



Multidisciplinary Senior Design Conference
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Rochester Institute of Technology
Rochester, New York 14623

Project Number: P13371

HYDRAULIC NANOMANIPULATOR OPERATION, ASSEMBLY AND BEST PRACTICES MANUAL

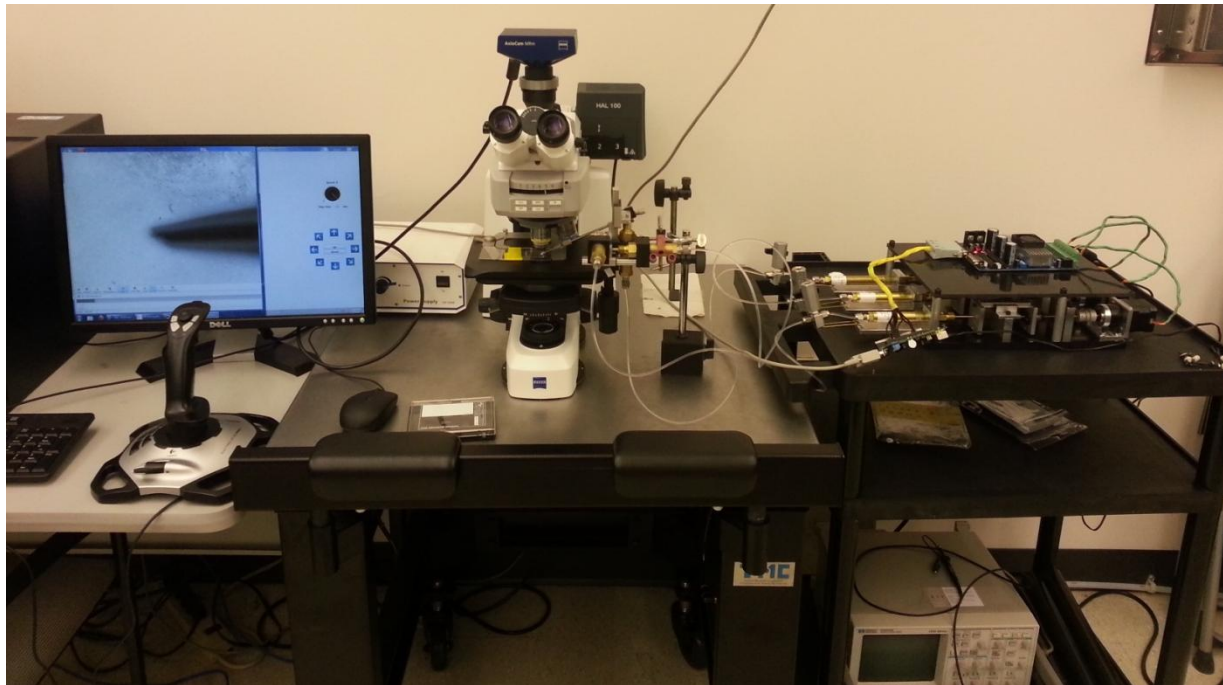
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Hydraulics:

Bleeding the System:

When bleeding the system, disconnect the hydraulic line from both the manipulator and the pump assembly in the order specified below. (Note: crimping of the hydraulic lines at the fittings must be avoided)

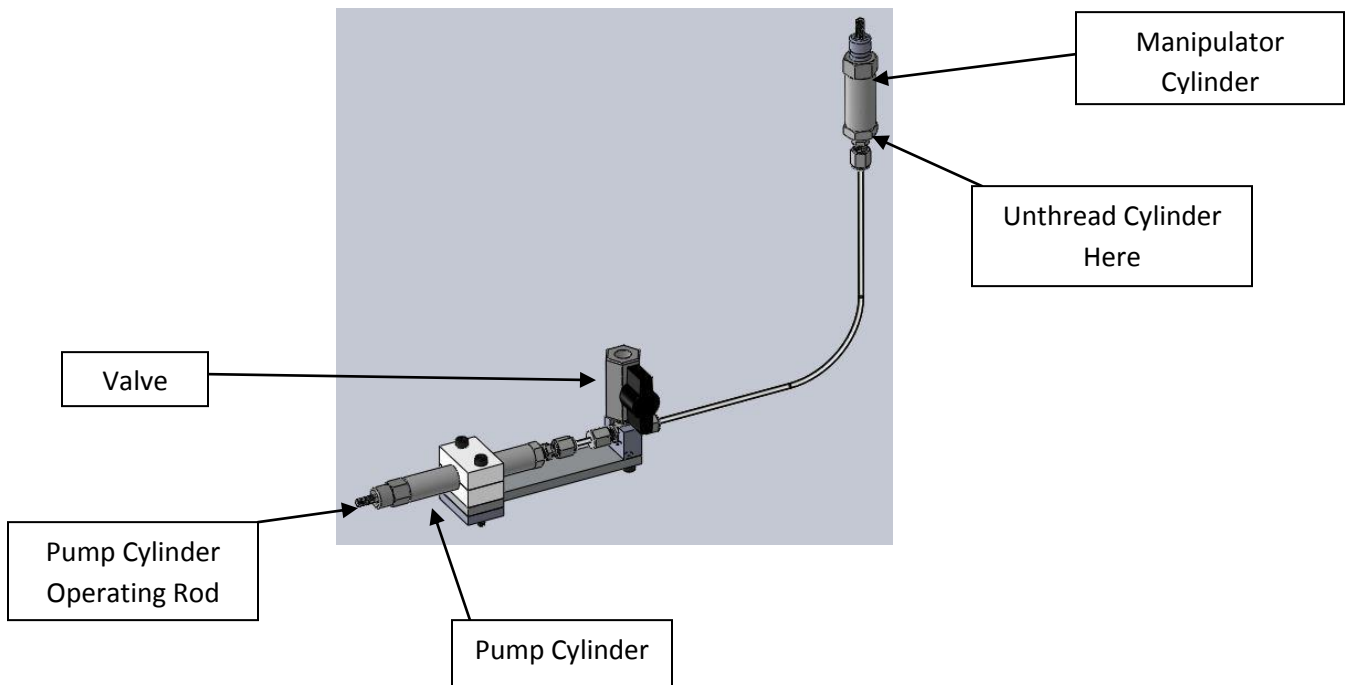
Assembly/Disassembly

- 1) Unbolt the half moon brackets (total 6 x 8-32 bolts) on the pump side, from the base plate
- 2) Unbolt the three vertical plates (total 3 x 6-32 bolts) connecting the pump-side cylinder to the lead screw carrier
- 3) Unbolt the three plates from the cylinder operating rods (at this point the manipulator should be unattached)
- 4) (Due to the clearance of the manipulator thread receivers and cylinder mounts, the manipulator axes must be disassembled and reassembled in a certain order)
- 5) Unbolt the manipulator Z-axis cylinder mount (total 1 x 3mm bolt)
- 6) Slide the cylinder mount and carriage off of its corresponding track
- 7) Unbolt the Z-axis cylinder from its corresponding thread receiver
- 8) Repeat steps 4-6 for the Y-axis
- 9) With both the Z-axis and Y-axis and corresponding carriage/thread receivers removed unbolt the X-axis cylinder mount (total 1 x 3mm bolt)
- 10) Slide the cylinder mount away from the thread receiver so that the remainder of the manipulator can be rotated off of the X-axis cylinder operating rod
- 11) To reassemble, reverse the process

Bleeding the Lines

- 1) When bleeding the hydraulic lines, first fill a pan with tap water so that the entire line can be submerged (3"-4" in depth)
- 2) Submerge the system (Cylinder-line assembly with manipulator cylinder mount still attached)
- 3) Unscrew the Swagelok end of the manipulator cylinder itself (this way none of the fitting need to be unfastened)
- 4) Push out all fluid using the long stroke pump cylinder
- 5) Open the valve and draw fluid in

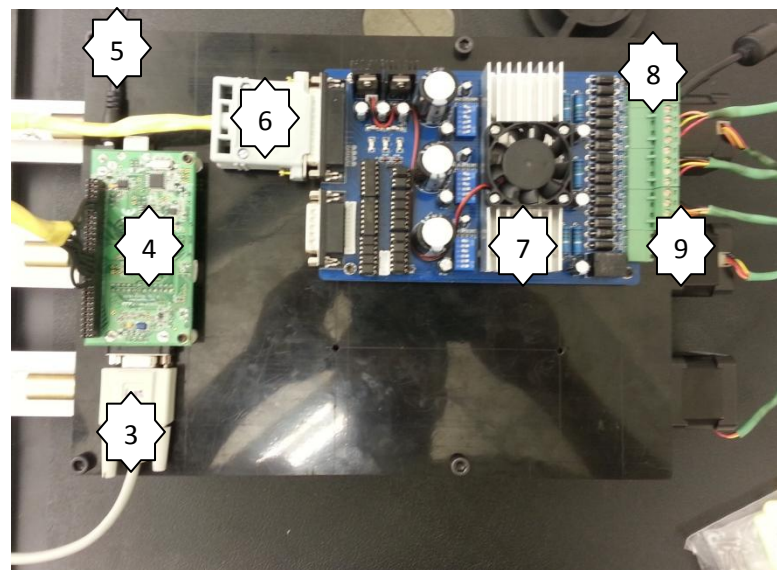
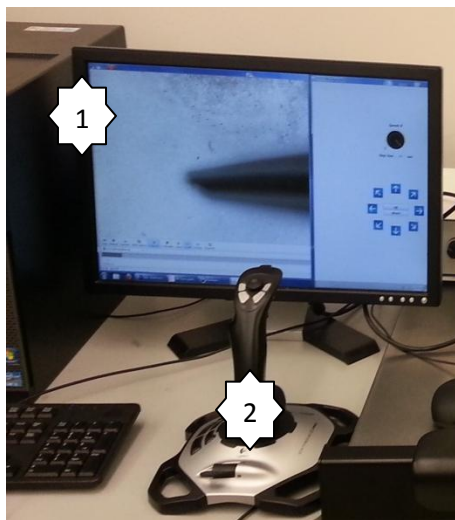
- 6) Close the valve and push fluid/air out (helps to have outlet elevated)
- 7) Repeat steps 5-6 until line is air free
- 8) Submerge line completely and repeat steps 5-6 to ensure no air was drawn in from the outlet being in the air
- 9) Draw the cylinder in so that ample length on the pump cylinder operating rod is exposed (Note: when initializing the system the lead screw carrier should be wound back almost all the way toward the motors so that once the cylinder is installed, the cylinder can be plunged slightly to apply pressure within the line to initialize movement. Be sure to leave the correct operating rod length for initialization)
- 10) While submerged completely thread manipulator cylinder back together closing the system
- 11) Close valve



Controls:

Parts of the Hydraulic Nanomanipulator controls system

- (1) Computer with graphical user interface
- (2) USB Joystick
- (3) DB-9 serial cable
- (4) Freescale CSMB12 microcontroller with testControl.c loaded
- (5) Freescale CSMB12 power cable
- (6) 60-pin to DB-25 connector
- (7) Motor control board
- (8) Motor control board power supply
- (9) Stepper motor leads (x3)



Connecting the Control System for a P13371 Hydraulic Nanomanipulator

- 1) Install Eclipse IDE for your computer (1): <http://www.eclipse.org/downloads/>
- 2) Download the Java source file from P13371 website ([add link](#)) and open it in the Eclipse environment
- 3) Plug in the joystick (2) to a USB port on your computer
- 4) Ensure that the freescale microcontroller (4) has been preloaded with C source file from P13371's website ([add link](#))
- 5) Using the DB-9 serial cable (3) connect your computer (1) to the freescale microcontroller (4)

Note: The microcontroller is used by the CE department of RIT and was signed out by Richard Tolleson of the RIT CE Department

- 6) Using the 60-pin to DB-25 connector (6) connect the microcontroller (4) and the motor control board (7).

Note: The 60-pin header orientation is set according to figure XXXX

- 7) Connect the stepper motor leads (9) to the motor control board (7)

Note: Make sure there is no power connection to the motor control board while connecting/unconnecting stepper motors

Note: The stepper motors axis (X, Y, Z) are labeled on the stepper motor and should be connected to the correct port on the motor control board

- 8) Connect the motor control board power supply (8) to the board (7) and plug the other end into a wall outlet

Note: The stepper motors will chatter until the microcontroller is powered on since the motor control board inputs are not isolated

- 9) Connect the microcontroller power cable (5) to the microcontroller (4)

Note: A USB cable can be used in place of the barrel style power connection just ensure the correct PWR_SEL jumper is set on the microcontroller, reference the microcontroller's documentation for proper configuration

- 10) In the Eclipse environment, run the Nanomanipulator.java class to initialize the GUI

- 11) Begin Nano-manipulation!