



MOTION RECORDER

OPERATING MANUAL

Version 2.3.6

Developed for *Universal Robots E-Series*

Summary

- 1. Revisions**
- 2. Introduction**
 - i. User guide
 - ii. References
- 3. Icon legend and colors**
 - i. Extra Information
- 4. Software Introduction**
 - i. Easiest way to create cobot programs
 - ii. Programs with complex movements
 - iii. Programs with non-geometrical shapes
 - iv.** Production cycle with a large number of product types
- 5. Installation**
- 6. Interface**
 - i. Installation Node
 - ii. Program Node
- 7. Script Functions**
- 8. Troubleshooting**
- 9. Warranty**
- 10. Contacts**

Revisions

Robot-ics may modify this product without notice, when necessary, due to product improvements, modifications or changes in specifications. If such modification is made, the manual will also be revised. See the latest version of this manual online at: www.robot-ics.com/support

Introduction

User guide

The **Motion Recording Software** it was developed for improve the performance of Universal Robot cobots. It can be installed and used only with the E-Series graphic interface.



WARNING: the operator must have read and understood all the steps and the instructions of this manual before use the Motion Recording software.

References

During the explanation of this manual, there will be often references to the original Universal Robot user manual. Any UR (UR3e, UR5e, UR10e or UR16e) manual can be used since they are identical.

Icon Legend and Colors

In this manual we will see many icons to indicate different levels of importance about the software.

Information Icon



With this icon we are giving suggestions for better understand a software logic problem or for underline any useful procedure, however they will not affect the functionality of the software.

Warning Icon



All the information close to this icon are important for avoid unwanted error during the use of the software.

Danger Icon



All the information close to this icon are very important and must have been read through and understood from the user to avoid unexpected or dangerous movements

In some area of the manual there are sentences with different colors for underline the importance of some function or concepts or for any keyword.

With **green** we will underline some special feature of the software.

With **orange** we will underline any procedure to follow for avoid unwanted effects.

With **red** we will report all negative consequences of any wrong procedure.

With **aquamarine** we will underline the name of the buttons present on the software.

With **fuchsia** we will underline some work or process usable with this product.

Additional information

On the website www.robot-ics.com it is possible to have:

- More information about the software;
- Watch demo video;
- Download this manual in other languages.



The information on this manual will be as clearly as possible, anyway since the software is constantly developed, we suggest to ensure to have the same version for the software and manual.

It is always possible to download from www.robot-ics.com last version of the manual.

Software Introduction

The **Motion Recorder Software** offer the possibility to register all movements executed manually by cobots of Universal Robots and generate the code to be used in an automatic program, in addition, the program records the activation and deactivation sequence of the cobot outputs. Furthermore, it is possible to lock certain axis and modify the sensibility of the robot for a fine tuning of the recording. The last function of the software is to create an intuitive database to facilitate the work of managing the records.

All the functions are done to make easier and more productive the programming of the robot.

Easiest way to create cobot programs

The software makes easier the creation of the software since the cobot will reply exactly all the movements previously executed in manual mode, decreasing the possibility of generate problems during the resolution of inverse kinematics. In this way also a not professional robot programmer can easily create his first working program.

Advanced path programs

This software allows to create programs with very complicated paths, for example to follow the silhouette of special parts. In this case moving the cobot along the profile of the object is the easiest way to generate the path.

A typical example of the **gluing** programs. Often the glued parts have very complicated shapes and not all company and users have access to the expensive CAD software and tool for create the correct paths.

Instead with **Motion Recorder Software** it will be possible to get also the most complicated path without external tools.

Programs with non-geometrical paths

Another opportunity to use **Motion Recorder Software** is when the operator needs to program paths where the cobot has to move in tight spaces. For example when the cobot has to work inside a **CNC machine for loading/unloading**, with narrow spaces.

Probably the work where you are going to see the best advantage of this software are during the process of **painting, brushing, or sanding**. In this kind application the quality of the workmanship is dictated by the experience of the operator, and the recording of paths is the most efficient way to teach it to a robot.

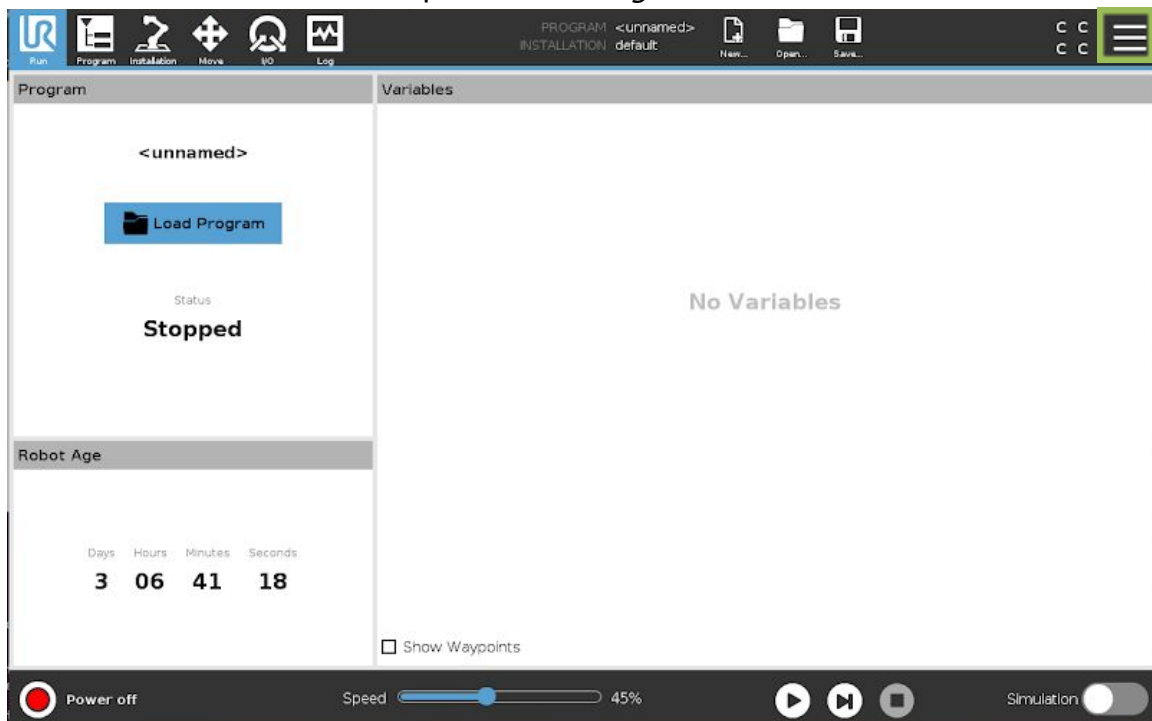
Another good application of the software is on the **vision/scanning 3D**, in this case will be very easy to teach the correct orientation of the tool in difficult position to be sure not to have areas in shadow. Without the software will be much more complicated and slower to make a whole program of this type.

Production cycle with a large number of product types

A further product highlight of the software it is the possibility to create an internal database to easily manage all the programs relative to the products so that the operator can easily implement new models or modify the existing ones.

Installation

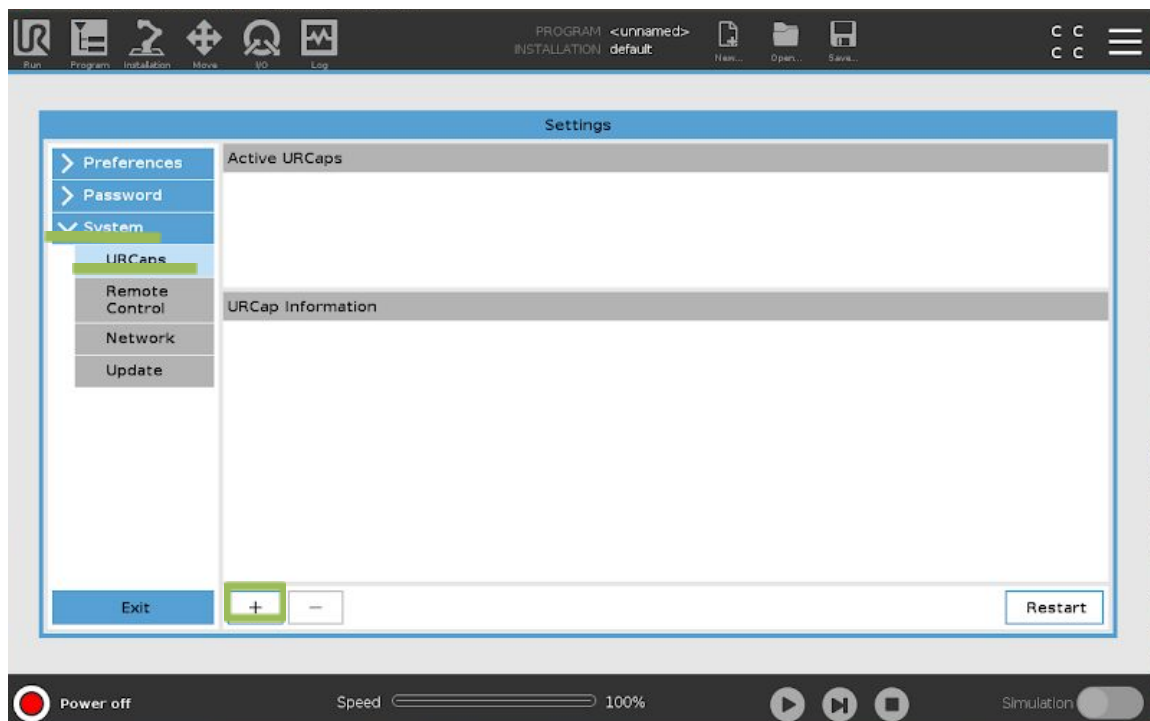
- Download the software on the [web page](#), and load it on an USB
- Insert the USB in the teach pendant or in the control box of cobot E-Series
- From the main windows open the “Settings”



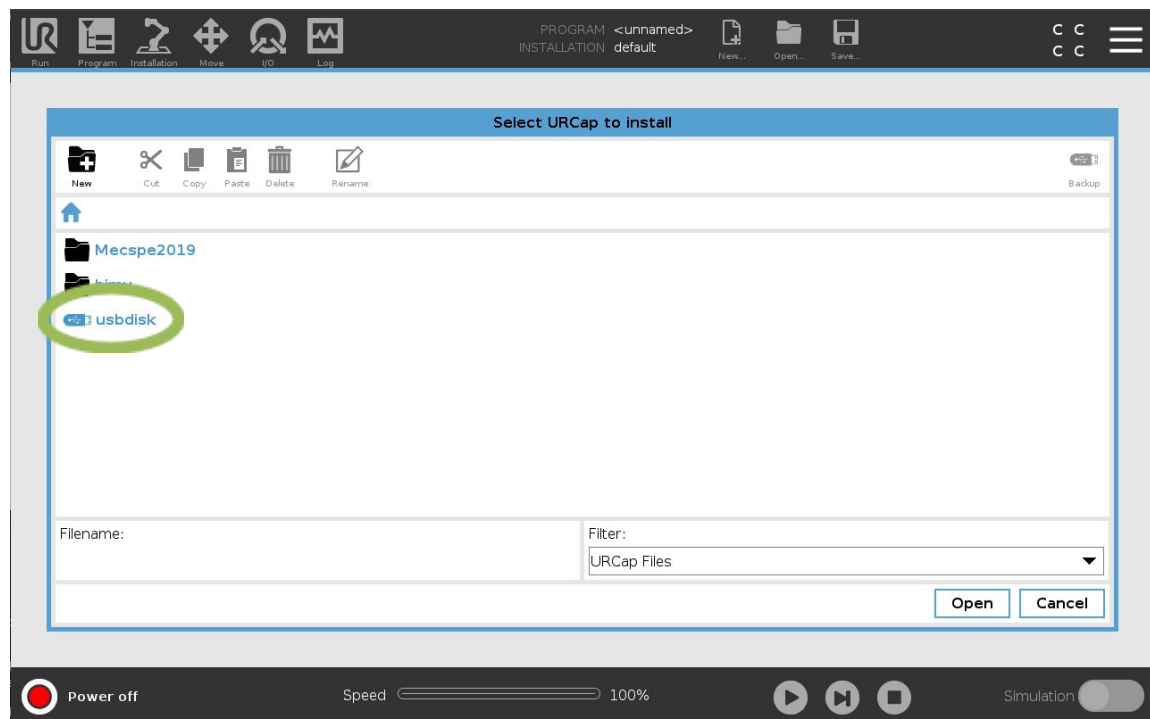
- Select “Settings”



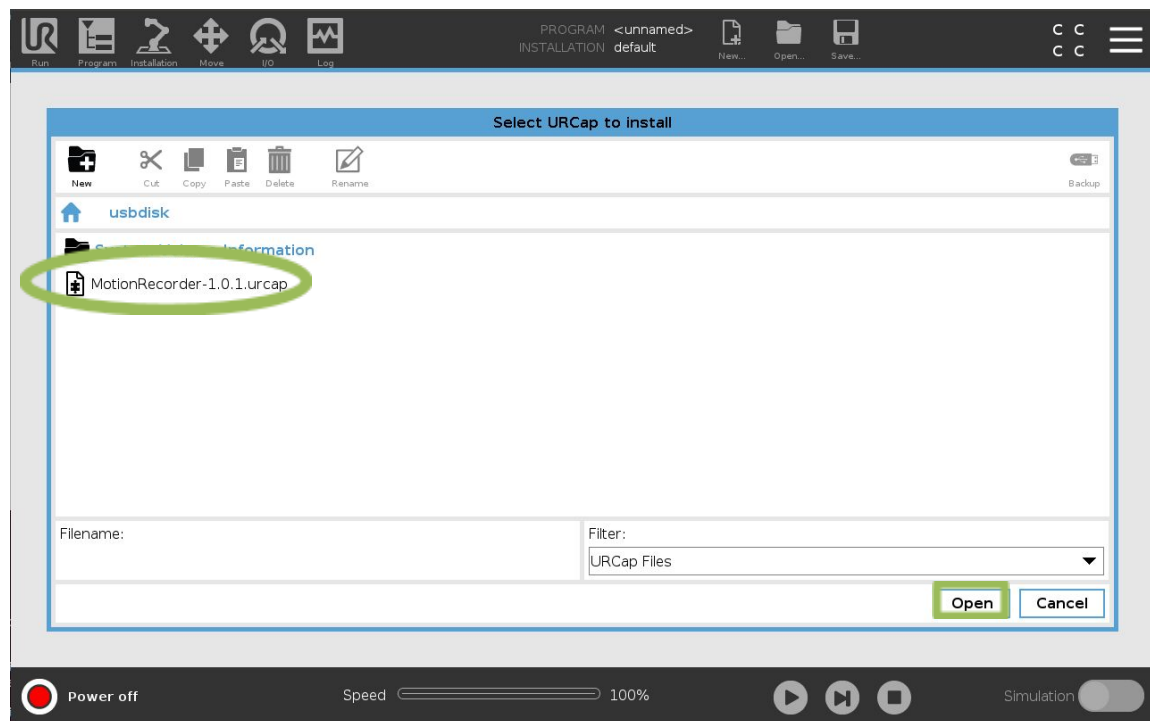
- “System” -> “URCap” and press the button “+” to have access to the navigation window of connected devices



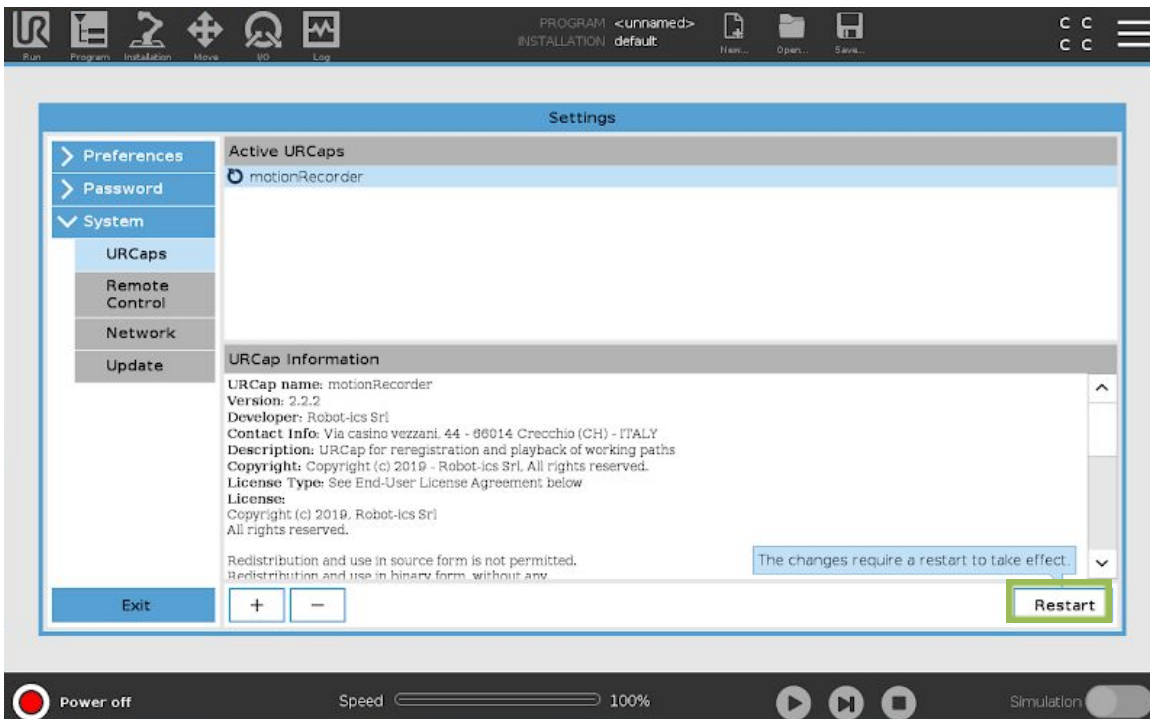
- Select “usbdisk”



- Select the file “*MotionRecorder-x.x.x.urcap*”. Double click on it and press “*Open*”.



- The cobot will execute a pre-setup and after will be necessary a reboot.



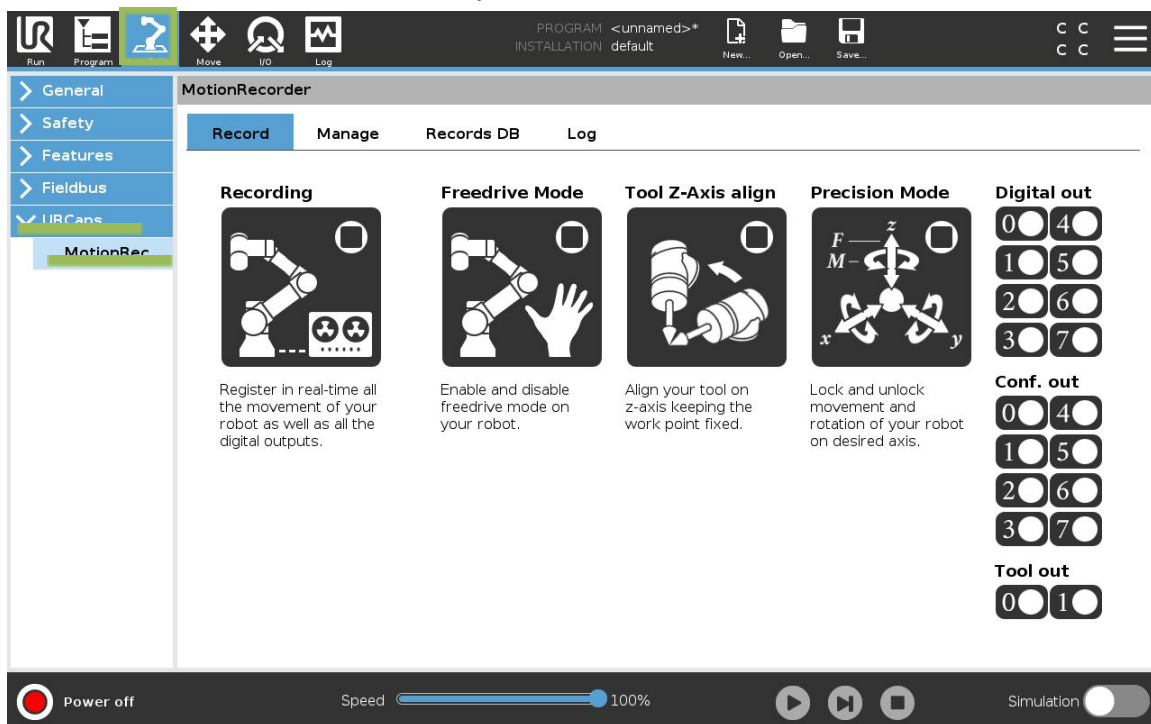
- When the robot will be restarted **Motion Recorder Software** will be ready to be used.

Following this procedure it is possible to install the software, but by default the version is limited, to unlock all the features of the **Motion Recorder Software** simply insert the dongle on a USB port of the cobot.

Interface

Installation Node

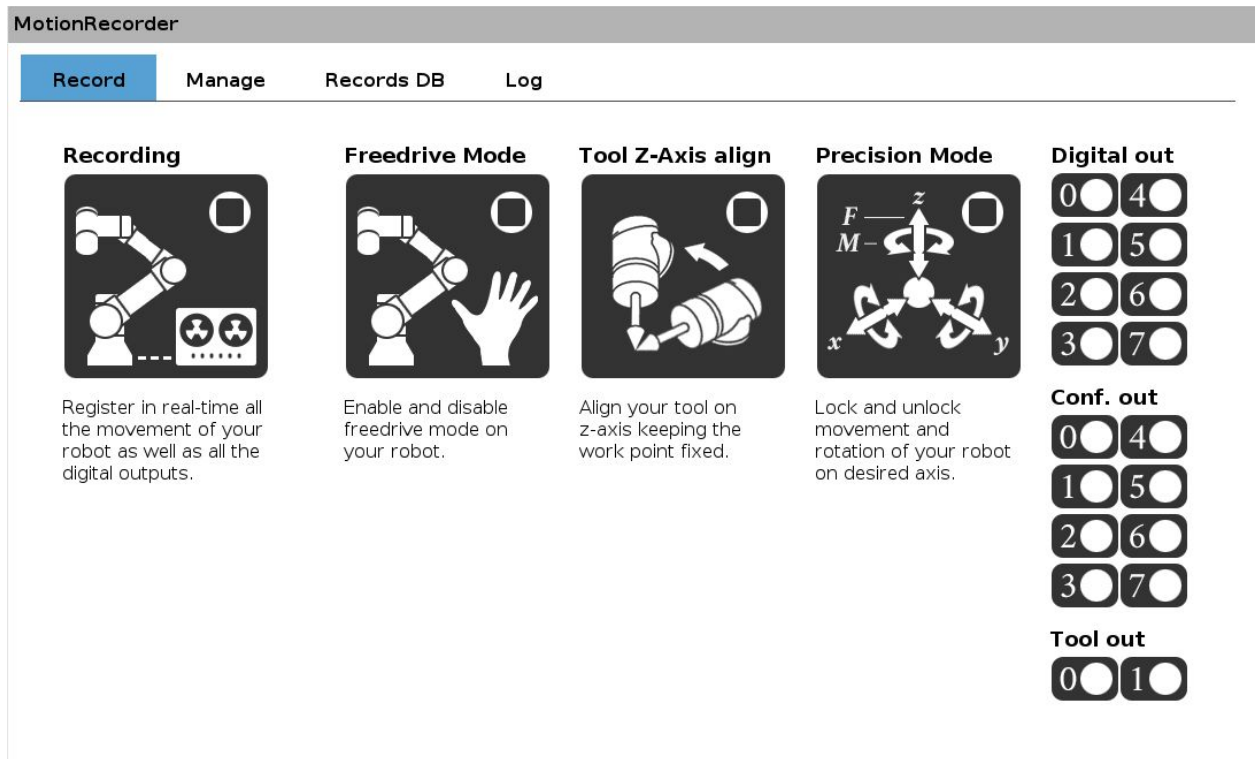
The interface of **Motion Recorder Software** for create the database of paths is under the menu “*Installation-> URCaps -> MotionRecorder.*”



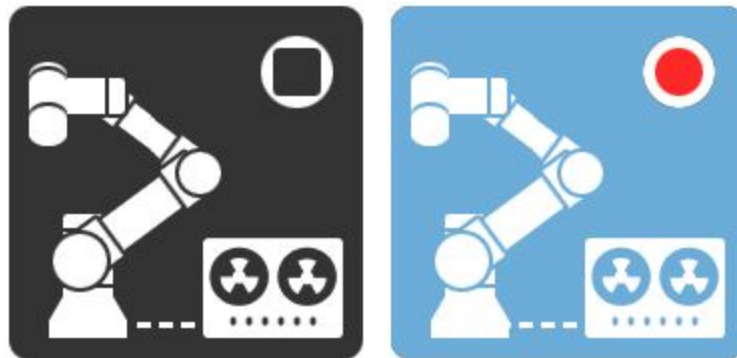
In the software windows there is 4 tab buttons to access to 4 different Menu:

- **Record:** here is possible to register the movements adjusting the positions.
- **Manage:** here you can see all saved paths with creation date, delete or replay a saved path.
- **Records DB:** check daemon's status, and change the port of communications.
- **Log:** here there is the log of all the commands given to the software.

Menu Record



The **Recording** Button



When the **Recording** button is activated the cobot start the recording in real time of paths and of the I/O. When we deactivate it a dialog windows will appear where we can give a name to the path and insert it in the database. In case we don't like the result of the recording it's possible to delete it with the button **Delete**.

The **FreeDrive Mode** button



The **FreeDrive Mode** button will activate the freedrive mode of cobot. Pressing this button will be possible to move manually the cobot. In this status the cobot is in equilibrium, but if we apply any external pressure the robot will move in the force direction.



Suggestion: Read more information about freedrive in the manual of UR collaborative robots [\(link\)](#).



In this status will be very easy to give the **wanted configuration of axis** and there is no risk that cobot goes in a **fault** status because of a wrong inverse kinematic calculation.

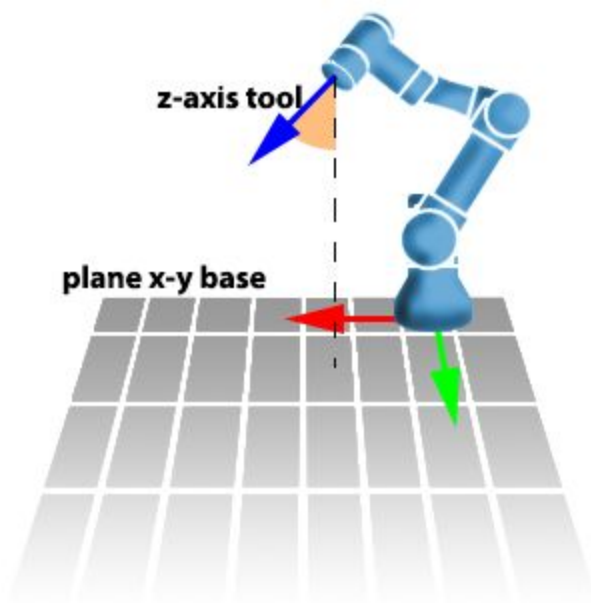


Activating the freedrive without **set the correct payload and his center of gravity** may cause **sudden unwanted accelerations**. We suggest to execute the auto setup of robot tool. You can find more information at page II-77 in the manual of UR collaborative robots [\(link\)](#).

The
***Tool Z-Axis
align*** button



When is active align the axis Z of the current tool perpendicular to the plane X-Y of cobot base (with the Z direction entering the plane).



In this way we can obtain the cobot with a **exactly perpendicular orientation to the working plane**, which is impossible to obtain only with ***Freedrive Mode*** button.

The Z Axis of the tool can be modify in the windows *Installation -> General -> TCP*, please refer to the UR manual, chapter 16.1.1 TCP Configuration, for more information.

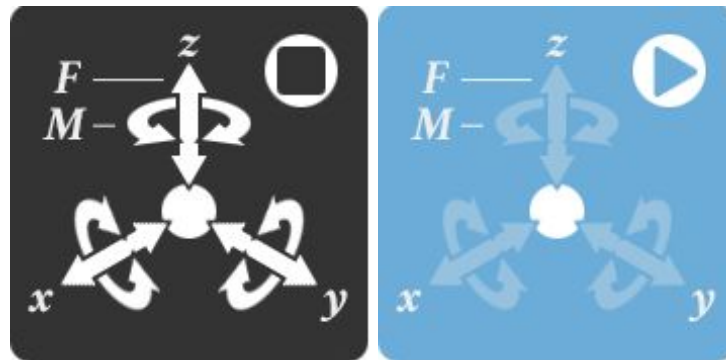


SUGGEST: In case we want a **non-orthogonal orientation to the base** but with a specific angle, we can setup a temporary TCP with the same offset angle.



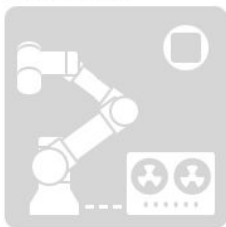
The cobot itself does not have the overall dimension of tool, so the cobot could execute very large movements with the possibility to **hit himself**. We suggest to make the initial movements with the freedrive and later optimize the orientations with the **Tool Z-Axis align**.

The
**Precision
Mode**
button



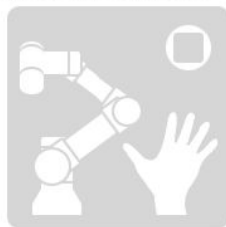
Pressing this button 7 more buttons and a slide bar will show up.

Recording



Register in real-time all the movement of your robot as well as all the digital outputs.

Freedrive Mode



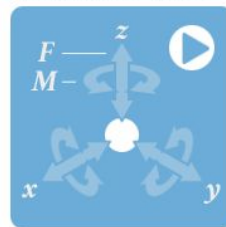
Enable and disable freedrive mode on your robot.

Tool Z-Axis align

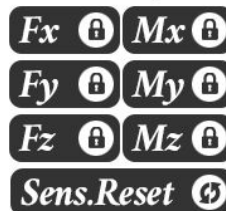


Align your tool on z-axis keeping the work point fixed.

Precision Mode



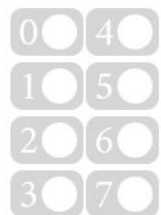
Precision Opts



Digital out



Conf. out

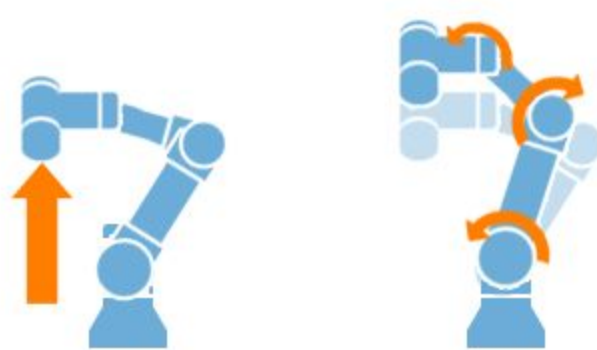


Tool out



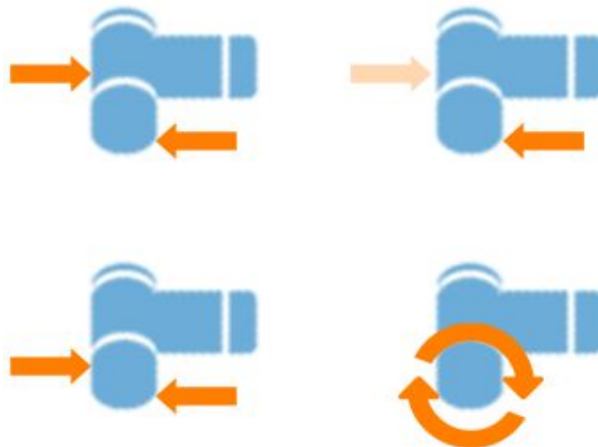
WARNING!
Avoid using Precision Mode close to robot singularity points

When this modality is active you can still move the robot manually, but instead of freedrive mode the logic will be determinate by the force sensor inside the tool flange. This sensor allows to evaluate the external forces applied to the flange. So, when the cobot will detect any force in a certain direction it will not just release the stressed axis but it will execute a coordinated motion in the same direction of the force.



With this system will be easy to **move the robot in a defined direction**, so will be more easily **follow a specific shape**.

It is very important to **apply the force on the flange or on the tool connected to it**; every force applied before the flange will be not read from the cobot and could generate **unexpected movements**.



In the picture there is an example of how two similar forces generate 2 different movements: translation (upper images), torque (lower images).



If you are going to use a non-calibrated tool and will be activated the function **Precision Mode**, the cobot moved from the initial point will keep moving, because a **non-balanced tool** will result as an **external force**.



When the function **Precision Mode** is active it is necessary that robot is **correctly fixed on his base and is not swinging**, otherwise the vibration could generate some **unwanted motion**.

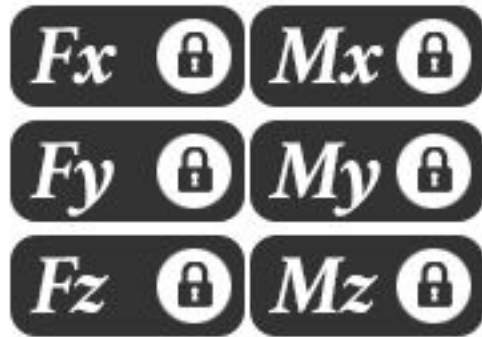


When the function **Precision Mode** is active the external forces are detected from the sensor and the axis configuration is calculated to allow the robot to move in a certain direction. Since for this kind of movement the robot uses the inverse kinematics it is possible to have **unexpected accelerations near the points of singularity**.

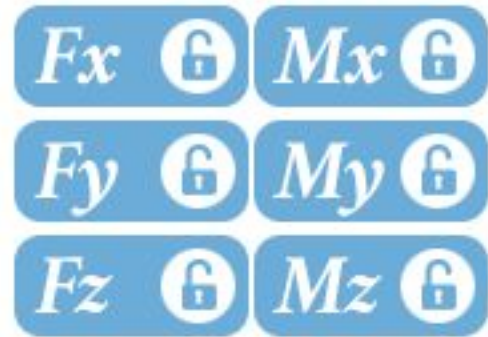


The 6 buttons allow to lock/unlock the movements along axis separately

Precision Opts

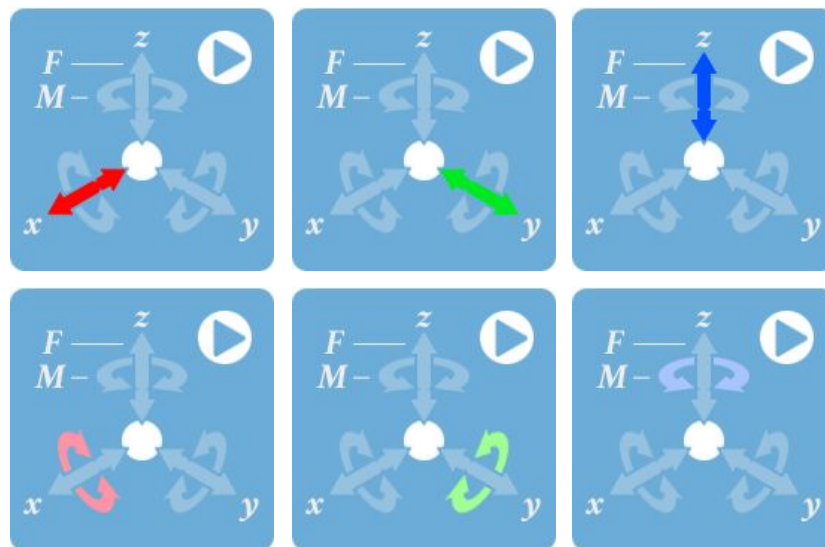


Precision Opts



(3 translations e 3 rotations), in this way is more easy to have the **linear control of the path**.

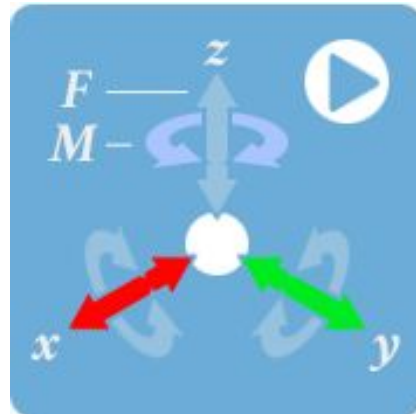
To understand better the enabled motions, the active axes will be colored on **Precision Mode** icon.



E.g.:

Blocking the Z-Axis (Fz) and the rotation around X (Mx) and around Y (My), we get a clean translation on the plane, holding the orthogonality to the plane, allowing only the Z rotation.

Precision Opts



The **Precision Mode** is useful for **copy with precision** certain paths so the movements speed of cobot will be quite “low”, however it will be possible to speed it up during the execution of the program.

The **Zero FTsensor** button



Allow to reset the ZERO of the force/torque sensor inside the cobot. (consult the [Universal Robots Script Manual](#) for more info)



The sensor is very accurate around a position of “zero”, so the best way to use it is to reset the zero when we want to use the sensor, and work around this new position. To do this is **just avoid to apply any external force to the cobot** and then press the reset button. In this moment the cobot will have a new “zero” configuration and around that point has **the most accurate sensibility of external forces**.



It is extremely important to reset the sensor only when **there are no forces are applied to the sensor**, otherwise that force will be the new “zero” value, and when that force will not be applied, the cobot will automatically start to **move in the opposite direction**.

The
OUTPUTS
button

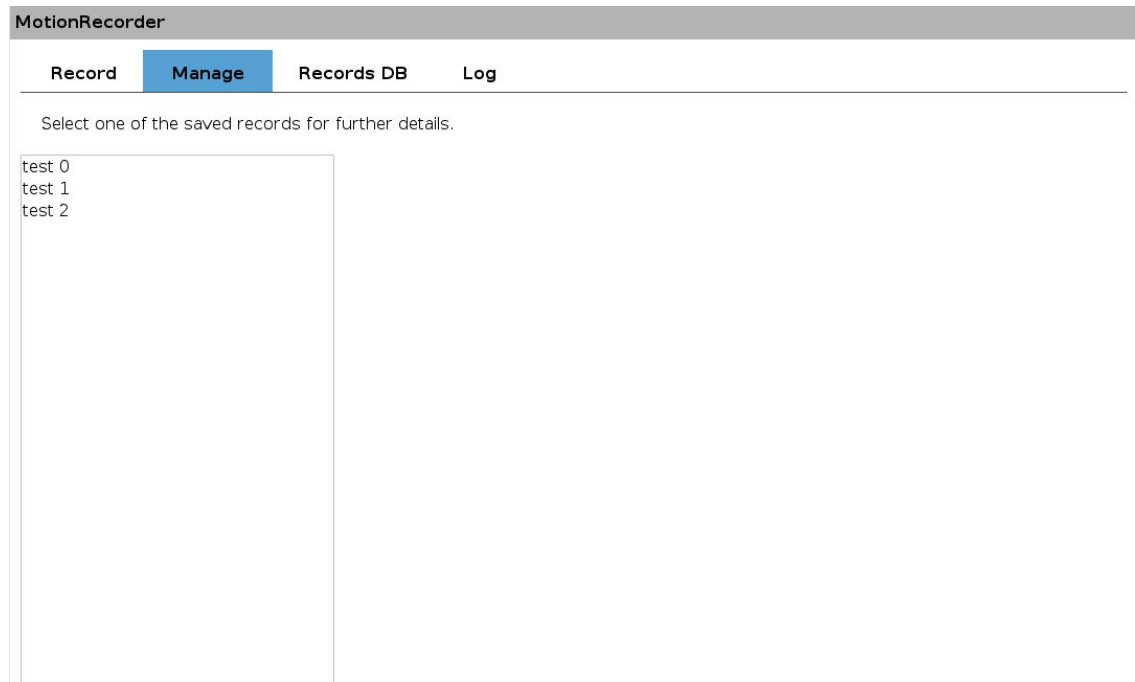


This buttons give the possibility to activate/deactivate a digital output without changing the window. The **Motion Recorder Software** in addition to the motion, will records the change of status of the digital outputs.

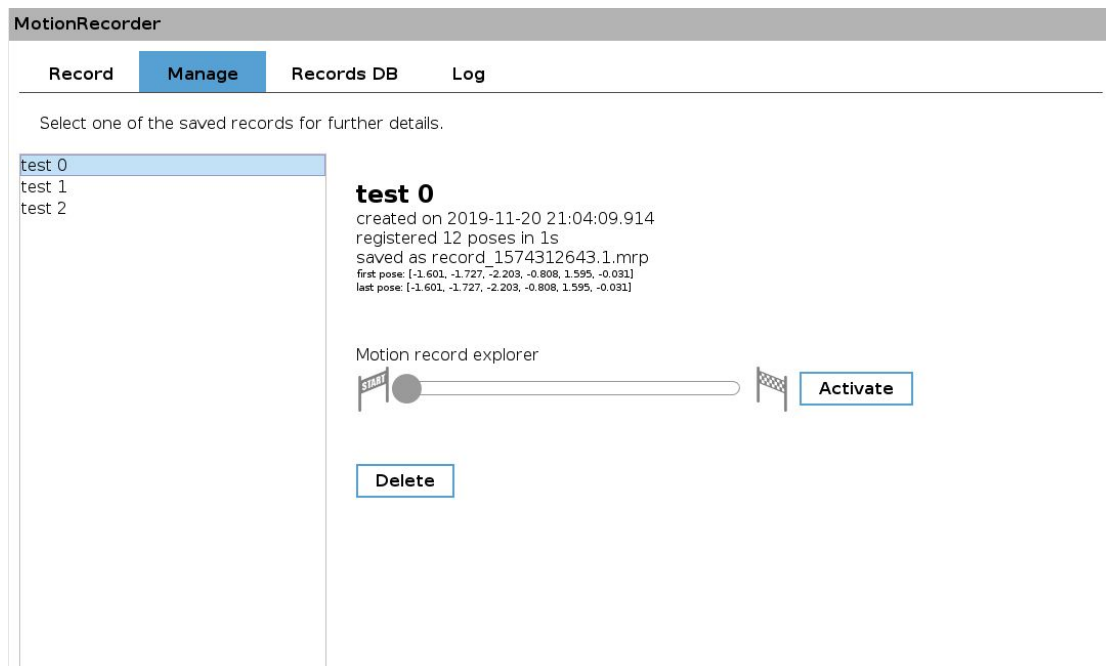
It's possible to change all the digital outputs of the cobots:

- 8 standard digital outputs
- 8 configurable digital outputs
- 2 tool digital outputs

Menu Manage



In this window it is possible to have access at all created path with the **Motion Recorder Software**. They will appear in order of creation. When you select one path all information about it became visible, and the buttons *Delete* and *Activate* and a slider bar appears.



Pressing **Delete** will eliminate the path.

Pressing **Activate** will activate the slider bar.

Move the slider bar will make the cobot reproduce the recorded motion.

After pressing **Activate** the cobot will go on the first point of the path. With the slider it is possible to move the cobot along the recording, it's possible to play the path in correct, or inverse way, or stop the cobot to a specific point of the records.



While reproducing the path the cobot will execute all the points from the begin till the point of the cursor.

Any “pause” will be not played.

On the information shown after the registration is done there is the unique ID of the path in case we want open the file in another environment using a *.script* file.

Menu Records DB

MotionRecorder

Record

Manage

Records DB

Log

Records DB status

RUNNING

Cap Callbacks Port

Records DB Port

Stop

This window is for check the communication with database and there is a button for stop and reactivate it.


In addition offers the possibility to change the database port, useful when another URCAPS uses the same one.

Menu Log

MotionRecorder

Record **Manage** **Log**

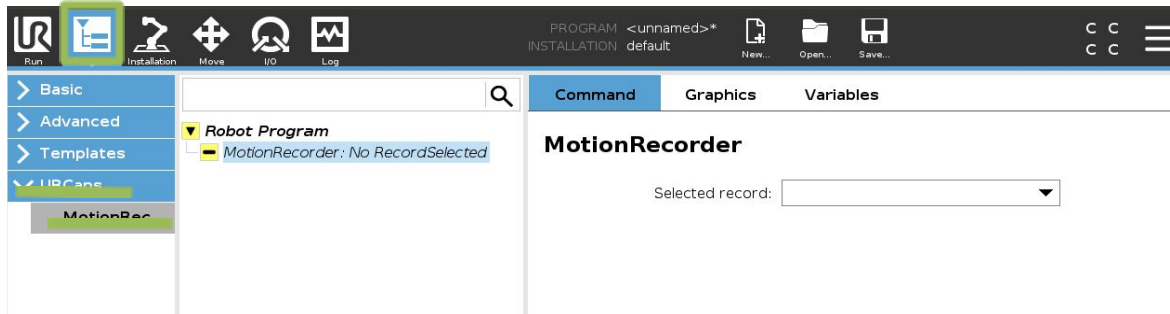
2019-06-06 14:02:57.253 Read 0 records from /programs/records/RercordsManager.out
2019-06-06 14:03:02.501 Robot-ics Motion Recorder successfully loaded!
2019-06-06 14:03:22.908 Deamon status: ERROR
2019-06-06 14:03:38.66 Precision Mode enabled.
2019-06-06 14:04:05.860 Precision Mode disabled.
2019-06-06 14:04:06.605 New Motion Recording started.
2019-06-06 14:04:07.287 New Motion Recording stopped.
2019-06-06 14:04:09.232 Record "test" succesfully saved in

 **RobotX** | REINVENTING
AUTOMATION

Here is possible to keep track of all operation done inside the **Motion Recorder Software**.

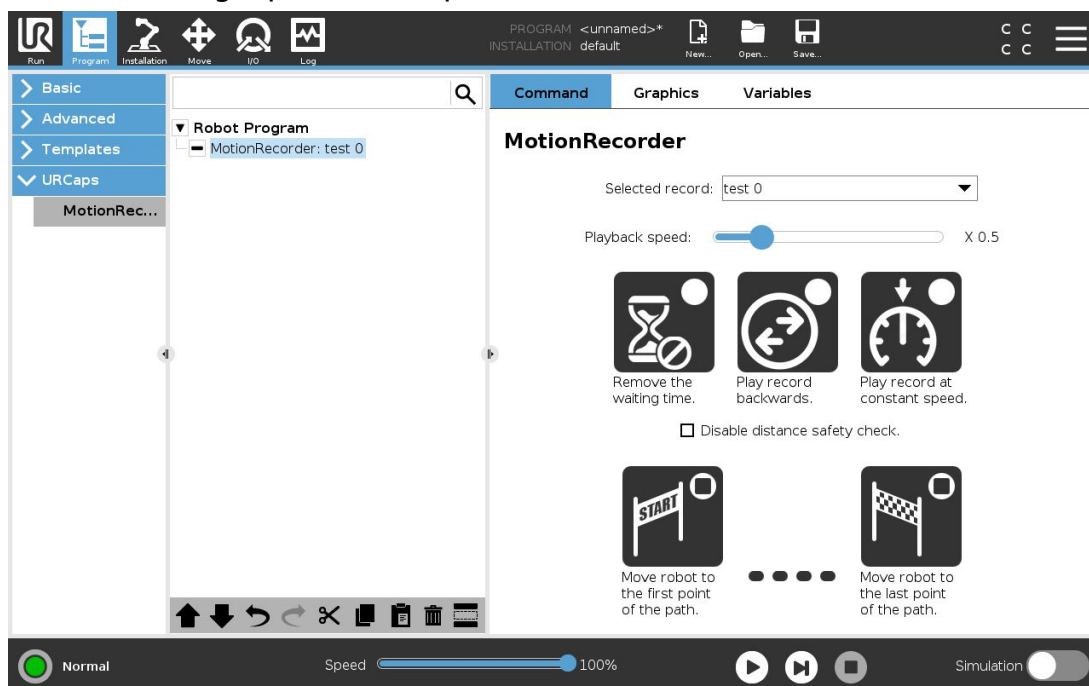
Program Node

After that the paths are created, with **Motion Recorder Software** the operator can use them inside any program. The block to insert in the program is in: *Program -> URCaps -> MotionRecorder*.

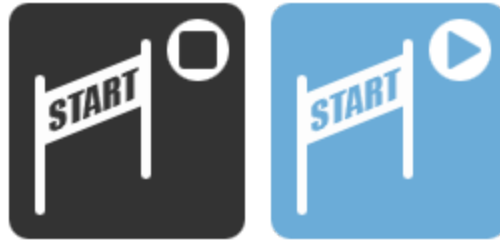


The block **MotionRecorder** has a drop-down menu with the list of recorded paths.

After selecting a path other options will be shown.



The buttons
*go to starting
point*



The buttons
*go to finish
point*



Allow to move the cobot outside the program on the starting position or on the arriving position.

During this execution the cobot will move at **extremely reduced speed**, since the cobot can find unexpected obstacles.



These buttons **make easier the teach of the points** before or after the recording path.

The
NO-Waiting
button



Allow to replay the paths **considering all the pause** used during the recording, **or ignoring** them.



This is very useful when you have to do a lot of **unwanted pause** during the recording, for example if the operator had to change his position for a better holding, or to change the mode from *freedrive* to the *precision* mode.

The *Inverse* button



Allow to replay a path in the **same recording order, or reversed** (from the end to the begin).

The Slider *Speed*



With the bar it's possible to **increase or decrease the speed of the path**, compared to how it was recorded.



Playing a path with high speed could cause a **protective stop** of cobot.

The *Cruise* *Control* Button



Allow to replay the recording with a **constant speed**. This option will **not play any pause** (the *NO-Waiting* button will be active).



Special movements with alternation of pure translation and pure rotation will be not possible to have a constant speed.

Script Functions

If the user wants to use the full power of the software and use its functions outside the GUI of polyscope, it's possible to use the script functions, the languages of the cobot of UR.

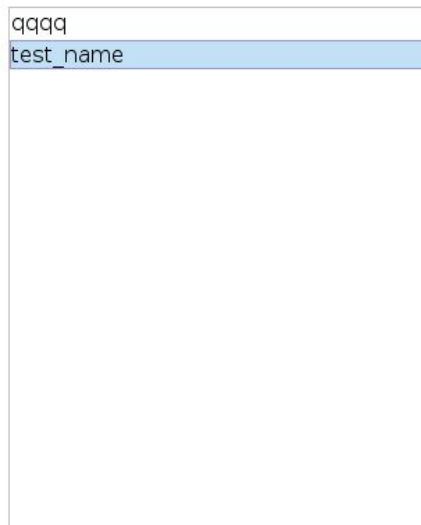
For uses the script functions, needs to create a "*script block*". In this block it's possible write all the function that the cobot is able to understand, a list of these functions will be shown below.

ics_go_start_pose(file_name, a=d2r(80), v=d2r(60)):

Command the Cobot to go to the first position of the chosen path.

Parameters

file_name: a string variable that contains the name of the recording. The real name of a record can be read in the *Installations->URCaps->MotionRecorder->Manage*. This point will be reached with movej movement. An example can be the string "*record_1569945688.3*".

A screenshot of a text input field. The text 'test_name' is entered and highlighted with a blue selection bar. Above the text, the letters 'qqqq' are visible. The input field is part of a larger interface, likely for creating or editing a script block.

test_name

created on 2019-10-01 09:01:35.796
registered 16 poses in 1s
saved as record_1569945688.3.mrp
first pose: [-1.601, -1.824, -2.241, -0.673, 1.595, -0.031]
last pose: [-1.601, -1.824, -2.241, -0.673, 1.595, -0.031]

Motion record explorer



Activate

Delete

a=d2r(80): is the acceleration in radiant of the joints, the default value is of 80 degree / seconds².

v=d2r(60): is the velocity in radiant of the joints, the default value is of 60 degree / seconds.

ics_go_finish_pose(file_name, a=d2r(80), v=d2r(60)):

Command the Cobot to go to the last position of the chosen path. The variables

ics_MR_move(ics_mr_no_w8, ics_mr_inverse, ics_mr_constant_speed, ics_mr_speed, ics_mr_filepath):

Command the Cobot play a recorded path.

Parameters

ics_mr_no_w8: a Boolean variable that indicates whether the path should be reproduced without considering the waiting points or considering them.

ics_mr_inverse: a Boolean variable that indicates if the path must be reproduced as it was recorded, or on the contrary.


ics_mr_constant_speed: a Boolean variable that indicates if the path must be reproduced with constant speed or as recorded.

ics_mr_speed: a real number indicating how much the playback speed should be altered. The value of 1 indicate that the speed will be the same of the recorded speed. The minimum value it's 0.1(the speed will be of 1/10 of the recorded one) and the maximum 2 (the speed will be the double).

ics_mr_filepath: a string variable that contains the name of the recording. The real name of a record can be read in the *Installations->URCaps->MotionRecorder->Manage*. This point will be reached with movej movement. An example can be the string "record_1569945688.3".


Troubleshooting


Here a list of the most frequent error messages and how to solve them.


High Angle	<div><div>Info High Angle</div><div> the angle between the tool and the base is greater than 90 degrees. Reduce the angle with freedrive and call this function again</div><div><div>Stop Program</div><div>Continue</div></div></div>
Description	This error happens using the <i>Vertical Align</i> function, and the cobot is in a configuration that force him a rotation of more than 90° for reach the perpendicularity to the base plane. The reason is to avoid crashes between tool and cobot.
Solution	Move in freedrive the cobot in a configuration where the angle between Z-Axis of the tool and the base plane X-Y is less than 90°.

Unreachable Align Pose	<div><div>Safety Message</div><div> Protective Stop</div><div>C204A1: Path sanity check failed: Sudden change in target position</div><div>Status report generated, go to log tab. Report date: 2019-06-11 12:43:06.511</div><div><div>Enable Robot</div><div>Save Log Report</div></div></div>
Description	This message is generated by the cobot software, and for the description you can find more information on the UR manual.


	This message appears when the Vertical Align button is pressed while the cobot is near an unreachable pose.
Solution	It is enough to move the tool closer to cobot base so during the motion the tool flange will remain in the reachable area.


Unable find solution inverse kinematics	<div> <div>An error occurred in the running program</div> <div>  The robot cannot reach the requested pose. Script function get_inverse_kin is unable to find an inverse kinematics solution. <div> Program node: Program node type: Error position: </div> <div> <div>OK</div> <div>Go to problem</div> </div> <div> <div>Advanced view (script)</div> </div> </div> </div>
Description	This message appears when moving the cobot in Precision Mode near the singularity position. Since the Precision Mode force the calculation of inverse kinematic of the cobot, in certain position this calculation is not possible and give that error.
Solution	Using the Precision Mode when the cobot is far away from the singularity.

High Speed Protective Stop	<div style="background-color: #4a86e8; color: white; text-align: center; padding: 5px; font-weight: bold;">Safety Message</div> <div style="text-align: center; margin-top: 10px;">  Protective Stop </div> <p>C153A3: Position deviates from path: (wrist 1). Check payload, center of gravity and acceleration settings. Log screen may contain additional information.</p> <p>Suggestion Check payload, center of gravity and acceleration settings.</p> <p>Status report generated, go to log tab. Report date: 2019-09-18 10:00:56.668</p> <div style="display: flex; justify-content: center; gap: 20px; margin-top: 10px;"> <div style="border: 1px solid #4a86e8; padding: 5px 15px; text-decoration: none; color: #4a86e8; font-weight: bold;">Enable Robot</div> <div style="border: 1px solid #4a86e8; padding: 5px 15px; text-decoration: none; color: #4a86e8; font-weight: bold;">Save Log Report</div> </div>
Description	<p>When playing a recorded path, it is possible to change the speed with the slider. So, a trajectory with many curves and high speed could generate a high inertia that the cobot is unable to balance.</p>
Solution	<p>It is enough to reduce the playing speed.</p>



Change the safety parameters could also fix the problem but this change will be valid for the whole program.

High Distance	<div style="border: 1px solid #4a86e8; padding: 10px; margin-top: 10px;"> <div style="background-color: #4a86e8; color: white; text-align: center; padding: 5px; font-weight: bold;">High Distance</div> <div style="margin-top: 10px;">  <p>the robot is too far from the first point of the path. Bring the robot closer to the starting point before call the MotionRecorder Block.</p> </div> <div style="display: flex; justify-content: center; gap: 20px; margin-top: 10px;"> <div style="border: 1px solid #4a86e8; padding: 5px 15px; text-decoration: none; color: #4a86e8; font-weight: bold;">Stop Program</div> <div style="border: 1px solid #4a86e8; padding: 5px 15px; text-decoration: none; color: #4a86e8; font-weight: bold;">Continue</div> </div> </div>
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	<div style="text-align: center;"> <div style="background-color: #4a86e8; color: white; padding: 5px; margin-bottom: 10px;">High Distance</div> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 10px;"> <p>the robot is too far from the last point of the path. Bring the robot closer to the final point before call the MotionRecorder Block.</p> <div style="display: flex; justify-content: center; gap: 20px; margin-top: 10px;"> <div style="border: 1px solid #4a86e8; padding: 5px 15px; cursor: pointer;">Stop Program</div> <div style="border: 1px solid #4a86e8; padding: 5px 15px; cursor: pointer;">Continue</div> </div> </div> </div> </div>
Description	<p>This message appears when inside a compiled program is called the MotionRecorder block while the cobot is far away from the starting configuration of the path. It is useful to avoid that cobot will automatically choose a random trajectory.</p>
Solution	<p>Create Waypoint closer at starting/arriving point of the recording before call the MotionRecorder block.</p>

Warranty

Robot-ics warrants the **Motion Recording Software** and the products with it for a period of 2 years from the date of reception when utilized as intended.