OMRON

Software Manual
TMvision

TM ROBOT

Original Instructions

I627-E-03

This Manual contains information of the Techman Robot product series (hereinafter referred to as the TM Robot). The information contained herein is the property of Techman Robot Inc. (hereinafter referred to as the Corporation). No part of this publication may be reproduced or copied in any way, shape or form without prior authorization from the Corporation. No information contained herein shall be considered an offer or commitment. It may be subject to change without notice. This Manual will be reviewed periodically. The Corporation will not be liable for any error or omission.

TM logo is registered trademark of TECHMAN ROBOT INC. in Taiwan and other countries and the company reserves the ownership of this manual and its copy and its copyrights.

Contents

Tables

Figures

Revision History Table

Revision	Date	Revised Content
01	October 2018	Original release
02	July 2019	Added 1.72.3500 features
03	December 2019	Minor texts fixed and added Light Intensity. Added 1.76.3300 features

1. General

1.1 Overview

TMvision is a combined hardware and software built-in feature of TM Robot. Regarding the hardware: There is a visual camera module at the end of the TM Robot for you to experience complete visual software functionalities. The software comes in two functions: Standard and Licensed. The Standard function supports most robot applications, while the Licensed function consists of separate modules that may be purchased as needed.

With approvals from a variety of robot vision manufacturers, TMvision comes with functions such as feature identification, object location, enhance mode, barcode identification as well as color classifier integrated into TMflow for users to design the robot task step by step.

TM Robot's built-in Vision Designer supports Eye-in-Hand (EIH), Eye-to-Hand (ETH), and Upward-Looking cameras with balanced high-level integration and multiple supports. The hardware and software integrated internal Vision Designer does away with the complex vision components of conventional systems, and saves you time in getting familiar with robots that you may know little about. For users familiar with robot and machine vision, TMvision comes with a wide range of assistance and integration tools for you to generate diversified visual robot integration platforms.
This manual begins with the built-in EIH camera to outline the TM exclusive Task Designer system with the built-in camera. It then describes the external camera's software and hardware integration, and ends with an introduction of advanced licensed functions.

This manual applies to TMflow Version 1.76. There will be differences between the functions and interfaces of different software versions. Confirm your software version before using and reading this manual. To confirm the software version, click [i] at the top right of the screen for the information.

1.2 Warning and Caution Symbols

The Table below shows the definitions of the warning and caution levels used in our manuals. Pay close attention to them when reading each paragraph, and observe them to avoid personal injuries or equipment damage.

DANGER:
Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in death or severe property damage.

	**WARNING:** Identifies a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, and might result in serious injury, death, or significant property damage.
	**CAUTION:** Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.

Table 1: Danger, Warning, and Caution Symbols

1.3 Safety Precautions

	**DANGER:** This product can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed:

- All personnel who install, operate, teach, program, or maintain the system must read the *Hardware installation Manual*, *Software Manual*, and *Safety Manual* according to the software and hardware version of this product, and complete a training course for their responsibilities in regard to the robot.

Read Manual Label; Impact Warning Label

- All personnel who design the robot system must read the *Hardware installation Manual*, *Software Manual*, and *Safety Manual* according to the software and hardware version of this product, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The TM Robot must be used for its intended use.
- Results of the risk assessment may require the use of additional risk reduction measures.
- Power to the robot and its power supply must be locked out and tagged out or have means to control hazardous energy or implement energy isolation before any maintenance is performed.
-  Dispose of the product in accordance with the relevant rules and regulations of the country or area where the product is used.

1.4 Validation and Liability

The information contained herein neither includes how to design, install, and operate a complete robotic arm system, nor involves the peripherals which may affect the safety of the complete system. The integrators of the robot should understand the safety laws and regulations in their countries and prevent hazards from occurring in the complete system.

This includes but is not limited to:

- Risk assessment of the whole system
- Adding other machines and additional risk reduction measures based on the results of the risk assessment
- Using appropriate software safety feaures
- Ensuring the user will not modify any safety measures
- Ensuring all systems are correctly designed and installed
- Clearly labeling user instructions
- Clearly marked symbols for installation of the robot arm and the integrator contact details
- Making accessible relevant documents, including the risk assessment and this Manual

CAUTION:
This product is a partly complete machine. The design and installation of the complete system must comply with the safety standards and regulations in the country of use. The user and integrators of the robot should understand the safety laws and regulations in their countries and prevent major hazards from occurring in the complete system.

1.5 Limitation of Liability

No safety-related information shall be considered a guarantee by the Corporation that a TM Robot will not cause personnel injury or property damage.

1.6 Functional Note Symbols

The following table defines the functional note symbols used in this manual. Read the paragraphs carefully.

	**IMPORTANT:** This symbol indicates the relevant functional details to assist programming and use.
	**NOTE:** This symbol indicates the relevant functional use tips to assist programming efficiency.

Table 2: Function Note Symbols

2. Eye-in-Hand

2.1 Overview

The TM Robot's built-in Vision Designer system integrates hands, eyes and brains of conventional robots into one. This not only enables you to execute high precision jobs but also provides flexibility for fast line changes. Regarding hardware operation, users can move the robot to right above the object and press the Vision button on the camera to generate a Vision node in TMflow for subsequent visual job programming. See the relevant *Hardware Installation Manual* for the position of the buttons.

TMvision is designed for coordinate adjustment and vision job administration, and users can set parameters of visual features on lighting and imaging in the Vision node to enhance the speed and quality of identification. Refer to the following chapters for details and instructions.

2.2 Vision Base System Positioning Mode

TM Robot comes with a 2D camera as the built-in vision system that supports the positioning model on the object-oriented base or the robot alignment-oriented base. For the the object-oriented base positioning model, users must create a workspace and make sure the workspace is parallel to the object. Failure to do so may result in distorted imaging and visual identification job failures. TMvision offers four positioning methods: TM Landmark, fixed-point, visual servoing, and object-based calibration as described below.

2.2.1 TM Landmark

TM Landmark provides a fast, simple and flexible base system positioning method as a reference to the environment. Capturing TM Landmark with TM Robot will generate the position information of six degrees of freedom (including X, Y, Z, RX, RY, RZ) once to build a base system accordingly for users to record following points and motions. When the robot is repurposed or relocated, when the relative position of the robot and landmark changed, it's simple - use the robot to take a photo of TM landmark again, to regain 6 DoF of the new location and renew the landmark base system. The recorded points and motions on the Landmark base system will be converted to the base system automatically to make the robot move to the same positions as before.

TM Landmark is a 0.2 cm thick and 5x5 cm square plastic plate as shown in the figure below. By capturing and recognizing TM Landmark's black and white borders and central graphic features through TM Robot's EIH camera, the robot can create the base system in the center of the TM Landmark's black and white border. Note that the accuracy of landmark positioning is not sufficient for identification and alignment purpose. In principle, TM Landmark is not designed for users to have the robot directly go to individual points or execute motions after creating a base system. Instead, it is an alignment tool to lead the robot toward a valid visual point. Users should use the TM Robot visual positioning function to identify and locate the object in the last step to get the best results.

TM Landmark generates a base system with six degrees of freedom, and the data in the RX, RY, and Z directions are not easy to obtain accurately with EIH 2D vision (i.e. whether the camera plane is parallel to the object and how long is the distance between the camera plane and the object). TM Landmark can enhance the positioning ability of the 2D vision along these axes. Despite the fact that TM Landmark is able to get the data of the X, Y, and RZ direction, chances are users may fail to place or attach TM Landmark precisely in the operating environment, it is not recommended to use the data directly for positioning. Due to the fact that these three degrees of freedom compensate the positioning of the base data in EIH 2D vision, users should use both methods. As a regular approach, users should use TM Landmark to have the robot guide its relative relationship between the peripherals or the RX, RY, and the Z axes. That is to say, using the positioning of TM Landmark on the three axes to ensure the visual points recorded in the TM Landmark base system after updating with the landmark base system of the visual point camera posture, are able to return back to the state of parallel with workpiece features (RX, RY) and to the correct distance to workpiece features (Z). Users can then use this positioning as the basis for a subsequent 2D vision job, and use each of the TMvision 2D functions to align the remaining axial directions of X, Y and RZ. Even if the relative position between base of robot and the TM Landmark changes, users can reuse the points and the motions recorded in the landmark base system from the former project by having the robot shoot the TM Landmark again.

When planning a project, users may place TM Landmark in the target task environment to create a TM Robot vision job and perform subsequent motions with the base system. Shooting the TM Landmark again in later operations will have the robot reset to the original base system automatically, i.e. to change alignment of robot according to site conditions without being confined to a fixed alignment.

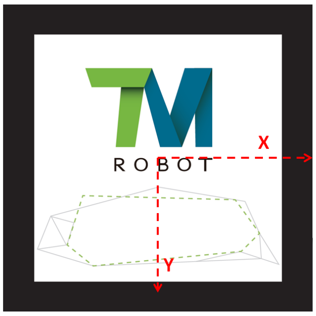


Figure 1: TM Landmark

Note

NOTE:
The farther away the TM Landmark is from the camera the less accurate the alignment will be. The tradeoff is that a bigger field of view tends to capture changes of relative alignment between the robot and the TM Landmark. A shorter distance between the camera and Landmark has the advantage of better alignment accuracy but at the cost of a smaller field of view and Landmark's easily falling outside the file of view. Users are advised to edit two vision jobs: one nearer and the other farther, when using TM Landmark. The farther one is aimed to quickly detect the TM Landmark in a workspace to create the first base system. Then, pull the robot close while orienting the RX, RY, and RZ angles of the second visual points (set these axes in the original base system orthogonal) to zero and keep them as close as possible, e.g. camera and TM Landmark 10cm apart from each other. Shoot the same TM Landmark to get a more accurate Landmark base system.

2.2.2 Fixed Positioning

The fixed positioning function is designed with a pre-set object placement area and pre-set height for vision jobs. Users can create a workspace with the TM calibration plate. When using the TM calibration plate for fixed-point alignment, the relative height of the camera and the work plane is also defined. When using fixed-point alignment to establish a workspace, users must ensure that the absolute height of camera and object is equal to the workspace created by the TM calibration plate.

Figure 2: Fixed Positioning

2.2.3 Servoing

The servoing function is for users to define the object features. In each servoing process, TMvision automatically sets the robot position based on the defined object to return the relative position of the camera and object.

2.2.4 Object-based Calibration

The principle of object-based calibration is basically teaching as servoing and ending as fixed-point positioning. First, run the tilt correction with the calibration plate to define the visual servoing workspace with the actual workpiece and convert to the fixed point positioning with calculations. Since the servo calibration is used only when defining the workspace for the first time, the robot will place the workpiece at the four corners of the camera's field of view to create the workspace with four movements and make the fixed-point positioning calculation with the workspace accordingly. This takes advantage of the fixed positioning's speed for positioning and the servoing without the calibration plate. For the object calibration, the features of the object should not be too big to fit in the field of view during the servo calibration.

2.3 Camera List

The list of cameras on the left side of TMvision shows the cameras in use and their status. Right-click any listed camera to pop up a window that lets you refresh the list of cameras or detect an external camera.

2.4 Controller

To help users control the robot movements, TMvision provides the controller interface for users to move the robot to the appropriate positions and edit vision jobs.

2.5 Camera Kit

The camera kit is used to adjust camera imaging, including the following settings:

Name	Function
Camera Parameter Setting	Includes shutter and focus for the built-in camera and contrast and white balance for extracted images. All modules feature auto once function. Click Save to validate change made after adjustment jobs ended.
Focus / Aperture	To assist adjusting focus and aperture of an external camera. It provides visual tools for easy regulation. Users may read the scores of the current focus and aperture on the left, which vary with change in focus and aperture with the external camera. The calibration ends when the scores hit the Max line and stop rising even after more adjustment.

Brightness Setting	Includes illuminance visualization tool to enable users adjusting lighting tools for optimized illumination distribution. The left side controls sensitivity of the visualization tool. The two trackbars in the settings indicate the upper and lower limits of the visualization display. The brightness over the upper and lower limits are defaulted to their limits for display. If the illuminance in the field of view is uniform, colors shown by visualization tools may be close to each other in case of high sensitivity (upper and lower slides being farthest away from each other).
Tilt-Correction	Secure TM Landmark or calibration plate to the target plane as a calibration tool to enable the robot's automatic adjustment to the tilt angle and vertical alignment of the camera to target plane. Adjust camera parameter settings to ensure TM Landmark or the calibration plate is detectable before running tilt-correction. Keep adequate clearance around the robot, as in an automatic tilt-correction process the robot will move around its current position.

Table 3: Camera Kit Functions

Note

NOTE:

1. The default resolution of the camera is 5M pixels, and so is the production calibration. 5M pixels positioning is supported in Fixed Point and Landmark.
2. If your robot came with TMFlow 1.68 out of the box, once upgraded to TMFlow 1.72 or later, the default 5MP camera setting won't take effect. Please contact service team to conduct 5MP calibration procedures to enable this functionality.
3. Previous vision jobs built with 1.2M pixels will retain previous settings.

2.6 Calibrate Workspace

Workspace calibration includes automatic and manual calibration to help users create workspaces for fixed-point vision jobs. Workspace calibration will generate the information of the workspace as well as the VPoint. Refer to *Expression Editor and Listen Node* for details of VPoint.

2.6.1 Automatic Calibration

The automatic workspace calibration goes with four steps:

1. Tilt-Correction
2. Confirm Workspace
3. Calibrate Workspace
4. Save Results

Note

NOTE:

- Before starting calibration: Position the identification target in the center of the field of view using the controller or manual handle. Place the camera 10 to 30 cm above the target. Determine the plane where the feature is located before placing the calibration plate on the plane. If the workpiece geometry does not allow for a calibration plate, you may replace the

- workspace with an object of the proper height to place the calibration plate at the same height as the identification feature.
- Click **Yes** when the message to skip tilt-correction prompts to bypass tilt-correction while calibrating a workspace with eye-in-hand.

IMPORTANT

IMPORTANT:
Keep adequate clearance around the robot as in an automatic calibration process the robot will move around the initial position.

Once set up, do not touch the calibration plate before starting the calibration process.

Step 1. Tilt-Correction:
Correct tilt before workspace calibration to ensure the calibration plate is perpendicular to the camera parallel to the camera's focal plane.

Step 2. Confirm Workspace:
Visually check tilt-correction. Click the icon in the flow chart to calibrate tilt again if necessary. The position of the robot, at the start of the calibration process, is called the initial position of the robot in this workspace. This process also defines the VPoint.

Step 3. Calibrate Workspace:
Click Start to have the robot take pictures of the calibration plate with multiple angles to calculate the relative position of the workspace created by the calibration plate to the robot.

Step 4. Save Results:
Once the accuracy has been validated, save the calibration results in a workspace file to access it in fixed vision jobs.

2.6.2 Manual Calibration

The manual workspace calibration goes with four steps:

1. Confirm Workspace
2. Set TCP Setting
3. Calibrate Workspace
4. Save Results

Note

NOTE:
- Before starting calibration: Mount the required calibration tool on the robot tool flange. Techman Robot recommends using the calibration pin set provided by Techman Robot as the calibration tool. Using TMFlow (TCP Setting), set the Z height of the calibration tool. Position the identification target in the center of the field of view using the controller or manual handle. Place the camera 10 to 30 cm above the target; determine the plane where the feature is located before placing the calibration plate on

the plane. If the workpiece geometry does not allow for a calibration plate, users can replace the workspace with an object of the proper height to place the calibration plate at the same height as the identification feature.

- Simply click **Yes** when the message to skip tilt-correction prompts to bypass tilt-correction while calibrating workspace with eye-in-hand.

IMPORTANT

IMPORTANT:
Once set up, do not move the calibration plate until the completion of the calibration process.

Step 1. Confirm Workspace:
The robot must be positioned at the initial position of the robot in this workspace.

Step 2. Set TCP Setting:
Set the Z height, using TMFlow (TCP Offset), for the calibration tool being used.

Step 3. Calibrate workspace: Point the calibration tool to the calibration plate grid shown on the screen. When being prompted. Click **Next**. Repeat this step five times. Use the controller to manipulate the robot when performing this calibration.

Step 4. Save Results: Once the accuracy has been validated, save the calibration results in a workspace file to access it in fixed vision jobs.

2.7 Live Video

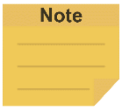
Live Video provides a live camera image with functions at the bottom (from left to right): zoom out, display ratio, zoom in, text tool, play, play once, pause, and grid

Figure 3: Live Video

Functions	Suitable for hand-eye relationship
Zoom out Zoom in	The Eye-in-hand / eye-to-hand function is designed to change display ratio of the camera. This zooms in and out image displayed without changing the scope of extraction by the camera.
Text tool	Set the color, the offset, the size, the style, the prefix and the suffix of

	the text and the objects on the screen.
Play Play Once Pause	Set up extract mode (default = continuous extract) for users convenience to capture current image shown on camera; pause extract: to freeze image and stop capturing; extract once: to get current image when pressing the extract button.
Grid	Turn on grid at the center of the live video to help composition.

Table 4: Live Video Functions



NOTE:
Users can move the mouse cursor anywhere on the screen to view the coordinates and the RGB values of the pixel in the live video.

2.8 Task Designer

TMvision provides users with a means of editing visual work, see Chapter 3 Task Designer for details.

2.9 Hard Drive Setting

Hard Drive setting provides users with the ability to manage photo storage space and requires the TM SSD (sold separately) to save source images or result images for analysis. Images can be saved in **png**, **jpg**, or **bmp**. The **Source Image** is saved as **png** by default, the **Result Image** as **jpg**. The pie chart in the bottom left displays used space, available space, and reserved space. Users may check from **Do not save data** or **Delete from the oldest data** in **Stop status handling.** Click **Select Path** to assign the path to store files, and drag the slider to configure the size reserved for the free space.

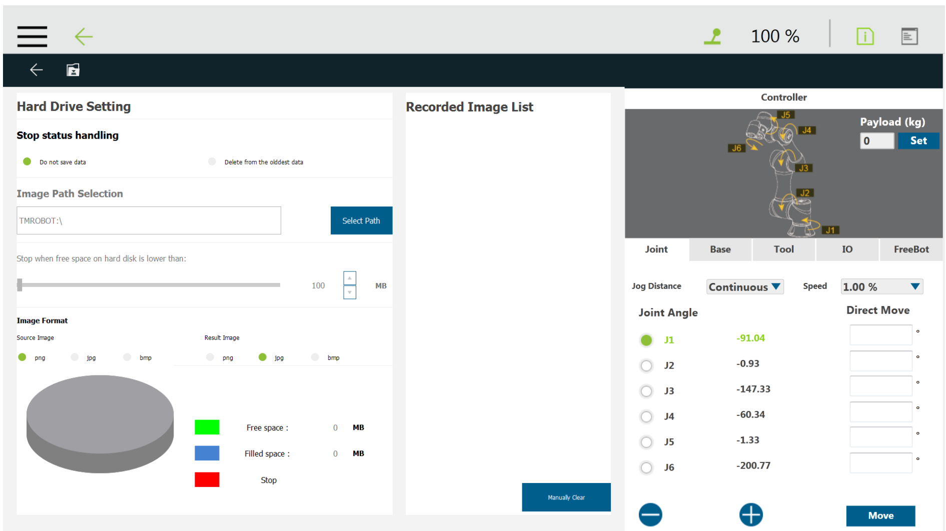


Figure 4: Hard Drive Setting

3. Task Designer

3.1 Overview

TMvision contains the following task designer functions: Visual Servoing, Fixed Point, AOI-only, Vision IO, Landmark Alignment, and Object-based Calibration. Users can select the required applications according to their needs and execute jobs with diversified visual algorithm.

In addition to Vision IO and AOI-only identification, other applications can use the Find function to position the base system to establish the relationship between the robot motion and the visual components. As shown in the figure below, record point P1 on vision base system 2 and create relative relationship with the object to access object visually.

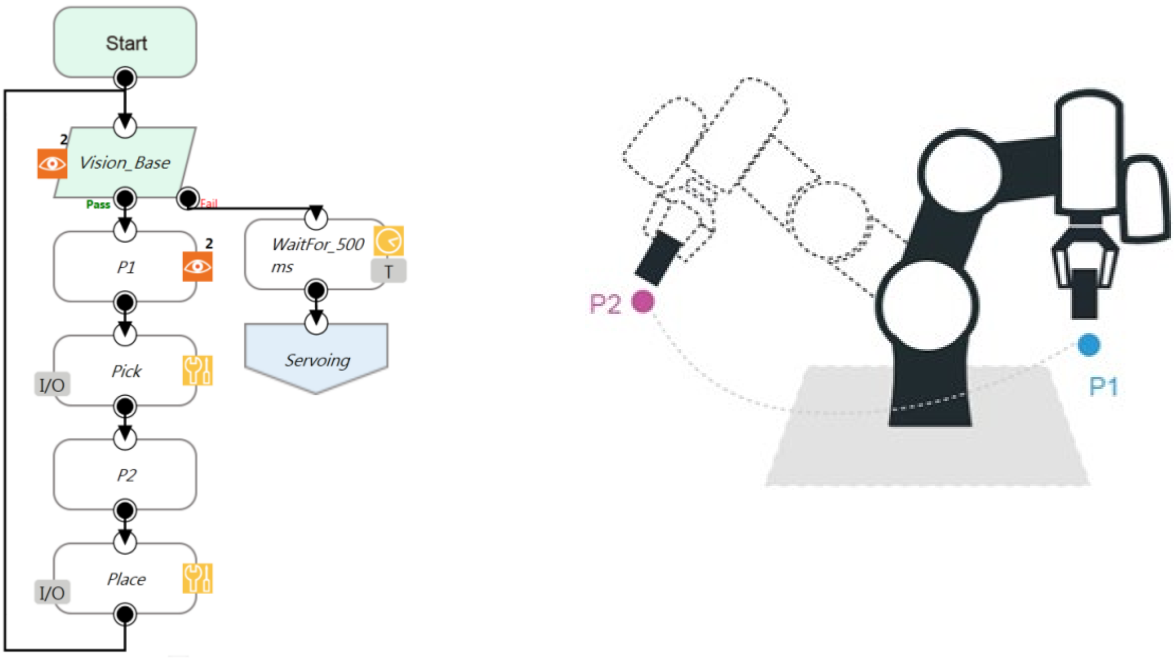


Figure 5: The Flow of Pick and Place

IMPORTANT:
When using a vision base system, select the current base system shown at the top right of TMflow as the vision base system.

NOTE:
In case of invalid selection, re-record the base system with the "Re-record on another base " in the Point Manager.

3.2 Select Application

Select the TMvision Task Designer in the work list and choose appropriate application according to intended use. Basic categories are as follows:

Applications	Suitable for hand-eye relationship	Workspace	Base system output
Fixed	Eye-in-Hand / Eye-to-Hand	✓	Create base system based on object position
Servoing	Eye-in-Hand	×	Create base system based on the robot position
AOI-only	Eye-in-Hand / Eye-to-Hand	×	×
Vision IO	Eye-in-Hand / Eye-to-Hand	×	×
Landmark Alignment	Eye-in-Hand	×	Create base system based on Landmark position
Object-based Calibration	Eye-in-Hand	×	Create base system based on object position

Table 5: Select Applications

Users can save vision images by setting criteria based on the results of object detections, recognitions, and measurements. Images available to save include the original image (source image) and the last image taken (result image).

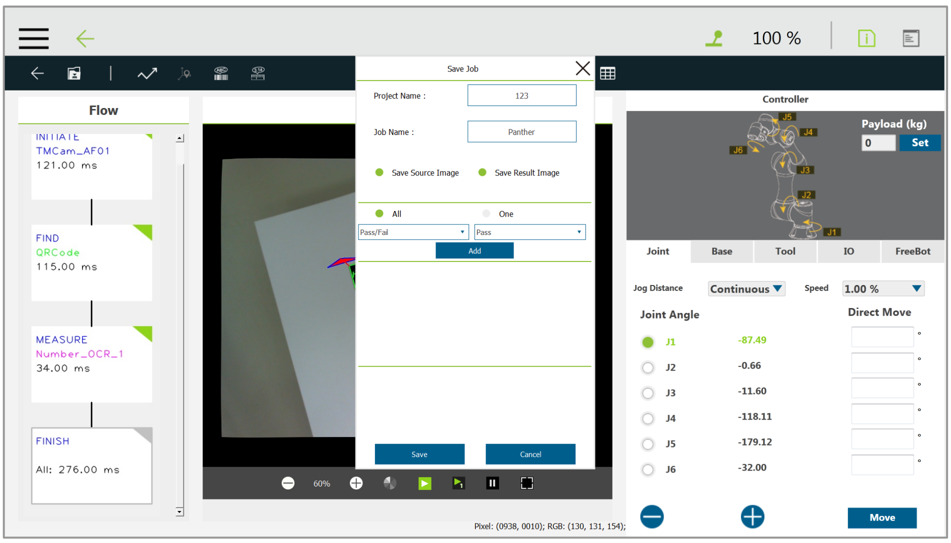


Figure 6: Save Vision Images Based on Results

3.2.1 Visual Servoing

Enter the TMvision Task Designer window and select Visual Servo to use this function. Visual servoing is only suitable for eye-in-hand. Alignment is achieved by getting continuously closer to the object's target coordinate on the image. The workspace does not need to be established. If the target angle has wide variations, use a calibration board to conduct level calibration during the initial alignment. The servoing time is determined by region of convergence and the robot movement path. This can be applied to situations where the relationship between the camera, workspace, and the robot can easily change due to changes in human action and the environment. After the level is calibrated, select INITIATE on the left side of the Flow to make basic parameter settings. Setting parameters are as follows:

Name	Function
Adjust camera parameters	Includes shutter and focus for the built-in camera and contrast and white balance for extracted images. All modules feature an auto once function. Click Save to validate changes made.
Switch to record image	Use the internal TM SSD images for identification.
Start at initial position	Check this to return the robot to its initial position before visual identification. Uncheck this and the robot will execute visual identification at the current position.
Lighting	Control light source switch at end of the robot.
Light Intensity*	Use the slider to set the brightness level
Move to the initial position	Move the robot to the initial position
Reset initial position	Reset initial position of the robot
Idle for Robot Stablilization	Set the length of time manually or automtically to have the robot self-adjust before taking pictures.

*Available for HW 3.0 models or newer.

Table 6: Visual Servoing Settings

After the basic parameters have been set, confirm that the image is clear and can be seen. Select the Find function at the top and use the pattern matching function to match the pattern's shape feature in the selected frame.

Once the matching patterns have been determined, TMvision will compare the image in the current field of view against the one in storage to compute shape features and identify differences between them as well as give scores for similarity determination. Users may set up appropriate thresholds to determine whether the two images are of the same object.

Note

NOTE:

1. TMvision provides an easy feature editing function. If patterns selected contain unnecessary features users can click Edit pattern icon to modify features of the pattern.

2. Even though **Enable Timeout** is unchecked, there will be a 50 seconds timeout as the system timeout protection for TMvision. Once TMvision triggered the system timeout protection, the project will be stopped and display the error code.

Exit and return to the flow chart once completed. You may set servoing target when there is at least one Find function in the in visual flow chart.

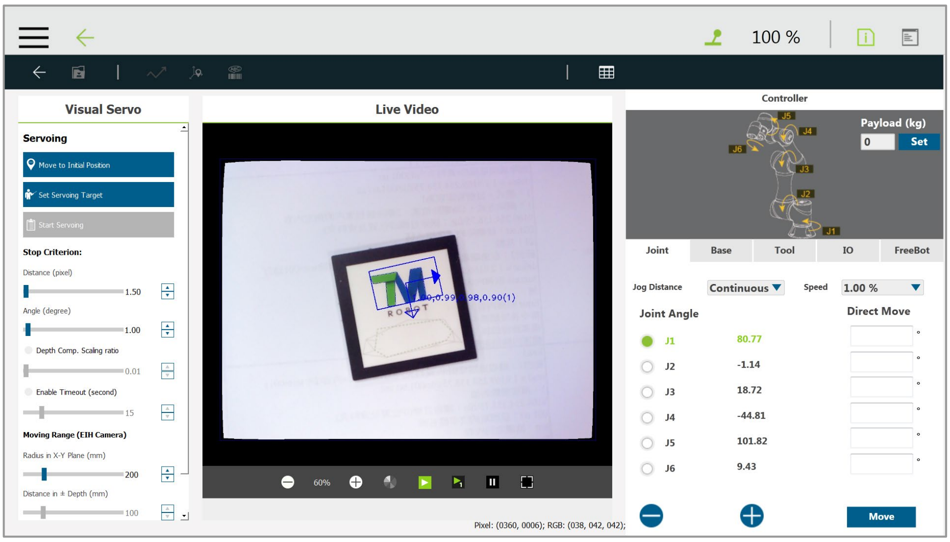


Figure 7: Visual Servoing

Parameters of the teaching page are described below:

Name	Function
Move to the initial position	Move the robot to the initial position
Distance (pixels)	When features distances between the current object and the target model are less than or fall below the set value of the distance, it is judged to be a match.
Angle	When features angles between current and target object fall below the set value of the angle, it is judged to be a match.
Depth compensation	Whether or not to perform depth compensation based on the Scaling value of the found object.
Radius in X-Y plane	Stop the robot movement when the horizontal movement distance exceeds this value.
Distance in ± depth	Stop the robot movement when the vertical movement distance exceeds this value.
Set servoing target	Determine servo target position by clicking the button and options below. (1) Use current position (2) Locate target at image center

Start Servoing	Click and hold to run the servoing process. Only save the results after successful servoing.
Stop Criterion	Use the sliders to configure the stop criteria of the **Distance**, the **Angle**, the **Depth**, and the length of **Timeout**.
Moving Range	Use the sliders to configure the ranges of the limitations in the **Radius**, the **Distance**, and the **Rotation** angle of the camera. If the camera goes beyond the range, the system will take the fail route and leave the **Vision** node.

Table 7: Parameters of the Teaching

After configuring the servoing target setting, click Start Servoing and press the (+) button on the robot stick to have TM Robot begin servoing the visual screen. Save the results once TMvision prompts servoing completed successfully.

3.2.2 Fixed Point

Enter the TMvision Task Designer window and select Fixed Point to use this function. The fixed point function is designed for EIH and ETH for the robot to calculate and position objects with absolute coordinates by creating workspaces. Accuracy varies with that of workspace calibration. See 2.2 Vision Base System Positioning Mode for details on creating workspaces. After choosing the workspace, use INITIATE in Flow on the left side to set basic parameters. Setting parameters are shown below:

Name	Function
Adjust camera parameters	Includes shutter and focus for the built-in camera and contrast and white balance for extracted images. All modules feature an auto once function. Click Save to validate changes made.
Switch to record image	Use the internal TM SSD images for identification.
Start at initial position	Check this to return the robot to its initial position before visual identification. Uncheck this and the robot will execute visual identification at the current position.
Move to the initial position	Move the robot to the initial position.
Reset workspace	Reset the robot's workspace.
Lighting	Toggle camera light on or off.
Light Intensity*	Use the slider to set the brightness level.
Idle for Robot Stablilization	Set the length of time manually or automatically to have the robot self-adjust before taking pictures.

Snap-n-go	Improve efficiency by concurrently taking snaps and keeping the flow going to save time for non-vision tasks that follow. After the image has been captured, the system will go to the next node and keep the image processing in the background from the flow. Note that when the processes after the Vision node require the result from the Vision node and the background image processing is still running, there will be conditions and returns as follows: ● If the next node requires the parameters of the result, such as the Boolean variables Done and Pass generated by the Vision job, users will have to edit an If node for the system to determine how to proceed. ● If the next node is also a Vision node which includes a Vision base point or a Vision job, the flow will not continue until it is done with the last Vision node.

*Available for HW 3.0 models or newer.

Table 8: Fixed Point Settings

After configuring the basic camera parameters, select the Find function at the top and select the pattern matching function as shown below. TMvision will use the framed shaped feature to find its alignment on the image and build the visual base on the object.

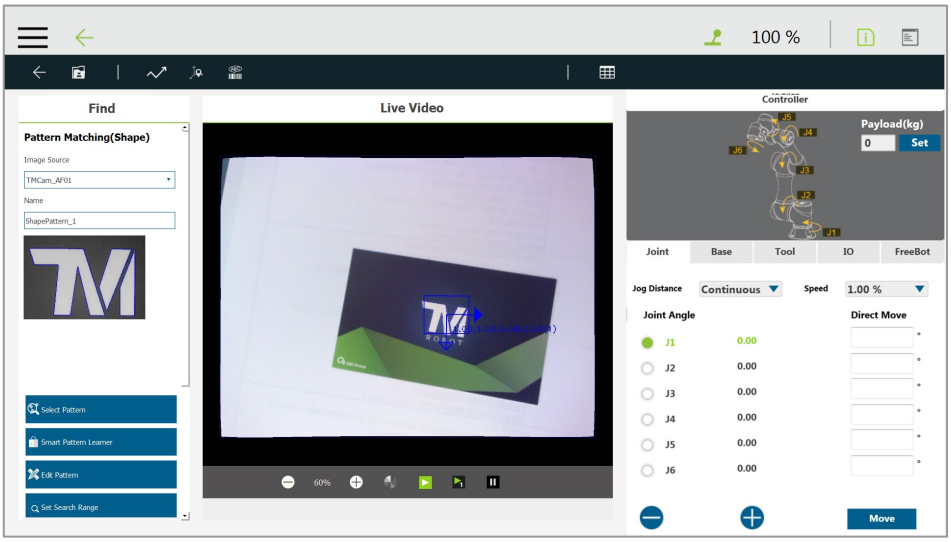


Figure 8: Fixed Point

Once the matching patterns have been determined, TMvision will compare the image in the current field of view against the one in storage to compute shape features and identify differences as well as give scores for matching. Users may set up thresholds to determine whether the two images are the same object. Save the results once the object is validated "Object is detectable and only ONE object is detected".

3.2.3 AOI-only

Enter the TMvision Task Designer and select AOI-only to use this function. The AOI-only identification is applicable to EIH or ETH to read Barcode and QR code, Color Classifier, and String Match without workspace and base system output. To identify a barcode, make sure there is only one clear and readable barcode in the framed region and use INITIATE on the left side of Flow to set basic parameters. The parameters are shown as below:

Name	Function
Adjust camera parameters	Includes shutter and focus for the built-in camera and contrast and white balance for extracted images. All modules feature an auto once function. Click Save to validate changes.
Switch to record image	Use the internal TM SSD images for identification.
Start at initial position	Check this to return the robot to its initial position before visual identification. Uncheck this and the robot will execute visual identification at the current position.
Move to the initial position	Move the robot to the initial position.
Reset workspace	Reset the robot's workspace.
Lighting	Control the light source switch at end of the robot.
Light Intensity*	Use the slider to set the brightness level.
Idle for Robot Stablilization	Set the length of time manually or automatically to have the robot self-adjust before taking pictures.
Snap-n-go	Improve efficiency by concurrently taking snaps and keeping the flow going to save time for non-vision tasks that follow. After the image has been captured, the system will go to the next node and keep the image processing in the background from the flow. Note that when the tasks after the Vision node require the result from the Vision node and the background image processing is still running, there will be conditions and returns as follows: ● If the next node requires the parameters of the result, such as the Boolean variables Done and Pass generated by the Vision job, users will have to edit an If node for the system to determine how to proceed. ● If the next node is also a Vision node which includes a Vision base point or a Vision job, the flow will not continue until it is done with the last Vision node.

*Available for HW 3.0 models or newer.

Table 9: AOI-only Settings

After setting the basic parameters, choose the pattern matching function in the Find function at the top to proceed with matching. The identification is for a specific spot only, not for the entire field of view. Users can use the Find function to adjust the search range to find the object feature. Once the object feature is found, the object's barcode can be accurately idenfified. The barcode identification will output the identification result. Use the Display node to confirm the accuracy of the barcode.

3.2.4 Vision IO

Enter the TMvision Task Designer window and select Vision IO to use this function. When an obvious change occurs in the picture, the difference before and after the change can be used to determine whether a change has occurred to the Sensing Window. The Vision IO module views the camera as an IO module, and continuously monitors a specific area in the screen. When the area shows significant change in content, a trigger signal is sent to TMflow.

Startup method:

Task Designer → Vision IO

In comparision to the previous vision tasks in the flow, when selecting Vision IO at startup, users can set up in the prompt as shown in the left of the figure below.

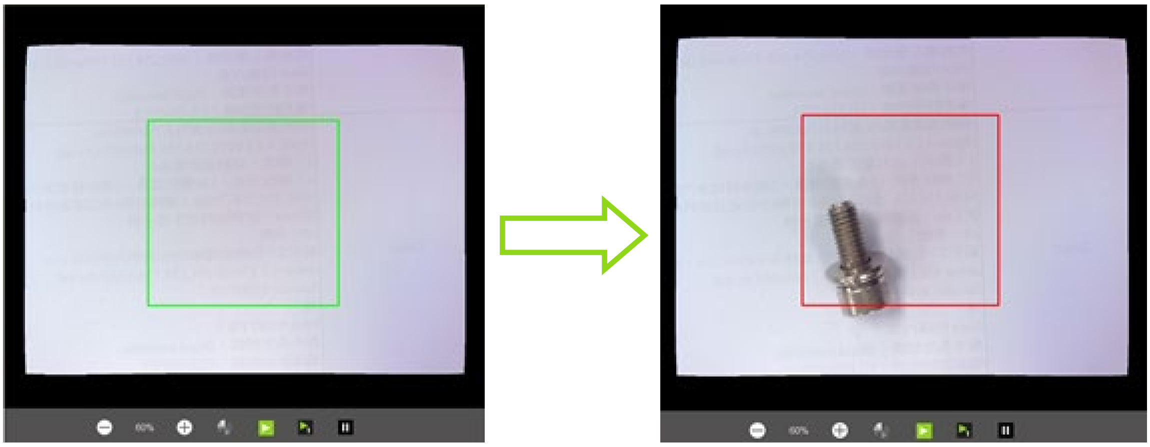


Figure 9: Vision IO

Name	Function
Move to Initial Position	Move the robot to the initial position
Rest Initial Position	Rese the initial position of the robot.
TimeOut	Set the time waiting for Vision IO. If the IO is not activated within the time limit, the process exits through the Fail path.
Set sensing window	Set a region in the live video as an area to monitor. After the setting is completed, if the level of variations goes over the threshold, it means that triggered event occurs.
Threshold	Trigger event sensitivity: The lower the threshold, the more sensitive.

Table 10: Vision IO Settings

3.2.5 Landmark Alignment

Enter the TMvision Task Designer window to select and use the Landmark Alignment function. Users may run this function with the official TM Landmark. This is meant to build subsequent teaching points on the base system added by the TM landmark.

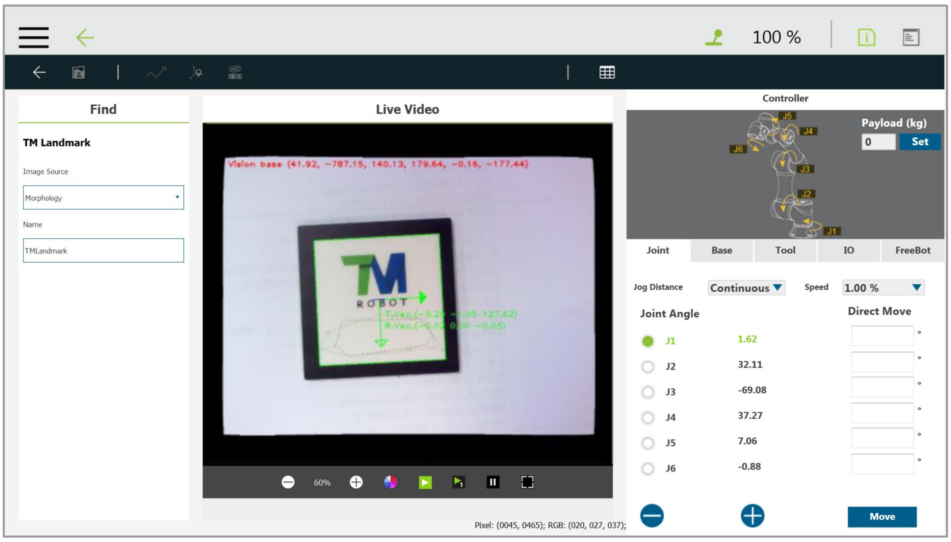


Figure 10: Landmark Alignment (1/2)

For points that were recorded on the robot base, users must teach all points again if the relative relationship between the robot and the object has changed. If the vision base system was created through Landmark and the aligning point is based on the previous vision base system, if the relative relationship between the robot and the object has changed, it only takes the vision node execution to update the Landmark vision base system.

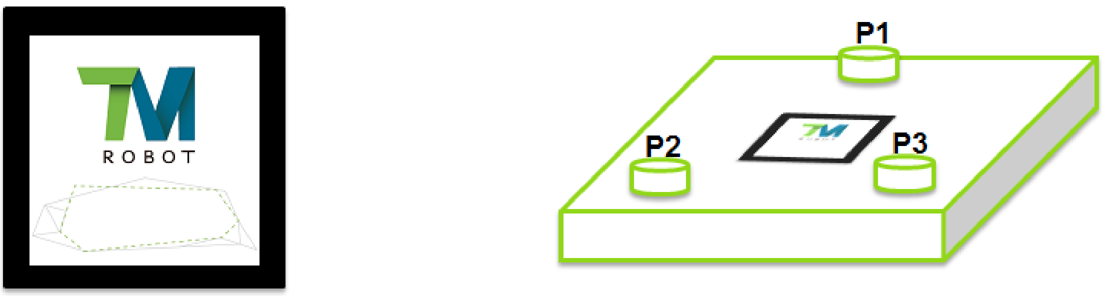


Figure 11: Landmark Alignment (2/2)

The Landmark Alignment parameter settings are as follows.

Name	Function
Adjust camera parameters	Includes shutter and focus for the built-in camera and contrast and white balance for extracted images. All modules feature an Auto once function. Click Save to validate changes.
Switch to record image	Use the internal TM SSD images for identification.
Start at initial position	Check this to return the robot to its initial position before visual identification. Uncheck this and the robot will execute visual identification at the current position.

Move to the initial position	Move the robot to the initial position
Reset workspace	Reset the robot's workspace
Lighting	Toggle camera light on or off.
Light Intensity	Use the slider to set the brightness level
Idle for Robot Stablilization	Set the length of time manually or automatically to have the robot self-adjust before taking pictures.
Snap-n-go	Improve efficiency by concurrently taking snaps and keeping the flow going to save time for non-vision tasks that will follow. After the image has been captured, the system will go to the next node and keep the image processing in the background from the flow. Note that when the processes after the Vision node require the result from the Vision node and the background image processing is still running there will be conditions and returns as below. ● If the next node requires the paramaters of the result such as the Boolean variables Done and Pass generated by the Vision job, users will have to edit an If node for the system to determine how to proceed. ● If the next node is also a Vision node which includes a Vision base point or a Vision job, the flow will not continue until it is done with the last Vision node.

*Available for HW 3.0 models or newer.

Table 11: The Fixed Settings

NOTE:
Users can add Enhance, Identify, and Measure modules to the Landmark Alignment flows for the use of flexibility.

3.2.6 Object-based Calibration

Object-based calibration is applicable to EIH only, which employs the difference in the robot servoing movement to calculate relative relationship between the object and the robot without workspace creation. If the positioning target angle has large variations, users must run the horizontal calibration with the calibration plate before determining the initial position. This function delivers high precision for objects with simpler shapes by building the fixed-point base system directly on the object to reduce the errors on the height measurements made with the calibration plate. When the horizontal calibration is completed, click Find function to select Pattern Matching(Shape) apart from Pattern Matching(Image), Blob Finder, Anchor, and Fiducial Mark Matching for TMvision to frame the shape.

Once the matching patterns have been determined, TMvision will compare the image in the current field of view against the one in storage to compute shape features and identify differences between them as well as give scores for similarity determination. Users can set thresholds to determine if the two images are the same object. Exit and return to the flow chart once completed.

Once edited and there is at least one Find module in the visual flow chart, click Calibration to perform object-based calibration.

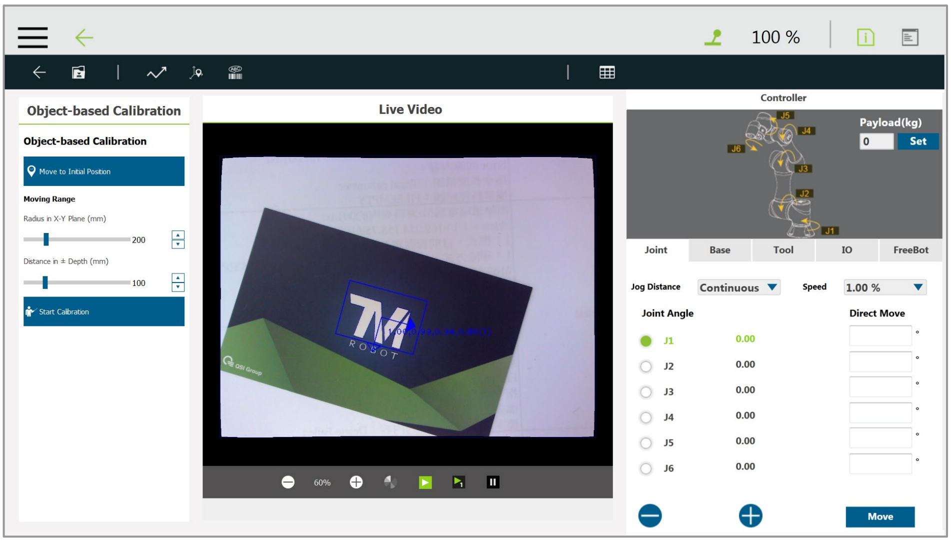


Figure 12: Object-Based Calibration

Name	Function
Move to the initial position	Move the robot to the initial position.
Radius in X-Y plane	When the horizontal moving distance exceeds this value, stop the robot movement.
Distance in ± depth	When the vertical moving distance exceeds this value, stop the robot movement.
Start calibration	Click and hold to the **+** button on the robot stick to servo the object. The robot will move four times to place object at each of the four corners of image field to complete the action. Only save the file after the robot successfully completes these actions.

Table 12: Object-Based Calibration Settings

3.3 Function list

The TM Robot Vision Designer provides three module functions: Enhance, Find and Identify.

3.3.1 Enhance

Enhance provides multiple functions to enhance image features and improve successful project identification in special application environments.

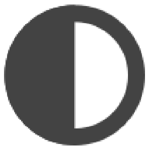
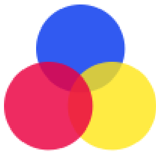
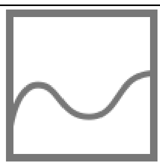
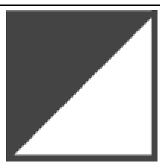
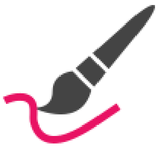
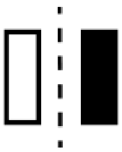
Function module		Function description
Contrast Enhancement		Adjust image contrast.
Color Plane Extraction		Obtain specific colors (such as red, blue, or green) or saturation.
Smoothing		Filter out noise and increase the image's smoothness.
Thresholding		Transform a raw image into a black and white one.
Morphology		Erode, dilate, patch, or open the image.
Flip		Flip the image.

Table 13: Function List – Enhance

3.3.1.1 Contrast Enhancement

Adjust image brightness and contrast to enhance the contrast between object and background to improve accuracy of object detection.

When the contrast between the region of interest (ROI) against the background is poor, you may enhance it with this module to improve the success rate of object comparison. Users are advised to maximize differences between brightness of foreground and background by adjusting the contrast value. Then adjust the gamma value to brighten the bright area and dim the dark area.

Enhance settings	Function description
Image source	Switch among source image modules
Contrast	Adjust contrast. Adjust in the negative direction for a negative image.
Brightness	Adjust brightness
Gamma	Adjust image gamma value
Reset	Reset parameters
Color plane	Select specific color plane for adjustment.
Lookup Table	Conversion curve for the input and output
Histogram	Image's histogram

Table 14: Function List – Enhance (Contrast Enhancement)

3.3.1.2 Color Plane Extraction

Users can extract a specific color plane from an image or convert the color plane from RGB space to HSV space. With the emphasis on the different color planes of the objects and the backgrounds, users can choose the appropriate color plane to increase the contrast between the object and the background and improve the detection accuracy.

The object search module basically operates in a grayscale space. Imported color images are converted into grayscale. Users may use this module to convert images into color space with the best foreground/background difference to improve object identification.

Enhance settings	Function description
Image source	Switch among source image modules
Color plane	The color plane will evaluate: - Gray - Red - Green - Blue - Hue - Saturation - Value
Histogram	Image's histogram

Table 15: Function List – Enhance (Color Plane Extraction)

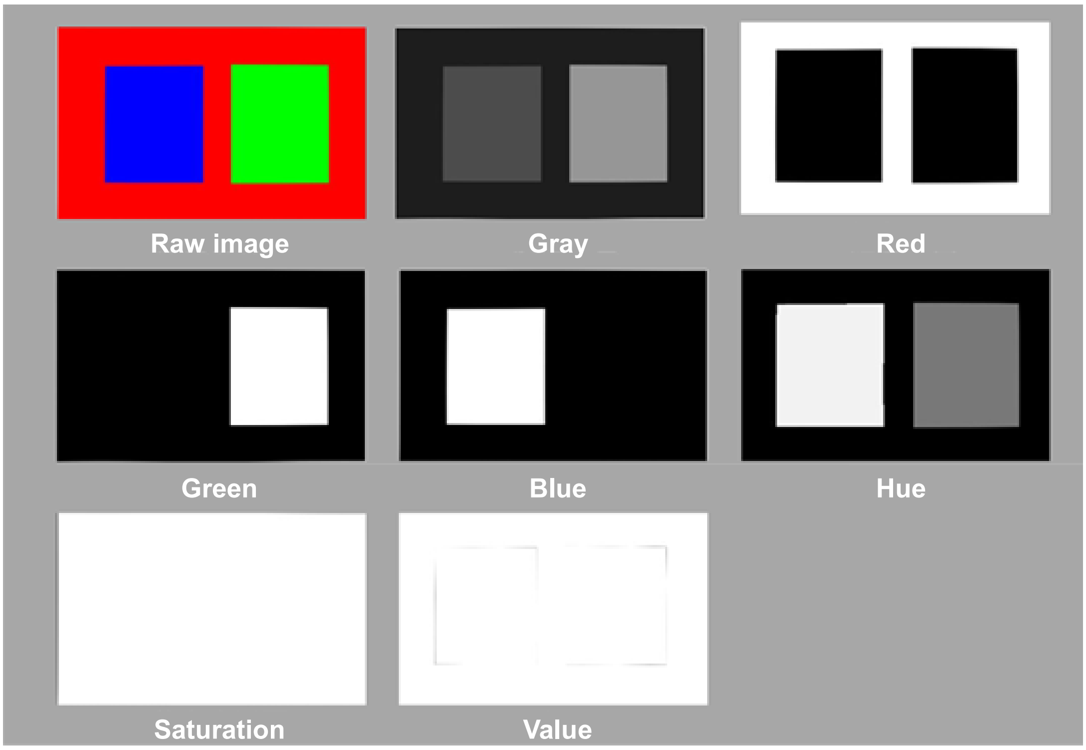


Table 16: Function List – Enhance (Color Plane Extraction – Color Plane)

3.3.1.3 Smoothing

Enhance settings	Function description
Image source	Switch between source image modules
Filter type	Select filter type: - Mean Filter - Gaussian filter - Median filter
Mask size	Regarding mask size: larger mask size results in a smoothing effect in a greater region where the median filter will adjust width parameters only.

Table 17: Function List – Enhance (Smoothing)

3.3.1.4 Thresholding

Set the gray value of pixels larger than the upper threshold to gray value upper limit and pixels smaller than the lower threshold to gray value lower limit, and simplify the color scale of the image.

Enhance settings	Function description
Image source	Switch between source image modules

Threshold type	Binary: If higher than threshold, set as white. If lower, then set as black. Binary (Inverted): Set to black if higher than threshold. Otherwise, set to white. Truncated: If higher than threshold, set equal to threshold. To Zero: If lower than threshold, set as zero. To Zero (Inverted): If higher than threshold, set as zero.

Table 18: Function List – Enhance (Thresholding)

3.3.1.5 Morphology

Morphology computing is often applied to binarize images, applying closing or opening effects to the current image for noise removal or connecting broken foreground objects.

Enhance settings	Function description
Image source	Switch between source image modules.
Operation type	Dilation: Expand the white area. Erosion: Erode white areas. Opening: Erode the white area before dilating it to open connected weak sides or remove broken fractures. Closing: Dilate the white area before eroding it to patch up broken faces or voids. Gradient: Subtract the image after erosion from the image after dilation to extract the edge area.
Structuring element	Rectangle Cross Ellipse
Element size	The larger the element size the greater the calculation range.
Iteration	Number of repeated operations

Table 19: Function List – Enhance (Morphology)

3.3.1.6 Flip

This function can be used to flip the image.

Enhance settings	Function description
Image source	Choose the source image
Flip Direction	Vertical, horizontal.

Table 20: Function List – Enhance (Flip)

3.3.2 Find

Function module	Function description	Output (floating point)
Pattern Matching (Shape)	Locate an object in the image based on its geometrical features.	Relative to coordinates X, Y and rotation angle R of image home (upper left).
Pattern Matching (Image)	Locate an object in the image based on its pixel value distribution features.	Relative to coordinates X, Y and rotation angle R of image home (upper left).
Blob Finder	Locate an object by the color difference between the object and the background.	Relative to coordinates X, Y and rotation angle R of image home (upper left).
Anchor	Change home coordinates of object detection by manually adjusting the anchor point.	Relative to coordinates X, Y and rotation angle R of image home (upper left).
Fiducial Mark Matching	Use the two obvious features on the object for matching.	Relative to coordinates X, Y and rotation angle R of image home (upper left).

Table 21: Function List – Find

3.3.2.1 Flow

The left side of the vision programming flow chart shows the computing flow of vision tasks. The highlighted bold frame indicates the process now in focus. The green frame indicates the process functioned successfully, and the orange frame indicates the process functioned unsuccessfully.

IMPORTANT

IMPORTANT:
If any of the processes in a flow are orange, the flow cannot be saved.

3.3.2.2 Pattern Matching(Shape)

The function uses the geometrical shape of the object as its pattern model and matches it to the input image to find the object in the image. It supports variations due to object rotation and dimension. It is best for objects with rigid profiles.

Name	Function description
Pattern Selection	After selection, this image will pop up. Users can select the object in the image.

Smart Pattern Learner	To create fast visual extract tasks with process learning the pattern model. Step 1: Add object search module (shape), click "Smart Pattern Learner". Step 2: Shoot background. Step 3: To shoot a workpiece, press Next to identify the target object once it gets located. Step 4: Adjust the threshold, internal distance, and external distance. Step 5: Press Next to exit the Smart Pattern Learner.
Pattern editor	Click and the edit window pops up for you to edit shape feature of the object.
Set search range	Set the location, size, and rotation of the range to search.
Number of Pyramid Layers	The number of processing iterations to perform on the image. More layers reduces processing time, but for images with a lot of detail, the detail may get lost, resulting in detection errors.
Mininum Score	Object can be identified only when the score of the detection is higher than the minimum setting.
Max. Num. of Objects	The maximum number of objects that can be detected in the image.
Sorted by:	When the maximum number of objects is greater than 1, the outputs will be sorted according to the setting of this field.
Directional Edge	Select whether the shape edge is directional.

Table 22: Function List – Find (Patten Matching (Shape))

IMPORTANT

IMPORTANT:

- Search range: Set rotation angle smaller for symmetrical objects , e.g. rectangles (-90~90), squares (-45~45), and circles (0~1).
- The number of Pyramid Layers are directly linked with speed of pattern matching. The algorithm matches layers from top down. As an additional layer is added, the pixel resolution is halved, but the search speed is up. The frequently used value for the layers falls between 3 and 5. Users may set up according to characteristics of pattern edge feature. Fewer layers will preserve more feature details, and more layers result in less processing time.
- Smaller minimum scores reduces omissions from judgments at the cost of more misjudgments. Frequently used values fall between 0.75 and 0.85.

<table>
<tr><th colspan="2">Pattern</th></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Check Directional Edge</td><td>Uncheck Directional Edge</td></tr>
</table>

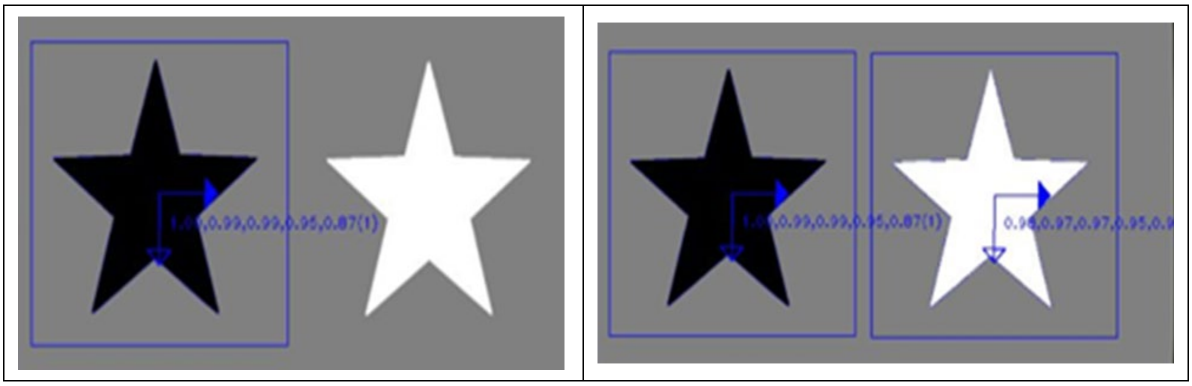


Table 23: Function List –Find (Patten Matching (Shape))

NOTE:
The pattern matching algorithm determines matching of objects based on strength and directions of object edges. Edge direction refers to whether the edge is from light to dark or from dark to light. When directional edge is checked, the direction of the pattern's edges will influence the identification result (star on the left side gets detected). Otherwise, both stars will be detected.

3.3.2.3 Pattern Matching (Image)

This function uses the image of the target object itself as its pattern model and matches it to the input image to position the object in the image. It supports variations due to object shift and rotation. Differing from shape pattern matching, this function does not support dimension changes and may take a long time to compute. It may be employed when the workpiece lacks visible features or has fuzzy edges.

Name	Function description
Pattern Selection	After selection, this image will pop up. Users can select the object in the image.
Set search range	Set the location, size, and rotation of the range to search.
Num. of Pyramid Layers	The number of processing iterations to perform on the image. More layers reduces processing time, but for images with a lot of detail, the detail may get lost, resulting in detection errors.
Min. Score	If the score of the detection result is higher than this minimum score, the system will identify this as the object.
Max. Num. of Objects	The maximum number of objects that can be detected in the image.
Similarity Metric	Users can pick the most appropriate measuring method from among the "Correlation Coefficient" or "Absolute Difference" methods. The former has a slower speed, but is tolerant of ambient light differences, and the light and shadow changing ability is stronger.
Sorted by:	When the maximum number of objects is greater than 1, the output result will be sorted according to the setting in this column.

Table 24: Function List – Find (Patten Matching (Image))

IMPORTANT:

- Search range: Set rotation angle smaller for symmetrical objects , e.g. rectangles (-90~90), squares (-45~45), and circles (0~1).
- The number of Pyramid Layers are directly linked with speed of pattern matching. The algorithm matches layers from top down. As an additional layer is added, the pixel resolution is halved, but the search speed is up. The frequently used value for the layers falls between 3 and 5. Users may set up according to characteristics of pattern edge feature. Fewer layers will preserve more feature details, and more layers will reduce processing time.
- Smaller minimum scores reduces omissions from judgments at the cost of more misjudgments. Frequently used values fall between 0.75 and 0.85.

3.3.2.4 Blob Finder

Differing from detecting objects of fixed geometry by pattern matching, objects without fixed geometry should use this function for detection.

Name	Function description
Set search range	Set effective detection range
Color plane	Choose color space to use
Extract color	Click and enclose color of ROI on image.
Red, green, blue Plane	Distribution range of ROI color
Area size	To set up area of foreground scope: Objects with foreground pixels outside of this area will be discarded.
Max. Num. of Objects	The maximum number of objects that can be detected in the image.
Sorted by:	When the maximum number of objects is greater than 1, the outputs will be sorted according to the setting of this field.

Table 25: Function List – Find (Blob Finder)

3.3.2.5 Anchor

The anchor function sets the initial position and the orientation of the object base system. Users can find objects with a Find module, and the default base system of the objects is marked with blue arrows, which is for users to anchor a point at the end of the flow. Setting the initial position to the top left vertex and parallel to the black frame will orient the vision base with the anchor.

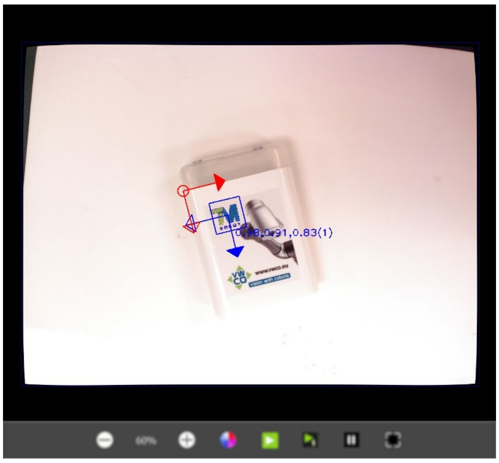


Figure 13: Anchor

NOTE:
The hollow arrow denotes the X direction, and the solid arrow denotes the Y direction.

Name	Function description
Manual adjustment	Manually drag the anchor point to the target position.
X direction shift (pixels)	Move the anchor in the X direction.
Y direction shift (pixels)	Move the anchor in the Y direction.
Rotation	Rotate the anchor about its initial position.

Table 26: Function List – Find (Anchor)

3.3.2.6 Fiducial Mark Matching

The Fiducial Mark Matching function is designed to detect and position the two positioning points on PCBs. It is fast and reliable. However, this function has a smaller search range and lower success rate when the objects zoomed or rotated. For example, this function is suitable for PCB operation, which features little shift in feeding position and requires quick and accurate positioning.

Name	Function description
Set fiducial marks	Set two anchor points on the image in sequence
Set search range	Set search range of the two anchor points on the image in sequence
Threshold	Set matching threshold
Similarity Metric	Users can pick the most appropriate measuring method from "Correlation Coefficient" or "Absolute Difference". The former has a slower speed, but is tolerant of ambient light differences, and the light and shadow changing ability is stronger.

Table 27: Function List – Find (Fiducial Mark Matching)

3.3.2.7 One Shot Get All

This function creates multiple sets of independent processes for one visual task by taking one shot to output multiple-objects and multiple-sets of identification results to save a lot of repetitive computing time as only one shot is required.

This feature supports fixed-point positioning, AOI identification only object search modules, and ETH "Pick'n Place" module.

Step 1: Create a visual object search process module such as Find > Pattern Matching (Shape).

Step 2: Select the INITIATE process, but do not open it.

Step 3: Add another visual object search process module to make the One Shot Get All menu appear.

Step 4: Select Parallel to add independent search processes in parallel to each other, or select Cascade to add process modules one after the other.

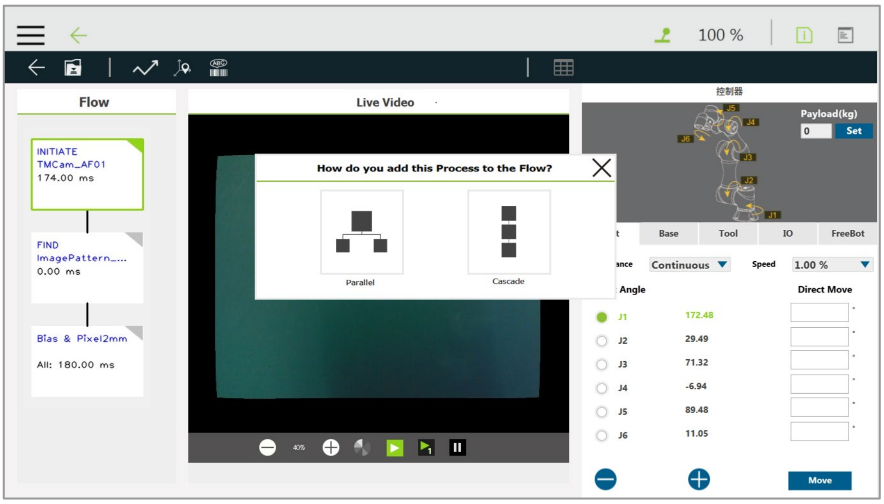


Figure 14: One Shot Get All (1/4)

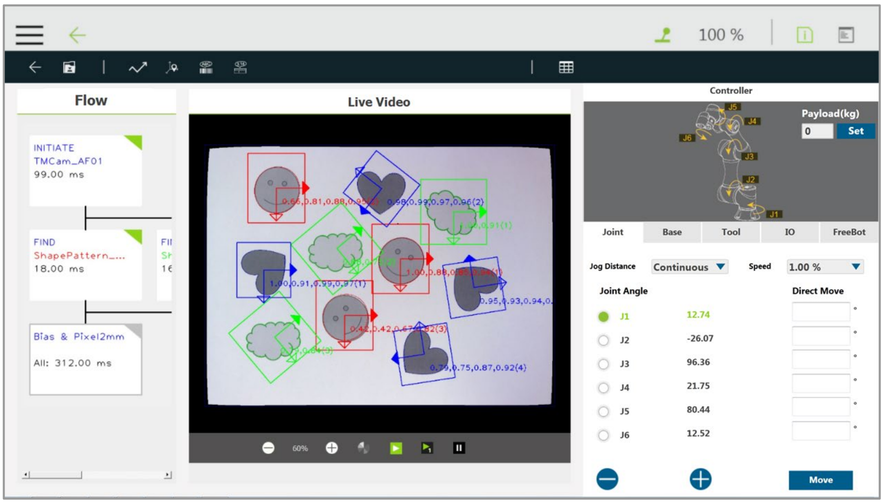


Figure 15: One Shot Get All (2/4)

Step 5: Saving the vision job. Vision jobs can be saved subject to the conditions of "Object is detectable and only ONE object is detected", i.e. only one of the objects shall be and can be found.

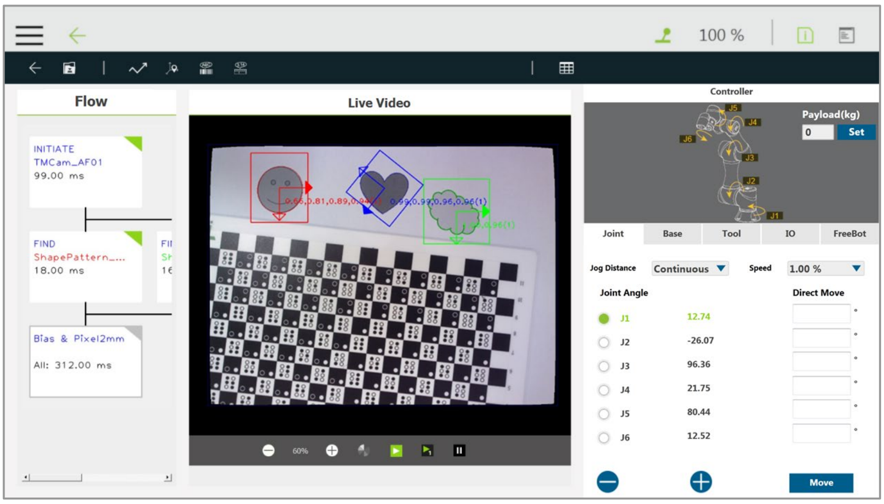


Figure 16: One Shot Get All (3/4)

The vision job generates N sets of the vision base after finished, they generate, and each set of the vision base comes with variables var_MAX and var_IDX as the maximum number of the object searching and the current base index respectively.

By taking one single shot to capture multiple objects, objects can be picked and placed in sequence with batches. As shown below, after passing the vision node, the individual maximum number of the object searching and the individual current base index will be reset. As one job finishes, the base index variable var_IDX proceeds the action +1 with the SET node to denote a job completed and compares with var_MAX in the IF node. If var_IDX equals var_MAX, it means the job is done for that object and will search for the next object in order until all jobs are done.

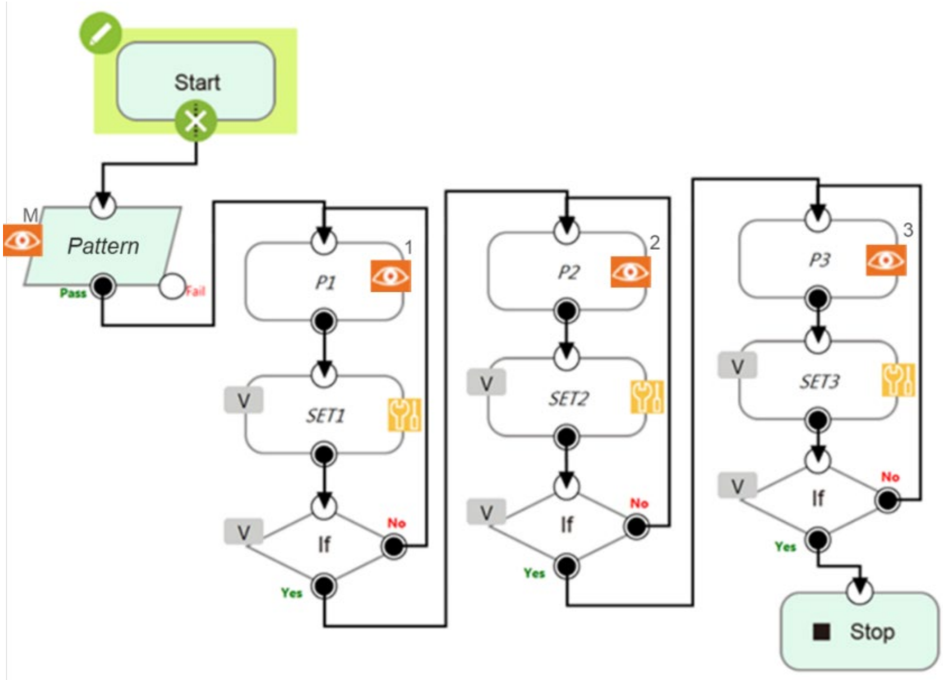


Figure 17: One Shot Get All (4/4)

3.3.3 Identify

This function provides two basic functions: Barcode and color identification with string output once successfully identified. Users may compile processes in TMflow with output of results.

Function module		Function description	Output (floating point)
Barcode / QR code		Read the barcode, the 2D DataMatrix, or the QR code.	Content of the barcode or QR, for a successful read. “” (empty string) for a failed read.
Color Classifier		Color classifier	Users set the characters for the string and for the training.
String Match		Compare strings	Matching results customized by users

Table 28: Function List – Identify

3.3.3.1 Barcode / QR Code

This function supports the decoding of 1-D barcode, QR code and 2-D DataMatrix. The user frame selects the barcode region in the Set Barcode Range for the identification. For barcodes in white symbols on black background: You may select "Enhance" (and set Alpha value to -1) to invert the image before identifying it.

IMPORTANT

IMPORTANT:
Make sure there is only one clear barcode in the area for reading.

Barcode / QR code supported:

1D Barcode Type	Minimum bar width (pixel)	Minimum bar height (pixel)
EAN-8	2	8
EAN-13	2	8
UPC-A	2	8
UPC-E	2	8
CODE 128	2	2
CODE 39	2	2
CODE 93	2	2
Interleaved 2 of 5	2	2

Table 29: Function List – Identify (Supported Barcodes)

2D Barcode Type	Minimum block size (pixel)
QR code	4 x 4
Data Matrix	6 x 6

Table 30: Function List – Identify (Supported QR codes)

3.3.3.2 Color Classifier

This function assists users in dealing with a color identification. Users are required to set up color classification area and select the color feature area for identification before clicking Next to initiate the training process. In addition, users are required to place patterns of different colors as prompted and name each color during the training process. Once trained successfully, the TMvision can classify color of the object to its most suitable category. Click Parameter Adjustement to set RGB and HSV parameters for each color in the list with the sliders, and click OK to update paramaters or Reset to cancel.

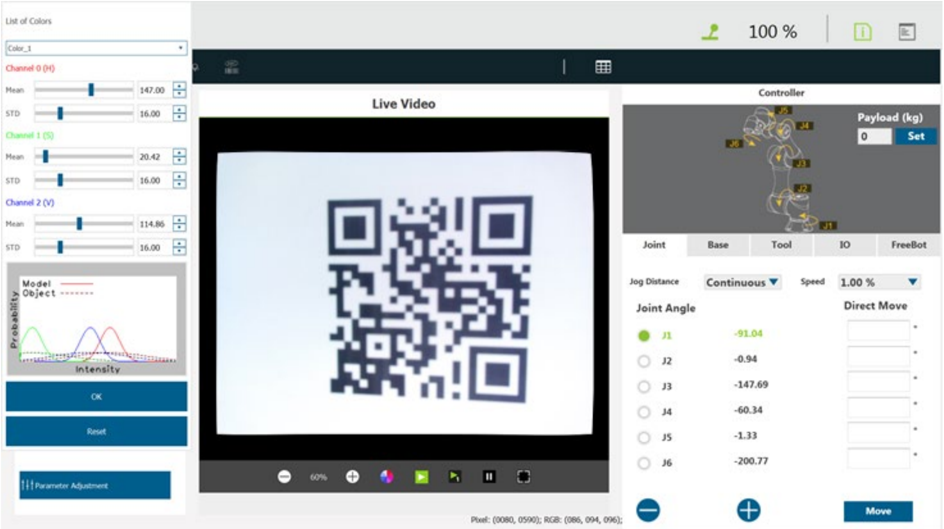


Figure 18: Color Classifier

3.3.3.3 String Match

This function compares strings from sources in the flow or with a fixed string set by users, and generates the matching customizable results for further applcations. In String 1, users can select the source in the Connected To dropdown, or check Fixed String and fill a desired string in the field below. Repeat the same process for String 2. Finally, customize the messages with color to output as the results for Match or Mismatch.

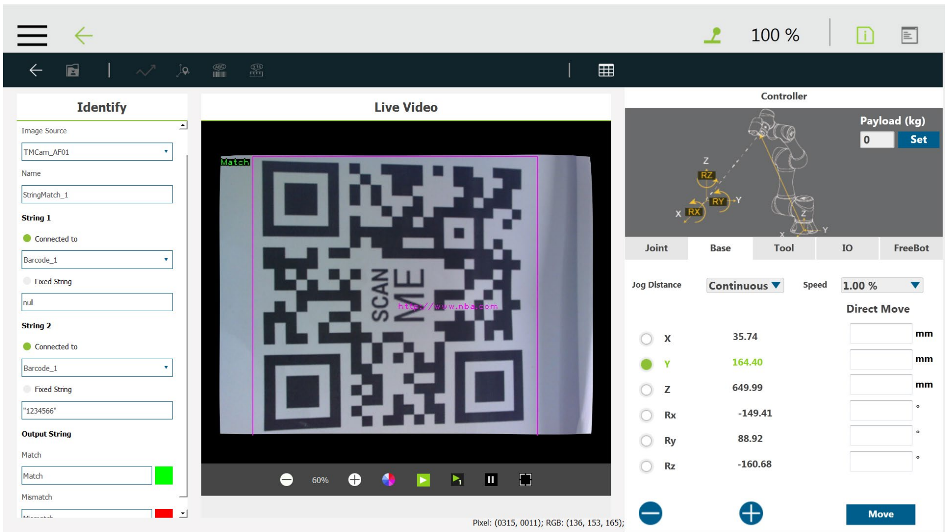


Figure 19: String Match

4. TM External Camera

4.1 Overview

TM external camera is the TMvision's licensed software module, which requires the purchase. It can support connections for up to two external cameras at the same time. TMvision also provides a support tool to help users adjust the external camera's various parameters. External cameras can be used for all TMvision tasks except servoing. There is also an alignment compensation function that is divided into the eye-to-hand or upward-looking camera according to application. The following introduces various camera types and related settings.

WARNING:
Due to the hardware resource restrictions, when using HW 1.0 models or HW 2.0 models, the system is incapable of connecting 2 or more cameras with 5M pixels or more.

4.2 Types of Camera Supported

Brand	Type	Specification	Remark
BASLER	acA2500-14gc/gm	GigE (14 fps at 5 MP) Rolling Shutter	
	acA 2500-20gc/gm	GigE (14 fps at 5 MP) Global Shutter	
	acA 2440-20gc/gm	GigE (23 fps at 5 MP) Global Shutter	
	acA 3800-10gc/gm	GigE (10 fps at 10 MP) Rolling Shutter	HW 3.0 only
	acA 4024-8gc/gm	GigE (8 fps at 12.2 MP) Rolling Shutter	HW 3.0 only

Table 31: Types of Camera Supported

4.3 External Camera Installation Procedure

IMPORTANT:
Ensure the camera is connected to the control box's network outlet and the signal light is on.

Step 1:	Enter TM Flow -> System setting -> Network setting.
Step 2:	Select "Static IP" and enter the following settings. Click Confirm. Set IP address: use either 192.168.61.101 or 192.168.88.102 subnet mask: 255.255.255.0

	Default gateway: 0.0.0.0
Step 3:	Enter the Setting page -> Visual setting -> left side "Camera list" on a blank spot, click the right mouse button -> select "Detect GigE Camera".
Step 4:	Wait for the camera detection to refresh -> left side "Camera list" on a blank spot, click the right mouse button -> select "Refresh Camera List".
Step 5:	GigE camera complete and the camera appears on the camera list. The camera will show "Unknown" at this time.
Step 6:	Once the user completes the steps in the implementation section 4.4 Calibrating the External Camera, the external camera function will be activated.

4.4 Calibrating the External Camera

Once the external camera has been connected, the user needs to calibrate the camera and choose between the eye-to-hand or upward-looking mode for the camera. This establishes the corresponding position between the external camera and the eye-in-hand camera, as well as calibrates the camera's internal parameters.

4.4.1 ETH Camera Calibration

	Manual Calibration:	**Automatic Calibration:**
Step 1:	Select the "Unknown" external camera at the left side camera list to establish a new vision job, and then select "calibrate camera".	
	When the menu presents, select "Eye-to-Hand" and then choose manual calibration.	When the menu presents, select "Eye-to-Hand" and then choose automatic calibration.
Step 2:	Calibrate the eye-to-hand camera's internal parameters. Move the calibration plate into the camera's field of view. Click "Next Step" and repeat this step 15 times with different calibration plate positions and angles. Click "Next Step" when done.	
Step 3:	Click "Next Step" to build a workspace.	
Step 4:	Set and select the tool center of the Calibration Set. Click "Next Step" when done.	Calibrate workspace. Move the eye-in-hand camera to within the visual range of the calibration plate. Calibrate the eye-in-hand and eye-to-hand camera's external parameters and relative relationship. Click "Next Step" when done.
Step 5:	Calibrate the eye-in-hand and	Save the calibration result.

	eye-to-hand camera's external parameters and relative relationship. A red dot will appear at the top of the calibration plate screen. Point to the red dot on the calibration plate using the TCP. Repeat this step and select "Next Step" to complete the calibration.	
Step 6:	Save the calibration result.	

4.4.2 Upward-looking Camera Calibration

	Manual Calibration:	**Automatic Calibration:**
Step 1:	Select the "Unknown" external camera on the left side camera list to establish a new vision job, and the then select "calibrate camera".	
	When the menu presents, select "Upward-looking" and choose manual calibration.	When the menu presents, select "Upward-looking" and choose automatic calibration.
Step 2:	Calibrate the upward-looking camera's internal parameters. Fix the calibration plate to the end of the robot and move the calibration plate into the field of view of the camera. Click "Next Step" and repeat this step 15 times with different calibration plate positions and angles. Click "Next Step" when done.	Fix the calibration plate to the end of the robot. Choose the tool center and set the initial position. Click "Next Step" when done.
Step 3:	Move the calibration plate to a height appropriate for identifying the object. Click "Next Step" when done to start the automatic workspace setting.	Calibrate the upward-looking camera's internal parameters. Click "Next Step" when done.
Step 4:	Calibrate workspace. Click "Next Step" when done.	
Step 5:	Save the calibration result.	

IMPORTANT:
Before performing manual calibration, use the calibration set to calibrate the appropriate tool center. Make sure the tolerance is less than 0.3mm, and then use the calibration set to click the intersection at the top of the calibration plate.

4.5 Lens Setting

Lens selection has a large impact on image quality. Generally, the lens center is closer to the real image, but the areas around the center are usually not clear enough or bright enough and can be easily distorted. We recommend that when the user chooses a lens, the user should adjust the focus and the aperture based on the size of the workpiece.

4.5.1 Focus / Aperture

The camera kit provides focus and aperture adjustment functions. This can help users adjust an externally connected industrial camera's aperture and focus to the most appropriate position and obtain the clearest image quality. Focus and aperture adjustment page's "Focus Flow" displays the camera's focus status. "Aperture Flow" displays the aperture adjustment status. The X-axis represents the time and the Y-axis represents the score that changes with time. The red line represents the previous highest value. The user can adjust the focus adjustment ring and the aperture adjustment ring on the camera lens to see the values on the corresponding flow change. The user should adjust the aperture and the focus to make the value (black line) reach the maximum value (red line). This is the most appropriate aperture and focus.

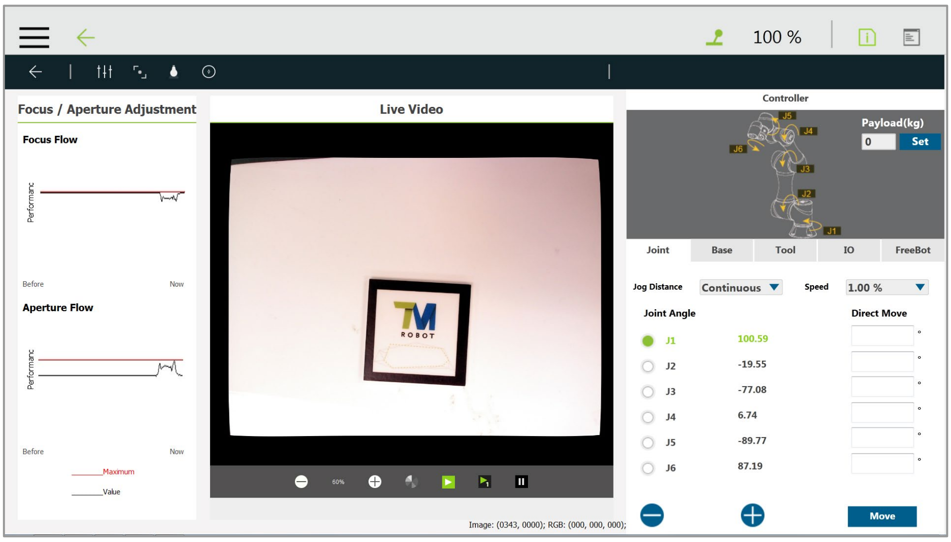


Figure 20: Focus/Aperture

4.6 Eye-to-Hand

Not only can TMvision integrate internal vision, but also match to the supported external cameras to feed the obtained information back to the robot. This operation allows the robot motion to synchronize with camera shooting and decreases the flow cycle. An illustration of the eye-to-hand camera configuration is as shown below.

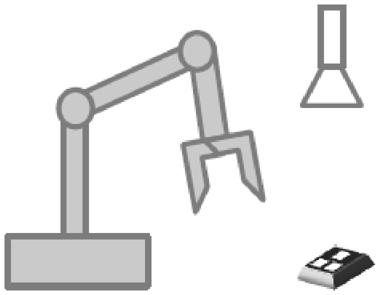


Figure 21: Eye-to-Hand

4.6.1 Pick'n Place

Pick'n Place, as one of the most common uses of Eye-to-Hand, is the fixed position application for the eye-to-hand function. This function uses the establishment of a workspace so that the robot can use the absolute coordinates to calculate and position objects. Its precision is determined by the calibration accuracy of the workspace. For details on fixed positioning and building a workspace, refer to 3.2.2 Fixed and 2.2 Vision Base System Positioning Mode. In addition, the external camera can be used to complete more tasks. For example, TMvision can use the external camera to implement "Fixed function" or use the combination of external camera and internal camera to achieve other applications.

4.6.2 AOI-only / Vision IO

The eye-to-hand module supports the AOI-only with Vision IO function. For details, refer to 3.2.3 AOI-only and 3.2.4 Vision IO.

4.7 Upward-Looking

The TMvision upward-looking function uses the relationship between the base and the robot obtained by placing the calibration plate on the object. Command is given to the robot based on the identified feature to move to the object's position of the first upward-looking teaching. This corrects the position deviation of the object caused by claw or suction nozzle instability. In addition, the upward-looking module supports AOI-only and Vision IO function. The following is an illustration of the upward-looking camera's setting.

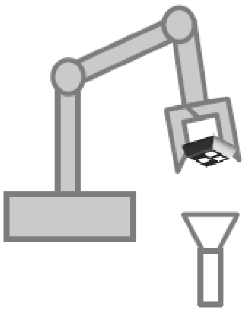


Figure 22: Upward-Looking

4.7.1 Alignment Compensation

The alignment compensation function allows the user to use the upward-looking camera to position the workpiece and to establish a vision tool center. This function compensates the workpiece's X and Y-axis coordinates' deviation and rotation angles' deviation for each item picked. This means that even if the user caused a workpiece deviation during the pick'n place, the robot can still accurately place the workpiece at the correct position.

Step 1:	Establish a new vision job and choose the upward-looking module.
Step 2:	Select alignment compensation, move to the initial position, and establish object detection.
Step 3:	Save job to automatically form a vision tool center.
Step 4:	Now the alignment compensation function can be used. Use this vision tool center to establish points. Even if the workpiece grabbing position deviates when moving to the point position, the function can still compensate the workpiece position and accurately move to the correct position.

4.7.2 AOI-only / Vision IO

The upward-looking module supports the AOI-only and Vision IO function. For details, refer to 3.2.3 AOI-only and 3.2.4 Vision IO.

IMPORTANT

IMPORTANT:

- When calibrating or conducting alignment compensation, pay attention to the stability of the calibration plate or object. If the object or calibration plate moves significantly when the robot moves the object, this object is not suitable for alignment compensation and the object grabbing method needs to be improved.
- Set the tool center position before calibration. The closer the tool center position is to the object plane the more accurate it is.

5. TM OCR

5.1 Overview

TM OCR is the TMvision's licensed software module, which requires purchase. It provides that users with a simple operating interface to set OCR jobs. OCR is divided into OCR and Number OCR. Measurement, identification, and TM OCR function can be used through the menu at the top of the TMvision setting interface. TM OCR supports the eye-in-hand camera and external cameras. If an external camera (eye-to-hand, upward-looking) needs to be matched to conduct OCR identification, activation of the external camera is required. For the activation and the use of the external camera, refer to Chapter 4. TM External Camera.

5.2 OCR

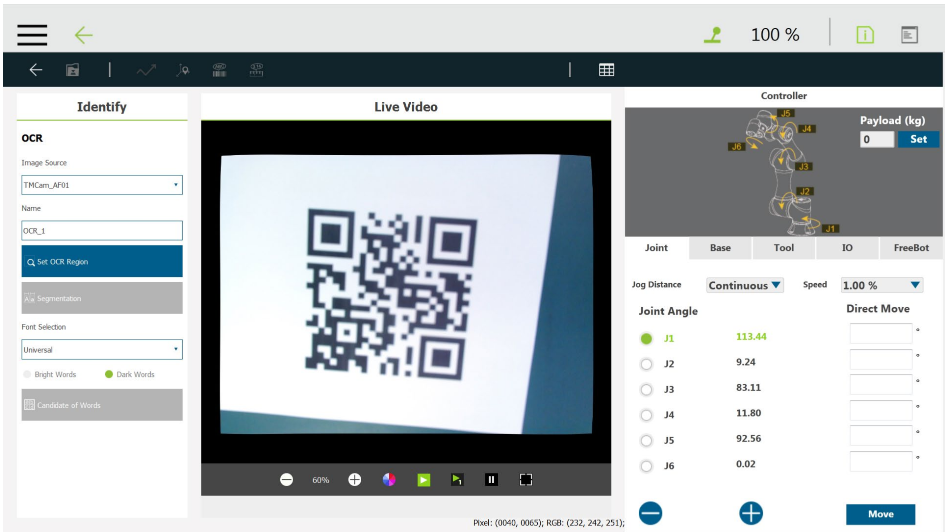


Figure 23: OCR

5.2.1 Support Content

- OCR function can output the identification results in strings.
- OCR supports nine common fonts and their bold format (Regular 400, **Bold 700**) shown in the table below.

Font	Type
serif	Lucida Bright, Times New Roman
sans-serif	Arial, Verdana, MS Gothic
monospaced	Courier New, Consolas, OCR A Extended, OcrB

Table 32: OCR Supported Fonts

- OCR supports 94 printable characters ranging from ASCII codes 21_{hex} to $7E_{hex}$ including letters, digits, punctuation marks, and a few miscellaneous symbols.

- OCR identification area is a single line. Characters go from left to right in a straight line or a curve. A single line contains 32 characters at max.

5.2.2 Parameter Setting Interface

Name	Function description
Image source	Choose image source.
Name	Name the task.
Set OCR Region	Set the location, size, and rotation of the range to search.
Segmentation	Adjust character segmentation parameters.
Font Selection	Choose the font to be identified.
White text/black background or black text/white background	Choose White text/black background or black text/white background.
Candidate Characters Menu	Output according to the selected character list. Eliminate other similar characters.

Table 33: OCR Parameter Setttings

5.2.2.1 Set OCR Region

The region can be divided into rectangles or curves. Drag the frame over the desired region to adjust the size of the region. Click the rotate symbol on the edge of the frame to rotate the region. The arrow on the edge of the frame represents the direction the characters are written. When using the curved region, single click the arrow to switch the direction of the arrow in correspondence to the concave or convex curved characters.

5.2.2.2 Segmentation

Name	Function description
Bounding Rect Width	Character width must be within this range.
Bounding Rect Height	Character height must be within this range.
Min Char Spacing	Characters are combined when character spacing is lower than this value.
Char Fragment Overlap	Characters are combined when the character overlap ratio exceeds this value.
Min Char Aspect Ratio	Character height divided by width. Characters are segmented if it is lower than this value.
Tilt-angle	Angle correction. Turn tilted characters upright.

Table 34: OCR Parameter Setttings – Segmentation

5.2.2.3 Character Selection

TMvision provides four trained types of characters for users to choose from, Universal (94 characters), Universal_Digit (numeral 0~9), Universal_UpperCase (Latin alphabet (A~Z)), Universal_LoweCase (Latin alphabet (a~z))

5.2.2.4 Candidate Characters Menu

Candidate characters can be set in the candidate character menu. Characters in black indicate candidate characters, and characters in gray indicate eliminated characters. The identification result does not output eliminated characters. Users can use @ (all), $ (numeral), # (upper case), * (lower case), or % (symbol) to list and combine possible candidate character combinations. The first symbol in the combination represents the candidate character of the first character, the second symbol represents the candidate character of the second character, and so on.

5.3 Number OCR

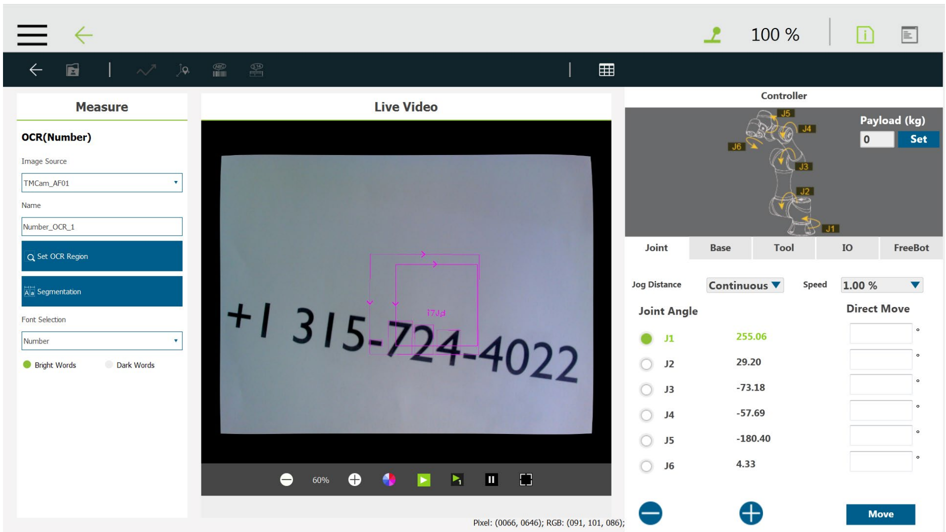


Figure 24: Number OCR

5.3.1 Support Content

- Number OCR function can output identification result in floating-point numbers.

Font	Type
serif	Lucida Bright, Times New Roman
sans-serif	Arial, Verdana, MS Gothic
monospaced	Courier New, Consolas, OCR A Extended, OcrB

Table 35: Number OCR Supported Fonts

- Supports Seven-segment-display.
- Supports 12 characters, including numbers (**0~9**), **-** , and **.** to determine positive, negative, the numbers, and the decimal point.
- Identification region is a single line. Characters go from left to right in a straight line or a curve. The output numeral range is valid for 7 digits as the single-precision floating-point format.

5.3.2 Parameter Setting Interface

Name	Function description
Image source	Choose image source.
Name	Name the task.
Set OCR Region	Set the location, size, and rotation of the range to search.
Segmentation	Adjust character segmentation parameters.
Font Selection	Choose the font of the region to be identified.
White text/black background or black text/white background	Choose white text/black background or black text/white background.

Table 36: Number OCR Parameter Setttings

5.3.2.1 Setting Identification Region

The identification region can be divided into rectangles or curves. Drag the frame over the desired region to adjust the size of the identification region. Click the rotate symbol on the edge of the frame to rotate the identification region. The arrow on the edge of the frame represents the direction the characters are written. When using the curved region, single click the arrow to switch the direction of the arrow in correspondence to the concave or convex curved characters.

5.3.2.2 Segmentation

Name	Function description
Bounding Rect Width	Character width must be within this range.
Bounding Rect Height	Character height must be within this range.
Min Char Spacing	Characters are overlapped when character spacing is lower than this value.
Char Fragment Overlap	Characters are combined when the character overlap ratio exceeds this value.

Min Char Aspect Ratio	Character height divided by width. Characters are segmented their ratio is lower than this value.
Tilt-angle	Angle correction. Turn tilted characters upright.

Table 37: OCR Parameter Setttings – Segmentation

5.3.2.3 Font Selection

The Number OCR provides two font models for the user to choose from, Number and seven-segment-display. While Number font includes the OCR fonts and seven-segment display font model, seven-segment-display font adopts font Digital Counter 7 and font Ticking Timebomb BB for reading only.

6. TM Identify & Measure

TM Identify & Measure is a TMvision licensed software module that requires purchase. In addition to standard Color classifier and Barcode identification, licensed identify functions are: Pose Variation (Shape), Pose Variation (Image), Specific Color Area Size, Subtract Reference Image, Line Burr, and Circle Bur. Measurement Module functions are: Counting (Shape), Counting (Image), Counting (Blobs), Counting (Edges), and Gauge.

6.1 Identify

Traditional manual inspection can lead to errors caused by personnel fatigue or negligence. The TMvision identification function can provide comprehensive improvement. The menu at the top of the TMvision setting interface can be used to add identify functions to the vision flow. The following describes the various functions in detail.

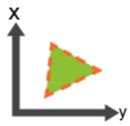
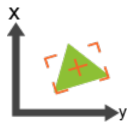
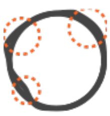
Function module	Output (floating point)
Pose Variation(Shape) 	String. Output TMflow variation "OK" or "NG" according to conditions.
Pose Variation(Image) 	String. Output TMflow variation "OK" or "NG" according to conditions.
Specific Color Area Size 	String. Output TMflow variation "OK" or "NG" according to conditions.
Subtract Reference Image 	String. Output TMflow variation "OK" or "NG" according to conditions.
Line Burr 	String. Output TMflow variation "OK" or "NG" according to conditions.
Circle Burr 	String. Output TMflow variation "OK" or "NG" according to conditions.

Table 38: Identification Functions

6.1.1 Pose Variation (Shape)

This module uses the object's shape feature to calculate variation and askewness to determine whether the object's level of pose change is within the decision range. This can be used to inspect whether the label position on the product has changed or is askew.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Pattern Selection	After clicking, this image window will pop up. The user can select items from the image.
Edit Pattern	Click and the edit window pops up for you to edit shape features of the object.
Set search range	Set the location, size, and rotation of the range to search.
Num. of Pyramid Layers	The number of processing iterations to perform on the image. More layers reduces processing time, but for images with a lot of detail, the detail may get lost, resulting in detection errors.
Min. Score	Object can be identified only when the score of the detection result is higher than the minimum setting.
Directional Edge	Select whether the shape edge is directional.
Decision	Pose's X-variation: X-direction's allowable shift deviation. Pose's Y-variation: Y-direction's allowable shift deviation. Pose's angle variation: Angle's allowable rotation deviation.

Table 39: Pose Variation (Shape) Functions

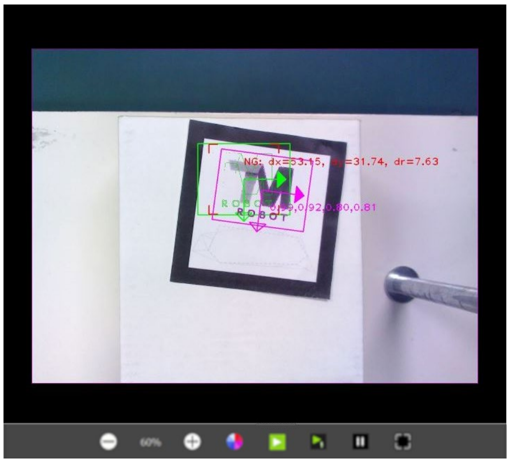
OK	NG
	

Table 40: Pose Variation (Shape) Examples

6.1.2 Pose Variation (Image)

This module uses the object's image feature to calculate variation and askewness to determine whether the object's level of pose change is within the decision range.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Pattern Selection	After clicking, this image window will pop up. The user can select items from

Name	Function description
	the image.
Edit Pattern	Click and the edit window pops up for you to edit shape features of the object.
Set search range	Set the location, size, and rotation of the range to search.
Num. of Pyramid Layers	The number of processing iterations to perform on the image. More layers reduces processing time, but for images with a lot of detail, the detail may get lost, resulting in detection errors.
Min. Score	Object can be identified only when the score of the detection result is higher than the minimum setting.
Similarity Metric	The user can use the "Correlation Coefficient" or the "Absolute Difference" to select the most appropriate measuring method. The former is slower, but it can resist environmental lighting and has stronger light and shadow change capability.
Decision	Pose's X-variation: X-direction's allowable shift deviation. Pose's Y-variation: Y-direction's allowable shift deviation. Pose's angle variation: Angle's allowable rotation deviation.

Table 41: Pose Variation (Image) Functions

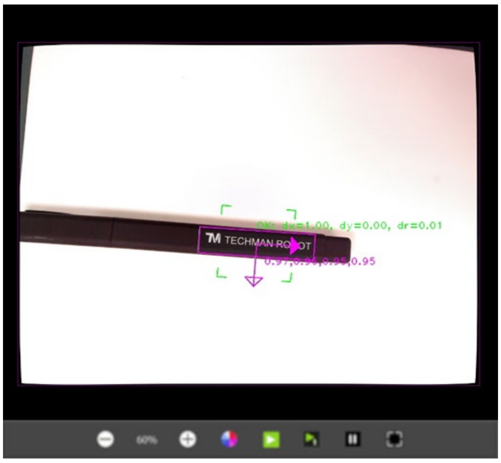
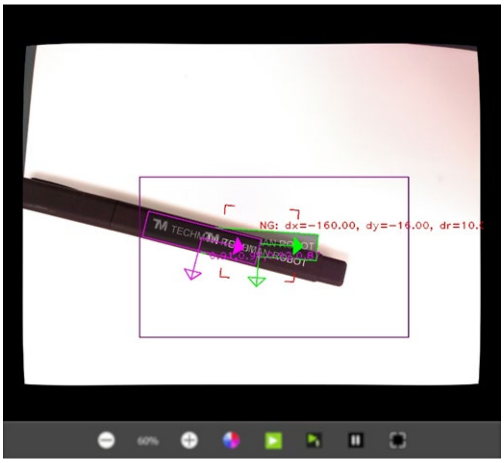
OK	NG
	

Table 42: Pose Variation (Image) Example

6.1.3 Specific Color Area Size

This function uses the object's color area to determine whether the size of the area is within the decision range.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this window will pop up. The user can select the region to be detected on the image.
Add region to be omitted	Click to set the region to be omitted. The area within the range will not be added to the decision.

Name	Function description
Color plane	Choose RGB or HSV color space.
Extract color	After clicking, this image window will appear. The user can select the color region to be detected on the image.
Red/Hue	Adjust the color feature's red/hue value to be detected.
Blue/Saturation	Adjust the color feature's blue/saturation value to be detected.
Green/Value	Adjust the color feature's green/value to be detected.
Decision	Area size: The total colored area in this range determined to be OK.

Table 43: Specific Color Area Functions

This example detects whether the liquid capacity in the container reaches the standard.

OK	NG
	

Table 44: Specific Color Area Size Example

6.1.4 Subtract Reference Image

This module uses the difference between the source image and the reference image to calculate whether the number of defects and their sizes is acceptable.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this image window will pop up. The user can choose the reference image on this image.
Add Region to be Omitted	Clicking can set the region to be omitted. Defects within the range will not be included in the decision.
Intensity Threshold	Only differences with the reference image's gray value larger than this value will be included in the defect area.
Defect Area Size	Only defect areas in this range will be included in the defect quantity.
Decision	Defect quantity: Total defect quantity in this range is determined to be OK.
Bounding Box	Select this function to show the defect position with a bounding box.

Deburring	Remove the image edge or erroneous determination caused by pattern matching.
Local Alignment	Enhance stability of recognition in case the object is too small to detect by correcting the position and the angular deviation. The compensate range of the position and the ange are ±5 pixels and ±5°, respectively.
Element Size	Remove the burr calculation element size.

Table 45: Subtract Reference Image Functions

This example shows the detection of whether the product printing has defects.

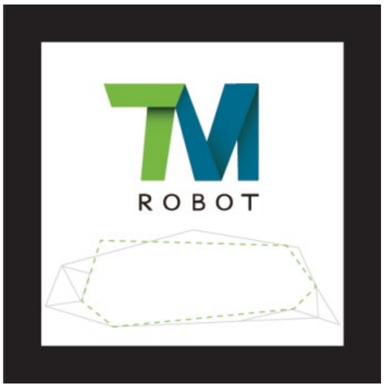
Reference image	Defect image	Detection result image
		

Table 46: Subtract Reference Image Example

IMPORTANT:
When the "Find" module caused a position error, the burr on the edge will be erroneously determined as damage. The user can select the deburring function. The larger the element size the greater the calculation range.

6.1.5 Line Burr

This module uses the differences between the detected edge and the ideal straight line distance to calculate whether the total defect area is within the decision range.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this window will pop up. The user can select the region to be detected on the image.
Scan Direction	Detect the edge's brightness change direction. After choosing the ROI, the frame will show the detection direction.
Intensity Threshold	Only gray value threshold differences larger than this value will be detected.
Distance(Pixel)	Only differences with the ideal straight line distance larger than this value will be included in the defect area.
Decision	Defect area size: Total defect area in this range is determined to be OK.

Detection Specification	Defect points at most take up 30% of the detected straight line to ensure the stability of the detected straight line.

Table 47: Line Burr Functions

This example detects whether the part's edge has burrs or defects.

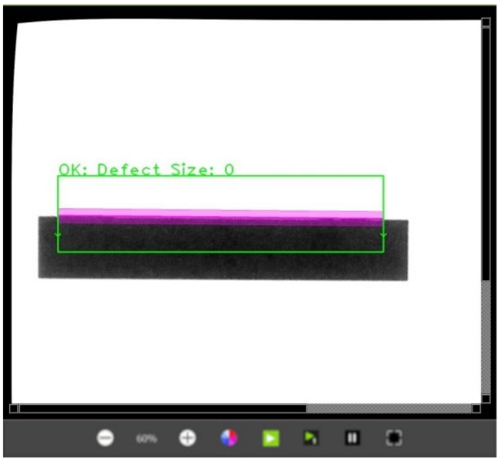
	
OK	**NG**

Table 48: Line Burr Example

6.1.6 Circle Burr

This module uses the differences between the detected edge and the ideal circular radial distance to calculate whether the total defect area is in the decision range.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this window will pop up. The user can select the region to be detected on the image.
Intensity Threshold	Only threshold differences greater than this value will be detected.
Detection angle	The spacing angle of the detected edge points.
Distance(Pixel)	Only differences with the ideal circular radial distance greater than this value will be included in the defect area.
Decision	Defect area size: Total defect area in this range is determined to be OK.
Detection specification	Defect points take up at most 25% of the detected round to ensure the stability of the detected round.

Table 49: Circle Burr Functions

This example is detecting whether the edge of the detected round object has burrs or defects.

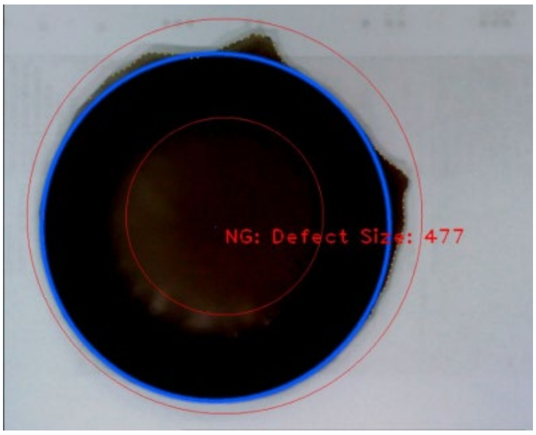


Figure 25: Circle Burr Example

6.2 Measuring

The object measurement module is TMvision licensed software. Select the menu at the top of the TMvision setting interface to add the measurement function to the vision Flow. TMvision measurement module can be used to calculate the object's quantity and the image's geometric position and angle, as well as make measurements. The measurement results are outputted as variations. The user can match the TMflow logic node according to the variations to check whether the measurement results conform to regulations. The user can pre-set the flow according to the results. The following describes this functions in detail.

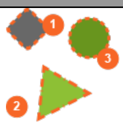
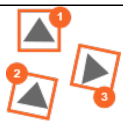
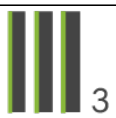
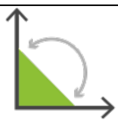
Function module		Output (floating point)
Counting (Shape)		Value, object quantity. When the object cannot be found, the output of TMflow variation is 0.
Counting (Image)		Value, object quantity. When the object cannot be found, the output of TMflow variation is 0.
Counting (Blobs)		Value, object quantity. When the object cannot be found, the output of TMflow variation is 0.
Counting (Edges)		Value, object quantity. When the object cannot be found, the output of TMflow variation is 0.
Gauge		Value, object quantity. When measurement cannot be done, the output TMflow variation is -1.

Table 50: Measuring Functions

6.2.1 Counting (Shape)

Name	Function description
Image source	Choose image source.
Name	Name the task.
Pattern Selection	After clicking, this image window will pop up. The user can select items from the image.
Edit Pattern	Click and the edit window pops up for you to edit shape feature of the object.
Set search range	Set the location, size, and rotation of the range to search.
Num. of Pyramid Layers	The number of processing iterations to perform on the image. More layers reduces processing time, but for images with a lot of detail, the detail may get lost, resulting in detection errors.
Min. Score	Object can be identified only when the score of the detection result is higher than the minimum setting.
Directional Edge	Select whether the shape edge is directional.

Table 51: Counting (Shape) Functions

The following example uses the shape feature to detect product quantity (This example first uses the Morphology function to capture the shape of the object in the image. This improves object detection in spite of differences in objects).

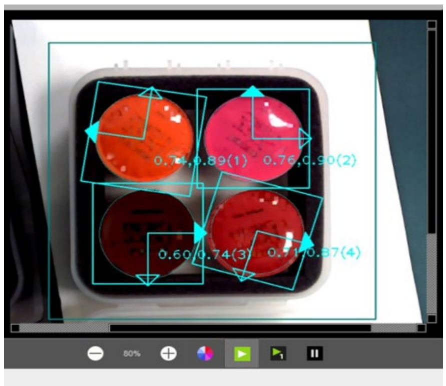
	
Pattern Selection	**Identifiable object**

Table 52: Counting (Shape) Example

6.2.2 Counting (Image)

The following example uses the image feature to detect the correct number of printings.

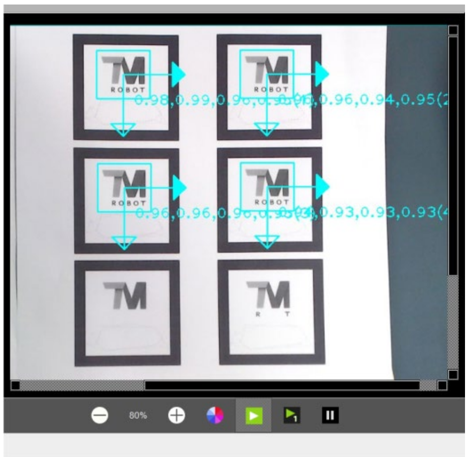


Figure 26: Counting (Image) Example

6.2.3 Counting (Blobs)

This module uses the object's color and area feature to calculate the number of irregular objects in the image.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this window will pop up. The user can select the region to be detected on the image.
Add Region to be Omitted	Click to set the region to be omitted. The area within the range will not be added to the decision.
Color Plane	Choose RGB or HSV color space.
Extract Color	After clicking, this image window will appear. The user can select the color region to be detected on the image.
Red/Hue	Adjust the color feature's red/hue value to be detected.
Blue/Saturation	Adjust the color feature's blue/saturation value to be detected.
Green/Value	Adjust the color feature's green/value to be detected.
Area Size	Only color area in this value range will be included in the quantity.

Table 53: Counting (Blobs) Functions

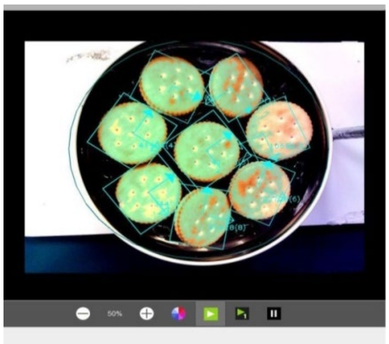
	
Pattern Selection	**Identifiable object**

Table 54: Counting (Blobs) Example

6.2.4 Counting (Edges)

Use the detection of part edges to calculate the number of parts.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	After clicking, this window will pop up. The user can select the region to be detected on the image.
Scan direction	Detect the edge's brightness change direction. After choosing the ROI, the frame will show the detection direction.
Intensity Threshold	Only threshold differences greater than this value will be detected.
Search width (pixel)	The spacing distance of the search edge.
Search angle	The searchable edge angle.

Table 55: Counting (Edges) Functions

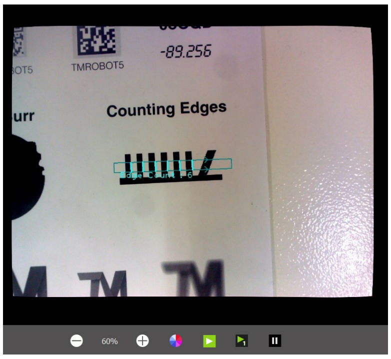
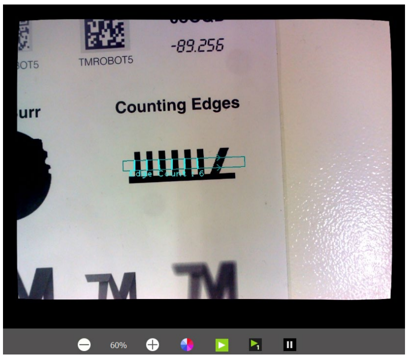
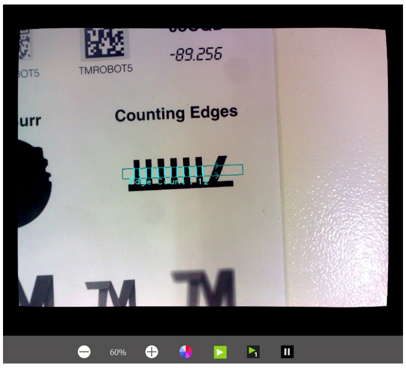
		
Dark to light	**Light to dark**	**Dual direction**

Table 56: Counting (Edges) Examples

NOTE:
Based on the camera resolution, the theoretical maximum number of vertical edges that can be detected is 1296.

6.2.5 Gauge

This module can add new anchors, straight lines, round shapes, objects (shape), or objects (image) as measuring elements. Choose two elements to measure pixel distance or angle. The measurement result is displayed as red lines and characters.

Name	Function description
Name	Name the task.
Add New Object	Add new measurement elements from the list.
Add New Measure	Choose two elements from the list to measure the distance or angle (only angles can only be measured between straight lines).
Unit of Distance	The pixels can be converted to millimeters by the calibration plate or TM Landmark (for reference only).

Table 57: Gauge Functions

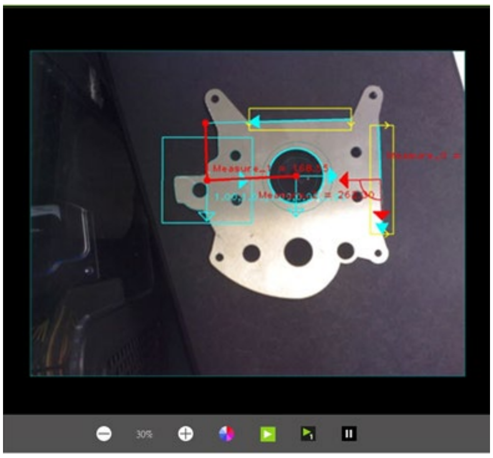


Figure 27: Gauge Example

6.2.5.1 Anchor

Choose a point in the image as the anchor to measure the distance and the angle between the anchor and any other element. Use the slider to adjust the anchor point placement and angle.

Name	Function description
Image source	Choose image source.
Name	Name the task.
Manual Adjustment	Manually drag the anchor point to the target position.

Name	Function description
X direction shift (pixels)	Move the anchor in the X direction.
Y direction shift (pixels)	Move the anchor in the Y direction.
Rotation	Rotate the anchor around the initial point.

Table 58: Anchor Functions

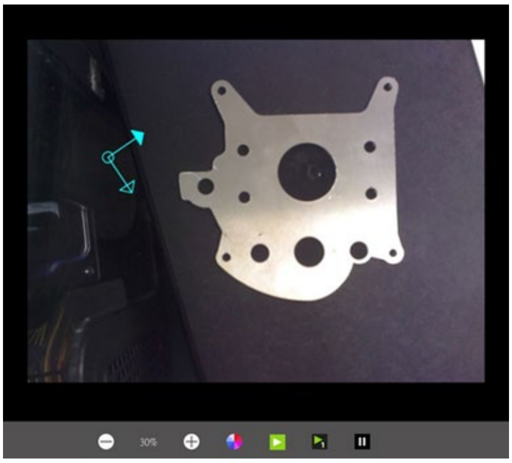


Figure 28: Anchor Example

6.2.5.2 Line

Name	Function description
Image source	Choose image source
Name	Name the task
Select ROI	Select the object edge of the newly added straight line in the pop-up window. The direction that the mouse is dragged determines the direction of the straight line.
Scan Direction	Brightness change direction of the detection edge. After selecting the ROI, the frame will show the detection direction.
Intensity Threshold	Only threshold difference greater than this value will be detected.

Table 59: Line Functions

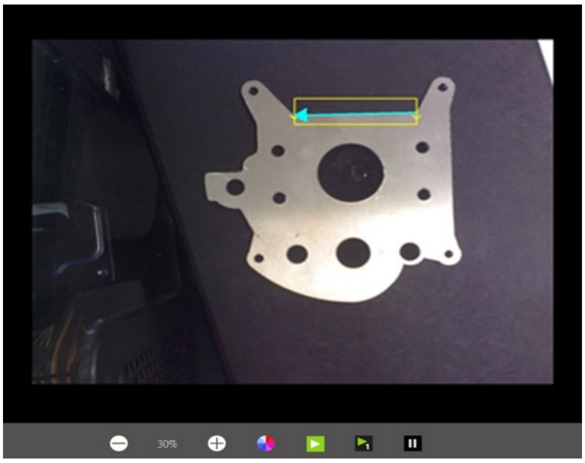


Figure 29: Line Example

IMPORTANT:
The straight line between two pixels is applicable to measure the angle but not the distance.

6.2.5.3 Circle

Name	Function description
Image source	Choose image source.
Name	Name the task.
Select ROI	Select the newly added round shape in the pop-up window. The ROI shows two rounds with the same center. The shape is adjusted to be between the two rounds with the same center. The image strength threshold and the measurement angle are adjusted to stabilize the result.
Scan Direction	Detect the edge's brightness change direction. After choosing the ROI, the frame will show the detection direction.
Intensity Threshold	Only threshold differences greater than this value will be detected.

Table 60: Circle Functions

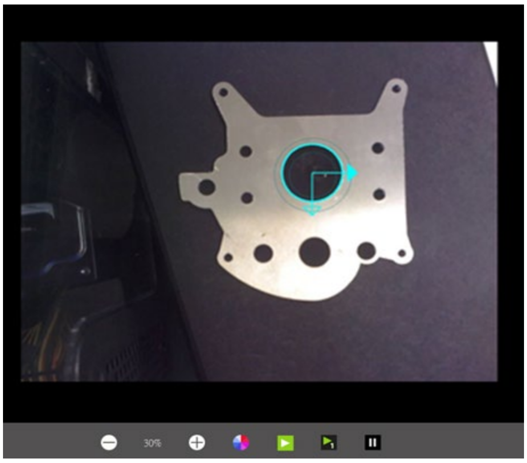


Figure 30: Circle Example (External)

6.2.5.4 Shape-based Pattern

Click Select Pattern to select the shape of the newly added object in the pop-up window. Use Edit Pattern to change the object shape and Set Search Range to set the pattern's range in the image. Adjust the number of Pyramid Layers and the minimum score to stabilize the result.

6.2.5.5 Image-based Pattern

Click Select Pattern to select the image of the newly added object in the pop-up window. Use Set Search Range to set the pattern's range in the image. Adjust the number of Pyramid Layers and the minimum score to stabilize the result.

OMRON AUTOMATION AMERICAS HEADQUARTERS • Chicago, IL USA • 847.843.7900 • 800.556.6766 • automation.omron.com

OMRON CANADA, INC. • HEAD OFFICE
Toronto, ON, Canada • 416.286.6465 • 866.986.6766 • automation.omron.com

OMRON ELECTRONICS DE MEXICO • HEAD OFFICE
Ciudad de México • 52.55.5901.4300 • 01.800.386.6766 • mela@omron.com

OMRON ELECTRONICS DE MEXICO • SALES OFFICE
San Pedro Garza García, N.L. • 81.12.53.7392 • 01.800.386.6766 • mela@omron.com

OMRON ELECTRONICS DE MEXICO • SALES OFFICE
Eugenio Garza Sada,León, Gto • 01.800.386.6766 • mela@omron.com

OMRON ELETRÔNICA DO BRASIL LTDA • HEAD OFFICE
São Paulo, SP, Brasil • 55 11 5171-8920 • automation.omron.com

OMRON ARGENTINA • SALES OFFICE
Buenos Aires, Argentina • +54.11.4521.8630 • +54.11.4523.8483
mela@omron.com

OTHER OMRON LATIN AMERICA SALES
+54.11.4521.8630 • +54.11.4523.8483 • mela@omron.com

Authorized Distributor:

Controllers & I/O
• Machine Automation Controllers (MAC) • Motion Controllers
• Programmable Logic Controllers (PLC) • Temperature Controllers • Remote I/O

Robotics
• Industrial Robots • Mobile Robots

Operator Interfaces
• Human Machine Interface (HMI)

Motion & Drives
• Machine Automation Controllers (MAC) • Motion Controllers • Servo Systems
• Frequency Inverters

Vision, Measurement & Identification
• Vision Sensors & Systems • Measurement Sensors • Auto Identification Systems

Sensing
• Photoelectric Sensors • Fiber-Optic Sensors • Proximity Sensors
• Rotary Encoders • Ultrasonic Sensors

Safety
• Safety Light Curtains • Safety Laser Scanners • Programmable Safety Systems
• Safety Mats and Edges • Safety Door Switches • Emergency Stop Devices
• Safety Switches & Operator Controls • Safety Monitoring/Force-guided Relays

Control Components
• Power Supplies • Timers • Counters • Programmable Relays
• Digital Panel Meters • Monitoring Products

Switches & Relays
• Limit Switches • Pushbutton Switches • Electromechanical Relays
• Solid State Relays

Software
• Programming & Configuration • Runtime

I627I-E3-03 Note: Specifications are subject to change. © 2020 Omron. All Rights Reserved. Printed in U.S.A.

Printed on recycled paper.