



## WP9 – Dissemination

# Training for WP4 module “Motion-capture teleoperation teaching by demonstration”

### Responsible partner

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CEA : B. GRADOUSOFF

### Contributing partners

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None.

### Summary

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This training document provides information about the system setup and use of the Motion-capture based teleoperation module, used for teaching trajectories by demonstration.

## 1. Equipment used

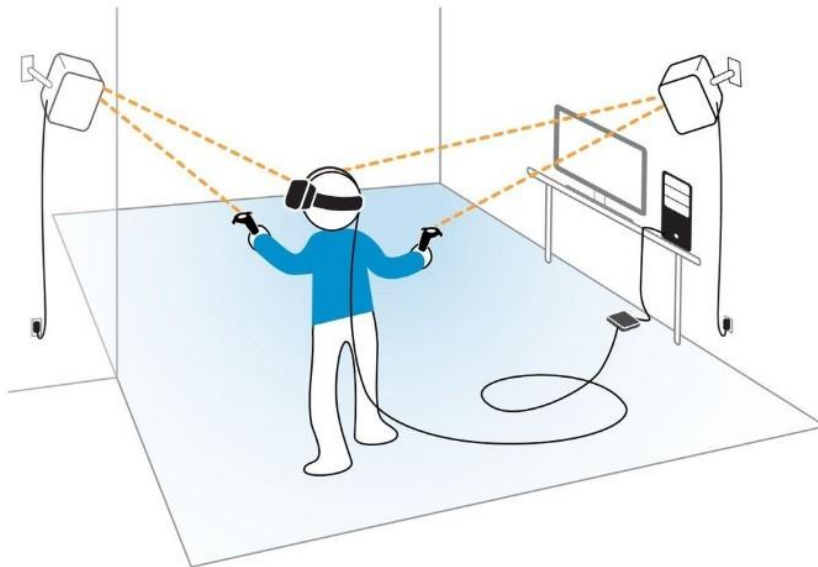
### 1.1. HTC VIVE

The HTC VIVE kit is used to track the user's movements. More precisely the components used by the HTC Vive Kit are :

- 2 lighthouses
- The virtual reality headset (It only needs to be turned on to enable the cameras and trackers detection).
- A hand controller
- A tracker



The *HTC Vive* Motion-capture setup teaches various geometric primitives, such as waypoints and motions. Teaching is done with the HTC remote control.



## 1.2. Robots used

The current setup uses 2 6 DOF UR10e collaborative robots. Robot control is done by connecting both robots to a ROS controller.



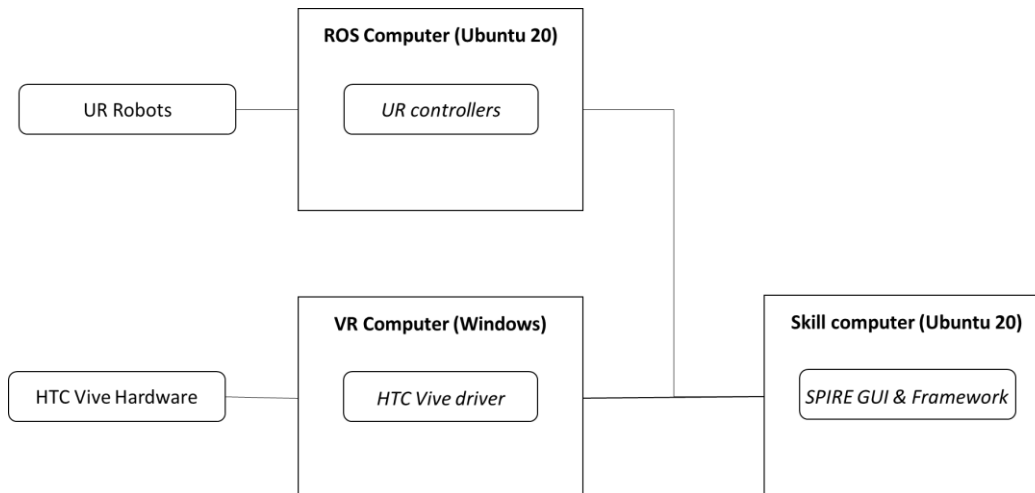
## 1.3. Software dependency list

The main software modules needed to operate the system are:

CEA LIST SPIRE skills framework: this framework implements our version of the skill concept, and provides multiple toolboxes for teaching by demonstration, geometric data processing, skills composition, and execution.

ROS: used to control external UR10e robots.

The following diagram illustrates the relationship between these modules.



## 2. Quick start guide

### 2.1. Step 1: VR installation

1. Plug the headset into the associated computer and turn it on. A green light should be seen on the headset hub as shown in the following picture.



2. Plugs the two lighthouses. They should be placed at two corners of the robotic cells to track robot movement during the calibration phase and the user movements.

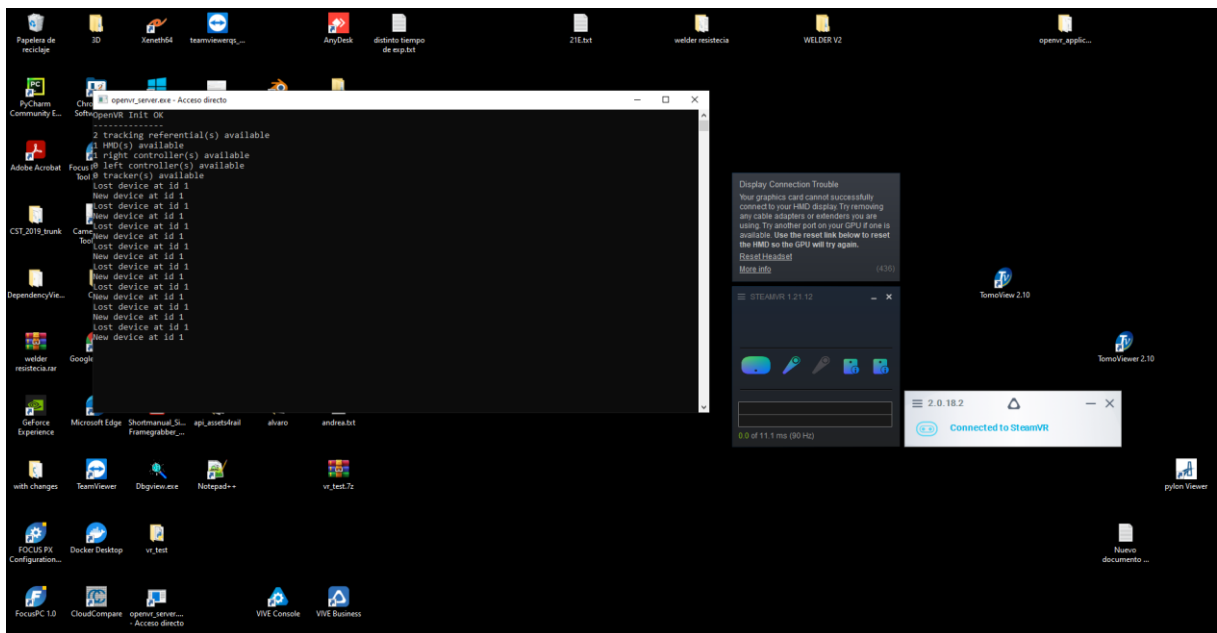


3. Launch Steam VR. If it is the first use, a first interactive and guided calibration step should be done with Steam VR software. Once realized, cameras and headsets must be detected automatically.

- Pair the hand controller and the tracker by following the HTC Vive guidelines: <https://www.vive.com/uk/support/vive-pro/category/howto/pairing-the-controllers-with-the-headset.html>. Once paired, the tracker should be mounted on the robot tool.



- Once everything is detected by Steam VR simply launch the `openvr_server.exe`. Once launched, it must indicate the list of the materials connected.



## 2.2. Step 2: Launch ROS and SPIRE

- Launch the ros controller by executing the following commands in a terminal :

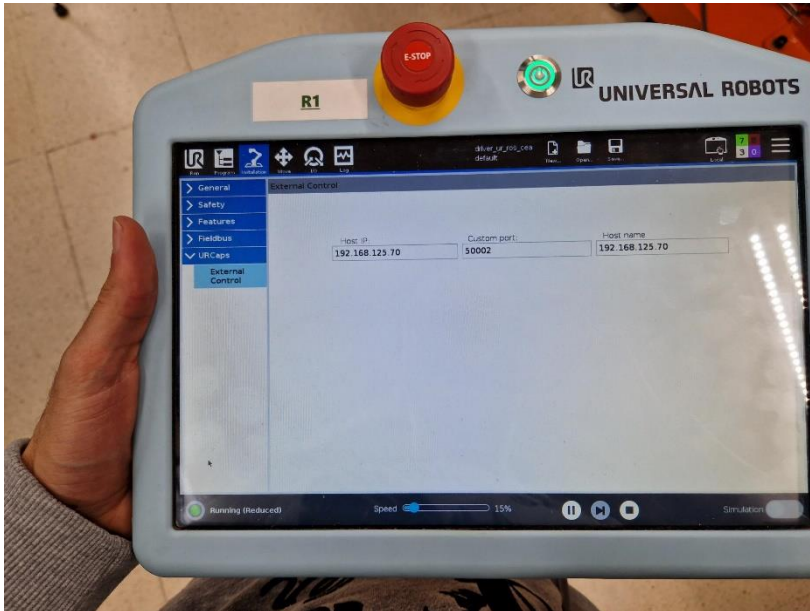
```
roscore
```

```
roslaunch launch_folder/selmark.launch
```

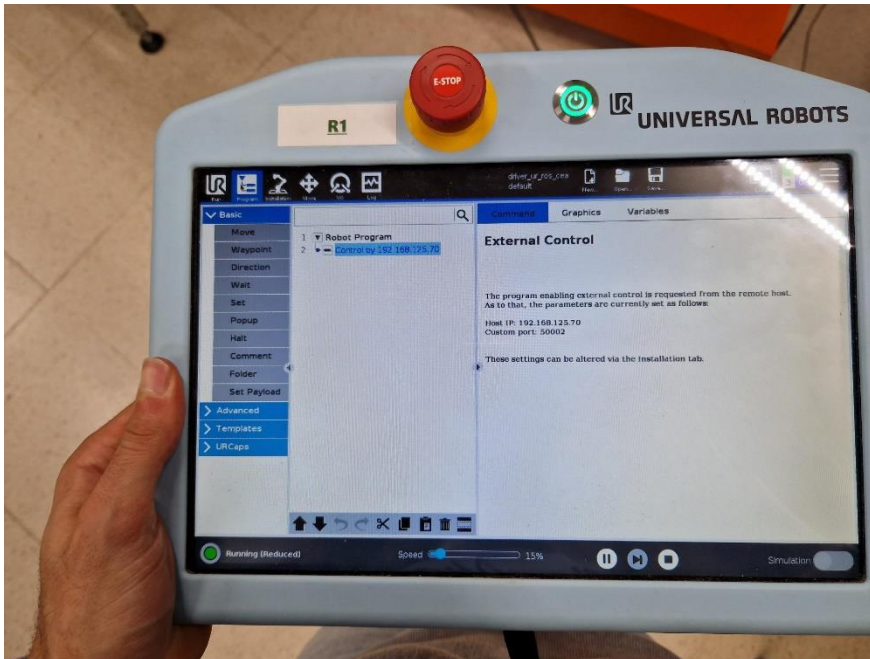
- Launch SPIRE GUI in a terminal by using the following command :

```
python3 new_teaching_gui/app.py
```

3. In the UR teach pendant, go into the installation tab and in the urcap remote, enter the IP address of the ros pc, with port 50002 for robot 1 and 50021 for robot 2.

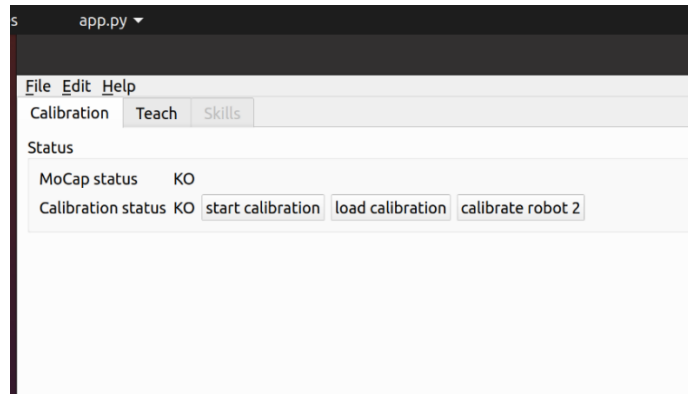


4. Launch the external control UR script on both robots



### 2.3. Step 3: Calibration via SPIRE GUI

Once the spire is launched, the following GUI should appear with the default tab the one related to the calibration :



The calibration process should be realized only once if lighthouses are not moved between applications. To perform the calibration, the tracker must be mounted on the robot terminal axis. The hand controller must be placed on a table, visible by the cameras, and near to 0 z value of the robot base. By clicking on the start calibration button, the system will automatically perform rotation and translation movements. Once the process is done, the user should see the calibration status turned to OK. If not it means that the calibration has not been successful and should be performed another time. To avoid that issue, make sure that the tracker is visible to the cameras during the entire process. The calibration parameters are saved automatically to be reused next time the user launches the spire GUI.

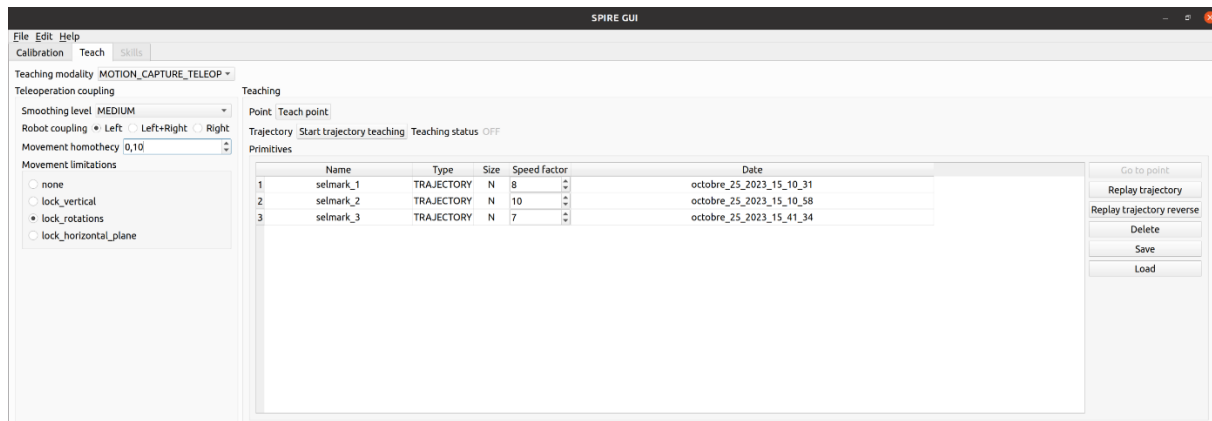
In the case of the selmark application, the second robot calibration is not required, as the transformation from robot 1 to robot 2 is fixed and known.

## 2.4. Step 4: Teleoperation and skill use

To perform the teleoperation :

- 1- Select the Teach tab of the Spire GUI.
- 2- Select the robot you would like to control
- 3- Keeps the trigger of the hand controller pushed to teleoperate the robot. The teleoperation stops if the trigger is released.

The Teach tab of the Spire GUI offers lots of assistance to help the user during the teleoperation.



The main options are :

- Smoothing level (low, medium, high): The higher the value is, the smoother the teleoperation.
- Robot coupling : Choose the system(s) you would like to teleoperate
- Homothety: Choose the homothety factor between the user and the robot. For instance, a 0.5 value means that a 1m movement of the user will result in a 0.5m movement of the robot TCP.
- Movement limitations: limit the movement of the robot. It can block the robot rotations during the teleoperation, constrain the robot to only move on the z-axis, ...
- Trajectory recording: Records the trajectory of the robot during the teleoperation. The trajectory could then be replayed by using spire skills
- Recording table: list the recordings available (it could be points or trajectory). The speed factor column enables us to set how many times faster we would like to replay the trajectory selected.
- Replay trajectory (inverse): option to replay a trajectory selected (or replay it backward). It takes into account the speed factor set.
- Go to the point: Go to the point selected