ROBOT VISION

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.

![Diagram of iVY system layout]

- **Up to two cameras and lights can be connected.**
- **Vision board connects directly to bus.**
- **Up to two encoders can be connected.**
- **Either optional tracking board or lighting control board can be selected. (Tracking board is equipped with lighting control function.)**

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

### Conventional system without robot vision

<table>
<thead>
<tr>
<th>Positioning by workpiece</th>
<th>Positioning by workpiece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick-up</td>
<td>Assembly</td>
</tr>
<tr>
<td>Workpiece 1</td>
<td>Workpiece 2</td>
</tr>
<tr>
<td></td>
<td>Workpiece 3</td>
</tr>
</tbody>
</table>

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.

### System with robot vision

- **Positioning is not needed.**
- **Detection by camera + pick-up**
- **Positioning is not needed.**
- **Assembly**

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.

![Diagram of robot controller with image processing function]
**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 alignment (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.

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**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), 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.

### 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.

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**Search results**

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**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.

**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.

**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.

**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.

### Example of robot vision language

<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>

### Conventional robot vision vs. iVY system

**Conventional robot vision**

MOVE P, P9
OFF LINE
SEND (" ") TO CMU
SEND CMU TO P10
ON LINE
MOVE P, P10

**Communication with image processing unit**

**Program of image processing unit**

**Program of host PLC**

**iVY system**

MOVE P, P9
VSEARCH 1,2,0
P10=VGETPOS(0)
MOVE P, P10

**Searches for workpiece.**

**Reads the point.**

**Moves to this point.**

**MERITS**

- No communication time lag
- Controllable only with the robot program.
- Needs only few command lines.
- Simple and easy to understand

### So, the iVY system can solve such problems.

- **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.**
  
  Changing the setup such as for positioning tasks will take a lot of time when there are a large number of part types and more and more work tends to involve small lot production with different parts. 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.
Robot vision  iVY system

iVY System

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”!

Features

1. Amazingly easy to use!
   Ordinary robot vision requires a great deal of time and trouble due to tasks such as setting up data transfer. However the Yamaha “iVY System” is super easy to operate because it utilizes a unique work positioning function.

2. Super-easy one-step calibration
   Calibration (coordinate matching alignment task) is an easy job on the iVY system and finished in a short time because all the operator does is comply with the conversation type commands from the programming box.

3. Uses edge search for great stability
   Machine vision on most current equipment uses gray search which is easily affected by the work piece surface state and lighting conditions. The iVY system however includes a “search engine” using edge search that is strongly resistant to outside effects and so opens up a whole new range of machine vision applications.

4. High-speed bus connection is resistant to noise and fast!
   Connecting a bus line directly to the CPU board in the robot controller yields data transfer speeds some 5,000 times higher than serial data transfer on commercial vision equipment.

5. Robot program provides easy control of vision tasks
   Vision tasks such as camera switching, image capture, and work search can now be easily controlled from the robot program. Tasks ranging from moving the robot to camera control are all carried out in one unified sequence so writing a program is easy.

6. Yamaha delivers total support!
   The controller, robot and vision are all manufactured by Yamaha. The iVY system delivers total support for tasks ranging from image capturing by the camera to operating the robot.

iVY system layout

Basic system contents

- RCX240 controller
- iVY system (Plug-in Board)
- iVY Studio (Support software)

Connections to up to 2 camera and lighting units

Connections to up to 2 encoders

Select a tracking board or lighting control board (tracking board comes with lighting control function)
iVY System basic specifications

**iVY board**

- **Edge (contour) searches**
The edge search format of the iVY system is relatively unaffected by missing and soiled workpieces.
- **Generous number of registered models**
  Up to 40 models can be registered and used in searches. This permits easy setup changes simply by changing the model number.
- **Supports 2 cameras**
  Up to 2 cameras can be connected (both cameras must be the same type).
- **iVY Studio permits search conditions to be monitored during automatic robot operation**
  iVY Studio permits monitoring of work search conditions during automatic robot operation, and monitoring of fiducial mark search conditions during calibration setting operations.

**Lighting control board (Options)**

- **Digitally modulated light format used for PWM**
  A digitally modulated light format is used for pulse width modulation (PWM), resulting in stable light modulation.
- **Light emission format (continuous light / strobe light) is selectable according to the application**
  The light emission format can be selected according to the application in question. Continuous light: 100-step light modulation (0 to 100%) Strobe light: 10μs to 33ms light emission time setting
- **Supports 12V and 24V lighting specifications (constant voltage type)**
  Either a 12V or 24V lighting specification can be used to supply power which matches the LED lighting specification in question. LED lighting colors (red, white, green, blue) are also supported.
- **2Ch lighting output, with max. output capacity of 60W**
  2 lighting channels can be used simultaneously, provided that the total power consumption for both channels does not exceed 60W (for 24VDC. For 12VDC, the maximum is 30W). The modulated light and lighting control mode settings can be specified individually.

**Tracking board (Options)**

- **Conveyor tracking support**
  The tracking board receives pulse signals (AB phase) from conveyor encoders in order to continuously check the positions of conveyed workpieces. This allows workpieces to be picked up without stopping the conveyor.
- **Equipped with 2 pulse counters**
  The tracking board has 2 pulse counters, allowing workpieces to be checked on 2 lines simultaneously. Each of the pulse counters supports pulse inputs of up to 2Mpps.
- **Equipped with lighting control function**
  The tracking board is equipped with the lighting control board functions, allowing it to perform all the iVY system functions with only an iVY board and a tracking board.
iVY System

Accessories and part options

### Standard accessories

#### iVY board

- **With power supply harness**: KX0-M4402-00
- **Without power supply harness**: KX0-M4402-10

#### iVY board accessories

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

### 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.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Software model</strong></td>
<td>KX0-M4988-00</td>
</tr>
<tr>
<td><strong>OS</strong></td>
<td>Microsoft Windows 2000 / XP / Vista</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>Exceeding the environment recommended by the OS being used</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>64MB or more (Recommend)</td>
</tr>
<tr>
<td><strong>Hard disk</strong></td>
<td>Vacant capacity of more than 40MB in the installation destination drive</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>800 × 600 dots or more, 32768 colors (16bit High Color) or more (recommended)</td>
</tr>
<tr>
<td><strong>Network</strong></td>
<td>TCP/IP Ethernet port × 1</td>
</tr>
</tbody>
</table>

### Options

#### Lighting control board

- **Model**: KX0-M4400-G0

#### Lighting control board accessories

<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>KX0-M657K-10</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>KX0-M657K-00</td>
</tr>
</tbody>
</table>

#### Tracking board

- **Model**: KX0-M4400-E0

#### Tracking board accessories

<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>KX0-M657K-10</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>KX0-M657K-00</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>KX0-M657K-20</td>
</tr>
</tbody>
</table>

#### Camera cable

Cable for connecting the camera to the iVY board.

<table>
<thead>
<tr>
<th>Model</th>
<th>Length</th>
<th>Single unit model</th>
<th>Set Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5m</td>
<td>KX0-M66F3-00</td>
<td>KX0-M66F3-10</td>
<td></td>
</tr>
<tr>
<td>6m</td>
<td>KX0-M66F3-10</td>
<td>KX0-M66F3-10</td>
<td></td>
</tr>
<tr>
<td>9.5m (relay 3.5m+6m)</td>
<td>KX0-M66F0-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7m (relay 1m+6m)</td>
<td>KX0-M66F0-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5m</td>
<td>KX0-M66F4-10</td>
<td>KX0-M66F4-10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Length</th>
<th>Single unit model</th>
<th>Set Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay cable 3.5m</td>
<td>KX0-M66F0-20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relay cable 1m</td>
<td>KX0-M66F0-30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: When installing a camera cable in a moving section, use a relay cable so that it can be easily replaced if needed.

#### Lens

<table>
<thead>
<tr>
<th>Model</th>
<th>Focal Length</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm</td>
<td>KM7-M7214-60 (ML-0813)</td>
<td></td>
</tr>
<tr>
<td>12mm</td>
<td>KM7-M7214-40 (ML-1214)</td>
<td></td>
</tr>
<tr>
<td>16mm</td>
<td>KM7-M7214-30 (ML-1614)</td>
<td></td>
</tr>
<tr>
<td>25mm</td>
<td>KM7-M7214-20 (ML-2514)</td>
<td></td>
</tr>
</tbody>
</table>

#### Close-up ring

<table>
<thead>
<tr>
<th>Model</th>
<th>Diameter</th>
<th>Single unit model</th>
<th>Set Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3mm</td>
<td>KX0-M7215-00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0mm</td>
<td>KX0-M7215-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0mm</td>
<td>KX0-M7215-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0mm</td>
<td>KX0-M7215-30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tracking encoder cable (10m)

- **Model**: KX0-M66AF-00

#### LAN cable with shield cloth (5m)

- **Model**: KX0-M55G0-00
Dimensional outlines

### CCD camera

#### CCD camera dimensions

![CCD Camera Dimensions](image)

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

**Mount**
- Diameter: 29.1

**Cover**
- Diameter: 39.5

**4-M2 Depth:** 3

**3-M3 Depth:** 3

**a2 H7 Depth:** 1.5

#### Lenses

- **8mm lens [ML-0813]** (Model No.: KM7-M7214-60)
  - Focal length: 8 mm
  - Aperture value (F No.): F1.3
  - Angle-of-view (degrees): 45.0 Vertical, 57.8 Horizontal
  - Closest approach distance: 0.2 m

- **12mm lens [ML-1214]** (Model No.: KM7-M7214-40)
  - Focal length: 12 mm
  - Aperture value (F No.): F1.4
  - Angle-of-view (degrees): 21.9 Vertical, 29.0 Horizontal
  - Closest approach distance: 0.3 m

- **16mm lens [ML-1614]** (Model No.: KM7-M7214-30)
  - Focal length: 16 mm
  - Aperture value (F No.): F1.4
  - Angle-of-view (degrees): 23.0 Vertical, 30.4 Horizontal
  - Closest approach distance: 0.4 m

- **25mm lens [ML-2514]** (Model No.: KM7-M7214-20)
  - Focal length: 25 mm
  - Aperture value (F No.): F1.4
  - Angle-of-view (degrees): 21.6 Vertical, 28.5 Horizontal
  - Closest approach distance: 0.5 m

#### Standard lens angle-of-view table

<table>
<thead>
<tr>
<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 Vertical, 57.8 Horizontal</td>
</tr>
<tr>
<td>12mm lens [ML-1214]</td>
<td>12</td>
<td>F1.4-CLOSE</td>
<td>21.9 Vertical, 29.0 Horizontal</td>
</tr>
<tr>
<td>16mm lens [ML-1614]</td>
<td>16</td>
<td>F1.4-CLOSE</td>
<td>23.0 Vertical, 30.4 Horizontal</td>
</tr>
<tr>
<td>25mm lens [ML-2514]</td>
<td>25</td>
<td>F1.4-CLOSE</td>
<td>21.6 Vertical, 28.5 Horizontal</td>
</tr>
</tbody>
</table>

Notes:
- 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>8mm lens [ML-0813]</th>
<th>12mm lens [ML-1214]</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Viewing angle (mm/mm)</td>
<td>WD (mm)</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>Horizontal</td>
</tr>
<tr>
<td>0.5</td>
<td>72</td>
<td>96</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>1.5</td>
<td>29</td>
<td>38</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>57</td>
</tr>
</tbody>
</table>

| None | Viewing angle (mm/mm) | WD (mm) | Magnification |
|-------------------|-------------------|-------------------|
| | Vertical | Horizontal | Vertical | Horizontal |
| 0.5 | 82 | 100 | 358 | 0.04 | 65 | 87 | 458 | 0.06 |
| 1 | 117 | 156 | 515 | 0.03 | 181 | 242 | 1270 | 0.02 |
| 1.5 | 34 | 45 | 143 | 0.11 | 38 | 50 | 269 | 0.10 |
| 2 | 26 | 35 | 108 | 0.14 | 31 | 42 | 223 | 0.12 |
| 5 | 29 | 39 | 120 | 0.12 | 45 | 60 | 320 | 0.08 |
| 10 | 14 | 19 | 103 | 0.35 | 14 | 19 | 103 | 0.25 |

Notes:
- This table shows viewing angles when using the standard lens and close-up ring. If no close-up ring is used, then a WD smaller than this value in this table cannot be used.
- If using a close-up ring, then only a WD close to this value can be used.
- The values in this table are at most only a reference and do not signify an absolute index.
- To find viewing angle and WD other than for our standard lens, visit our website at: http://www.moritex.co.jp/products/.

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