

## Basis-assets und Beschreibung der Projektteile:

### Location-projekt:

Documents - GitHub - what-we-want

Used GitHub Desktop to co-develop

### Used Tech for development: HARDWARE

- · Lenovo ThinkPad P1 (Win 10)
  - · Vive Pro set (2 base station 2.0, HMD, ...)
  - · 4 Vive Trackers + dongles
  - · 1 external audio interface with 8 Line Outputs (PreSonus Studio1824c)
  - · 8 mono male jack connector cables
  - · 4 Sennheiser wireless in ear system (ew G4) + 4 wireless receivers
  - · 4 Headphones (beyerdynamic DT880 Pro & DT770 PRO)
  - · 3 USB Hubs (1 USB-C, 2 USB-A)
  - · 1 Displayport - USB-C Adapter
  - · 1 external screen + HDMI cable
  - · Midi Pad
  - · Mouse
  - · diverse electricity cables
- 
- SOFTWARE
    - · Visual Studio 16.3.6
    - · Unity2019.2.10f1
    - · SteamVR App 1.8.21 + Steam Account
    - · AudioStream package/Asset

### Required Plugins:

Steam VR Unityplugin

AudioStream (Unity Asset Store, commercial): Can target multiple outputs on an audio interface. Unity does not have a native functionality for multi-channel output, so this plugin is required.

DearVR Unity (commercial, sponsored): Required for binaural audio functionality. Turned out to be superior to Resonance Audio.

MidiJack (Open Source): Connects control UI in the application to a MIDI device.

Howto:

Create a new scene:

- Create a new scene, e.g. name "TW Sample Scene".
- Add all audio sources in this scene.
  - Each AudioSource should also have a DearVRSource component on it, with the desired spatial audio settings (look at the sample scenes for reference).
  - Each AudioSource should also have a GenerateUI component on it, so it can be controlled via the on-screen interface. Set the values as desired, to define a dropoff range for this sound, and to assign MIDI input to this audio source's properties. Set them to -1 if no MIDI input is required.
- Add the name of the scene to the list in the SceneList asset (can be found in Scripts/TurningWorld)

General setup (might be incomplete):

- Open the Base Scene
- On the Player game objects, set the Index on the Steam VR Tracked Object component to the index of the VR tracker that should be used for this player.

### Scenes:

Base Scene (location: Assets-Scenes-AdditiveScenes):

Includes

- Camera frontal
- Camera top
- Directional Light
- Floor
- MiniMe
  - CubeMe
    - Cube
  - FirstPersonCam
- Player A,B,C & D
  - CubeA, B, C & D
    - Cube
- Turning World Manager
  - Audio Listener

- Dear VR manager
- AudioControlUI
  - AudioSourceControl
    - ...
  - SceneControl
    - ...
  - SceneSwitcher
    - ...
  - SceneManager
  - EventSystem

Additive scene:

Should include all the audio sources for a scene, and nothing else.

### **Modules/Parts/Features:**

AudioMixer: The audio mixer “OutputDeviceRouting”, located in Scripts/TurningWorld, manages the routing of the audio signals of 4 virtual AudioListeners to 4 output channels. Can be left as is.

Cameras: There are three different cameras that can be freely switched at runtime by switching the Output Display in the dropdown on the top left of Unity’s Game window.

- Display 1: Frontal view
- Display 2: Top view. This view displays the audio controls, to load and unload scenes and control individual audio sources within the scenes
- Display 3: First person view. The first person camera can be moved with WASD or arrow keys, mouse to look around.

Base scene: The base scene includes all the basic setup and functionality for the experience, including SteamVR for tracking, multiple audio listeners, and the Turning World. This scene should not include any audio sources and can be left as is.

Additive scenes: Additive scenes include nothing but the audio sources in a scene. They are dynamically loaded and unloaded at runtime.

SceneList: The asset “SceneList” in Scripts/TurningWorld holds a list with the names of all additives scenes that can be loaded at runtime.

UI Generator: UI generator scripts dynamically create the UI depending on what additives scenes have been added to the SceneList asset.

Turning World: The turning world is the core workaround to allow multiple players with individual audio listeners in a scene. Players move individually, but share one AudioListener, so moving the AudioListener with the players will not work. Instead, a copy of all audio sources is created for each player, a “world copy”. Since the AudioListener cannot be moved

with the players, the entire world copy is moved and rotated instead. So it is not the player in the scene that moves, but the world copy for this player.

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*Hi Chris, ich hatte vor einem Jahr schon einmal ein Manuel angefangen, ich habe es mal hier unten angefügt!*

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Manuel setting up WHAT WE WANT TO HEAR

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## SOFTWARE

- Visual Studio 16.3.6
- Unity2019.2.10f1
- Steam VR Unityplugin
- SteamVR App 1.8.21 + Steam Account
- DearVR unity v1.2.0(Amazingly I got this sponsored from DearVR, thanks again!)
  
- AudioStream package/Asset
  
- (c#, Object Orientated Programming)

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## Installtions processe

- Install software Unity, Visual Studio

- Install Steam VR (App), Vive software

- vive software installiert: <https://www.vive.com/de/setup/>

produkt 'Vive' gewählt'

während installation prozess: Steam account erstellt und steam installiert

steam performance test heruntergeladen und durchgeführt

- meine grafikkarte ist nur 'medium' geeignet

- Install Steam VR Unity (Plugin, Asset)

- Tracker connection

Update Tracker and paired with SteamVR (App)

[https://www.vive.com/us/support/wireless-tracker/category\\_howto/pairing-vive-tracker.html](https://www.vive.com/us/support/wireless-tracker/category_howto/pairing-vive-tracker.html)

- Connect Tracker dongle via USB (3.0) to PC. Tracker sends data to USB dongle.
- Push the middle button of the tracker long to put it on and go in connection mode (blinking), it should be visible in steamvr window, right click on it and press 'pair tracker', follow instructions. Tracker should be now lid in blue.
- At my PC, only 2 trackers where allowed per USB Hub, else they couldn't be found. The HMD also includes 2 'trackers', pairing process sometimes tricky. I somehow manage to connect all 4 trackers after changin order of connecting tracker, controller.... When it worked once, it always worked after! I even managed a connection over one USB-Hub, but performance was very bad (stockte).
- Right cick on it and choose manager tracker, there you can assign a role. (Classically left and right hand are used for the controllers, so I decided to assign 'left or right food' to each one of the two trackers.)
- In unity, I added the script 'Steam VR\_Tracked Object' to a player, there I choose 'device 3 or 4' which represents the tracker.
- There is no need to pull any prefarb, or the steam camera into the scene!
- (In Unity, I had the problem that the audio sources seem tilted vertically. To solve this we attached the 'Virtual Listener' to a cube attached to the player. Then we rotated the X axis of the cube 90°. The copied sources are now horizontally, but they seem uside down, if we rotate Z 180° as well we could fix that, but noticed that actually the left and right cables between soundcard and senders are swopped! So we just wopped them to fix the problem. I believe we solved this problem later, I think we just had to actually 're-swop' the cables, not sure anymore here)
- Auto Turn off with trackers has to e disabled as the HMD is not moved: in SteamVr (1.9.16) Settings -->Startup/shutdown, I set 'Turn off controllers after 'Never' (was on 5 or 10min before) (15:49 turned on two trackers)

(If the above used solution does come out to not work, try the following: - Another possibility could be to choose in 'developer Settings' 'Disable Power Management'.

- Further suggestion from a online discussion: disable the "usb selective suspend" in windows setting if necessary.)

- Install DearVR
- Install AudioStream

### Aubau in Unity/ In der Scene:

AdditiceScenes Solution:

Es gibt **A.) eine Base Scene**, diese hat alles nötige drin, bis auf die Audio Sources/Audio Scenen

Diese werde seperat durch **B.) die TW (Turning World) / Sound Scenen** geladen.

*(Legend)*

Angaben/Scripte im Inspector

Objects

### Aufbau Sound Scenen (TW – TurningWorld Scenen)

- Audio Sources
  - Audio Source Sript (unity integrated)
    - set Audio clip
    - Output set to None
    - enable Play on Awake
    - set 3D Min & Max Distances here.
  - Dear VR Source (Script)
    - disable internal reverb (can be enabled but needs much processing power)

- enable Unity Distance graph (to use 3D settings of unity Audio Source) (doesn't work with reverb effects!)
- Generate UI (Script) (Causa Creation)
  - set Min (i.e. = 0) and Max (i.e. 10, has to be set something for the control to work) Dropoff Range
  - set potential Midi controls, values can also be 0

### **Aufbau Base Scene:**

- Camera Frontal
- Camera Top
- (Directional Light *(not needed)*)
- Floor *(for my own orientation)*
- MiniMe
  - Movement *(Script)*
  - Mouse Look *(Script) (currently disabled)*
  - CubeMe *(Object)*
    - Virtual Listener *(Script Causa Creation)*

### Set to right Output Mixer (i.e. MiniMeOutput)

- Cube (small cube, marks purely the front of the object)
- FirstPersonCam (Object)
  - Camera (Script unity intern)
- PlayerX
  - Steam VR Tracked Object (Script) Set the Index for the equivalent Tracker you want to use. Set/Find those in Steam App.
  - CubeX
    - Virtual Listener (Script) (Causa Creation)



Set the wanted Output Mixer (i.e. Output X)

- Cube (small cube, marks purely the front of the object)
- ein Objekt TurningWorldManager
  - TurningWorldManager (Script) Dieses muss eine Referenz auf das WorldInstance Prefab haben.

Index turning word manager, enlarge player list to the accurate output device mixers number, Die Players liste kann man mit Referenzen auf VirtualListener befüllen, muss man aber nicht, weil sie sonst auch Automatisch aus der Szene gesucht werden.

Set to the Muted Mixer (MutedOutput), this means that all the audio sources we don't want to hear get muted here, besides the rerouted Player Outputs.

- Audio Listener (Unity integrated, one per scene allowed)

muss im Ursprung liegen (d.h. Position muss 0, 0, 0 sein)

- Object Dear VR manager
  - Dear VR Manager (Script)
- AudioControlUI
  - AudioSourceControl
    - ...
  - SceneControl
    - ...
  - SceneSwitcher
    - ...
  - SceneManager
  - EventSystem

### **Audio Mixer:**

Set up Mixer (I.e OutputDeviceRouting):

- Master (change nothing)
- Muted Output

must be muted (M enabled)

- I.e MiniMe Output
  - Audio Stream Output Device (effect) added.

Set the correct ID for the soundcard output you want to use

PassThrough on '0'

- OutputX (for player X, several can be set up)
  - Audio Stream Output Device (effect) added.

Set the correct ID for the soundcard output you want to use.

PassThrough on '0'

So far max 8 Output Device Mixers allowed, reason AudioStream or Fmod (otherwise memory problems appear).

All mixers are childs of the master (not child of each other)

### **Soundcard Output devices ID**

See Play/execute Set-up

### **Set up a Player through copying**

- copy Player B two times, rename into 'PlayerC' and 'PlayerD'.
- rename child cubes of Player, in 'CubeC' and 'CubeD'
- change the material of players: 'Mesh Render' script of CubeC/D, under 'Material -> Element', pick a material.
- in Audio Mixer 'Outputdevicerouting', duplicate OutputB (or A) and rename them in 'OutputC' and 'OutputD'
- in 'TurningWorldManager' element (hierarchy) choose 'Players->Size: 4', add CubeC/D to the Elements.
- in PlayerC/D-CubeC/D choose the appropriate Virtual Listener Output.

- every player needs to get addressed the fitting Tracker, maning got to script 'Steam VR\_Tracked Object' (of Player in hierarchy) and choose Device Index. Currently:

PlayerA: Device3 (-73), Tracker Role (SteamVR) left shoulder

PlayerB: Device4 (-DE), Tracker Role (SteamVR) right foot

PlayerC: Device5 (-B6), Tracker Role (steamVR) left foot

PlayerD: Device6 (-D3), tracker role (steamVR) right shoulder)

Device ID high doesn't seem to have anything to do with the assigned in roles in steam VR, but it might be connected to the order of putting the trackers on!?

- every output in mixer need to get assigned the correct output index number.

**[Build Scenes help](#)**

To build a scene in the AdditiveScenes Solution, it can help to drag in the Audio Scene that needs to be build into the hierachy of the Base Scene, then things can be tested. (just not controlled by the UI). For play mode this scene can then simply be erased from the hierachy

*MiniMe (mainly made for me to be able to move in the scene without trackers and to build scenes. I added an Extra Mixer Group to the OutputDeviceRouter called 'MiniMeOutput' and linked this to the Virtual Listener in the MiniMe Object.).*

Ich habe eine First Person Camera auf MiniMe geschmissen, die auf Display 3 rendert. Das MouseLook und Movement Script liegt auf MiniMe, dort kann man über die Parameter im Inspector die Sensitivität von Maus und Bewegung einstellen.

*MouseLook ist im Moment ausgedreht, das solltest du nur andrehn, wenn du wirklich in der First Person Camera dich herum bewegst - ansonsten drehst du MiniMe ständig herum auch wenn die Maus bewegt wenn du eigentlich ein anderes Display eingestellt hast als das First Person Display.*

put the 'Movement (Script)' auf MiniMe und set Speed Values to 1

*put the 'Mouse Look (Script)' auf MiniMe and chose 'Axes: Mouse X'*

## **Play/ Execute Set up**

To load TW Scenes into Base Scenes:

1. Open >File >Build Settings, drag and drop appropriate TW scene into 'Scenes in Build' window, make sure scene is enabled.
2. Define Scenes in 'Assets/scripts/TurningWorld/SceneList' (choose the Asset in the Project window, set the name in the list in the inspector).

The Scene named here show are then shown in the UI when Base scene is started

It might take a moment to load all scene when Play mode ist started, depending on their size.

If I want an audio source not to immediately start playing when TW scene is loaded, the audio source has to be disabled in the inspector!

Correct Soundcard Output ID's have to be set in the AudioStreamAsset of the Mixer.

Find in unity menu → tool → Audio Output devices.

List have to be checked again when i.e soundcard or other audio devices are unplugged or the system audio settings are changed!

Die Audio Output Devices die abgefragt werden, werden über FMOD implementation (standard unity) beim windows system abgefragt.

(From AudioStream oder Cause Creation...????)

### Listening into-Live performance

um reinzuhören in was jemand hört kann ich im Audio stream Plugin 'Passthru' auf '1' stellen, dann höre ich den sonud auch auf dem default ausgang des Laptos (hier z.b. headphones auswählen)

- um die anzeige der UI auf einem anderen display zu sehen, kann ich beim element 'audio Control UI' unter 'canvas' das 'target Display' ändern.

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## SEPERATE COMPONENTS Notes

### Scripts from Causa Creation

Turning world set up: for every player copies of the Original Audio Source are made. The Original Audio Sources are routed into the muted Mixer (thus not heard).

The tracking data from vive input gets converted. Instead of it moving multiple listeners through the original audio sources (not possible as unity default only 1 listener per scene allowed!), are instead copies of the audio sources (for each player!) moved in the equivalent distance around the centred audio listener.

Transformation:

tracked player position TO Original Audio sources = Copied Audio sources per player TO unities audio listener

The audio sources of 1 spectator get mapped on a MixerGroup, this mixer group gets addressed to a specific hardware output.

When Unity is in <Play> Mode, the audio copies are shown (under Player A, B,.. objects) as: 'PlayerX\_World'. There you can also see where the sources are actually routed/send to ( i.e. 'Output Device A, B,...', from in the Mixer).

- VirtualListener Script ???

????creates copies (pairs) of original audio sources for the player.

(imitiert quasi die mehreren AudioListener. D.h. das GameObject das die getrackte Nutzerin darstellt bekommt so ein VirtualListener Script).

Am Script wird eingestellt, auf welchen Output diese audio sources gehen sollen.

- TurningWorldInstance (Script) ???

convertes tracking data (position, rotation) of player into movement copied audio source pairs

copies also functions of DearVR

- .....

- AudioControlUI

functions:

Midi connection

control scenes, start stop, pause, fade in/out

control single audio files >start, stop, pause, jump to certain moment (seconds), volume

control animation >start, stop, pause

pre-select changes (\* Über das Häkchen rechts oben in den Audio Control UIs können jetzt die Controls von einzelnen Sounds ausgewählt werden. Dann kannst du über die Buttons unten alle ausgewählten Sounds starten, pausieren ,oder stoppen. Damit kannst du mehrere Sounds exakt gleichzeitig starten.)

- - fade out/fade in kann ich im -audioControlUI – sceneManger umstellen (wert sind in sekunden)
- Generate UI (Script) & Midi Input

UI Controls werden für alle AudioSources erstellt, die ein GenerateUI Script auf ihnen haben.

In diesem GenerateUI script kannst du jetzt auch Midi Input Numbers für On/Off, Volume und Range angeben.

Midi Input:

Du findest die Nummern zu den Tasten und Reglern deines Midi Geräts raus indem du das Window/Midi Jack Fenster aufmachst. Wenn du ein Midi Gerät verbunden hast solltest du da jetzt die Inputs sehen wenn du welche machst. Die Inputs haben so eine Form: s(80)d(29,7F) from C6FA56C8. Das relevante ist das was in der zweiten Klammer steht, also hier das (29,7F). Das bedeutet die Nummer der Taste bzw. des Reglers von dem dieser Input kommt ist 29. Achtung, dieser Wert ist ein Hex Wert, du musst ihn noch in Dezimalwert umrechnen (z.B. hier: <https://www.rapidtables.com/convert/number/hex-to-decimal.html>). Dann hast du die Midi Input Number als Dezimal Wert, und den kannst du bei einer GenerateUI Script eintragen um diesen Midi Input mit dem entsprechenden Wert der AudioSource zu verbinden."

- - UI window sichtbarkeit im scene window aus machen. Ich kann die Layer des UI object (hier 5) ausblenden. Automatisch dieser layer zugewiesen. In unity im layers dropdown menu oben rechts kann ich die layer ausblenden. (dort könnte ich sie auch locken)

### Audio file Samples

- working with Mono sources (there is no point in positioned stereo sound, as we later add spatialisation)
- still open (--> test what happens if I change Audio Compression bei den audio clips, zur zeit ist 'Vorbis eingestellt! Vielleicht läd es mit einer anderen kompression schneller PCM ist warschienlich eine gute möglichkeit. Vorbis ist woh optimiert für kure clips)

### Audio Source (Script)



Spatializer Häkchen (in inspector) erschwindet wenn 'Spatializer = None' in 'Project settings' is choosen.

Dieses Häkchen braucht man scheinbar auch nur für externe Spatializer, nicht für den in Unity integrierten, für diesen reicht es den schieber auf 3D zu schieben (im Audio Source Inspector).

### Dear VR (script)

- 'Dear VR unity' spatializer Plugin. Manuel:  
[https://cdn.shopify.com/s/files/1/0120/4748/2938/files/dearVR\\_UNITY\\_Manual\\_\\_v1\\_2\\_1\\_rev2.pdf?2890](https://cdn.shopify.com/s/files/1/0120/4748/2938/files/dearVR_UNITY_Manual__v1_2_1_rev2.pdf?2890)
- Unity installation:

Package importieren

unter 'Edit'- 'Projectsettings' muss bei 'Spatializer Plugin' 'dear VR' ausgewählt werden

object erstellen, dann 'Dear VR Source (Script)' hinzugefügt, dies fügt automatisch auch eine Audiosource hinzu

außerdem muss es ein 'Gamobject' mit einem 'Dear VR Manager (Script)' geben!

I mostly didn't used any reverb effects, the internal reverb works in theory, but is processer intensiv. I tried once setting up a reverb effect as a group, but couldn't get it to work without 'knistern'

### Unity Mixer (from unity manuel):

Audio signal processing space

AudioSource --> AudioMixer --> AudioListener

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|

3D spatialization is applied to audioSource before it enters the AudioMixer:  
"the attenuation applied to an AudioSource based on its distance from the AudioListener is applied to the signal before it leaves the AudioSource and is routed into an AudioMixer "

Master Mix kann nicht gemutet werden.

### AudioStream Asset

- import Asset. Read 'Read me File' of Asset, here it says I need to import parts of the 'FMOD Unity integration' <https://www.fmod.com/download> downloaded Version 2.00.06

Import package (right-click on 'assets' in unity, choose 'import package' – 'external package' – choose destination of the package (i.e. 'downloads'))

- Problem: got an error code; Solution: only imported the recommended FMOD files, as described in AudioStream ReadMe File.

### Camera views

(<https://www.youtube.com/watch?v=xvyrzwwU1DE>)

I can switch between different camera's by setting different Displays and by choosing those in the Game window

**PROBLEM:** Due to SteamVRI some how only see a view through/or at least related to the HMD.

**SOLUTION:** in the camera's I have to set the 'Target Eye to None (Main Display)'! (it as on 'both') Now i can swap between my non VR camera's / the different display's I set.

## Player aktivieren/deaktivieren

Um Player in einer Szene zu deaktivieren (zum them knacken, audio buffer überlastung) muss 1. der player deaktiviert werden, im inspetor das häkchen weg und 2. das element im turning world manager gelöscht werden, z.b. right click on element and delete. Potenziell reicht es auch die Busse im Mixer zu muten... nicht sicher hier

## Animations:

- Tut. unity, create a round circling voice / animation:
  - create a parent for the audio source, i.e. 'rotator', place in there the audio source, i.e. 'john'. Reset to middle of the wished rotation/i.e. middle of the room.
  - Now elevate (Y) the rotator or the audio source as much as you like. (As the parent value currently doesn't get picked up by the Turning World, elevate the audio source)
  - move the audio source on the X (or Z) axis as far out as wished.
  - Open the Animation window, click on 'create Animator and an Animation Clip'
  - name the animation, i.e. 'rotation'. Potentially create a new folder in the Assets called i.e. 'Animations'.
  - in Animation window click on red record button (circle), place the object where you would like it to start, eventually just change the value and reset it to the value you started with. A keyframe should be set in the timeline.
  - now go to the place on the timeline you'd like to set next keyframe, i.e 60(sec.). If you need a bigger area move mouse in the timeline window and scroll.
  - change value to set new keyframe
  - now you can stop the recording and play it pressing 'play button', the animation should move.
  - to change speed, move animation around on timeline, can also be done in play mode, this gets recorded/changed also in play mode.
  - now by default the animation moves in a curve, to change that, click on 'Curves', on the button of the animation window. There you can select the keyframes (drag a field around it, potentially zoom out by scrolling the mouse), right click on them and choose 'both tangente -> linear' (shape of the curve should have changed, be linear/straight)

- to now finally loop the animation, find the Animation file you created earlier in the animations folder. Click on it and in the inspector enable 'loop Pose'

- Animationen controlled through UI

Damit das Resetten (also nicht nur pausieren, sondern auf ausgangspunkt zurücksetzen) der Animation funktioniert, muss man einen State Übergang im Animator hinzufügen. Das musst du leider bei jeder neuen Animation machen - wie das aussehen soll siehst du im Sphere Animator für die animated john scene, dort hab ich das schonmal gemacht.

Bei neuen Animationen funktioniert das dann so:

Im Animator Window auf den Tab "Parameters", auf "+" klicken, und Trigger auswählen. Benennen mit "Restart".

Rechtsklick auf Any State -> Make Transition -> Ziel auf deine eigentliche Animation.

Dann den Transition Pfeil auswählen, bei Conditions auf "+", und Restart aus dem Dropdown auswählen

Falls Animation sofort stoppen soll muss in der Transition auch noch "Has Exit Time" abgedreht werden, und Fixed Duration an, und Transition Duration auf 0.

### Soundcard:

note: the driver of soundcard I was using had at the beginning a Mixer enabled that mixed all the incoming sound signals together, this led to quite some confusing, be aware to check the settings of the soundcard, if the Line outs really just play there addressed sound signal.

