Design of a Low Cost Nanomanipulator

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Primary Customer: Dr. Michael Schrlau

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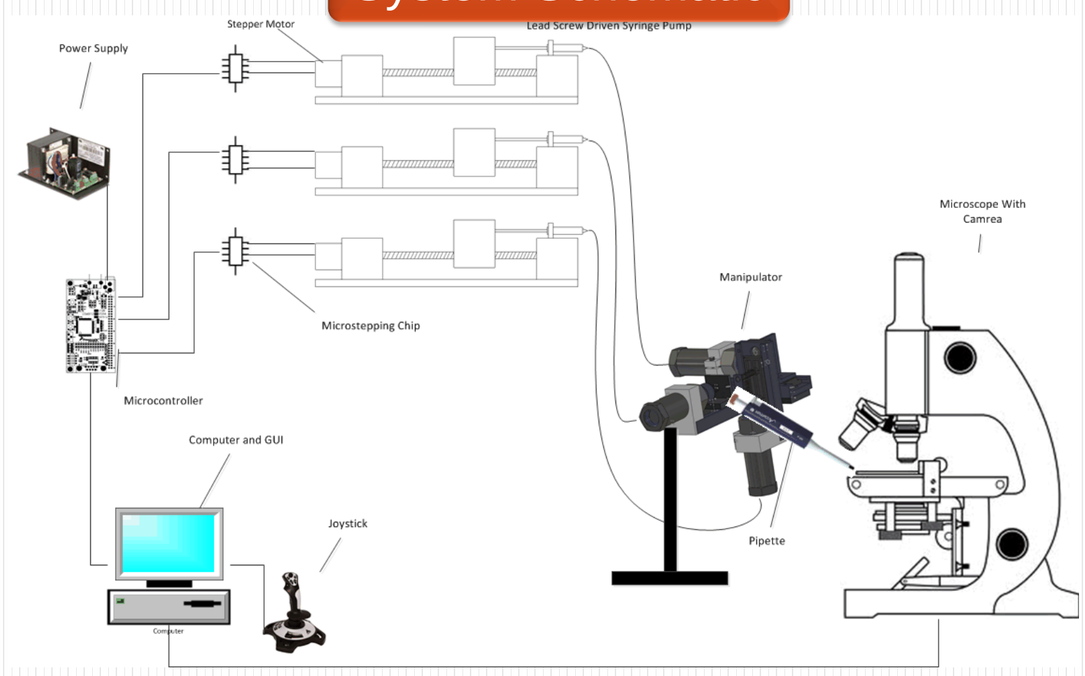
What Is a Nanomanipulator?

A nanomanipulator is a tool that allows manipulation of microscopic specimens while under a microscope. It reduces human hand movement to increments as small as 100 nanometers .

System Schematic



Motivation & Background

- Nanoscience is expensive and inaccessable
- By creating a low-cost manipulator this technology can be introduced to more students at high school and undergraduate levels.

System Design Process

- Brainstormed different possibilities and organized into a Morph Chart.
- Used a selection matrix to determine which designs would fulfill the customer needs.

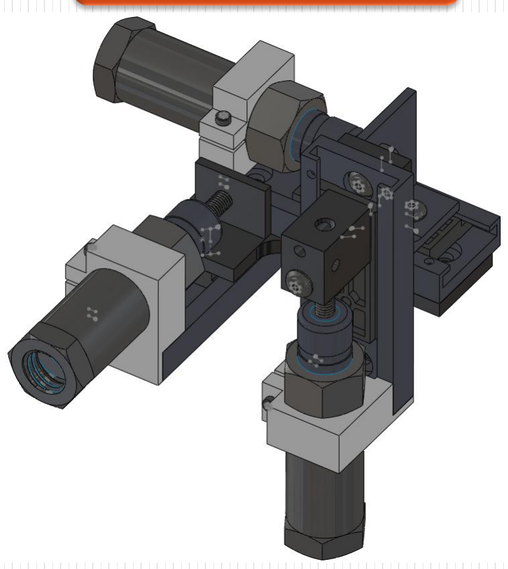
Customer Needs and Specifications

- Move instruments under a microscope at a resolution of 100 nanometers -1000 times smaller than a human hair!
- Make the system for less then $2500 – about 1/3 to 1/6 the cost of commercially available manipulators.
- Mimic the performance of the commercially available manipulators.
- Control the entire system with a computer and a joystick.
- Live camera feedback from microscope to computer

Final Design

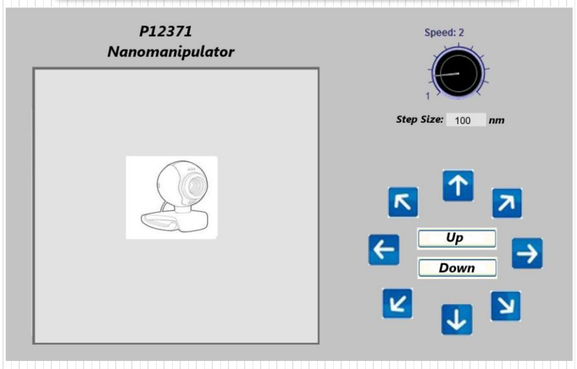
- Hydraulic Actuator chosen to minimize vibrations
- Controlled with a pump driven by a high precision lead screw to increase resolution.
- Stepper motors with advanced microstepping capabilities allow for precise control via a computer.

Manipulator

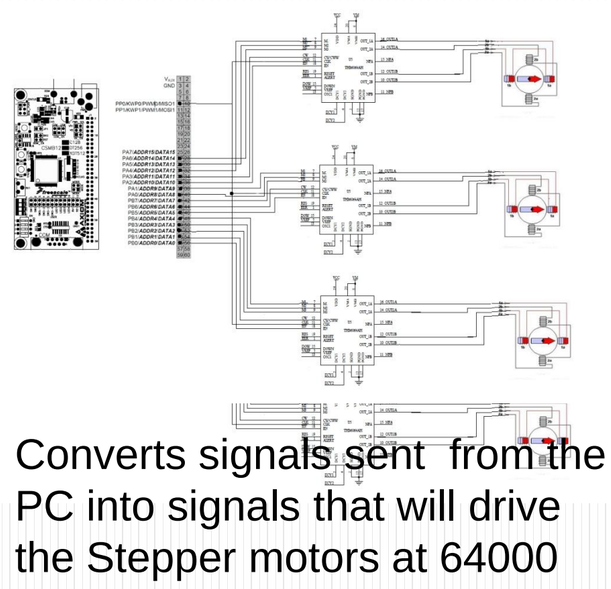


A hydraulically driven system on sliders that will move the instrument in all three axes while under the microscope.

User Interface

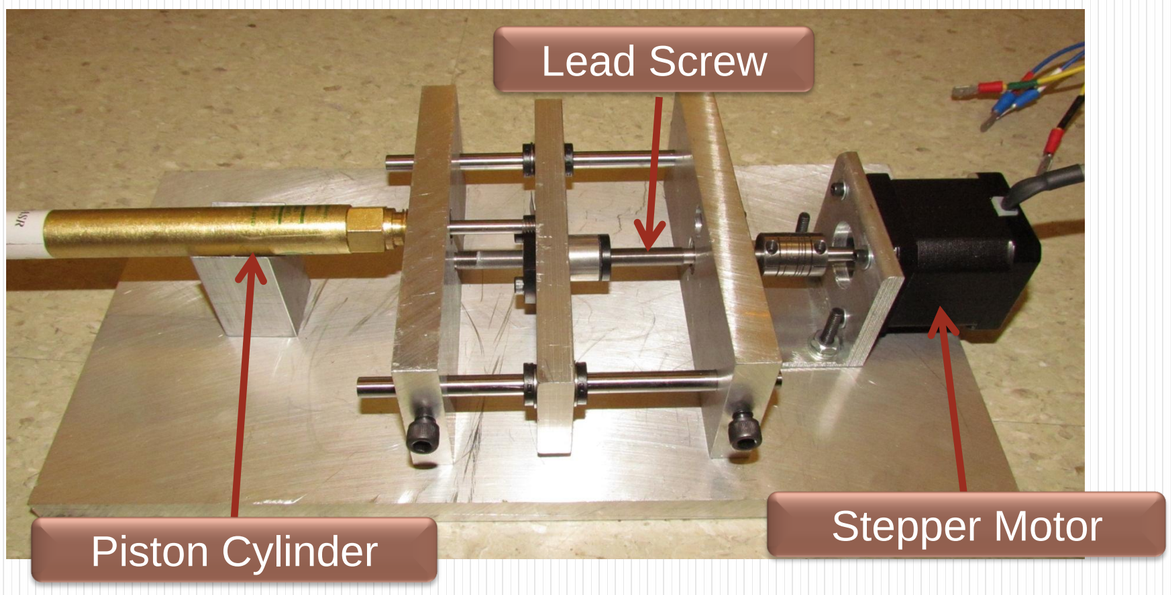


Control System



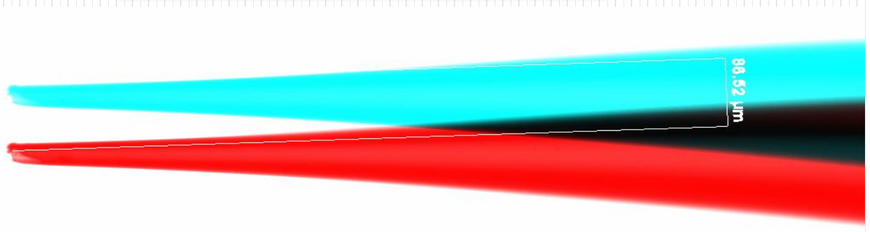
Converts signals sent from the PC into signals that will drive the Stepper motors at 64000 steps per revolution.

Pump Assembly



The stepper motor will turn a lead screw that moves the piston cylinder. The piston cylinder is connected to the manipulator via a hydraulic line.

Resolution Test



An overlay of two photographs taken of a pipette through the microscope. This shows one full revolution of the lead screw resulting in 88.5 µm of movement.

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