User Manual

Leverage-Robotics ToolCubes User Manual

Contents

Safety

The user must read and understand this manual prior to using the Leverage-Robotics ToolCubes. A user is anyone who is involved in commissioning, maintenance, inspection, programming or disposal.

Warnings

During automatic tool change, make sure that no body parts or objects get in the path of the robot or between grippers.

When handing over a ToolCube to the robot, make sure that no fingers can be pinched by the gripper

Use the forces and speeds of the gripper wisely.

If possible, use the appropriate stands to store the ToolCubes. If ToolCubes are to be placed elsewhere in the workspace, care must be taken to ensure that they stand securely and upright.

Intended use

ToolCubes are intended to expand the possibilities of a two-finger gripper in order to enable more flexibility in pick and place tasks. In this sense, the use of the ToolCubes is limited to use as a gripping tool for picking up and putting down objects. ToolCubes should only be used within the scope of their technical data. Leverage Robotics is not liable for damage resulting from improper use

Commissioning

This section describes the commissioning of the ToolCubes.
It is essential to read the safety instructions before installation.

Delivery

Included:

- Storage box
- 5 ToolCubes:
    - Center Gripper
    - Magnet Gripper
    - Surface Gripper
    - Single Vacuum Gripper
    - Double Vacuum Gripper
- 5 parking slots suitable for the ToolCubes
- USB-Stick with software plugin and manual

Not included:

- Installation material
- Installation tools

Be sure that the right mounting material and tools are ready, to firmly mount the stands of the ToolCubes in the robot's working area.

Ambient conditions

During transport and storage:

- Temperature range: -20°C -40°C
- Humidity: < 80% (non-condensing)
- No contact with:
    - Liquids
    - Corrosive gases

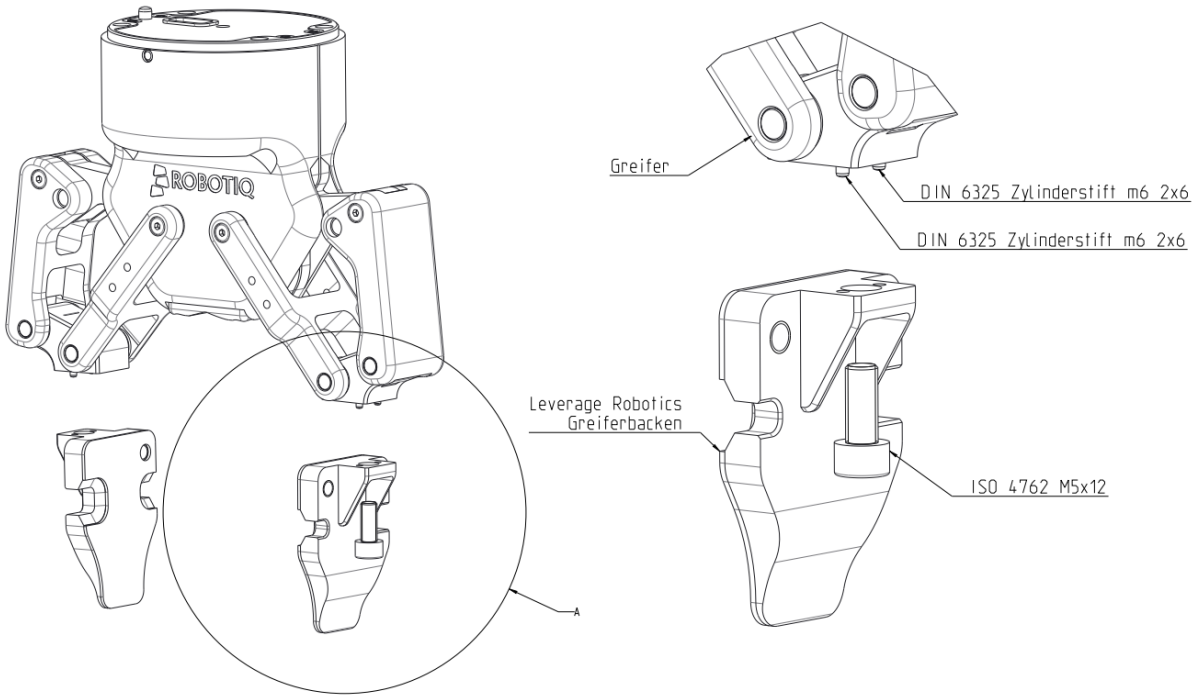
Additionally during operation:

- Temperature range: 10°C - 30°C
- Vibration: < 0.2G

Hardware Installation

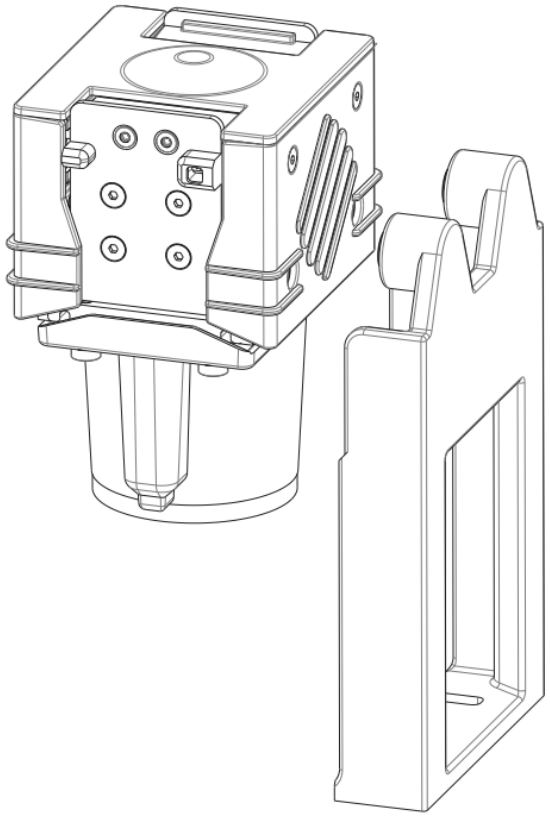
Gripper

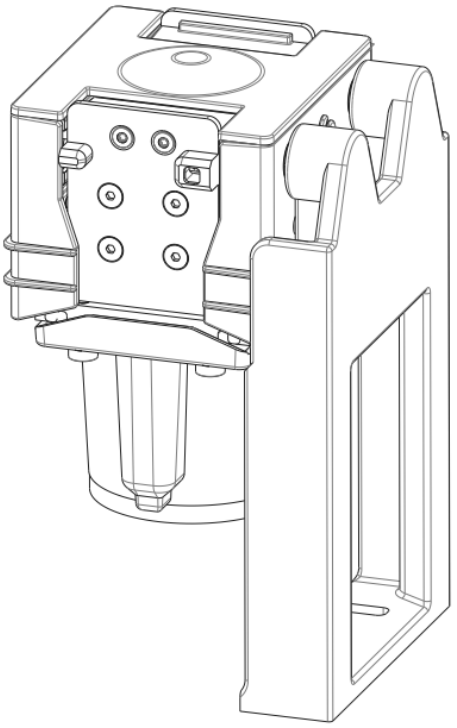
The jaws are attached directly to the robot gripper and form the mechanical interface for securely gripping and using ToolCubes.



ToolCube parking slots

The stands attach to a horizontal surface such as a worktable via two slots. They must not move or wobble. Washers with an outer diameter of 17-20 mm are recommended for fastening.
Screws should be tightened with a maximum of 5 Nm.
All stands should be installed at least 30cm from the base of the robot. Make sure that the toolcubes are placed in such a way that the robot can reach them directly from the work area. Otherwise, if via points are missing, the robot may collide with the holder before or after a tool change.





Software Installation (Universal Robot & Robotiq Gripper 2F-85)

A URCap plugin is available for use with a Universal Robot. This was tested together with the Universal Robot UR5e and a Robotiq Gripper 2F-85. It is possible that the software also works with grippers from other manufacturers. In this case, please contact us to verify the seamless interoperability.

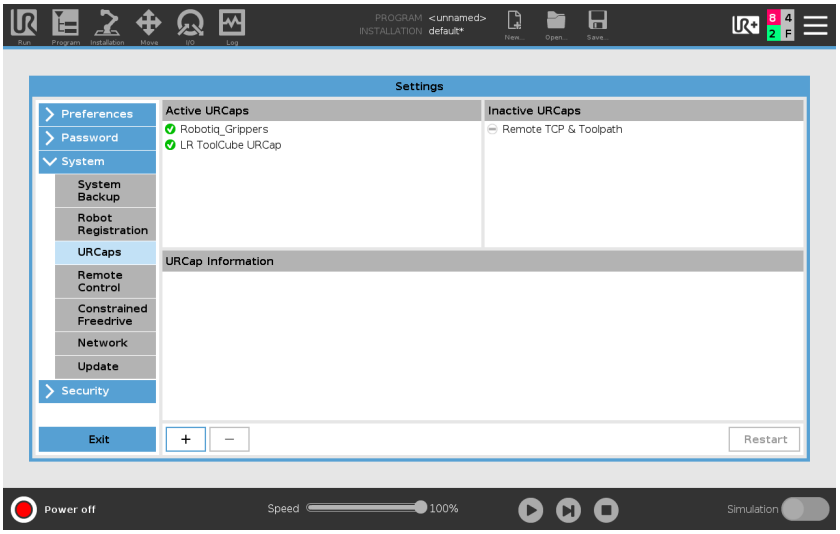
License agreement

The software provided by Leverage Robotics GmbH is protected by copyright and must therefore be treated confidentially. Passing on or duplicating the software is prohibited and will be prosecuted. The exact provisions can be found in the license agreement in Appendix 2.

Instructions

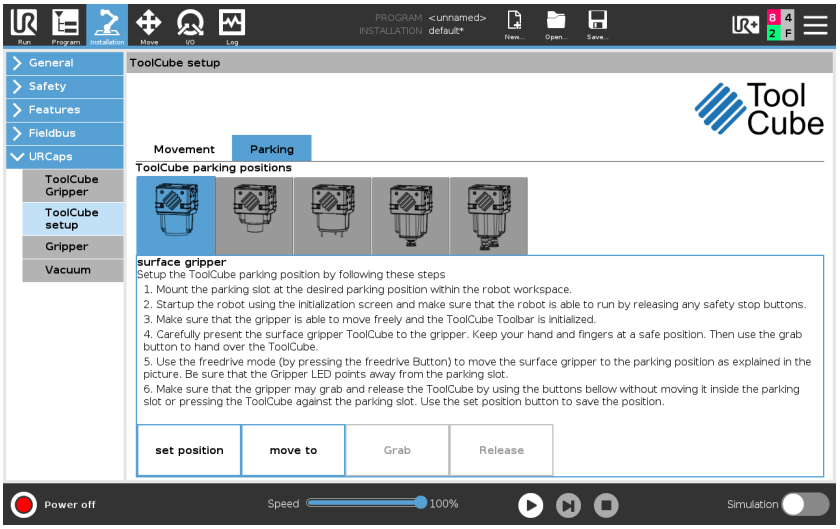
configuration

- Install your gripper including the software according to the manufacturer's instructions
- Install the supplied ToolCube URCap



  - Insert the supplied USB stick into the USB port on the teach panel
  - In the menu at the top right, call up the Point “Settings”
  - Select the sub-point “System->URCaps”
  - Click on the button with the symbol “+”
  - Navigate to the USB stick and select the file urcap file
  - Click on “Restart”, to restart the system.
- Basic configuration of the ToolCube UrCap
  - Call up the "Installation" tab
  - Select: UR-Caps->ToolCube Gripper
  - Select the gripper you want to use

Configuration of the automatic tool changer



Setting up the parking position ToolCubes for automatic changing

- Call up the "Installation" tab
- Select: UR -Caps->ToolCube Setup
- Select the ToolCube to be used Follow
- the displayed steps to save the parking position
- Click on “Save” in the top area and save the installation

Control of the toolcubes

Universal Robot & Robotiq Gripper

Initialization

Attention: When initializing the gripper, it can open and close it automatically.

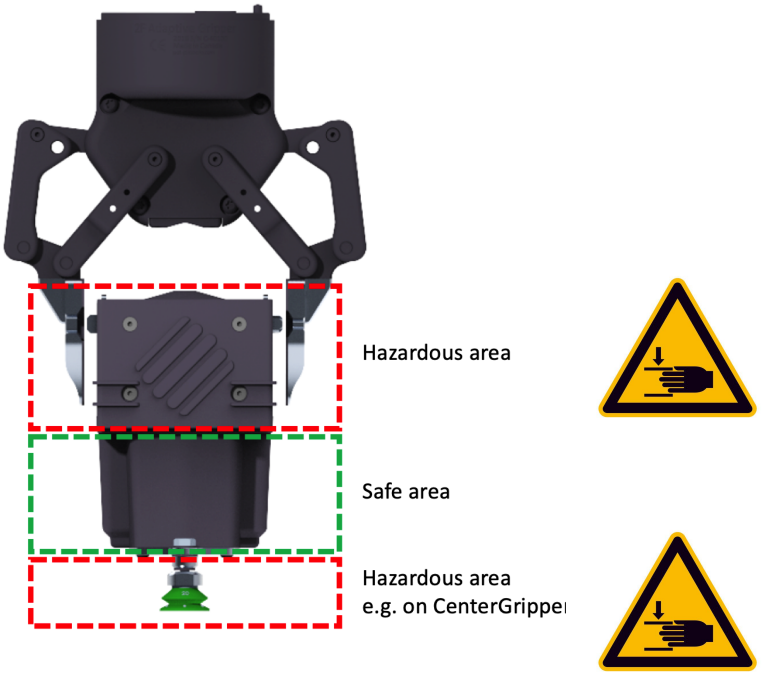
After starting the robot or after an emergency stop, the software or the gripper must be reinitialized

- Ensure that the gripper can move freely
- If necessary, remove objects (including ToolCubes) that are in the gripper using the function (e.g Via the gripper function “Emergency Open”) Open
- “ToolCube Toolbar” via the UR+ menu at the top right Press

- “Initialize” **(careful, the gripper is moving)**

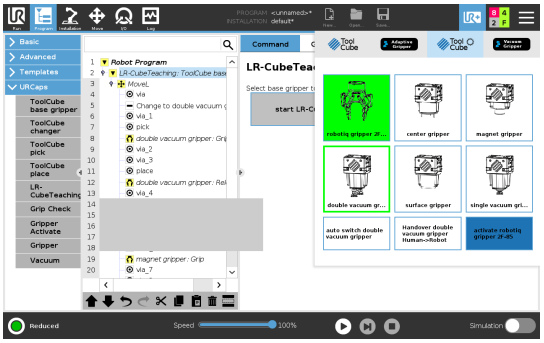
Manual change

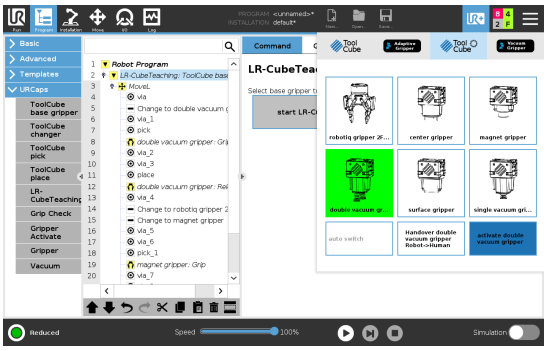
Attention: When manually transferring a ToolCube to the gripper, fingers can get between the gripper jaws and the ToolCube and, depending on the force of the gripper used, can lead to bruises or cut injuries (danger area).
Only hold the ToolCube in the lower area (safe area).



Steps:

- Open “ToolCube Toolbar” via the UR+ menu at the top right
- If necessary: Initialize the ToolCube software (See: Initialization)
- Select/click the ToolCube (will be outlined in green)



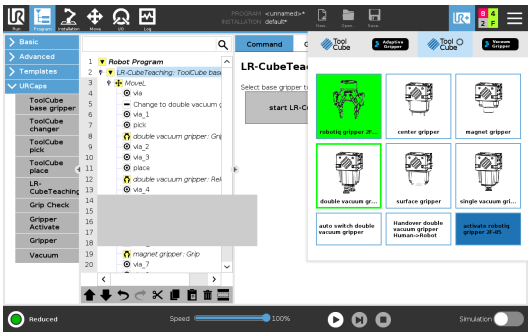
- Hold the ToolCube flush against one of the gripper jaws on one side of the mechanical interface
- Check whether the fingers are not endangered when closing the gripper jaws
- Click on "Handover" and gently carry the tool with you when closing. The tool is gripped and displayed as "recorded" in the software (green background).
- 

Automatic change

Attention: The robot and the gripper move slowly but fully automatically during the change. Have an emergency stop safety switch ready in case unexpected trouble occurs.

The automatic change requires that a parking position is set up mechanically for the ToolCubes and configured in the software. This is still a prerequisite to enable the change in the program sequence.

- Open “ToolCube Toolbar” via the UR+ menu at the top right
- If required: Initialize the ToolCube software (see: Initialization)
- Select/click the ToolCube (will be outlined in green



- ensure that the robot gripper reaches the parking position of the tool or the area above it without collision in a direct line
- keep your emergency stop or safeguard stop button within range and stop the robot immediately if necessary. The running script can also be canceled at any time using the stop button at the bottom of the screen.
- Click “Auto switch” (Robot and Gripper are now moving slowly but autonomously)
- When the robot has grabbed the new tool and stands still over it, the switch is complete.

Programming

Several program blocks are available for programming, which are available in the program editor under “URCaps”

Change ToolCube

Requirement: Automatic change configured

Select a ToolCube for use. In the program flow, this ensures that the ToolCube is changed appropriately. If the ToolCube is already equipped, this action is skipped.

When changing ToolCubes automatically and especially in the program sequence, make sure that the robot can easily reach the parking positions of the tools used on a direct path. It may be necessary to add additional via waypoints. Also, when switching from one tool to another, it may be necessary to first switch to the gripper and then to the tool in order to place necessary via waypoints between changing tools.

Gripper Grip/Release

Gripping and releasing with a ToolCube. Also allows parameterization of the gripping.

UR-Script functions

UrScript functions allow a more fine grained control over the ToolCube functions.

lr_gripper_activate()

Activation of the ToolCube module (see also: Initialize)

lr_%gripper_name%_move(pos, speed, force, async=False)

Move the gripper or toolcube without special grip or release movements
Replace %gripper_name% with :

```
gripper
tc_center_gripper
tc_magnet_gripper
tc_suction_gripper
tc_vacuum_1_gripper
tc_vacuum_2_gripper
```

Parameters:
pos: gripper position in meters [m]
speed: external gripper speed in meters per second [m/s]
force: estimated external gripper force in Newton [N]
async: false: function waits for a gripper movement to be completed , True: Function does not wait and gripping movement is performed parallel to further script execution

`lr_tc_%gripper_name%_grip(pos, speed, force, async=False)`

Starts a gripping movement with the given parameters
Replace %gripper_name% with:
`gripper`
`tc_center_gripper`
`tc_magnet_gripper`
`tc_suction_gripper`
`tc_vacuum_1_gripper`
`tc_vacuum_2_gripper`

Parameters:
pos: Gripper position in meters [m]
speed: External gripper speed in meters per second [m/s]
force: Estimated external gripper force in [N]
async: False: Function waits for a gripper movement to be completed, True: Function does not wait and gripper movement is carried out parallel to further script execution

`lr_tc_%gripper_name% _release(pos, speed, force, async=False)`

Performs a grab motion to release something.
Replace %gripper_name% with:
`gripper`
`tc_center_gripper`
`tc_magnet_gripper`
`tc_suction_gripper`
`tc_vacuum_1_gripper`
`tc_vacuum_2_gripper`

Parameters:
pos: gripper position in meters [m]
speed: outer gripper speed in meters per second [m/s]
force: estimated outer gripper force in [N]
async: false: function waits for a gripper movement to be completed, True: the function does not wait and the gripper movement is carried out in parallel with further script execution

`lr_tc_equip(tc_id, a=DEFAULT_ACCELERATION, v=DEFAULT_VELOCITY)`

Change the ToolCube. If a ToolCube is already being used, then this is stored first.

Parameters:
tc_id: The ID of the ToolCube. Use one of the predefined constants:
`LR_TC_ID_GRIPPER`
`LR_TC_ID_CENTER_GRIPPER`

```
LR_TC_ID_MAGNET_GRIPPER
LR_TC_ID_SUCTION_GRIPPER
LR_TC_ID_VACUUM_1_GRIPPER
LR_TC_ID_VACUUM_2_GRIPPER
```

a: Acceleration of the robot movement when changing the ToolCubes automatically. By default, the predefined speed from the installation is used.

v: Speed of the robot movement when changing the ToolCubes automatically. By default, the predefined speed from the installation is used.

```
lr_tc_unequip(a=DEFAULT_ACCELERATION, v=DEFAULT_VELOCITY)
```

Change the current ToolCube. Automatic change of the ToolCube or placement of the ToolCube

Parameters:
a: Acceleration of the robot movement when the ToolCube is changed automatically. By default, the predefined speed from the installation is used.

v: Speed of the robot movement when changing the ToolCubes automatically. By default, the predefined speed from the installation is used.

Control without software components

Since the ToolCubes function purely passively, they can also be used with any other robots and grippers without a software plugin. The following gripper settings can be used for this.

Gripper opening table:

Gripper opening / function	CenterGripper	MagnetGripper	SurfaceGripper	Single VacuumGripper	Double VacuumGripper
Deposit ToolCube	85 mm	85 mm	85 mm	85 mm	85 mm
Pick up ToolCube	71 mm	71 mm	70 mm	72 mm*	72 mm*
Activation	45.5 - 71 mm	46 mm	57 mm	55 mm	55 mm
Deactivation	45.5 - 71 mm	71 mm	70 mm	72 mm	72 mm

(*) With the VacuumGripper it is recommended to reduce the gripper opening by 2 mm before gripping a component so that the components can be reliably released during deactivation. When the component is released, the gripper opening is 68 mm (deactivation). After releasing, the gripper opening is reduced again to 66 mm.

Specified force range:

	CenterGripper	MagnetGripper	SurfaceGripper	VacuumGripper (single/double)
Force range	80 N - 235 N	80 N - 200 N	85 N - 235 N	120 N - 235 N

Specifications

The ToolCubes all work passively. They are activated using a standard two-finger gripper in conjunction with the Leverage Robotics fingertips. The prerequisite is that the gripper allows an opening of 85 mm and can apply the required activation forces (see tables for gripper opening and force range).

Weight table:

	CenterGripper	MagnetGripper	SurfaceGripper	VacuumGripper (single)	VacuumGripper (double)
Weight in g	355	323	342	384	393

TCP table:

	CenterGripper	MagnetGripper	SurfaceGripper	VacuumGripper (single)	VacuumGripper (double)
Vertical TCP offset to the gripper tip in mm	62.2	53.7	62.5	93.2	85.5

Dimensions:

	CenterGripper	MagnetGripper	SurfaceGripper	VacuumGripper (single)	VacuumGripper (double)
HxWx D in mm	110.5 x 82.4 x 96	100.3 x 82.4 x 96	109.1 x 82.4 x 96	139.5 x 82.4 x 96	134 x 82.4 x 96

CenterGripper

The CenterGripper can be used to grip round and triangular objects in the center. The maximum diameter of the object to be gripped is 45mm. The minimum diameter of the object to be gripped is 2mm.
The CenterGripper can also be used as an internal gripper. The minimum diameter of the hole is then 6.5mm and the maximum diameter is 45mm.

MagnetGripper

The MagnetGripper can be used to grip ferromagnetic parts. The maximum weight of a flat component that can be gripped with the MagnetGripper is 300 g. It is recommended to test the intended handling of the component several times, as the alloy, surface finish and shape of the component determine the maximum weight. It is also recommended to grip the component at or above the component's center of gravity, if possible, in order to avoid center-of-gravity-dependent torques.

SurfaceGripper

The SurfaceGripper can grip flat and heavy components with smooth and slightly rough surfaces (up to 5kg). The component is fixed and the wobbling of the component is almost completely prevented.

VacuumGripper

The VacuumGripper can grip flat and slightly curved components with a smooth and slightly rough surface. The component surface must be impermeable to air (glass, metal, plastic, airtight cardboard, etc.).
The maximum weight of the component to be gripped is 1.5 kg with the given surface finish. Different suction elements in combination with the surface finish can lead to different loads. It is always advisable to carry out a test attempt.

Servicing and maintenance

Vacuum Gripper (single / double)

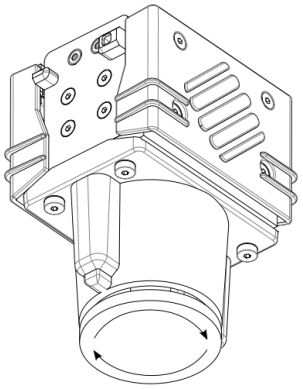
The wear and tear of the suction cups depends on the application. It is recommended to inspect them weekly for possible damage. If cracks appear, the suction cups must be changed.

SurfaceGripper

The wear of the suction disc depends on the application. It is recommended to inspect them weekly for possible damage. If cracks appear, the pane must be replaced.

Weekly check of the suction disc

The tight fit of the suction disc must be ensured. To do this, the suction disc must be tightened clockwise as far as it will go.
Check the suction disc for cracks or other damage.



Disposal

Disposal by means of recycling is recommended.

Residual risks and protective measures

A safe distance and handling of the ToolCubes must always be ensured. The remaining risks and corresponding protective measures are dealt with below.

Sharp and pointy parts

The gripper jaws and the lower area of the ToolCubes have pointed edges in places (e.g. CenterGripper). Particular attention should be paid to the movement of the robot arm when a human is in the immediate working environment of the robot. The current requirements for safe human-robot collaborations must always be strictly respected.

Unplanned falling of gripped parts

Depending on the application, gripped components can fall down unplanned. It must be ensured that falling components do not pose a danger to people - keep a sufficient distance or take other effective protective measures.

Mobility of the machine

When troubleshooting (e.g. transferring a ToolCube to the gripper), body parts can become trapped between the tool and the gripper. It must be ensured that the tools safe area are grippedMovement of the robot arm and the gripper must be carried out with special care. An emergency stop of the robot must be possible at any time and immediately.

Sharp edges

When manually squeezing the ToolCubes, the skin can be pinched between the jaws and the housing. The ToolCubes are not designed for manual use, but for automatic actuation using a two-finger gripper. In order to avoid skin pinching, it is recommended to wear protective gloves when operating manually.

Contact

Leverage Robotics GmbH
Hansastraße 89
81373 Munich
E-Mail: info@leverage-robotics.com

Appendices

EC Conformity
Software