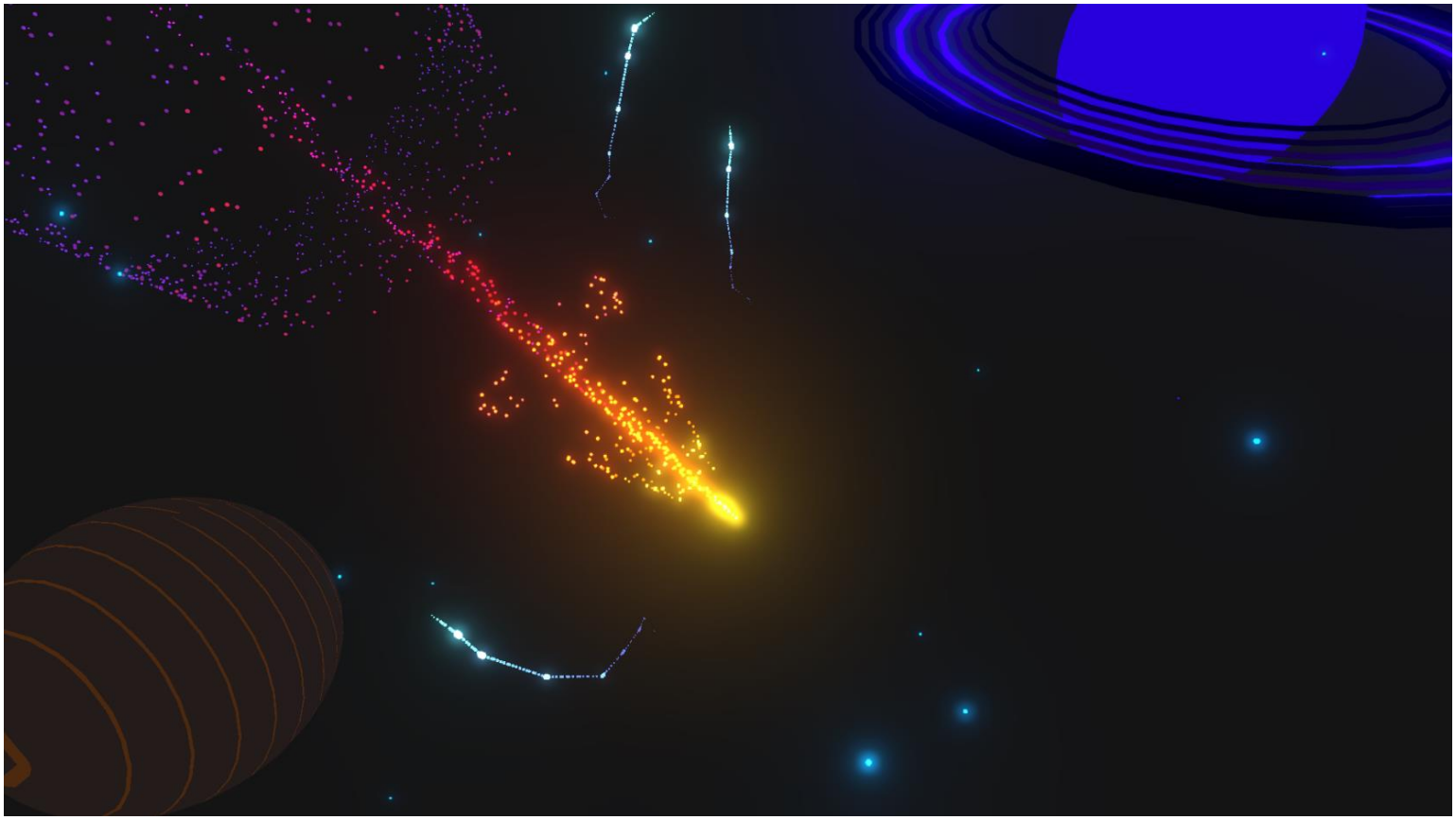
Real-Time Audio Visualization

Graduation Project



Graduation Project
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Abstract

This research paper aims to address the challenge faced by smaller venues and disc jockeys who struggle to meet audience expectations for visuals due to budget constraints. The objective is to develop a cost-effective and user-friendly solution that fills this gap in the market. The research process involves iterative testing and refinement to ensure that the final product aligns with user expectations. The resulting product offers a convenient plug-and-play solution, accommodating various software preferences through integrations while providing additional tooling specifically designed for visual jockeys. Emphasis is placed on enhancing the workflow and end products for users through a user-friendly interface and comprehensive manual. The demand for such a product is evident in the market, as demonstrated by the generated jobs and positive reception throughout the course of the graduation project. By successfully addressing this market need, the product fills a significant void and offers a practical solution for venues and disc jockeys seeking to deliver captivating visuals within their budgetary constraints.

Glossary

Kick - Percussion instrument producing a deep, low-frequency sound.

Snare - Percussion instrument with a sharp sound, consisting of a drumhead stretched across a shell with metal wires (snares) underneath.

BPM - Beats per minute, indicating the tempo of a musical composition.

DJ - Disc jockey who mixes and plays recorded music for an audience.

VJ - Video jockey creating and manipulating visual content for music performances.

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1 Introduction

Audio visualizers have been an integral part of the entertainment industry for several decades, dating back to as early as 1977. Although their popularity has decreased over the years, the significance of visual engagement has become increasingly important. In recent times, the entertainment venue industry has seen a significant improvement in both audio and visual quality. However, the tools for creating these visuals have remained stagnant. This paper aims to explore ways in which the visuals and tooling for the entertainment venue industry can be improved. The focus will be on enabling venues to set up visuals with minimal assistance from visual jockeys, who are responsible for handling visuals in real-time. Additionally, the paper will discuss how better tools can be provided to these visual jockeys to enhance their ability to create more engaging visuals.

1.1 Project description

This research project aims to explore the development of an efficient workflow that is easily adoptable by disc jockeys (DJs, Glossary) and venues alike, with a particular focus on enhancing the toolset available to visual jockeys (VJs, Glossary) within their preferred program. This paper will investigate various tools, including but not limited to kick detection(Glossary), snare detection(Glossary), and BPM (Glossary), that can be integrated into the existing workflow to facilitate an improved audio-visual experience for the audience.

1.2 Coaches

This graduation project is a free written assignment, not affiliated with an existing company. As such, the project will benefit from the guidance of an external coach. Ruben Hulzebosch, a teacher and a professional disc jockey (DJ), will serve as the internal supervisor. He will provide valuable guidance on identifying gaps in the industry and how this project can address them. His expertise in music and knowledge of industry expectations for a product of this nature will also prove valuable to the project. The project will also be supervised by Ton Nieuwenhuis, the CEO of ticktickboom, who brings experience as a visual jockey (VJ). As the external supervisor, he will provide valuable insights into the needs and expectations of VJs and how this product can address them.

2 Problem Analysis

During the project's development in the summer of 2022, preliminary observations indicated a demand for the product at hand. However, the underlying reasons behind this demand remained unknown. Further investigation was necessary to comprehend the driving factors behind the product's market appeal.

2.1 Market

In recent years, there has been a significant increase in interest and demand for festivals, as individuals are eager to participate in outdoor events once again. In light of the COVID-19 pandemic, alternative methods for hosting festivals have emerged, such as live streams, extended reality concerts, and drive-in concerts (Fadroski & Gqlshare, 2020, *How Worldwide Festivals and Concerts Are Inventing New Ways to Happen? - European Festivals Association - European Festivals Association*, n.d.). While physical festivals are slowly returning as the pandemic recedes, it is apparent that the impact of virtual festivals will continue to shape the landscape of physical festivals (Lee (2021), Estanyol (2021)). As the demand for new technologies and enhanced participation options at physical festivals continues to grow, there has been a notable emphasis on integrating online and offline experiences (Estanyol (2021), Volanti (2015)).

2.2 Users

The current landscape of the entertainment industry is witnessing a gradual resurgence in both festivals and DJs (Technavio, n.d.). DJs play a crucial role in seamlessly blending tracks and curating an immersive musical experience for their audience. They possess the skill to gauge the crowd's energy and adapt their music accordingly. To accomplish this, DJs employ various equipment such as turntables, DJ controllers, mixers, and software.

While DJs focus on real-time music mixing, VJs complement their performances by providing real-time visuals. VJs utilize a diverse range of tools, software, and technologies including videos, graphics, animations, and effects to create captivating visual sets that synchronize with the music. They can adjust or create visuals on the fly, enhancing the overall sensory experience.

It is worth noting that there is a scarcity of reliable sources specifically addressing the demand for VJs. However, the NOS, the Dutch news, has highlighted the shortage of technicians within the entertainment and festival industry as a whole (NOS, 2023). These venues typically invest in state-of-the-art equipment and audio-visual infrastructure, relieving the burden on DJs and VJs to procure their own equipment. However, due to the shortage of technicians, there may be fewer events and opportunities available in the industry.

2.3 End-User (Audience)

Live music performances offer a unique opportunity for artists to connect with their fans and create memorable experiences. One crucial aspect of any live performance is the visual aspect, which plays a significant role in enhancing the overall experience for the audience. Each genre of live performance has distinct visual expectations, but the Electronic Dance Music (EDM) genre is particularly known for its exceptional visual displays.

EDM audiences have come to expect elaborate stage designs, thematic visual presentations, and immersive experiences that transport them to other worlds (Edmfestivalinsider (2021)). Audiences often cite the visual element as a crucial factor in their decision to attend EDM events. As a result, it is crucial for EDM performers to consistently exceed these expectations to maintain a high level of attendance (Little (2018)).

While larger festivals such as Tomorrowland, Ultra, and Electric Daisy Carnival have the financial resources to support these grand displays, they typically occur only once a year. These festivals offer a unique opportunity for EDM fans to experience the genre's grandeur on a massive scale. However, audiences often desire more frequent opportunities to attend EDM performances, which can be held in smaller clubs or venues. These events may not have the same high-end setups and visuals as the larger festivals, but they can still provide an immersive experience through creative use of lighting, projections, and other visual elements.

Therefore, it is important for EDM performers to carefully consider their visual presentation, regardless of the size of the venue. While larger festivals may offer more resources to create grand displays, smaller events can still create memorable experiences through innovative use of visuals. By consistently exceeding their audiences' visual expectations, EDM performers can maintain a loyal following and continue to grow their fan base.

2.4 Problem Statement

While larger festivals have the resources to hire professional VJs and technicians, smaller venues often face budget constraints that prevent them from doing so. The shortage of technicians in the industry has led to increased prices for their services. Additionally, there has been limited progress in the development of visual tooling, further impacting the availability and affordability of visual production. This is evident even in large EDM festivals, where the most commonly used program is Resolume ("Reddit - Dive Into Anything," n.d.). Resolume is specifically designed for real-time audio-visual performances and allows users to mix, manipulate videos, images, and visual effects in real-time. However, Resolume provides a basic and very time consuming option to add real-time audio-visual synchronization (Galaxy (2018)).

While TouchDesigner, another widely used program in the audio-visual entertainment industry, offers real-time audio-visual synchronization, its setup process for festivals is more time-consuming. In TouchDesigner, the entire setup needs to be created beforehand, whereas with Resolume, effects can be displayed on the fly. Consequently, using TouchDesigner for each festival requires creating a new setup from scratch (R_Ruthless (n.d.)).

In addition to the aforementioned products, EboSuite is another tool that offers real-time audio analysis and generates visuals based on the audio input. However, it is important to note that EboSuite is only compatible with Ableton and does not readily support integrations with other software or platforms. Moreover, while EboSuite provides a means to create visuals, it still necessitates DJs and venues to invest time and effort in configuring the visuals. Additionally, the scope of the visuals is constrained to a specific setup, limiting its versatility and adaptability to different performance environments.

These factors highlight the need for a solution that addresses the demand for real-time audio-visual synchronization, while also providing a more efficient and user-friendly setup process. Such a solution would benefit both smaller venues with limited budgets and larger festivals seeking enhanced visual experiences for their audiences.

2.5 Possible Solutions

The current landscape of solutions for creating real-time audio-responsive visuals presents certain limitations and challenges. Some existing options, primarily offer 2D capabilities, or limited 3D customization which may not fulfill the requirements of VJs seeking more diverse and dynamic visual experiences. On the other hand, solutions like TouchDesigner provide extensive functionalities and real-time audio-visual synchronization, but have a steep learning curve. While Ableton Link offers some degree of audio synchronization, its functionalities may be limited when it comes to comprehensive visual tooling for VJs. These existing solutions do not offer an easy plug-and-play option that provides a balance between user-friendly operation and sufficient tooling to empower VJs in delivering high-quality visuals.

Therefore, there is a clear need for a more accessible and comprehensive solution that combines the convenience of plug-and-play functionality with robust tooling for VJs. This solution should enable real-time audio responsiveness, offer a range of visual effects and customization options, and provide an intuitive interface for seamless integration into live performances.

2.5.1 Concepts

Building upon an already developed prototype during the summer of 2022, a strong foundation has been laid for the project, providing an opportunity to generate innovative ideas. The overarching objective is to create a seamless plug-and-play solution that caters to the diverse needs of the audio-visual entertainment industry. While prioritizing ease of use, the goal is to empower users with the ability to craft their own captivating visuals in a three-dimensional space. As the entertainment industry encompasses a wide array of possibilities, various directions have been explored to expand the project's scope. The various concepts have been examined through the application of the SWOT analysis method, which assesses the Strengths, Weaknesses, Opportunities, and Threats associated with each concept. Detailed SWOT analyses for each concept can be found in the following three figures. These analyses provide an overview of the advantages and disadvantages of each concept, so it becomes clearer to identify the most favorable one among them. This exploration enables the project to consider diverse applications and potential avenues within the industry, ensuring that the resulting solution aligns with the needs and demands of users and stakeholders.

Instrumental Visualizer

The concept of integrating instruments with the visualizer arose to enhance user and audience interaction. By incorporating musical instruments, the aim was to foster connections among individuals, encouraging them to engage in collaborative music-making and collectively generate captivating visuals. This innovative approach not only promotes social interaction but also serves as a gateway for individuals to develop a deeper interest in instruments and music, as they experience a novel way of visualizing and experiencing music.

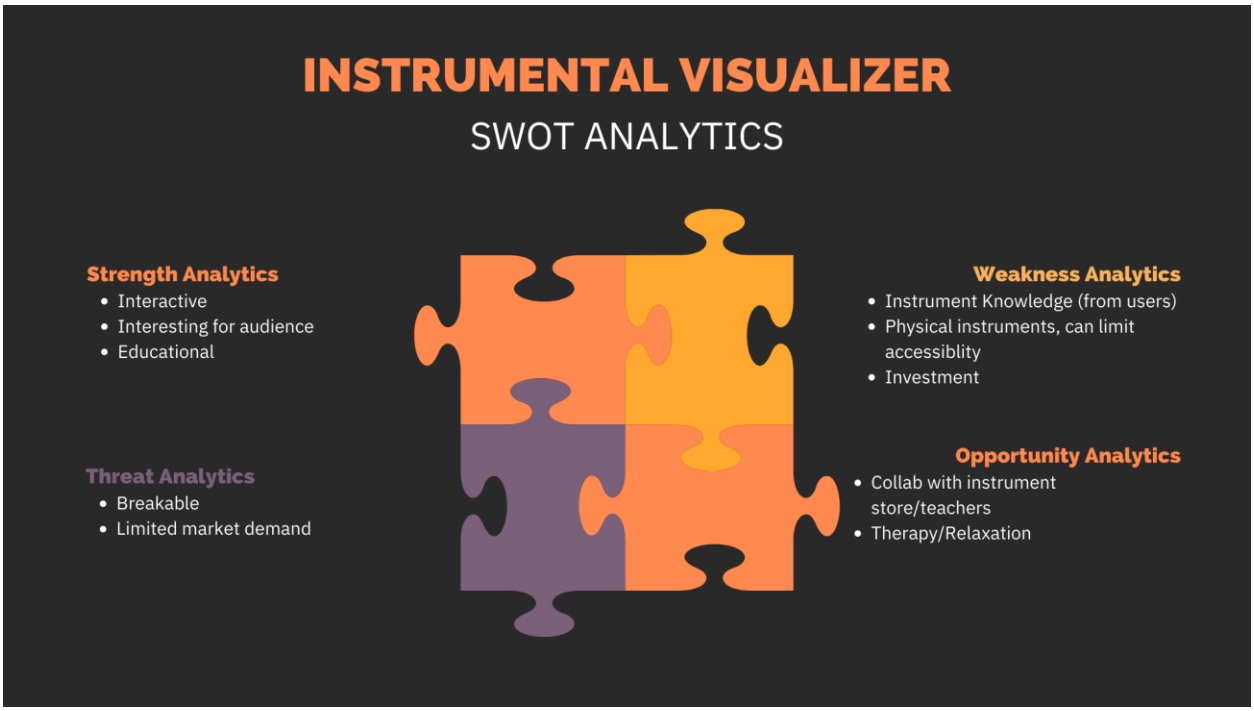

Figure 1 Swot Analysis on Instrumental Visualizer

Advanced Real-Time Visualizer

Building upon the rudimentary algorithm used in the initial project, the proposed idea involves the implementation of advanced algorithms to detect and analyze more intricate elements within the audio. This expanded functionality would encompass the identification of complex components such as build-ups, melodies, and hi-hat patterns. By incorporating these advanced algorithms, the visualizer would be able to respond more intelligently and dynamically to the nuances and subtleties of the audio, resulting in a more immersive and captivating visual experience.

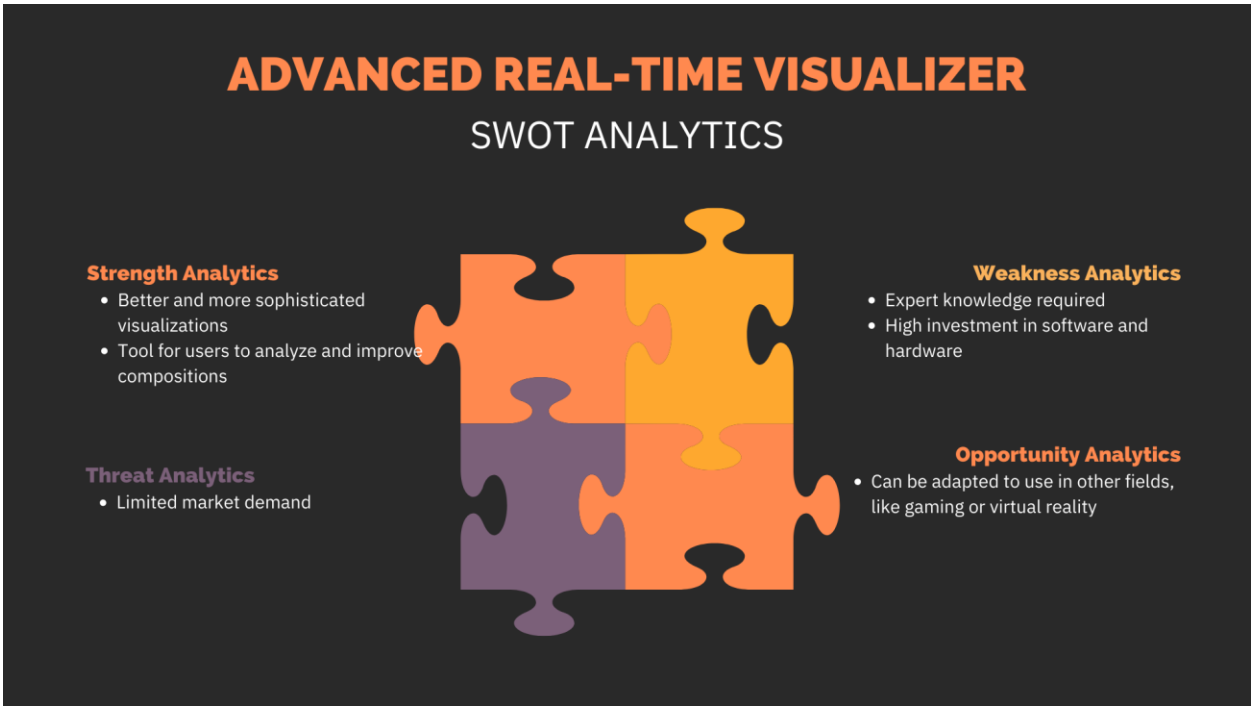

Figure 2 Swot Analysis on Advanced Real-Time Visualizer

Real-Time Visualizer Tool

To realize this idea, a comprehensive revamp of the algorithm and tooling is planned to enhance its cleanliness, efficiency, and user-friendliness. The goal is to streamline the workflow and provide a more intuitive interface for users to create their own visuals and scenes. Additionally, integrations with popular programs or protocols such as Ableton Link and Resolume will be developed, expanding the horizons for users operating in this domain. These integrations will unlock new possibilities, allowing seamless synchronization with music production software and enabling the visualizer to seamlessly integrate into live VJ performances. The aim is to empower users with a versatile and accessible platform that encourages creativity and fosters seamless collaboration between audio and visuals.

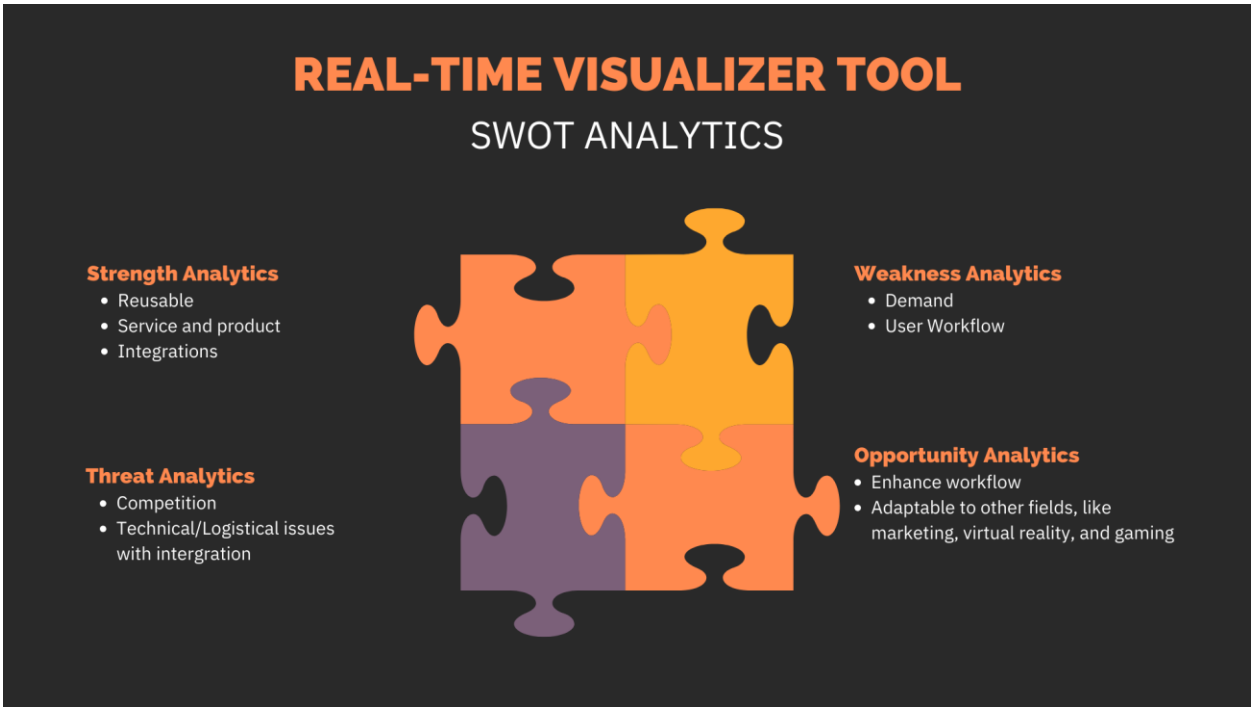

Figure 3 Swot Analysis of Real-Time Visualizer Tool

2.5.2 Result

After engaging in thorough discussions and brainstorming sessions with the coaches, Ruben and Ton, as well as seeking valuable input from a friend and colleague, Christos, who is an experienced VJ and DJ, several important conclusions have been reached.

The concept of integrating instruments into the visualizer has shown potential as an interactive installation. However, it poses significant challenges due to the reliance on hardware, which can introduce errors, bugs, and breakages. Moreover, it became apparent that this concept does not fully address the initial problem statement.

In contrast, the second concept presents a closer alignment with the problem at hand. It involves the exploration of experimental algorithms, many of which are not commonly implemented in existing programs. This uncharted territory, particularly in the realm of real-time audio analysis, presents exciting opportunities. While some audio analysis tools exist for music tracks, real-time analysis is a relatively new frontier.

The final concept emerges as the most effective solution to the problem. It not only addresses the stated problem but also offers a viable minimal product with strong market potential. Importantly, this concept ensures that VJ jobs are not replaced but rather enhanced through the integration and implementation of the visualizer. It strikes a balance between solving the problem at hand and empowering VJs to elevate their work and visuals.

Based on these insightful discussions and evaluations, the chosen concept holds promise for creating a marketable product that addresses the identified needs while fostering collaboration and innovation in the VJ community.

2.5.3 Concept

After further development, the selected idea has evolved into a minimal viable product (MVP) that comprises a set of fundamental features. The product incorporates basic music element detection, such as kick detection and frequency banding, as well as several tools that respond to audio, including color, size, movement, and visual effects (VFX). Crucially, the product has been designed to be plug-and-play, providing users with a seamless and straightforward experience. The proposed MVP will be integrated into a demo scene to demonstrate its capabilities.

3 Theoretical Framework

Groundwork has been accomplished through the creation of an earlier prototype, which involved conducting research into the analysis of music using the Fast Fourier Transform (FFT). This algorithm plays a crucial role in decoding audio and extracting usable data to visualize various elements. The prototype's success in implementing this visualizer within the Unity framework provides proof of its feasibility.
Prior to initiating the project, thorough research was conducted to determine the existence of visualizers that utilize real-time audio input to generate visuals. Surprisingly, the findings revealed a lack of comprehensive visualizers that effectively harness real-time audio for visual creation. While the Windows Media Player is a well-known example of a visualizer that utilizes real-time audio, its popularity has faded over time.

3.1 Research Question

How can design features and functionalities be incorporated in a visual synchronization tool to enhance ease of use for venues and facilitate real-time customization of visuals by VJs for seamless synchronization with music during DJ performances?

3.1.1 Sub-Questions

What software and hardware are necessary to set up the real-time audio visualizer?
Quantitative research on secondary online sources will be conducted to discover multiple possibilities to be considered. From these possibilities the one that best fits the project will be chosen. With the minimal required external applications and equipment so that the ease of use is increased.

What are the essential tools and software required by VJs and other users to create visually appealing and engaging content?
Through conducting qualitative interviews, primary data will be gathered. With this data a list of preferable tools will be generated. Which can be sorted on importance and ease of implementation, and will be a great guideline to follow by throughout the project.

In what frequency ranges are the most common music elements from the rhythmic EDM genre visible?
Through quantitative research on secondary online sources, the average most common frequency ranges for each music element will be collected. This data will be used in the algorithms, so that the algorithms can create more accurate data.

3.2 Scope

Deliverables

The project aims to deliver a high-quality prototype that offers a plug-and-play experience for users. The prototype will include a basic tool set tailored for visual artists, along with a showcase scene to demonstrate its capabilities. To ensure ease of use and successful implementation, a comprehensive manual will be provided.
The manual will provide step-by-step instructions specifically tailored to the three key user groups involved: DJs, venues, and VJs. Each group will be guided through the setup process, enabling them to easily integrate the visualizer into their performance or workflow.

Inclusions

The product ensures seamless plug-and-play functionality while offering essential tools for VJs.

Exclusions

The product will not come with a finished scene.

Assumption

The assumption is that the product is user-friendly for DJ's and venues, while also offering expanded options and possibilities for VJ's.

Constraints

The project is subject to time frame constraints, which limit the implementation of various tools, especially for VJs. Despite the potential for a wide range of tools, only a limited selection can be integrated within the given time frame.

4 Method

The product's success depends on meeting the needs of its users, making the application of design thinking essential. By prioritizing user needs and perspectives, a comprehensive understanding of each user group is achieved. Conducting various tests enables a deeper insight into their unique requirements, enabling the integration of crucial features and functionalities that cater to their specific needs. This user-centered approach ensures that the final product aligns effectively with user expectations and delivers a good user experience.

4.1 Respondents

To ensure comprehensive testing and cater to the diverse user base, multiple user groups will be involved in the evaluation of the product. The first group consists of DJs and venues who will primarily focus on the setup process and usability of the visualizer without the need to create their own visuals. The second group comprises VJs who will assess the setup process and integration with their preferred software. Lastly, the audience will be included to gauge the overall impact and enhancement of their experience through the visuals generated by the product. By involving these distinct user groups, the testing process aims to gather valuable feedback and insights to improve the product's functionality and meet the specific needs of each user category.

4.2 Instruments

A variety of tests will be conducted in different scenarios to gather comprehensive feedback and insights. These tests will be designed to assess the performance and usability of the visualizer in various settings and user interactions. The goal is to ensure that the product meets the needs and expectations of users across different scenarios.

Form

The primary objective of the form is to collect data on the core elements that users expect from the product. This will ensure that their expectations are effectively addressed and incorporated into the development process. The form will be created using the Google Forms platform, utilizing a combination of multiple-choice and open-ended questions. Given that much of the information requires more nuanced responses, the inclusion of open-ended questions will allow users to provide detailed feedback and insights. This approach aims to gather comprehensive data that will inform the development of the product in line with user expectations.

Playtest

Two variants of playtests will be conducted to gather valuable insights and feedback. The first playtest will focus on user setup of the visualizer, assessing whether users require additional assistance in the process. A step-by-step guide will be provided, and observations will be made to understand how users navigate the setup. The aim is to identify any areas of difficulty or confusion for users.
The second playtest will specifically target VJs, evaluating their ability to set up the visualizer in Resolume and create visuals in Unity using the provided manual. Observations will be made during the test, and participants will be asked follow-up questions to gather more detailed information about their experience, including any challenges they encountered and what aspects they appreciated.

Observation & Interview

The final test will involve observation of the visualizer in action with an audience. The visualizer will be set up, and the audience's response to the visuals will be closely observed. After a certain period, a casual conversation will be initiated with the audience, and a set of questions will be asked to gather their feedback. These questions will primarily focus on whether they noticed any distinct aspects of the visuals, their level of enjoyment, and whether the visuals enhanced their overall immersion in the experience.

4.3 Data Collection & Analysis

The data collected from the various tests will be carefully analyzed to identify key feedback and prioritize implementation. A comprehensive list of valuable feedback will be generated, considering the significance and feasibility of each suggestion.
Feedback that addresses critical user needs and aligns with the project's goals will be prioritized for immediate implementation. These are the enhancements that will have the most impact on the overall functionality, usability, and user experience of the product.
While there may be other valuable feedback that cannot be included in the current iteration due to time constraints, these suggestions will be documented for future consideration. It is important to acknowledge the potential value of such feedback and explore possibilities for incorporating it in future updates or iterations.
However, it should be noted that not all feedback will be implemented. Some requests may be deemed too minor in nature or not align with the project's vision and scope. Additionally, certain suggestions may not be feasible or practical within the current state of the product. These decisions will be made based on careful evaluation and consideration of the project's resources and constraints.
Ultimately, the goal is to prioritize and implement the most valuable feedback to ensure the product meets the needs and expectations of its users, while also considering practicality, feasibility, and project limitations.

5 Development

Through testing, prototyping, and continuous refinement, a wide array of features has been successfully implemented and fine-tuned. The utilization of multiple plugins has greatly enhanced the user experience, streamlining usability and minimizing external software dependencies. Additionally, the incorporation of sophisticated algorithms has yielded valuable data, enabling the creation of visually engaging and captivating content.

5.1 Core

The initial prototype of the product utilized the Fast Fourier Transform (FFT) algorithm to analyze and decompose music into distinct patterns and elements. The FFT algorithm, an optimized version of the Discrete Fourier Transform, efficiently converts time-domain signals into their frequency-domain counterparts. However, before implementing this algorithm, extensive research was conducted to explore alternative approaches, such as the integration of AI or machine learning. While AI-based methods hold the potential for more accurate and detailed data analysis, their development requires significant resources and time, which exceeds the scope of this graduation project. Therefore, the decision was made to employ a tailored variant of the FFT algorithm that best suits the specific requirements and objectives of this project.

Frequency Bands

In this tool, the frequency ranges are referred to as frequency bands, and there are a total of 64 bands. Each band represents a specific range of frequencies. The width of the frequency ranges within each band increases exponentially, aligning with the exponential relationship between frequency and pitch. This phenomenon can be attributed to human perception, as our ability to discern small changes decreases as the amount increases (Wikipedia contributors, 2023).

Kick Detection

By employing the FFT method, it becomes feasible to obtain intensity measurements for all frequency ranges. This capability enables the analysis of low-frequency data, which can be leveraged to detect kicks. In this context, a kick is identified as a notable spike in intensity within the low-frequency range, surpassing a specific threshold. Through testing, it was determined that the threshold should be dynamic to accommodate variations in volume and consistent bass across different tracks. Thus, the threshold is now determined by averaging the intensity of the low-frequency ranges over a specific time period.

Tempo

The implementation of kick detection enables the product to determine the overall tempo, or BPM (Glossary), of the audio. The tempo is provided in two variants. The first is the general tempo, calculated over an extended duration, that represents the overall tempo of the audio. The second is a shorter timed tempo that adjusts to the current intensity of the song, such as during a buildup, where double kicks occur.

5.2 Tooling

With the implementation of the core functionality, it is now possible to generate visually responsive content that is synchronized with audio inputs. These visualization tools should be designed with user-friendliness in mind, both to streamline the creation process for experienced users and to facilitate ease of use for newcomers to the platform. By prioritizing accessibility and intuitive design, users can more easily harness the power of the audio-visualizer tool and create stunning, immersive experiences with minimal barriers to entry.

Size

The audio-visualizer tool includes a size-responsive feature, which allows objects to dynamically change in size based on the audio input. This feature can be implemented in two distinct ways. Firstly, the object's size can be synchronized with the frequency band(s) allocated to that object, resulting in a real-time size adjustment that corresponds to changes in the audio signal. Alternatively, the size of the object can be adjusted according to a graph over a specific time period, triggered each time the kick hits.

Movement

The audio-visualizer tool incorporates a feature that enables objects to respond to the audio input by moving. Two methods are available for implementing this functionality.
The first option involves linking the movement of the object to the intensity of specific frequency band(s). In this approach, the object's movement corresponds to the variations in intensity within the chosen range.
The second option is to have the object move in one direction over time, triggered by the kick.
During the initial development, the movement of the object was linear or exponential in a single direction. However, after conducting testing, it was determined that more precise control over the movement was desired. As a result, the tool was updated to incorporate graphs that allow for accurate control of the object's movement over time, including the ability to specify different directions of movement and different speeds.

Colour

The utilization of the color tool, which changes the color over time, requires a certain level of expertise from the user. To simplify the process, the tool provides pre-made materials that do not require further knowledge. However, for more advanced users, it is possible to create a custom shader with the appropriate parameter name. The color transformation is achieved through a gradient that is influenced by specific frequency bands or triggered by the kick.

VFX

Visual effects (VFX) are intricate effects that enhance the immersion of the environment, such as explosions, fire, smoke, and more. These effects often involve multiple parameters that can be adjusted in real-time to achieve the desired visual impact. However, incorporating audio-driven control for all these parameters would be a complex and time-consuming task. As a result, for the current implementation, only the VFX playback feature has been included.

Sequencers

In addition to triggering effects on every kick, an alternative approach is to utilize a "sequencer" tool to queue them up. The sequencer comes in various forms, such as linear, random, and all, determining the order in which the effects within it will be played. Sequencers not only allow for effects to be included but also enable the incorporation of other sequencers, leading to the creation of complex visuals. The highest priority sequencer determines which elements to play on each kick, enhancing the control and versatility of the visual composition.

5.3 Integrations

The product incorporates several integrations to improve ease of use and facilitate cross-program functionality.

klakNDI

NDI is a software tool that allows the transmission of video data between devices on the same network. A plugin called klakNDI for Unity offers similar functionality as the program itself. This alternative was preferred over using the NDI program, as it eliminates the need for additional software, streamlining the setup and usage process for the user.
The plugin is utilized to send video data to Resolume, the most commonly used VJ program, with virtually no latency, if used on the same device, with stable internet connection it is also possible between devices. This solution can accommodate multiple camera views and is therefore ideal for setting up complex visual scenes.

WASAPI

The WASAPI plugin is utilized to perform loopback audio on the device, thereby allowing the registration of any audio played on the device in Unity. This not only accelerates the development and creation of visuals but also enables the product to visualize any audio played on the device.

LASP

The LASP plugin is capable of outputting microphone audio with improved efficiency and reduced latency compared to Unity's original capabilities. Initial tests revealed significant latency issues, which would greatly decrease the value of the product. Using the LASP plugin results audio-visual delay is minimized, enhancing the overall experience. The microphone input can also be utilized to capture audio from other sources via cable, allowing for higher quality sound. Additionally, by adding an interface between the audio output and the product device, the audio quality can be further improved.

Ableton Link

Ableton Link is a preferred choice among DJs for synchronizing the tempo of their performances. To cater to this preference, the "AbletonLink" plugin has been integrated as an additional feature in the product. While the usage of this plugin is not mandatory, its implementation is highly recommended due to the enhanced accuracy it provides compared to the built-in algorithm. The built-in algorithm relies on real-time calculations to determine the tempo, which can introduce discrepancies and latency. In contrast, Ableton Link allows users to manually set the tempo, ensuring synchronization across all applications connected to the Link network.

5.4 Debug Tooling

While the majority of the aforementioned tools are designed for showcasing visuals to the audience, there are also specific tools created to ensure the proper functioning of algorithms and other features. These tools serve the purpose of validating and testing the accuracy and performance of the implemented functionalities. They also streamline the process of developing new features by providing efficient testing and debugging capabilities.

Frequency Band

Utilizing the FFT algorithm, frequency bands are generated to analyze the audio data. To aid in the debugging process and provide a clear visual representation, a resize tool has been used to visualize these bands. This tool allows for clear observation of the data collected and generated by the algorithm, assisting in identifying any potential issues or areas for improvement.
The visualization of frequency bands not only helps in debugging but also allows for the analysis of patterns in the music. By comparing the output of the algorithm with other algorithms, it is possible to verify the accuracy and effectiveness of each approach. This ensures that all algorithms are functioning as intended and provides valuable insights into the behavior of the music patterns.

Spectrogram

The spectrogram is a valuable tool for visualizing the intensities of frequencies over time in music tracks. It provides a clear visual representation that enables the identification and analysis of patterns within the music. By utilizing the visual data from the spectrogram, it becomes possible to find and analyze these patterns, leading to improvements in algorithms designed to detect and interpret them.
The spectrogram collects data from all frequency bands and assigns each band to a pixel, at specified time steps. The color of the pixel corresponds to the intensity of the respective frequency band. With each time step, the pixels are shifted horizontally, creating a visualization of the intensities of each frequency over time.
This spectrogram tool is particularly useful in the search for kick and snare detection frequency ranges. It also contributes to the development of the build-up detection algorithm, which is still a work in progress.

Graph

In addition to the spectrogram, graphs are employed to visualize the data collected by algorithms. These graphs play a crucial role in providing a visual representation of the gathered data and aiding in its analysis.
One particular graph is extensively utilized for visualizing the data obtained for the build-up detection algorithm. This graph allows for a comprehensive representation of the gathered data points, enabling the analysis of patterns and trends that contribute to identifying build-up sections within the music tracks.

5.5 Prototype Tooling

While the core implementations of the product have been completed, there are several additional features that are still under development.

Snare Detection

While snare detection has been implemented, it is still a work in progress due to certain challenges. One of the challenges is the presence of voice lines in tracks, which can overlap with the snare frequency range. Additionally, melodies and basslines may also fall within the snare frequency range, leading to inaccuracies in the algorithm. These factors need to be considered and addressed to improve the accuracy and reliability of the snare detection algorithm.

Build Up Detection

Recognizing build up elements in audio can be challenging due to the varied ways in which build ups can be created, even within the EDM genre. However, there is a common build up implementation that has been the focus of developing this algorithm. Typically, the buildup starts by increasing the bass and incorporating double hits, followed by a gradual dissipation of the bass. Additionally, the high frequencies gradually increase in intensity, while the overall intensity of the song also rises.
While the core functionality of the buildup detection algorithm has been implemented to identify these patterns, fine-tuning and optimization require significant time and effort. Unfortunately, due to the time limitations of the graduation project, the extensive fine-tuning process could not be completed.

Drop Detection

Implementing drop detection is a straightforward concept; however, it relies heavily on build up detection, which has not been fully implemented yet. The algorithm's concept is to identify the first kick hit following a detected build up as the drop. However, this approach presents a few challenges. Fake drops can result in incorrect visualizations, as they would be identified as actual drops. Additionally, there is a possibility that certain drops, which deviate from the typical heavy bass pattern, may go undetected by the algorithm.

5.6 Installations

During the graduation project, the product has been showcased in various locations and presented in diverse forms. Despite its fundamental plug-and-play nature, the product has demonstrated remarkable adaptability, successfully accommodating a wide range of scenarios and environments. Look at Appendix A for final product images and videos.

Spacebar

Since the start of the project, it has played multiple times at a bar called Spacebar (Figure 4). This is due to the close connections with the study association located in the same building as the bar. The bar serves as a venue for the study association's parties, providing an excellent opportunity to showcase the visuals and gather feedback from the audience. This exposure has reinforced the notion that there is a demand for such a product in the market before having started the graduation project.

Figure 4 Spacebar visuals

360 Room

Regular communication was maintained with Christos, a colleague in the same field during the graduation project. In his graduation project a year ago, Christos developed a "360" room concept, where projectors were installed on all the walls. Curious about the potential application of the visualizer, possibilities were explored and discovered its seamless compatibility. Leveraging the fact that the product is built in Unity, a 3D engine, which is able to create four cameras and output them to generate immersive 3D scenes within Unity, precisely aligned within the 360 room (Figure 5).

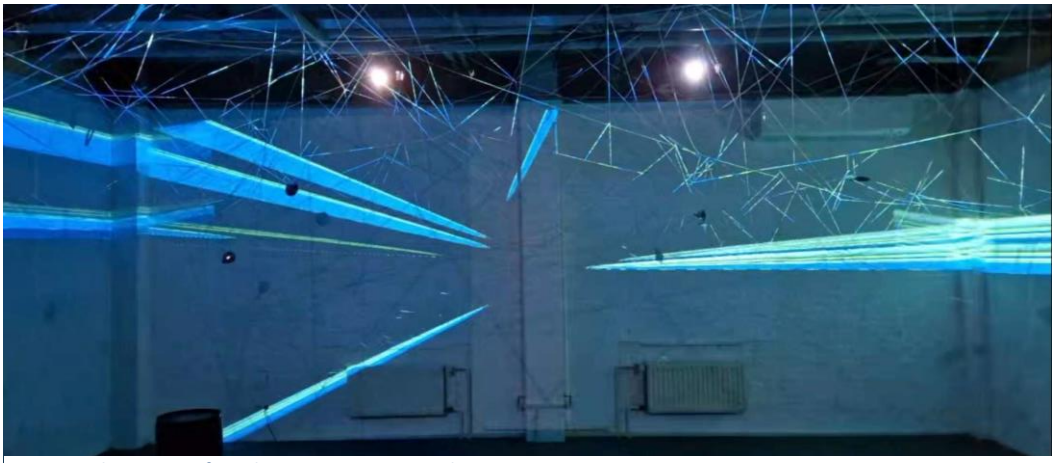

Figure 5 Showcase of working 360 room visuals

House party

Upon receiving an invitation to a house party featuring a small DJ booth/room setup, the visuals were brought along as an opportunity to showcase the work and test the product in a real-life scenario. Although the product was still a work in progress, visuals were created utilizing the implemented features. The primary objective of these visuals was to introduce the audience to a new visualizer concept, incorporating 3D visuals and advanced camera techniques for an enhanced visual experience (Figure 6).

Figure 6 House Party visuals

Extrema (Belgium)

A rare opportunity emerged when an invitation was extended by Christos to participate in one of Belgium's largest techno festivals. The installation consisted of multiple vintage TVs showcasing an array of visuals (Figure 7). Although added to the project at a later stage, influence over the concept was limited. Unfortunately, the visualizer deployed on the TVs exclusively featured pre-recorded videos, lacking the ability to respond to the audio and synchronize with the music. Last-minute efforts were made to introduce user interactivity by integrating a Launchpad into the visualizer, enabling users to trigger visual elements through button inputs. However, due to exhaustion from the setup and travel, these attempts could not be fully realized.

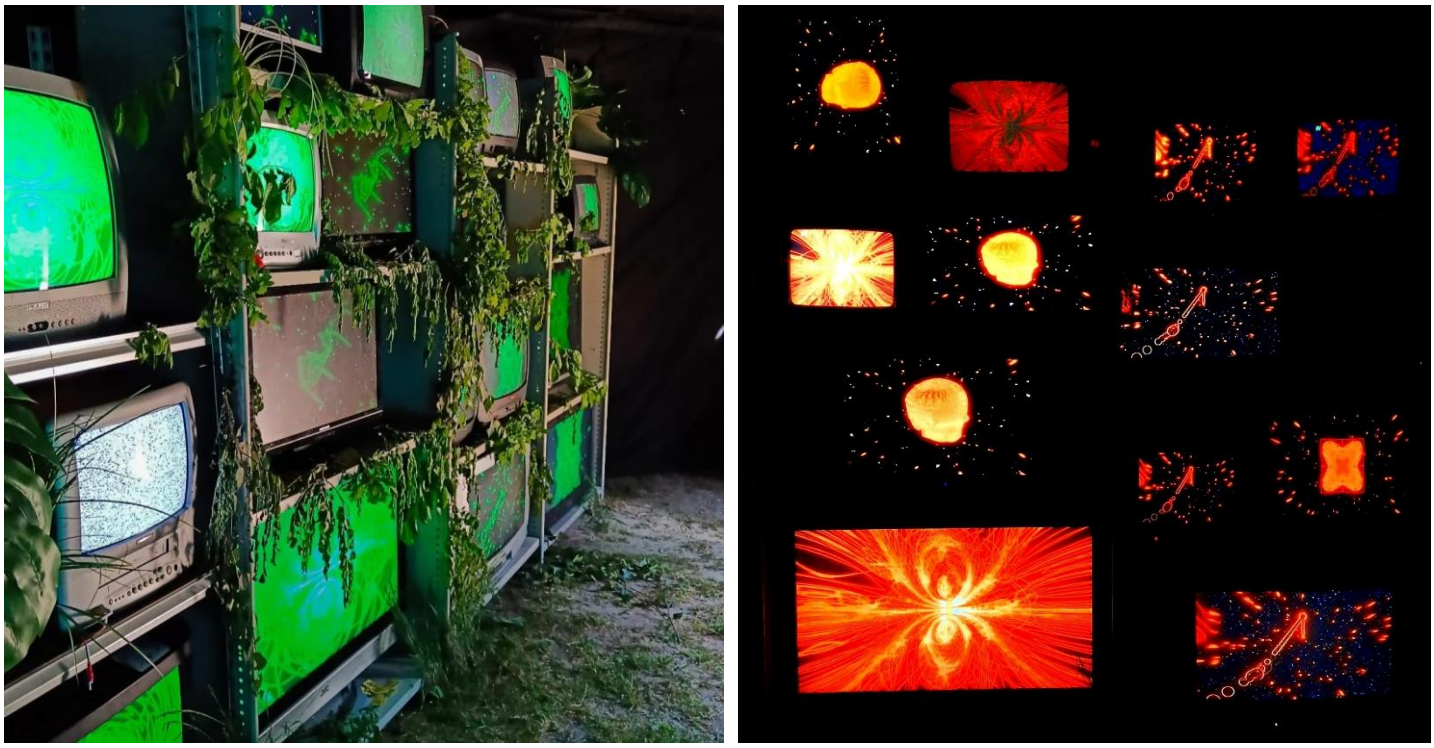

Figure 7 Extrema Visuals (Some made by Christos)

A.I. Performance

Christos reached out to collaborate on a small gig, an Anonymous iPhonholic (A.I.) performance. The performance encompassed a dancer/speaker, a DJ, and 2 VJs, with a central theme exploring the impact of phones on our daily lives. This project heavily utilized the integration of the real-time audio visualizer with Resolume. Preparations included the creation of audio-responsive visuals and some pre-designed effects within Resolume. However, during the live performance, certain effects were modified or added in response to the evolving nature of the event. The project allowed for artistic freedom and experimentation, resulting in a visually engaging and dynamic experience (Figure 8).

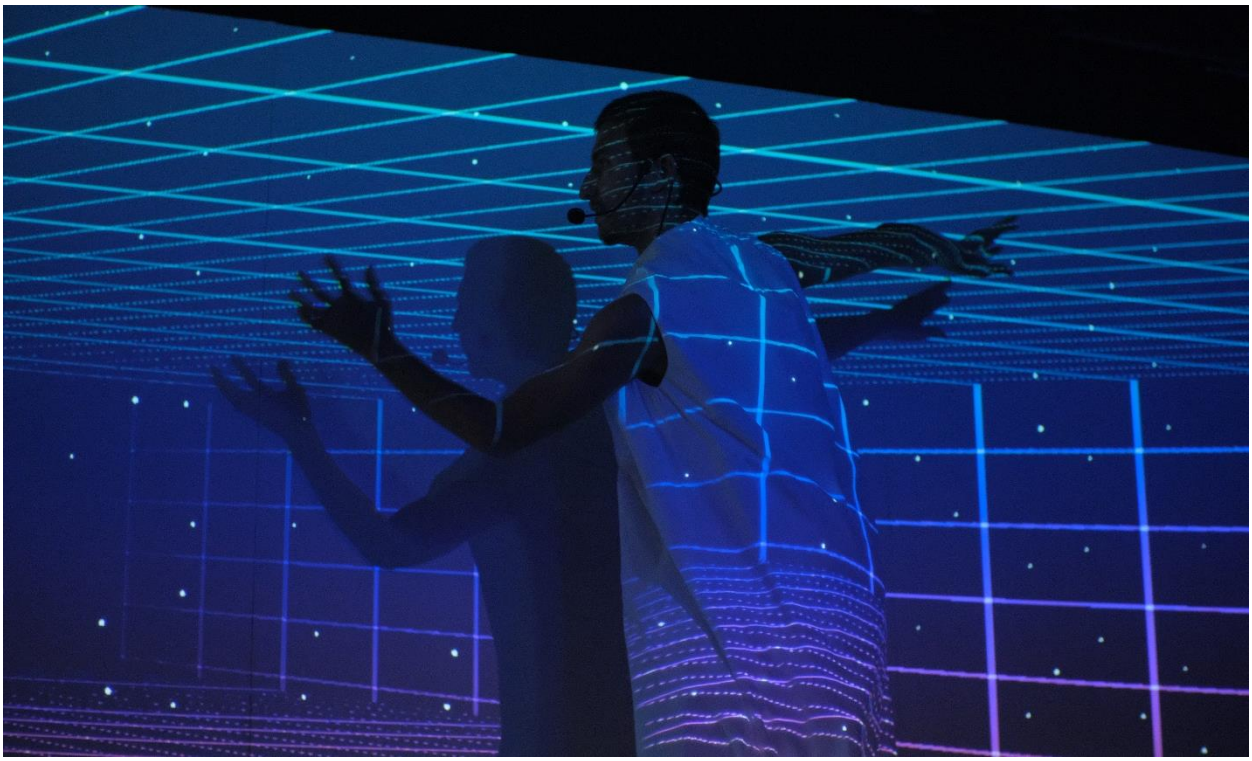

Figure 8 A.I. Party visuals with the performer

6 Testing

Throughout the project, a variety of tests were conducted using different methods, scenarios, and participants. Close collaboration with Christos provided invaluable feedback that significantly influenced the project's development. This iterative process of testing and collaboration enabled the identification of strengths and areas for improvement, ensuring the development of a robust and effective visualizer tool.

6.1 Spacebar

Prior to the graduation project, extensive testing of the prototype was conducted on the audience. Collaborating with the study association XP provided opportunities to test the visualizer in a bar, specifically among the members of XP. A customized visualizer, reflecting the theme and branding of the study association, was created for these events. The visualizer was evaluated based on audience preferences, as well as the feedback of the venue and DJ, to determine if there was demand for it.
The product was tested four times in the bar, with approximately 10 individuals being casually interviewed about their experience with the visualizer. The questions focused on whether real-time visuals made a difference compared to looping visuals, if the visuals were fitting, and if they increased immersion. It should be noted that these results may be somewhat biased, as many of the individuals interviewed were friends or acquaintances.

6.2 Christos

Throughout the collaboration, the product underwent three rounds of playtesting conducted by the colleague. On designated days in which the visualizer was utilized, emphasis was placed on the colleague independently setting up the product with the aid of a provided manual. Additionally, the colleague created visuals using the manual as a guide. Following this, a brief interview was conducted to delve deeper into the colleague's perspective on areas that require improvement, successful aspects, and potential gaps.

6.3 House Party

The visualizer was utilized at a house party, presenting testing opportunities for plug and play functionality and equipment compatibility. Although information about the available equipment was unknown prior to the event, the visualizer successfully adapted to the setup. The party also provided an opportunity to gather feedback from unfamiliar individuals, offering a neutral perspective on the visualizer's appeal and immersion.

This occasion also served as a test for the usability and effectiveness of the tooling created for the visuals. The creation of visuals specifically for the party allowed for an evaluation of their usefulness and ease of use. Personal observations were made regarding the tooling of the visualizer and its effectiveness.

Feedback was collected from five individuals, focusing on their perception of the visualizer's impact on their overall experience and immersion. Additionally, they were asked if they would consider using the visualizer for their own personal parties or events.

6.4 Form

A comprehensive form was utilized to gather input from DJs, VJs, and venues, encompassing their expectations and preferences for the product. The main objective of this form was to collect data that would ensure the product meets the users' needs and provides satisfactory features. The form consisted of a combination of open-ended questions and multiple-choice questions.

The open-ended questions encouraged users to express their interest in using the program and allowed them to articulate their specific expectations. The multi-select questions aimed to understand the software programs users currently employ, providing valuable insights for potential integrations with their preferred platforms.

One notable aspect of the form was that it allowed respondents to remain anonymous, ensuring that their answers were not influenced by personal connections or biases. As a result, the gathered data represents a diverse range of perspectives, with many responses coming from individuals who were strangers to the project.

6.6 Results

The data collected from these tests has provided valuable insights and a comprehensive overview of the product's performance. It is important to note that each test has yielded distinct results, as they were conducted at different stages of the product's development and focused on specific data collection objectives. By analyzing the diverse outcomes from these tests, a more nuanced understanding of the product's capabilities and potential areas for improvement can be obtained.

Spacebar

The visualizer played a total of four times, and each party at least 10 questioned participants expressed appreciation for the smooth transitions between visuals. Additionally, it was observed that individuals actively enjoyed watching the visuals, often capturing photos or videos of them. This further reinforces their positive reception. Informal discussions with the bar owners highlighted their positive observations regarding the ease of setting up the visuals with minimal effort.

In addition to the gathered data from the questionnaire and observations, valuable insights were obtained through personal observation and reflection. Notably, it was observed that the varying volume levels of the audio input from the bar's sound system affected the appearance of the visualizer, necessitating the implementation of additional settings that were not initially incorporated. Future iterations of the product took this into account.

Furthermore, DJs occasionally requested the inclusion of logos or adjustments to the visuals. However, due to limitations in the existing tooling, fulfilling these requests proved challenging. This highlighted the need for tooling updates. However, due to constraints resulting from bad coding practices, these were not implemented at the time. But these changes have been implemented when the graduation project started as the project was built from scratch.

However, it is important to note that these results of the parties and developments took place prior to the graduation period when the project was initially conceived as a hobby project. As a result, concrete results and findings have not been documented at this stage. The focus during this period was primarily on exploring and experimenting with different ideas and concepts, laying the groundwork for further research and analysis during the graduation period.

Christos

Throughout the development of the product, Christos played a significant role in providing valuable feedback and making small adjustments. One notable contribution was his input on the VJ scene implementation. As Christos is more experienced with Resolume, his preferred VJ program, he expressed a preference for tooling within his familiar program. To address this, a specific scene was created in Unity that showcased each visual effect individually, that responses real-time to audio. The visuals were then sent seamlessly and without any noticeable latency to the Resolume program using the klakNDI plugin. This integration allowed Christos to leverage his expertise in Resolume while still benefiting from the product's real-time visuals and audio synchronization capabilities.
Moreover, enhancements were made to the manual to improve its usability, including clearer instructions and additional information on setting up specific visuals. The tooling within the Unity project underwent minor adjustments to enhance user-friendliness, such as the addition of tooltips to provide more detailed descriptions and facilitate better understanding of their functions (Appendix C).

House Party

To set up the product, minimal equipment is required, including a cable for audio output from a 3.5mm jack and a cable for visual output to a screen or projector, typically an HDMI cable. During the house party, a 3.5mm jack-to-jack cable was brought, but it became apparent that the cable was not long enough to connect to the laptop, despite the unknown equipment setup. This feedback highlighted the need for longer cables, and it has been included in the product manual as a consideration for future setups.
Despite the cable length limitation, the visualizer was still able to be set up using the available equipment. However, the audio had to be sourced from the laptop's microphone instead of a direct output, resulting in lower audio quality and capturing voices from the audience, which affected the overall visual experience. However, since the attendees were not aware of the initial audio quality, it did not bother them, and they expressed their enjoyment of the unique visuals.
During the event, one individual expressed interest in having their own personalized visualizer for their parties, indicating a potential market demand for custom visualizers. Another individual, who organizes festivals, showed interest in potential collaboration for future events, further validating the product's market appeal and potential opportunities for partnerships.
In the end, it was evident that the plug and play setup was highly effective, as the product could be set up in less than 5 minutes.

Form

The form played a significant role in reinforcing certain decisions that had been made during the development process. It validated the choices regarding the tooling for kick detection and tempo, as well as the integration with Resolume and Ableton Link. However, it also highlighted the importance of additional features such as MIDI controller support and overall control over the visuals. Many DJs expressed their desire to have the ability to influence the visuals while performing, and having MIDI controller input for on-the-fly visual changes was identified as a crucial feature. Although this feature has yet to be implemented due to time constraints and other priorities, it is acknowledged as a priority for future iterations of the product.

The data collected on the software used by DJs was also important, as it provided insights into potential software integrations. While it was evident that most DJs preferred specific software, further research and exploration of integration possibilities were not conducted due to time constraints. Additionally, it was discovered that the DJs who responded to the questionnaire did not currently use visuals in their performances, but expressed a strong interest in using an easy plug and play visualizer (more detailed results in Appendix B). This feedback further emphasizes the demand and potential market for the product.

7.1 Conclusions

In conclusion, the research findings have provided valuable insights into the necessary software and hardware requirements for setting up the real-time audio visualizer. The final product eliminates the need for external software by utilizing plugin variants, resulting in a simplified setup process. While the specific equipment needed may vary, it has been optimized to require a maximum of two cables. Regarding the essential tools and software preferred by VJs and other users, Resolume emerged as the program of choice, even for larger festivals. Additionally, software such as Photoshop, Blender, and After Effects are commonly used for creating visually appealing content. The inclusion of a MIDI controller was identified as a desirable feature, allowing VJs to easily customize visuals during performances for seamless synchronization.

In terms of frequency ranges, the kick, snare, and hi-hats in the rhythmic EDM genre are typically found within specific short ranges. However, the melody spans a wide frequency range, making it challenging to detect and provide usable data for visualization purposes.

The main research question focused on enhancing ease of use for venues and enabling real-time customization of visuals by VJs. Through the implementation of plugins to reduce latency and facilitate cross-software integrations, the product offers an efficient and user-friendly setup. The algorithms developed provide valuable data for creating tooling and visuals.

The tests conducted and feedback received from participants have demonstrated a higher demand for the product than initially anticipated. This indicates its market potential and reinforces the need for further development and refinement.

The research outcomes have contributed to the design and functionality of the visual synchronization tool, enhancing ease of use for venues and empowering VJs to seamlessly synchronize visuals with music during DJ performances. The integration of plugins, optimized hardware requirements, and usability insights from tests have positioned the product for success in meeting user expectations and market demand.

7.2 Discussion

The final product of this project has successfully established a solid foundation through the implementation of core tooling and algorithms. The positive interest shown by users and the reliable feedback obtained from users during the testing phase validate the potential value and viability of the product. The involvement of users, who will either be utilizing the product ensures that the tests conducted provide valuable insights and realistic evaluations.

In retrospect, it is apparent that engaging in prototyping and testing at an earlier stage of the project could have yielded notable benefits. By doing so, it would have been possible to identify and address missing core tooling that could have further enhanced the final product. Nonetheless, the current implementation still offers a substantial array of tooling that proves to be highly useful, efficient, and meets the needs of the users. The ease and efficiency of creating new visuals, along with the user-friendly and efficient nature of the design process, are notable strengths of the product.

The success of installations and jobs undertaken during the development of the project further confirms that the product effectively addresses the identified problem. The positive reception from the users and enjoyment expressed by the audience in response to the visualizations demonstrate that the product not only fulfills the intended purpose but also captivates and engages the target audience.

The importance of conducting prototyping and testing at an earlier stage cannot be emphasized enough, as it allows for the identification of missing core tooling and ensures a more comprehensive final product. By using user feedback and experiences, future iterations can strive for continuous improvement and refinement, ensuring that the visual synchronization tool remains relevant, effective, and valuable in meeting the evolving needs of its users.

7.3 Recommendations

Based on the insights gained from user feedback and the potential for further improvement and expansion, several recommendations can be made to enhance the visual synchronization tool:

1. Implement the functionalities requested by users, like adding functionality for remote control via mobile devices, allowing users to manipulate the visuals from anywhere in the venue.
2. As the product evolves and incorporates more features and functionalities, optimizing the underlying algorithms becomes crucial. This optimization will ensure that the tool runs smoothly and efficiently, even with increased complexity.
3. Explore updating or creating new algorithms to support the visualization of different genres. By enhancing the tool's ability to respond to a broader range of audio inputs, the product can offer more immersive experiences and accommodate various music genres and styles.
4. Expand integrations beyond audio to include connections with lighting systems and smoke machines. By synchronizing visuals with these elements, the tool can create a more comprehensive and captivating atmosphere, elevating the overall audience experience.
5. Consider incorporating additional inputs beyond audio, such as different instruments, to enable more audience interactions and create connections between humans and music. This integration would open up new possibilities for collaborative performances and dynamic visual displays.
6. As the program continues to grow and mature, it may be beneficial to transition to a custom-built software solution. Developing a program from the ground up would provide greater freedom, flexibility, and customization options, enabling better optimization and tailoring of the tool to the specific needs of users.
7. Conduct thorough market research to identify gaps and opportunities for offering unique functionalities that are not currently available in other programs. Explore the possibility of combining multiple programs into a single solution to provide users with an original product. By doing so, the product will stand out in the market and cater to the specific needs and preferences of users, increasing its competitive advantage and potential for success.

By implementing these recommendations, the visual synchronization tool can continue to evolve and meet the demands of its users, offering a seamless and immersive experience for DJs, VJs, and audiences alike.

7.4 Self-Reflection

Throughout the past year, I have made significant progress in both my knowledge and expertise in this field. Starting my own company in this particular area has provided me with valuable insights into the industry and the potential for financial success with this product. However, I recognize the need to improve my marketing tactics and establish better communication and boundaries with clients.

While acknowledging that the current state of the product partially addresses the identified issues, I am personally unsatisfied with its level of uniqueness and differentiation. I believe that the visualizer needs further enhancements to satisfy the users. However, by implementing the specific steps outlined in the recommendations section, the product has the potential to become more distinct and efficient, ultimately positioning it to effectively fill the existing gap in the market.

Another aspect of concern is the limited availability of meetings with my external supervisor. Despite making multiple attempts to schedule meetings, several of them were either cancelled or not feasible due to our busy schedules. As a result, I may have missed out on valuable additional insights for the project. However, the meetings we did have proved to be valuable in gaining insights not only about the project itself but also about the future direction. My supervisor played a significant role by posing thought-provoking questions, such as how I envisioned the perception of my product and the market positioning (e.g., service, product, subscription). These inquiries have greatly contributed to the development of my product and the overall strategic planning for my company.

Although I could have arranged for more meetings with my external coach, I had frequent and productive meetings with my internal coach. These meetings served as valuable opportunities to provide status updates, seek assistance with challenges I encountered, and receive insightful ideas for implementation. My internal coach played a crucial role in keeping me on track and ensuring that I was consistently progressing in the right direction.

Reflecting on my journey, I can see how my initial goals and direction were somewhat unclear at the beginning of the graduation project. However, as the project progressed and I took on freelance jobs, I gained a clearer understanding of what needed to be created and implemented. This newfound clarity and external validation fueled my motivation and accelerated the pace of production.

While these achievements were highly motivating and reaffirmed the product's market viability, it is important to acknowledge that the installations and jobs required significant time and preparation. While this testing and execution process provided valuable insights and ensured the product's robustness, it also limited the available time for creating other features or refining certain elements. Consequently, the tooling may not be fully polished, and the manual may fall short of the initially envisioned standards.

As I transitioned into the professional field, I initially experienced some apprehension. However, the knowledge that the product and skills I offer are in demand and sought after by professionals provides me with a great sense of motivation and inspiration. This drives me to continue working diligently to enhance not only the product itself but also my personal growth and development as well as the growth of my company.

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Appendices

Appendix A – Product

All the data that is gathered of the product, either throughout the project, or final products.

Appendix A.1 - Videos

Throughout the project multiple videos have been recorded of functionalities or visuals that were made. They are all collected within a playlist, the following link will sent you to the playlist, and all videos are visible.

The link for the visual showcase throughout graduation:

https://www.youtube.com/watch?v=RgaM_Sdn_f8&list=PLWGfsJhgOYEWkPPWfwan3twt5Mu2onV_L

Link to a video that shows all installation in a short time:

https://youtu.be/zjD_PAjggwI

Appendix A.2 – Unity Pictures

Some final pictures were takes of some visuals that were made throughout the project, all these pictures are made from the Unity scene, with no other effects from other applications.

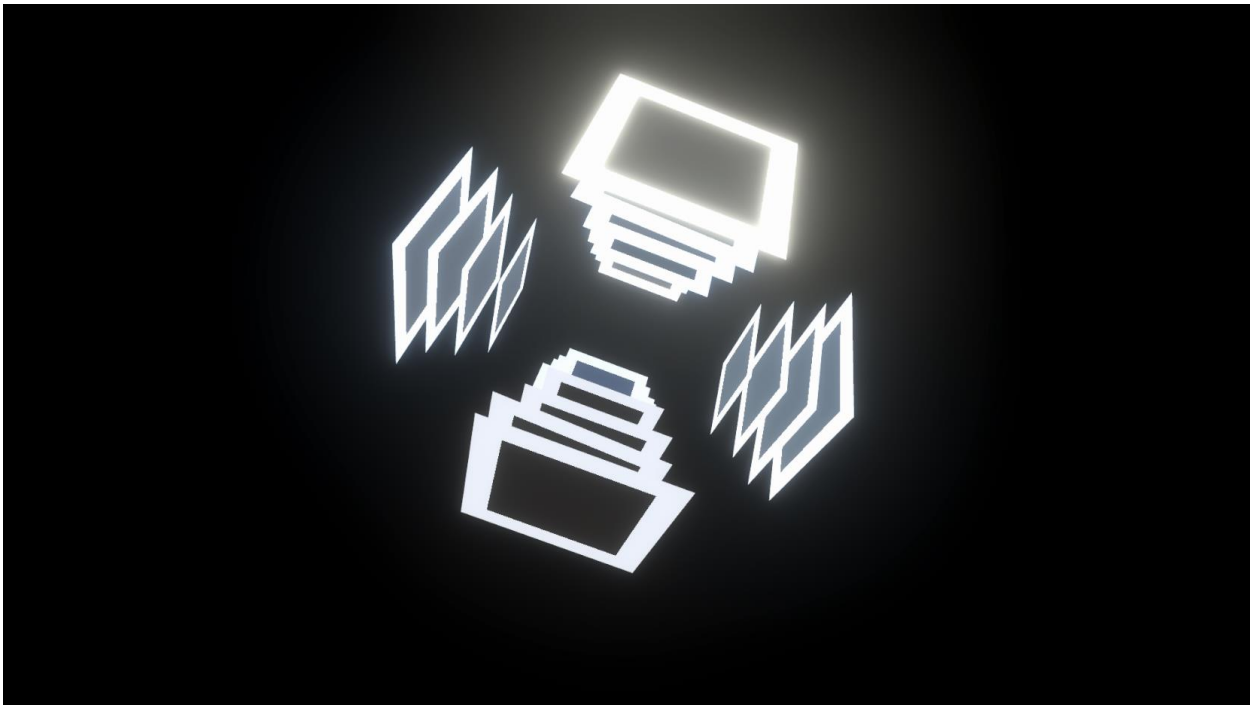


Figure 9 Cube responding to the kick by expanding

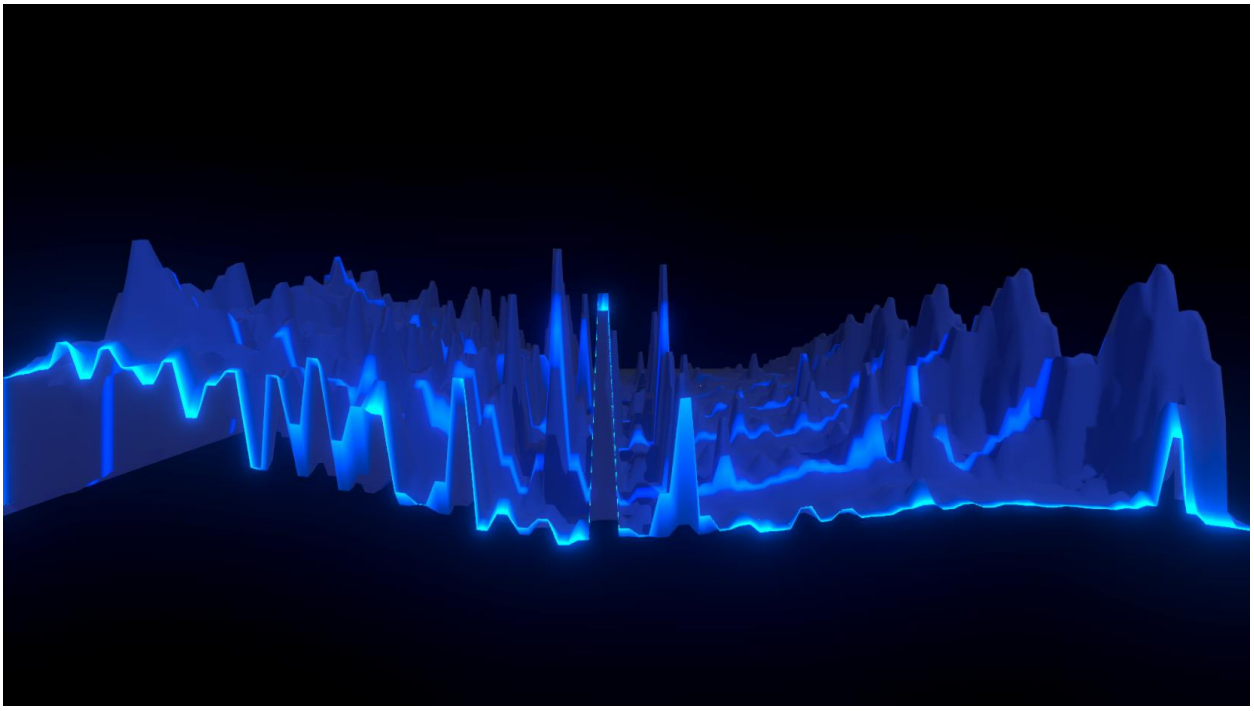


Figure 10 Unity mesh responding to different audio frequencies

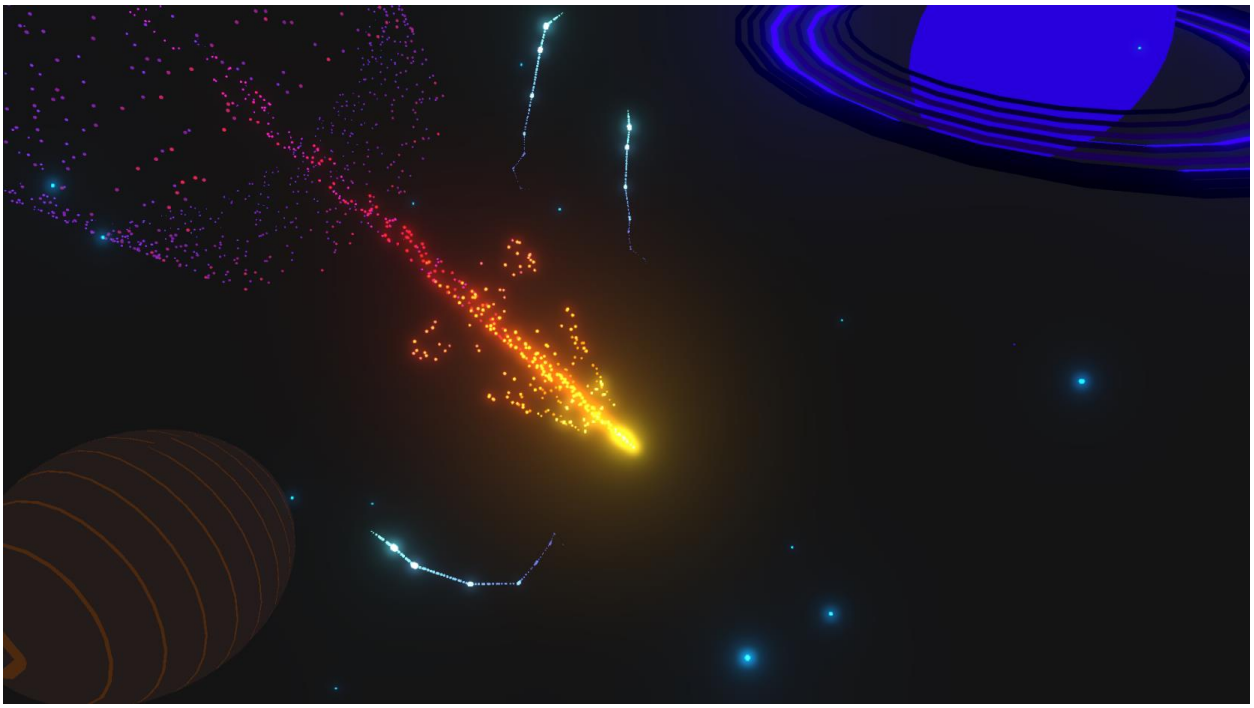


Figure 11 A galaxy scene, in which multiple elements respond to the music

Appendix A.3 – Resolume Pictures

All pictures were created by sending Unity visuals over to Resolume, and adding extra effects on those visuals within Resolume.

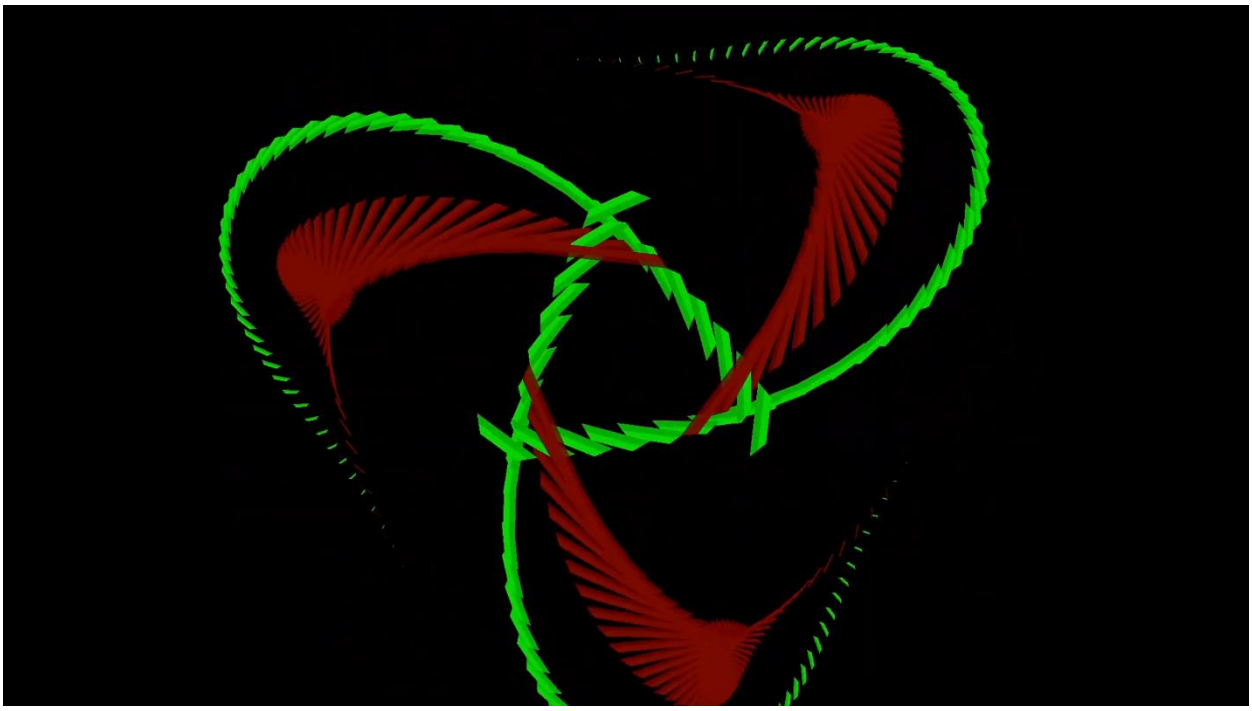


Figure 12 A scene originally created in unity, but added Resolume effect over it

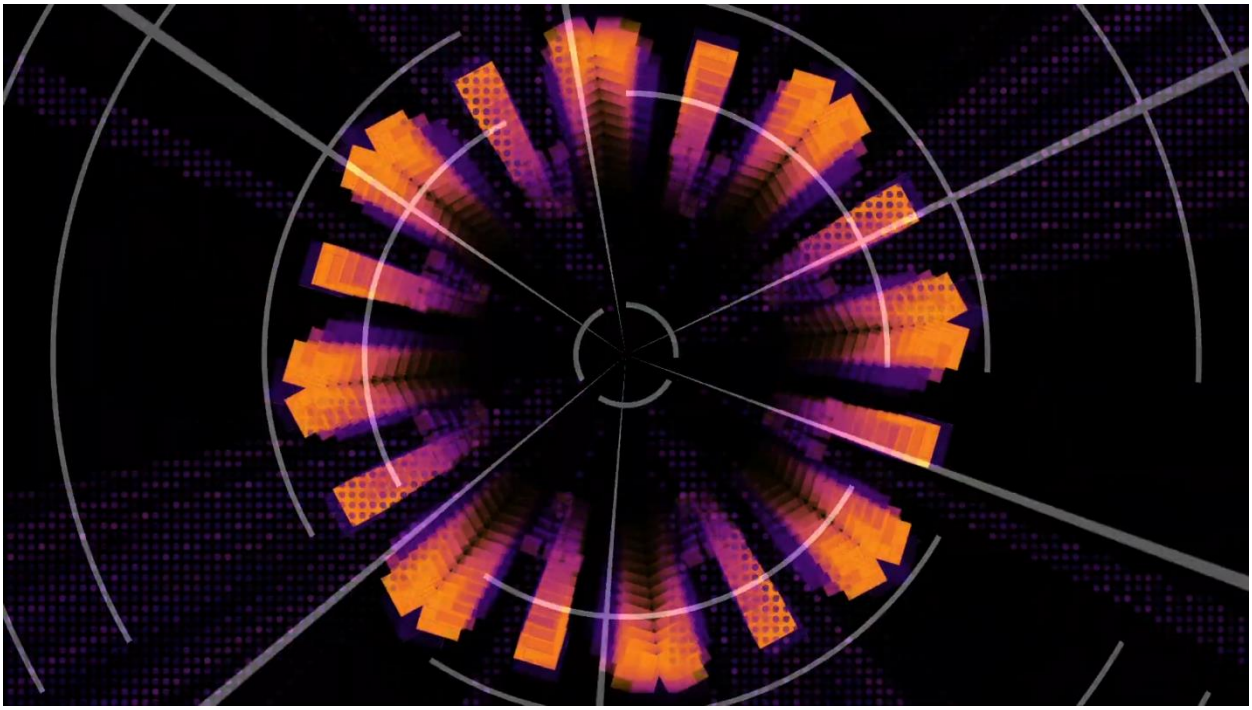


Figure 13 With the help of the support unity scene, this was created in Resolume, each element responding to music

Appendix B – Form Results

As a lot of the questions and data that was required to gather is open questions, and very different per individual, a lot of the data will be written out as summery, if you wish to see the complete results, please visit: Form Results .

A total of eight 18-25-year-old individuals and two 35 or higher year old filled in the form. In which all nine DJ's play within the EDM genre, in which common genres of the DJ's are: techno and drum and bass. The most common programs used while Djing can be found in figure 14.

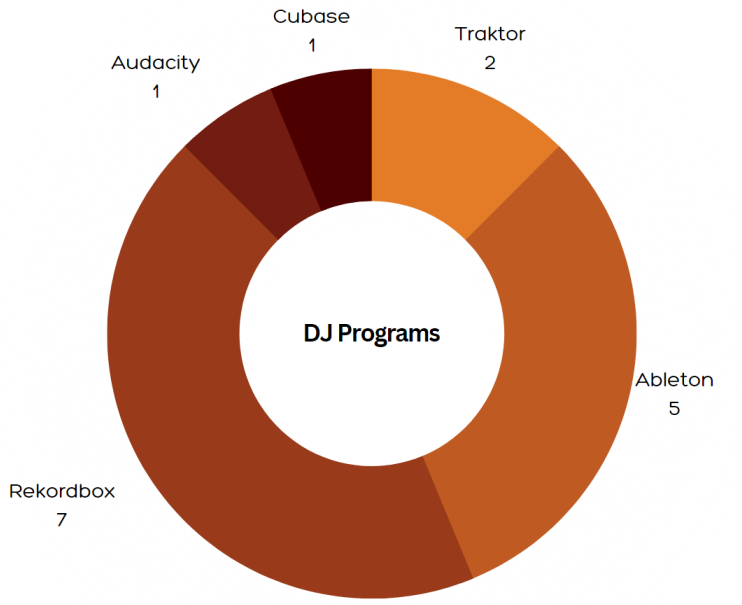
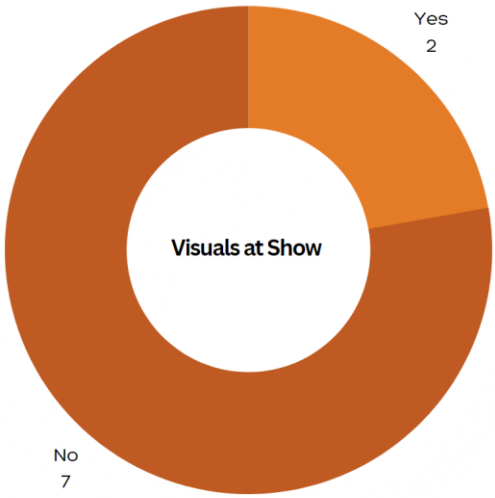
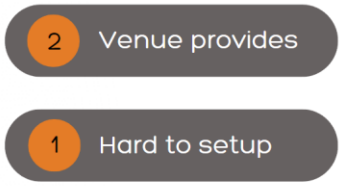


Figure 14 The common programs used by the nine questioned DJ's

Seven individuals do not use visuals at their show while only two do use them (figure 15). However the individuals who said that they don't use visuals, two of them say that their venue provides visuals or a VJ, and one individual mentions that they would like visuals but its hard to setup.

While eight of those individuals would certainly use visuals if they were easy to setup as seen in figure 16, and only one says maybe.





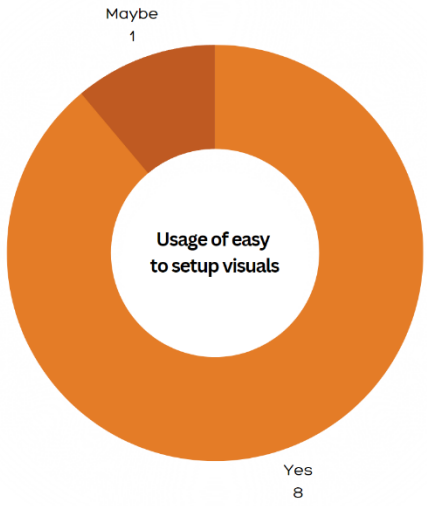


Figure 15 How many individuals play visuals at their show

Figure 16 Amount of people who would like to use visuals if it was easy to setup

Individuals expected the visualizer to have some basic customization, a user friendly experience, and that it has basic integrations like ableton link.
The individuals mention that the key moments where visuals should be on point are, drops and breaks, but also the possibility to at a start to the set or end. Some mention that the visuals should think about the vibe, as for techno it shouldn't be too bright, and the visuals should be an upgrade, an add on, thus not steal all the attention.

The individuals mention that they would like to have control over the colours, the speed, quantity, size, overlays, strobing and preferably control these with a midi controller.

Appendix C – Christos Interview

The following interview was conducted halfway through the project with Christos. While this is the only official interview conducted with him, multiple sessions were hold were we worked together on created visuals, thus more small unofficial was collected outside this interview, throughout the project.

Question 1: On a scale from one to six, how easy was it to set it up?

Christos: 5, it was very easy to setup

Question 2: What is something you would change to enhance the ease of setting it up?

Christos: Right now you need to create a build beforehand, in which the setting of using a microphone or not is locked in, thus if you want to change that settings you need to create a new build, if this could be done within the existing build, that would make it easier to switch.

Question 3: Did you feel like something was missing when setting the visualizer up?

Christos: The manual did not describe anything about the cables nor the cable length. Thus for people less experienced with technology might not know which cables to expect to be needed.

Question 4: On a scale from one to 6, how easy was it to implement visuals yourself?

Christos: 4, it did take a bit of time to get used to, but once used, it becomes easier. I suspect that by using the tool a lot more will eventually will speed up the process. Which is quite normal for every program that is new to someone.

Question 5: What are some adjustments you would like to see on the used tools?

Christos: Some tools do not have all the settings I would expect from the tools. Like in the movement tool, you can only move the object forward, I would also like to maybe move it side ways or diagonal.

Question 6: Did you feel like a specific tool was missing?

Christos: Yes, there was no tool to change the size according to the audio.

Question 7: What are some closing thoughts?

Christos: Currently you can create visuals in unity, and add effects over it in Resolume, however since you have a whole scene in unity, effects within resolume are hard to apply as it works better on single objects. Maybe you could create a tool so that we can get specific elements of the music in Resolume, so we can add effects over that instead.

Also maybe implementations of different daws and programs like touchosc, fl studio etc. And maybe a control panel where it is possible to see and tweak all the parameters, or some sort of UI.