HYUNDAI ROBOTICS

WARNING

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED INSTALLATION PERSONNEL AND MUST CONFORM TO ALL NATIONAL AND LOCAL CODES.

HD
HYUNDAI
ROBOTICS

Hi5aLC230628FMEN2

Hi5a Controller Function Manual

Learning control function

HD HYUNDAI ROBOTICS

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1 Overview

1.1. Purpose of the function

The purpose of this function is to ensure that the robot is free from vibration while making a high-speed motion. A kinetic model of the robot is utilized for controlling its motion, but it is not always accurate. Therefore, making the inaccurate model accurate by making the robot learn motions by repeating the steps of the learning program for a number of times can set the robot so that it makes motions at a higher speed with less vibration.

The accuracy of the kinetic model of the robot varies depending on the locations, positions, and load conditions of the robot. Therefore, the robot needs to learn the model to meet its locations, positions, and load conditions that are changed according to the steps taught by the user. This function utilizes a method in which the user designates steps and inputs options to the steps for the robot to learn.

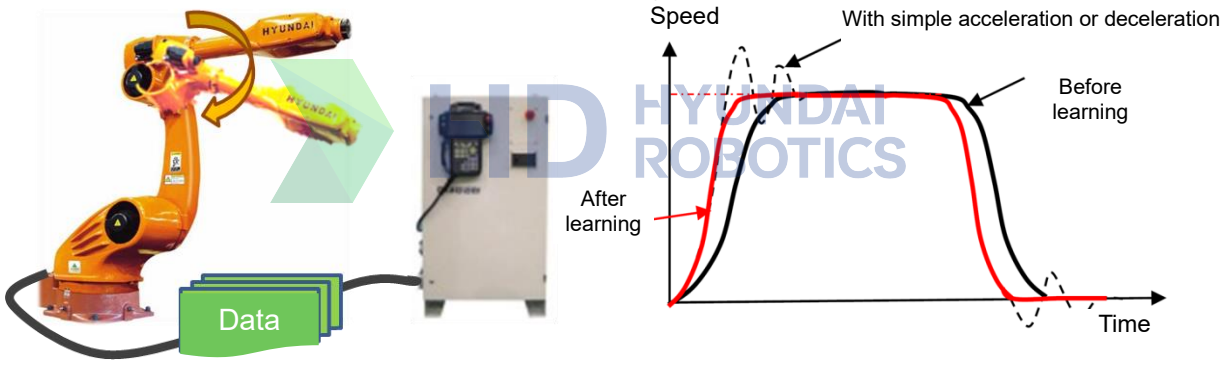

Figure 1.1 Concept of the learning control function

1.2. Major specifications

This function can be enabled without any additional system such as a sensor.

Item	Specification
Supported software version	V40.18-00 (It cannot be used together with a previous version.)
Supported robot/axis specification	Any robot that utilizes the vibration control function
Number of steps that can be taught	100 steps

1.3. Limitations on the function

1. This function can be enabled only for **stationary steps**.

2. This function can be enabled only for the **automatic mode**.

3. If the conditions of the steps are changed after this function is applied, the taught data may not work. Therefore, **this function must be enabled after the teaching of all the steps is completed**. Please pay attention to it.

1.4. Operating sequence

The operating sequence of the learning control function is as follows:

1. First, you need to decide whether to use the learning control function. If you decide to use it, enable it.
   - This function can be used in any of the following cases:
     ① When it is difficult to operate the robot because a stationary step creates high vibration; and
     ② When it is necessary to shorten the cycle time (C/T).

2. Set the C/T shortening ratio.
   - You can set the C/T shortening ratio to 0 at the minimum and 100 at the maximum.

3. Check the performance.
   - By conducting a visual check on the performance of the robot, identify the steps that require reduced vibration.

4. Designate IL options.
   - Designate the IL option for the steps that were identified in 3) above.
   - The maximum number of the steps for which IL options can be designated is 100.
   - The learning function can be enabled only for stationary steps. Learning will not work for a continuous step even when IL options are designated.

5. Activate (repeatedly) and complete the program.
   The learning will be completed by activating the program in the automatic mode repeatedly for about 10 times.

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2 Instructions

2.1. Setting of the function

As shown in the following figure, entering **[System] → [4. Application parameters] → [17. Learning control]** will display the window for setting the learning control function.
You can turn on/off the function by setting the function on/off menu.

You can designate the amount of C/T shortening by setting the C/T shortening ratio menu.

- Set it at 0% for suppressing the vibration while maintaining the existing C/T.
- Set it at 100% for shortening the C/T to its lowest. The C/T can be shortened by approximately 5%–10%.
  The amount of C/T shortening will vary depending on the conditions of the robot, load, teaching, etc.

If the function is turned off, all the learning information will be overridden, and the robot will move with the default (standard) setting. In this case, the learning information will not be deleted but will be saved so that it can be applied when the function is turned on.

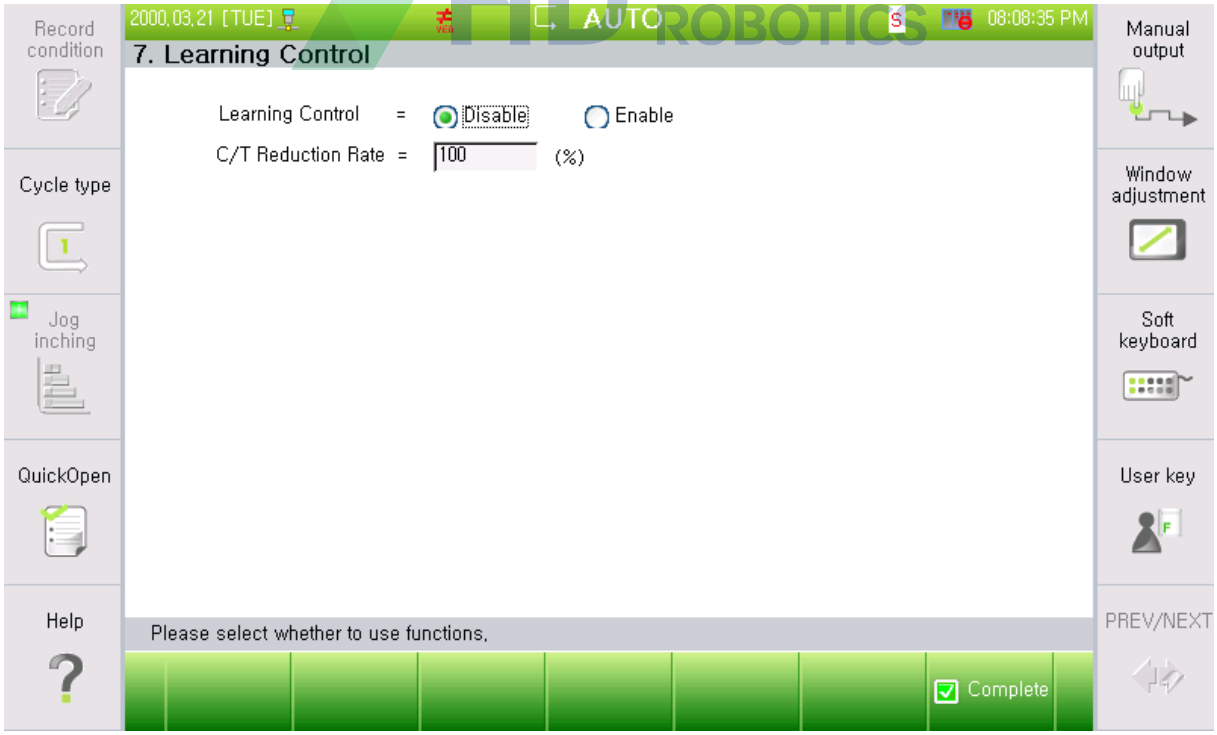

Figure 2.1 Window for setting the learning control function

2.2. Activation and completion of the function

The learning control function can be activated only in the automatic mode.

The learning will be completed by activating the program in the automatic mode repeatedly for about 10 times, without prompting any message for you to confirm completion. You can check the progress and completion state through the monitoring function (2.5).

2.3. Resetting of the function

When it is necessary to reset the function for resetting learning control parameters, you can reset it to the default value by using the **[Reset all]** or **[Reset one]** button at the lower bottom part of the window. **[※ The reset button will be activated only when the learning control function is on.]**

Clicking the [Reset all] button will reset the learning parameters of all the steps for which IL options have been set.
Clicking the [Reset one] button will reset the learning parameters of one step by designating an IL option number.

2.4. Programming (designating learning control steps)

Write a learning job program as follows:
If the conditions of the steps are changed after this function is applied, the taught data may not work. Therefore, this function must be enabled after the learning of all the steps is completed.

You can write a job program easily by designating IL options and option numbers to selected steps. **[※ Refer to Figure 3 below for an example of programming.]**

Moving the cursor to the option column of a step and clicking the [IL] button at the bottom part of the window will display the smallest number automatically among the IL option numbers.
Be careful **not to change option numbers arbitrarily, which may lead to setting with overlapping numbers.**

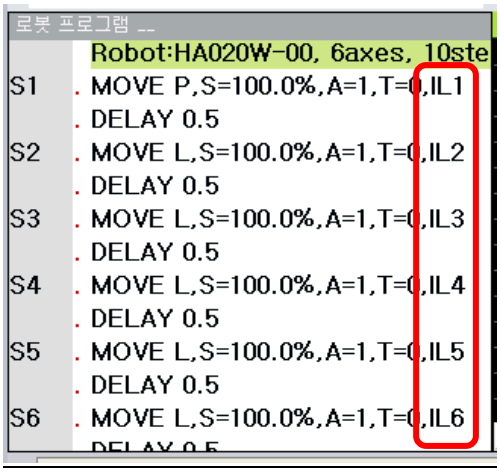

Figure 2.2 Example of job programming for the learning control function

〈Instructions for programming〉

- This function is not affected by the use of “CONPATH.”
- If any step is added during the learning progress/completion, the taught setting might be changed. In this case, an error will occur, which requires resetting of the IL numbers.
- Changes in vibration or C/T may lead to small changes in the path.
- The sequence of the use of IL numbers does not matter. (e.g., IL3-IL2-IL1, IL1-IL10-IL20)
- However, among the input IL numbers, the front-most number will be assigned automatically.

2.5. Test result - Monitoring

You can view the progress and result of the function on the monitoring window.

You can check it by selecting **[Service] → [1. Monitoring] → [21. Learning control data]**.

- [Data No.] matches the IL option number.
- [Program No.] matches the job program number of the IL option.
- [Step No.] matches the step number of the IL option.
- [Progress] shows the learning progress of the step of the IL option. 100% means that the learning has been completed.

Inserting an IL option in a step of the job program will assign the job program number and the step number for which the IL option is input in the [Data No.] matching the IL option number.

Figure 2.3 Window for monitoring the state of the learning control function

3 Errors and warnings

3.1. Errors

1. **E28105: The ROBOT.INL file does not exist.**
   - The “MOVE” command of the IL option is issued while the ROBOT.INL file does not exist.
   1) If you have not turned on the learning control function after resetting, turn it on.
   2) If the file has been deleted, create it by turning off and on the function.

2. **E28107: The ROBOT.INL file does not exist (reset all).**
   - [Reset all] was executed while the ROBOT.INL file does not exist.
   1) If you have not turned on the learning control function after resetting, turn it on.
   2) If the file has been deleted, create it by turning off and on the function.

3. **E28108: The ROBOT.INL file does not exist (reset one).**
   - [Reset one] was executed while the ROBOT.INL file does not exist.
   1) If you have not turned on the learning control function after resetting, turn it on.
   2) If the file has been deleted, create it by turning off and on the function.

4. **E28109: The ROBOT.INL file does not exist (during setting).**
   - Parameter setting was executed while the ROBOT.INL file does not exist.
   1) If you have not turned on the learning control function after resetting, turn it on.
   2) If the file has been deleted, create it by turning off and on the function.

3.2. Warnings

1. **W28500: The program number saved for the IL condition does not match the current program.**
   - The program saved for the IL condition for “MOVE” does not match the current program.
   1) Learning will not be progressed.
   2) After copying the program, assign a new IL number.
   3) If the existing program has been changed, run the learning again.

2. **W28501: The step number saved for the IL condition does not match the current step.**
   - The step saved for the IL condition for “MOVE” does not match the current step.
   1) Learning will not be progressed.
   2) If the existing program is used after a step is deleted or added, reset the program, and run the learning again.
   3) After copying the step, assign a new IL number.

3. **W28502: The ROBOT.INL file does not exist.**
   - The “MOVE” command of the IL option was executed while the ROBOT.INL file does not exist.
   1) Learning will not be progressed.
   2) If you have not turned on the learning g control function after resetting, turn it on.
   3) If the file has been deleted, create it by turning off and on the function.

4. **W28503: The learning control function is turned off (during issuance).**
   - The “MOVE” command, including the IL option, was issued while the learning control function is off.
   1) Learning will not be progressed.
   2) For using the IL option, turn on the learning control function.

5. **W28504: The learning control function is turned off (during execution).**
   - The “MOVE” command, including the IL option, was executed while the learning control function is off.
   1) Learning will not be progressed.
   2) For using the IL option, turn on the learning control function.

6. **W28505: Step unavailable for learning (continuous).**
   - The IL option was included and executed for a continuous step that is unavailable for learning.
   1) Learning will not be progressed in a continuous step.
   2) Delete the IL option in a continuous step.

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