ROBOT VISION iVY \textbf{RCX240}

Easy to use and reduction of work steps.
"Finds and Picks up" and "Pursues and Picks up" without teaching.

Many robot users might think, "We tried vision recognition, but it seemed to take a lot of work" or "we tried it before, but making adjustments was a tough job".

But YAMAHA iVY system solves these problems.
Anyone can make the setup easily to contribute to reduction of work steps.
iVY system layout

A robot controller with an image processing function is completed only by setting the iVY board in the 4-axis controller RCX240 or RCX240S. As "eye" is put in the robot, the robot finds and takes workpiece, checks deviations in workpiece position, and makes correction if the workpiece deviates largely. This expands the range of applications.

Options
- Lighting control board
- Tracking board
- CCD camera
- LAN cable (Shielded cross-cable)
- Camera cable
- Lens
- Close-up ring

Conventional system without robot vision
- Positioning by searching for workpiece
- Automatic correction even if the camera moves
- Applicable to conveyor tracking

System with robot vision
- Detection by camera + pick-up
- Positioning is not needed.

When the workpiece is changed, the positioning jig replacement work is needed. In particular, when using a small lot of workpieces, the setup costs or jig manufacture and management costs are needed.

Even when the workpiece is changed, it is flexibly supported only by changing the part type data. Since no mechanical positioning is needed, cost reductions, such as equipment downsizing or jig cost reduction become possible.
**POINT 1**

**Easy for anyone to use, applicable to a wide variety of applications**

When the system was upgraded by combining the robot with a generally available image processing unit, it took a long time conventionally to adjust the robot controller and image processing unit, and perform the correction calculation. In YAMAHA "iVY system", the vision board is integrated into the robot controller and the functions are limited to the positioning and position correction so as to greatly simplify the operability. This makes the system incredibly easy to use when compared to conventional vision systems. YAMAHA aimed at "a vision system that anyone can easily use". Please try to use YAMAHA's new robot vision.

**Conventional robot vision**

1. Alignment with robot coordinates is difficult.
2. Correction calculation is needed when the camera moves.
3. Operation deviation between the camera and robot due to communication time.
4. Adjustment of communication format is needed.

**iVY system**

1. Simple calibration function is incorporated.
2. Coordinates are corrected automatically even when the camera moves.
3. High-speed connections through dedicated bus line.
4. Controller is incorporated to provide the central operation.
5. Applicable to all models of YAMAHA robot lineup.

**Special skills are required and many work steps are needed.**

Connecting an external camera to the robot controller requires tasks such as coordinate matching (calibration), and correction programs are needed, so the startup work is difficult. When using for simple applications, many work steps are needed. So, possible applications are limited.

**Easy operation extends applications**

YAMAHA iVY system can be calibrated very simply. Furthermore, the coordinates are corrected automatically when a camera is installed on the robot. As iVY system can be used, it can be applied to various applications.

**POINT 2**

**Easy workpiece registration only with 3 steps**

YAMAHA aimed at "a vision system that anyone can easily use". But, image recognition itself has been around for a long time. However, conventional image recognition required complex tasks such as coordinate matching (calibration) or coordinate correction during camera movement, and it never became very popular. YAMAHA vision iVY System can be operated by anyone including machine designers or actual machine operators.

**STEP. 1 Capture images.**

Put the workpiece within the camera field-of-view and specify an image capturing range.

**STEP. 2 Set the contour.**

Contour is automatically extracted. Paint the necessary contour with a pen tool.

**STEP. 3 Register the detection position.**

Specify the detection position with the mouse. Desired positions can be set.

**Search results**

Put the workpiece within the camera field-of-view and specify an image capturing range. Contour is automatically extracted. Paint the necessary contour with a pen tool. Specify the detection position with the mouse. Desired positions can be set.
**POINT 3**

**Dedicated software "iVY Studio" included**

The iVY system includes dedicated software “iVY Studio”. All operations related to the vision, such as registration of fiducial marks used for the calibration or workpieces (edge setting, various parameter setting, and image capturing range setting, etc.), backup, restore, and operation monitor can be performed only with this software.

**Support software iVY Studio**

- Search trial-run, part type registration
- Reference mark registration (for calibration)
- Up to 40 workpiece types can be registered.
- Workpiece can also be added easily.
- Up to 40 workpieces can be detected at once.
- Data backup
- This software functions as a monitor during program operation.

**POINT 4**

**Simple calibration function (coordinate matching alignment work) incorporated**

Conventional equipment combining “image processing unit + robot” requires many steps in “calibration” that aligns the camera coordinates with the robot coordinates. In the iVY system, the operation is completed easily in a short time only by following interactive instructions using the programming box. Additionally, the coordinate values are corrected automatically even when the robot installation position is changed, such as upward clamping, downward clamping, robot Z-axis clamping, or SCARA robot Y-arm clamping.

**Just follow instructions on Wizards**

**POINT 5**

**Setup time reduced greatly**

When using a general vision, a coordinate conversion program needs to be created in the robot controller since the robot coordinate data differs from the vision format. Since the robot controller is integrated into the iVY system, the robot coordinate data can be stored into the robot point data using single process. This ensures very simple operation. Additionally, the unified control of the camera control and light control can be performed using the robot program. The control becomes easy and the number of start-up steps can also be reduced.

**Comparison of setup time**

- **iVY system**
  - Setup time is shortened greatly
- **General-purpose vision**

**POINT 6**

**Free selection from YAMAHA robot lineup**

This robot vision is applicable to all YAMAHA robots that can be operated by the RCX controller. According to the applications, an appropriate robot can be selected from the single-axis robots FLIP-X series, linear single-axis robots PHASER series, Cartesian robots XY-X, and SCARA robots YK-XG. A low-cost and easy-to-use robot vision system can be constructed with an optimal model suitable for applications.

- **Cartesian robots XY-X**
- **SCARA robots YK-XG**
- **Linear motor single-axis robots PHASER**
- **Single-axis robots FLIP-X**
**POINT 7**

**Workpiece handling without teaching**

When the robot handles a workpiece, the teaching work to the correct position is absolutely required. If the workpiece position deviates, the correct handling cannot be performed. Use of iVY system makes it possible to detect the correct position through the image recognition after coarse positioning. The workpiece can be transferred without teaching, so the start-up steps are reduced and workpiece can be changed or added flexibly.

**POINT 8**

**Edge search engine with excellent stability**

The gray search (normalized correlation search) that was frequently used for conventional visions is vulnerable to adverse effects, such as lighting conditions, or workpiece chipping or contamination. The environments and applications are restricted.

The iVY system incorporates an “edge search engine” that performs the search process using information on contour shape. This contour search is resistant to effects on external environment and the range of applications is extended.

**POINT 9**

**High-speed connections through dedicated bus line**

By directly connecting the robot controller and CPU board through the bus, a data communication speed approximately 5,000 times higher than that of the serial communication speed with general vision is achieved. Programming also becomes easy since the time lag due to communication does not need to be considered. Additionally, this robot vision supports the conveyor tracking that requires high-speed processing.

**POINT 10**

**Applicable to conveyor tracking**

The iVY system is applicable to the conveyor tracking only by adding the tracking board. As the pulses (AB-phase) are taken from the encoder installed on the conveyor, the workpiece that is flowing can be picked up without stopping the conveyor.

As up to two encoders for the camera, lighting, and conveyor can be connected, the iVY system is applicable to movement between the conveyors.
Vision is also controlled easily with robot programs.

The robot program executes all vision controls including camera switching, image capturing, and workpiece search. Program creation is simple when compared to general vision systems since the operations from the robot movement to the camera control are performed consistently. Furthermore, the debug work can be performed efficiently to greatly reduce the total number of work steps.

<table>
<thead>
<tr>
<th>Command name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCAPTURE</td>
<td>Captures images from the camera.</td>
</tr>
<tr>
<td>VSEARCH</td>
<td>Searches for the specified part type.</td>
</tr>
<tr>
<td>VMONITOR</td>
<td>Switches the monitor mode between on and off.</td>
</tr>
<tr>
<td>VGETCNT</td>
<td>Acquires the number of parts that were found.</td>
</tr>
<tr>
<td>VGETPOS</td>
<td>Acquires the position data.</td>
</tr>
<tr>
<td>VGETTIME</td>
<td>Acquires a period of time used for the search command that was executed.</td>
</tr>
<tr>
<td>VGETSCR</td>
<td>Acquires judgment values for the detected workpiece.</td>
</tr>
<tr>
<td>VSAVEIMG</td>
<td>Saves images in BMP format.</td>
</tr>
</tbody>
</table>

- **Number of teaching steps needs to be reduced.**
  Robot teaching work requires a lot of labor and time. The iVY system acts as “robot eye”. The final fine positioning can be automated to greatly reduce the teaching time that was required for the conventional models.

- **Positioning mechanism needs to be simplified.**
  In the current trend toward small-lot production of multiple models, a larger number of models means that positioning and other aspects of setup will require more time and trouble. Use of the iVY system makes it possible to greatly reduce costs necessary for manufacture, management, and replacement of positioning jigs.

- **Random workpieces need to be handled.**
  Use of a position detection function of the iVY system makes it possible to simply construct operations, such as "workpiece is directly placed from the parts feeder" and "workpiece in the pallet is gripped and transferred".

- **Workpiece flowing on the conveyor is picked up.**
  The iVY system is applicable to conveyor tracking. The position of the flowing workpiece is continuously recognized according to the signals from the encoder. The workpiece can be picked up without stopping the conveyor.

- **Consultation destination is not found if a trouble occurs.**
  When a generally available image processing unit is combined with the robot, various problems such as being unable to capture images, unable to write data, or position deviation occur. YAMAHA iVY system will solve such troubles. The iVY system delivers total support for tasks ranging from capturing of images from the camera to operating the robot.
iVY System

Applicable controllers ► RCX240/RCX240S

● Robot with image processing functions

“SEARCH and TAKE” “CHECK POSITION and ASSEMBLE”
YAMAHA offers a whole new production line concept that eliminates time-consuming teaching and positioning tasks with “iVY-system”.

Main functions ► P.72

■ Ordering method

RCX240

Controller

Double for Ce

Regenerative unit

Option YD

Network Option

IVY System

Option board

Light/Tracking

Dripped

Battery

Note. For details on the various selection items, refer to P.533

■ Basic specifications

iVY board

<table>
<thead>
<tr>
<th>Item</th>
<th>IVY board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable controllers</td>
<td>RCX240 / RCX240S</td>
</tr>
<tr>
<td>Pixels</td>
<td>640 (H) × 480 (V) (300,000 pixels, VGA)</td>
</tr>
<tr>
<td>Settable part types</td>
<td>40 part types</td>
</tr>
<tr>
<td>Connectable cameras</td>
<td>Maximum 2 units</td>
</tr>
<tr>
<td>Camera types</td>
<td>Double speed compatible analog camera</td>
</tr>
<tr>
<td>Memory</td>
<td>128MB SDRAM, 256MB miniSD card</td>
</tr>
<tr>
<td>External I/F</td>
<td>Ethernet (100BASE-TX)</td>
</tr>
</tbody>
</table>

Search method

Edge search (Correlative edge filter, Sobel filter)

Image input

Trigger

S/W trigger, H/W trigger, Camera internal synch

External trigger input

2 points

Functions

Search function

Position offset, Auto registry of point data

ID recognition

QR-Code [Model2], DataMatrix

Setup support functions

Calibration, image save function, model registration™, fiducial mark registration™, monitor function™

Note. Requires Windows PC.

Tracking board (Options)

<table>
<thead>
<tr>
<th>Item</th>
<th>Tracking board (option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable controllers</td>
<td>RCX240 / RCX240S</td>
</tr>
<tr>
<td>Light adjusting system</td>
<td>PWM control (0 to 100%) (Cycle 60kHz)</td>
</tr>
<tr>
<td>Stroboscopic light (10 to 30000us)</td>
<td></td>
</tr>
<tr>
<td>Trigger</td>
<td>S/W trigger, H/W trigger</td>
</tr>
<tr>
<td>External trigger input</td>
<td>2 points</td>
</tr>
<tr>
<td>Lighting power input</td>
<td>12VDC or 24VDC (Supplied from outside commonly to 2 channels)</td>
</tr>
<tr>
<td>Maximum response frequency</td>
<td>2MHz</td>
</tr>
<tr>
<td>Input phase</td>
<td>A, X, B, Z, Z</td>
</tr>
<tr>
<td>Counter / Step-up multiplication</td>
<td>0 to 65535 / Double, quadruple</td>
</tr>
<tr>
<td>Other</td>
<td>Provided with broken wire detect function</td>
</tr>
</tbody>
</table>

Note. The tracking board is required when using the tracking function.

Lighting control board (option)

<table>
<thead>
<tr>
<th>Item</th>
<th>Lighting control board (option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable controllers</td>
<td>RCX240 / RCX240S</td>
</tr>
<tr>
<td>Number of lighting connected units</td>
<td>Up to 2 units</td>
</tr>
<tr>
<td>Light adjusting system</td>
<td>PWM control (0 to 100%) (Cycle 60kHz)</td>
</tr>
<tr>
<td>Stroboscopic light (10 to 30000us)</td>
<td></td>
</tr>
<tr>
<td>Trigger</td>
<td>S/W trigger, H/W trigger</td>
</tr>
<tr>
<td>External trigger input</td>
<td>2 points</td>
</tr>
<tr>
<td>Lighting power input</td>
<td>12VDC or 24VDC (Supplied from outside commonly to 2 channels)</td>
</tr>
<tr>
<td>Lighting output</td>
<td>When DC12V is supplied: Less than 30W with 2 channels totaled</td>
</tr>
<tr>
<td>Maximum response frequency</td>
<td>2MHz</td>
</tr>
</tbody>
</table>

Note. Requires Windows PC.
Instruction manuals can be downloaded from our company website. Please use the following for more detailed information.
http://global.yamaha-motor.com/business/robot/

■ System configuration illustration

* The above configuration example shows a system where the iVY board and tracking board are used.
* Connections to the STD.DIO, ACIN, and SAFETY connectors is not shown in the above illustration.

■ Dimensional outlines  CCD camera

CCD camera dimensions
(Model No. : KX0-M7913-00)

Mount

Cover

C-mount

Rear panel

1.5

3.0

7.8

26.5

13

1.5

4-M2 Depth: 3

3-M3 Depth: 3

6.2 H7 Depth: 1.5

21

16

12

20

13

29

39.5
iVY System

### Lenses

**8mm lens [ML-0813] (Model No. : KM7-M7214-60)**

![Diagram of 8mm lens]

**12mm lens [ML-1214] (Model No. : KM7-M7214-40)**

![Diagram of 12mm lens]

**16mm lens [ML-1614] (Model No. : KM7-M7214-30)**

![Diagram of 16mm lens]

**25mm lens [ML-2514] (Model No. : KM7-M7214-20)**

![Diagram of 25mm lens]

### Standard lens angle-of-view table

<table>
<thead>
<tr>
<th>Lens Type</th>
<th>Focal length (mm)</th>
<th>Aperture value (F No.)</th>
<th>Angle-of-view (degrees)</th>
<th>Closest approach distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm lens [ML-0813]</td>
<td>8</td>
<td>F1.3-CLOSE</td>
<td>45.0</td>
<td>57.8</td>
</tr>
<tr>
<td>12mm lens [ML-1214]</td>
<td>12</td>
<td>F1.4-CLOSE</td>
<td>21.9</td>
<td>29.0</td>
</tr>
<tr>
<td>16mm lens [ML-1614]</td>
<td>16</td>
<td>F1.4-CLOSE</td>
<td>23.0</td>
<td>30.4</td>
</tr>
<tr>
<td>25mm lens [ML-2514]</td>
<td>25</td>
<td>F1.4-CLOSE</td>
<td>21.8</td>
<td>28.5</td>
</tr>
</tbody>
</table>

Note. Field-of-view table for our standard lenses. As the field-of-view widens, distortion on image edges may increase.

### Viewing angle, WD, and magnification when using close-up ring

<table>
<thead>
<tr>
<th>Close-up ring (mm)</th>
<th>Viewing angle (mm/°)</th>
<th>WD (mm)</th>
<th>Magnification</th>
<th>Viewing angle (mm/°)</th>
<th>WD (mm)</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>74</td>
<td>59</td>
<td>0.05</td>
<td>77</td>
<td>59</td>
<td>0.05</td>
</tr>
<tr>
<td>0.5</td>
<td>74</td>
<td>58</td>
<td>0.11</td>
<td>77</td>
<td>57</td>
<td>0.11</td>
</tr>
<tr>
<td>1</td>
<td>74</td>
<td>57</td>
<td>0.18</td>
<td>77</td>
<td>56</td>
<td>0.18</td>
</tr>
<tr>
<td>1.5</td>
<td>74</td>
<td>55</td>
<td>0.24</td>
<td>77</td>
<td>54</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
<td>53</td>
<td>0.3</td>
<td>77</td>
<td>52</td>
<td>0.3</td>
</tr>
<tr>
<td>5</td>
<td>74</td>
<td>43</td>
<td>0.6</td>
<td>77</td>
<td>40</td>
<td>0.6</td>
</tr>
</tbody>
</table>

### Standard lens angle-of-view table

<table>
<thead>
<tr>
<th>Lens Type</th>
<th>Focal length (mm)</th>
<th>Aperture value (F No.)</th>
<th>Angle-of-view (degrees)</th>
<th>Closest approach distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm lens [ML-0813]</td>
<td>8</td>
<td>F1.3-CLOSE</td>
<td>45.0</td>
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</tr>
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<td>29.0</td>
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<td>F1.4-CLOSE</td>
<td>23.0</td>
<td>30.4</td>
</tr>
<tr>
<td>25mm lens [ML-2514]</td>
<td>25</td>
<td>F1.4-CLOSE</td>
<td>21.8</td>
<td>28.5</td>
</tr>
</tbody>
</table>

### Accessories and part options

**iVY System**

#### Standard accessories

- **iVY board**
- **iVY board accessories**
  - Name | Single unit model | Set Model |
  - Camera trigger input cable connector | KX0-M657L-00 | KX0-M657K-00 |
  - Custom tool | KX0-M657M-00 | KX0-M657K-00 |

**Support software for PC iVY Studio**

iVY Studio is support software for the iVY system that allows registering part types and reference marks as well as monitoring the work search status during automatic robot operation by connecting to the robot controller.

**Environment**

- **Software model**: KX0-M4988-00
- **OS**: Microsoft Windows 2000 / XP / Vista
- **CPU**: Exceeding the environment recommended by the OS being used
- **Memory**: 64MB or more (Recommended)
- **Hard disk**: Vacant capacity of more than 40MB in the installation destination drive
- **Display**: 800 × 600 dots or more, 32768 colors (16bit High Color) or more (recommended)
- **Network**: TCP/IP Ethernet port × 1
Options

- Lighting control board

<table>
<thead>
<tr>
<th>Name</th>
<th>Single unit model</th>
<th>Set Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting power cable connector</td>
<td>KX0-M657L-10</td>
<td>KX0-M657K-10</td>
</tr>
<tr>
<td>Wiring lever</td>
<td>KX0-M657M-10</td>
<td></td>
</tr>
<tr>
<td>Lighting input trigger cable connector</td>
<td>KX0-M657L-00</td>
<td>KX0-M657K-00</td>
</tr>
<tr>
<td>Custom tool</td>
<td>KX0-M657M-00</td>
<td></td>
</tr>
</tbody>
</table>

- Tracking board

<table>
<thead>
<tr>
<th>Name</th>
<th>Single unit model</th>
<th>Set Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting power cable connector</td>
<td>KX0-M657L-10</td>
<td>KX0-M657K-10</td>
</tr>
<tr>
<td>Wiring lever</td>
<td>KX0-M657M-10</td>
<td></td>
</tr>
<tr>
<td>Lighting input trigger cable connector</td>
<td>KX0-M657L-00</td>
<td>KX0-M657K-00</td>
</tr>
<tr>
<td>Custom tool</td>
<td>KX0-M657M-00</td>
<td></td>
</tr>
<tr>
<td>AB phase input cable connector</td>
<td>KX0-M657L-20</td>
<td>KX0-M657K-20</td>
</tr>
<tr>
<td>AB phase input cable connector case</td>
<td>KX0-M657M-20</td>
<td></td>
</tr>
</tbody>
</table>

- Camera cable

Cable for connecting the camera to the iVY board.

- CCD camera

Model KX0-M7913-00

- Lens

Model

<table>
<thead>
<tr>
<th>Photograph</th>
<th>Width</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM7-M7214-60</td>
<td>8mm</td>
<td>ML-0813</td>
</tr>
<tr>
<td>KM7-M7214-40</td>
<td>12mm</td>
<td>ML-1214</td>
</tr>
<tr>
<td>KM7-M7214-30</td>
<td>16mm</td>
<td>ML-1614</td>
</tr>
<tr>
<td>KM7-M7214-20</td>
<td>25mm</td>
<td>ML-2514</td>
</tr>
</tbody>
</table>

- Close-up ring

Model

<table>
<thead>
<tr>
<th>Photograph</th>
<th>Diameter</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>KX0-M7215-00</td>
<td>0.5mm</td>
<td></td>
</tr>
<tr>
<td>KX0-M7215-10</td>
<td>1.0mm</td>
<td></td>
</tr>
<tr>
<td>KX0-M7215-20</td>
<td>2.0mm</td>
<td></td>
</tr>
<tr>
<td>KX0-M7215-30</td>
<td>5.0mm</td>
<td></td>
</tr>
</tbody>
</table>

- LAN cable with shield cloth (5m)

Model KX0-M55G0-00

- Tracking encoder cable (10m)

Model KX0-M66AF-00