

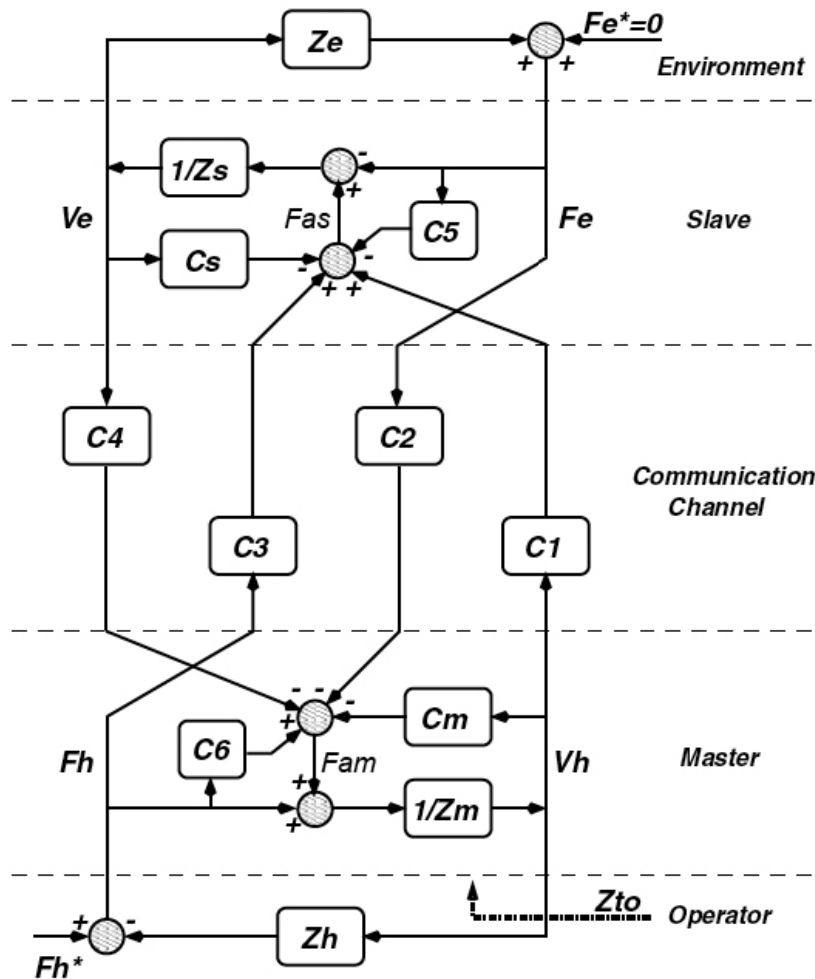
Problem Set 7

Position-Exchange Teleoperation

Out: 11.20.06

Due: 11.20.06

Using a pair of Phantom Omnis, you will work with a team to create position exchange teleoperators. Below is a 4-channel teleoperator architecture adapted from K. Hashtrudi-Zaad and S. E. Salcudean, "Analysis of Control Architectures for Teleoperation Systems with Impedance/Admittance Master and Slave Telemanipulators" International Journal of Robotics Research, Vol. 20, No. 6, June 2001, pp. 419-445.



For each teleoperator you create, provide the values of all the C constants in the block diagram, as well as the equations for the controllers F_{am} and F_{as} (the force applied by the master and slave actuators). Demonstrate each controller to David or Allison in class. The implementation is collaborative, but each team member should hand in his or her own answer sheet.

You should begin with the `C:\Program Files\SensAble\3DTouch\examples\HD\graphics\CoulombForceDual` code that comes with the OpenHaptics API, copy it to your own directory, and edit only one file, called `"main.cpp"`.

1. (10 pts.) Since we are performing position-exchange control (the Phantom Omnis do not have force sensors), what can we say immediately about the following controller constants?

$$C_2 = \underline{\hspace{2cm}} \quad C_3 = \underline{\hspace{2cm}} \quad C_5 = \underline{\hspace{2cm}} \quad C_6 = \underline{\hspace{2cm}}$$

2. (10 pts.) Create a position-forward teleoperator (with no force feedback to the master).

$$C_I = \underline{\hspace{2cm}} \quad C_4 = \underline{\hspace{2cm}} \quad C_m = \underline{\hspace{2cm}} \quad C_s = \underline{\hspace{2cm}}$$

$$F_{am} = \underline{\hspace{10cm}}$$

$$F_{as} = \underline{\hspace{10cm}}$$

3. (10 pts.) Create a position-exchange teleoperator in which the master and slave robots use identical proportional controllers (in all three degrees of freedom).

$$C_I = \underline{\hspace{2cm}} \quad C_4 = \underline{\hspace{2cm}} \quad C_m = \underline{\hspace{2cm}} \quad C_s = \underline{\hspace{2cm}}$$

$$F_{am} = \underline{\hspace{10cm}}$$

$$F_{as} = \underline{\hspace{10cm}}$$

4. (10 pts.) Create a position exchange teleoperator in which the master and slave robots use identical proportional controllers, but there is position scaling between the two. Scale down the master motion by a factor of two relative to the slave motion. (You can also try scaling up the master motion by a factor of two relative to the slave motion.)

$$C_I = \underline{\hspace{2cm}} \quad C_4 = \underline{\hspace{2cm}} \quad C_m = \underline{\hspace{2cm}} \quad C_s = \underline{\hspace{2cm}}$$

$$F_{am} = \underline{\hspace{10cm}}$$

$$F_{as} = \underline{\hspace{10cm}}$$

5. (10 pts.) Create a position exchange teleoperator in which the master and slave robots use different controller gains. Make the slave controller stiffer than the master controller. This scales down haptic feedback to the master. (Or you can make the master controller stiffer than the slave controller. This scales up haptic feedback to the master.)

$$C_I = \underline{\hspace{2cm}} \quad C_4 = \underline{\hspace{2cm}} \quad C_m = \underline{\hspace{2cm}} \quad C_s = \underline{\hspace{2cm}}$$

$$F_{am} = \underline{\hspace{10cm}}$$

$$F_{as} = \underline{\hspace{10cm}}$$