

Teleoperation between Meca500 Robot Arms and Force Dimension lambda. 7 Controller

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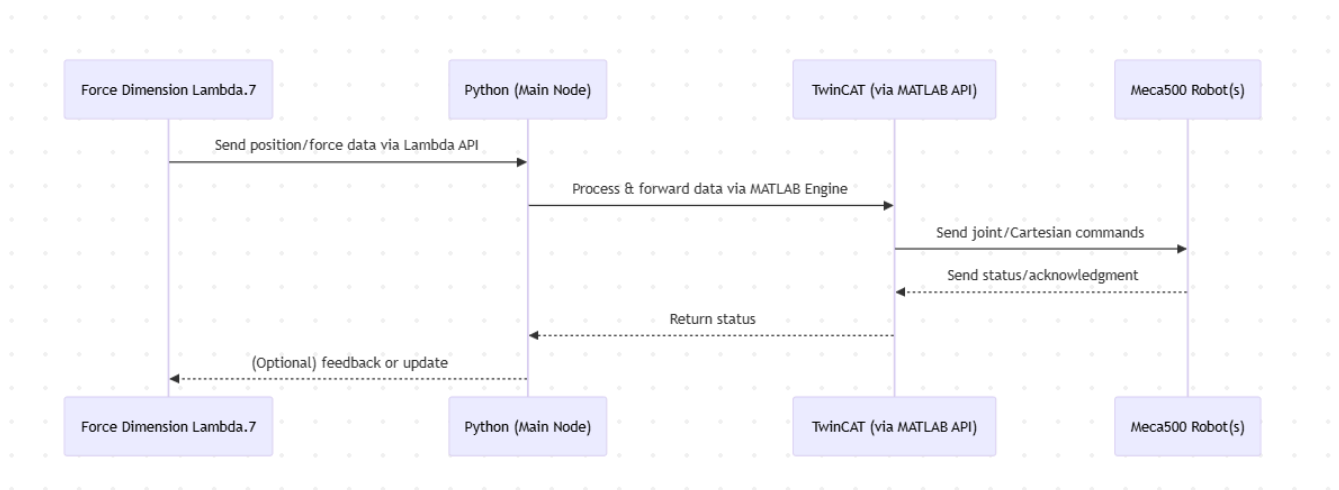
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1.0 Introduction

This document will show the current status of the teleoperation between two Meca500 Robot arms, and the two controllers of Force Dimension's lambda. 7 Controller. The current state of the teleoperation allows control over the Mecas using the Force Dimensions along 6 degrees of freedom. Translation along x, y, and z and rotation roll (ϕ) (rotation about the x-axis), pitch (θ) (rotation about the y-axis) and yaw (ψ) (rotation about the z-axis). This teleoperation currently does not support haptic feedback but can be easily implemented using the current architecture of the system.

2.0 System Overview

The general data flow of the system is shown in the following sequence diagram.



It is a very simple flow where the controller sends live data to the central node (Python program) through Force Dimension's API. This data is then formatted within C++ and

Python scripts to be sent to TwinCAT through TwinCAT's MATLAB API. The Meca robots are configured in TwinCAT so they receive the new position data to move the robots.

3.0 Hardware Setup

The Meca500 robots are connected in series with a Bota force sensor. They are connected to the ethernet port of the PC. The Meca's must be configured to EtherCAT mode (this can be done through the Meca500 user manual). The lambda. 7 is connected to the PC through USB.

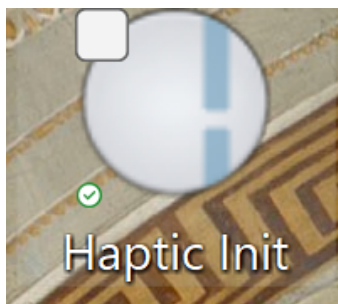
4.0 Software Setup

The system consists of a TwinCAT project (to communicate with the Meca's in EtherCAT), multiple matlab scripts to interface with the TwinCAT project, and C++ scripts to interface the Force Dimension SDK (C++) to Python which is where the main logic is. The TwinCAT project being used was created by Hoorieh as well as the Matlab scripts used to interface with the Meca robots. The scripts are relatively self explanatory. They hold the functionality to start, stop, move and set etc. the Meca robots. Refer to README.md in the src folder to see the whole software setup.

5.0 System Operation

This will be a step by step guide on how to run the teleoperation:

1. Ensure the Meca's are turned on and set by pressing the power button and then the calibration button.
2. Plug the Force Sensor into the Meca's since the EtherCAT stream is serial and must access all devices. Now the Meca's hardware is configured
3. Turn on both lambda. 7 Force Dimension controllers
4. Run "Haptic Init" on the desktop.



5. When you see both devices detected, "Initialize" both. This will start an initialization sequence for both controllers.
6. When the initialization is complete, "Check" both controllers.
7. When these sequences are complete, close the "Haptic Init" window. This is important since we cannot access the controllers through the teleoperation if this is still running. The Force Dimension controllers are now configured.
8. Open the TwinCAT XAE shell.
9. Open the project solution in the twincatproj/hooriecopy directory
10. Make sure TwinCAT is in Run Mode and the project is running by selecting the green play button at the top after it is in run mode. TwinCAT is not configured.

11. In Matlab, go to the matlabsrc directory and run `matlab.engine.shareEngine` in the terminal. Now the software is ready to run.

12. In the src directory, run `controller.py`. This will wake up the Meca's, and connect the controllers to them for teleoperation.

6.0 Future Work & Improvements

The current setup is made so it will be easy to expand. Currently, the teleportation only maps movement from the Force Dimension controllers to the Meca's. Haptic feedback would be very easy to integrate using the same architecture.