meshmapper instructions

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April 2021

The following are notes relating to creating a warping mesh for the 4m domes at FGS, specifically the warping meshes for the image and video playback software. This should be read in conjunction with the following document

http://paulbourke.net/dome/meshmapper/

You will need

- The zip archive supplied with this document containing the meshmapper software, test pattern and initial parameter file "last.cfg".

- X11 installed, namely XQuartz from here https://www.xquartz.org/

- A 3 button mouse, or know how to configure a touchpad to include a right mouse button.

- A display that is ideally the same or greater resolution than the dome.

- Familiarity with the Mac Terminal program and some knowledge of UNIX.

To run meshmapper the display the operator is using should be mirrored with the display connected to the dome, note this is the opposite to the playback software. Ideally these will be configured to the same resolution, namely 3840x2400 [Note that the last time I spoke to Damian there was still some doubt about whether the intended projector would be 3840x2400 or 3840x2160]. If this is not possible then they MUST be configured to be the same aspect ratio. The meshmapper application must be run as a full screen application, there is a -f option for this, so the command line might be
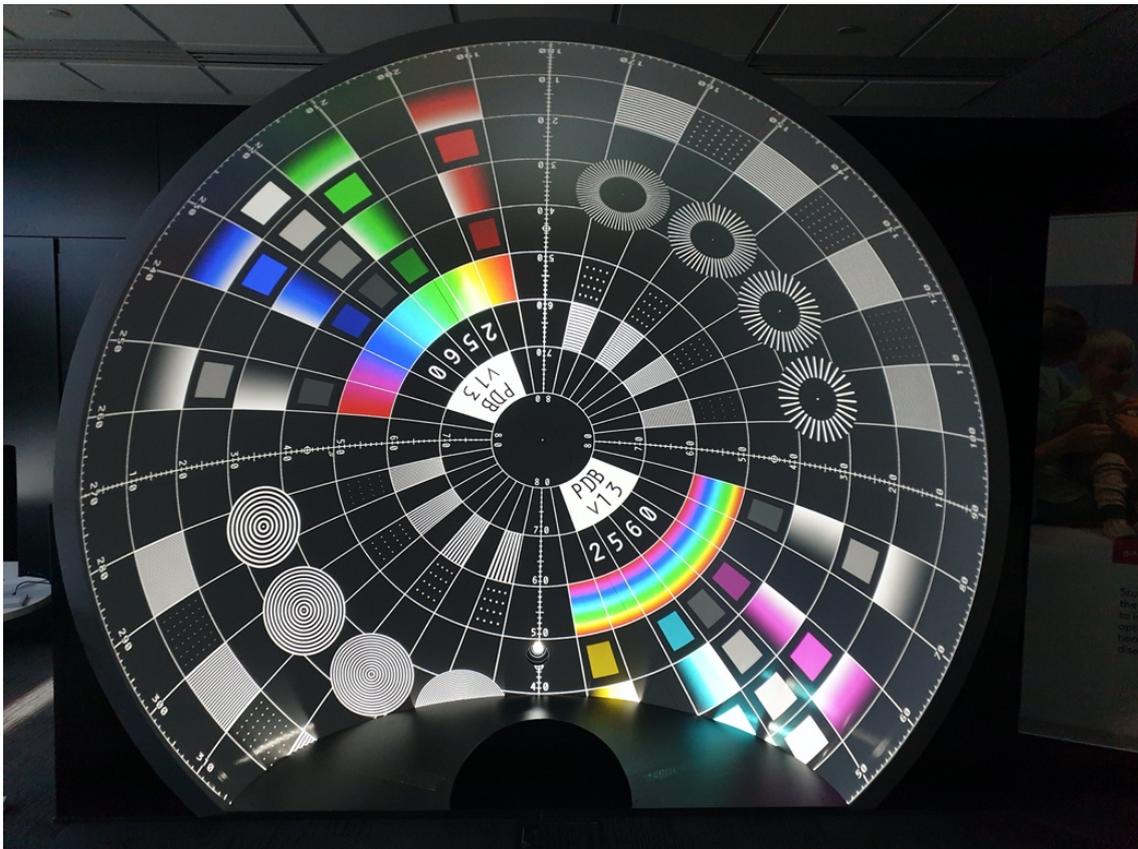
meshmapper -f 2560.tga

This assumes the program is on the current unix binary path. If not then change directory (cd) to the directory containing the meshmapper binary and use
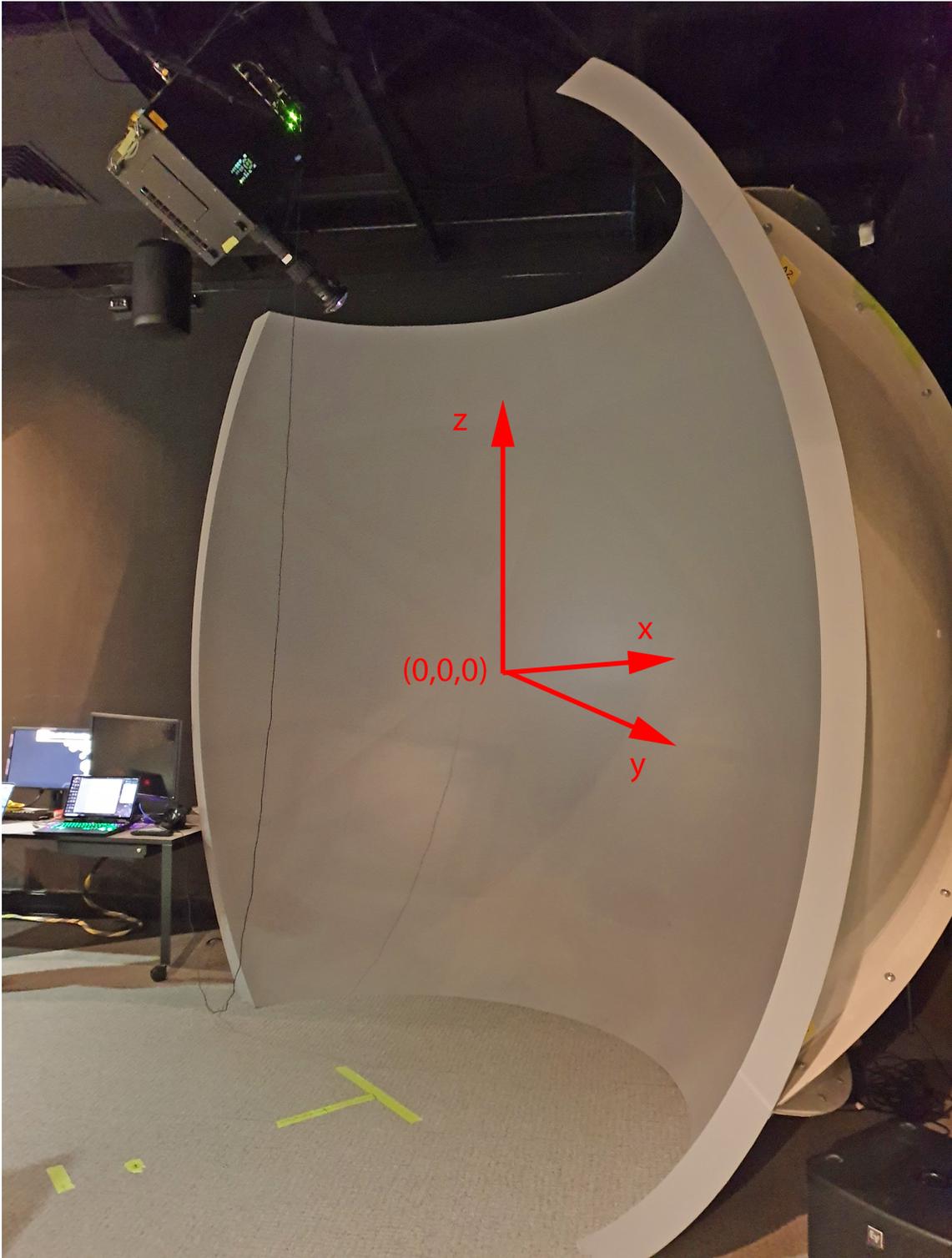
./meshmapper -f 2560.tga

The meshmapper is a simulation that incorporates all the physical properties of the dome, projector, spherical mirror and projector lens. One adjusts the parameters until the result looks correct in the dome. For the test pattern supplied (2560.tga) this would mean all the radial lines are straight, the circular lines are circles, and the center is located at the center of the dome. An example of a correct

alignment is shown below, noting that this should only be evaluated from someone standing in the center of the dome.

The parameters are stored in the text file "last.cfg". When the program is quit (esc key) this file will be updated with the currently adjusted values and used the next time the program is run. So, if you find close settings you may want to make a copy of this file which can then be renamed to "last.cfg" to get back to those settings.

Some of the parameters can be measured (like the diameter of the dome), some measured only approximately (such as the position of the projector lens), others cannot easily be measured at all (like the lens offset). The plan is to measure the measurable ones can closely as possible and interactively adjust the others using meshmapper until one gets the correct result on the dome. The coordinate system has the origin at the center of the sphere from which the dome is cut, the y axis is to the right, the z axis up and the x axis forward into the dome.

Note that because the dome and projector are assumed to be centered on the y=0 plane and the system assumed to be symmetric, the y axis values are not used or zero when defining the dome and projector position. The following table summarises these parameters, see the supplied "last.cfg" for estimated values for the FGS domes.

Parameter	Status	Comments
Projector position	Can be reasonably well estimated	The problem is not knowing exactly where the projection point in along the lens. Should be measured once projector is installed and aligned
Projector throw	Can only roughly be estimated	Notionally the mirror/projector distance divided by 0.45 (the width of the image on the mirror)
Projector aspect	Known exactly	3840/2400 or 3840/2160 depending on the projector mode.
Projector offset	Hard to estimate	Lens offset. Should be at least 0 horizontally but the number we need here is the vertical lens offset. Will be set during projector alignment.
Projector angle	Can only roughly be estimated, ideally 0	No real reason for the projector to be tilted. Adjust all feet to base position.
Mirror position	Known fairly well	Note that the mirror is not a ¼ circle so the x axis origin is negative.
Mirror radius	Known fairly well	
Dome radius	Known exactly	
Dome angle	Should be 90 degrees in this case, upright	This is to deal with domes that may be sightly tilted due to incorrect installation.
Dome bearing	Should be 0	This is to deal with domes that may be slightly rotated about the x axis dues to incorrect installation.

The procedure then is to adjust the various parameters using the keyboard controls, these can be found by typing

meshmapper -h

Currently giving the command line as follows

```
Usage: meshmapper [options] tgaimage
Options
    -h     this text
    -p     use a polar mesh rather than cartesian
    -f     full screen
    -d     verbose/debug mode
    -r s   read existing geometry file
Left mouse button for popup menus

Keyboard
          h      camera home
          p      choose to modify projector
          m      choose to modify mirror
          d      choose to modify dome
 0,1,2,3,4       choose to modify mesh node
          n      modify nothing
        x,X      modify position (projector, mirror, mesh)
        z,Z      modify position (projector, mirror, mesh)
        y,Y      modify position (mesh)
        r,R      modify radius (mirror or dome)
        a,A      modify tilt angle (projector or dome)
        b,B      modify bearing (dome)
        t,T      modify throw (projector)
        o,O      modify offset (projector)
          f      modify dome top (dome)
          w      windowdump
      esc,q      quit
```

Once the test pattern looks correct on the dome, from the right click menu choose "Save fisheye warp mesh". This will create a file called "test_xyuv.data". This file would be renamed to the conventions used in the image and movie player which is "warpmap.data" and placed in the package contents of each player.

Before running meshmapper one needs to configure and align the projector physically. The image supplied called "vertical_line.png" might assist with this. It should be scaled the aspect ratio of the projector and presented full screen. Of course in all this one needs to ensure the dome is covered in light, using a bright display background colour can ensure this.

The center red line should ideally be aligned by physically moving the projector, with horizonal lens shift set to zero. Noting that this can be achieved by rotating the projector about the vertical axis as well as shifting it. One should be able to ensure the projector lens axis is perpendicular to the mirror by using the "vertical_line.png" image. The vertical lens shift should be adjusted to minimise the amount of light on the floor.

The projector zoom should be adjusted so as the maximise the number of pixels on the dome, this is typically zooming until the tips of the bottom dome cut-off shown in red below, are illuminated.