Official LEL CAVE / Dev Lab Training Guide

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Contents

1. Intro to the Lab

The Living Environments Laboratory (LEL) is a state of the art facility located within the Wisconsin Institutes for Discovery (WID) building on the University of Wisconsin – Madison campus. The LEL is made up of three areas located on the lower level of the WID: the CAVE lab, the development lab (Dev Lab), and they lab's office space. Within the CAVE lab area exists a 9'6" x 9'6" x 9'6" C6-CAVE virtual reality system. The development lab contains a single 9'6" x 9'6" power-wall display system that mimics one side of the CAVE. This guide will train new employees or users of the lab on basic understanding and operation of the CAVE and Dev Lab equipment. Below, figure 1 shows the CAVE and figure 2 shows the Dev Lab's power wall. The CAVE has a sliding door for its 6th wall.

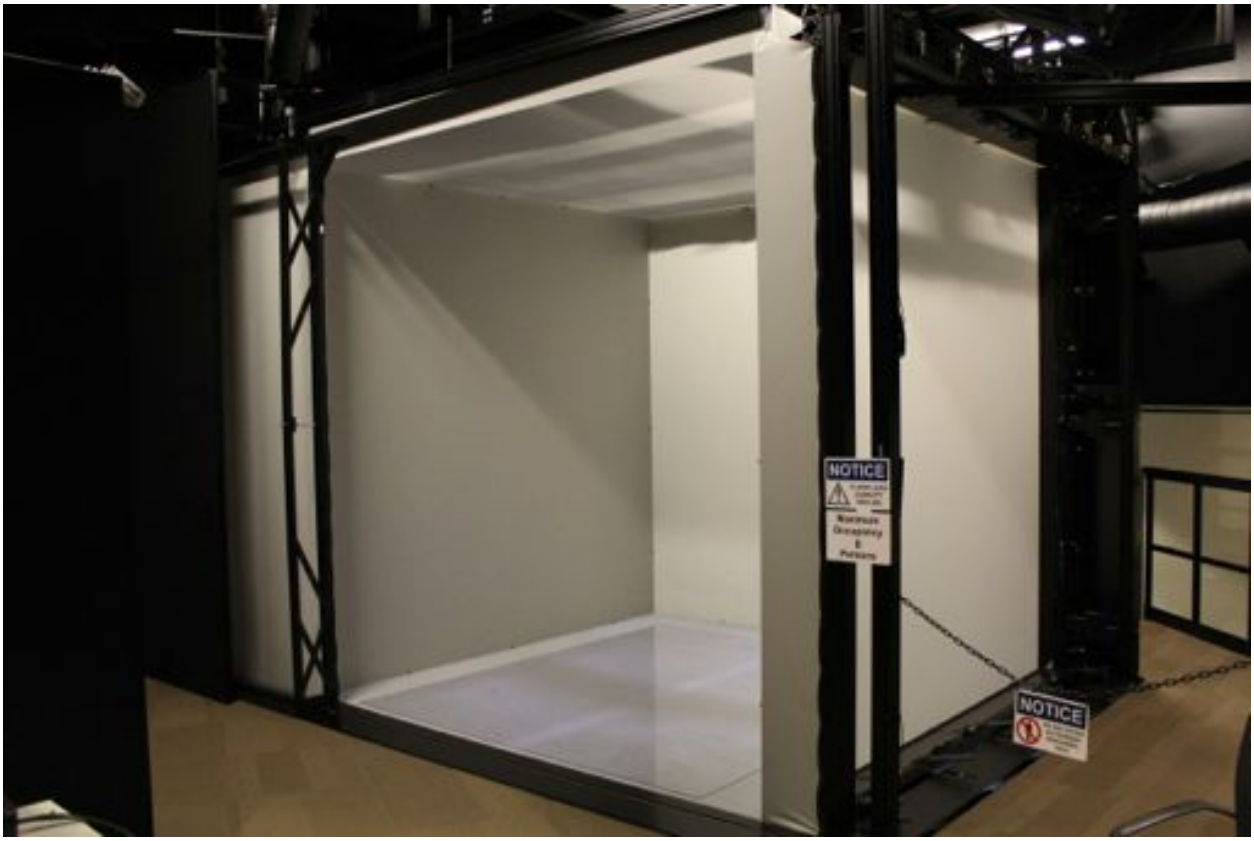

Figure 1 - The LEL's CAVE

Figure 2 - The Dev Lab Power Wall - The dimensions match a single wall from the CAVE.

2. The Equipment

The LEL possesses a significant amount of virtual reality equipment that requires some training in order to properly use. The CAVE is made up of 12 Titan Dual 3D 1080p projectors run by a

cluster of 8 computers. The Dev Lab wall runs on 2 Titan Dual 3D 1080p projectors and 2 computers. The Dev Lab also contains a 55" 3D TV and an overhead utility projector. Each lab space has an Intersense IS900 tracking system for head tracking and input device (wand) tracking. RealD 3D active stereo shutter glasses are worn to achieve 3D stereoscopic viewing. A device known as an AMX serves as a control system for operating the projectors and other components of the lab. The following sections with discuss the various pieces of equipment and how to properly use them. This guide will begin with explaining the AMX, since it acts as a central control for the system and is what you actually need to know how to operate in order to turn the system on.

A. AMX

The AMX is the touch screen device located to the right of the main head node computers in the CAVE and Dev Lab. It serves as a control console for performing various actions with the CAVE and Dev Lab projectors, lighting system, and curtains. An image of the AMX is shown in figure 3:

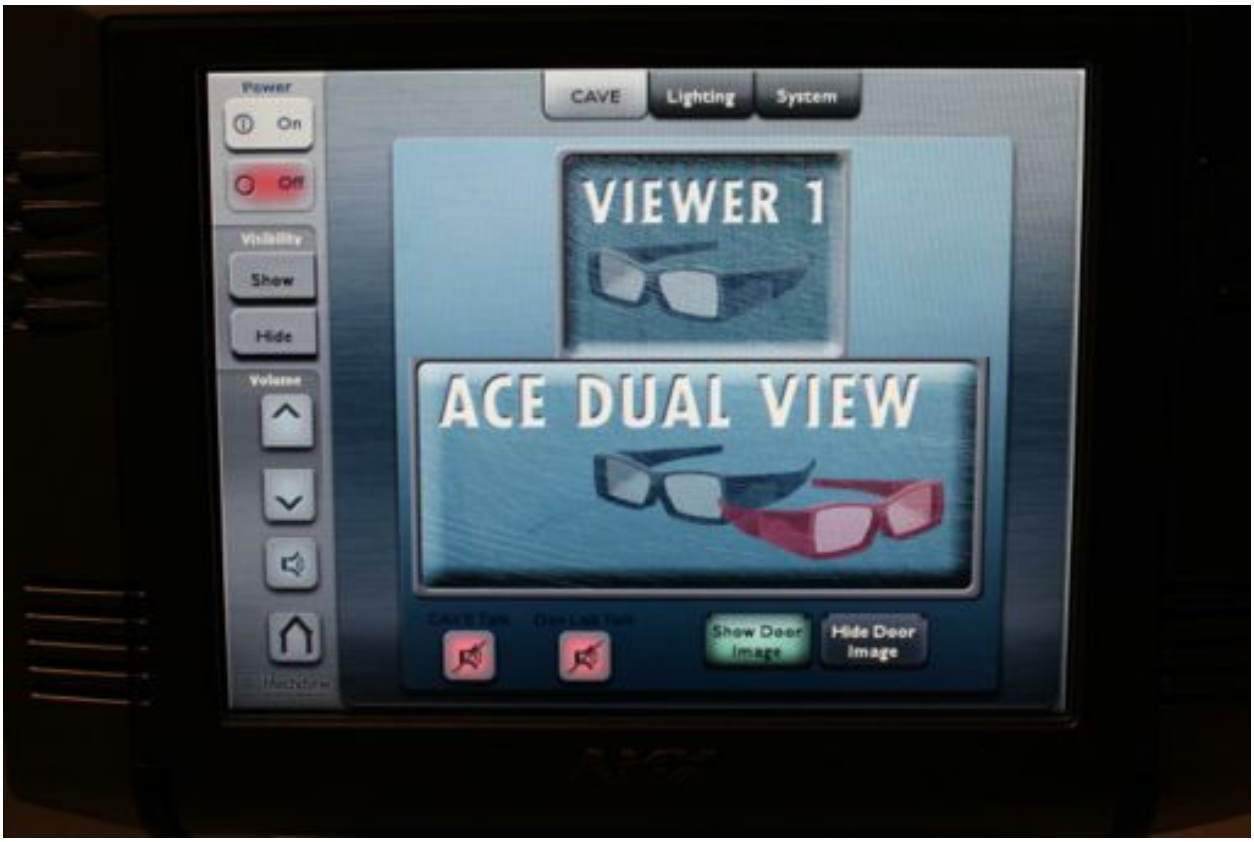

Figure 3: An image of the CAVE's AMX screen

How to turn on and off the display projectors: The upper left corner of the AMX screen contains the main On / Off buttons for turning the CAVE or Dev Lab projectors on or off. Upon pressing the "On" button, the On/Off buttons will be covered by a "Projectors are Warming Up" message. During this time, don't attempt to press those buttons again. The projectors will sequentially turn on and begin to become brighter. After approximately 3-4 minutes, the "warming up" message will go away. Note: a user of the system can continue performing the next steps to load a scenario, they don't need to fully wait until the "warming up" message goes away. Along the top of the AMX screen is 3 "tabs" that allow access to additional control screens. As the AMX in the CAVE and Dev Lab differ slightly on their features, the following two sections will explain each and how to operate features important to running the two display systems.

i. CAVE

In the CAVE, the tabs read "CAVE", "Lighting" and "System". Pressing the "CAVE" tab, will present the user will two buttons labeled "Viewer 1" and "ACE Dual View" – these are toggles for switching between single viewer or dual view modes. The LEL CAVE is unique in the sense that it is one of the only dual view capable CAVEs in existence. Dual view allows two people to be tracked and navigating or interacting with a scenario at the same time. This should generally remain on "Viewer 1" unless you are running a specific dual view enabled-application.

Pressing the "Lighting" tab will bring up three switches for controlling the lighting and curtains within the CAVE space that read: "Lights", "Curtains", and "Under CAVE Lights". The "Lights" On/Off buttons control the overhead lights above the desk area of the CAVE lab. The "Curtains" Open/Close buttons open or close the curtains. The "Under Cave Lights" buttons control whether the lights under the CAVE are turned on or off. An image showing the Lighting tab is shown in figure 4.

Figure 4 - CAVE AMX lighting tab.

In general, when the CAVE isn't in use, the Curtains should be open, the under CAVE lights should be on, and the regular lights should be off (as shown in figure 4). There is an additional light switch on the wall by the stairs of the CAVE lab that controls the bright over-head lights above the CAVE; these can be optionally on or off when not using the CAVE – but should be turned off when running scenarios in the CAVE.

The "System" tab contains controls for turning on and off specific projectors. In general, you don't need to worry about any of the settings under this tab. The page also shows the current lamp hours used for each projector. Each projector's lamp hours have a life of up to 2000 hours total.

ii. Dev Lab

In the Dev Lab, the tabs read "Dev Lab", "Video Routing", "Plasma", and "System". The "Dev Lab" tab contains a similar switch like the CAVE's AMX for toggling between single viewer and ACE dual view modes. Likewise, this should generally remain on "Viewer 1" unless running a dual view application.

The "Video Routing" tab in the Dev Lab contains switches for controlling which PC's are showing on which displays. Options for displaying include "Dev Lab Head 1" which is the PC whose

desktop is shown on the monitor in the Dev Lab adjacent to the 3D TV (see figure 5), as well as "Laptop" which is whatever PC the USB dongle is plugged into (currently not functioning). These two devices can be shown on the overhead "Utility Projector" or the "Plasma" 3D TV.

The "Plasma" tab has controls and settings for adjusting the 3D TV – generally you shouldn't need to worry about this tab.

The "System" tab is similar to the one on the CAVE AMX. It contains controls for turning on and off specific projectors. In general, you don't need to worry about any of the settings under this tab. If you needed to use the overhead Utility projector, pressing the on button will turn the projector on. The projector is set to show whatever content is on the Dev Lab head node monitor (figure 5).

B. CPUs

Both the CAVE and the Dev Lab are run on a cluster of CPUs. All of the CPUs are running the Windows XP 64 SP2 operating system (this was a requirement of the CAVE installation). This next section will describe these PCs in further detail for each location and discuss the additional general PCs available for lab projects.

i. CAVE

The CAVE runs on a cluster of 8 PCs in total. Single viewer mode runs on 4 PCs and Dual view mode requires 4 additional PCs. All 8 PCs are housed in a server room that is adjacent to our labs. In total, 6 PCs account for the rendering of the CAVE display walls, 3 per viewer (i.e. 3 for single view and 3 more if dual view is active). A monitor, keyboard and mouse exist in the CAVE lab that controls the CAVE head node (the 4th machine besides the 3 that run the CAVE rendering). The CAVE head node's monitor is shown on the right side of figure 6. The CAVE head node interfaces directly with the tracking system. It is also at this head node machine where a user can load different CAVE scenarios. Details of how to do this will be explained in "Running Scenarios" section.

From the head node machine, users can access the individual CAVE node machines via VNC (Virtual Network Computing) connections. Icons for accessing the various machines exist on the top center area of the head node's desktop. Two of the CAVE's display walls are rendered on each of the 3 CAVE render nodes and are divided up as follows: Front Wall + Right Wall, Door Wall + Left Wall and Floor + Ceiling. You shouldn't need to worry about accessing these machines directly the majority of the time. Should a crash happen in your program, there's a chance you might have to manually close your application by going to each machine (this would only be necessary if the "Kill" feature of Cluster Launcher doesn't work – to be explained in the

"Running Scenarios" section). Access to the dual view head node and dual view rendering nodes is also available via the head node in the CAVE lab.

The specs for each CAVE node machine are as follows: 2 x Quad-Core Intel Xeon 2socket1366 E5640, 4core/8thread, 2.66GHz, 12MB L3-cache, DDR3-1066 memory CPUs, 2 x NVIDIA Quadro FX 5000 graphics cards, 24GB DDR3-1333 registered ECC main memory, 1 x DVD/CD writer optical drive, 2 x 500GB 7,200rpm SATA 3Gbps NCQ 32MB cache hard drives, and 64 bit Windows XP Professional SP 2 with NVIDIA graphics drivers.

ii. Dev Lab

The Dev Lab wall runs on two PCs – one machine performs single view and an additional machine exists for dual view. The specs for these two machines are identical to the CAVE machines. These two machines are also housed in the server room, but access to them is available via the mec0 machine whose monitor is located on the right wall when entering the Dev Lab (see figure 5). VNC connections from this machine allow access to the DL_V1_HEAD and DL_V2 machines, which are the machines the Dev Lab projectors display.

Figure 5 - Dev Lab head node monitor and the Dev Lab AMX. (3D TV In Background)

iii. Additional Machines

Additionally, there are extra CPUs within the CAVE and Dev Lab space to be used as workspaces for projects. These machines are important – particularly for incorporating extra peripheral devices into a scenario (Microsoft Kinect, Nintendo Wii-Fit Balance Board, etc.) The reason being is that since the main CPUs are located in the server room, it's not really possible to connect peripheral devices directly to them. Therefore the typical flow for connecting

peripheral devices is to connect them to one of these additional machines in the CAVE lab space or Dev Lab and then execute some networking code to send the data across to the CAVE / Dev Lab head node's and rendering nodes. The following figure shows the extra machine in the CAVE lab along with the monitor that shows the CAVE head node.

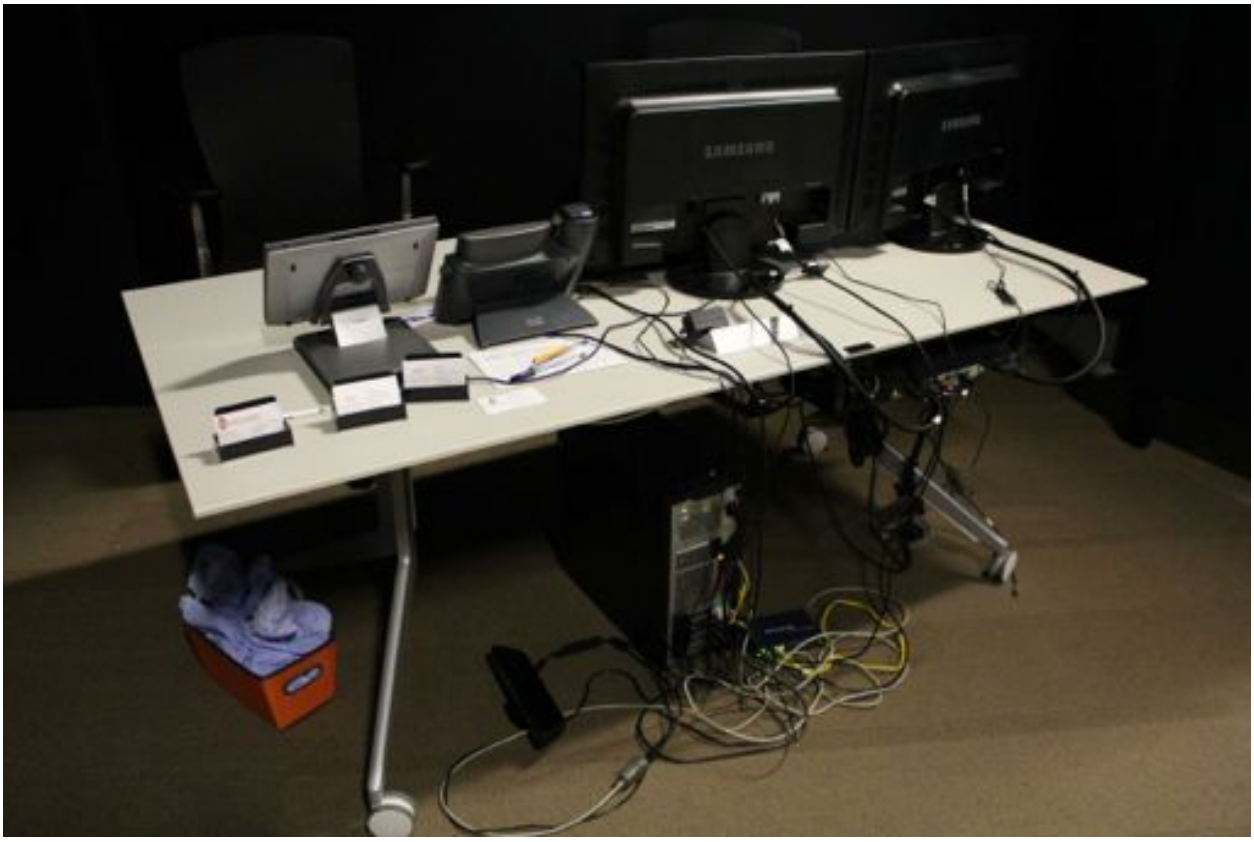

Figure 6 - Additional Machine for peripheral device communication in the CAVE lab space. The head node monitor is shown on the right, while the monitor for the additional machine is on the left. The additional PC is shown underneath the table.

C. Projectors

The CAVE runs on 12 Titan 3D Stereo Dual View 1080p Projectors. 4 projectors are connected per rendering node. Turning on and off of the projectors is achieved via the previously mentioned buttons on the AMX console. The Dev Lab runs two of the same Titan projectors. Projectors are mounted on racks in pairs on the 4 horizontal walls of the CAVE. Mirrors are used below and above the CAVE angled so that an image can bounce off of them to produce the correct alignment of images for the ceiling and floor within the space boundaries of the CAVE lab space. The 4 towers that hold the projectors **should not be touched**, as they are optimally aligned so that the projectors produce as best an image as possible for each CAVE wall. **Likewise, projectors and their settings should not be manipulated directly**. Should any

sort of issue happen that appears to be a problem with a projector, contact Ross Tredinnick (rdtredinnick@wisc.edu). An image of a projector is shown in figure 7.

Figure 7 - The door top projector

D. Tracking System

The CAVE and Dev Lab possess the means to track a user's viewpoint and input devices in 3D with 6 degrees of freedom (x,y,z translation & rotation). This is done by way of an Intersense IS-900 tracking system. The device used to track a user's viewpoint is called a head tracker and the input device is known as a wand. After turning on the head tracker and wand and standing in the center of the CAVE, the two devices should obtain tracking and you should obtain proper rendering relative to your perspective.

i. Head Trackers

The head tracker is a small rectangular device with an attached battery pack. Before entering the CAVE, the tracked user attaches the head tracker to the top of the 3D glasses by a velcro attachment on each device. The head tracker can be turned on by pressing the button on it for a couple of seconds until the green light starts flashing. To turn off the tracker press and hold the same button until the lights on

the head tracker turn off, then release the button. An image of a head tracker is shown in figure 8.

Figure 8 - Head Tracker

ii. Wand

The wand is the main device we use for interaction with scenarios within the CAVE and Dev Lab. The wand is a 3D input device that is wireless and is tracked in the same fashion as a head tracker. This allows 6-degree of freedom (3 translations, 3 rotations) movement of the input device within the scene. On top of the wand are 4 buttons and a joystick. A single button exists on the back of the wand. To turn on the wand, press and hold the far left top button, until the green LED lights begin to blink. At this point you can let go of the button and the wand should now be on. To turn off the wand, press the far left button and far right button at the same time – the lights should turn off and the wand will now be off. An image of a wand is shown in figure 9.

Figure 9 - Wand

iii. Charging Stations

Two charging stations exist in each the CAVE and the Dev Lab. This is where the head trackers and wand should be returned after use so that their battery can recharge. Each device should be turned off before placing them in their charging station locations. An image of a charging station is shown in figure 10.

Figure 10 – A charging station for the wand and head tracker, plus extra batteries.

iv. Extra Batteries

Extra batteries exist in the charging stations. Should a wand or head tracker ever run out of its charge, these extra batteries can be used to continue working. The wand and head tracker have a basic compartment on the back of them that can be unlatched – the new battery then must replace the existing battery at the same orientation. The lower LED of the wand or the head tracker will blink when battery power is low on the device. Should the device run out of power it simply won't be able to turn on or function. Replacing the battery with one of the extra batteries should fix this issue.

E. 3D Glasses

i. Single Viewer

In order to view a scene in true 3D stereo within the CAVE, users must don a pair of our realD 3D Glasses. These 3D glasses are active stereo and synchronized via small stereo emitter boxes that are connected to the projectors. The glasses can be turned on by pressing a button on the upper right side of the glasses on the top portion of the glass rims.

As previously mentioned – several of the glasses have a velcro attachment on top and a head tracker can be attached at this location. The glasses don't need to be explicitly turned off after use as they will turn off automatically. These glasses have a charge time of roughly 1-1.5 hours.

Figure 11 – The realD single viewer CE4S 3D glasses

ii. Dual View

When running dual view scenarios, there is a separate type of glasses that need to be worn that are shown in figure 12. These glasses allow the viewer to see from the perspective of the 1st or 2nd tracked viewer by way a button on the top of these glasses. Head trackers can be attached to these glasses by Velcro in a similar fashion to the single-viewer glasses.

Figure 12 - Dual View Glasses

iii. Charging Rack

The single-viewer 3D glasses can be charged by placing the glasses back into the rack, and attaching a charging cord to the bottom right corner of the glasses. The charging rack is shown in figure 13.

Figure 13 - 3D Glasses rack

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3. Running Scenarios

A couple different methods exist for running user-created scenarios within the CAVE. A program exists on the CAVE and Dev Lab head nodes called Cluster Launcher, which allows programs to be simultaneously launched on the various render nodes of the CAVE synchronously. Learning how to use cluster launcher will be important for properly launching a scenario.

A. Virtual Lab

Virtual lab is a piece of software that Mechdyne wrote for the Lab that sits on top of Open Scene Graph (www.openscenegraph.org). It has a Python programming language interface for loading meshes, sounds, and creating interactive scenes within the CAVE. There's a poorly written documentation file for Virtual Lab whose location will be discussed in the "Further Reading" section.

B. Cluster Launcher

A cluster launcher icon as shown in figure 14 exists on the desktop of the Dev Lab and CAVE head nodes. A number of applications exist in the drop down box that can be run within the CAVE. In order to run your own scenario, you should choose the "VirtualLab" drop down item. From here you must type in the correct directory location where the main python file exists to run a scenario. On the line below this – type "-p <name of python file>" then press the "Launch" button. You should see a screen appear on the head node as well as on the machines in the CAVE or Dev Lab – this means that the scenario is loading. **To close a scenario that has been loaded in the CAVE – press the ESC key on the head node with the scene window in focus. This will close all of the windows within the CAVE or Dev Lab as well.** Should a problem occur when you run your scenario (such as a crash), you can press the "Kill" button within cluster launcher to force a shutdown of your application.

Figure 14 - cluster launcher icon

Figure 15 - trackD Icon

C. TrackD

TrackD is the required software that must be run in order to attain proper tracking within the CAVE or Dev Lab. An icon for TrackD exists on both the CAVE and Dev Lab desktops. Be sure that TrackD is running or that you open this application before trying to launch a scenario. After launching the scenario and stepping into the CAVE with a head tracker or wand turned on, tracking should be obtained within a couple of seconds.

D. Default Controls

When running a scenario using virtual lab – there are some default controls that exist across most scenarios. The second button from the left on the top controller (in the CAVE the "yellow" button) is the button for interacting with, picking up and moving objects. The joystick moves the user in the direction of the wand beam when pressing it forwards or backwards – when moving it left or right it will turn you in those respective directions. Pressing the 1st and the 3rd button at the same time will reset you to the origin of the scene. Custom code can be added in your scenarios to either do different things with these buttons, or define your own button actions. The second button from the right on the joystick will rotate the scenario about the wand's beam. This can be a useful feature for scenarios where you may be looking at a single object – but beware, especially for larger scenarios with more depth, this can cause some dizziness for those in the CAVE with you.

4. Safety

The LEL CAVE and Dev Lab are valuable resources for the UW and care of one self and of the equipment must be kept in mind at all times during use of the spaces. The following rules must be adhered by when using the spaces:

- No shoes or bare feet in the CAVE – users must wear socks or surgical booties
- Don't touch the CAVE or Dev Lab projection screens. Also don't touch the small black emitters in the corners of the CAVE – these are for the tracking system. In general it's advised to stay on the plexi-glass on the floor of the CAVE.
- Don't restart any of the machines, including the head nodes that run the CAVE or Dev Lab displays. If you feel that you get into a situation where this must be done for some reason, contact Ross.
- No open beverages in the CAVE or Dev Lab. Lids / bottles are OK.

- Don’t rapidly move the wand or head tracker back and forth – it can cause damage to the hardware inside of the devices.
- Don’t touch or lean against the towers that hold the projectors, nor the projectors themselves – they are all calibrated precisely for the best rendering and viewing experience possible.
- No installation of software onto any of the Dev Lab or CAVE machines. If you have any software you wish to install, contact Ross.
- Always return all wands and head trackers to their charging stations after use (and turn them off before returning them)
- A very maximum of 8 people in the CAVE at once – reasonably it should be kept to 5-6 at most.