

## Microvision Instructions

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### Concept

The Microvision system at CMU is a early prototype of a system commercialized by MIT people (under a different name than Microvision). It uses stroboscopic illumination and image processing to measure motion in all three dimensions.

### SETUP

Mount your sample on the protoboard that slides into the microscope stage. Move the lens out of the way when you do this, by turning the metal ring (turret?) above the lenses. **DO NOT GRAB THE LENS OR THE BLACK THING (piezoelectric positioner) TO MOVE THE LENS.** Make sure that the chip can be positioned under the lens without hitting the piezoelectric positioner with the metal leveling screws on the chip platform.

I suggest a 20x lens, unless you need much higher or lower resolution. If there is a label on the lens reading "Mirau", this is not the lens you want (Mirau lens is for interferometry, which we're still getting set up). The lenses are in plastic containers sitting around the Microvision. Be careful with them, don't crash them or get fingerprints on the lenses. Place the sponge underneath while changing them, in case they bump against something.

The Microvision can supply voltages between +/- 10 V for excitation of your chip. If you need more, you can use an external amplifier, and/or an external DC voltage source (talk to John Neumann about this).

All the hardware is normally left on all the time. Make sure everything is turned on before launching the software. The wiring, except for connecting "signal +/-10V, 50 ohm" to your sample, shouldn't be changed, and you won't need to set it up. The microscope stage is moved with the Joystick.

The LED is driven by a special box we made at CMU, which requires a power supply of +5, -7 volts. Check that this is turned on. The +5 volts may be set a bit lower, like 4.2 volts, if the LED was too bright.

You will probably need to ask gripe for an account on cm-1@ece.cmu.edu in order to use the machine. You will log in using you ECE name and password. Before logging in, choose fvwm2 (not KDE) from the drop-down menu. Some X-windows flavors do not work with the microvision software.

After logging in, I suggest changing to your /home/username directory, otherwise your afs space will get used up quickly by the image files that are generated. You should be nice and clean up when you are sure you are done and have taken your data off of cm-1.

### SOFTWARE

Go to the directory you want to store the experiments in, and type "cmacq". A window will pop up (probably half off the screen- just drag it where you can see it). First, go the File/Save and name your experiment. A .cmg file will be created which will store your parameters so you can refer to them later to see what you did. When the measurement is running, a directory structure something like this will be created to store the data:

```
experiment_name/frequency=XXX/phase=X/plane=XX.nd
```

You don't really need to think about this unless you are cleaning up your files.

The setup of the experiment goes from left to right using the buttons near the top of the main window. Only some of them are absolutely necessary; the others are just for doing a quick check of things.

### Hardware Settings

Set the desired peak and offset voltages for the excitation.

Make sure the Objective setting matches the lens you are using. Set Optovar to 1x.

External Amplification should be set to 1 unless you are using an external amplifier.  
Everything else you can leave alone.

### **Focus Image**

Click on this to bring up a window, which has the real-time image from the video camera. There is a metal rod on the right side of the microscope which switches the view between the eyepiece, the camera, or both. The eyepiece is useful for initial coarse focusing, but be sure to block it off when doing the actual measurement because light from the ceiling lamps will enter the eyepiece and be focused on your chip.

Use the knob on the side of the microscope to get your chip roughly in focus. **DO NOT PRESS ANY BUTTONS ON THE MICROSCOPE** except the coarse/fine button. There are others that will crash the stage (and your chip) into the lens. Use the joystick to center your region of interest in the bright center of the camera image, but be careful not to crash the leveling screws on the chip holder into the black piezoelectric lens holder as it is very fragile and expensive, and takes a long time to get.

Use the mouse and the slider at the top of the focus window to fine focus the structures you want to measure. If there is a lot of red color in the image, you will need to turn down the voltage to the LED, as the camera is saturating (some red is OK, because the exposure time will be less when you do the actual measurement). On a clean, flat CMOS chip, a voltage around 4.1 or 4.2 works well. The voltage you want to adjust is the positive voltage to the "Microvision LED Driver" box. Don't go above 5 V in any circumstance.

### **Focal Planes**

In order to do measurement of z-motion, the Microvision software needs to take images above and below the nominal focus plane (which you set in the previous step). When you press the Focal Planes button, a box will pop up showing the range of z focus planes. Leave the range alone, because the middle has to match the focus plane you chose before. You can choose the number of steps, and choose a number that will give you either 1 or 2  $\mu\text{m}$ , depending on the depth of focus of the lens you are using (for 50x use 1  $\mu\text{m}$ , for others use 2  $\mu\text{m}$ ). Press "Acquire" and the machine will take some images (you can see the LEDs on the piezo driver box list the focal planes as it moves the lens). A window will pop up where you can view the images- the structure of interest should be clearly visible, but if there is very bright white (saturation for some reason is not red in this window) you may have to turn down the voltage of the LED (this is a better place to do this than in the focus window, actually, if you can judge shades of white accurately). Use the arrow buttons in the "Animate" panel to check to make sure that the image is in better focus for the planes in the middle than the two extremes. If it is not, you may want to go back and re-focus. **IF YOU CHANGE THE FOCUS SETTING, YOU MUST RUN THE FOCAL PLANES ACQUISITION AGAIN.**

There are a few other things like "sample image" and "Test motion" in the main window that can be used for testing to see if things are working OK, but it is not necessary to do them every time you do an experiment.

### **PARAMETERS**

Under the top row of buttons is the area where you set parameters for the experiment.

First select "Frequency" if you want to do a frequency sweep, for example to look for a resonant peak. If this is your selection, then the measurements will be taken with the voltages set in the Hardware Settings box. Conversely, if you are doing an amplitude sweep, the experiment will be done at the frequency set in the Hardware Settings box (1000 Hz is the default).

Hit "Edit" next to parameter list. The top line of the box allows you to type in a list of frequencies, or you can use the menus underneath to generate a list.

Don't change anything in the "Plane List". These are the planes that were set in the "Focal Planes" menu.

Make sure the "Phase List" reads 0,1,2,3,4,5,6,7. If it doesn't you can edit it.

Crop Region is necessary so that you don't slow down your experiment and fill up huge amounts of disk space. Hit the edit button and choose a small region around your moving structure. "ROI" stands for "region of interest".

Now you are ready to run the experiment. Turn off the lights (I don't know if this is necessary with the bright LED), make sure the microscope is set so only the camera looks at the chip, and make sure not to bump or vibrate the table. Then hit "Run Now" and wait until it's done.

## **ANALYSIS.**

Go to Tools/Launch Analysis. You need to give an analysis name. Anything is fine, I just use the experiment name. In the ROI menu, choose the "single" mode (not dot) and hit specify. Here you can really zoom in and choose something just slightly larger than your structure. Then you can select Run to run the analysis.

Sometimes there are error messages when you try to run the analysis. Sometimes a large z-vibration may make your sampe go out of focus, and you need to change the focal plane range or use a smaller motion. Other errors are not so obvious, and you may need to just run the experiment again with a slightly different focus or ROI.

After the analysis, you can look at the results. You should take a look at at least a few of the "View Motion/position" graphs to make sure the look at least reasonably sinusoidal (one period). If they don't, then don't trust what the response graph says.

If you want to run another experiment with the same, or just slightly different parameters, use "Save As" to create a new experiment. You cannot go back and change parameters after the experiment runs, so you need to create a new experiment. At least you don't have to type everything over again by using "Save As".

## **EXPORTING RESULTS**

The results of the analysis are stored in some text files. If your experiment was named "exp1", then go into the exp1 directory and you'll see files with names that end in .anl. "Frequency=XXX.anl" contains position data for the different phases (what you see in the "view motion" graphs). "Response....0.anl" contains the magnitude and phases of the motions; they are listed as

frequency      xmag xphase      ymag yphase      zmag zphase  
for each frequency in your experiment.

There is also a rarely used file, "response...0\_f2.anl" which contains an analysis of second harmonic motion. I guess this might be useful if you forgot to include a DC offset with your excitation voltage.