

Fakespace Labs, Inc.

WIDE5 HEAD MOUNTED DISPLAY



Version 3.3

Manual and Application Notes Regarding Video and Display Interface

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This display is derived from an STTR project by Fakespace Labs in collaboration with the University of Southern California's Department of Interactive Media.

Introduction

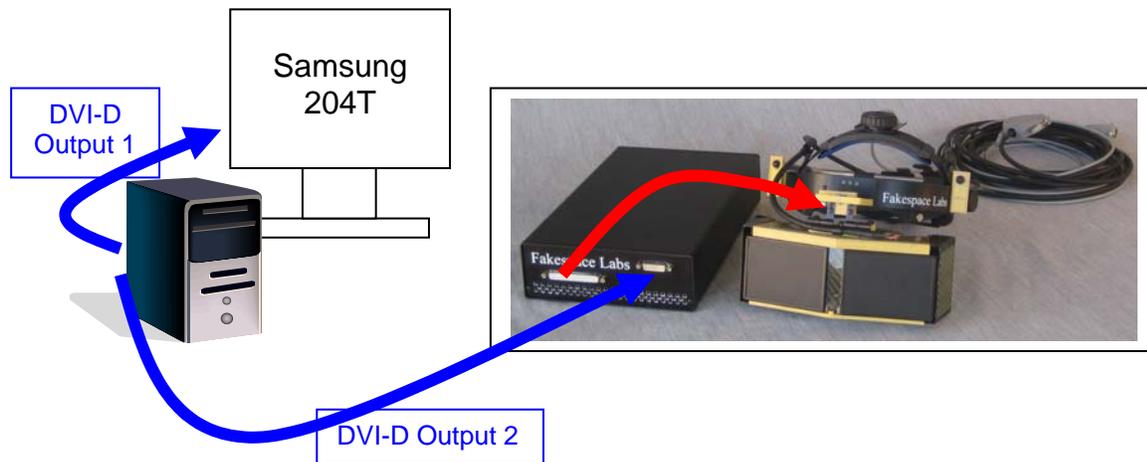
The Wide5 HMD is stereo and has a very wide field of view so the rendering to achieve this is slightly different than that typically used for desktop or projected displays. In addition to rendering images for the left and right eyes, one renders images to create the peripheral field of view as well.

Physical Connections

The HMD interfaces to the PC using DVI's digital interface (called DVI-D, single link). Some PCs only detect if there is a digital device connected at power on, so the PC needs to power up with the video devices already attached.

Basic Configuration

The configuration used most with the Wide5 is what NVidia calls CLONE mode. In this mode, one has two displays attached to the PC - one is a desktop monitor, and the other is the Wide5. The video on the port attached to the Wide5 is an exact copy of the desktop monitor. This method works with laptops, for example. In some cases, such as the DELL Precision M60, you may need to use the docking station for DVI-D output. With a desktop PC system, one requires a desktop monitor which works well at 1600x1200, for example, the Samsung 204T.

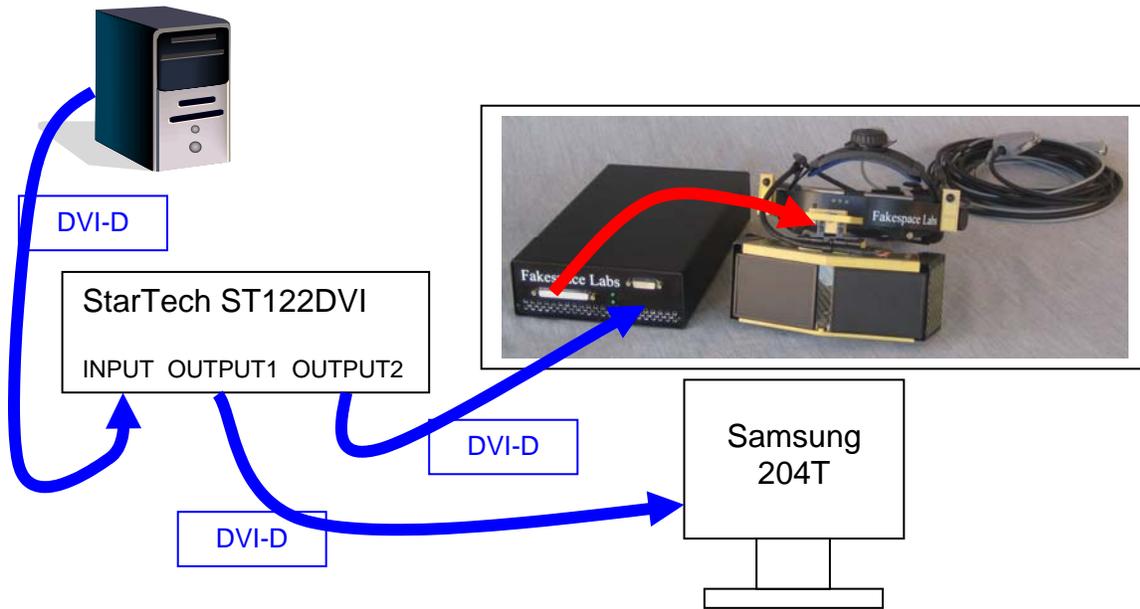


Laptop Note – with DVI Out

If your laptop has a late model graphics card and DVI out, you are set and can use the “Clone” or “Dual View” modes under the Nvidia nview tab of the Advanced menu from the Desktop → Properties → Settings → Advanced menu. With a laptop that has only the HD 15 analog connector, see the sections titled “Interface To Analog VGA / SGI / 13W3 Machines”. Some laptops (e.g. Dell Precision M60) have just a VGA output on the laptop but support external DVI-D with the docking station.

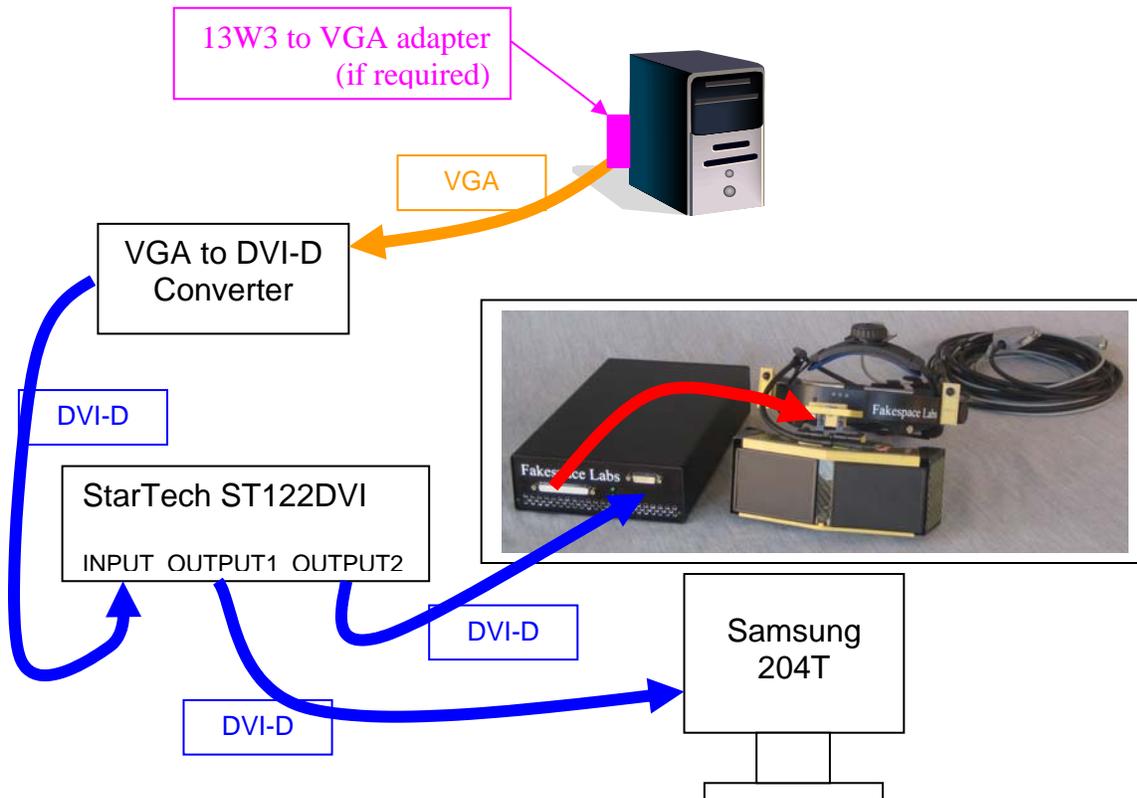
Optional - Splitter Configuration

If one prefers or does not have two outputs on the machine, a distribution amplifier may be used. The DVI Splitter by StarTech, model ST122DVI, works well. (Splitter and 204T are optional and are not necessarily supplied with the Wide5).



Interface To Analog VGA / SGI / 13W3 Machines

Machines which do not have DVI-D outputs, but have VGA connectors (the high density 15 pin connectors, female on the computer side) or 13W3 connectors (DB shell with a mix of 3 coax and signal pins, female on the computer side), require a converter. Fakespace Labs can supply an appropriate converter. In this case, the configuration is as shown below. (The VGA to DVI-D converter, ST122DVI, 13W3 adapter, Samsung 204T, and cables are included with Wide5-H systems)



SGI Note

The SGI machine may need to be powered up with the VGA to DVI-D converter setup attached as above. The VGA to DVI-D converter only works correctly if the incoming signal has the correct timing. Thus, if you had a 1920x1200 monitor attached and then changed over to the converter, the SGI machine won't switch to the correct mode. You will need to use the setmon / ircombine tools to set the video output correctly to 1600x1200 at 60Hz for the output you wish to use.

Laptop Note – VGA output Only

In this configuration you will need the VGA to DVI-D converter and it is easier with an external monitor like the Samsung 204T which can take both analog VGA and DVI-D. Power up the laptop with a VGA cable connecting the Samsung 204T to the VGA port. Switch over to just the external monitor with the FN / F8 key. From the Desktop, go to Properties → Settings and adjust the resolution to 1600 x 1200. You may need to set the display to 60Hz in the Advanced panel if using a different VGA monitor. Then unplug the VGA cable and attach the VGA to DVI-D converter, you should now have 1600x1200 DVI-D video as needed.

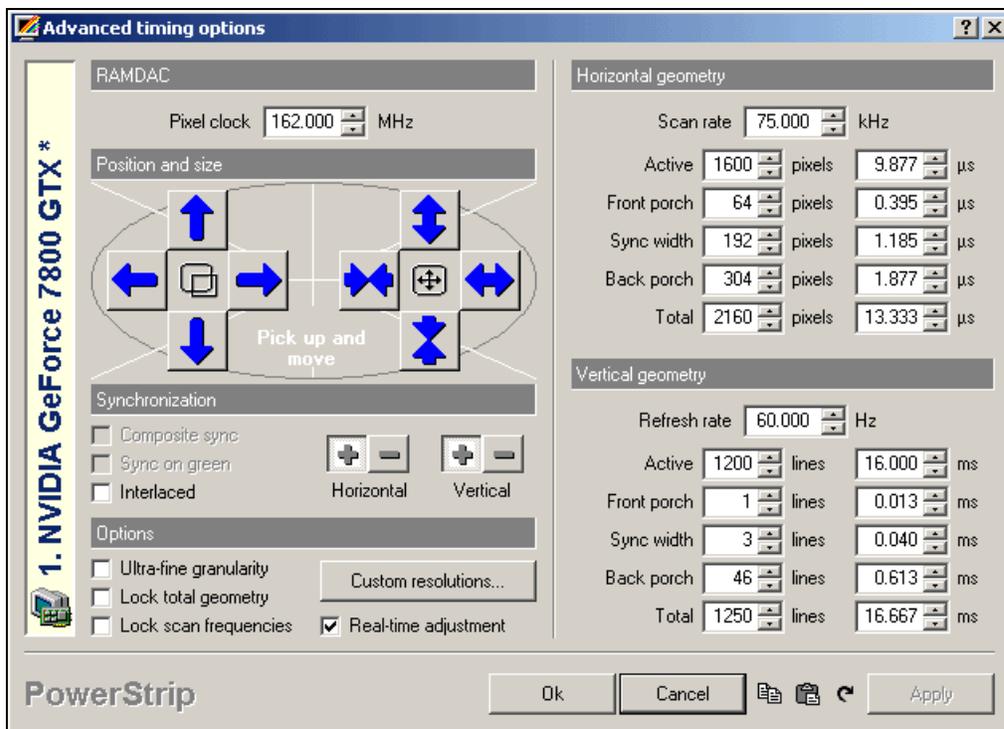
Video Interface

The display interfaces over DVI-D. It uses the following video format: 1600x1200 at 60Hz with a clock rate of between 140MHz and 162MHz. Some graphics cards drop the clock rate or change the resolution of the output. In this situation, as the interface clock rate is not correct, you will see a flashing image in the HMD or the images will not look correct in the HMD. The HMD has been used with a variety of NVIDIA cards including the 6800 GTX, 7800 GTX, and Dell Laptops with NVIDIA graphics. The HMD also works correctly with Apple and has been used on a Mac Mini.

If you are having difficulty in setting the video format correctly, there is a utility called PowerStrip from EnTech in Taiwan which lets you explicitly set the video timing. This can be found at:

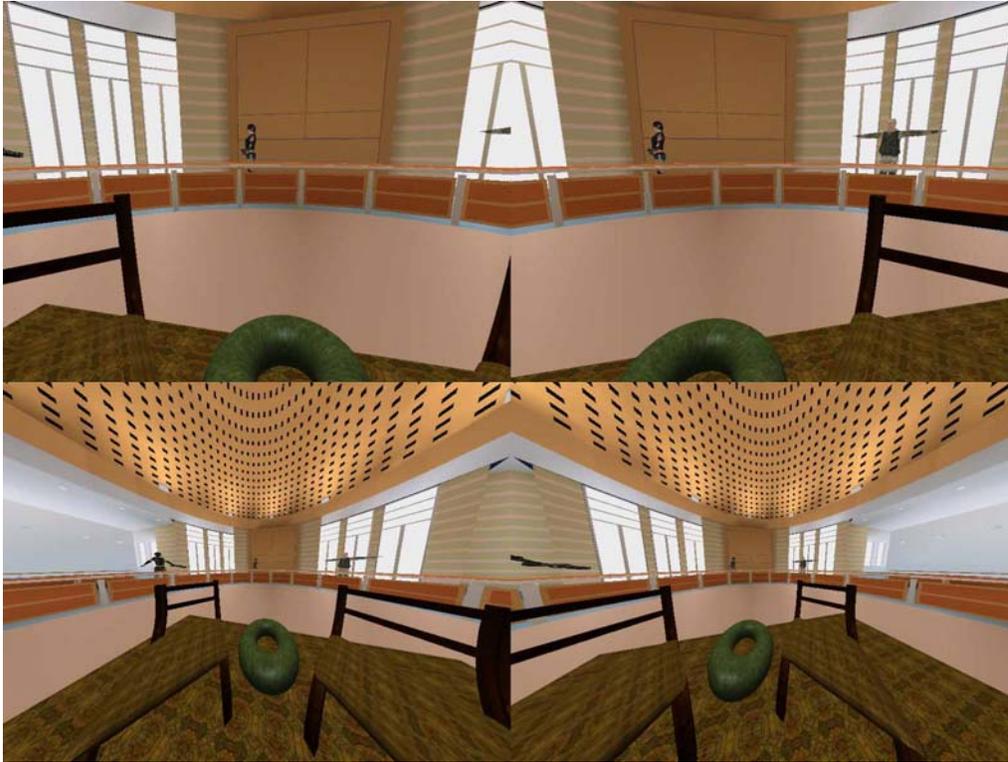
<http://www.entechtaiwan.com/>

PowerStrip can set the video timing on almost all graphics cards. Here is an example of correct settings in PowerStrip:



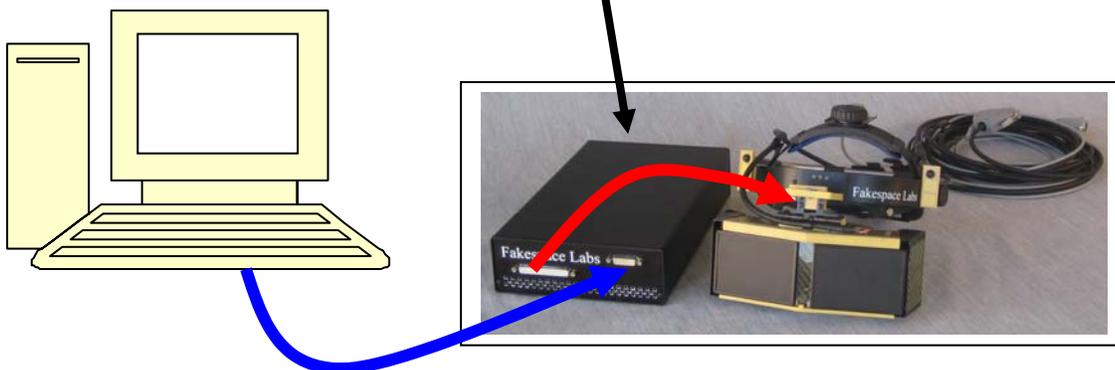
Graphics Layout and Fields of View

The HMD uses a full screen of video at 1600 x 1200 pixels. This is divided into four 800x600 quadrants, as shown below.



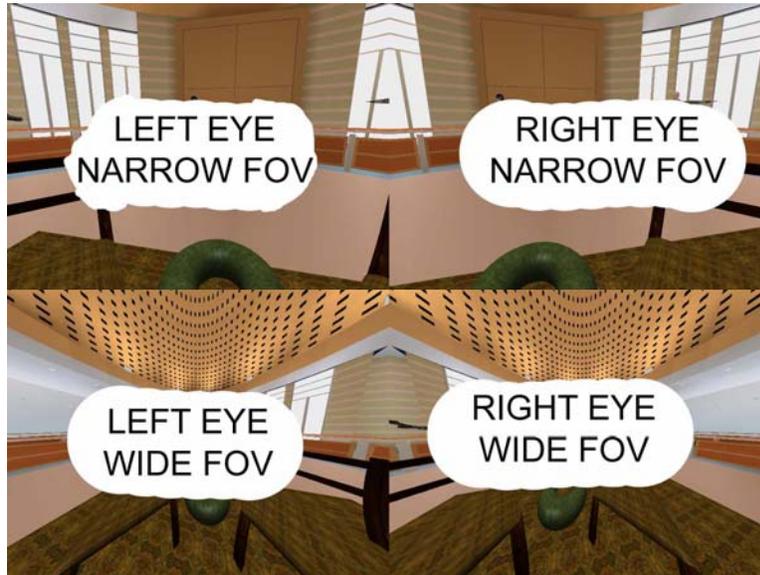
Each of these 4 views is used in constructing the view seen in the HMD. The video from the graphics card goes through electronics which resample and downsample these four images creating two images for the HMD displays. Visually, the displayed pixels appear most dense near the center of the field of view and taper off quickly to the periphery.

The images are processed in the control box, shown here.



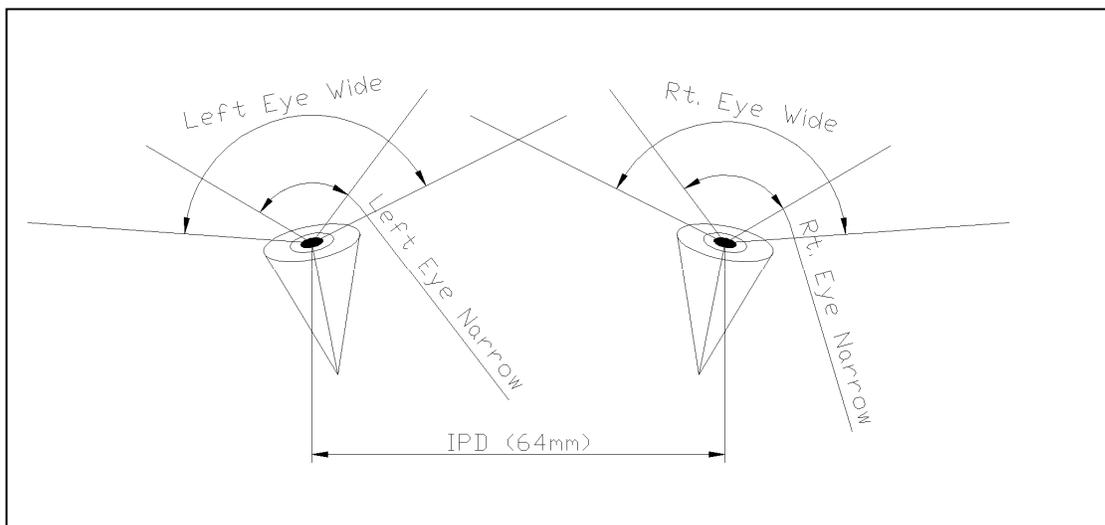
Viewport Layout and Fields of View

These images are arranged as follows (note – this has changed since Version 2.X):



The HMD optics are canted outwards by $\pm 11.25^\circ$, so this too must be considered when setting up the graphics transforms. The displays are biased to looking down so this is also incorporated and the narrow window needs to look down by an additional angle compared with the wide images. The images rendered comprise a total rendered diagonal field of view of over 177° including the consideration of the canted optics. The parameters are ideally in a configuration file of some kind as they may change.

Below is a view from above the two eyes, showing the horizontal fields of view rendered for each eye and the interpupillary distance (IPD). The IPD on the display is not adjustable. The exact parameters follow.



The fields of view and offsets of the four views are as follows (updated 6/08/06):

<p>Left Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 10°</p>	<p>Right Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 10°</p>
<p>Left Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 5°</p>	<p>Right Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 5°</p>

Note – the angle for “look down” of the wide image needs to be 5 degrees less than that for the narrow. Please note that depending on how the tracker is mounted and how the display sits on the head, the angle may need to be adjusted. Obviously there will be a local sign convention to be honored. IE:

base_angle = adjust as required by tracker and get the horizon in the right place
 look_down_narrow = base_angle + 10
 look_down_wide = base_angle + 5

If the view angles are not correct, the images in the HMD will not be right. The narrow image is inset into the wide image and the images are dithered at the boundary. If the angles are not correct between the narrow and the wide, then one will perceive a discontinuity in the image. When set correctly, the images will create an image that should look good enough that users instinctively reach out to touch objects in the virtual environment. Getting the images calibrated and the tracker correctly interfaced is essential in creating a compelling experience. If you are having trouble, please contact us.

Prior Versions, Included for reference.

The fields of view and offsets of the four views are as follows (updated 3/14/06):

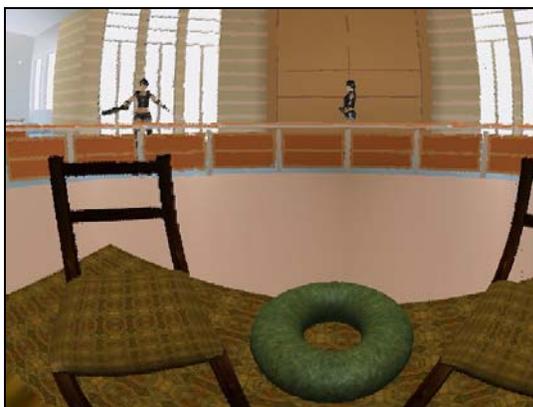
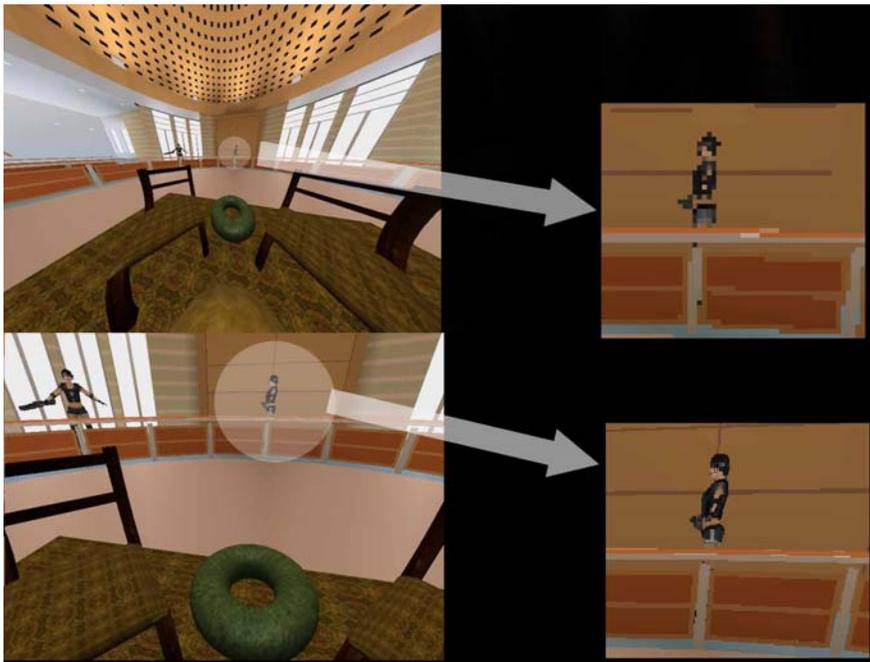
<p>Left Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 5°</p>	<p>Left Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 10°</p>
<p>Right Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 5°</p>	<p>Right Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 10°</p>

The following table is as of 2/23/06, and is now superseded but included for reference:

<p>Left Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 15°</p>	<p>Left Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the left by 11.25°</p> <p>Look down by 25°</p>
<p>Right Eye Wide FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 140°</p> <p>Horizontal FOV: 149.463° (diagonal FOV is 155.36°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 15°</p>	<p>Right Eye Narrow FOV</p> <p>Viewport: 800x600 pixels</p> <p>Vertical FOV: 80°</p> <p>Horizontal FOV: 96.4183° (diagonal FOV is 108.866°)</p> <p>Look to the right by 11.25°</p> <p>Look down by 25°</p>

Why the four views are needed:

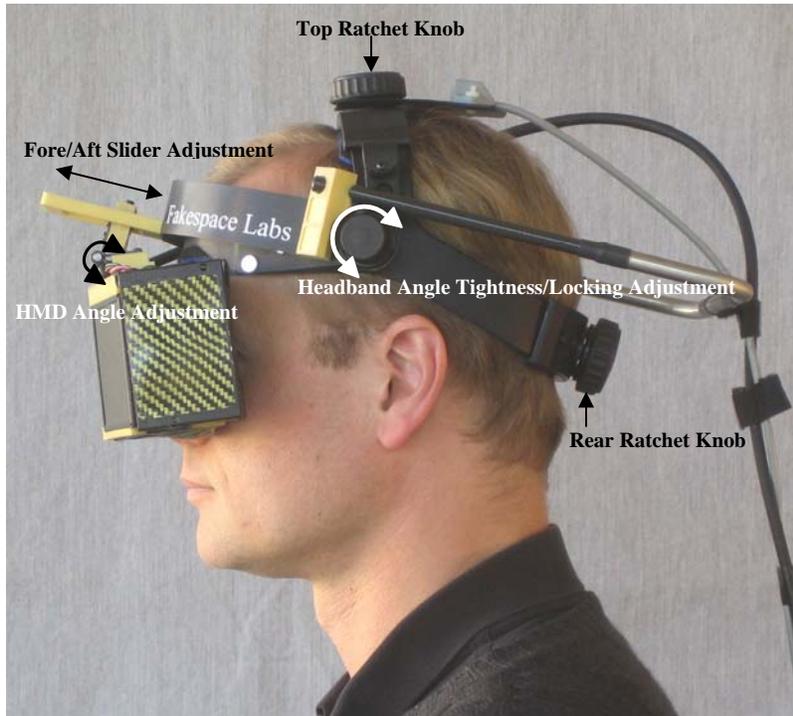
The “resolution” of the HMD varies across the field of view in terms of the number of pixels per unit of angle. More pixels are located in the central portion of the viewer’s vision than are created by a standard OpenGL type rendering if we were to use a single viewport with the actual field of view of the display. The OpenGL images below illustrate the problem. The HMD field of view is about that shown in the wide field of view image to the left. The person standing in the center of the field of view covers very few pixels as shown in the inset image, bottom left. In the HMD, however, that part of the image is in the center of the user’s view and a lot of pixels are used. To overcome this problem, in the middle of the HMD display, the image on the right is used and stitched into the wide field of view image. The composite image is shown in the HMD.



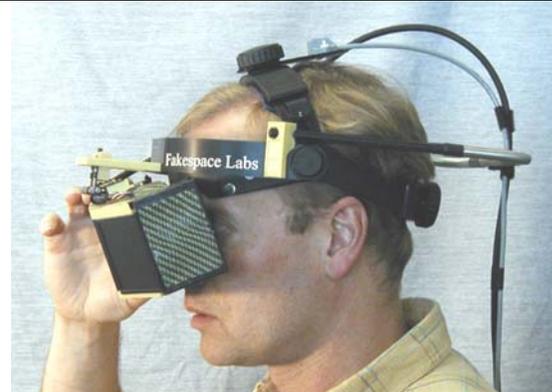
The image pair above is used to create a single image like the one shown to the left. In the actual HMD, the curves in the image to the left appear as straight lines. This stitching and mapping is accomplished in hardware.

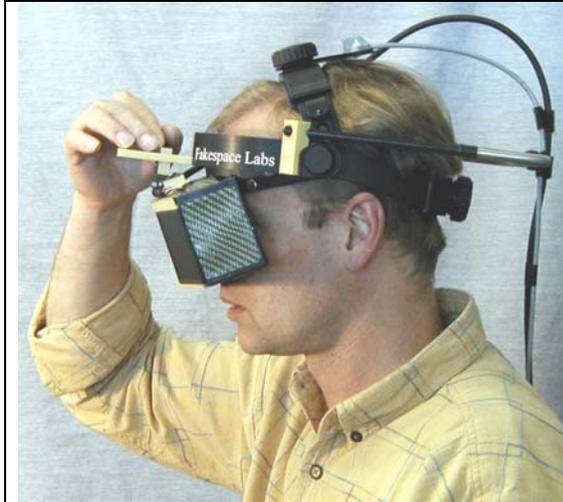
Properly Fitting the HMD for a Clear Image

The Wide5 HMD offers five positioning adjustments in order to tailor the fit to individual users. The following guide explains how to achieve the best fit when wearing the Wide5. The five adjustment mechanisms are detailed below:



	<p>1. It is easiest to put on the Wide5 with the HMD flipped up as shown and with the fore/aft slider adjustment pushed as far from the user's face as possible.</p>
	<p>2. The top ratchet knob adjusts how far up or down the Wide5 headstrap sits on the user's head. The headstrap should sit as low as possible while still being above his or her ears.</p>

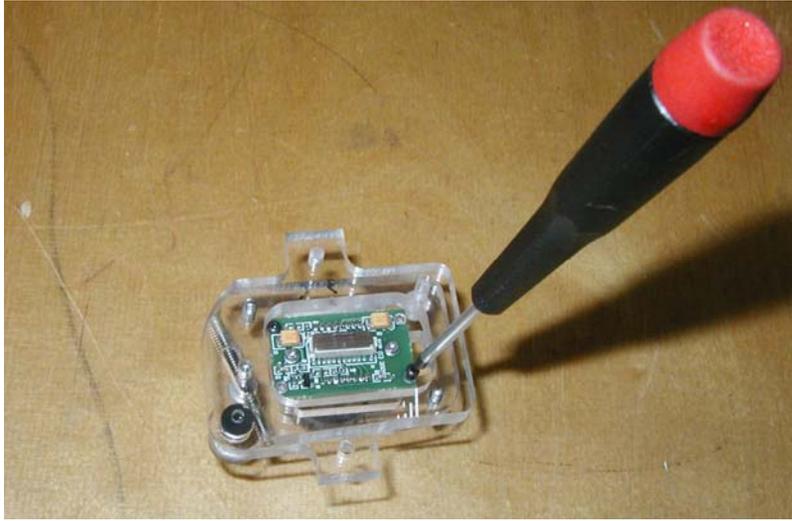
	<p>3. The rear ratchet knob adjusts the Wide5 headband tightness. The headband should be snug on the user's head.</p>
	<p>4. The HMD is now flipped down so that the user can see through the optics. Note that the fore/aft slider adjustment is still positioned away from the user's face.</p>
	<p>5. Adjusting the angle of the headband determines the height of the HMD with respect to the user's eyes. The HMD should be set so that the user's eyes are centered on the HMD optics. The headband angle can be locked by tightening the headband angle tightness/locking adjustment knobs (one on each side of headband, with only one visible here).</p>
	<p>6. Next, the angle of the HMD relative to a user's face is adjusted. This is most easily done with the HMD fore/aft slider adjustment pushed away from the user's face. The HMD angle should be adjusted to the position where the user sees the best, clearest image.</p>



7. Lastly, the user uses the fore/aft slider adjustment to move the HMD as close as comfortably possible to his or her face.

8. In order to take off the Wide5, the user should first flip up the HMD, push the HMD forward away from his or her face, and loosen the ratchet knobs. The Wide5 can then be removed easily.

Appendix 1 – Attaching the Dragonfly™ (by PointGrey) to the Camera Mount



Dragonfly camera attaches to the back surface of the front piece of the camera mount using four #0-80x0.25 button head cap screws (2 shown here). Use a 0.035 Allen wrench. The screws thread in to the clear acrylic piece.



Dragonfly camera and camera mount as seen from the front.

Please note – the camera mounts contain small high performance magnets.

Appendix 2 – Attaching the Camera Mounts and Boards on the Wide5

Please follow these steps to attach the adjustable camera mounts.



Camera mount attaches to x-travel bridge using two #4-40x0.5 button head cap screws and nuts. Use a 1/16 Allen wrench.



The #4 nuts sit in grooves on the back of the x-travel bridge.

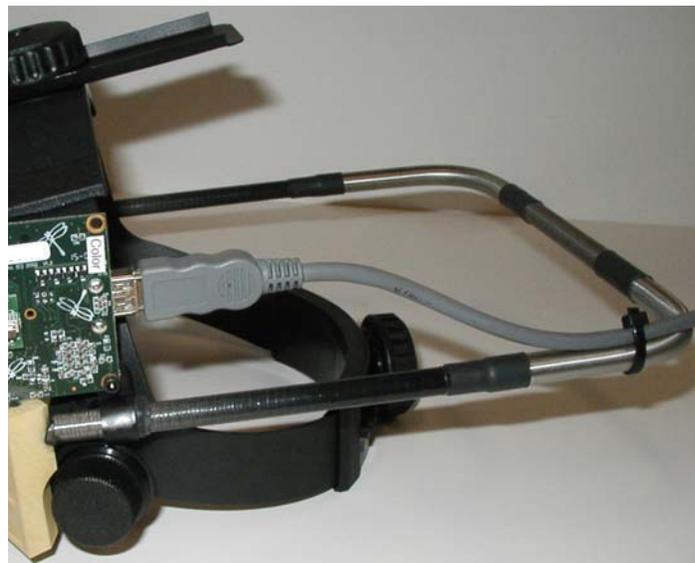


X-travel bridge attaches to Wide5 HMD using two #4-40x0.5 flat head cap screws. Use a 1/16 Allen wrench. Screws thread in to center beam. The process is the same for assembling and mounting the right eye camera.

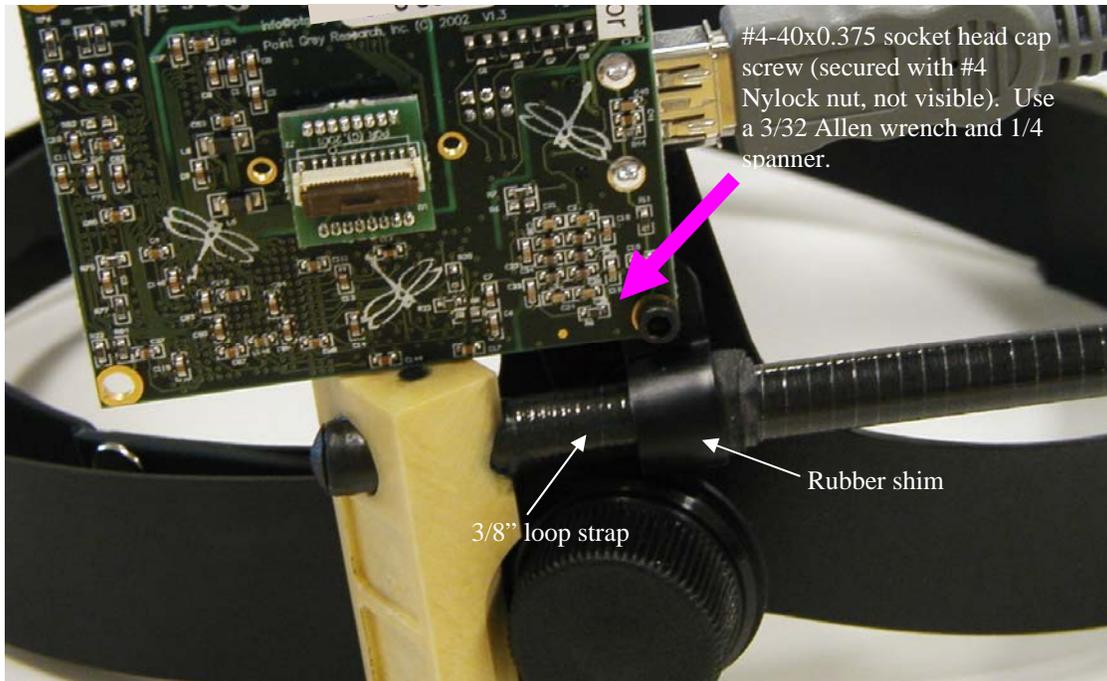
Mounting the Dragonfly Electronics on the Wide5



Suggested routing of Dragonfly flex cable on Wide5.



Routing of Dragonfly Firewire cable on Wide5.



Dragonfly electronics' mounting on Wide5