

## Video Recording, Camera Tracking and VFX

Link to all the videos – [https://drive.google.com/drive/folders/1v5Rklikl6cCBx2lvPX8fMNLz\\_K7y8qIh?usp=sharing](https://drive.google.com/drive/folders/1v5Rklikl6cCBx2lvPX8fMNLz_K7y8qIh?usp=sharing)

### Finishing up the animations

In the previous part, I had finished only the main animations that “Wheatley” would use while talking to the person taking the video. This week I started with creating more animations in Source Filmmaker (as described in previous week’s report) and exporting them to Blender. I did not use Mixamo this week since I found Source Filmmaker is very nice when animating characters from Source engine based games. I created 20 different modular animations that I could chain or repeat according to the dialog in Blender. This helped massively in regards to time management since time for creating each module was very less as compared to creating the full animation in one go. Plus the “boringness” from repeated animations can be hopefully overcome by moving the camera around in the final augmentation.

### VFX – Grand plan

I had detailed each and every move “Wheatley” would make along with the corresponding sound files extracted from the original game. With this, I set out to shoot a scene that would require both camera and object tracking. The original plan was to put Wheatley on a microphone stand very similar to how his character appears in the video game and have him chat (and also rant, bounce, spin etc.) with the person shooting the video. Initially when I recorded the video for this, I was not using anything special to help tracking. This turned out to be a nightmare in Blender. I spent nearly 3.5 hrs manually tracking very blurry and faint trackers for camera with no hope for tracking the microphone stand at all. In the second pass, I used electrical tape at the very tip of the microphone (where I was planning to attach Wheatley) and tracked that red tape. This turned out better but it was very difficult to get a sense of direction since all I had was a simple 3D point. Therefore, in the final version I used 2 pieces of electrical tape to track 2 points along the microphone stand in order to get a better handle. Despite this, it was impossible to get reliable movement out of object tracking. Object tracking solver requires at least 8 trackers or at least 4 reliable ones as shown in [1].

I found that it was difficult to put trackers on the microphone without it being obvious or looking bad. Moreover, the lighting in my room was also awkward and I was unable to shine more light at my table or use a different colored mousepad to change table color for more contrast. All of this made tracking and solving for stand motion very cumbersome. Then I managed to find a video that used only 2 trackers for motion tracking in a hackish way here [2]. The idea is to constrain the movement of the 3D object that you will add in the scene along these 2 points using an armature. The tutorial used a single bone but I needed a slightly more complex hierarchy – the 2 points being an “arm” and Wheatley at the “wrist” so to say. With this, I managed to get Wheatley doing all sorts of complex movement in the parts of video where the microphone stand is visible. The problem arose in the beginning and end parts of the video where the stand flings in or out of video. This was nearly impossible to do with the camera also moving in these parts. I realized this far too late and decided to leave this plan and switch to a simpler plan after discussing with sir. The relevant files for this are available on the shared drive link above.

### VFX – Simple plan

This time I decided to put Wheatley on the bed and only moved the camera to create “conversation” like effects from the grand plan. This video was much easier to shoot. I used all my learnings from the “Grand plan” along with the references [3-18] I used to quickly setup a scene. I used a graphics card box as a “threat” to Wheatley. The trackers were mainly the 4 corners of my ID card, the NVIDIA logo on the graphics card box and a couple of “flower patterns” from my bedsheet.

After the tracking was completed, I put Wheatley on the tracked ID card and made it so that it faces the person taking the video. I aligned the floor that Blender autogenerates with the actual bed plane and set it as shadow receiver. Then I spent some time finetuning the lighting in order to make it as believable as possible. I have used area light source roughly mimicing the size of the window the light was coming from. The light color is set to the color of the wall since any other color looked very odd.

I had also measured each distance (card-to-box, card-to-wall, card dimensions, box dimensions) in the scene which I also applied for setting the correct scale. This made overall placement of Wheatley significantly easier.

In the final render, I was rendering everything with Cycles engine with 4096 samples. This caused Wheatley to appear extremely sharp which looked awkward with everything else in significantly worse quality. I spent a lot of time figuring out perfect amount of lens blur but nothing I tried made it look correctly. Fortunately, a simple solution was to render it at lower number of samples and therefore I tried 64 samples and then denoised it. This caused it to look “sufficiently blurry”.

After all the elements were properly set, the final rendering took 6 hours to render the 2040 frames in the animation. This was despite reducing the light bounces and the number of samples significantly. I even modified the kernel and fan profiles of my machine allowing it to sustain load much longer.

## Signs of obvious modifications

*Are there any signs in your video that indicate that the video is augmented ?*

Yes. Even though the character placement and lighting feels right to me, there are places in the video where the bedsheet towards the camera is extremely flickery due to inaccurate camera solve. I found that this is almost a direct function of how good your camera is. Despite my best efforts, there are nearly 1200 frames out of the 2040 total that are very blurry. In fact some of these frames were so blurry that it was impossible even for me to manually align the tracker correctly. As a result of this, the tracked object in the tracking view is not as stable as it should be [8]. Unfortunately, this was the best video I could produce even with a tripod and image stabilization on. It is very likely that the video is being decoded in an unpredictable way on my machine causing many blurry and inconsistent frames. In the future work, I will definitely try to shoot with a better camera or pass the video through some sort of ML stabilizer to extract cleaner frames for motion tracking.

## Key takeaways

- Don't use raw video directly for motion tracking. Image sequence is more robust.
- Few high quality trackers are much better than many low quality trackers.
- Manually creating as many trackable features on the object is much better than relying on automatic feature finding modules [12, 13].
- Low solver error doesn't always mean better tracking [11].
- Using a high quality camera with known camera parameters and a high contrast scene makes motion tracking easier.
- Knowing the dimensions of the scene makes placement easier and more realistic.

## References

1. Blender 2.8 Markerless 3D tracking tutorial – <https://www.youtube.com/watch?v=PGwRpbYK45Y>
2. Blender VFX tutorial: Two point motion tracking – <https://www.youtube.com/watch?v=xxMI4aT4FQQ>
3. <https://blender.stackexchange.com/questions/14330/motion-tracking-what-do-the-graphs-represent-and-how-are-they-useful>
4. [https://docs.blender.org/manual/en/latest/movie\\_clip/tracking/clip/toolbar/track.html](https://docs.blender.org/manual/en/latest/movie_clip/tracking/clip/toolbar/track.html)
5. [https://docs.blender.org/manual/en/latest/movie\\_clip/tracking/index.html](https://docs.blender.org/manual/en/latest/movie_clip/tracking/index.html)
6. <https://blender.stackexchange.com/questions/3359/camera-tracking-markers>
7. <https://blender.stackexchange.com/questions/53435/solve-error-high-with-good-track>
8. <https://blender.stackexchange.com/questions/42329/how-can-i-get-better-results-when-doing-camera-motion-tracking/42332#42332>
9. <https://blender.stackexchange.com/questions/53435/solve-error-high-with-good-track/71785#71785>
10. <https://blender.stackexchange.com/a/71785> – was specially helpful for reducing the solver error rate post-recording
11. <https://blenderartists.org/t/bad-track-even-with-a-0-6-average-track-error/616934>
12. Fully Automatic Camera Tracking for Blender using Photogrammetry (Structure from Motion) – <https://www.youtube.com/watch?v=BwwaT2scoP0>

13. [https://github.com/miikapuustinen/blender\\_autotracker](https://github.com/miikapuustinen/blender_autotracker) – Initially experimented with this. Didn't turn out very well
14. <https://blender.stackexchange.com/questions/182322/script-to-auto-detect-features-to-track-using-python> – experimented with this for both object and camera tracking. It did extract features but they were not very interpretable
15. <https://github.com/s-leger/blenderTracking> – addon version of reference 10
16. Blender Trick to reduce Motion Tracking Error Rate incredibly after motion capture finished–<https://www.youtube.com/watch?v=0ZYOro1rUxw>
17. CGMatter YouTube channel – [<https://www.youtube.com/@CGMatter>](<https://www.youtube.com/@CGMatter>)
18. Default Cube YouTube channel – <https://www.youtube.com/c/DefaultCube> [previous part of report]

## Character Rigging and Animation

### Rigging Wheatley

Unlike a lot of humanoid characters, Wheatley is a spherical character that is supposed to roam around via rails. Therefore, we can't expect standard armature rigging (2 hands, 2 legs etc.) to work out of the box with our mesh. Instead I started with a new skeleton from scratch and tried to attach it to appropriate parts of the mesh with the help of few online tutorials [1, 2, 3]. However, even after spending a lot of time (nearly 2 days) to correctly rig Wheatley, I found out that we can use Source Film Maker (SFM) [4] – an official tool by the game developers to import our model from the game. This tool has fully rigged characters from the game and allows exporting these fully rigged characters to Blender. Therefore, in the interest of time, I simply took armature rigging for my character from SFM.

### Animating Wheatley

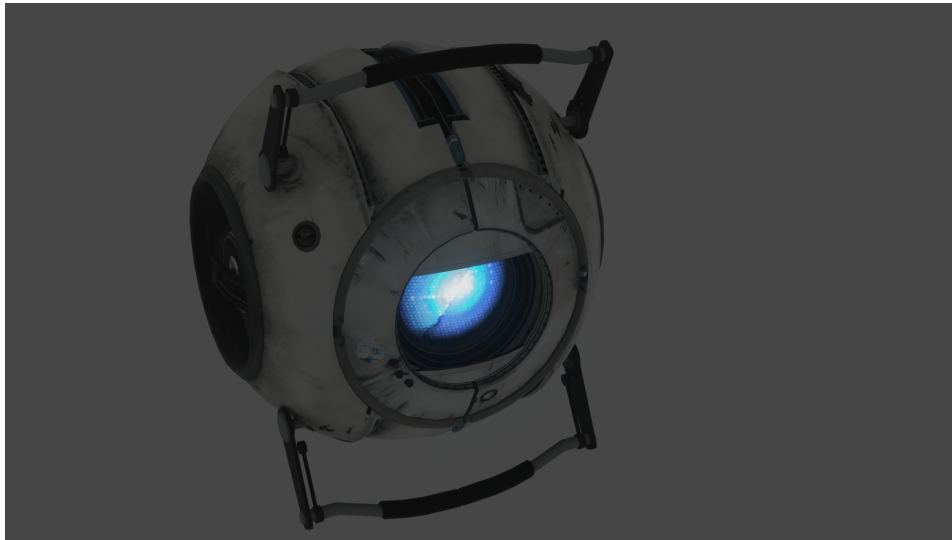
I started by uploading the rigged character on Mixamo. Then I used [5] – a VFX breakdown of animating other cores from Portal 2 as my reference and inspiration for my animation. I also prepared a far more detailed version of my animation sketch with dialogs extracted from the original game. This extracted audio and the animation sketch is also uploaded on the repo under relevant folders. My final animation will be about a minute long. I have animated a short 10 second clip out of it where Wheatley is just idle and looking around my room. After the animation was completed on Mixamo, I imported it in SFM first and made sure that it looked okay with respect to other elements of the game. I did few tweaks (mainly with speed and scale) to the animation in SFM and then exported the .smd animation file. This can be imported into Blender and applied to the rigged Wheatley with the help of “Blender Source Tools” [6].

After this, I plan to complete other parts of animation (laughing etc.) independently of each other with the help of Mixamo and SFM and then apply them in Blender with the help of NLA (Nonlinear Animation) editor in Blender.

### References

1. Character Rigging for Beginners (Blender Tutorial) – <https://www.youtube.com/watch?v=mYgznqvbisM>
2. Simple Rigging In Blender – <https://www.youtube.com/watch?v=EVBseo4YLa4>
3. Rigging Characters in Animation – [https://www.youtube.com/playlist?list=PLL3OEv6vd5VA8\\_FBkeitaeqC0kbcrhMTC](https://www.youtube.com/playlist?list=PLL3OEv6vd5VA8_FBkeitaeqC0kbcrhMTC)
4. Source Film Maker – <https://www.sourcefilmmaker.com/>
5. Portal 2 - Meet The Cores - VFX Breakdowns – <https://www.youtube.com/watch?v=a0W98bSAuxY>
6. Blender Source Tool – [https://developer.valvesoftware.com/wiki/Blender\\_Source\\_Tools](https://developer.valvesoftware.com/wiki/Blender_Source_Tools)

[previous part of report]



**Figure 1:** Wheatley's mesh extracted via the official copy of Portal 2 and imported in Blender

## Character Choice and Augmentation Plan

### Character Choice

I am choosing the character "Wheatley" from the game "Portal 2" for this assignment. "Wheatley" is an "intelligent personality core". These are purpose built (therefore having a distinct personality) robots with spherical shape that can attach to and control any electronics in the game. More info about this character can be found here – <https://theportalwiki.com/wiki/Wheatley>. Despite a somewhat simpler geometry, these personality cores can convey a lot of emotions as shown in this clip from the game – <https://www.youtube.com/watch?v=rWVGupqvCL8>.

### Animation Plan

For my video, I plan to start with a shot of my laptop that has a "Wheatley" wallpaper. In the first part of my video, I close my laptop and put that in a bag. Then as I'm leaving the room, "Wheatley" appears on my table (as if he just escaped from my wallpaper) and attempts to start a conversation. Then the entire video will be me moving my camera around the table to escape the conversation and capture him somehow in the laptop again. The main challenges in animating this character will be getting the expressions right by moving appropriate parts of the sphere. As can be seen from the video linked above, each layer of the spherical robot along with the handles can be animated. Each of the parts move very subtly to create a convincing emotion. Getting that right will be challenging.

### Character Mesh

To get the character mesh, I simply used my own copy of Portal 2 I own through Steam (the official distribution mechanism). Assets extracted in this way are allowed to be used in non-commercial projects and therefore this should not be violating any copyrights. The mesh consists of 2 (upper and lower) handles, the outer shell, the inner sphere and the 2 "eye" lids. The inner sphere has 3 degrees of (rotational) freedom while every other part has upto 2 degrees of freedom. Refer to the figure above and the aforementioned video to see these degrees of freedom in action.

### References

1. [https://developer.valvesoftware.com/wiki/Blender\\_Source\\_Tools](https://developer.valvesoftware.com/wiki/Blender_Source_Tools)
2. [https://developer.valvesoftware.com/wiki/Animation\\_in\\_Blender](https://developer.valvesoftware.com/wiki/Animation_in_Blender)