Pigments of Imagination

An A-Frame WebVR Project

by: Gabriel Zalles Ballivian, Tim Gmeiner, and Eito Murakami

Program Notes

Pigment of Imagination is a popular music track touching on themes of imagination and space-travel. The song is composed and produced by Timothy “Ill Poetic” Gmeiner and features vocals by both Ill Poetic and Nick Tolford, as well as flugelhorn by renowned jazz artist Stephanie Richards, and additional synthesizer parts by DJ/Producer King Britt. The stems from the song were used to create a special HOA mix, which you can hear online via the A-Frame project we created. In addition to the HOA, the A-frame project features custom animations that provide dynamism to the experience. During our experiments, we found that our HOA files did not load on most mobile devices, thus, alternate mixes in FOA and static binaural are also made available[1].

Relevance to Theme

While positional elements of sound are an interesting added dimension which can be explored compositionally, there is often a lack of access to new works of this type due to the high cost of multichannel loudspeaker arrays. Over the years, a number of JavaScript (JS) libraries have been presented which aim to simplify and democratize the generation of spatial audio, by employing convolution of HRTFs with ambisonic audio. WebXR offers a solution to the problem of equity, regarding the ability to both disseminate and create spatial audio.

HMDs have become increasingly affordable over the years, however, for most people these devices are still a luxury. Home surround sound systems, and sound bars, are also increasingly popular, but generally unaffordable for most people. In contrast, spatial audio over the web provides a flexible and ubiquitous solution for the dissemination of these works, using tools people already have and use for their everyday lives. Additionally, the APIs are designed for immersive media on HMDs, thus, people with sophisticated hardware can still enjoy these pieces with superior quality.

Given the restrictions created by the global pandemic of 2020-21, tools of this variety have become quintessential for artists engaged in this specific domain. In contrast to SDKs for

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[1] HOA only works using sufficiently fast internet connections.

particular OSs, WebXR solutions attempt to transcend the kernel, and instead rely on a community of gracious programmers, who work together to help these tools work seamlessly across the internet. The lockdown took away many of the resources we counted on for creating spatial audio, fortunately, it also forced us to adapt and learn about new ways of presenting these works; adapting to create sonic experiences in the era of the Internet of Sound.

Description

The main element allowing this work to be possible is the A-Frame Ambisonic component, which is an A-Frame component providing a high-level abstraction to the Omnitone API. The Omnitone project is responsible for the binaural decoding of HOA/FOA sound files which were created in Reaper, a cross-platform DAW, using the IEM Plug-In Suite.

Following the creation of our raw HOA sound file, with 16 channels, in uncompressed format, the sound files were imported into Audacity for compressing and splitting into two 8-channel files, as per the provided example. The OGG codec was chosen, also as per the example, and different quality settings were tested to determine a compromise between load-time and over-compression artifacts. Due to the length of the song, and the number of channels, we used a timeout feature in A-Frame which gives the listener's connection 10 second to download the 67MB of audio required of the project (as well as other assets). We ultimately selected a quality factor of 5 in the OGG compression, out of the possible ten quality levels.

As per the recommendation of the A-Frame documentation, we opted for the server solution provided by neocities.org (which is open-source). The animation-timeline-component was used to create the sequences involving A-Frame primitives. A particle system component was adopted to give the piece some additional movement. Several spheres were textured and set to rotate around the listener serving the theme of outer space. A 360 degree photograph from the European Southern Observatory[2] was used to texture our sky element, after it had been resized to a lower resolution (4K) in order to reduce its size. Some GLTFs were also imported into the scene which were collected from Google Poly.

The project was tested using several browsers and mobile phones with various internet connections, all in the San Diego area. While the assets loaded properly with some connections, a longer timeout was needed on other networks. The preload feature of A-Frame has not yet been implemented into our project for HOA. On mobile devices, we were unable to get Omnitone to playback HOA, so alternate versions in FOA and binaural were created to satisfy the needs of each user, based on their connection[3].

The HOA version on Desktop browsers such as Chrome and Firefox sounds really fantastic, and the virtualization of moving sources is clear and distinct. The vocalists' stems, which are fixed at the front sonically, clearly change in timbre as one changes perspective. In future projects we are interested synchronizing the bimodal elements of the audio-visual experience to further facilitate the localization of sound sources.

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[2] Creative Commons Attribution 4.0 International License.

[3] The binaural version is fixed with regards to perspective. There is no ambisonic rotation in this scenario.

Additional Notes (Tim Gmeiner [artist])

“Pigments of Imagination” presents the creative process as a narrative relating the neurological inner-workings of synesthesia to the universe around us through vocals and instrumentation. It is an exploration of the imagination as told through the story of a small child's journey to the moon. The musical aspects of this project include studies of composition, piano, theory, acoustics, sound-design, audio engineering/production, screenplay drafting, and visual communication by way of 3D texturing and world-building.

Highlights of the music-creation process relative to this project and conference theme include:

- Flugelhorn processed through granular synthesis.
- Vintage synthesizers patched together and captured as a single live performance.
- Live field recording of birds digitally manipulated through granular and wavetable synthesis. Stretching and other processing techniques were used to pitch live recordings to harmonic frequencies. The result was used as a sonic bed for instrumentation and vocals.
- Sounds of the Mars Rover run through granular processing to increase the stereo field of the composition, and create an atmosphere for the music and narrative.
- All collaborative elements of the song were recorded in environments native to each artist.
- Various forms of delays, reverb and convolution reverb were then used for processing while mixing the song to accentuate musical spaciousness prior to HOA mixing.

Supported Devices

https://webvr.rocks/ [*outdated but still useful list of supported devices/browsers*]

Chrome/Firefox on Desktop should work well for HOA/FOA/Binaural, so long as internet connection is fast enough. The heavy assets are the audio and the 4k image, which total around 80Mb (for HOA). Specs of working computer: 3.1 GHz Quad-Core Intel Core i7, 16GB RAM. Connection speed of working computer: 288Mbps download rate. Browser of working computer: Brave and Firefox.

- iOS:
  - Not supported for HOA (.ogg problem)
  - Not supported for FOA (reason undetermined)
  - Not supported for binaural[4]
- Android:
  - Not supported for HOA (reason undetermined)[5]
  - **Supported for FOA!!! (Samsung, Chrome, Firefox)**
  - **Supported for binaural**
- HMDs:
  - Under testing, need to test HOA/FOA/Binaural in various browsers.[6]

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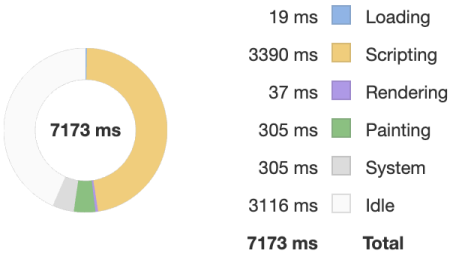
[4] Binaural audio starts automatically, which is not supported in iOS.

[5] Must have to do with loading assets. Example works with smaller file.

[6] None of the authors own one of these devices.

Load Time

From Brave browser inspector (performance tab). This is the load time for the HOA scene, with the connection described above.



CPU/RAM Usage

- HOA (on working machine): RAM 1.6GB, CPU ~30%[7].
- FOA (on working machine): RAM 300MB, CPU ~23%.
- Binaural (on working machine): RAM 500MB, CPU ~20%.

CPU usage similar likely due to identical graphics. Unclear why binaural requires more RAM than FOA. Could have to do with WAA playback instead of Omnitone. All values are approximates observed with task manager on Brave.

Assets/Scripts:

///——————Assets————————///

- Universe: ESO (European Southern Observatory) Photo: P. Horálek
  - Creative Commons info
- Planet textures: site. (Mars, Venus, Saturn)
- Poly - Paint can: Jarly Perez: site.
- Poly - Bedroom: Jason Toff site.
- Poly - Paintbrush - Karen Vanderpool: site.

Poly is being discontinued very soon. You won't be able to find these assets any longer there.

///——————Scripts————————///

Animation Timeline Component
Particle System Component

Main Links

View: gabrielzalles.neocities.org/poi
Download

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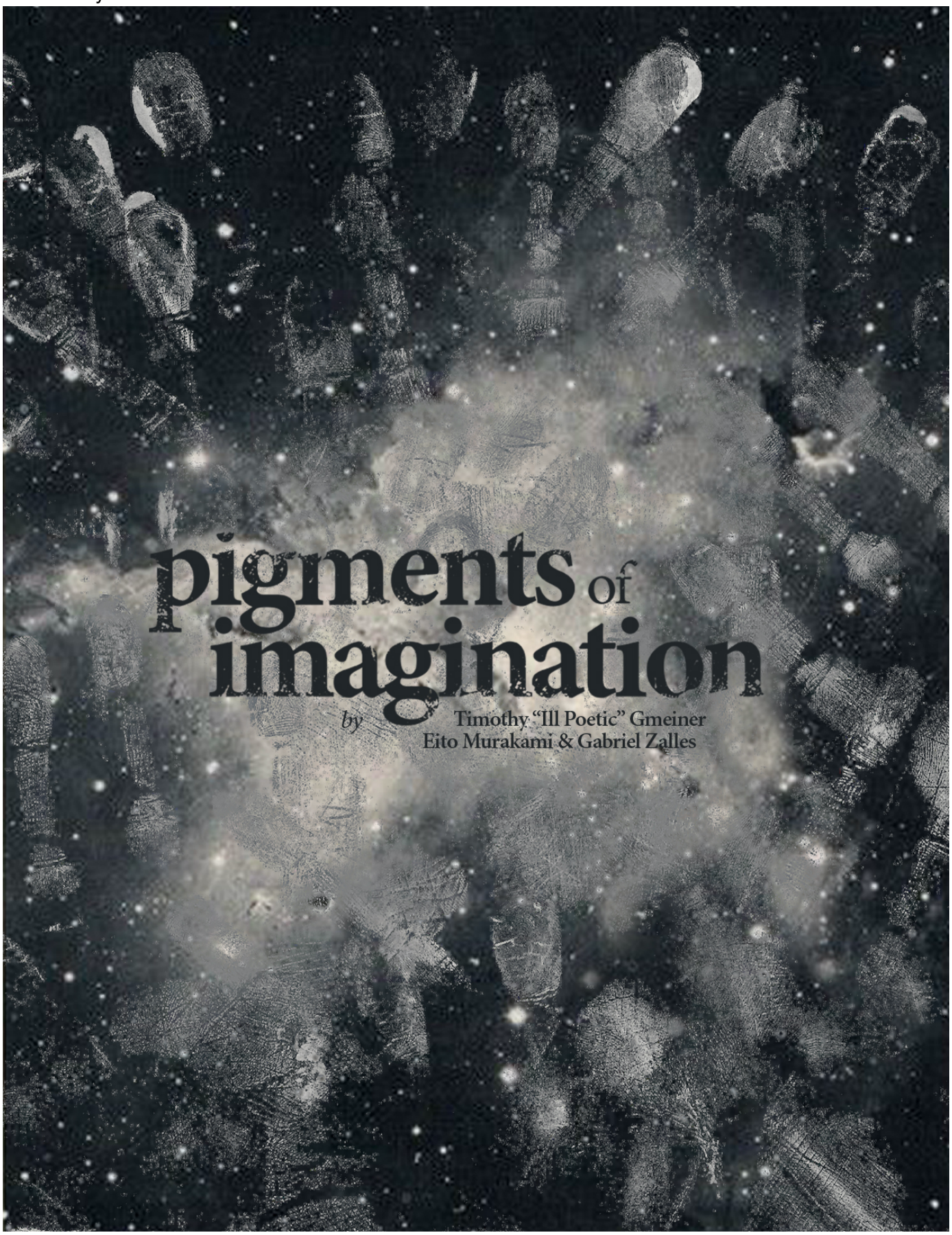
[7] The most recent measurement of the process's CPU usage, expressed as the percentage of a single CPU core used in total, by all of the process's threads. See.

artwork by Tim Gmeiner



Appendix: Prototyping Process Notes (Eito Murakami [co-creator])

This project has gone through several iterations as various technical limitations emerged. Here we explain some of the changes that have been made over time as well as the prototyping process that has allowed us to present the piece in its current state.

During the brainstorming phase, we designed a virtual 3D environment where we envisioned every component would provide the audience the ability to improvise as participants in the piece. In our prototype, we positioned an A-frame camera component at the average height of human eye level to provide a sense of realism. The background image was generated using an environment component by Diego F. Goberna, which offered a dozen presets with parameters to dynamically change the appearance of the virtual world.

Lighting in the prototype environment consisted of two different types: point and directional. Dynamically changing the position and intensity of each light source allowed us to highlight specific objects based on narrative of the musical composition. As explained previously, the background in the current version of the piece has been replaced by a 360 degree photograph from the European Southern Observatory. A camera is now positioned high above the ground to emphasize the spatial effect of ambisonic audio.

Based on the initial idea to visually follow the narrative of the composition, we collected specific items that appeared in the lyrics of the song. In order to import such objects in an A-Frame scene, we had to convert OBJ files to GLTF files using Blender. By using the animation-timeline component to dynamically change the size of objects, we were able to spawn objects sequentially. In the current version of the piece, a bedroom, a paint brush, and a paint can appear as static objects. Instead of using low-poly objects to depict the narrative, we designed planets, stars, and cubes to convey the theme of freedom and imagination.

Issues

- Gesture required to initiate audio context. Uncertain if gesture working on HMD. See.
- OGG compression using in HOA does not work with iOS. See.
- Gesture required to start audio in iOS (blocks binaural).
- Other?