UNITY DEVELOPMENT SETUPS AND execution
FOR 3D VR-based SKELETONIZER (VRSkel)

This document is submitted for the replicability stamp code review. The following is the Paper submission details:

Paper Title:

Virtual reality framework for editing and exploring medial axis representations of nanometric scale neural structures

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Machine specifications required to obtain acceptable runtime performance:

Machine	OS	Task	Specs
Asus ROG G703G	Windows 10 Pro	Immersive environment	32GB DDR4, Intel Core i9-8950HK 4.8 GHz, Nvidia GTX 1080 8GB GDDR5X, 2X 256GB PCIE SSD + 2TB SSHD FireCuda.

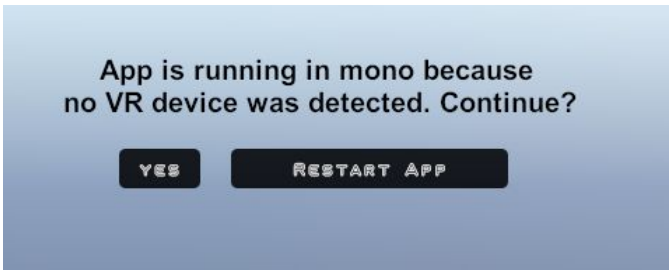
Overview

VRSkel is a 3D application of neuroscience implemented in Stereo and Mono settings that allows for a semi-automatic skeletonization process (creating and proofreading) to take place in two metaphors: External and Internal.

- Download Unity version 5.6.3f1 from Download Archive. Select Downloads (Win) -> Unity Editor 64 bit
- Source code and project is downloadable from google drive, link is here: IBPEXP.zip Unzip might take a few minutes. The project is around 4.5GB.
- You're gonna need an XBOX One controller! Same as this one: https://www.amazon.com/Microsoft-Xbox-Controller-Cable-Windows/dp/B00O65I2VY

- You're gonna need to have a working VR setup ready and working (the user study was operated using an Oculus Rift S model setup). We recommend using a similar setup in order to replicate results under the same conditions.
- The code is made to run in 8 different modes tailored according to the user study tasks. You're gonna need to open a code editor along with the Unity Editor to switch between the 8 tasks. The below table lists each state and the actions needed to run them correctly. Mainly you'll be editing two scripts only:
  Tracing_mono.cs, resides under **\VR_Skeletonizer\interactiveVR\assets\,**
  and **Raycaster_stab.cs** resides under
  \VR_Skeletonizer\interactiveVR\assets\Scripts\skeletonIO

	Modes	Actions
C R E A T E	**External Tracing In mono**	1-Plug in the XboxController if you're not using it in bluetooth mode. 2- Unplug the displayport of the VR headset if it's still connected. 3- Activate GameObject **FPSController** and **Laser** from the Hirerachy by checking the top box in the Inspector (**Figure1**). 4- Activate game object **[VRTKManager]** by unchecking the top box in the Inspector (**Figure2**). 5- from code **Tracing_mono.cs**, mimic the following at line 159 : `bool External_tracing =true;` `bool create_external = true;//create` `bool edit_external = false; // edit` `// Internal Approach` `bool Internal_tracing = false;` `bool create_itnernal = false; // create` `bool edit_internal = false; // edit` If the test is made for neuron 1, then set it to true and set false to neuron2, and viceversa: `// CELLS` `bool neuron1_trial = true;` `bool neuron2_trial = false;` 6- Press play, a message will popup on the screen:

<table>
<tr><td></td><td></td><td> 

Just click yes with the mouse and proceed.</td></tr>
<tr><td></td><td>External TracingIn VR</td><td>1- plug the displayport of the VR headset if it’s still connected.
2- Deactivate GameObject FPSController and Laser from the Hirerachy by checking the top box in the Inspector (Figure1).
3- Activate the game object [VRTKManager] by unchecking the top box in the Inspector (Figure2).
4- from code Raycaster_stab.cs, mimic the following at line 141 :


```
bool External_tracing =true;
bool create_external = true;//create
bool edit_external = false; // edit
// Internal Approach
bool Internal_tracing = false;
bool create_itnernal = false; // create
bool edit_internal = false;  // edit
```

If the test is made for neuron 1, then set it to true and set false to neuron2, and viceversa:

```
// CELLS
bool neuron1_trial = true;
bool neuron2_trial = false;
```

5- Make sure the headset is on from the STEAMVR window. Otherwise, just restart it from SteamVR.
6- Press PLAY.</td></tr>
<tr><td></td><td>Internal Tracing In VR</td><td>1- Follow the same steps concerning switching from mono to VR.
2- from code Raycaster_stab.cs, mimic the following at line 141 :


```
bool External_tracing =false;
bool create_external = false;//create
```

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```
bool edit_external = false; // edit
// Internal Approach
bool Internal_tracing = true;
bool create_itnernal = true; // create
bool edit_internal = false;  // edit
```

If the test is made for **neuron 1**, then set it to true and set false to **neuron2**, and viceversa:

```
// CELLS
bool neuron1_trial = true;
bool neuron2_trial = false;
```

3- Make sure the headset is on from the STEAMVR window. Otherwise, just restart it from SteamVR.
4- Press PLAY.
</td>
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<tr>
<td rowspan="2"></td>
<td>Internal Tracing in Mono</td>
<td>

from code **Tracing_mono.cs**, mimic the following at line 159 :

```
bool External_tracing =false;
bool create_external = false;//create
bool edit_external = false; // edit
// Internal Approach
bool Internal_tracing = true;
bool create_itnernal = true; // create
bool edit_internal = false;  // edit
```

If the test is made for neuron 1, then set it to true and set false to neuron2, and viceversa:

```
// CELLS
bool neuron1_trial = true;
bool neuron2_trial = false;
```
</td>
</tr>
<tr>
<td>External Tracing In mono</td>
<td>

from code **Tracing_mono.cs**, mimic the following at line 159 :

```
bool External_tracing =true;
bool create_external = false;//create
bool edit_external = true; // edit
// Internal Approach
bool Internal_tracing = false;
bool create_itnernal = false; // create
```
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		``bool edit_internal = false; // edit``` If the test is made for neuron 1, then set it to true and set false to neuron2, and viceversa: ```// CELLS bool neuron1_trial = true; bool neuron2_trial = false;``` When you press play, you need to read the skeleton file by launching the menu from your XBox and select READ MCF.
	External TracingIn VR	from code **Raycaster_stab.cs**, mimic the following at line 141 : ```bool External_tracing =true; bool create_external = false;//create bool edit_external = true; // edit // Internal Approach bool Internal_tracing = false; bool create_itnernal = false; // create bool edit_internal = false; // edit``` If the test is made for **neuron 1**, then set it to true and set false to **neuron2**, and viceversa: ```// CELLS bool neuron1_trial = true; bool neuron2_trial = false;``` When you press play, you need to read the skeleton file by pressing R on the keyboard.
	Internal Tracing In VR	from code **Raycaster_stab.cs**, mimic the following at line 141 : ```bool External_tracing =false; bool create_external = false;//create bool edit_external = false; // edit // Internal Approach bool Internal_tracing = true; bool create_itnernal = false; // create bool edit_internal = true; // edit```

		If the test is made for **neuron 1**, then set it to true and set false to **neuron2**, and viceversa: `// CELLS` `bool neuron1_trial = true;` `bool neuron2_trial = false;` When you press play, you need to read the skeleton file by pressing R on the keyboard.
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Important to know:

- After completion of each task and before you stop the session, you must save your progress. To do that:
    - In VR: you press keyboard S, then after a second or two, press W. This will sort out the nodes, then write them to disk.
    - In Mono: you launch the menu again using your XBOX controller, then you select SAVE.
- Each session has its own directory path of progress files, see the table below. For each participant, you need to copy the generated log and back it up somewhere. I usually

rename them with the participant name. Each skeleton save will produce two files with the name conventions **Skel_fileX.csv** .

	Modes	Actions
CREATE	**External Tracing In mono**	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Mono\SemiAuto\writeExternal
	External TracingIn VR	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Stereo\VRSemiAuto\writeExternal
	Internal Tracing In VR	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Stereo\VRSemiAuto\writeInternal
	Internal Tracing in Mono	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Mono\SemiAuto\writeInternal
EDIT	**External Tracing In mono**	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Mono\MCFS\edit_External
	External TracingIn VR	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Stereo\MCFS\edit_External
	Internal Tracing In VR	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Stereo\MCFS\edit_Internal
	Internal Tracing in Mono	\VR_Skeletonizer\interactiveVR\assets\SKELETON\Mono\MCFS\edit_Internal

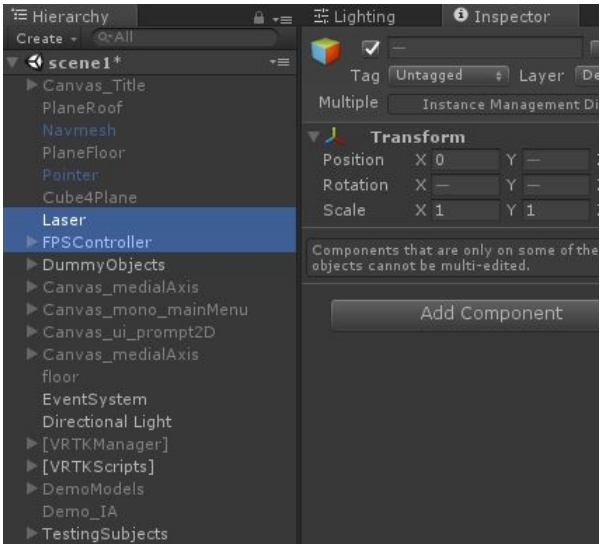

Figure 1

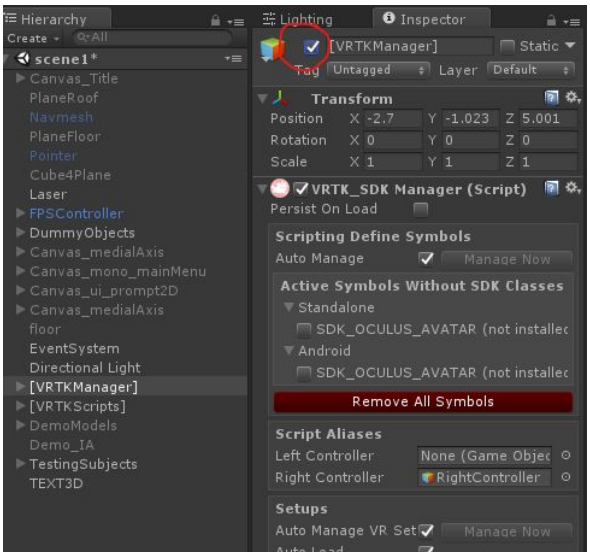

Figure 2

XBOX GUIDE for External Tracing:

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Xbox_LTrigger = accelerate

Xbox_RTrigger = shoot laser

Xbox button B = AddNODE | DelNode | Select and Connect

Xbox button X = UNDO

RB = move down

LB = move up

Menu (two bars) = show/hide menu

XBOX GUIDE for Internal Tracing:

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Xbox_LTrigger = accelerate

Xbox button B = AddNODE | DelNode | Select and Connect

Xbox button X = UNDO

Xbox button Y = siwtch on/off tourch

Xbox button A = when Menu is on, presses buttons | When the menu is off, it disconnects the stabilizer and stays put on the current spot.

RB = move down

LB = move up

Menu (two bars) = show/hide menu

TwoWindows = Toggle normals

VR:

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To reverse the normals with the grip button on the oculus controller. You need to launch the main menu, click on Interactive Analysis. The pointing stick will appear on both controllers. You

use them to launch the wrist menu and press on Rev-N button. You can now toggle between normals sides using the grip button.