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AR-BASED OPERATOR SUPPORT IN HRC TUTORIAL

Laboratory of Manufacturing Systems and Automation (LMS)

www.trinityrobotics.eu

The TRINITY project has received funding from the European Union's Horizon 2020 research and innovation programme under the GA 825196

Pre-requisites

Software	Hardware
Windows 10 Professional	PC (CPU: X64 architecture with SSE2 instruction set support, RAM: , GPU: DX10, DX11, and DX12-capable)
Unity 2020.3.8+	Windows Mixed Reality headsets
Blender 2.60+	Microsoft HoloLens 2

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Overview of the module features

- ✓ AR – Operator support module:
- ✓ Aids operators that work in a hybrid, human and robot collaborative industrial environment
- ✓ Supports operators in the assembly process through visual signals and notifications.
- ✓ Increases humans' acceptance by displaying visual alerts coming from a robot's controller in case of a hazardous situation
- ✓ The application provides friendly user interface
- ✓ The application displays textual instructions
- ✓ The application can visualize parts and components that used for the assembly.
- ✓ The application can visualize robot's trajectory

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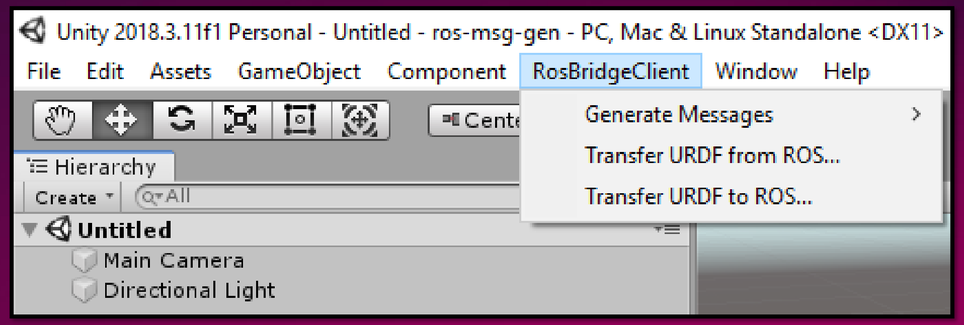
Workspace setup

AR Operator Support Module has been created based on Unity AR & Virtual Reality (VR) development platform (Unity 2021) and C# as the main scripting language.

- Download and install Unity
- Start Unity and follow-on screen instructions to sign in/create an account
- Create a new project
- Copy the RosSharp folder from AR module package into the Assets folder of your Unity project.
- Now RosBridgeClient and UrdfImporter are included in your Unity project. Once the plugins have been loaded, the following new menu items will show up:



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Importing the collaborative robot of the HRC

For importing the robots that are included in your HRC application you should provide the ***.urdf*** file.

General Approach:

1. Copy the .urdf file into an arbitrary Asset subfolder.
2. Copy all resources (mesh and texture files) into the same subfolder while maintaining the original folder structure of the ROS package.
3. In Unity, find the .urdf file in the Project window panel. Right click the file and select Import Robot from URDF in the context menu. (Alternative method: in Unity's menu bar, click GameObject > 3D Object > URDF Model (import) and select the .urdf file.)

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Importing parts and objects of your workcell

Unity natively imports Blender files. This works under the hood by using the Blender FBX exporter.

You have to create your workcell without the collaborative robot in Blender and save the **.blend file** in the Unity's **Assets folder.**

- To see your model in Unity, drag it from the Project View into the Scene View.
- If you modify your **.blend file,** Unity will automatically update whenever you save.

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Integration with the system (1/2)

The proposed AR application requires a direct connection with the hybrid production system.

- Communication with the back-end server should be established over a wireless network connection.
  - Two major components need for the complete integration of the AR application with an overall system → *Go to next slide*

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Integration with the system (2/2)

1. The Digital Twin of the manufacturing environment including the virtual reconstruction of the layout according to the CAD models of the involved components and the real-time data of the sensors placed at the shopfloor or on the robots.(Please contact LMS for more details about this and assistance in the development of DT)

2. A Central Controller that dispatches the scheduled tasks among the resources and monitors their execution through human and robot side interfaces

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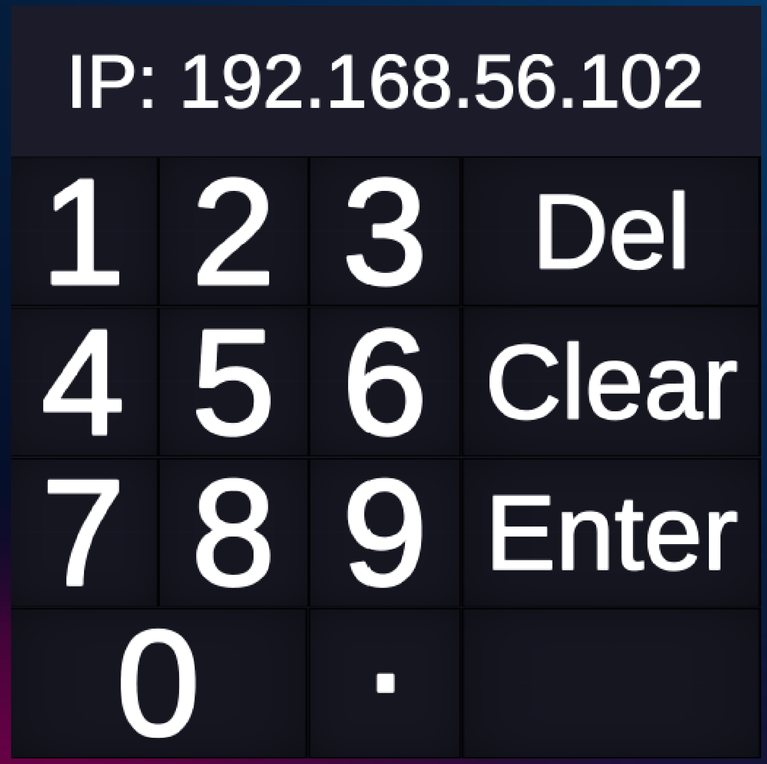
Execution Overview (1/4)

Initialization Phase

- WiFi Connection with ROS
- A marker is placed in a pre-defined position on the robot
- The user taps on the marker to be detected by HoloLens
- Robot and HoloLens reference frames are connected
- Correct superimposition of the virtual objects



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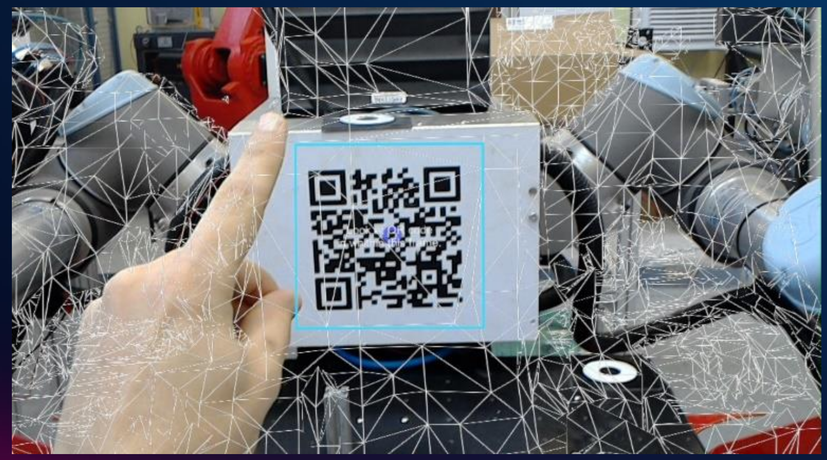
Execution Overview (1/4)

Initialization Phase

- LAN Connection with ROS
- A marker should be placed in a pre-defined position on the robot
- HoloLens detects the marker and performs the world calibration



* For help on the development of marker identification please contact LMS

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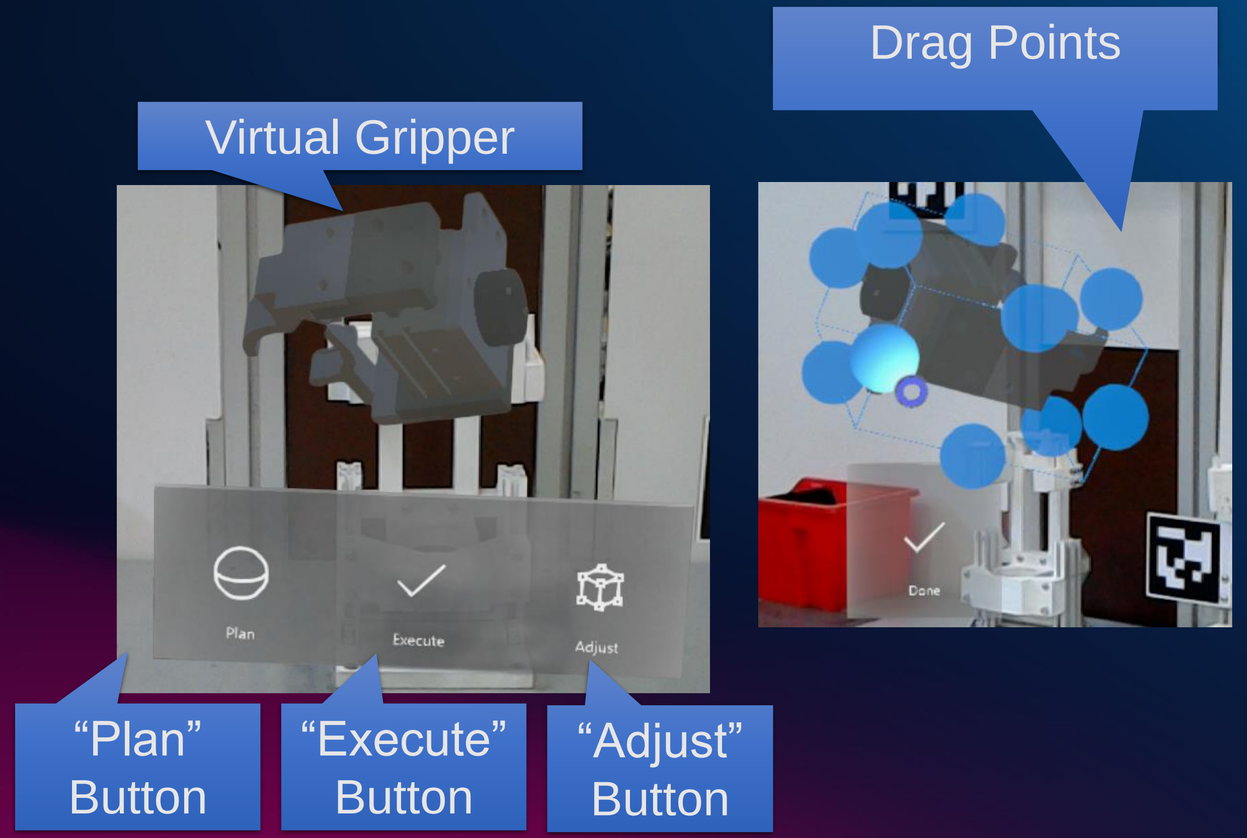
Execution Overview (2/4)

Robot Instructing Phase

The user can:

- Move the virtual tool in space
- Rotate the virtual tool
- Request a trajectory plan



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Execution Overview (3/4)

Planning outcome information

- The color of the virtual tool informs the user about the planning outcome
- The calculated path is displayed to the user

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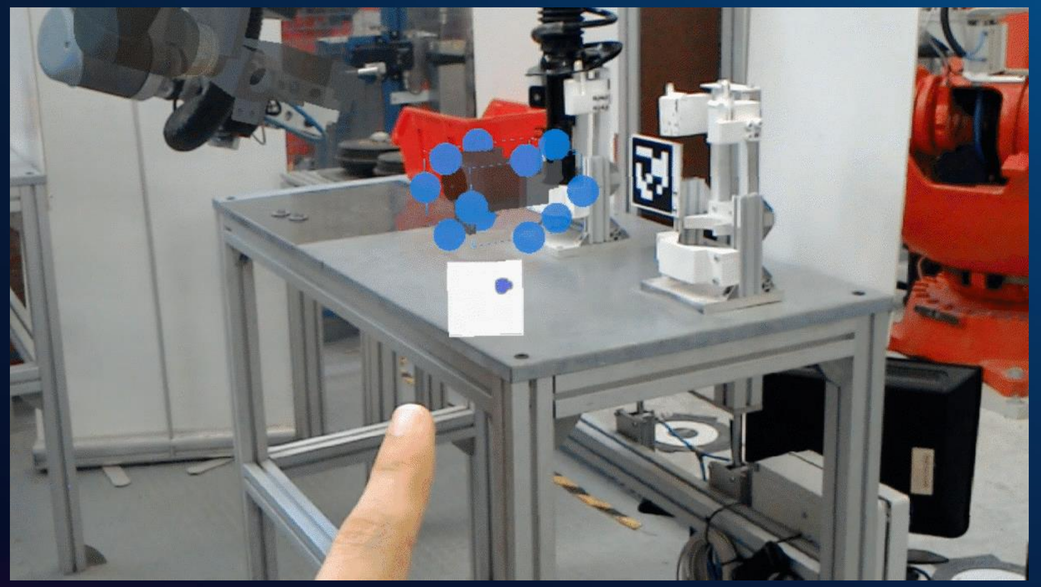

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Execution Overview (4/4)

Robot Execution Phase

- The user can move the robot by pressing the Execute button
- The robot moves to the displayed position
- The color of the virtual tool resets
- The user is able to repeat the process

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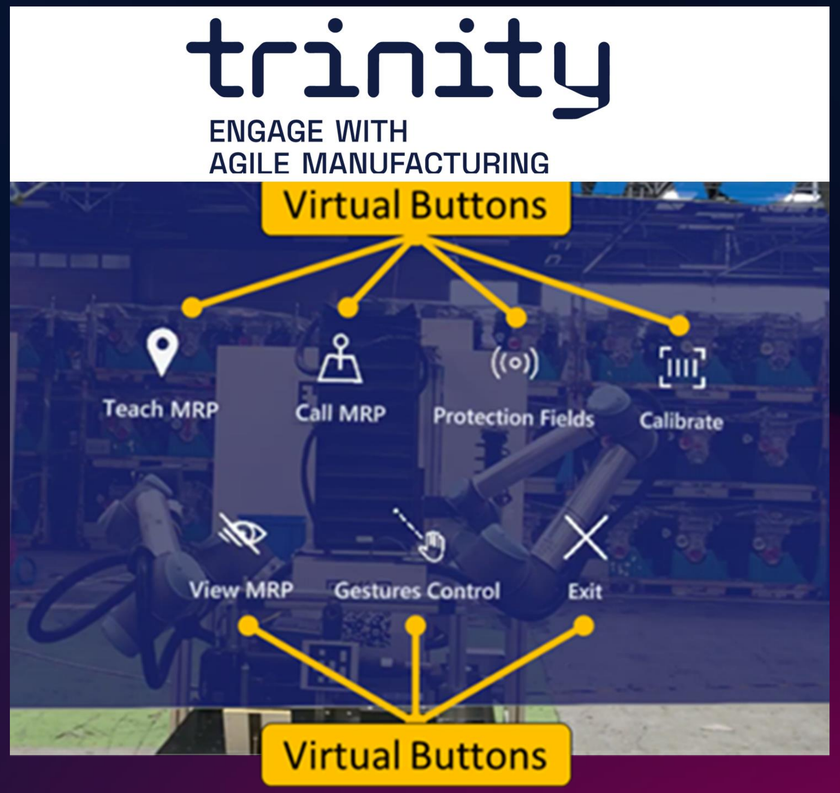
User Interface (1/2)



- This the Main Menu where the user will see all the functionalities
- This menu is a virtual panel that appears in the user's Field of View
- The user has the option to select the virtual panels and holograms which they want to be presented in their Field of View

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User Interface (2/2)

- The users have the option to select the virtual panels and holograms which they want to be presented in their FOV
- Specific information is available only when the user is looking at an area related to this information
  - *E.g. A working area's label, which is a virtual panel with the name of the specified area and is located on its top side, is rendered only when the operator looks at it. Users can only view those labels when they look at this area in the same manner that anyone can see real signs and labels on the environment.*

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Thank you!

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