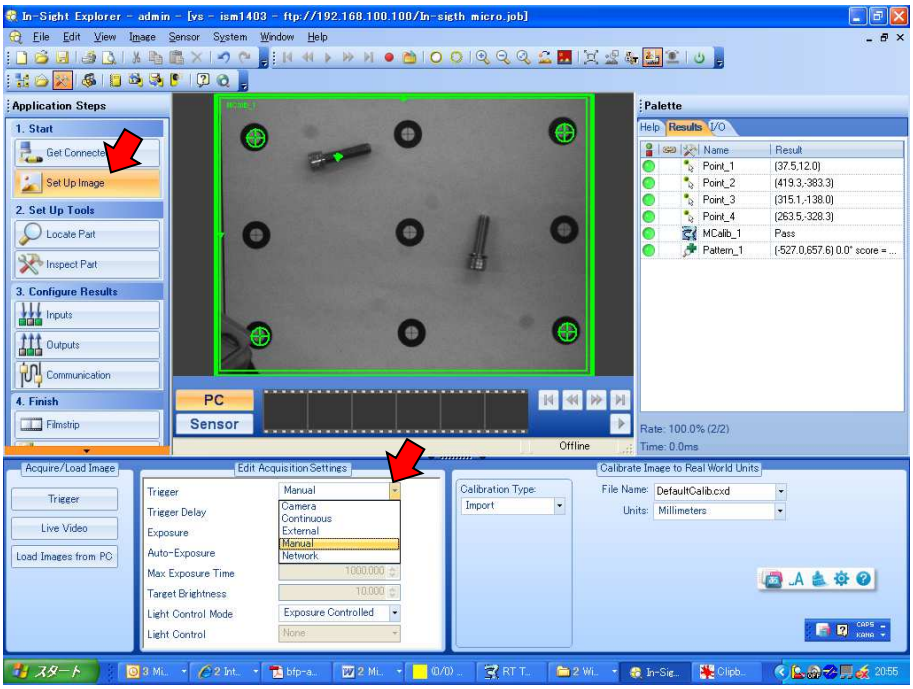
(3) Select calibration file.
(Selects the millimeter as a unit.)



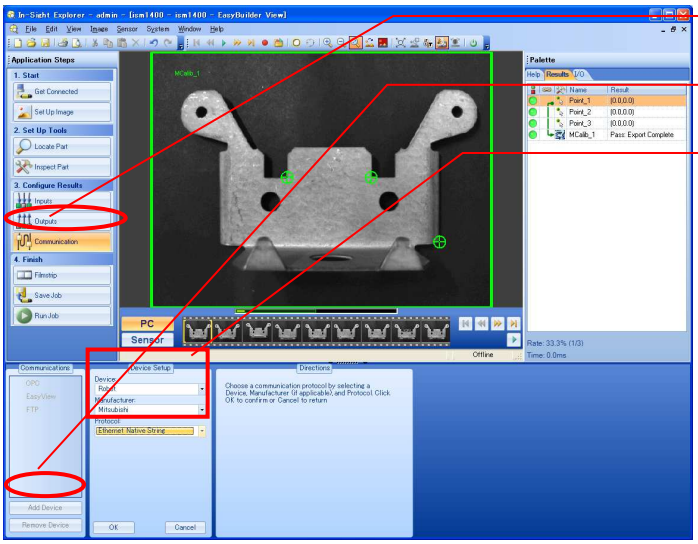
The file name is as follows. Export name + “Calib.cxd”

7. How to Vision-JOB

No	Procedure (and Caution)
7-1	Selects “Locate Part”. -> Selects “PatMax Patterns (1-10)”. -> Selects “Add” 
7-2	Selects “Search Area” and “Model Area”. -> Selects “OK”  Selects “Search Area”. (Green line) Selects “Model Area”. (Pink line)
7-3	Check “Recognition level”. 

7-4	Selects “Settings” -> Rotation Tolerance input “180”. (Selects Other items.) -> 
7-4	Selects “Set Up image”. -> Trigger selects “Manual”. 

8. Sets the output format of robot

No	Procedure (and Caution)
8-1	

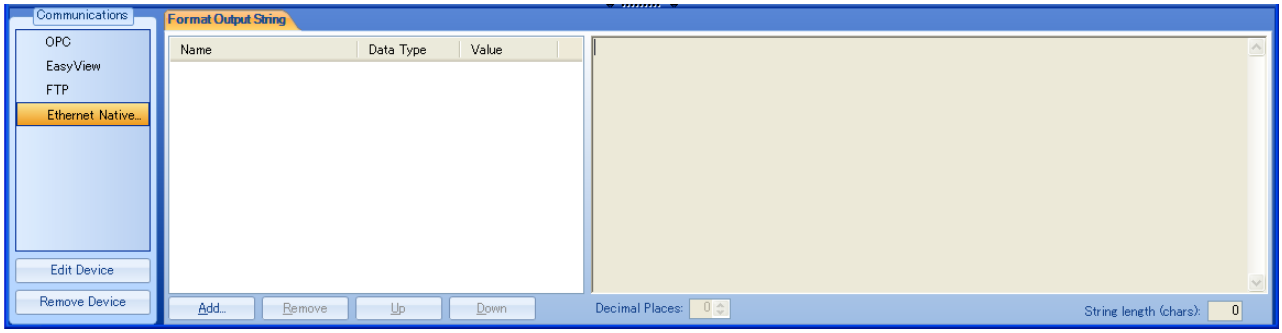
(1) Select “Communication”.

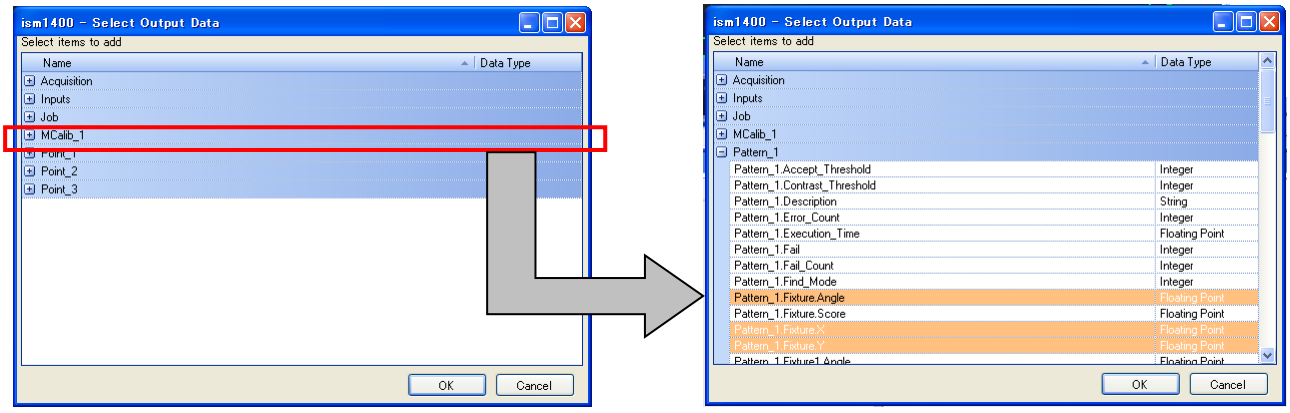
(2) Select “ Add device”.

(3) Click “OK” button after setting as follows.

Device : Robot

Manufacturer : Mitsubishi



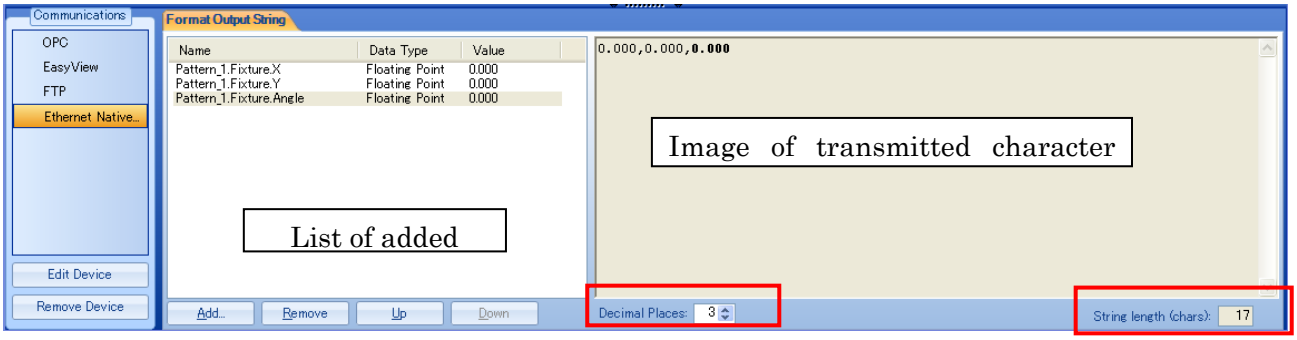


8-2

The example above is to register one pattern of the pattern matching, and to recognize two or more pieces. In this case, the recognition result is stored in “Pattern_1", and selects number, X, Y, and θ from it. The table below shows the display name and the meaning of a typical item.

No.	Display	Explanation
1	Pattern_1.Number_Found	Recognized number
2	Pattern_1.Fixture.X	1st recognition results X
3	Pattern_1.Fixture.Y	1st recognition results Y
4	Pattern_1.Fixture.Angle	1st recognition results θ
5	Pattern_1.Fixture1.X	2nd recognition results X
6	Pattern_1.Fixture1.Y	2nd recognition results Y
7	Pattern_1.Fixture1.Angle	2nd recognition results θ
8	<Same as above>	<Same as above>

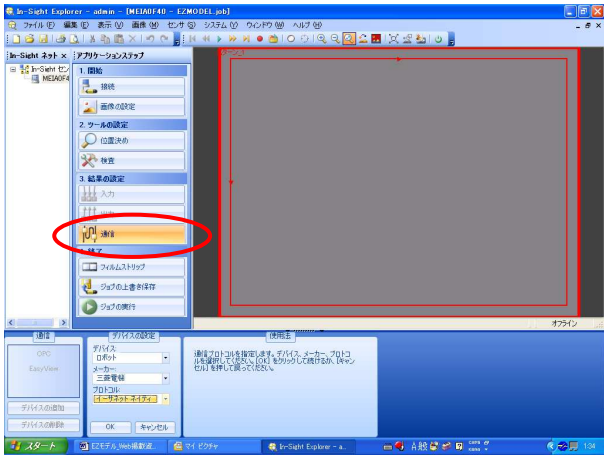
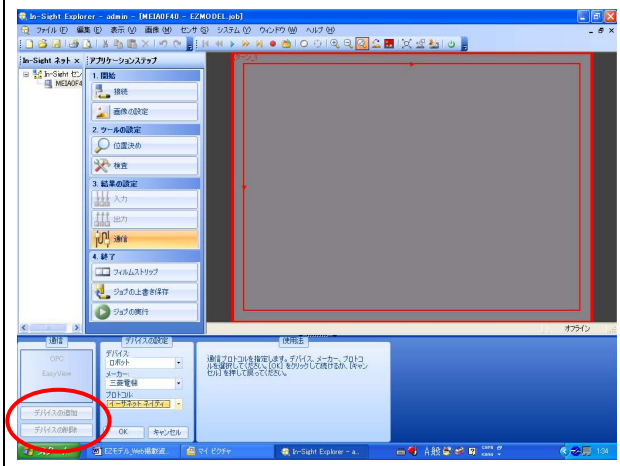
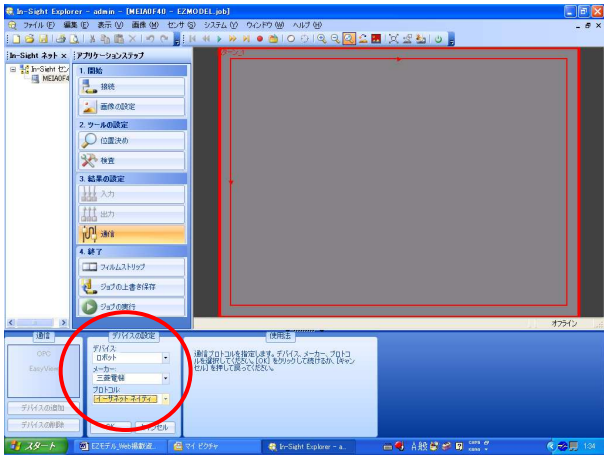
If these are added, it becomes as shown in the figure below.



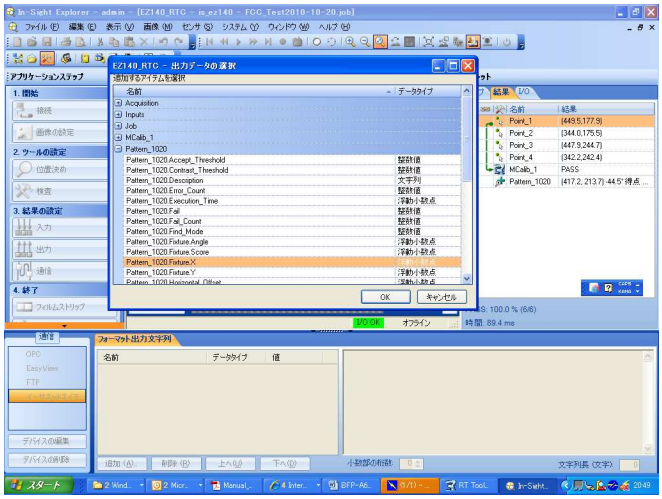
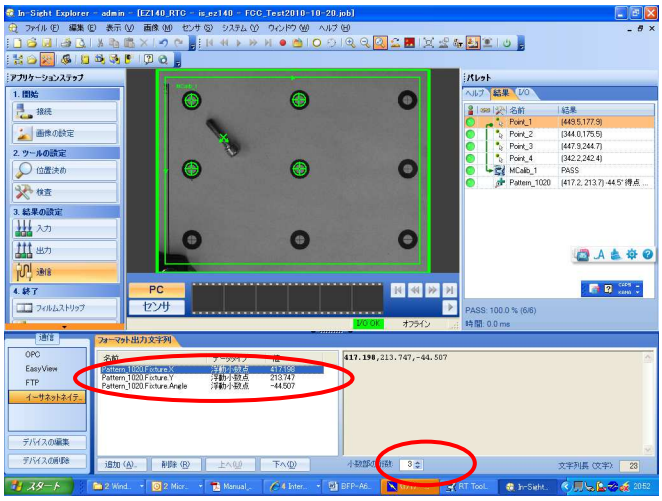
There is a limitation in the number of characters that can be transmitted at once. It is possible to save the number of transmission characters by changing the position of decimal point.
Decimal Places: 3 (Initial value : Three

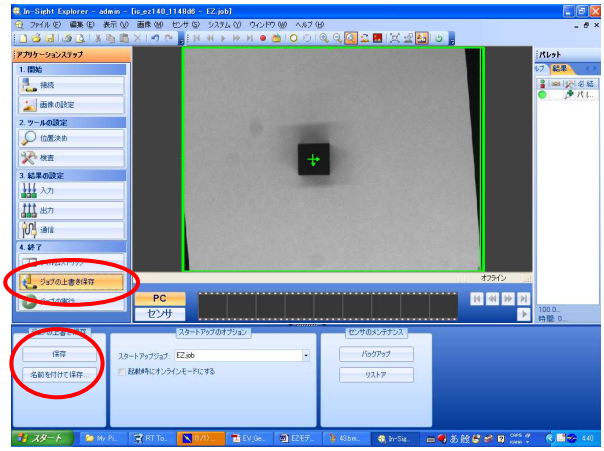
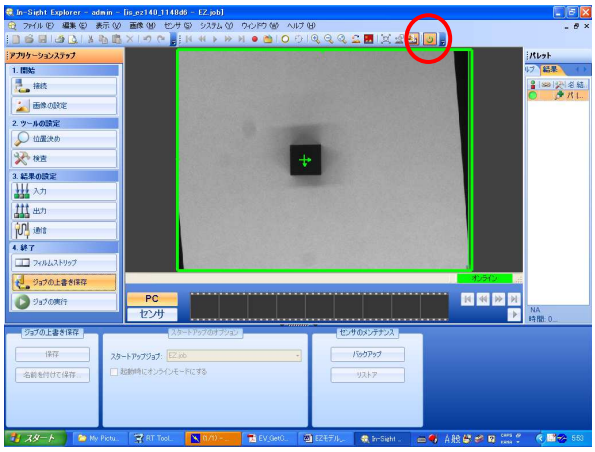
A current number of characters is displayed. Please refer as standards of the number of transmission characters. The number of characters that can be transmitted to the robot controller at once is 240 characters.
String length (chars): 17

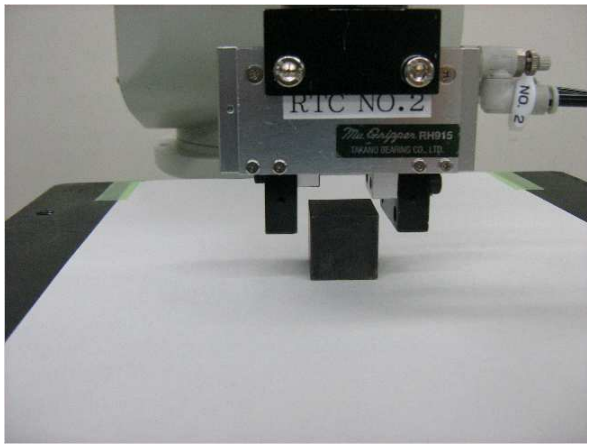
８．通信設定		
8-1	「通信」を選択する。	

		
8-2	「デバイスの追加」を選択 	
8-3	「デバイスの設定」を行う。 	デバイス　：ロボット メーカー　：三菱電機 プロトコル：イーサネット　ネイティブ

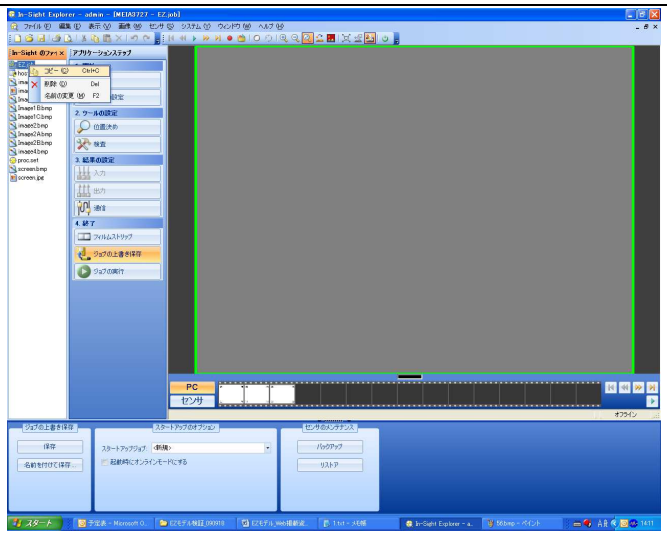
8-4		
8-5		
8-6		
8-7		
8-8		

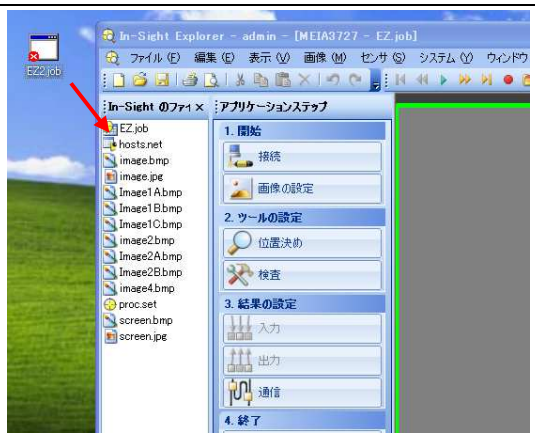
8-9	下図の三項目を選択し「OK」を押す。 	【選択項目】 1 ：ﾊﾟﾀｰﾝ_1. ﾌｨｸｽﾁｬ. X 2 ：ﾊﾟﾀｰﾝ_1. ﾌｨｸｽﾁｬ. Y 3 ：ﾊﾟﾀｰﾝ_1. ﾌｨｸｽﾁｬ. 角度
8-10	各項目の「少数部の桁数」を**“3”**に設定にする。 	カーソルを下に移動（選択）させて、すべての項目を**“3”**に設定すること。
8-11		

8-12	「ジョブの上書き保存」から作成 JOB を保存する。 	**＊同じキャリブレーションデータを用い、複数個の JOB を作成する場合は、NO.A の「JOB のコピー」を参照してください。**
8-14	「オンライン」ボタンを押す。 	
9．ロボット教示		
9-1	添付プログラム KHNE をロボットにコピーする。	
9-2	TB にて KHNE を開く。 	＊TB 操作 「F1」　→　「１」→ 「↑」「↓」で選択　→　「(＊プログラム名)」 → 「EXE」。
9-3	退避位置 PHOME を教示する。	

		
9-4	PWK を教示する。 	ワークをカメラ視野内に置きロボットで把持する。 何度かハンド開閉を行い、ワークがずれなくなったら PWK に教示する。
9-5	ビジョン認識エリアからロボットを退避させる。 	**このとき、９－４で PWK を登録したときのワークの位置がずれないようにすること。** **＊PWK を登録したときのワークの位置と９－６でビジョンが認識したワークの位置が異なると把持する位置関係が狂います。**
9-6	自動運転をかけ、STOP が点灯するまで待つ。	

		
9-7	プログラムを RT-Tool Box２で開き、５行目をコメントアウトし、ロボットに保存する。 【プログラム改造箇所】 4 Servo On 5 GoSub *KIHON 6 Mov PHOME → 4 Servo On 5 'GoSub *KIHON 6 Mov PHOME	
１０．自動運転		
9-6	自動運転をかける（オーバーライドは３％で実行すること） 	スピードは最も低速な３％で運転し、動作に問題が無ければ徐々に上げていくこと。
A．JOB のコピー		
A-1	In-Sight のファイル一覧からコピーしたい JOB を選び右クリック。「コピー」を選ぶ。	

		
A-2	デスクトップにカーソルを移し、右クリック「貼り付け」を押す。上手くいかなかった場合は A-1 でファイルを左クリックし、ドラッグ＆ドロップを押す。 	
A-3	デスクトップに出来上がったファイルを右クリックし名前の変更を選択する。 	
A-4	任意の名前に変更する。 	
A-5	変更したファイルを In-Sight のファイル欄にドラッグ＆ドロップで戻す。	



【　プログラム：KHNE　】

```
1 '******** MAIN     PROGRAM *********
2 *MAIN
3 Clr 0
4 Servo On
5 GoSub *KIHON
6 Mov PHOME
7 Dly 0.5
8 HOpen 1
¥9 '==== VISION回線オープン  =====
10 If M_NvOpen(1) <> 1 Then
11 NVOpen "COM2:" As #1
12 Wait M_NvOpen(1)=1
13 EndIf
14 '=========================
15 '==== VISIO認識開始  ==========
16 NVRun #1,"EZ"
17 *VSLOOP1
18 Print #1,"EV GetCellValue(""パターン_1.PASS"")"
19 Input #1,C11$   'コマンド実行OK/NG
20 Input #1,C12$   '文字数
21 If C11$<>"1" Then *VSLOOP1
22 If C12$<>"18" Then Hlt
23 Input #1,C13$
24 '====結果取得==============
25 *VSLOOP2
26 Print #1,"EV GetCellValue(""ジョブ.ロボットフォーマット文字列"")"
27 Input #1,C21$   'コマンド実行OK/NG
28 Input #1,C22$   '文字数
29 If C21$<>"1" Then *VSLOOP2
```

【MELFA－Vision でのプログラム】

```
26 NVPst #1,"TEST.job","E76","J81","M90",0,10
27 PVS0=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
28 If M_NvNum(1) = 0 Then Error 9001
29 PVS1.X=P_NvS1(1).X
30 PVS1.Y=P_NvS1(1).Y
31 PVS1.C=P_NvS1(1).C
32 PVS1.FL1=PWK.FL1
```

MELFA-Vision から EZ モデルへの変更点

```
30 MC22=Val(C22$)
31 Input #1,C23A$,MX,MY,MT,C23B$
32 If MX=0 Then Error 9001
33 PVS1.X=MX
34 PVS1.Y=MY
35 PVS1.C=Rad(MT)
36 PVS1.FL1=PWK.FL1
37 '====動作開始==============
38 '==============
39 PTRG=PVS1*PH                                    '目的位置作成
40 '==============
41 Mov PTRG,-60
42 Mvs PTRG
43 Dly 0.5
44 HClose 1
45 Dly 0.5
46 HOpen 1
47 Dly 0.5
48 Mvs PTRG,-60
49 Mov PHOME
50 Dly 0.2
51 Servo Off
52 Hlt
53 End
54 '******** KIHON    PROGRAM *********
55 *KIHON
56 'ワークを掴む位置にロボットを持ってくる。
57 'ハンド開閉を行いワークがずれないことを確認する。
58 'PWKにロボットの現在位置を登録する。
59 'ロボットをビジョンエリアから退避させる。
60 '自動運転を欠けHLTで止まるまで待つ。
61 '自動運転が終わったらメインのプログラムでの『GOSUB    *KIHON』をコメントアウトする。
62 Mov PHOME
63 Dly 0.2
64 If M_NvOpen(1) <> 1 Then
65 NVOpen "COM2:" As #1
66 Wait M_NvOpen(1)=1
67 EndIf
68 'ﾋﾞｼﾞｮﾝｼﾞｮﾌﾞを作成しHLTで止まるまで自動運転
69 '==== VISIO認識開始  =========
```

```
70 NVRun #1,"EZ"
71 *VSLOOP0
72 Print #1,"EV GetCellValue(""パターン_1.PASS"")"
73 Input #1,C11$   'コマンド実行OK/NG
74 Input #1,C12$   '文字数
75 If C11$<>"1" Then *VSLOOP0
76 If C12$<>"18" Then Hlt
77 Input #1,C13$
78 '====結果取得==============
79 *VSLOOP3
80 Print #1,"EV GetCellValue(""ジョブ.ロボットフォーマット文字列"")"
81 Input #1,C21$   'コマンド実行OK/NG
82 Input #1,C22$   '文字数
83 If C21$<>"1" Then *VSLOOP3
84 MC22=Val(C22$)
85 Input #1,C23A$,MX,MY,MT,C23B$
86 If MX=O Then Error 9000
87 PVS0=P_Zero
88 PVS0.X=MX
89 PVS0.Y=MY
90 PVS0.C=Rad(MT)
91 PVS0.FL1=PWK.FL1
92 PH=Inv(PVS0)*PWK
93 Hlt
94 '
95 Return
```

MELFA-Vision から EZ モデルへの変更点

【MELFA－Vision でのプログラム】

```
26 NVPst #1,"TEST.job","E76","J81","M90",0,10
27 PVS0=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
28 If M_NvNum(1) = 0 Then Error 9001
29 PVS1.X=P_NvS1(1).X
30 PVS1.Y=P_NvS1(1).Y
31 PVS1.C=P_NvS1(1).C
32 PVS1.FL1=PWK.FL1
```

【プログラム：ANGL】

```
1 '*********************************
```

```
2 *ANGLE
3 'チェッカーボードの原点にロボットの制御点を合わせてPORG1に教示
4 'チェッカーボードの原点から＋X軸方向の任意点にロボットの制御点を合わせてPORG２に教示
5 MX=PORG2.X-PORG1.X
6 MY=PORG2.Y-PORG1.Y
7 MFLX=0
8 MFLY=0
9 If MX<0 Then MFLX=1
10 If MY<0 Then MFLY=1
11 MY=Abs(MY)
12 MX=Abs(MX)
13 MT=Atn2(MY,MX)
14 If MFLX=0 And MFLY=0 Then '第一象限
15        PTH=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
16        PTH.C=MT
17 EndIf
18 If    MFLX=1 And MFLY=0 Then '第二象限
19        PTH=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
20        PTH.C=Rad(180)-MT
21 EndIf
22 If MFLX=1 And MFLY=1 Then '第三象限
23       PTH=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
24       PTH.C=-Rad(180)+MT
25 EndIf
26 If MFLX=0 And MFLY=1 Then '第四象限
27       PTH=(+0.00,+0.00,+0.00,+0.00,+0.00,+0.00)
28       PTH.C=(-1)*MT
29 EndIf
30       PTH.X=PORG1.X
31       PTH.Y=PORG1.Y
32 'PTH.Cの値をツールBOXで見てキャリブレーションの角度に入れる。
33 Hlt
34 End
```

【原点角度算出方法について】

ビジョンセンサはチェッカーボードを用いてキャリブレーションを行います。このチェッカーボードは固有のＸＹ方向を持っており、ビジョンセンサはこのＸＹ方向をキャリブレーション後のＸＹ軸として認識します。その為ロボットのＸＹ座標系に合わせこむ場合、チェッカーボードのＸＹ軸とロボットのＸＹ軸が、傾き成分においてどの程度ずれてるのかを教える必要があります。添付プログラム【ＡＮＧＬ】はその傾き成分を自動で計算するプログラムですが、その計算式の考え方を以下に示します。

チェッカーボードと座標軸とロボットの座標軸の傾きをＭＴし、ロボット座標系におけるチェッカーボードの

原点を（ＰＸ０、ＰＹ０）、チェッカーボードのＸ軸上の点を（ＰＸ１、ＰＹ１）とすると以下の式が成り立ちます。

【計算式】

$$MT = \tan^{-1}\left(\frac{PY1 - PY0}{PX1 - PX0}\right)$$

但しロボット座標系においてチェッカーボードがどの象限に存在しているかも加味する必要があります。その為チェッカーボードの原点角度ＭＴ３は以下の計算式で表されます。

$$MT2 = \tan^{-1}\left(\frac{|PY1 - PY0|}{|PX1 - PX0|}\right)$$

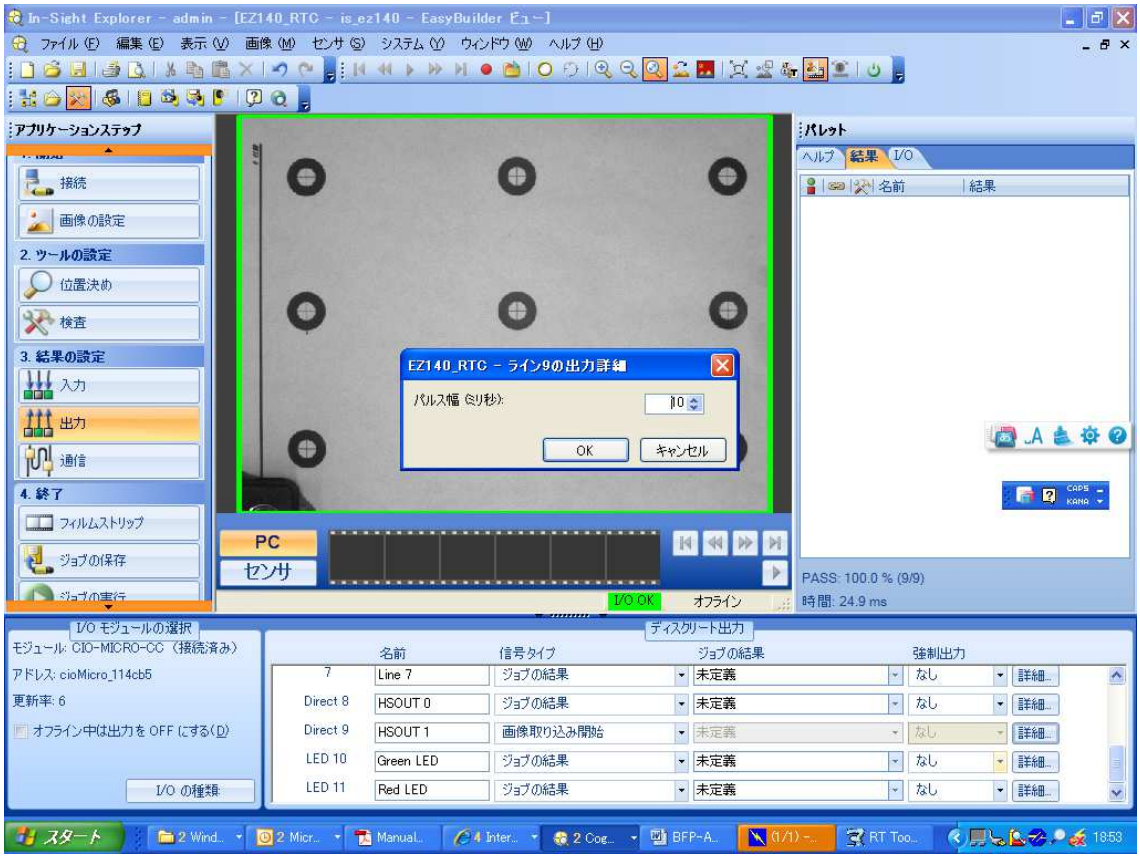
第一象限（ＰＹ１－ＰＹ０　＞　０　、ＰＸ１－ＰＸ０　＞　０）
ＭＴ３＝ＭＴ２

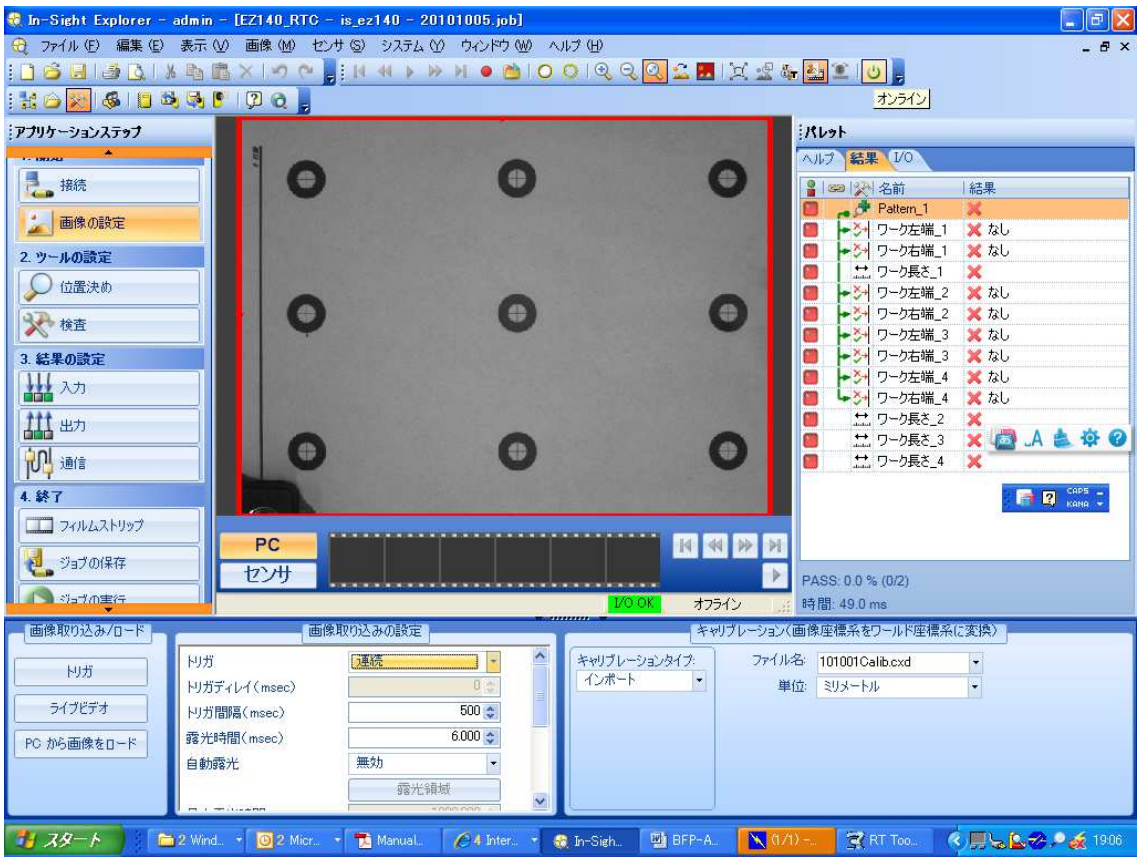
第二象限（ＰＹ１－ＰＹ０　＞　０　、ＰＸ１－ＰＸ０　＜　０）
ＭＴ３＝１８０－ＭＴ２

第三象限（ＰＹ１－ＰＹ０　＜　０　、ＰＸ１－ＰＸ０　＜　０）
ＭＴ３＝ＭＴ２－１８０

第四象限（ＰＹ１－ＰＹ０　＜　０　、ＰＸ１－ＰＸ０　＞　０）
ＭＴ３＝－ＭＴ２

上記、ＭＴ３がキャリブレーション時の原点角度になります。

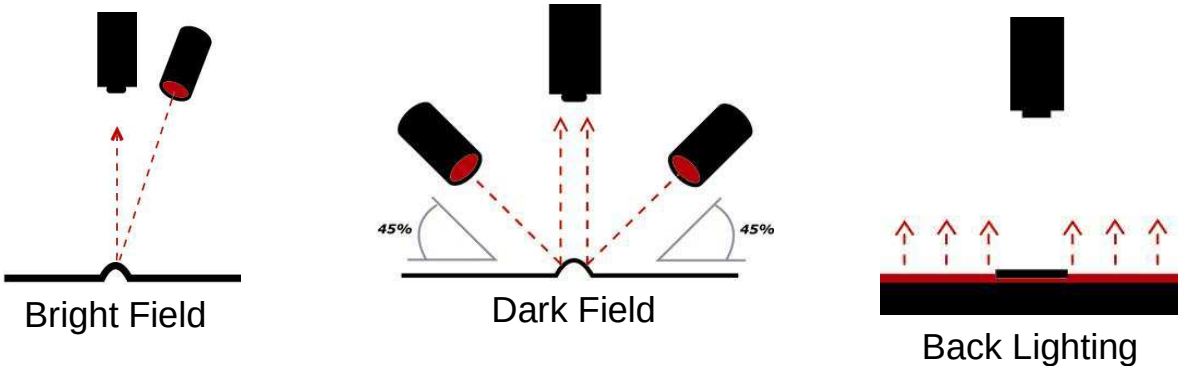

In-Sight Explorer - admin - [EZ140_RTC - is_ez140 - EasyBuilder ビュー]
EZ140_RTC - ライン9の出力詳細
パルス幅 (ミリ秒):
OK
キャンセル
PC
センサ
I/O OK
オフライン
PASS: 100.0 % (9/9)
時間: 24.9 ms
I/O モジュールの選択
ディスクリート出力

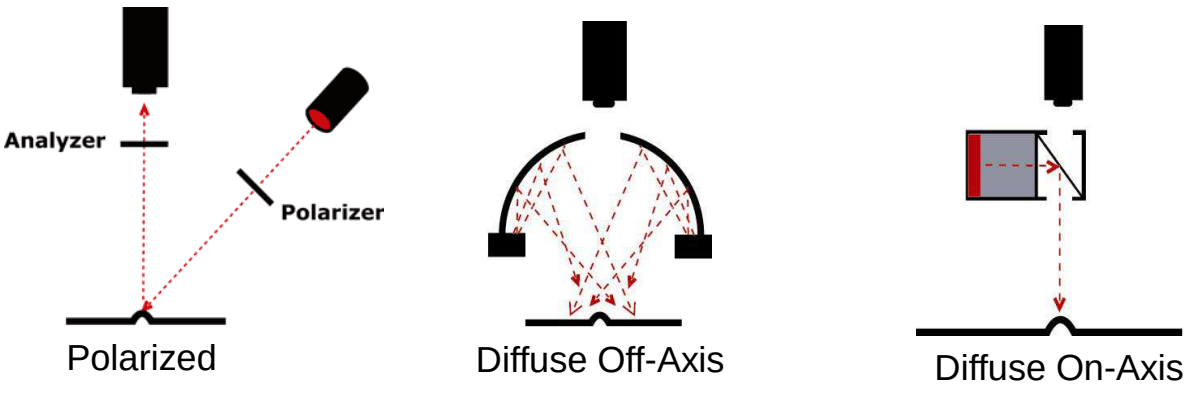

In-Sight Explorer - admin - [EZ140_RTC - is_ez140 - 20101005.job]
オンライン
PC
センサ
I/O OK
オフライン
PASS: 0.0 % (0/2)
時間: 49.0 ms
画像取り込み/ロード
画像取り込みの設定
キャリブレーション(画像座標系をワールド座標系に変換)

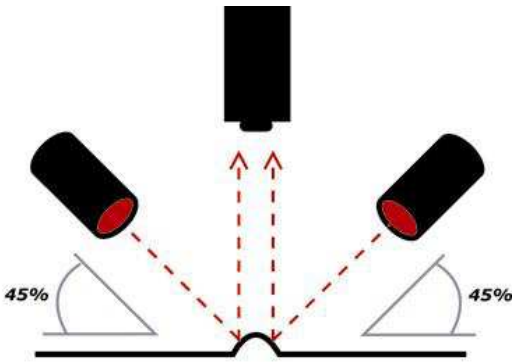
0000. Lighting Options

Light can be structured in different ways.

The angle and direction of the light will determine how the object is seen by the camera.







Dark Field

Shape and contour are enhanced.

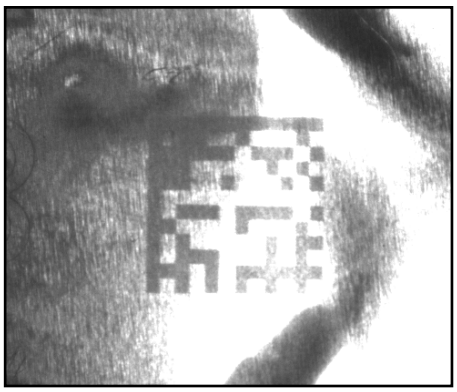
Diffuse surfaces are bright.

Flat, polished surfaces are dark.

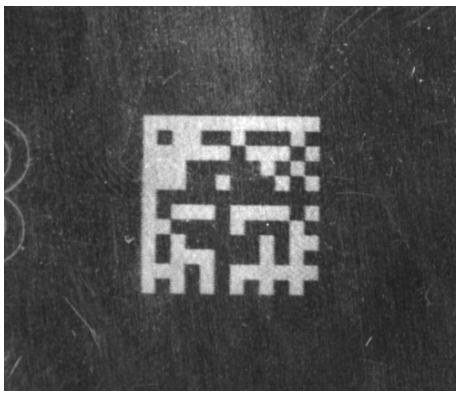
Use to emphasize height changes:

- Surface Inspection
- Edge Detection

Ring Light



Low Angle Light



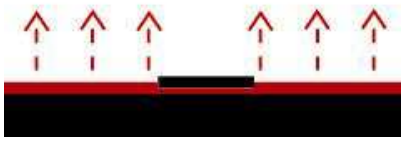
Shape and contour are enhanced.

Diffuse surfaces are bright.

Flat, polished surfaces are dark.

Use to emphasize height changes:

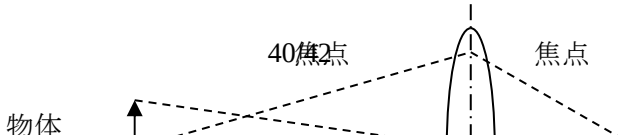
- Surface Inspection
- Edge Detection



Back Light

0000. How to select the camera lens.

ﾚﾝｽﾞによる結像を選択する時に焦点距離fがどの程度のものを選べばいいかを表す指針として近軸領域での結像公式があります。これは、レンズに厚みが無いと仮定しているため厳密とは言えませんがレンズと物体の位置関係によって結像位置と像の横倍率が簡単に求められます。このことから、物体を拡大・縮小するためにレンズと物体位置の関係と必要なレンズの焦点距離が決定できます。

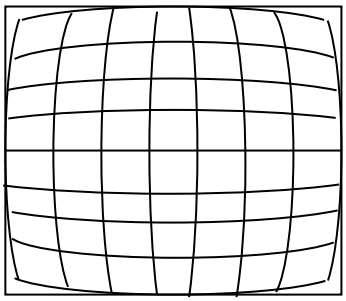


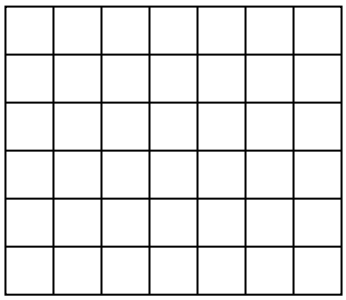
結像式 1/A+1/B=1/f

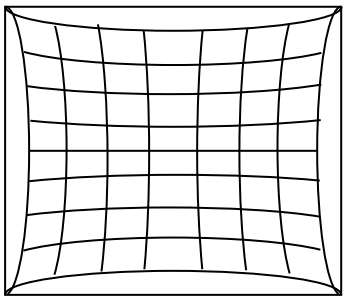
倍率：横倍率 M=B/A

レンズによるひずみ例

レンズにて広範囲な視野を画像として認識させる場合、以下に示すようなひずにが生じる場合があります。







0000. Appendix