

VR System Researcher Guidelines

Alkis Antoniades

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Chapter 1

Introduction

This document is intended to act as a guideline for:

1. How to prepare virtual environment material (panoramic photo and audio).
2. How to import this material into the VR system.
3. How to use the VR system.

For material preparation, most formats of photos/video and audio can be imported in the software used in the guidelines below. You may see certain file formats used in the guidelines below, and you will be instructed to export files to specific formats to be used by the VR system.

However, make sure that you do not convert the material to that format (or ask participants to necessarily provide you material of that format) before you prepare it using the instructions below. Doing so may lead to a degradation of material quality if not done correctly (and is, in any way, unnecessary unless stated).

Chapter 2

Panoramic Photo Creation

This chapter will guide you through using the Image Composite Editor (ICE) to create an image to be used as a panoramic environment.

2.1 Prerequisites

1. Appropriate* photos / video. Strongly recommended to have video so that you can use more features of ICE, i.e. stitching a panoramic photo directly using video and if that doesn't work you can break that video into frames, which you cannot do when starting with only photos.

“Appropriate” refers to sufficiently overlapping photos, (and also in the cases of video) with minimal phone tilt and viewing angle differences, spanning the desired rotation (e.g. at least 360° if the desired virtual environment is to appear seamlessly 360°).

If you are unable to open a video file in ICE (e.g. if the format is HEVC), you will have to extract frames using VLC, described in Chapter 3, and then stitch a panorama from photos instead.

2. The ICE software (v2.0.3 installer provided).

2.2 Process

1. Open ICE.
2. If you have photos, select "New Panorama From Images" (1.). If you have video, "New Panorama From Video" (2.)
3. Locate and select the desired file(s).

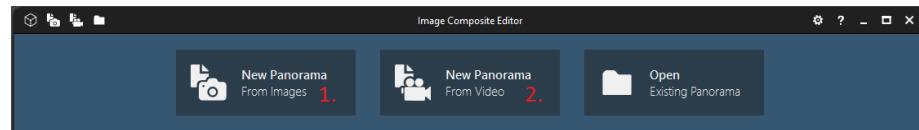


Figure 1: ICE Top Panel

2.2.1 Using Video Files in ICE

Once your video is loaded you will be presented with something similar to below.

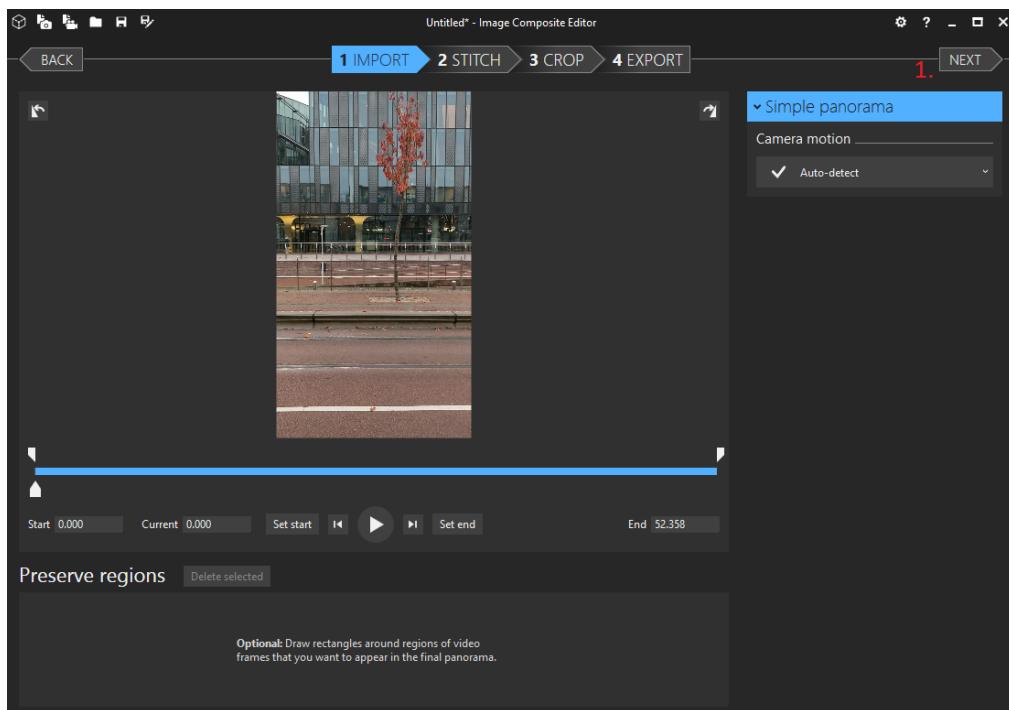


Figure 2: ICE Panorama From Video Start

You can press "NEXT" (1.) to continue, and the software will automatically break the video into frames and attempt to stitch a panoramic photo.

2.2.1.1 Preserve Regions Feature

If the automatic process does not produce an acceptable result (e.g. as in Section 2.2.3), you may use the "Preserve regions" feature to designate rectangles that the software should preserve as specified in the resulting panoramic image. This may help with defining some structure in the frame-breaking process, however, this is an advanced feature and may be tricky to work with since it could alternatively make things worse.

To use this feature, click and drag the video timeline (1.) to locate areas that you want to appear in the panoramic image as they are. Click rectangles as in (2.) to define regions to be preserved. You can see the regions you defined in the section below the timeline (3.).

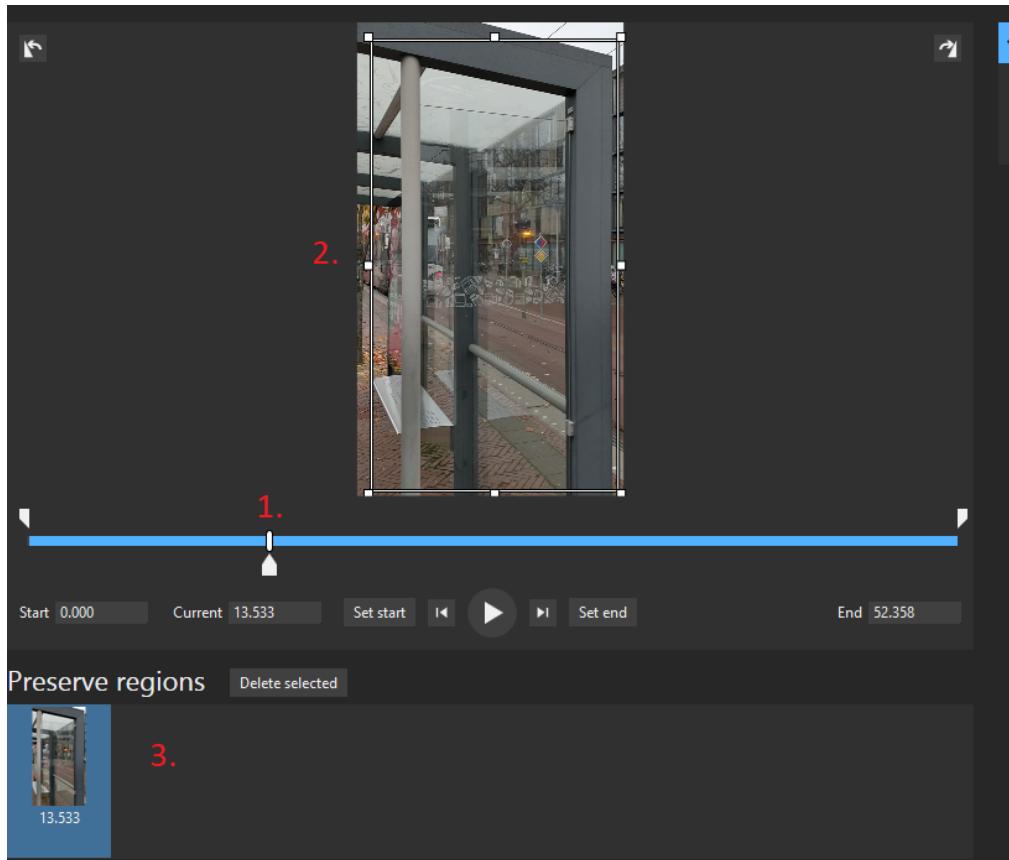


Figure 3: ICE Preserve Video Regions

If ICE is unable to produce an acceptable panoramic image (e.g. as in Section 2.2.3) when directly using video, you can try extracting frames from the video file, as described in Chapter 3, and then use those frames in ICE to stitch a panorama from photos, as described in Section 2.2.2.

2.2.2 Using Photos in ICE

Select (2.) in Figure 1. Make sure that the files are in alphabetical order, as shown below, and select all files or as many as necessary to form the desired rotation. For instance, if you have material that can form a 360° image but want a 270° image, you can simply select enough photos to form that rotation.

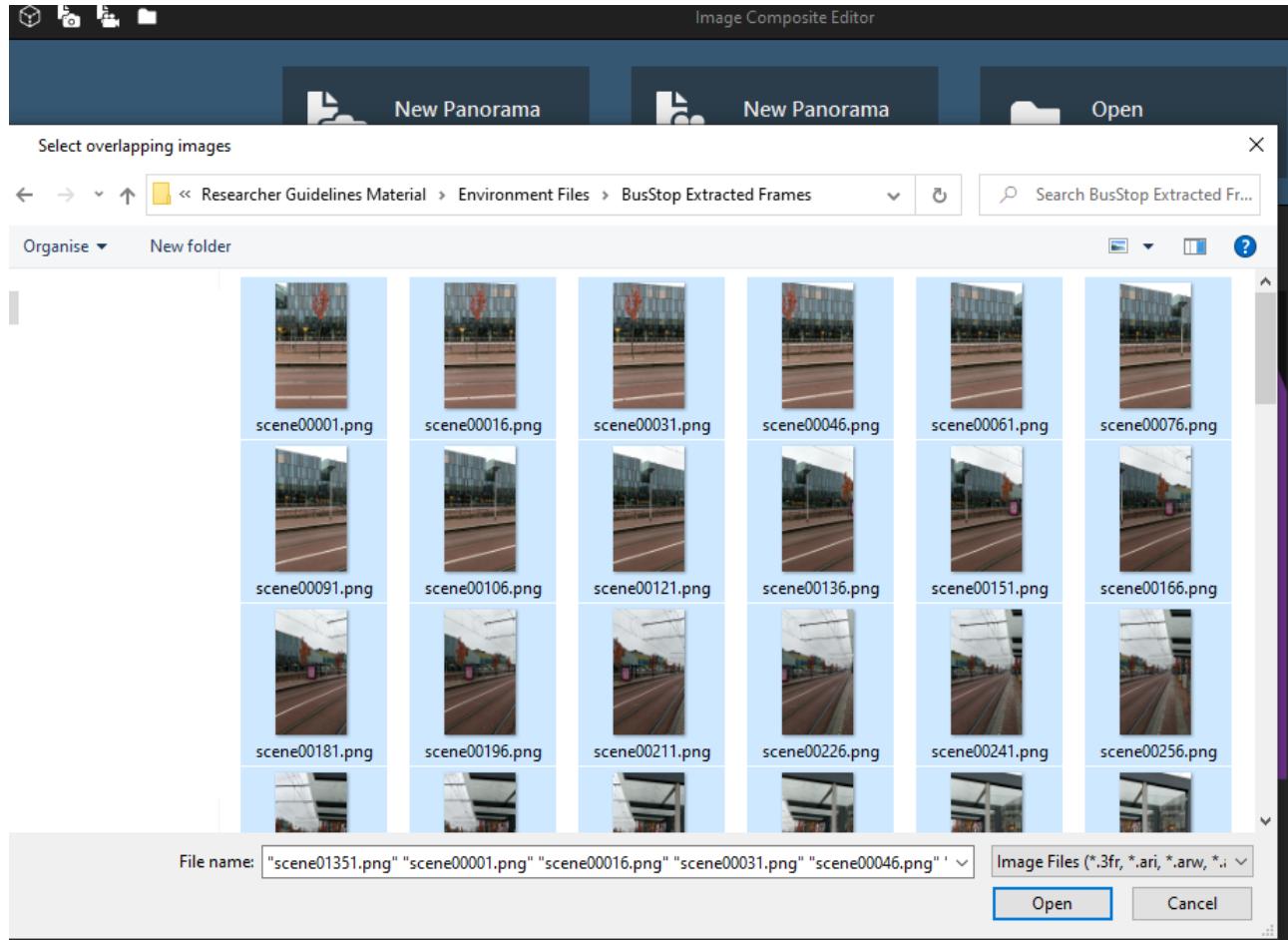


Figure 4: ICE Select Image Files

2.2.2.1 Simple Panorama

First try using simple panorama (1.), and ICE will attempt to automatically detect the overlap between images as well as whether the image forms a 360° rotation or not, and stitch them together to form a panoramic image.

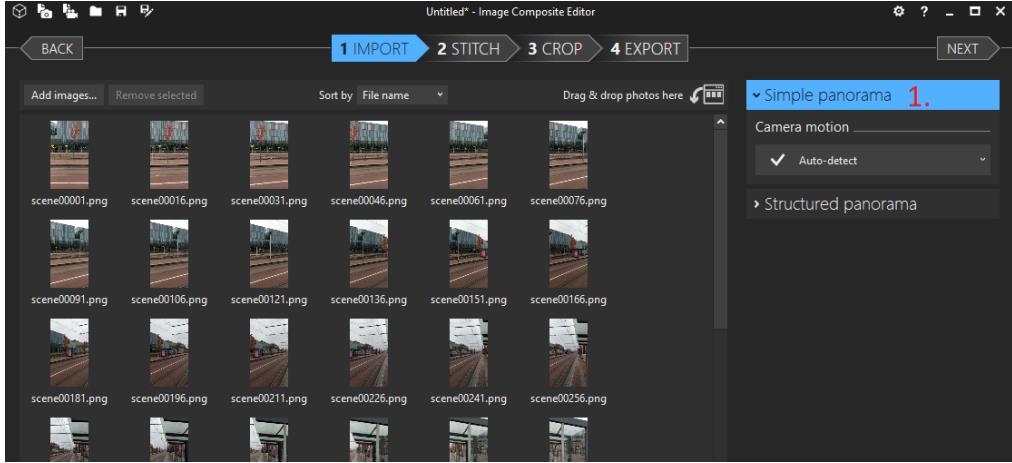


Figure 5: ICE Simple Panorama

2.2.2.2 Structured Panorama

If ICE was unable to automatically produce an acceptable result using Simple Panorama, you can alternatively use Structured Panorama (1.), which is a more advanced feature that may produce acceptable results in cases where nothing else seems to do it, since automatic stitching can be stubborn in some cases.

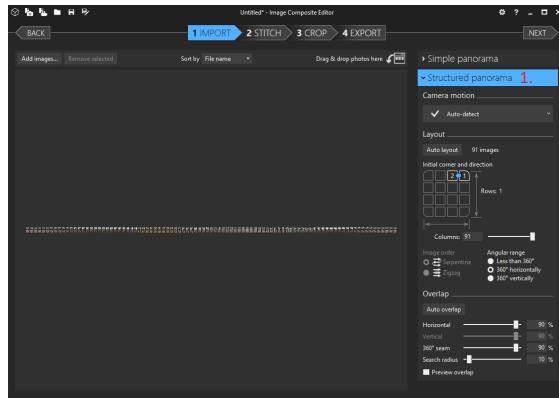


Figure 6: ICE Structured Panorama

Here you can adjust the different parameters to potentially improve the panorama stitching process:

1. How many rows/columns should the entered image form. 1 row to as many columns as the images you entered.
2. Whether the images span 360° horizontally or not.
3. How much of one image is contained in its direct neighbors.
4. Should be grayed out when 1 row is selected above.
5. Enabled when 360° Angular range is selected. Similar to horizontal overlap but for the horizontal edges of the image.
6. The search radius in which the image recognition process should attempt to find matches. In extreme cases where you can get the overlap to appear perfectly in the preview but the software doesn't stitch them together correctly, try setting this value to very low (or 0), and test.
7. Presenting an animation for how neighboring images overlap with each other. You should keep this enabled when adjusting the above parameters so that you can try to match the location of features in adjacent images.

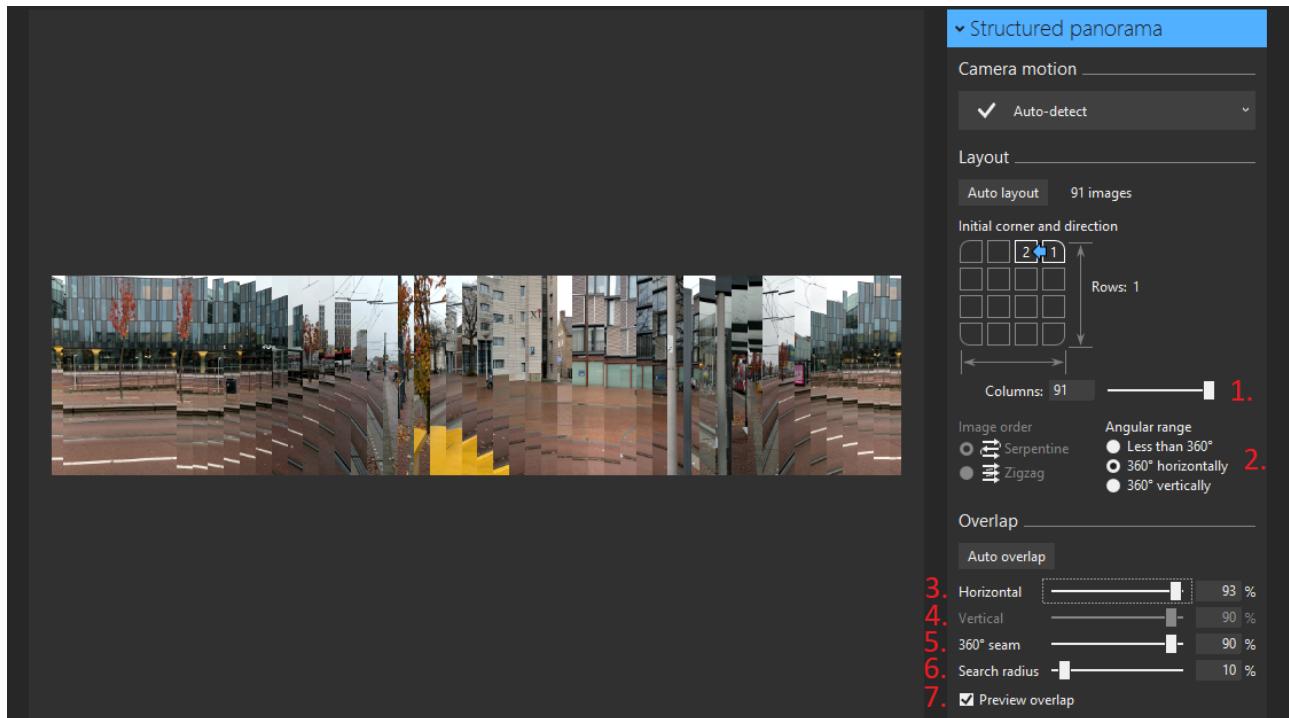


Figure 7: ICE Structured Panorama Parameter Adjustment

2.2.3 Stitching Failures

When either using video or photos, the software may not produce an acceptable result. The following two images illustrate such examples.

The image below is completely unusable, and you should try alternative suggestions mentioned in this document, depending on what method you used to obtain this result.

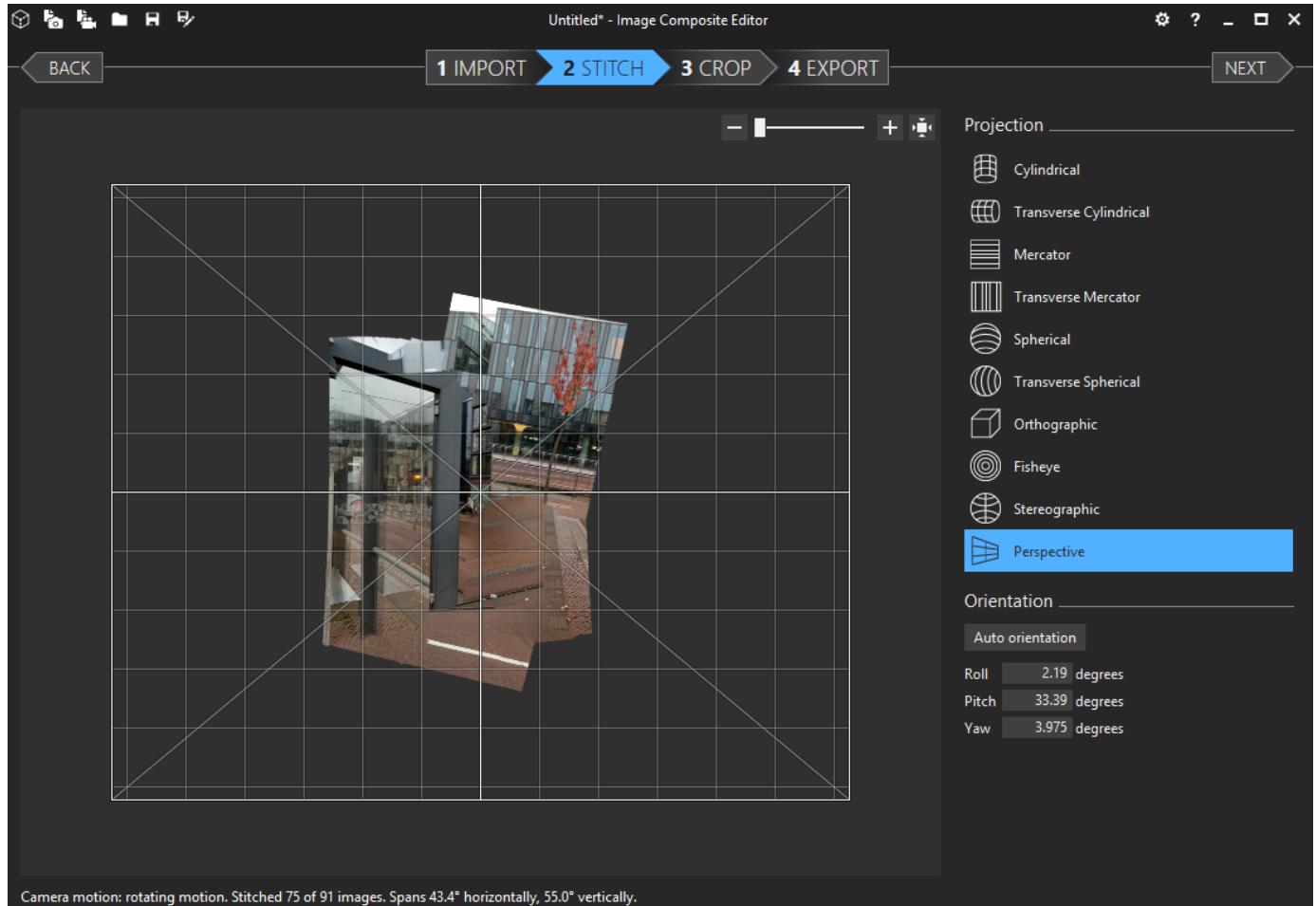


Figure 8: ICE Stitching Failure 1

The image below is still not as good as it could be, primarily because of the added horizontal tilt. It may be acceptable in cases where none of the suggestions listed in this document produce a better result, so you should try some alternatives.

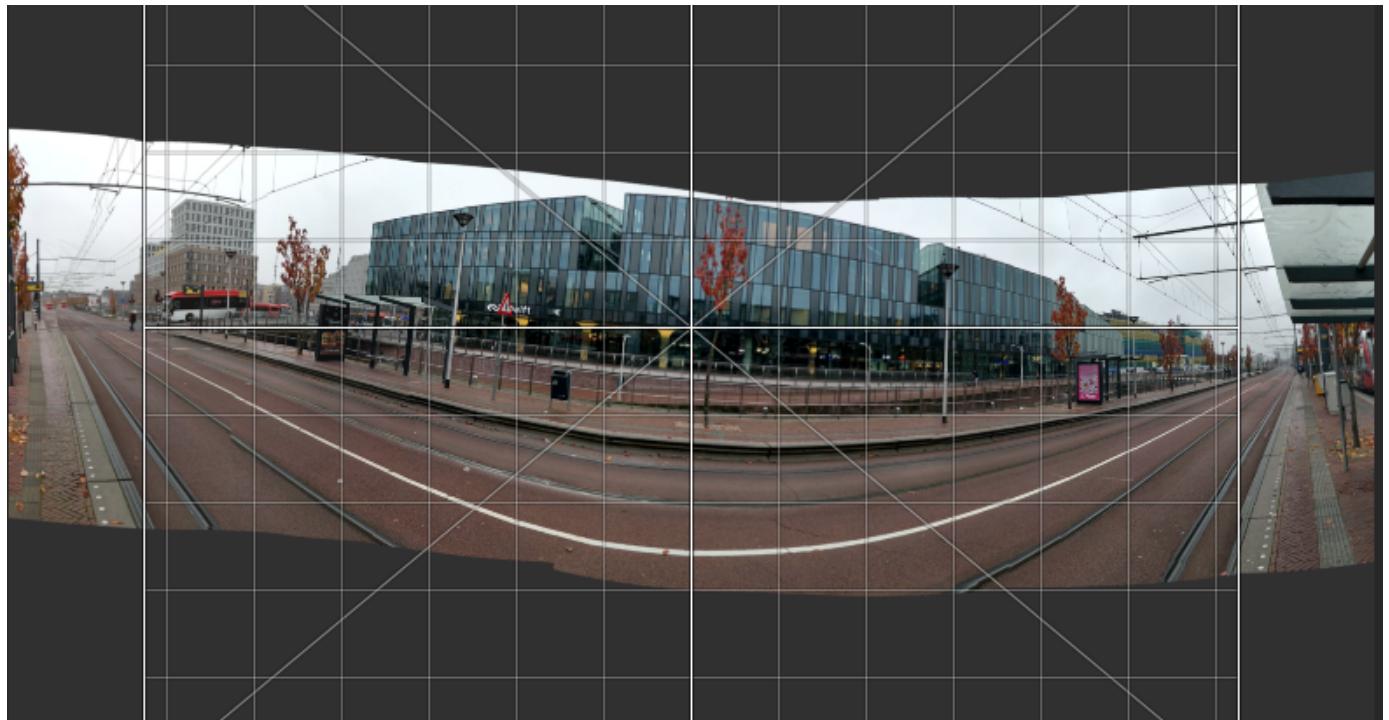


Figure 9: ICE Stitching Failure 2

2.2.4 Finishing the Panoramic Photo

Once you have a result that looks good enough:

1. Select Cylindrical Projection.
2. Move your mouse over the center horizontal line and click to drag the image horizontally. Do so to inspect the image and verify whether it is stitched correctly, and also connected at the ends if 360°.
3. Center the image to the desired default orientation that you want to see when you start the VR system.
4. Press NEXT.

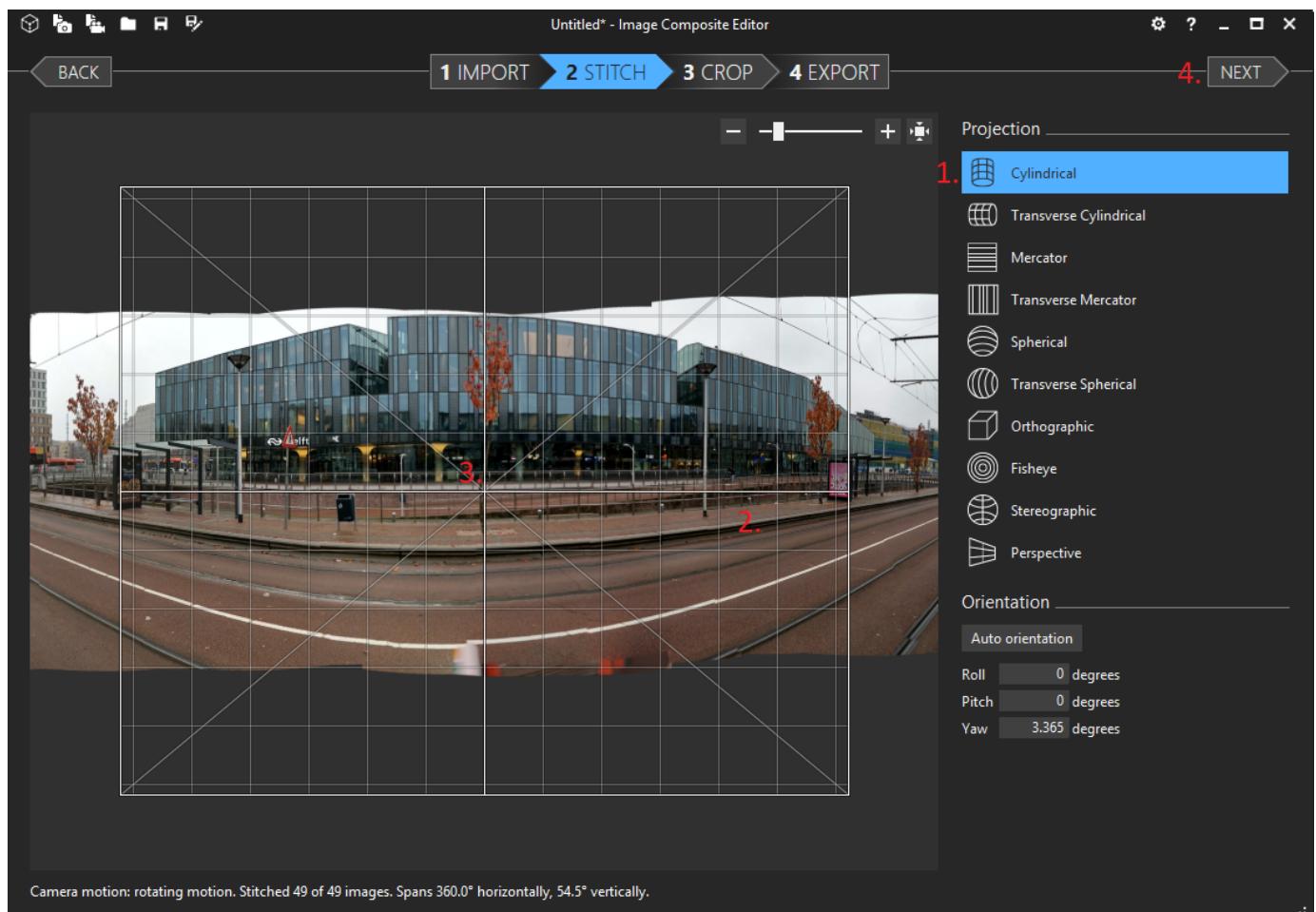


Figure 10: ICE Align Stitched Image

Click the button (1.) to fill-in gaps along the image perimeter. Once you press it the button will be grayed out and may use the checkmark below (2.) to choose whether you want autocompletion active or not.

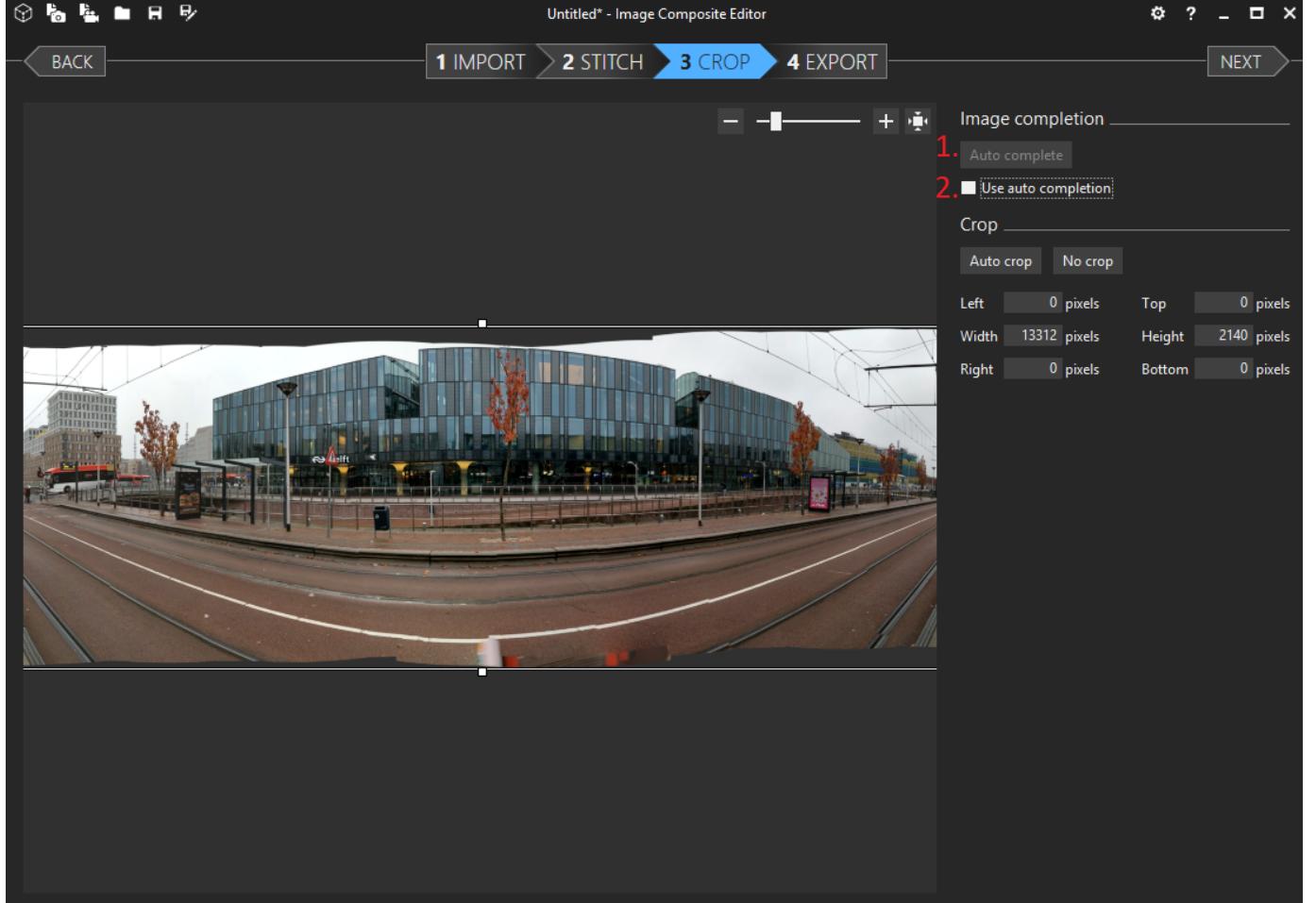


Figure 11: ICE Autocomplete - Before

Relevant to the maximum supported texture resolution in the VR system and how to adjust it, presented in Section 4.2, you may notice here that in some cases the image Width or Height may exceed the limit value of 16384. Do not adjust the value here because this does not rescale the image, but crops it. This results in cutting off pieces of the texture to fit the specified size, rather than making the entire texture smaller, which can be done using GIMP as shown in the later section mentioned above.

Here is the result of autocomplete in this image. You may notice some minor issues, e.g. part of the building was used to autocomplete part of the sky (1.), or the tram rail was placed incorrectly (2.). Issues such as these can be fixed through photo editing, which is demonstrated using GIMP in Chapter 4. When finished, press NEXT (3.) to continue to exporting your finalized image.

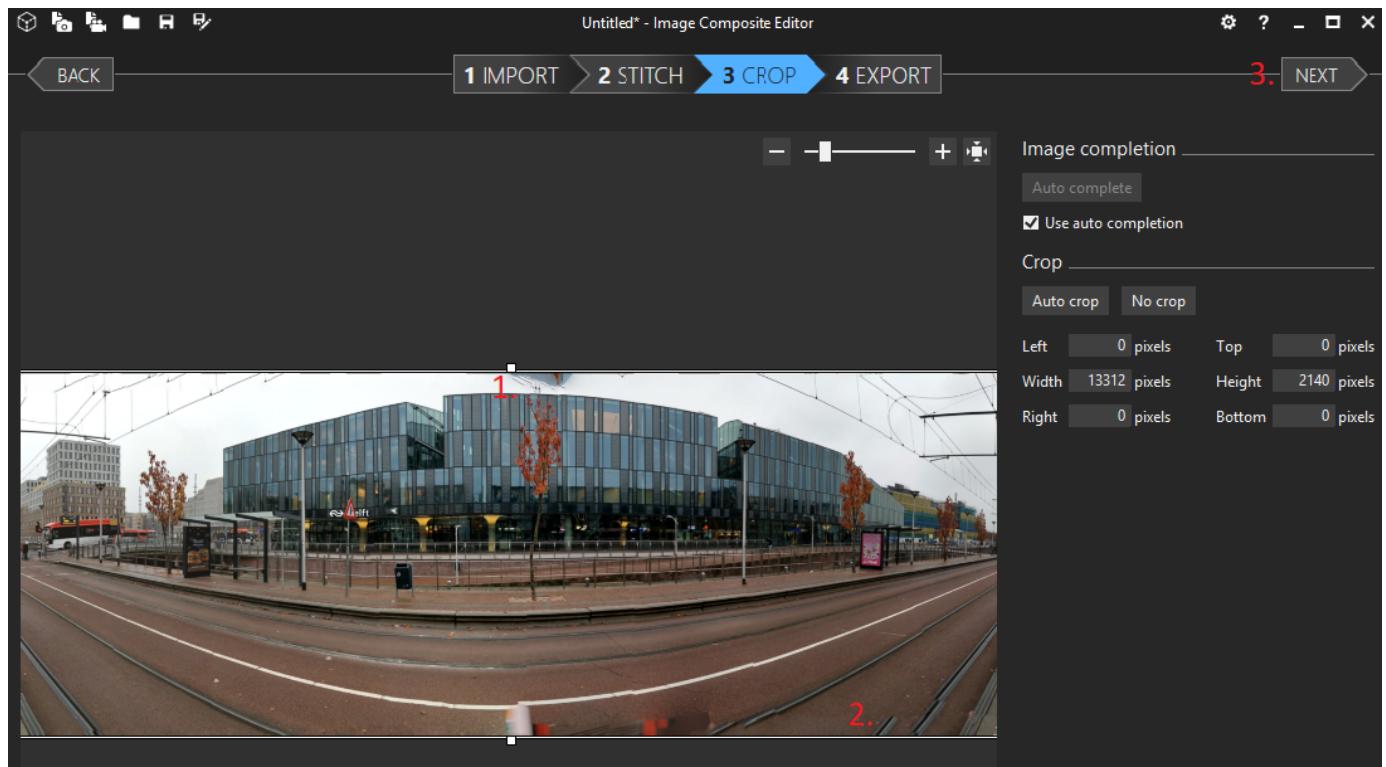


Figure 12: ICE Autocomplete - After

2.2.5 Exporting Images

On the Export page, select PNG from the "File format" dropdown (1.), and then press "Export to disk" (2.).

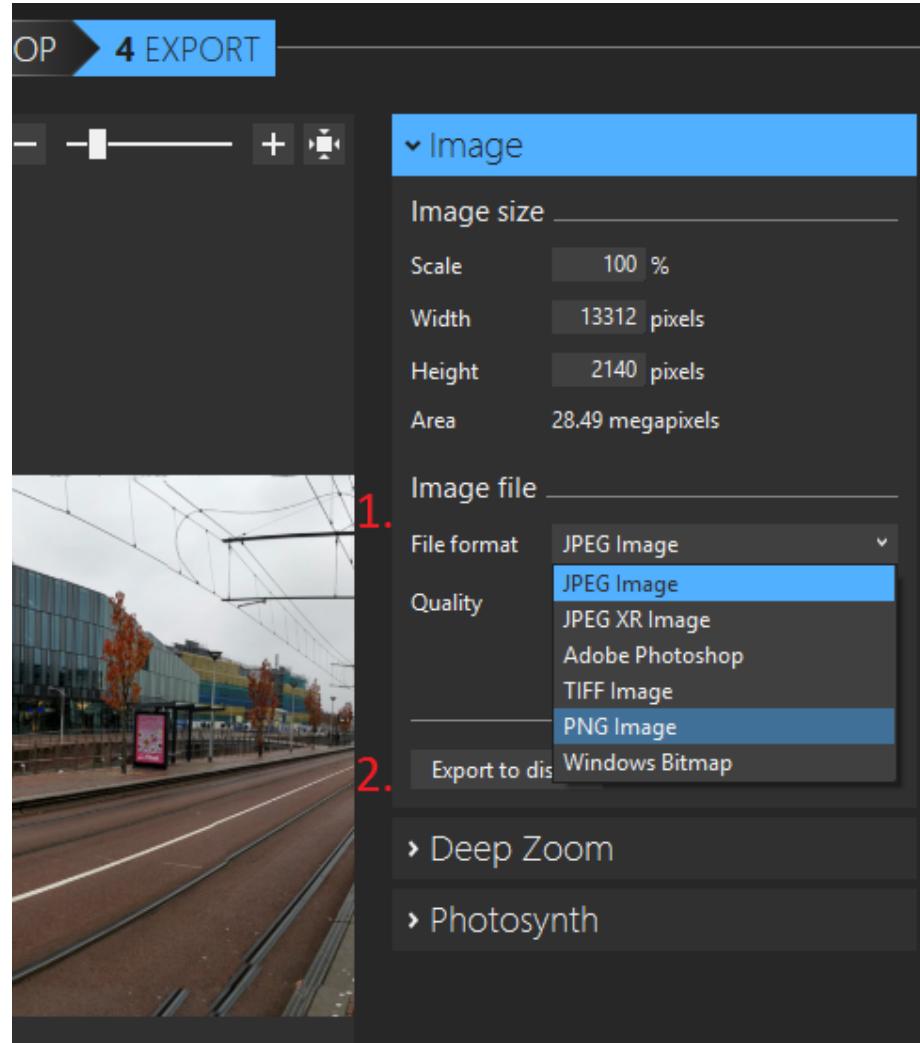


Figure 13: ICE Export File

Select the desired location to save the file.

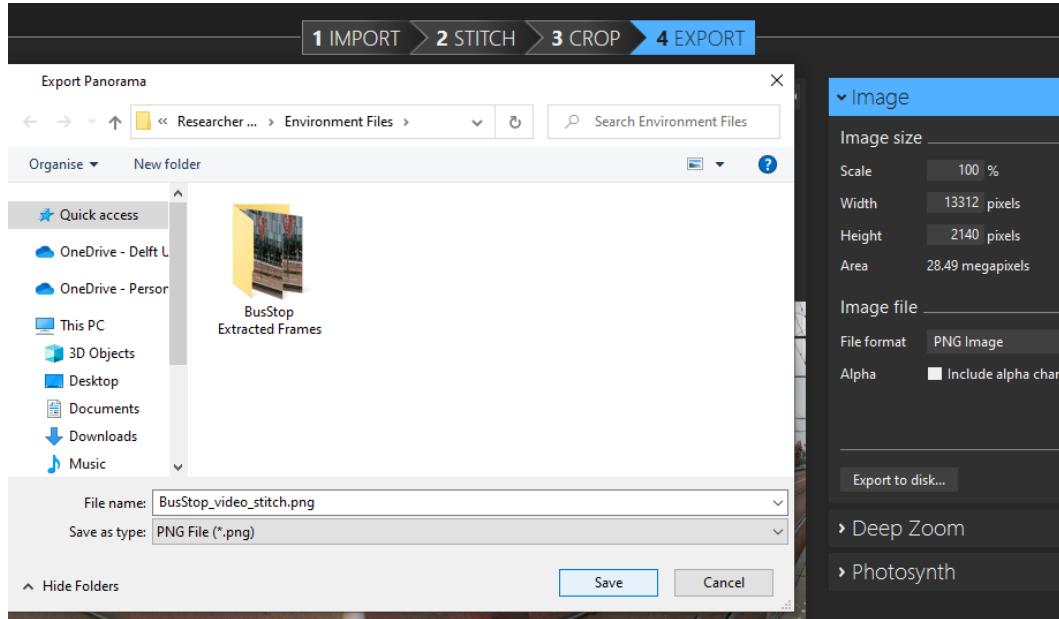


Figure 14: ICE Save File

Close ICE. Select "Discard" since you have already exported the file.

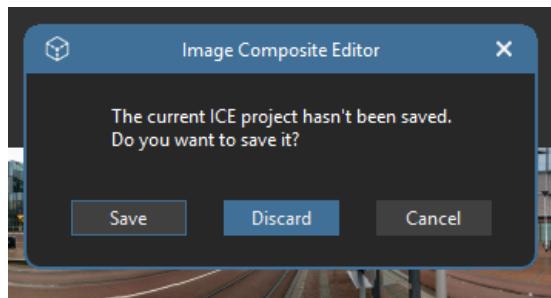


Figure 15: ICE Exit Prompt

Chapter 3

Extracting Video Frames Using VLC

Download the latest version at <https://www.videolan.org/vlc/>

If using video files, you can extract frames so that you can stitch those instead, to help ICE with detecting overlaps and similarities between images. As mentioned before, ICE splits videos into frames itself before stitching, but here we can split them into more frames, which adds to the level of detail obtained (but also to the time necessary for the stitching process).

3.1 Preparation For Each Video

1. Create a folder where you want the extracted images to be placed, and copy the file path.

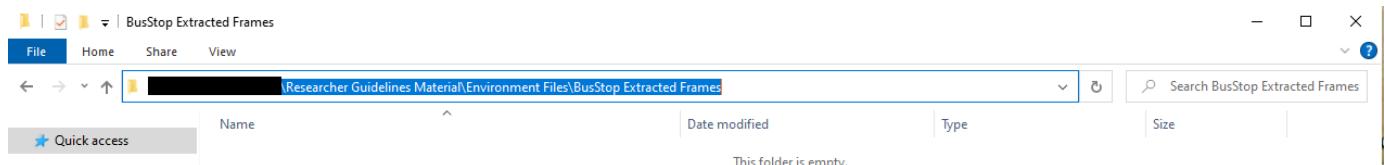


Figure 16: VLC Folder Creation

2. Open VLC media player. Go to Tools -> Preferences to open the settings.

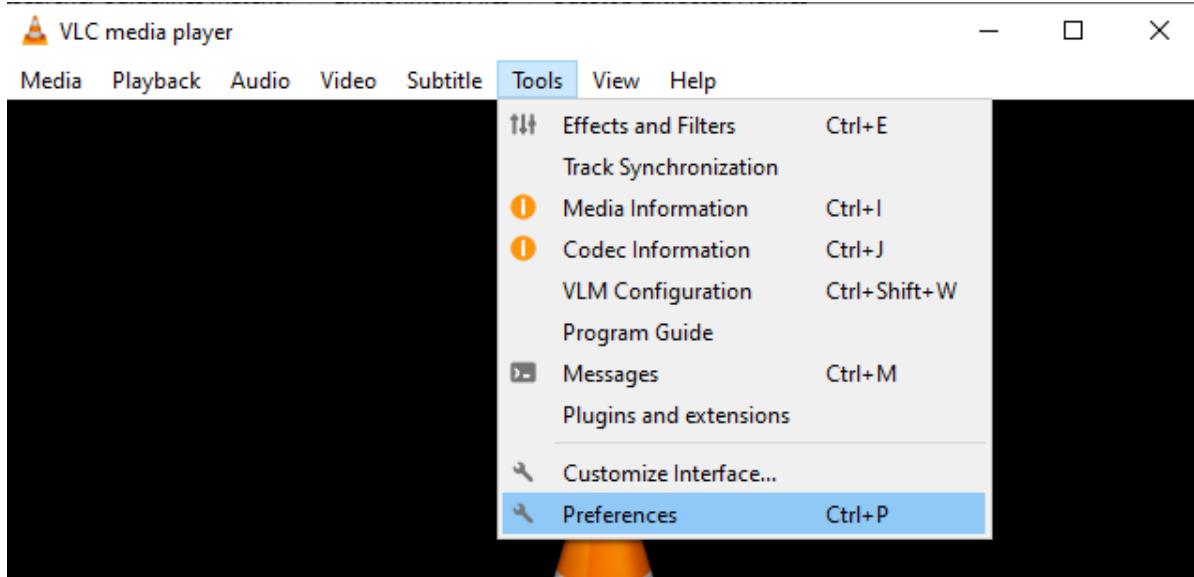


Figure 17: VLC Tools -> Preference

3. You will be presented with the Simple Settings (1). Press "All" to see the relevant settings we need to use.

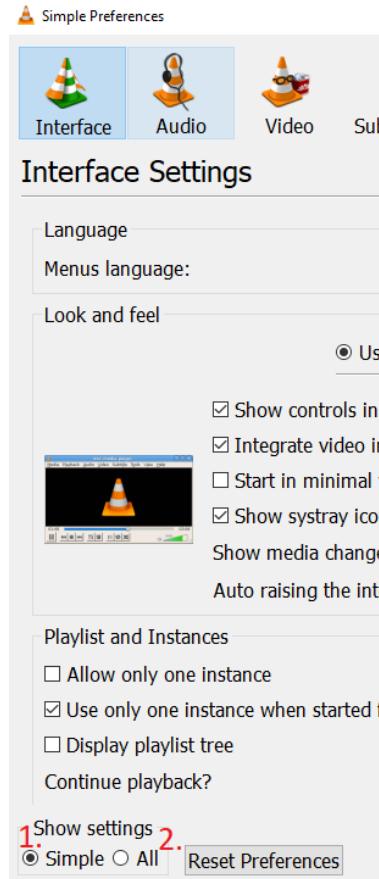


Figure 18: VLC Simple Settings

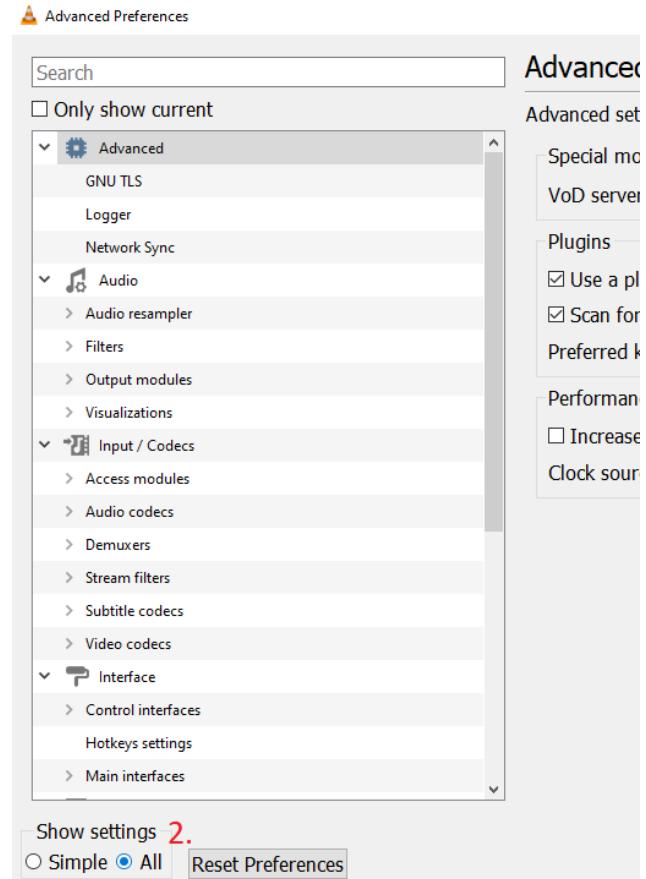


Figure 19: VLC All Settings

4. Scroll down to "Video" (1.) and click on the arrow next to "Filters" to expand the list (2.).

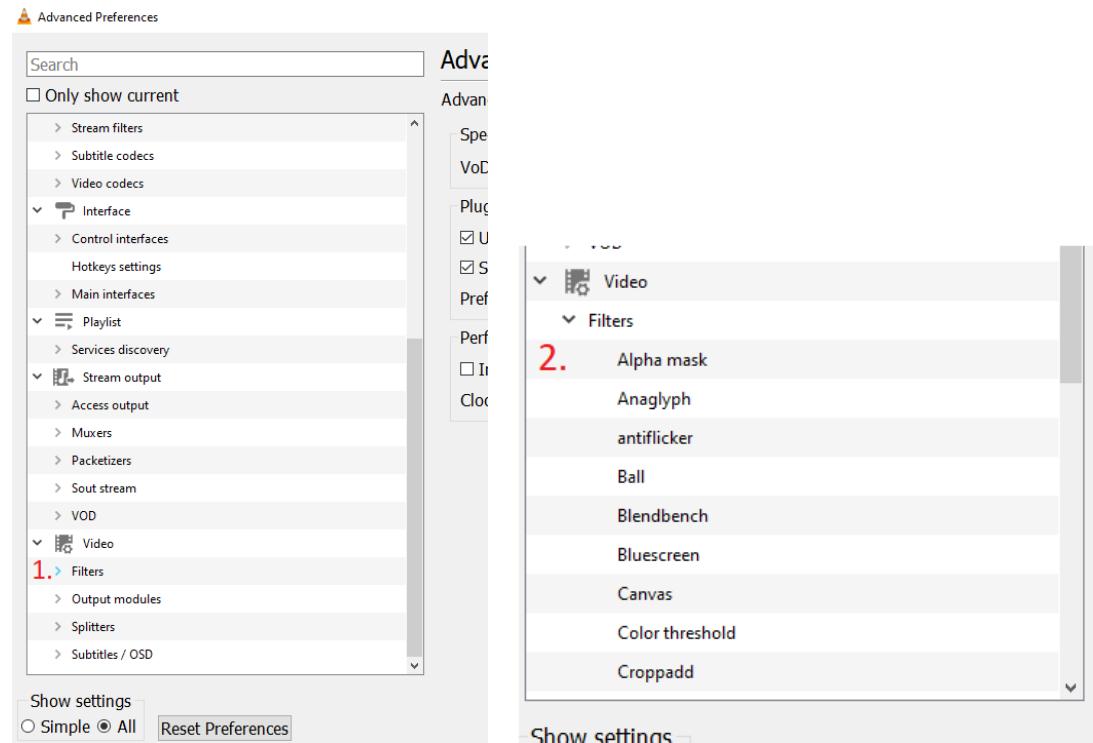


Figure 20: VLC Video Filters Collapsed

Figure 21: VLC Video Filters Expanded

Scroll down the filters list and click "Scene Filter" (1.).
 Use the settings below: (2.) Directory path prefix - The file path you copied in 3.1. (3.) Recording ratio: Frame interval after which a screenshot is taken. Depends on the video's frames per second (FPS), so you may need to try a lower / higher number if not enough (<50) / too many (>200) images are created.
 Recommended Starting Point: 15 - 30

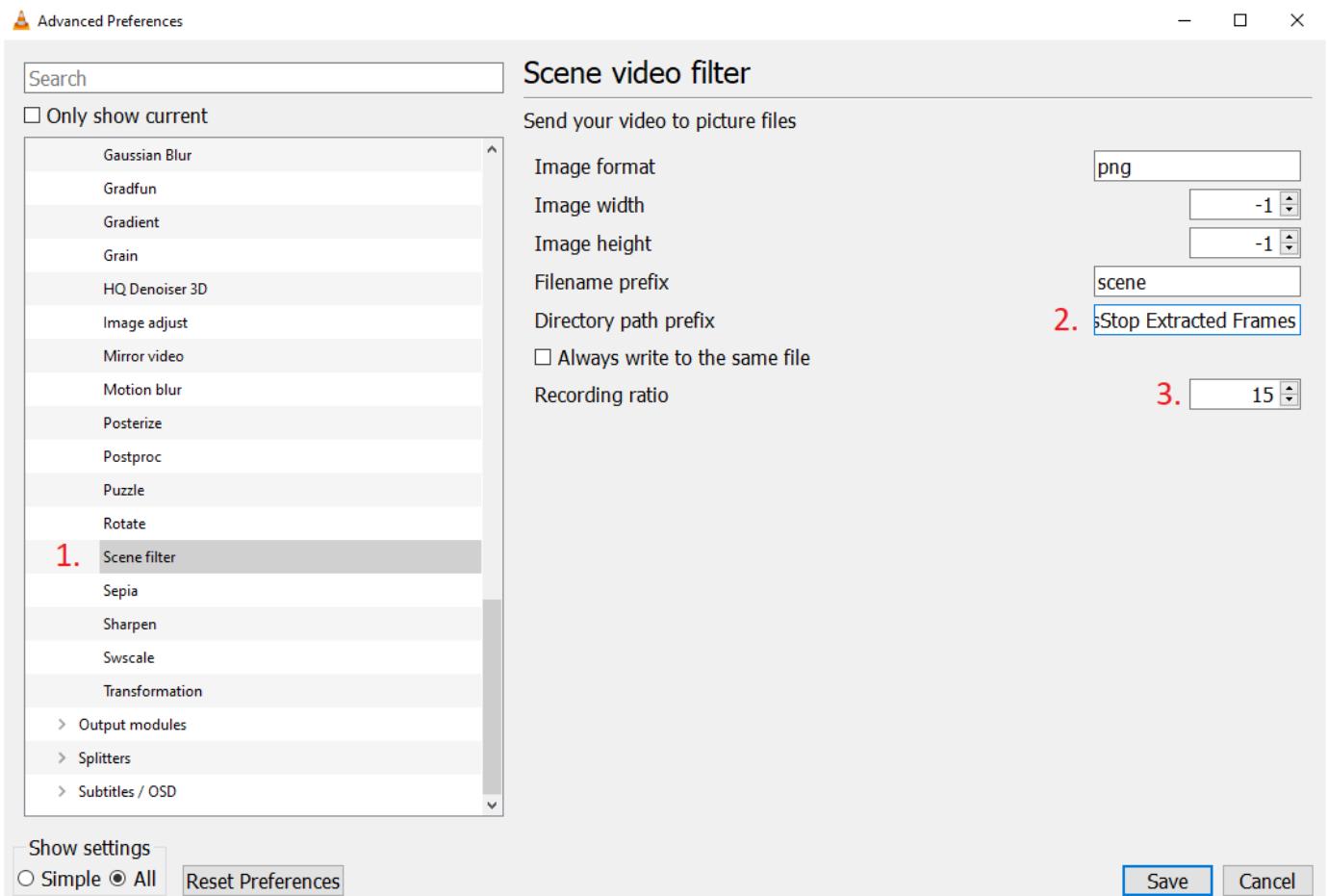


Figure 22: VLC Scene Filters

Go back to where you clicked the arrow at "1." in Figure 20 and click on "Filters". Tick the "Scene video filter" checkmark (1.) in the image below.

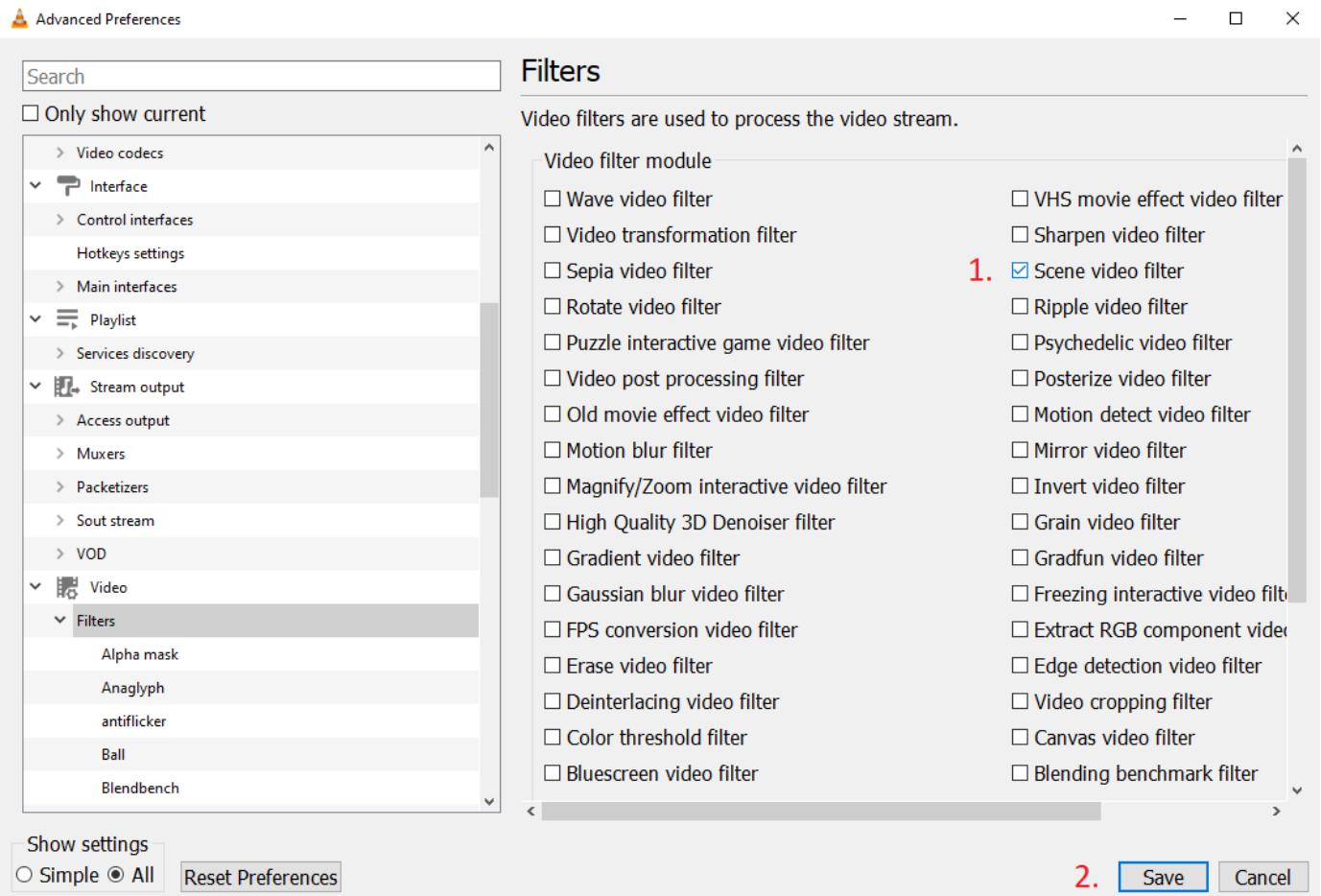


Figure 23: VLC Scene Filter Checkbox

Click Save (2.) and close VLC.

Open the desired video by either right clicking it and selecting Open with -> VLC media player (Figure 24), or by opening VLC and selecting Media -> Open File (25).

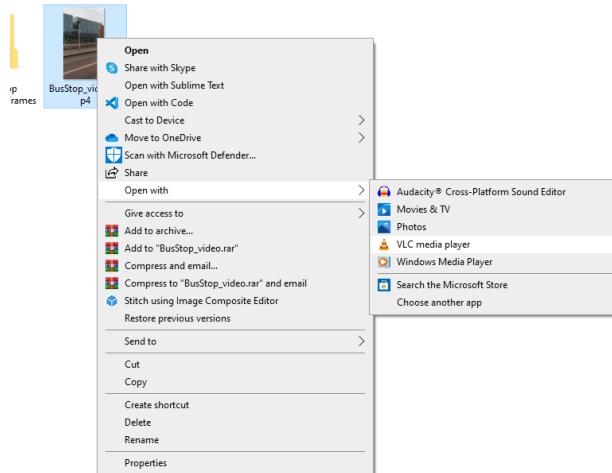


Figure 24: VLC Open Video From Context Menu

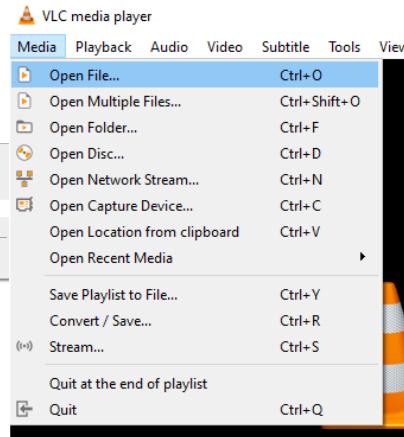


Figure 25: VLC Open Video From VLC

Let the video play until the end. This should extract frames from the video file. Open the folder you created and verify that the extracted frame images were placed there.

If the images are not in the correct orientation, rotate them. (On Windows you can press Left-Control + A to select all items, right click one, and select “Rotate Right / Left” depending on the orientation they were saved in.)

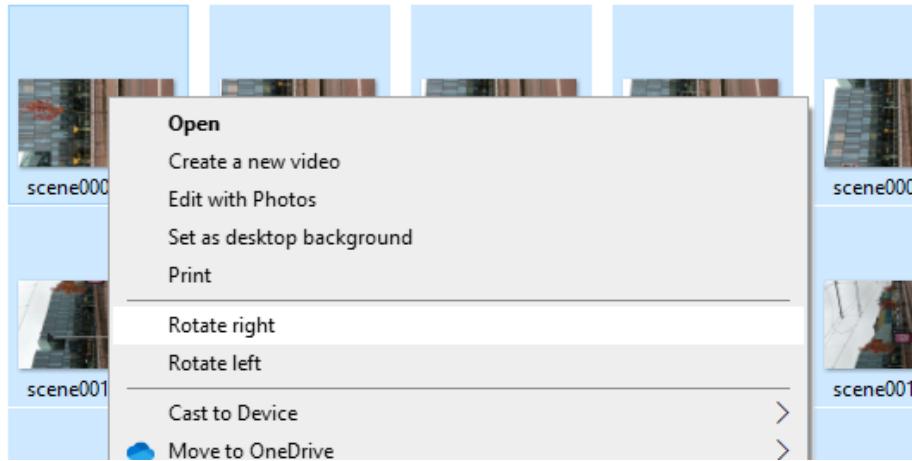


Figure 26: VLC Rotate Images

You can now use ICE to create a panorama from these extracted images.

You need to do this for every video you want to extract frames from. Simply create a new folder to extract frames in, specify the filepath of that folder in the Scene Filter settings, save, close VLC, and open the desired video for the software to extract frames (as described step-by-step in the previous sections).

When done with all the videos, untick the ”Scene Filter” checkmark (1.) you ticked in Figure 23 so that VLC doesn’t keep extracting frames for every video you may open.

Chapter 4

GIMP

Download the latest version at <https://www.gimp.org/>

You can use GIMP to edit the panoramic images created by ICE. There are three main use cases for using GIMP: 1. Changing the resolution of an image, 2. fixing graphical issues with an image, 3. stretching the top and bottom 1% of an image for the texture to appear as intended in the VR system.

"1." is necessary if the image resolution is larger than what Unity3D (the underlying game engine the VR system is built on) supports. "2." is optional but generally recommended to avoid graphical issues in an image potentially reducing immersion. "3." is always necessary to make the images appear as intended in VR.

4.1 Open Image in GIMP

Open GIMP. Press File -> Open... -> Locate the file in the location that it is saved in.

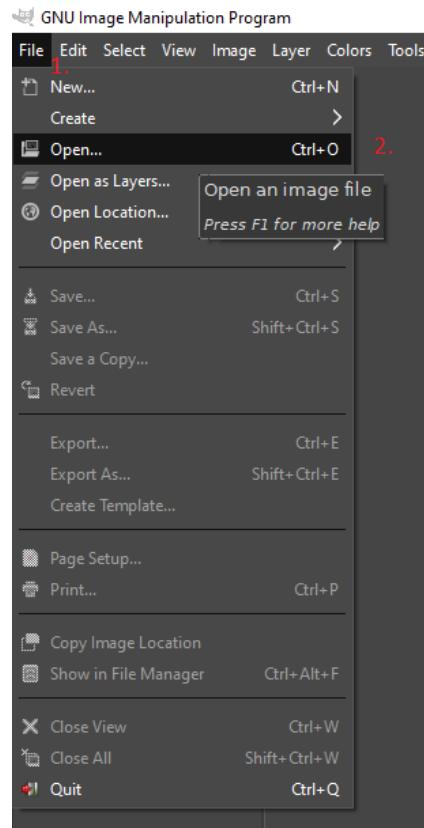


Figure 27: GIMP Open Image

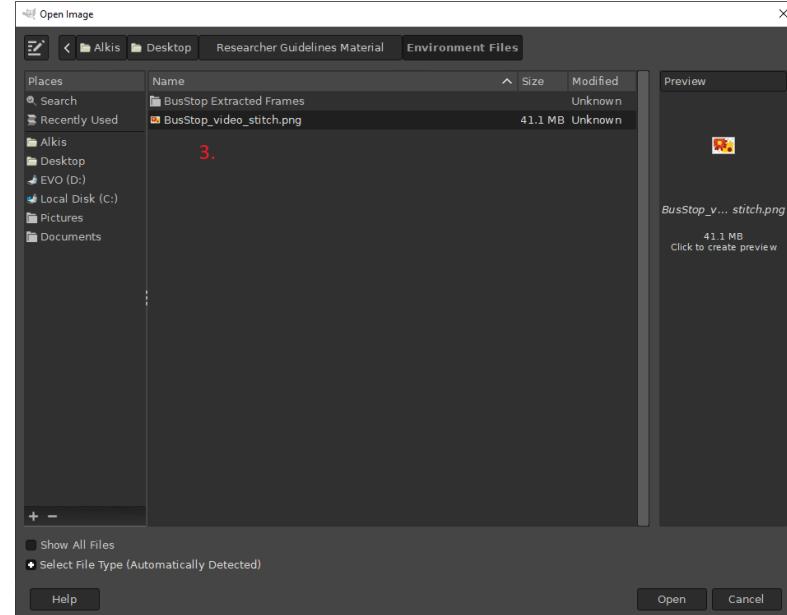


Figure 28: GIMP Find Image in File System

You should be looking at your stitched panorama image, like below.

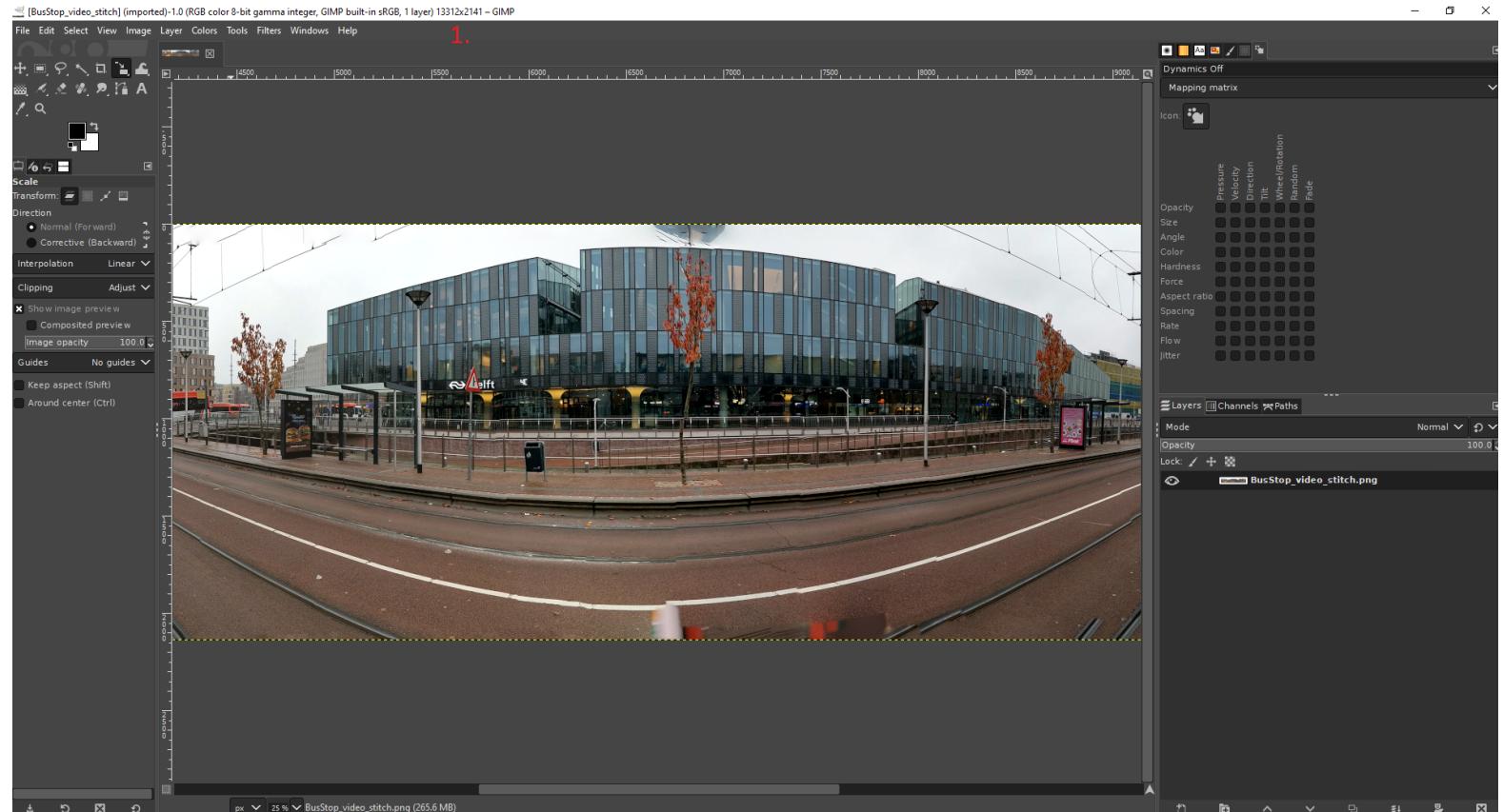


Figure 29: GIMP Start

4.2 Changing Image Resolution

Maximum supported texture resolution in Unity is 16384 x 16384. If the panoramic photo has higher resolution, it needs to be rescaled before it can be used, **or the VR system will not work!**

4.2.1 Check Image Resolution

You can see the resolution of an image by right-clicking on the file (1.), selecting Properties (2.), going to the Details tab (3.), and looking at the Dimensions (4.). You can alternatively check the image resolution from inside GIMP if you have already opened the image in the same menu used to rescale it. This can be seen on the GIMP title bar (1.) in Figure 29.

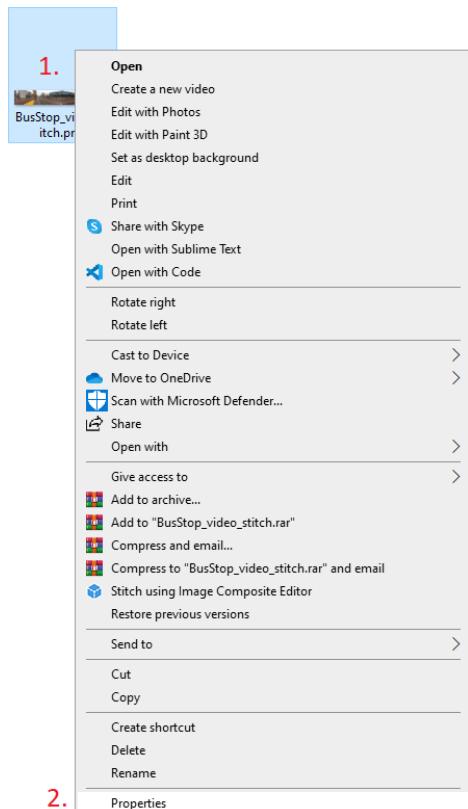


Figure 30: GIMP Click Image Properties

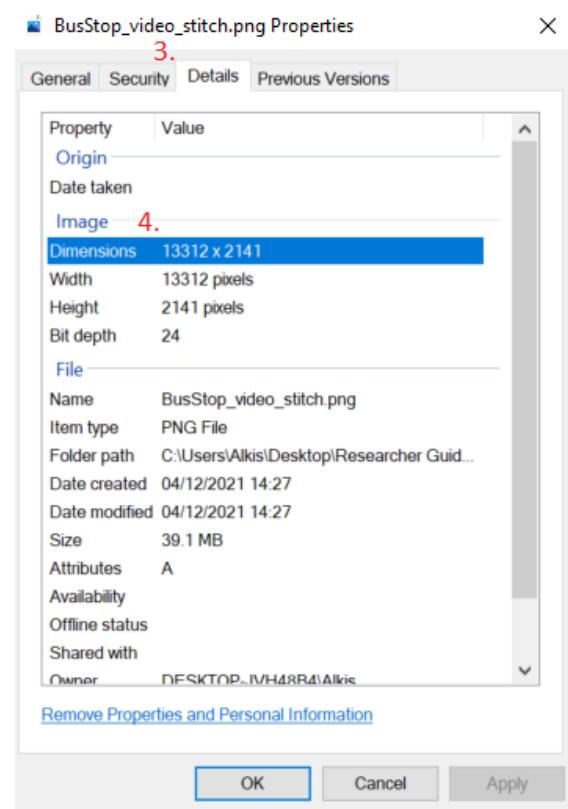


Figure 31: GIMP Check Image Dimensions

If the dimensions are within the limits mentioned, you can skip this section and move on to Section 4.3. Otherwise, continue on to rescale the image.

4.2.2 Rescaling An Image

Click Image (1.) -> Scale Image... (2.).

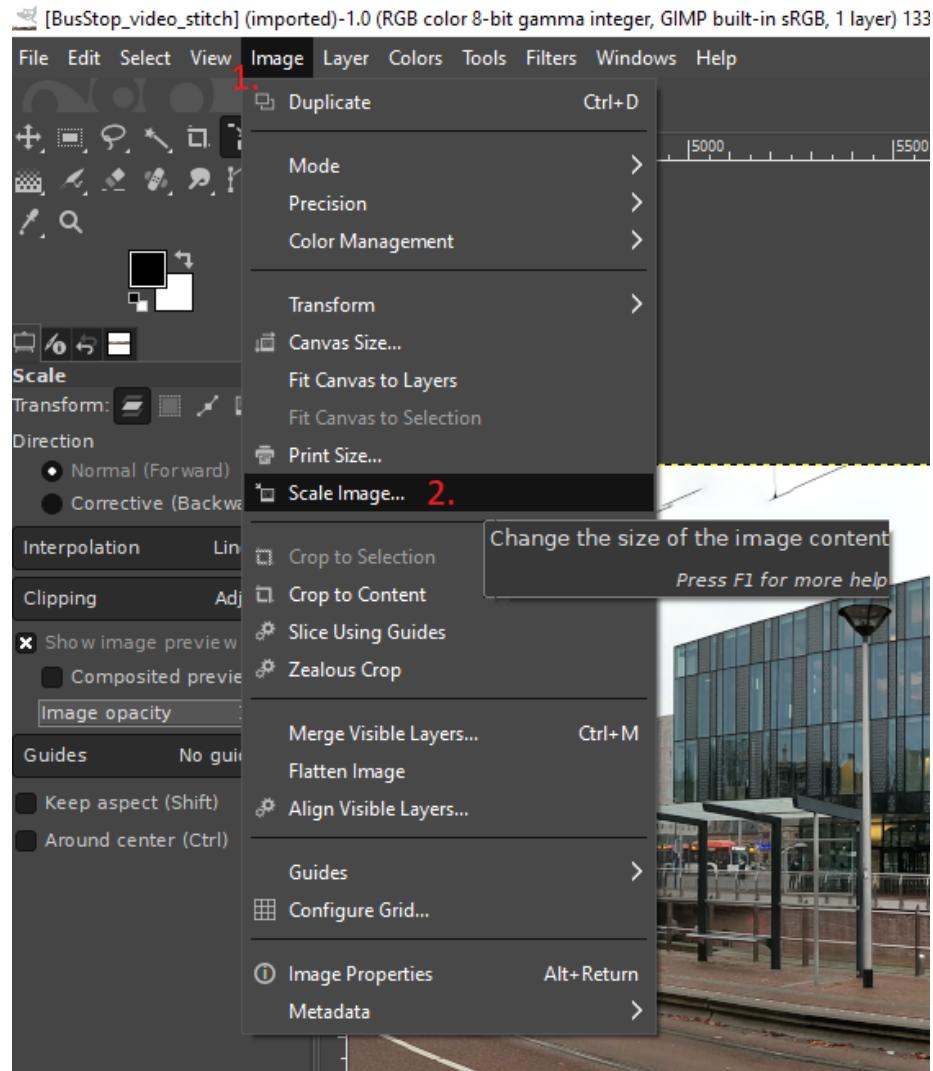


Figure 32: GIMP Image -> Scale

You should be presented with the Scale Image menu as below. Here you can see the Image Size (1.). Make sure that "px" is selected in the dropdown menu (2.), and that the chain icon (3.) is connected to preserve the image aspect ratio when rescaling. Locate the dimension in (1.) that exceeds the dimension limit (16384), and change it to that. The other dimension should also change if you have the chain icon connected. When you have the correct dimensions, press Scale (4.) to rescale the image.

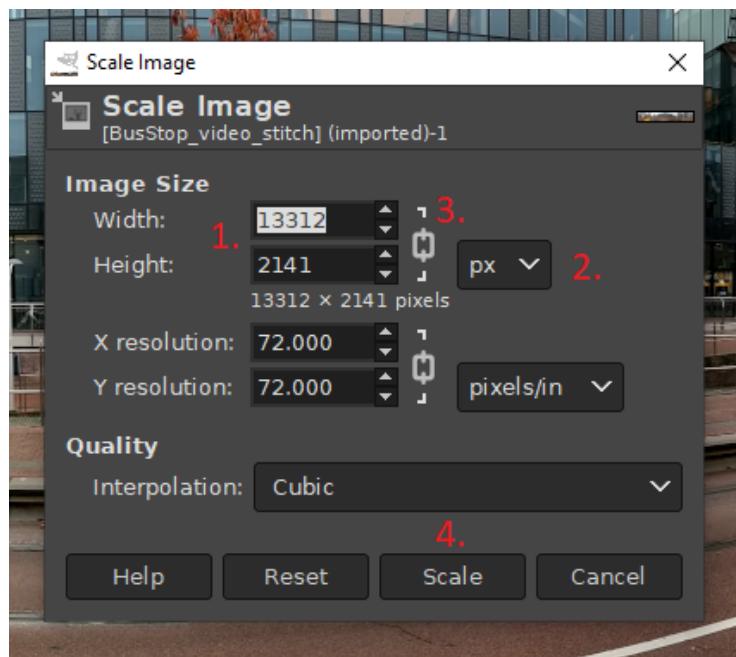


Figure 33: GIMP Scale Image

4.3 Fixing Graphical Issues

To fix graphical issues with the image, you may do an internet search for how to use GIMP (too much to mention here, and I am not an expert in image editing). In many cases, you can fix simple issues e.g. a byproduct of ICE autocomplete as seen in the image below (1.), using the Clone and Healing tools (2.). A demonstration can be seen in the relevant separate video.

In some cases, e.g. the graphical issue shown in (1.) can be fixed rather seamlessly. However, sometimes in cases with more well-defined features, e.g. imagine if the tree that is in front of the building in (3.) was repeated next to it. It would be more difficult to seamlessly copy over parts of the building to hide it. In cases such as these if you do not want to spend the amount of time and effort necessary to completely fix graphical issues, it may be appropriate to either simply ignore it, or use the Healing tool to smudge and blur over the graphical issue which may be an acceptable alternative.

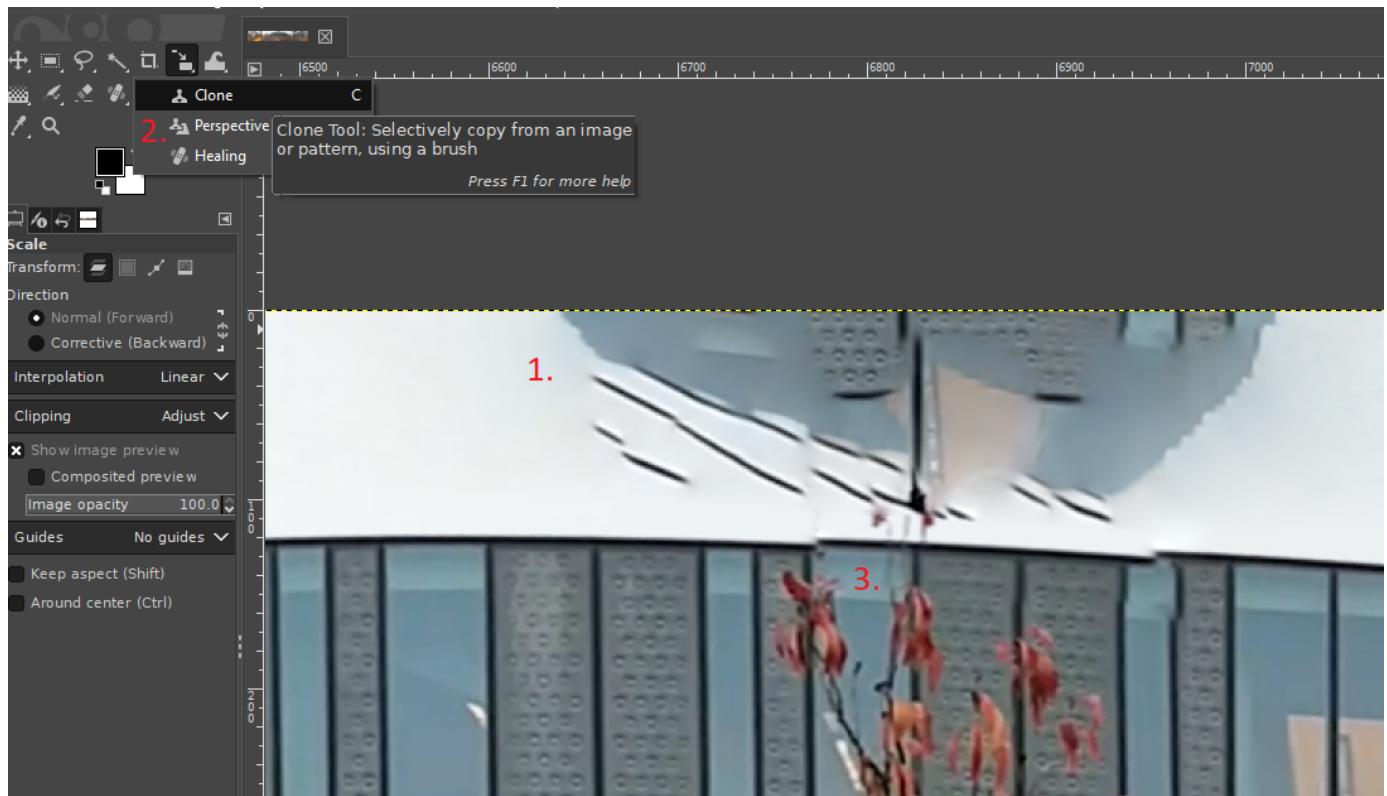


Figure 34: GIMP Graphical Glitch

4.4 Stretching Image Edges

To avoid seeing the edges of an image when looking up or down in VR, you need to stretch the top and bottom 1% of pixels. This step is **mandatory** due to how the VR system is developed. If you skip it, the image will appear distorted in the VR system.

4.4.1 Selecting Areas to Stretch

With the image open in GIMP (look at Section 4.1), use the Rectangle Select Tool (1.). With the Rectangle Select Tool selected, click on the image and drag to create a dotted line rectangle, as in (2.) below. The size of the rectangle doesn't matter since we will adjust it manually in the next step.

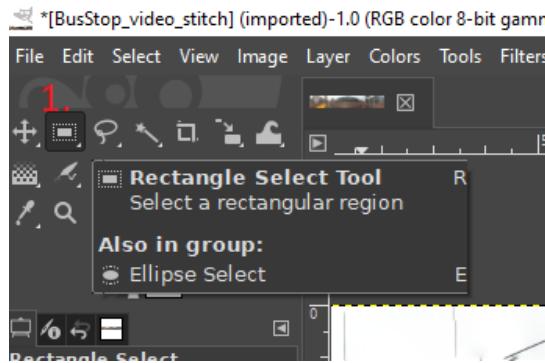


Figure 35: GIMP Rectangle Select Tool Start

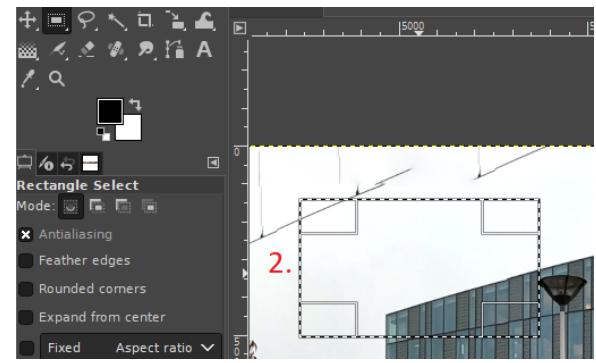


Figure 36: GIMP Rectangle Select Tool Drag Rectangle

With the rectangle selected and the four small rectangles in its corners as visible, set the settings of the Rectangle Select as in the image below (1). **Make sure that you have selected "%"** from the two dropdown menus (2.). After you have set them, you should see the rectangle you selected be transformed to cover the top 1% of the image as below (3.). If you don't, create a new rectangle and adjust the settings on that.

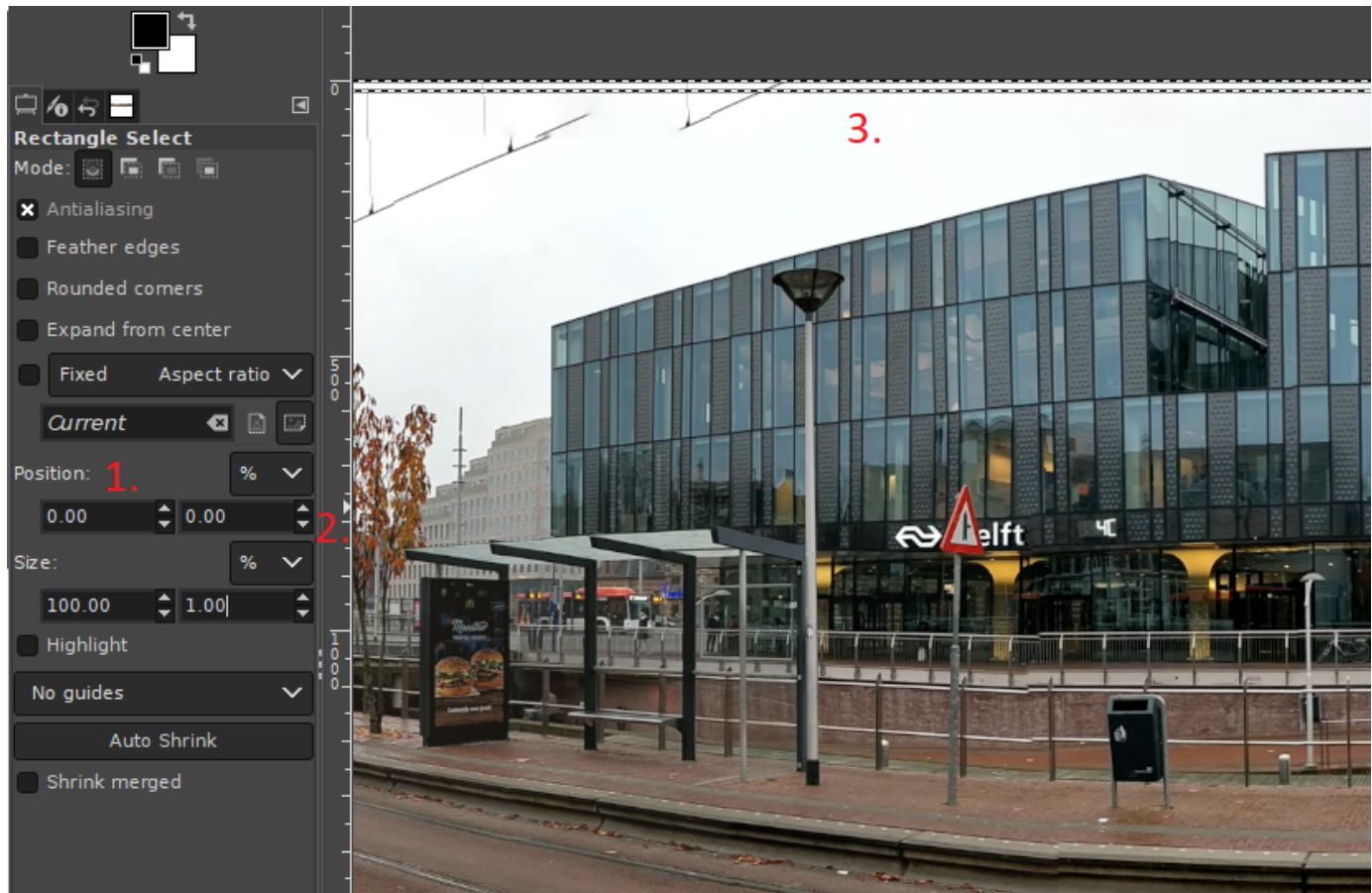


Figure 37: GIMP Rectangle Select Top Section Settings

4.4.2 Creating a New Layer

Continuing with the rectangle created before, click on the Move Tool (1.), and then press Edit -> Copy (2.), and Edit -> Paste (3.) (or CTRL + C -> CTRL + V).

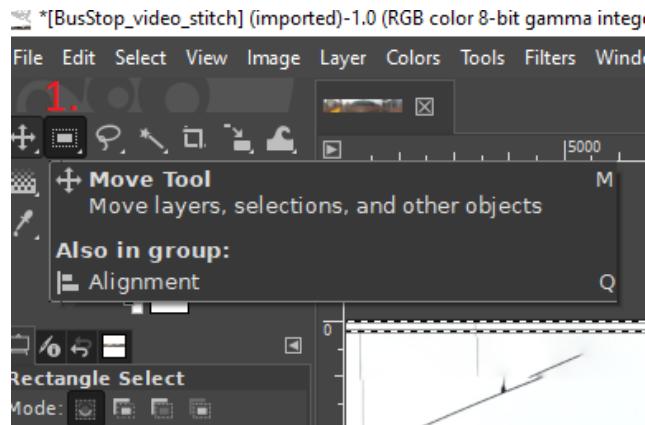


Figure 38: GIMP Rectangle Select Tool Start

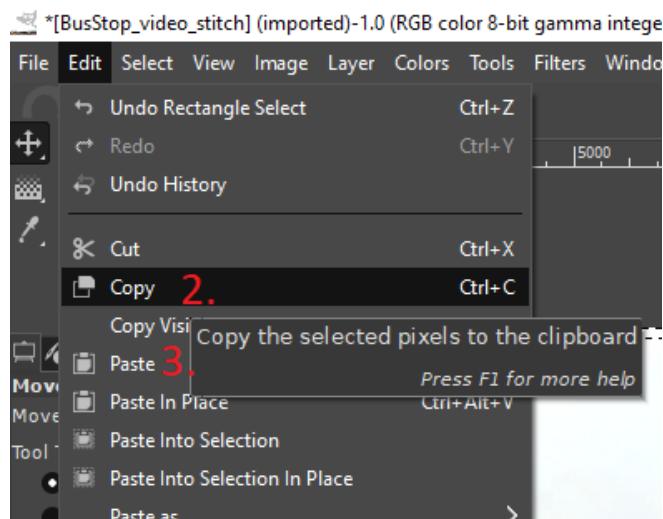


Figure 39: GIMP Rectangle Select Tool Copy Paste

After copying the region created previously, a new Floating Selection will be created (1.) next to the main image layer (2.). You need to save this as a new layer by either clicking the button at (3.) or by right clicking on the Floating Selection and clicking "To New Layer" (4.).

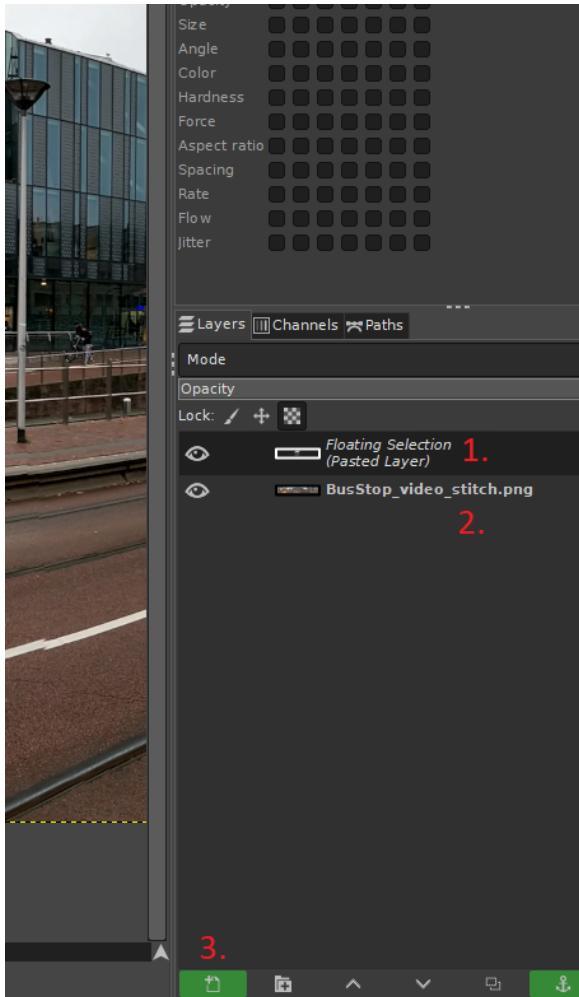


Figure 40: GIMP New Floating Selection

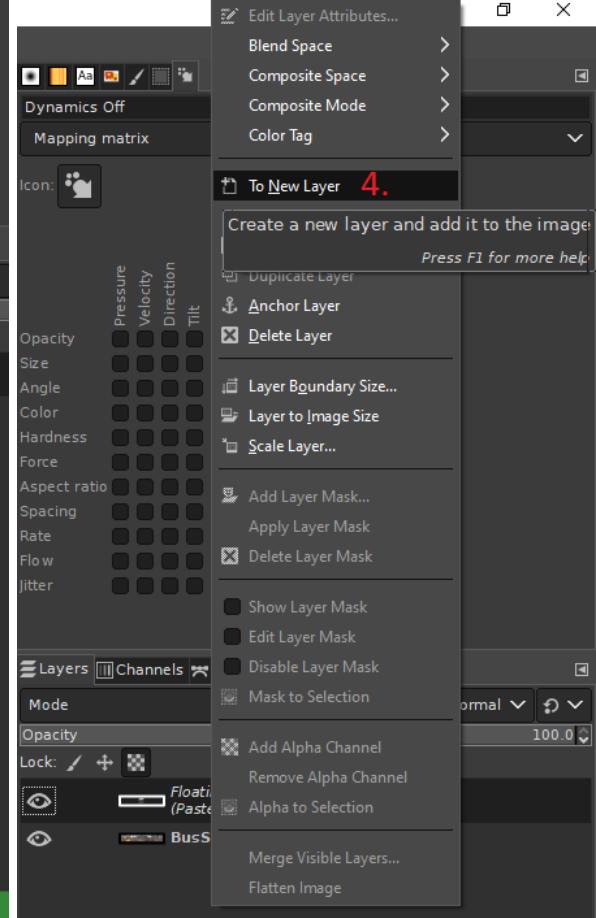


Figure 41: GIMP Save Floating Selection as New Layer

Go back to Section 4.4.1 and repeat this process of selecting a rectangle, configuring the settings to this time select the bottom 1% of the image. Copy the selected area and save it as a new layer (as described step-by-step above). Make sure that before doing this, you have the main image layer selected (2.) in the image above. Configure the settings of the Rectangle Select Tool as in the image below.

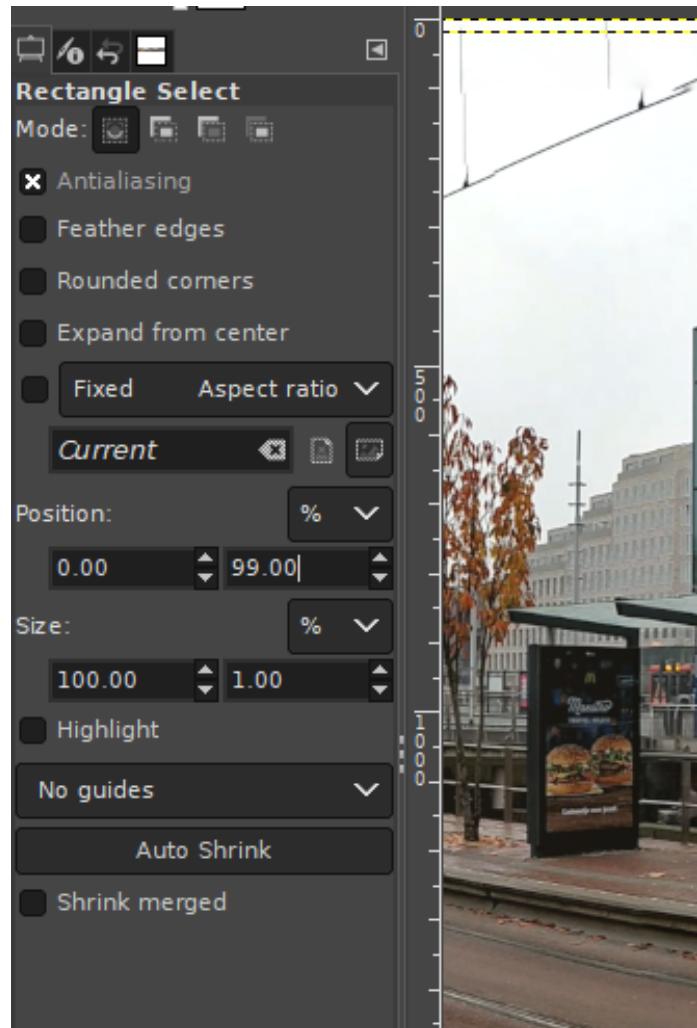


Figure 42: GIMP Rectangle Select Bottom Section Settings

You should now have three layers; the main one (which should have the same name as the image file) and the two new ones you created, as below.

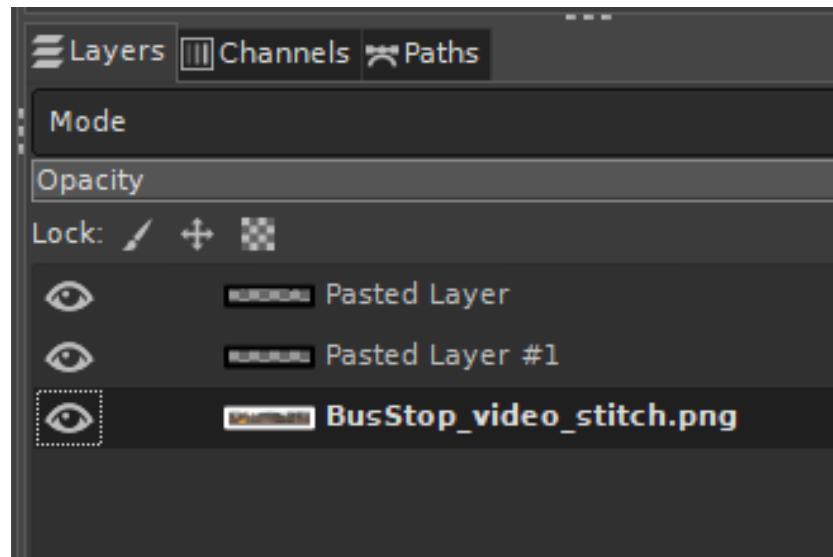


Figure 43: GIMP Three Layers

4.4.3 Expanding the Canvas

Click Image (1.) -> Canvas Size (2.)

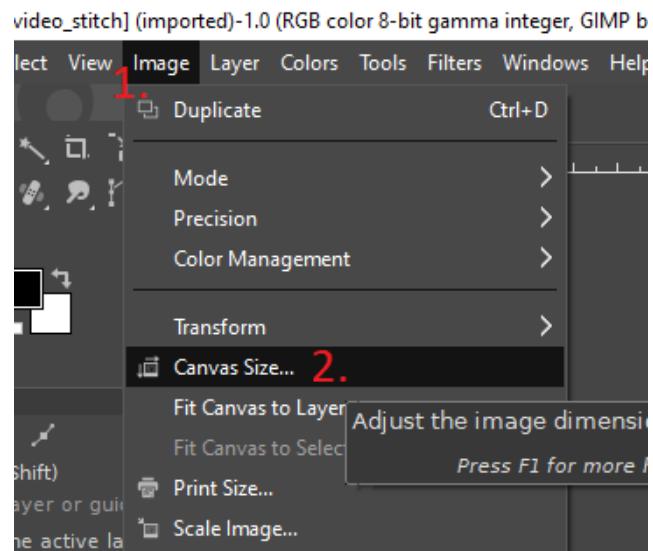


Figure 44: GIMP Accessing the Canvas Size Menu

You should be presented with the Set Image Canvas Size menu, as below. Make sure that "%” is selected from the dropdown menu (1.). Change the height to 300% (2.) and press Center (3.). Then select Transparency from the “Fill with” dropdown menu (4.), and finally press Resize (5.) to apply this change.

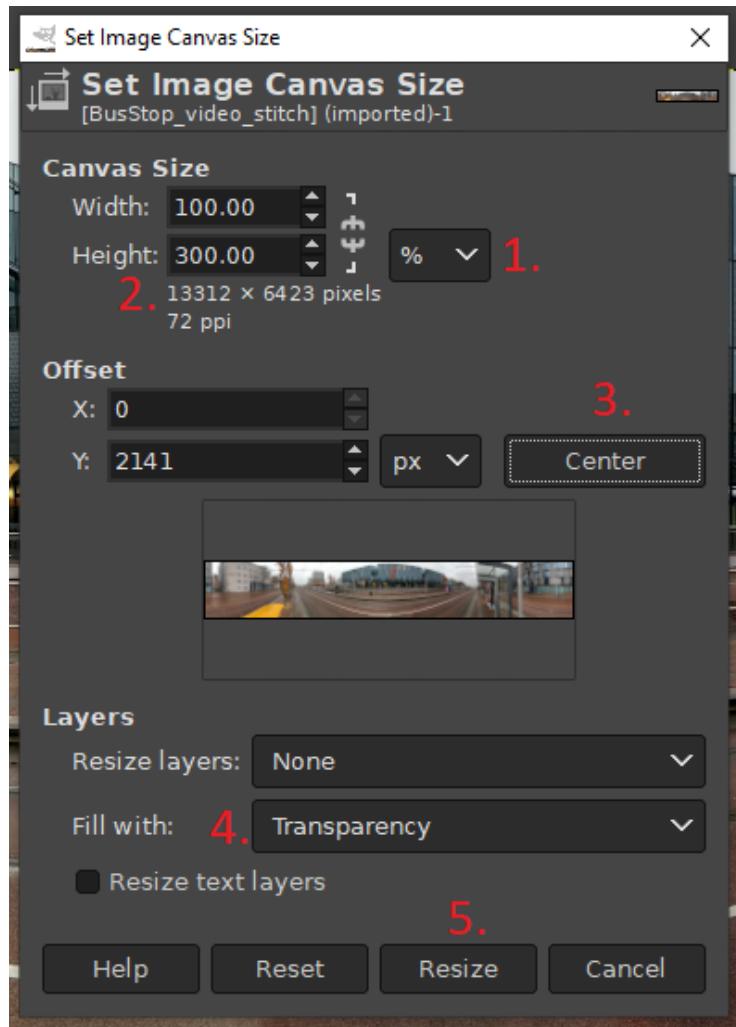


Figure 45: GIMP Set Image Canvas Size Specification

Your image should have now been transformed into something similar to the image below.

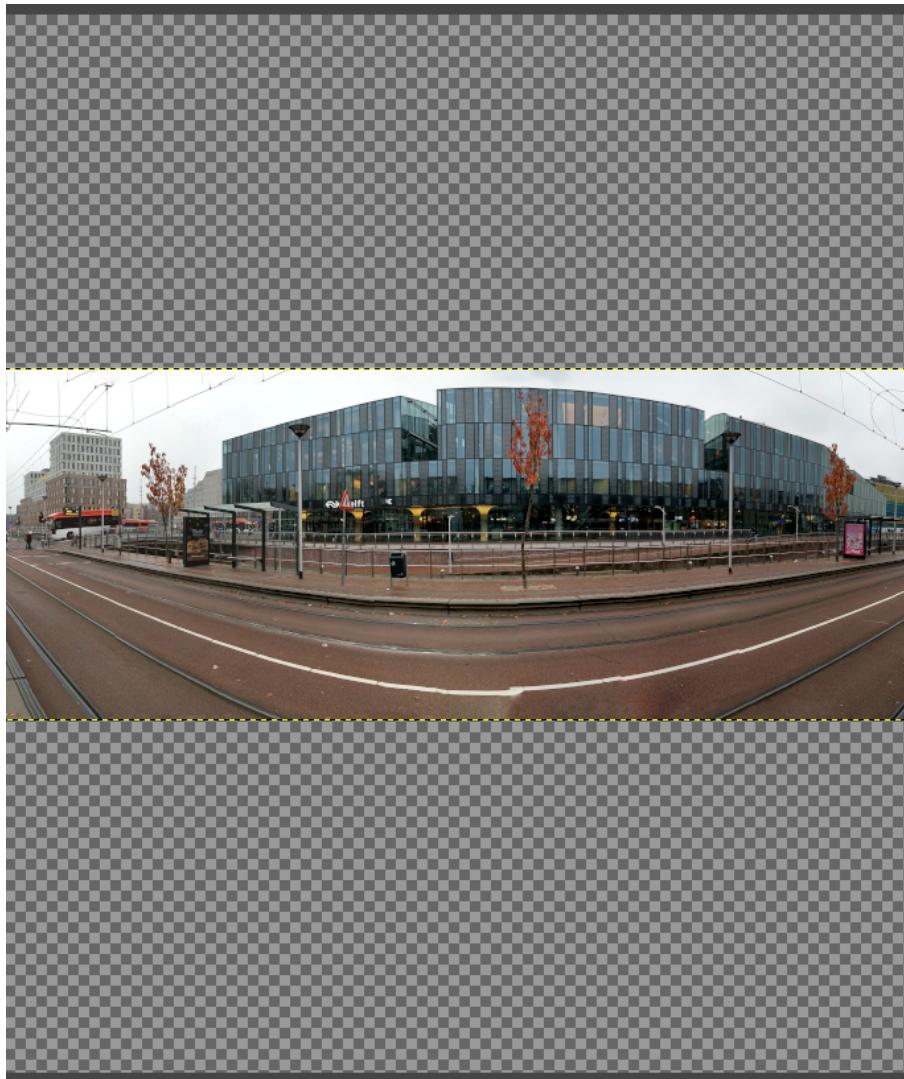


Figure 46: GIMP Expanded Canvas Start

4.4.4 Stretching Layers

Select either of the layers created previously. Here we will start with the one containing the top 1% copied section of the image we created first (1.).

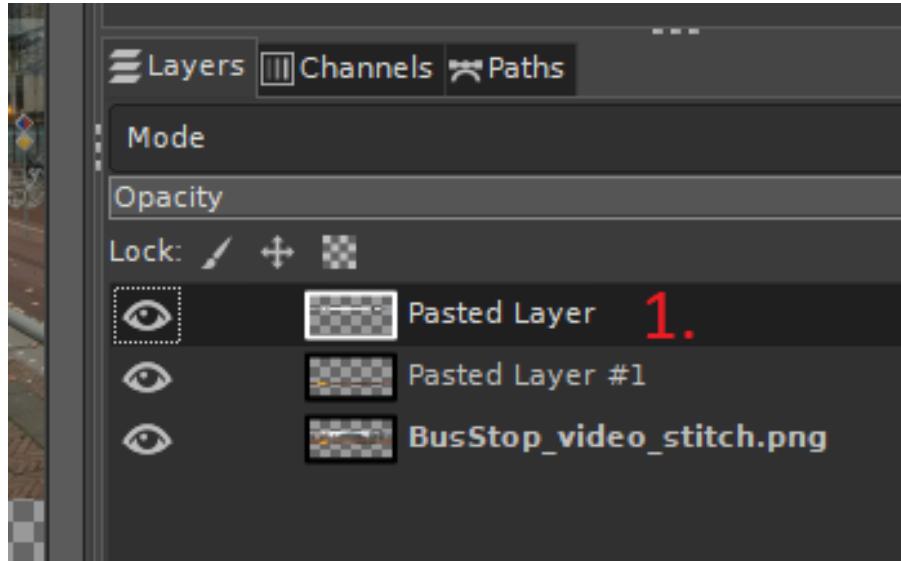


Figure 47: GIMP Select Top Layer

Access the Scale Tool (1.). GIMP groups multiple tools together, which can be accessed by right clicking on the base tool, e.g. (1.), and then selecting the one you want (2.). If you cannot see the same icon as the one shown in (1.), locate the correct tool group by looking at the neighboring icons or the other icons in the list that (2.) is contained in, and right click on the tool group to select the Scale Tool. This will also change the icon shown in the base menu to the tool you selected.

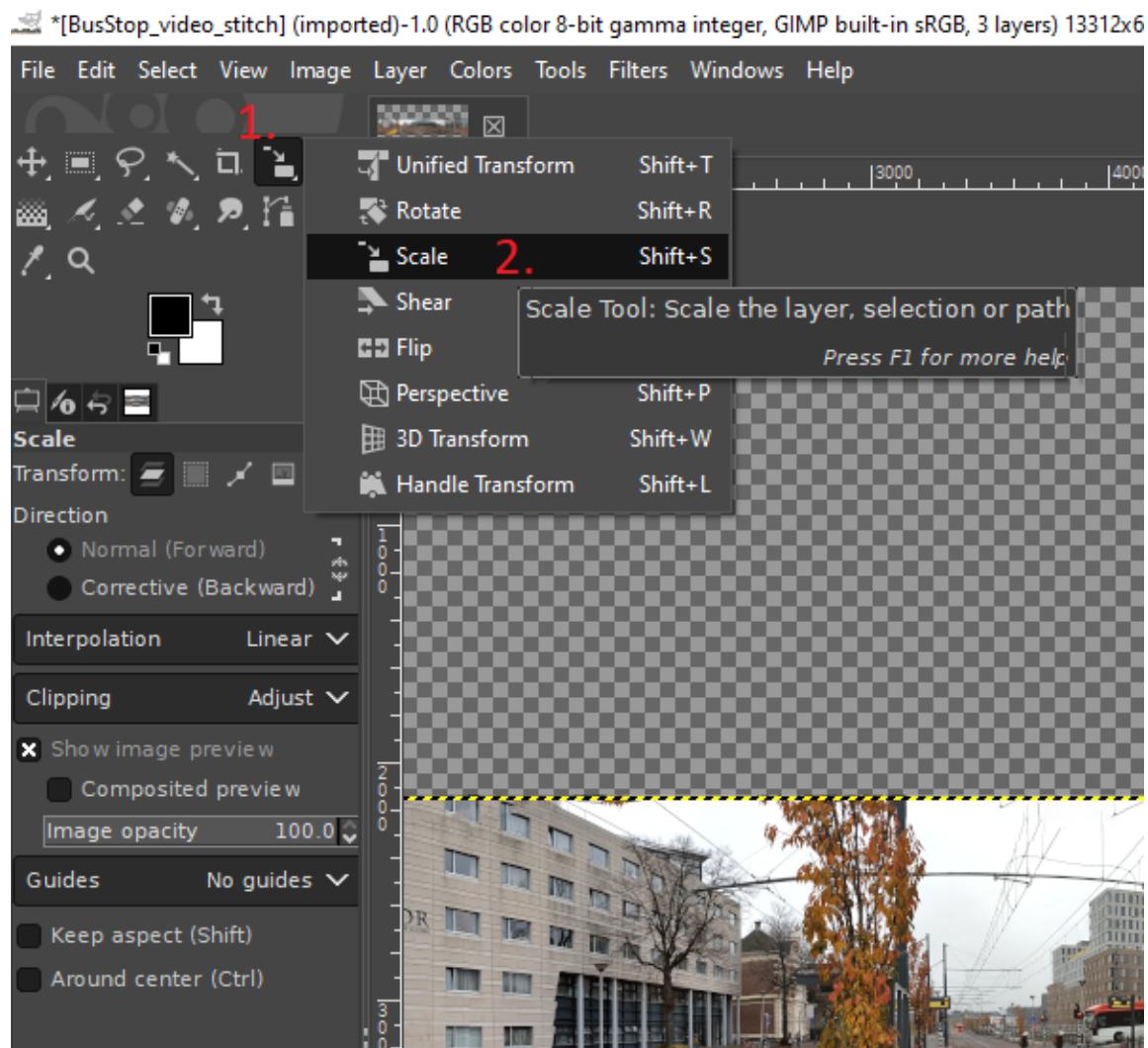


Figure 48: GIMP Scale Tool Access

With the Scale Tool selected, click on the area of the layer you have created and should have selected (1.).

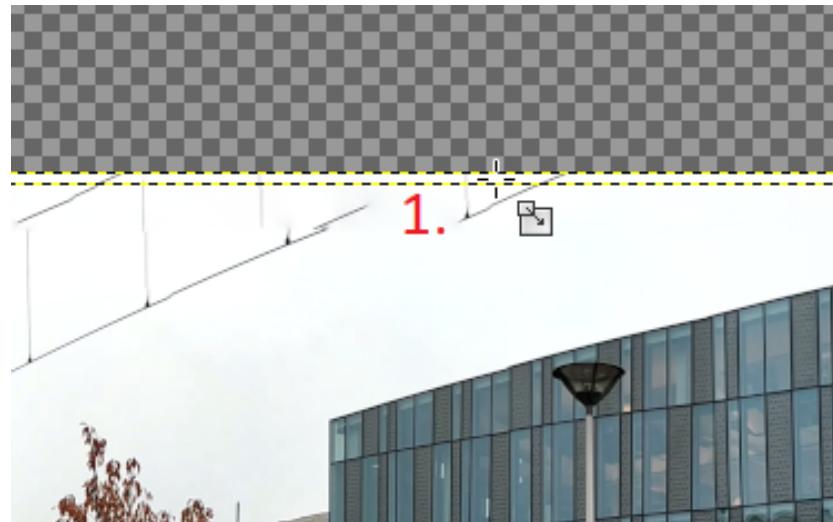


Figure 49: GIMP Scale Tool Top Layer Select

You should now see the Scale menu open on the top-right side of the image, as below.

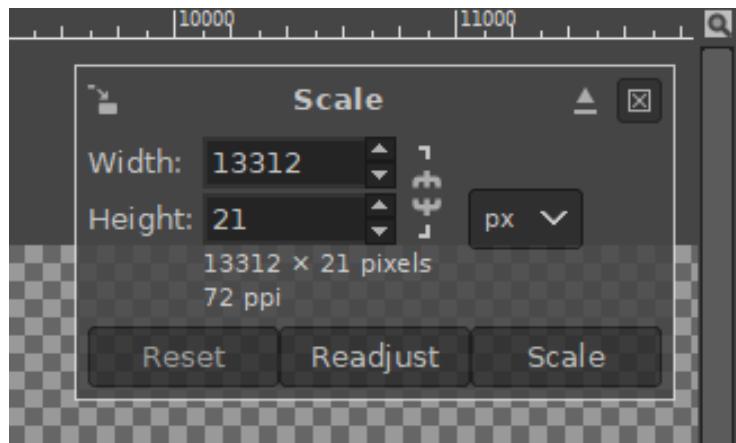


Figure 50: GIMP Scale Tool Menu

Alternatively, you can press Shift + S to access the Scale tool without having to go through the menus.

Go to the middle of the layer you have selected and hover over the rectangles which have appeared at the borders of the selected layer after you have accessed the Scale tool. Click on the rectangle when it becomes similar to (1.) in the image below. This is so that you only stretch the layer upwards.

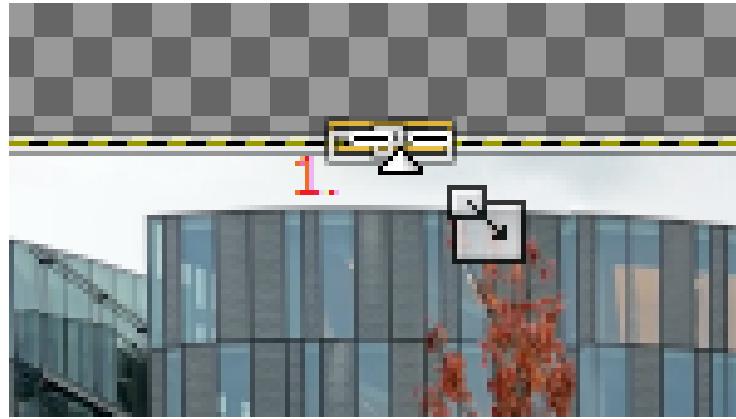


Figure 51: GIMP Scale Tool Select Top Layer

Make sure that the chain icon (3.) is unlinked, so that you can stretch the image only on the desired axis. While keeping the mouse left-click down, drag to stretch the selected layer upwards until the edge of the expanded canvas (checkered-gray area), similarly to the image below (1.). Then press Scale (2.) to apply this change.

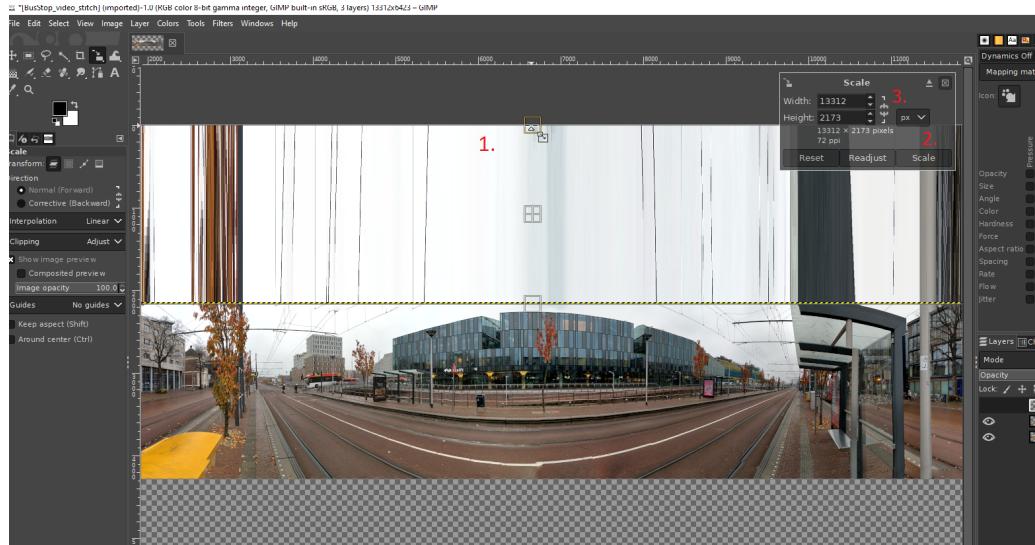


Figure 52: GIMP Scale Tool Stretch

Repeat the process described starting in 4.4.4, but this time select the layer containing the bottom 1% of the image you created. Access the Scale tool again, and hover over the rectangles that appeared at the edges of the layer, until the icon turns similar to (1.) in the image below.

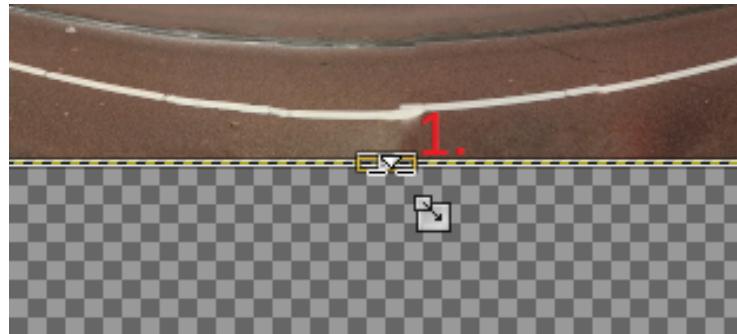


Figure 53: GIMP Scale Tool Stretch

Similarly to before, stretch the selected layer downwards until the edge of the expanded canvas, similarly to the image below. Again, press Scale (1.) to apply the change.

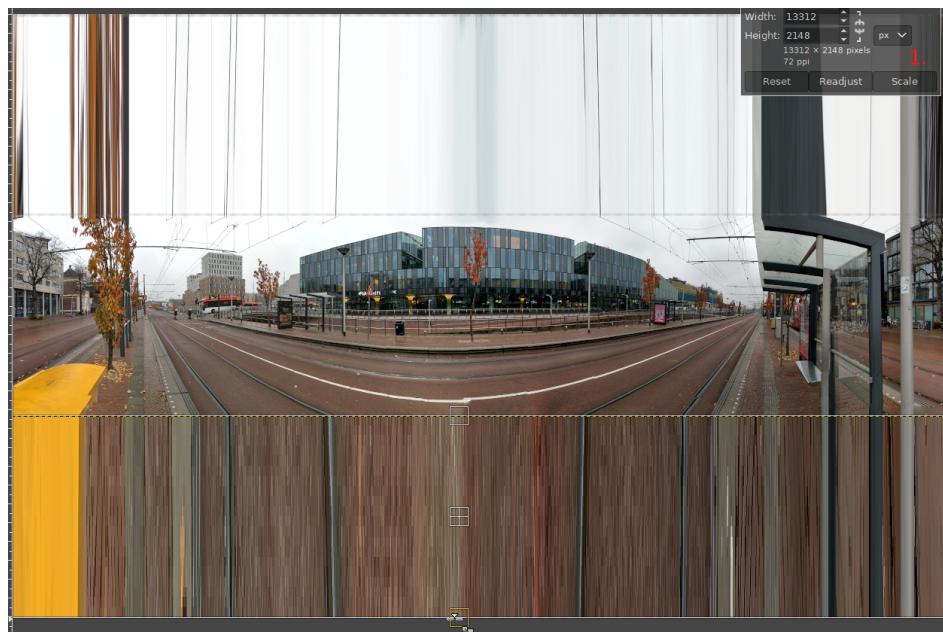


Figure 54: GIMP Scale Tool Stretch Bottom Layer

4.5 Exporting an Image

When done with editing the image, you should export it so that it is saved for use in the VR system.

Click File (1.) -> Export As (2.)

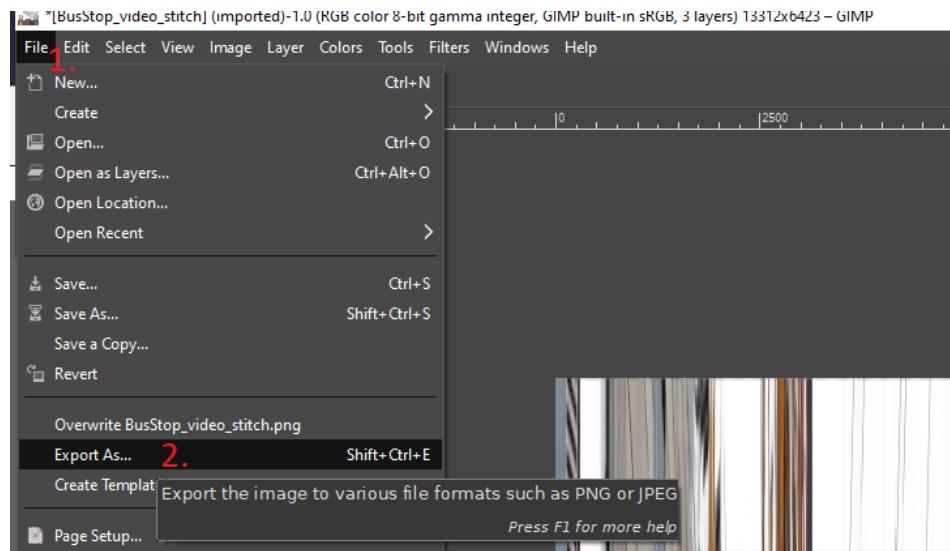


Figure 55: GIMP File -> Export

Choose a name for the file, making sure that it ends in “.png” (1.), and select a suitable location to save it. Then press Export (2.).

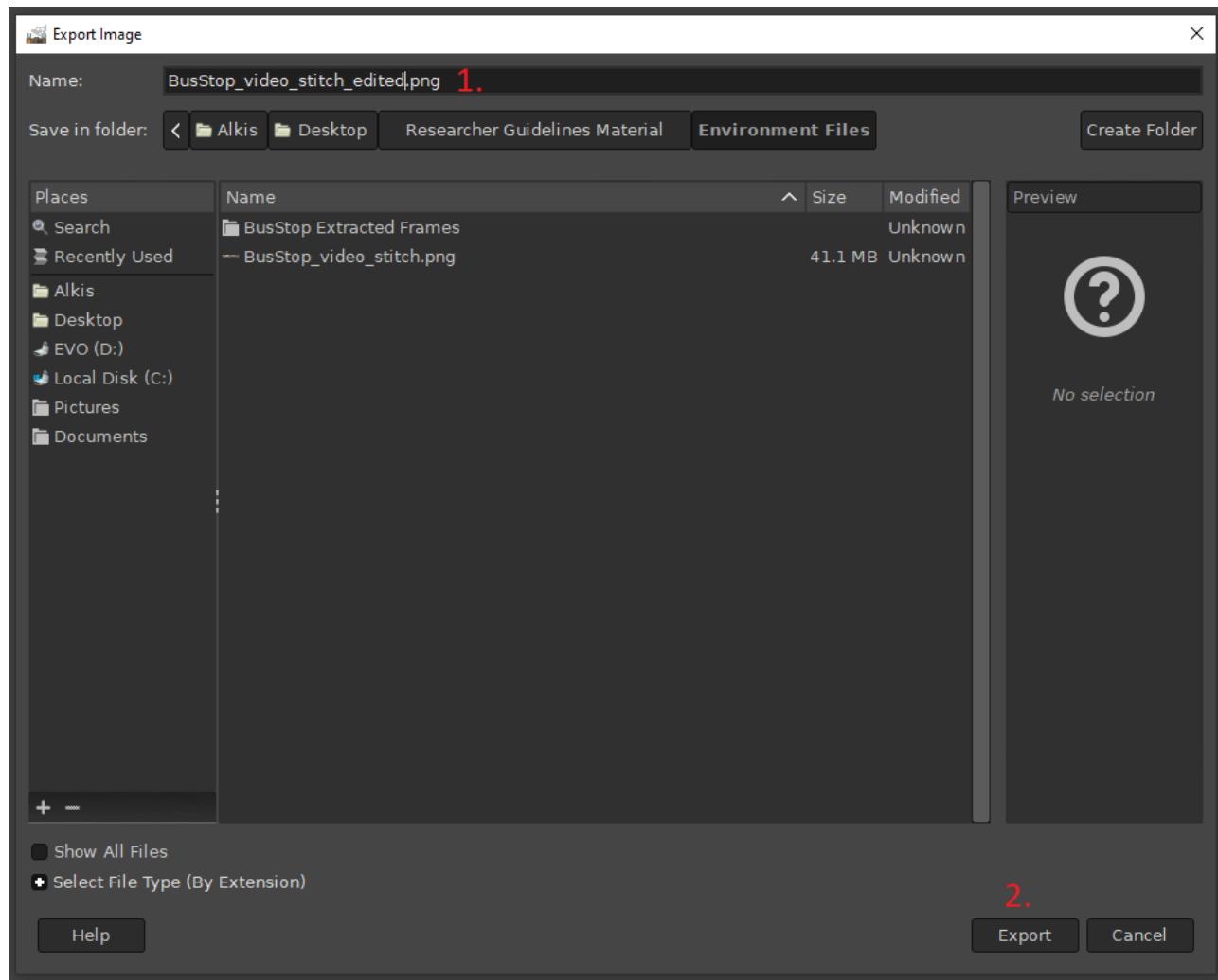


Figure 56: GIMP Export Menu

You can select similar settings as in the image below.

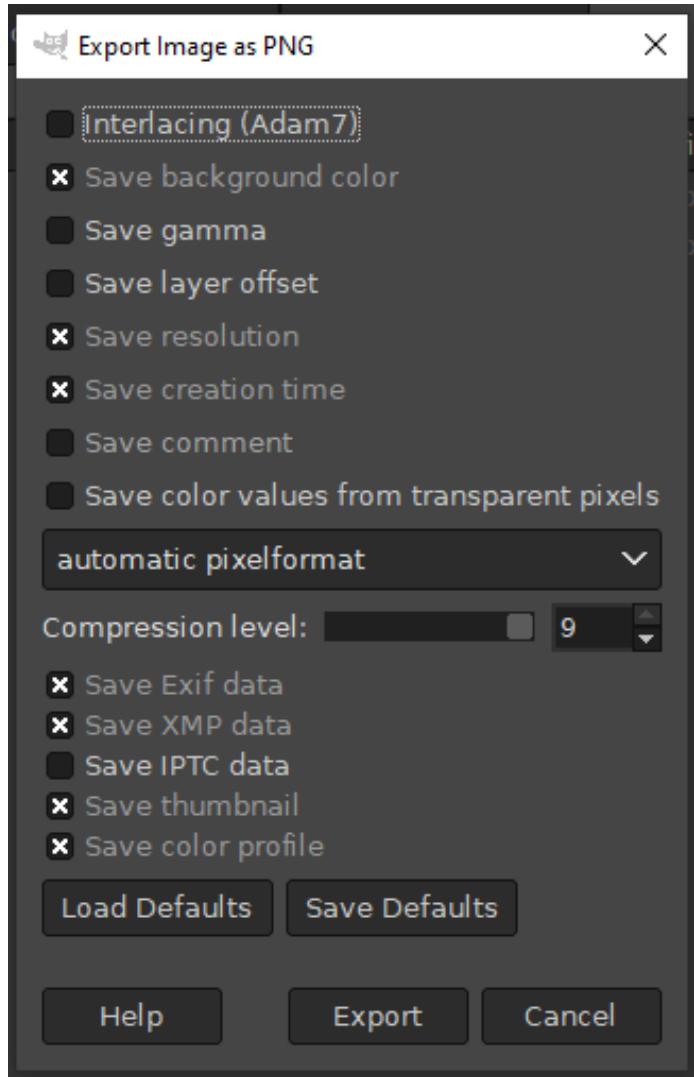


Figure 57: GIMP Export Settings

After the process is completed, you should see a new image file created in the location in which you saved it, as below.

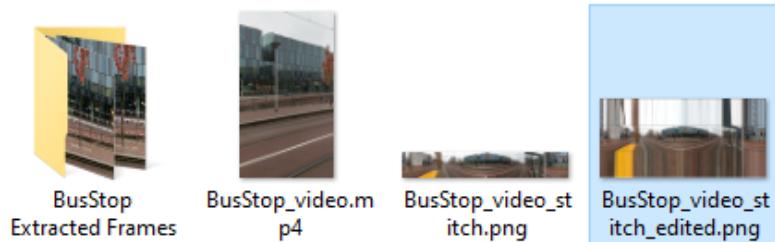


Figure 58: GIMP Newly Created Image File

You can close GIMP, and when prompted press Discard Changes (1.) since you have already exported the file.

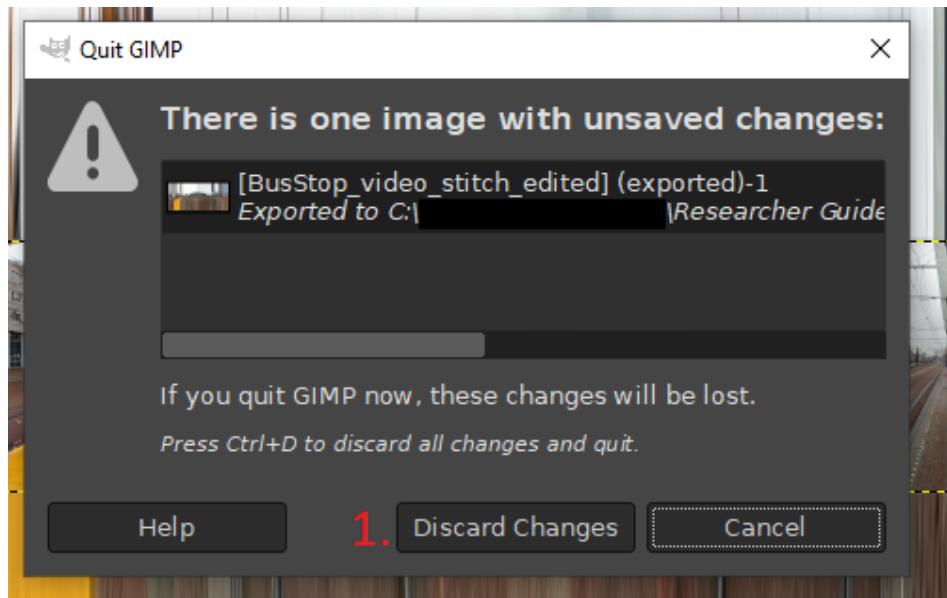


Figure 59: GIMP Closing Prompt

Chapter 5

Audio File Preparation

Download the latest version of Audacity at <https://www.audacityteam.org/>

Audacity can open most audio file formats, and you can even import a video file to use its audio as well.

5.1 Open and Play Audio File

Open Audacity, click File (1.) -> Open (2.) -> Select audio file in the folder where it is located on your computer.

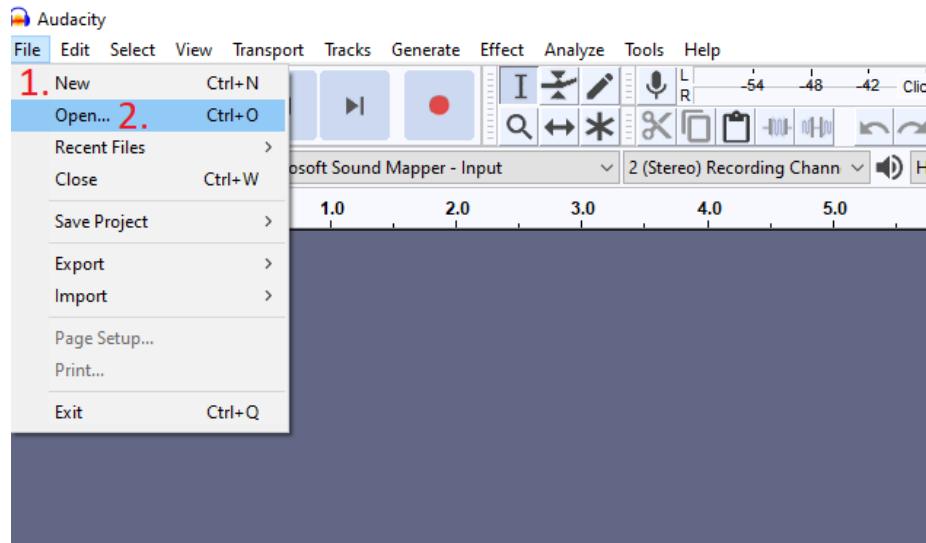


Figure 60: Audacity Open File

With the audio clip open in Audacity, you should be seeing a visual representation of the audio clip amplitude across time (1.).

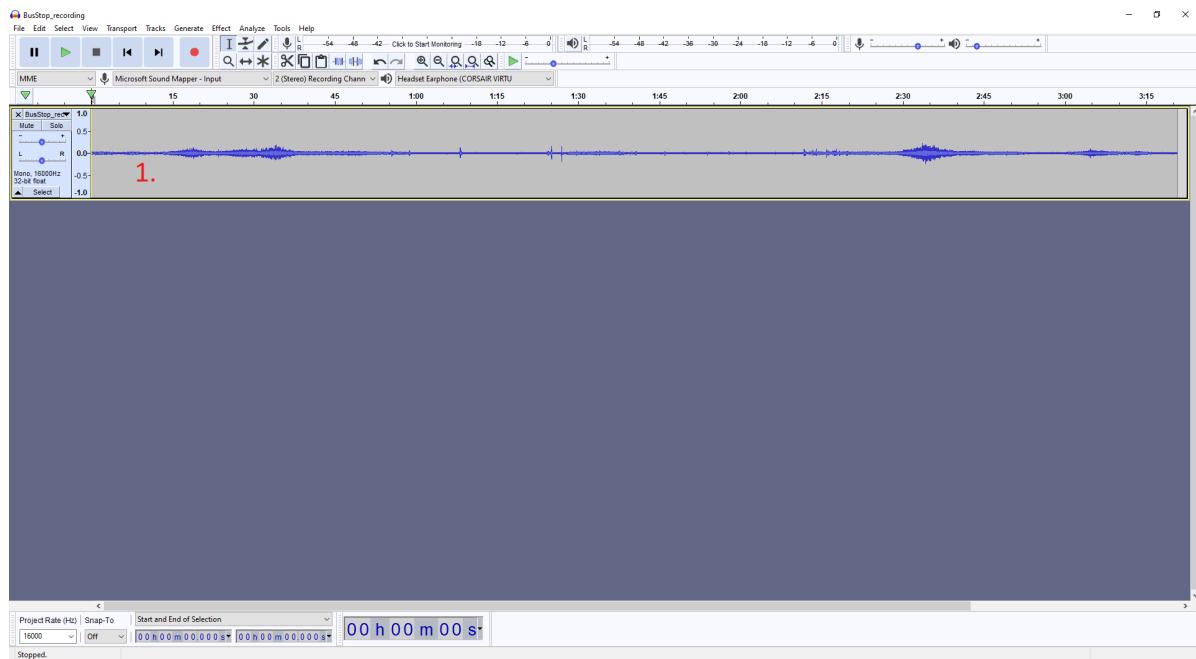


Figure 61: Audacity Mono Audio Amplitude Across Time

You can alternatively be presented with two amplitudes depending on whether your audio clip has mono or stereo sound, as in the image below.

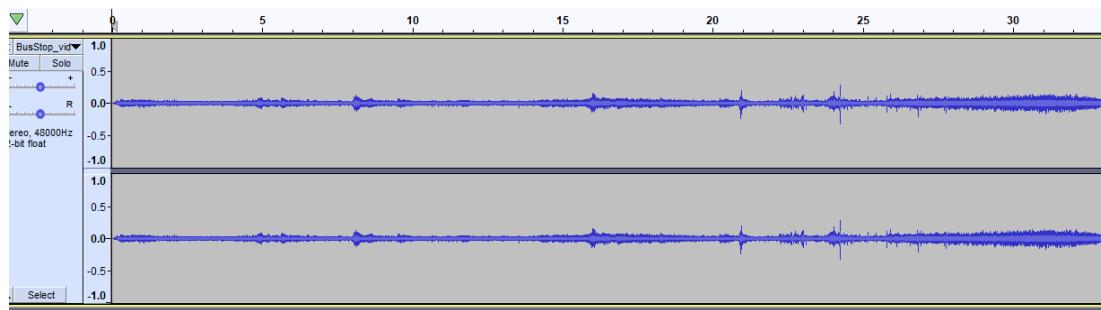


Figure 62: Audacity Stereo Audio Amplitude Across Time

Press the Play button (1.) to listen to the clip.

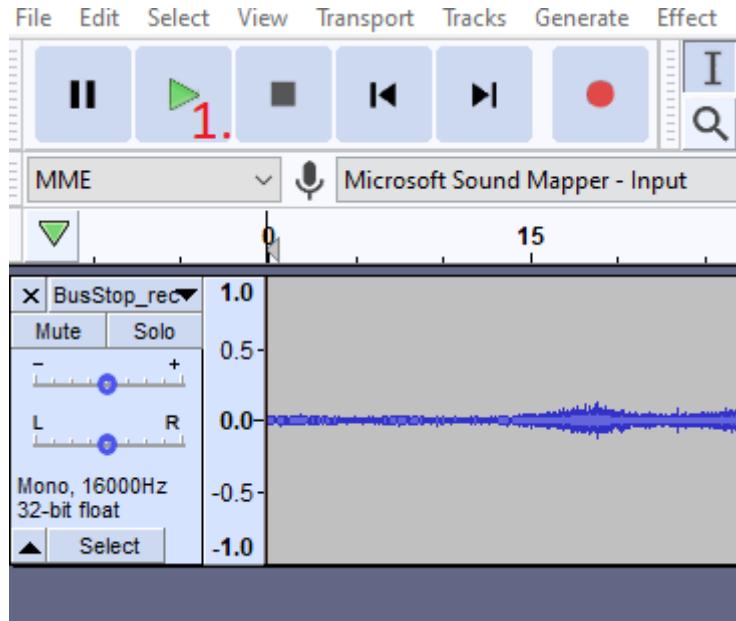


Figure 63: Audacity Play Audio

If sound too quiet or too loud at the usual volume that you listen to things, then you should adjust the amplitude of the audio clip. The intention is to make the audio part of the environment be immersive. To that end, an audio file may be too quiet/loud depending on recording factors. Therefore, while other audio clips may be listened to comfortably at the same PC volume, a specific clip may be unnaturally quiet (you need to be the judge of this, if e.g. you can't hear anything for the entirety of the clip, you may want to adjust the amplitude to perhaps see if there are any sounds at all), or painfully loud at that same volume. The goal is for every audio file to be listened to as intended using the same PC volume, so that you don't have to adjust it for every environment.

5.2 Adjust Audio Amplitude

You will need to select the entire audio clip, or click and drag an area on the amplitude over time representation you want to adjust. You should avoid doing the latter unless there are sounds e.g. wind noise that could be adjusted individually without affecting the realism of the clip.

To select the entire clip, click Select (1.) -> All (2.) or CTRL + A on Windows.

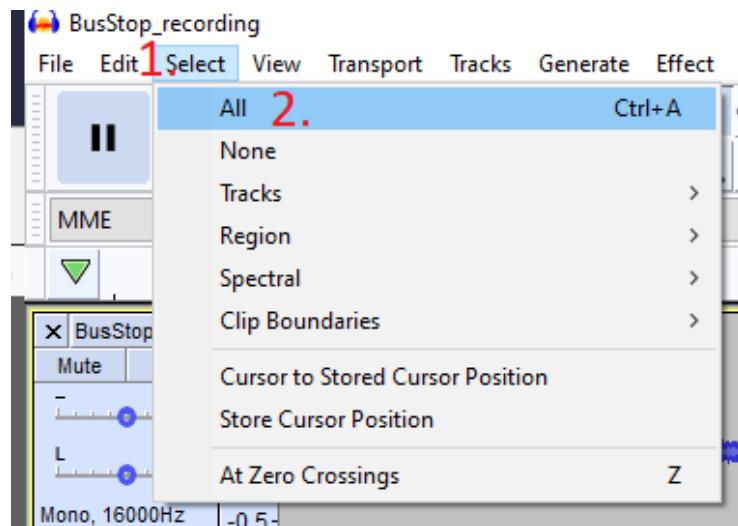


Figure 64: Audacity Select All

The clip will change to a lighter color to signify the selected area, e.g. the area selected in the image below.



Figure 65: Audacity Select Area

Click Effect (1.) -> Amplify (2.). "Effect" is next to the "Generate" button but is hidden by the menu.

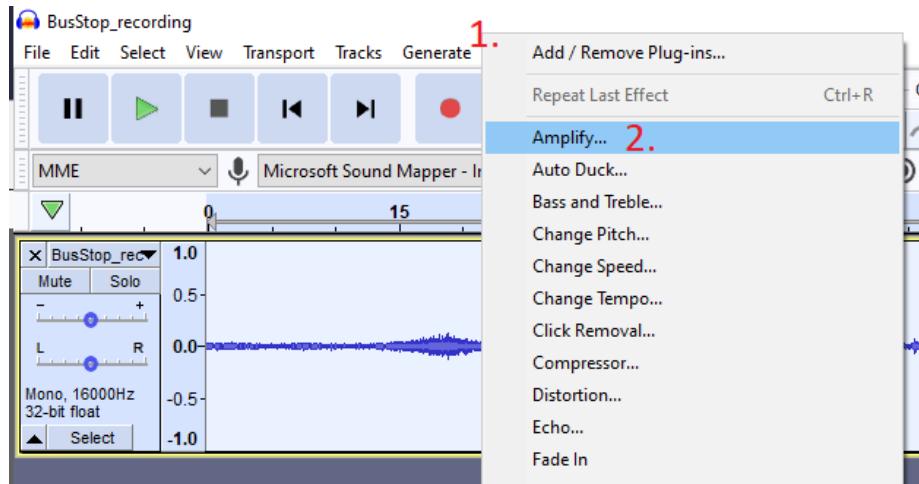


Figure 66: Audacity Amplify Access

Change the Amplification as desired using the slider (1.) (negative number to make the clip quieter, positive number to make the clip louder). Test with small numbers first (2.), e.g. +/-1. Press OK (3.) to apply.

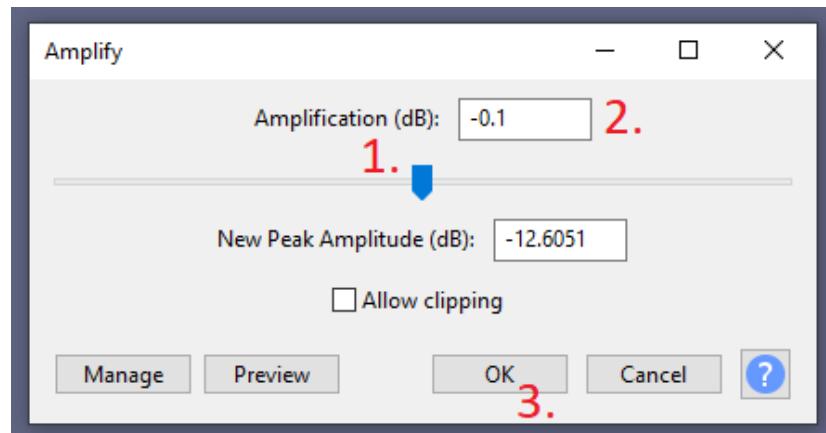


Figure 67: Audacity Amplify Menu

Listen to the audio and judge whether the clip sounds more appropriate now. You can press CTRL + Z in Windows to undo your change. Repeat the process until the audio clip sounds as you want it to.

5.3 Cropping Audio Clip

If the audio clip is longer than you would like it to be, you can crop it.

Click on the amplitude graphical representation at the desired time (1.).

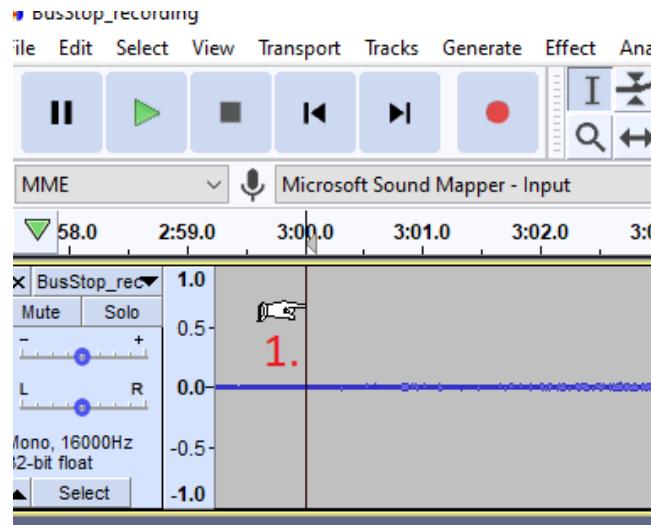


Figure 68: Audacity Select Time

Click Select (1.) -> Region (2.) -> Cursor to Track End (3.), or Shift + K to do the same.

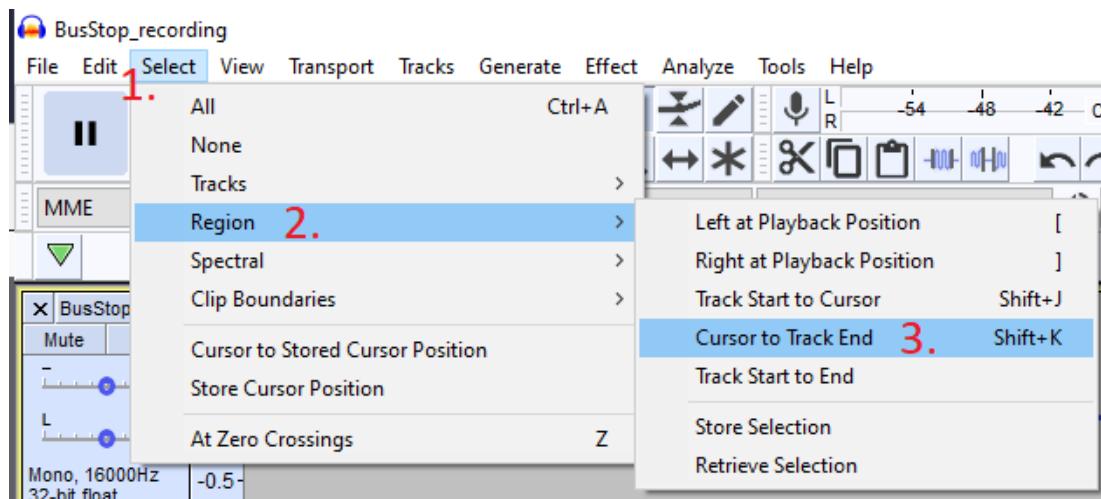


Figure 69: Audacity Region to Track End

You should now see part of the audio clip, from where you selected until the end, be highlighted, just like in the image below (1.).

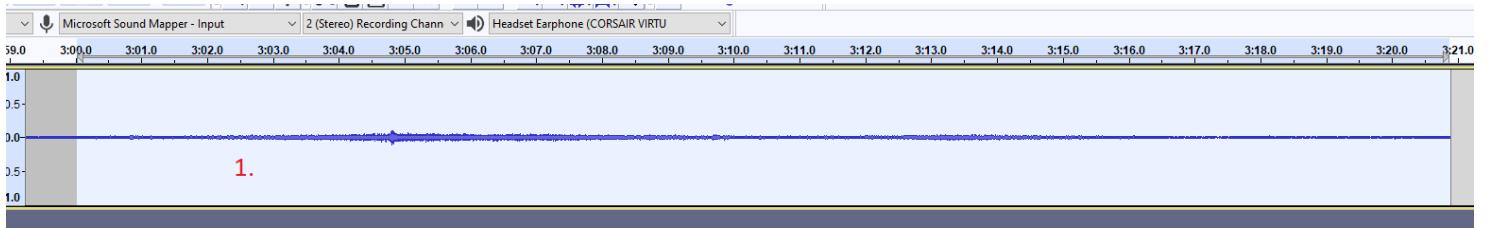


Figure 70: Audacity Selected Region to Track End

With the desired region selected, press Delete. You can do the same for regions within the clip that you may want, similar to Figure 65. Again, you should avoid doing this unless it is a sound that may be unnatural in the clip, e.g. an audio glitch.

You should now see the audio clip without the deleted section.

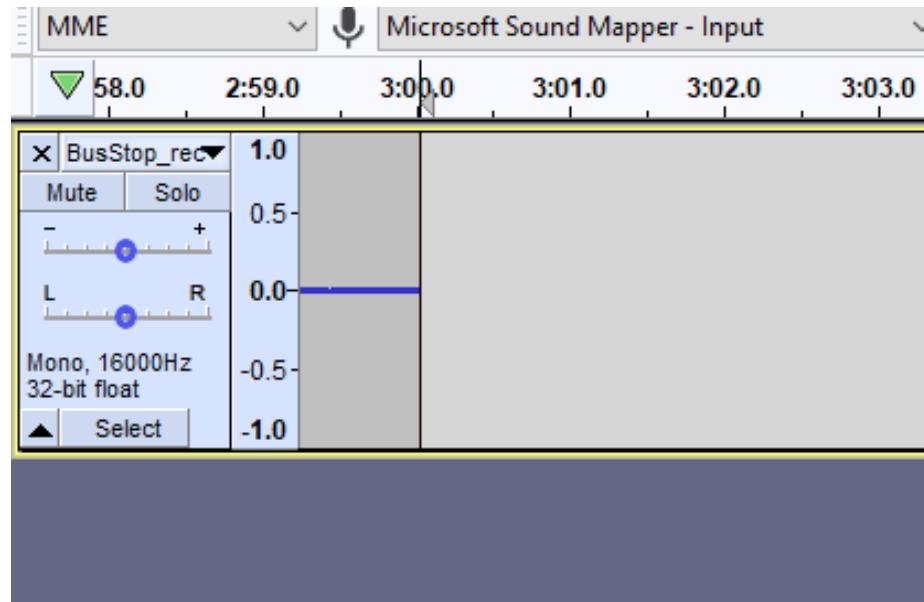


Figure 71: Audacity Clip Without Deleted Section

5.4 Export Audio File

When finished with the audio clip, you may export the file so that you can use it in the VR system.

Click File (1.) -> Export (2.) -> Export as WAV (3.)

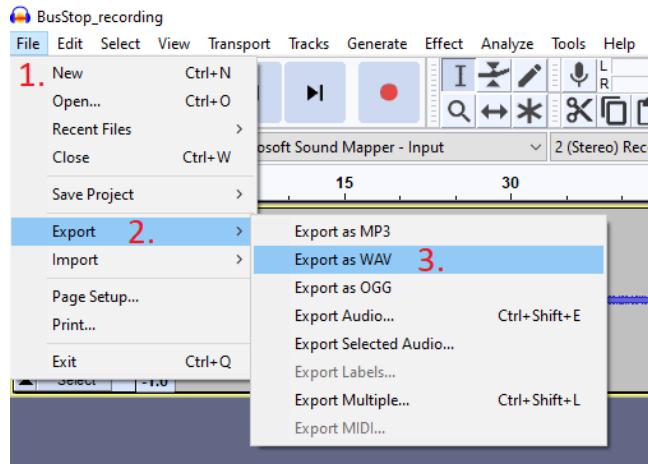


Figure 72: Audacity Export File Access

Select a suitable name (1.) and location for the file, and click Save (2.).

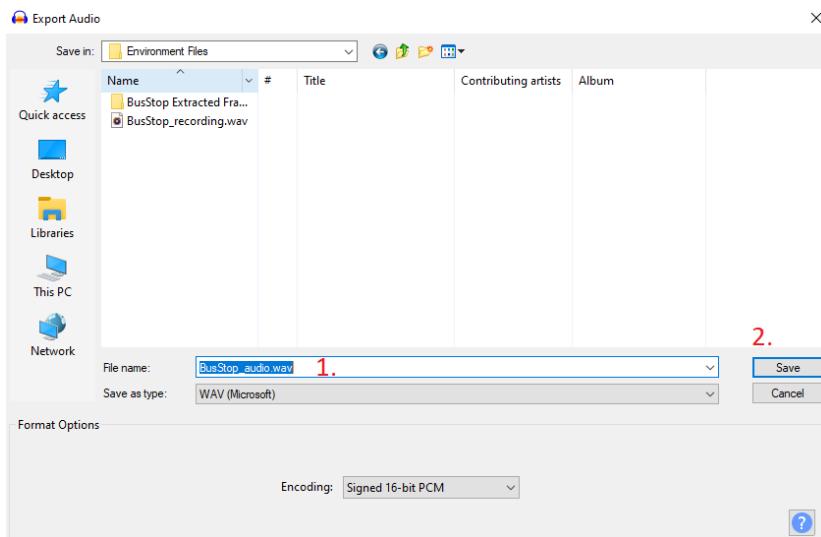


Figure 73: Audacity Export File Name and Location

Click OK (1.) in the following prompt.

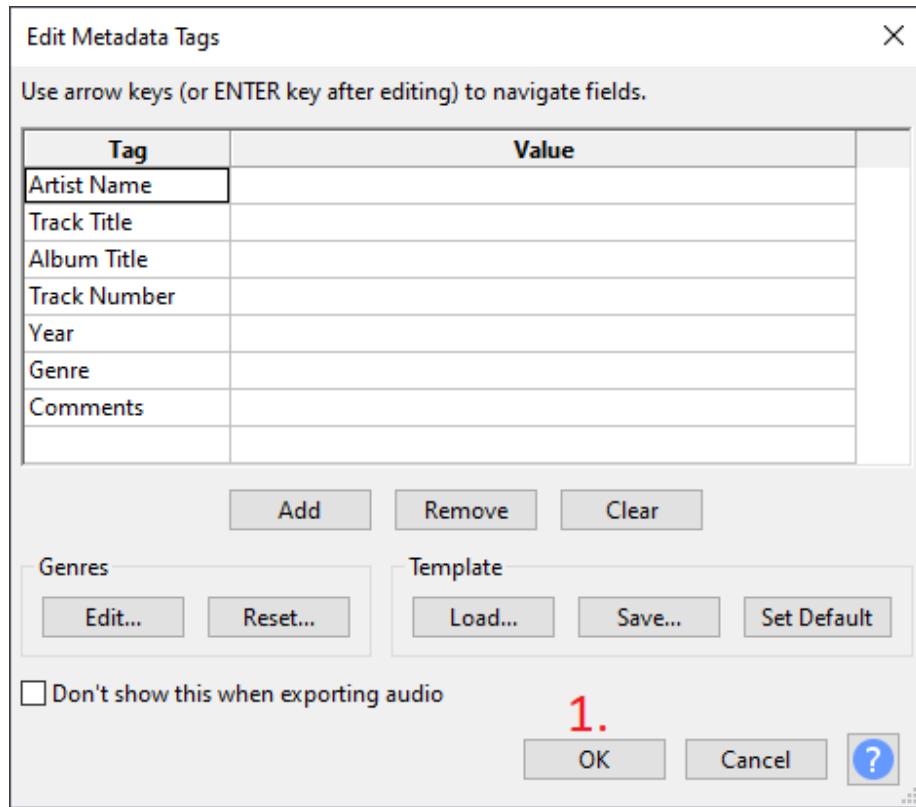


Figure 74: Audacity Export File Prompt

A new audio clip to be used in a virtual environment has now been created. When closing the application you will be prompted to save the project. Click No (1.) since you have already exported the file.

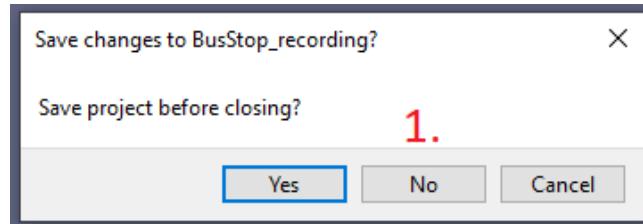


Figure 75: Audacity Closing Prompt

Chapter 6

Using the VR System

6.1 Adding Environment Files

Open the folder containing the VR system files, similar to the image below.

Craving Cues in VR_Data	14/11/2021 11:09	File folder
MonoBleedingEdge	08/11/2021 16:22	File folder
Craving Cues in VR.exe	26/10/2021 16:30	Application 639 KB
UnityCrashHandler64.exe	26/10/2021 16:31	Application 1,204 KB
UnityPlayer.dll	26/10/2021 16:31	Application exten... 27,495 KB

Figure 76: VR System Files

Navigate to "Craving Cues in VR_Data" -> StreamingAssets folder. Place panoramic photo and audio files in the Environments folder. Make sure that you follow the naming convention: "file name" .image, and "file name" .audio. "file name" need to be identical, e.g. "env1_image.png", "env1_audio.wav".

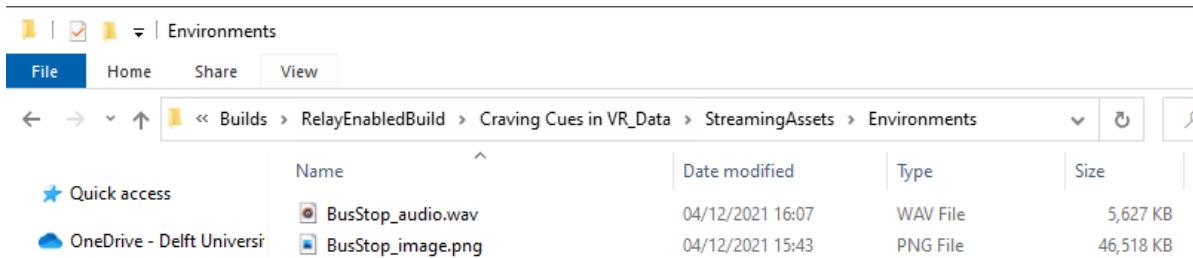


Figure 77: VR System Environment Files

Open EnvironmentToPresent.json file in the StreamingAssets folder using your preferred text-editing application, e.g. Notepad on Windows.

RelayEnabledBuild > Craving Cues in VR_Data > StreamingAssets	
Name	Date modified
Environments	04/12/2021 16:11
EnvironmentToPresent.json	27/10/2021 13:17
messages.json	24/11/2021 17:25
UnityServicesProjectConfiguration.json	14/11/2021 11:09

Figure 78: VR System Open EnvironmentToPresent File

Enter the common name of the files you entered in the Environments folder, without the “_video” or “_audio” parts.

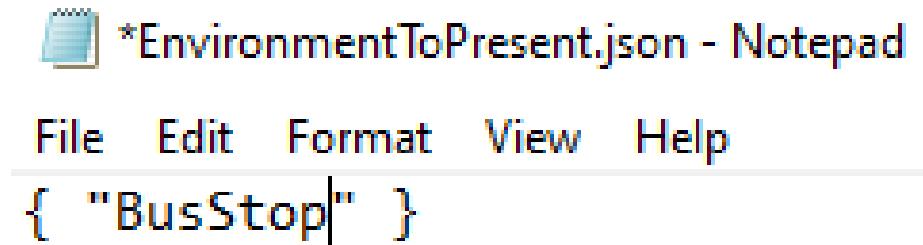


Figure 79: VR System EnvironmentToPresent File Edit

Save and close the file. You need to do this on both the researcher and the participant computers.

You can have as many files in the Environments folder as you like, but you can only open one environment in the VR system at a time, by designating the environment name in the json file as described above.

6.2 Adding Researcher Messages and their Responses

To add messages that will be available for researchers to send participants, open the “messages.json” file located in the StreamingAssets folder using your preferred text-editing application, e.g. Notepad on Windows. You need to do this only on the computer that is used to log in as researcher.

```
{  
    "chatMessages":  
    [  
        {  
            "messageContent": "Hello there!",  
            "messageResponses": ["Hi!", "Hello.", "No.", "General Kenobi."]  
        },  
        {  
            "messageContent": "How are you today?",  
            "messageResponses": ["Pretty good.", "Meh.", "Fantastic!", "No."]  
        },  
        {  
            "messageContent": "What is the meaning of life?",  
            "messageResponses": ["To live.", "To die.", "Who knows?", "42."]  
        },  
        {  
            "messageContent": "How much wood would a woodchuck chuck if a woodchuck could chuck wood?",  
            "messageResponses": ["As much as a woodchuck would be able to.", "2.", "Who knows?", "I hate you."]  
        },  
    ]  
}
```

Figure 80: VR System Messages File

By default the file contains sample messages and responses. You can remove these if you like, but make sure to only delete the content within the square brackets. To add your own messages, copy the structure between and including the inner curly brackets only containing the line with “messageContent” and “messageResponses”, as shown in the image below. Make sure to put a comma after the closing curly bracket if you intend to add additional messages after it.

```
{  
    "messageContent": "How much wood would a woodchuck chuck if a woodchuck could chuck wood?",  
    "messageResponses": ["As much as a woodchuck would be able to.", "2.", "Who knows?", "I hate you."]  
},  
[  
    {  
        "messageContent": "One more sample question.",  
        "messageResponses": ["Sample Response 1", "Sample Response 2", "Sample Response 3", "Sample Response 4"]  
    }  
]
```

Figure 81: VR System Select Message Structure

Replace “One more sample question.” with your own question/statement. Replace “Sample Response N” with your own intended responses. If you do not want responses for a particular question/statement, remove the contents of the square brackets in that block, but make sure that the square brackets are still present, as in the image below.

```
{
  "messageContent": "One more sample question.",
  "messageResponses": []
}
```

Figure 82: VR System Message With No Responses

Save and close the file.

6.3 Adding a Questionnaire

To add/edit the questionnaire that will be presented to participants, edit the “questionnaire.json” file located in the StreamingAssets folder using your preferred text-editing application, e.g. Notepad on Windows. You need to do this only on the computer that is used to log in as participant.

By default this file contains the short-form of the Tobacco Craving Questionnaire (TCQ),

Heishman, S., Singleton, E., & Pickworth, W. (2008). Reliability and validity of a Short Form of the Tobacco Craving Questionnaire. Nicotine & Tobacco Research, 10(4), 643-651. doi: 10.1080/1462200801908174.

You may change this as desired, but you need to keep the same internal structure in the json file. By default the file appears as in Figure 83.

```
{
  "qTitle": "Please answer the following questions regarding how you feel right now.",

  "qQuestions":
  [
    {
      "descriptionText": "",
      "questionText": "I would be less irritable now if I could smoke.",
      "acceptableResponseRange": ["1", "7"],
      "extremeRangeLabels": ["Strongly Disagree", "", "Strongly Agree"]
    },
    {
      "descriptionText": "",
      "questionText": "If I were smoking now I could think more clearly.",
      "acceptableResponseRange": ["1", "7"],
      "extremeRangeLabels": ["Strongly Disagree", "", "Strongly Agree"]
    }
  ]
}
```

Figure 83: VR System Questionnaire File.

The content between quotes next to "qTitle" is not used in the current version, and so will not be presented. If you want to show a message before the questionnaire is presented, please send them a normal chat message.

Each question must be in the structure shown by the highlighted text in Figure 84. Each question is presented with a slider. "questionText" is the text which will be presented on the specific slider. The numbers between quotes next to "acceptableResponseRange" are the slider values. Make sure that each number is between quotes. The content between in "extremeRangeLabels" will be oriented on the left, middle, and right under the the slider. Question segments (curly brackets) must be separated by a coma. Make sure that the square bracket and outmost curly brackets are closed at the end of the file.

```
{
    "qTitle": "Please answer the following questions regarding how you feel right now.",
    "qQuestions":
    [
        {
            "descriptionText": "",
            "questionText": "I would be less irritable now if I could smoke.",
            "acceptableResponseRange": ["1", "7"],
            "extremeRangeLabels": ["Strongly Disagree", "", "Strongly Agree"]
        },
        {
            "descriptionText": "",
            "questionText": "If I were smoking now I could think more clearly.",
            "acceptableResponseRange": ["1", "7"],
            "extremeRangeLabels": ["Strongly Disagree", "", "Strongly Agree"]
        }
    ]
}
```

Figure 84: VR System Questionnaire Segment Copy.

6.4 To Use the System

Open the application (Craving Cues in VR.exe) on the researcher and on the participant computers. The participant computer needs to have (light) VR capabilities and have the Oculus software installed. The researcher computer does not need to have the above, but it does need to be capable to run 3D applications. You can look on <https://docs.unity3d.com/Manual/system-requirements.html> for up-to-date information on minimum hardware and software requirements.

6.4.1 Researcher Perspective

6.4.1.1 Logging In

1. Enter a username (no use for this in the current version).
2. Select Researcher as the role from the dropdown menu.
3. Enter password (default is “a”.) This can be changed from the Unity Editor (ask the person maintaining the project). This is to have some simple security against the client in the lab logging in as researcher, which would just lead to having to restart the application, hence the simplicity of the password.
4. If wanting to perform simple tests on the same computer (e.g. to see how the virtual environment looks), tick the “Local Host” checkmark. If using on two computers, keep the “Local Host” checkbox unticked.
5. Press Log In”.

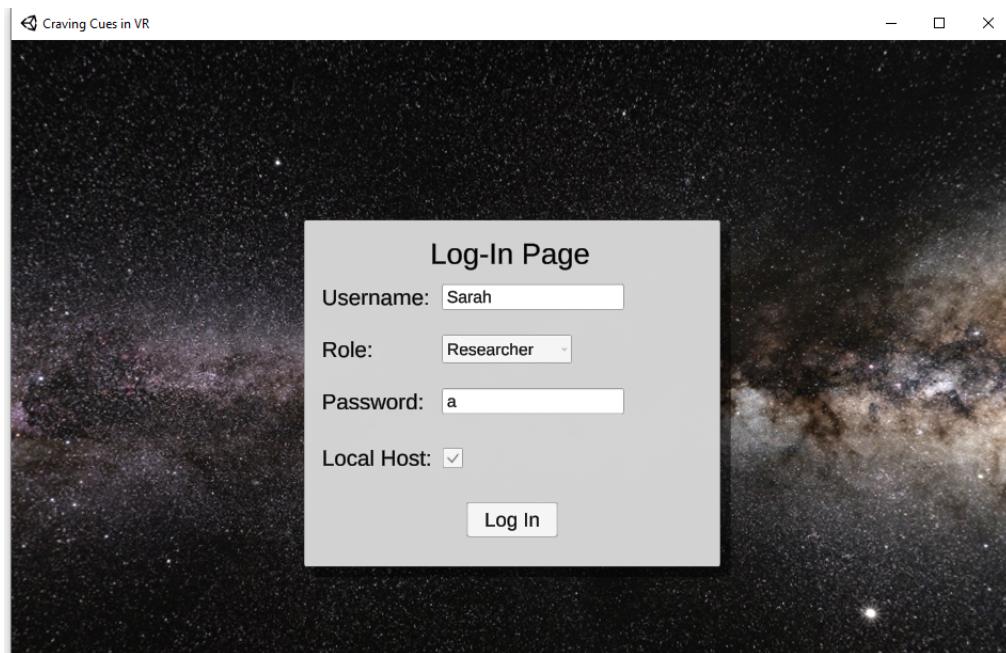


Figure 85: VR System Researcher Log-In

You will then be presented with a loading screen. If the "Local Host" checkmark was unticked, you will also be given a Relay ID, like below. You need to provide this Relay ID to the participant so that they can log in.

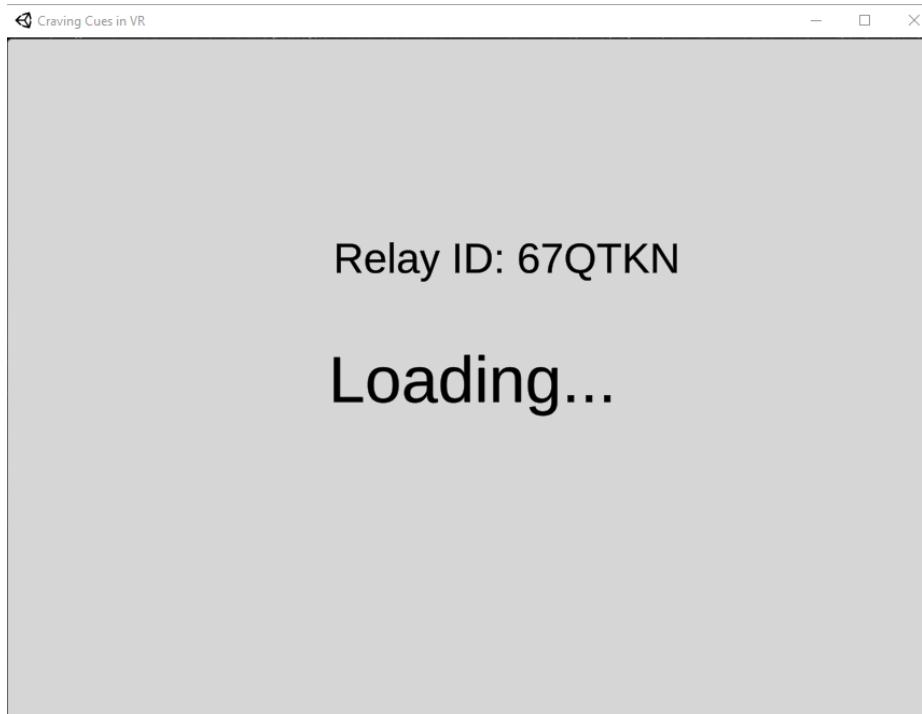


Figure 86: VR System Researcher Loading Screen

Once both a researcher and a participant have logged in, the virtual environment presentation will begin.

6.4.1.2 Sending Messages / Questionnaire to the Participant

1. Open the user interface (By default: Left-CTRL + Space). You can also press this key combination to close the user interface.
2. Select message template from list (1).
3. Optionally edit message (2.) and/or pre-defined responses (3.).
4. You can optionally type your own message in (2.) and add responses using (4.). You can also delete responses using the X button (5.).
5. Press “Send Message” (6.).

You can see the chat history in the Chat Log (7.). Messages you sent have a green background on the right side (8.), and messages received from the participant have a blue background on the left side (9.).

Do not send another message with available responses before the participant has responded to the first one. In the current version participants cannot select responses using a gamepad controller in a message with responses that is not the latest one received. Messages without responses are ok.

You can send a request to the participant for them to respond to a questionnaire by pressing the "Send Questionnaire" button (10.). Once you press the button it will be grayed-out and you will be presented with the message as in Figure 88a. Do not send a chat message to the participant after sending a questionnaire response request because they will be unable to continue responding to the questionnaire.

Once the participant submits their responses, you will be presented with the message as in Figure 88b. Responses will be saved as a .csv file named with the submission timestamp, in the "SavedData" folder located in the "StreamingAssets" folder only on the participant computer. After you receive the notification that the questionnaire responses have been saved, you may send additional messages to the participant.

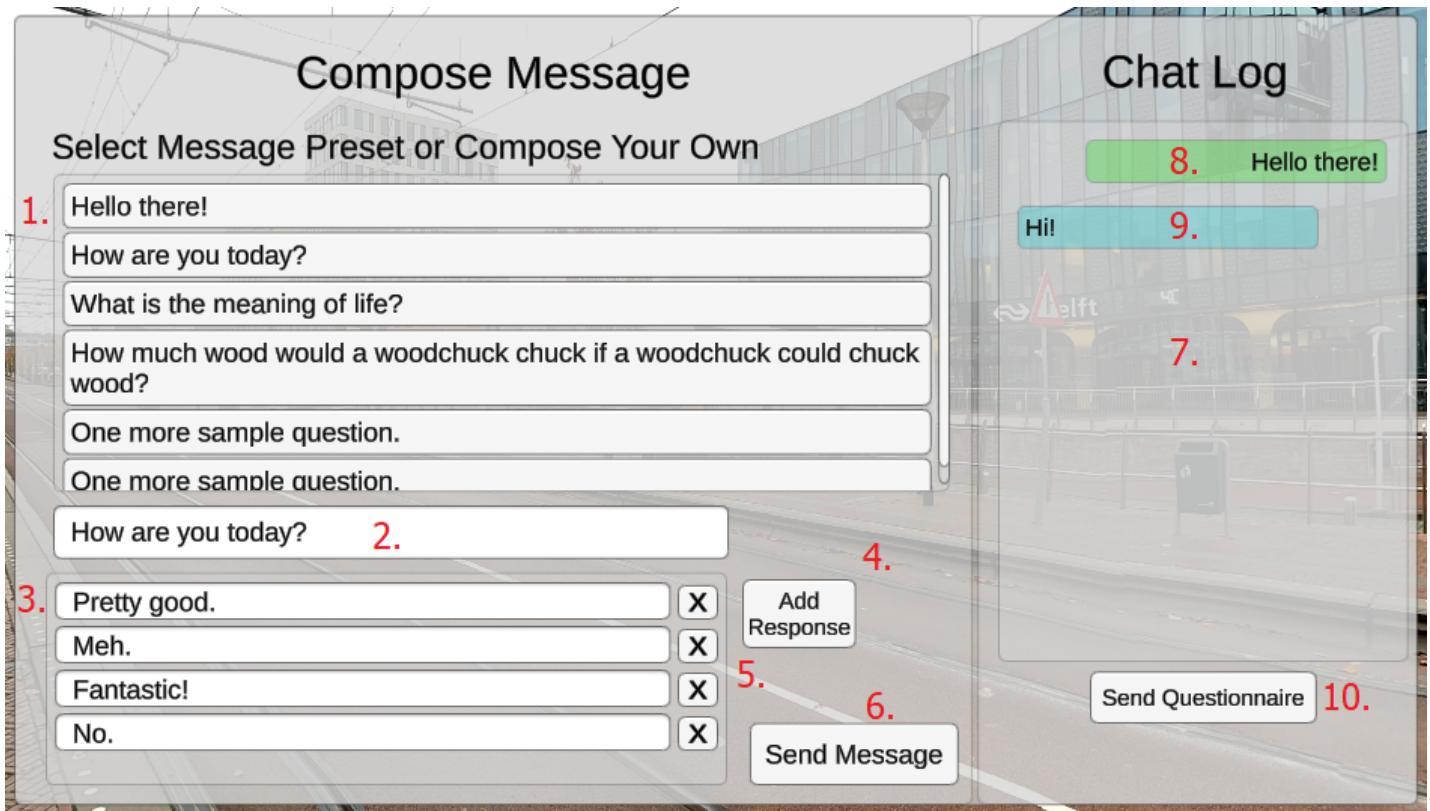
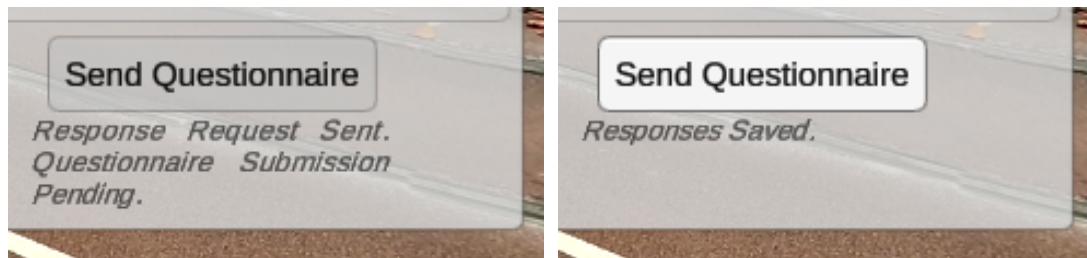


Figure 87: VR System Researcher Messaging UI



(a) Questionnaire Respond Request Sent.

(b) Questionnaire Responses Saved.

Figure 88: Send Questionnaire Status.

6.4.2 Participant Perspective

1. Enter a username (Has no use in the current version).
2. Select Participant as the role from the dropdown menu.
3. Enter the Relay ID given by the researcher.
- 3b. Alternatively, if testing on the same computer, tick the “Local Host” checkmark and the Relay ID field will disappear.
4. “Press Log In”.

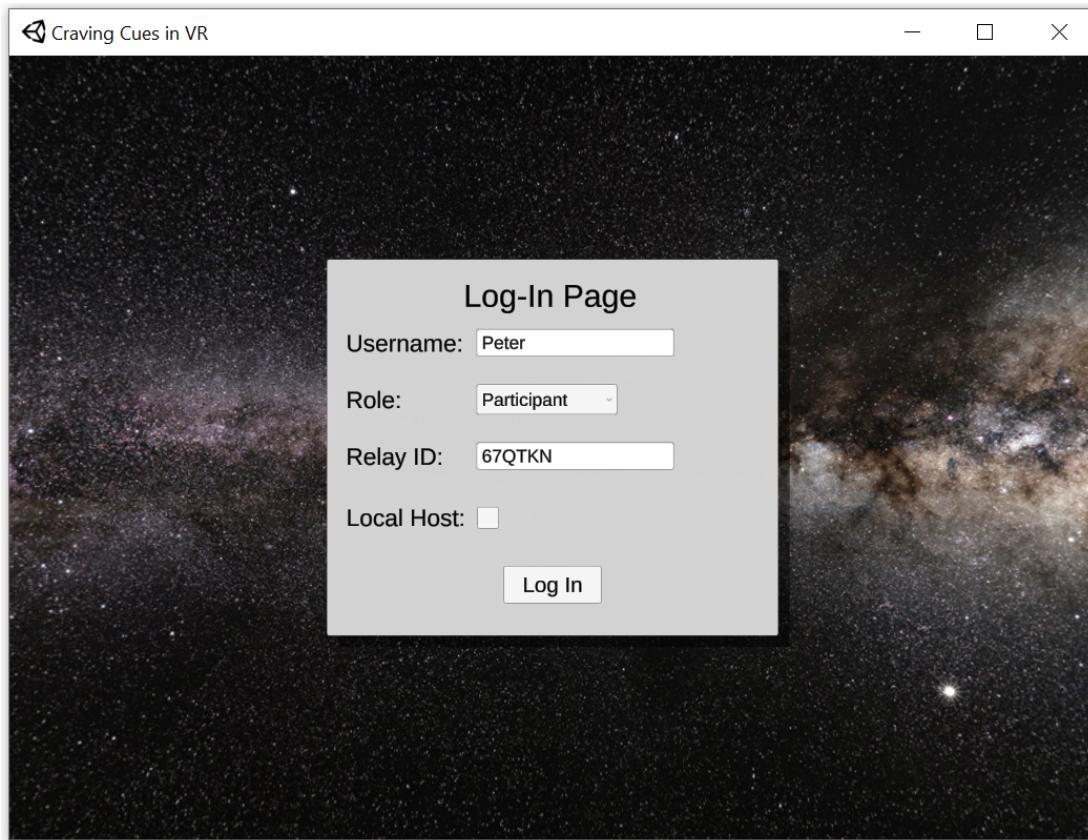


Figure 89: VR System Participant Log-In

Once both a researcher and a participant have logged in, the virtual environment presentation will begin.

You can look around the virtual environment using an HMD and control the user interface with a gamepad controller.

6.4.2.1 Responding to Researcher Messages

When a message has been received, a notification sound will play and the gamepad controller will rumble. You can open the user interface by pressing the Y button on your gamepad controller.

1. Received messages have a blue background and are placed on the left side (1.).
2. Press the Up / Down arrow on the gamepad controller D-Pad to navigate through available message responses (2.). The selected message is highlighted with a darker blue color, as in (3.).
3. Press the A button to send the selected message.
4. Messages you sent have a green background and are placed on the right side (4.).
5. Press the Y button to open / close the user interface.
6. Use the Left Stick to scroll through the chat history once there are more messages than what the smartphone screen can fit.



Figure 90: VR System Participant User Interface

6.4.2.2 Responding to Questionnaire

When a questionnaire response request has been received, you will be presented with a set of questions under the chat messages which you have already exchanged with the researcher. The option highlighted in blue is the currently selected one. You can use the vertical D-Pad buttons on the gamepad controller to navigate through the different questions, and the horizontal D-pad buttons to change the slider values. After the last question you may press the "Submit Responses" button to save your questionnaire responses.

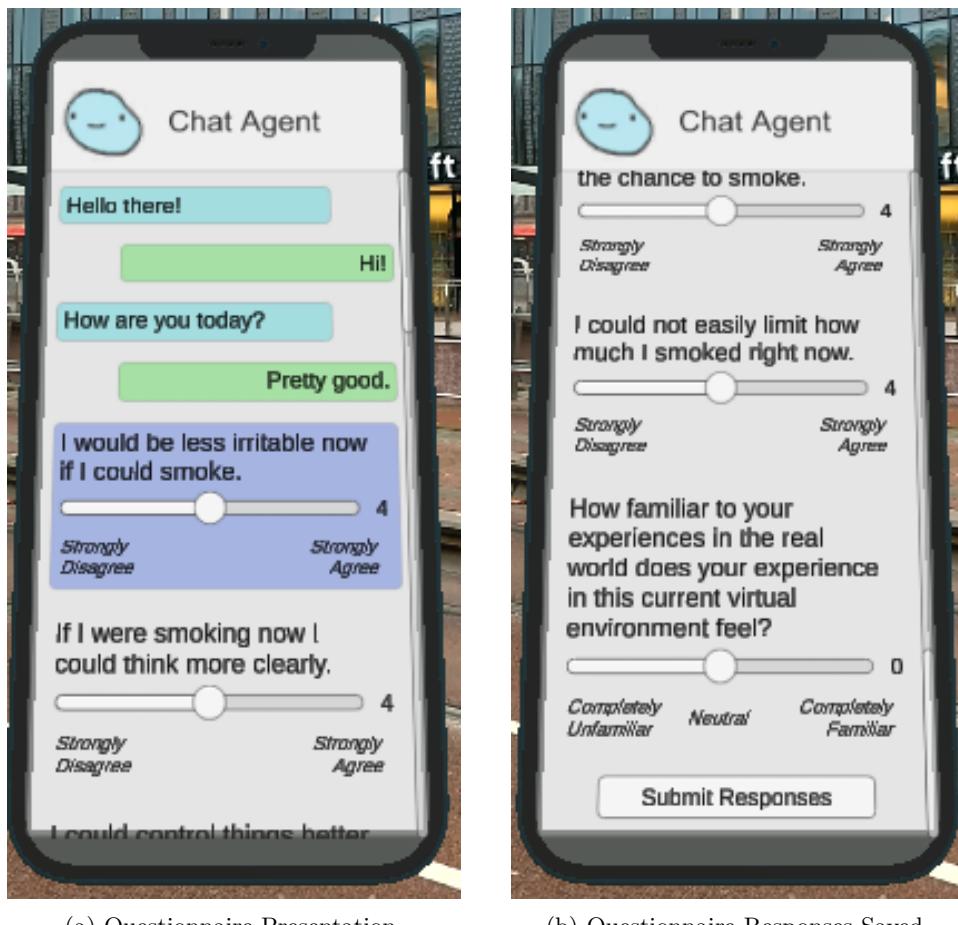


Figure 91: Submit Questionnaire Responses.