Automatic Electric Nanomanipulation Platform

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Purpose

To build computer-managed "electric tweezers", (manipulations of nanoparticles via electric fields), which are not limited in size or minimum power (as opposed to optical tweezers) but are hard to control, for future research.

Implementation

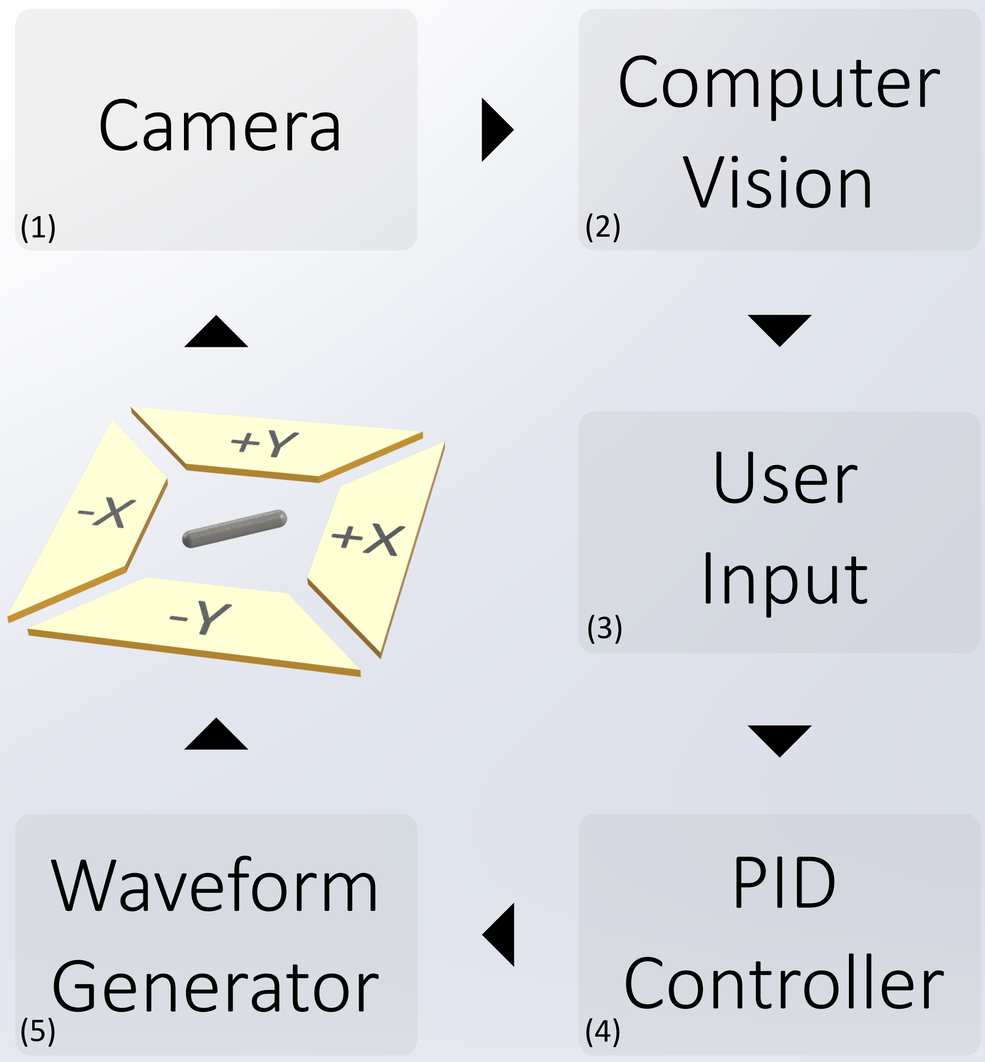
(1) A camera observes nanowires in a standard four-electrode electric tweezers setup

(2) Real-time OpenCV algorithms track nanowires over time

(3) A user interface decides movement targets

(4) PID loops calculate responses to maintain a particle's position

(5) A custom FPGA-based arbitrary waveform generator creates +/- X and Y control signals



Results

This system can position µm-scale nanoparticles to within approximately 2 µm in a 1000 Hz control cycle.

This is sufficient to work with nanowires very easily.

In Data section below left:

(a) Movement of nanowire with and without system

(b) The user interface

(c) Control cycle time vs camera resolution

(d) Waveform generator schematic

Future Work

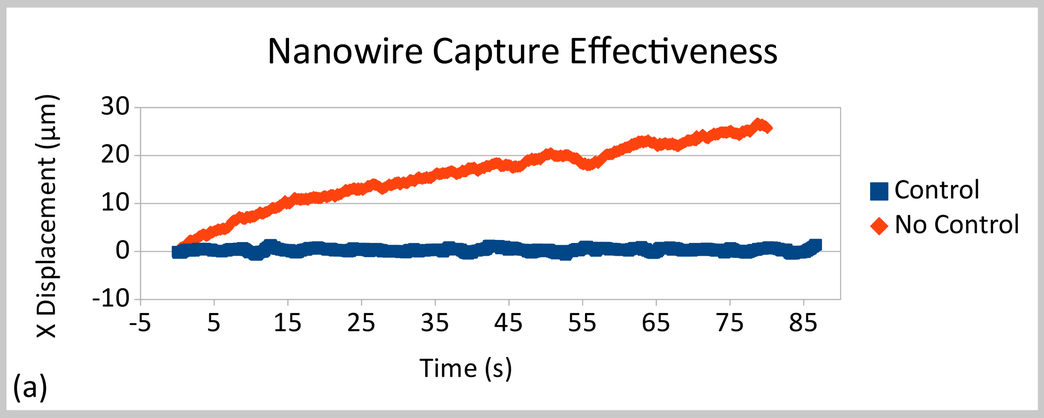
The system will be improved for slightly increased accuracy.

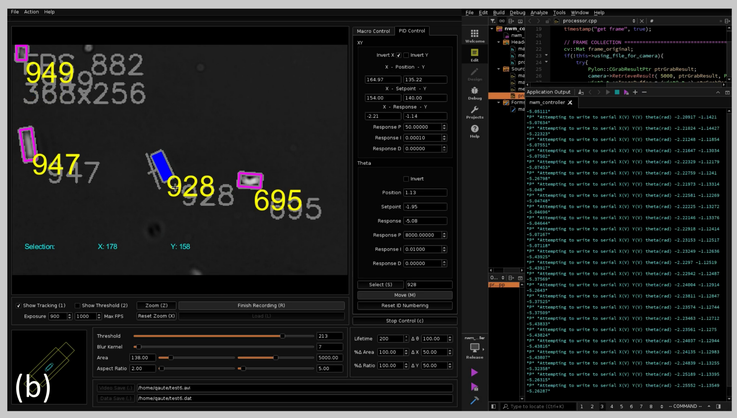
Now that nanowires can be manipulated easily, we can

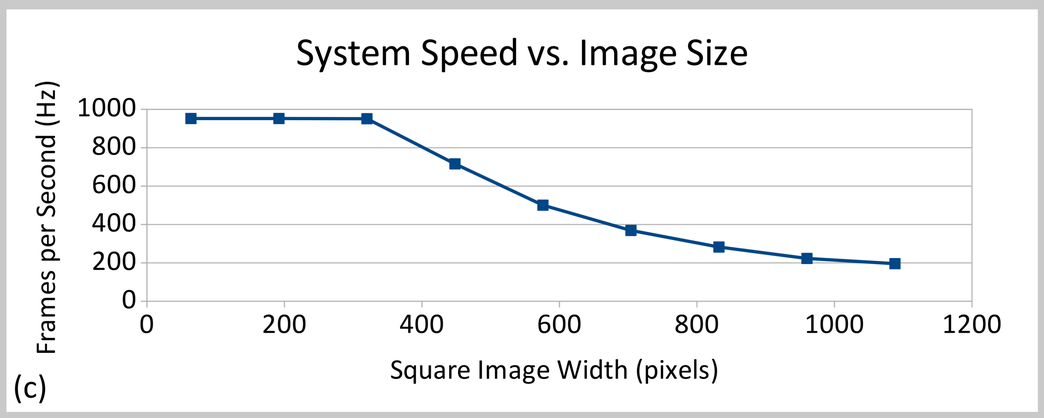
- test drug delivery to cells
- assemble nanowires into motorized machines
- manipulate other substances (MoS2 strips, etc.)

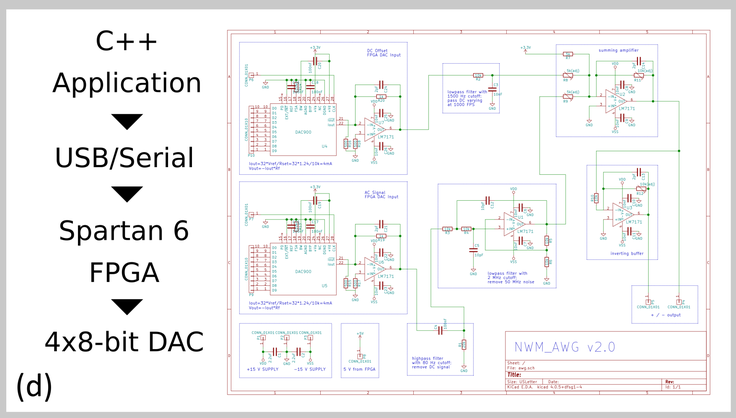
In the future, we hope to be able to manipulate multiple nanowires at once with individual control.

Design and Data (see Results)









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