

# Interactive Music Installation: Raising awareness about the lack of diversity at music festivals

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## Abstract

This study started with an idea given by the artist André Kodde to create a video-controlled interactive music installation that turns its users into music notes. The inspiration was to address the lack of diversity at music festivals as music festivals significantly discriminate against non-white, non-male artists and visitors. Background research was done on technology, typical interaction types and music mappings of existing music installations and the context-specific requirements of a music festival. Multiple prototypes were developed to crystallize the most suitable technology and interaction types for the context. In the final installation, the user can draw notes on a music score with their head to create different music tracks. The camera image is analysed with a face detection algorithm and the music score is visualized on a big screen using python with the libraries MediaPipe and OpenCV. Additionally, Ableton is used for music and LoopMIDI for the communication between Python and Ableton. The second prototype and the final installation were tested at a Maker festival and in a hallway testing respectively to gain insight into the usability, the user experience and the perceived control over the music. The interaction was found to be intuitive especially if the users first observed someone else interacting with the installation. The installation was categorized rather as an experience than an instrument because of the lack of physical feedback and because users are using their bodies as the main input. The limitations of this study lie mostly in the fact that it has not been tested and worked out with actors from the artist that would create a show around the installation and thus address the topic of diversity by limiting what type of music each user can make. The result of this project can however be a starting point for the artist to develop the installation further by adapting the music and visualizations and working out the show around the installation.

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# Chapter 1: Introduction

Music festivals have always lacked diversity regarding the crowds they attract and the artists they hire. Especially at bigger festival venues the line-up mainly consists of white, cis-male, non-LGBTQ+ artists [1]. Even though these proportions have levelled out slightly over the last years, more awareness and social pressure on the festival organizers to minimize this discrimination is needed. Thus finding new ways to raise this awareness should be searched for.

With the increased popularity of interactive music installations over the last years, they have also begun to be used to inform about important social issues. Interactive music installations create a physical embodiment or interface with which the user interacts with the installation and creates sound or music. Some interactive music installations have already been designed to raise awareness and as they already include the musical aspect, it is logical to use them in the music festival context.

This project is in cooperation with the artist André Kodde. André Kodde makes public art installations for festivals and often brings across a socially critical opinion in his work. The developed installation is supposed to allow his actors to interact with the audience at music festivals in an engaging way while raising awareness on the topic.

## 1.1. Goal

The goal of this thesis is to develop an outdoor interactive music installation for the artist André Kodde [2]. As the installation is supposed to be displayed at festivals, a main requirement is to make it suitable for outdoors, durable, and easy to set up. As the festival visitors will only shortly interact with the installation, the interaction has to be very intuitive with a short learning curve to not frustrate the user. The installation has to be designed in a way that the needed user input reflects the intuitive interactions a festival visitor might make. Additionally, the topic of diversity has to be conveyed clearly and in a concise way through the mapping between interaction and music.

## 1.2. Research Questions

Based on the previously stated goal, the following research questions have been formulated:

**Main-RQ:** How can an interactive music installation map the user's input to music to inform on the topic of the lack of diversity at music festivals?

**Sub-RQ1:** What is the state of the art in interactive music installations?

**Sub-RQ2:** What technology should be used for this type of installation?

**Sub-RQ3:** What are the typical interactions used in interactive music installations?

**Sub-RQ4:** How can the installation be designed to fit the festival's circumstances regarding limited setup time and lightning conditions?

The first research question will be answered with the final user testing of the installation. The first three sub-research questions will be answered through background research and in the case of the third sub-question, through user testing to test the interactions with the installation. The last sub-research question will be addressed through testing in similar conditions and taking into account the festival circumstances while designing the installation.

### 1.3. Structure

This report starts by giving an overview of the background information and state-of-the-art on the topic in Chapter 2. Chapter 3 then follows by explaining the used design processes and techniques and highlights what phases will be empathized. In Chapter 4, the evolution of ideas is described with the corresponding concepts behind them. The specifications are in Chapter 5, which explains the choices made and how the requirements will be translated into the final product. Afterwards, Chapter 6 will describe the realization of the final concept in addition to the performed user testing to evaluate the realization which will be described in Chapter 7. In Chapter 8, the results will be discussed and possible future work will be highlighted. Finally, Chapter 9 will conclude the work and summarize the findings and results.

## Chapter 2: Background Research

This chapter describes the background of the project by first describing the state-of-the-art of interactive music installations. Then, the context is established by giving information about the diversity problem at music festivals, the stakeholders and on the inherent biases in the technology that is used in the project. Finally, related work is listed in the field of interactive music installations and the conclusion is given for the project based on the gathered information.

### 2.1. Interactive Music Installations

The literature review was conducted mainly on Scopus and Google Scholar with a focus on peer-reviewed articles. The main search terms were “interactive music installation”, “interactive sound installation”, “motion-based”, “gesture”, and “interactive media installation. Excluded were all sources that included VR or AR, installations that are specifically targeted towards children or were dated before 2000.

#### 2.1.1. Interactions

To analyse the different interactions used in interactive music installations, the interactions were divided into two types. These types are the body position and movement and interactions between users.

##### 2.1.1.1. *Body position and movement*

Body position and movement are used as a type of interaction in two different ways. The first way is by analysing the participant's position in space and having them explore the space. The installation “SoundLabyrinth” [1], tracks the participant's position inside the dome-shaped installation and lets them explore different soundscapes depending on where they are walking.

The installation starts with sounds that are inspired by real objects and the further the participant walks into the installation these sounds evolve into more abstract music. “Skyhooks” [2] explores a similar approach whereby instead of walking through a closed space like the dome, the users explore a public place. Balloons are attached to the head of the users and they can walk through invisible sound bubbles that are mapped to positions in the air. In the installation “Mix and Match” [3], the user is also supposed to walk through different trigger zones.



Figure 1 “Skyhooks” installation

However, in this installation, these are on the floor which is divided into multiple squares that correspond to different music.

The second option is to translate the body movement into gestures that are interpreted as music. Bernhardt [4] designed an interactive music installation where the user's body movement is interpreted and classified into 5 different emotions. The installation then plays music that fits the emotion. The installation "Selfhood" [5] also tracks the users' movement

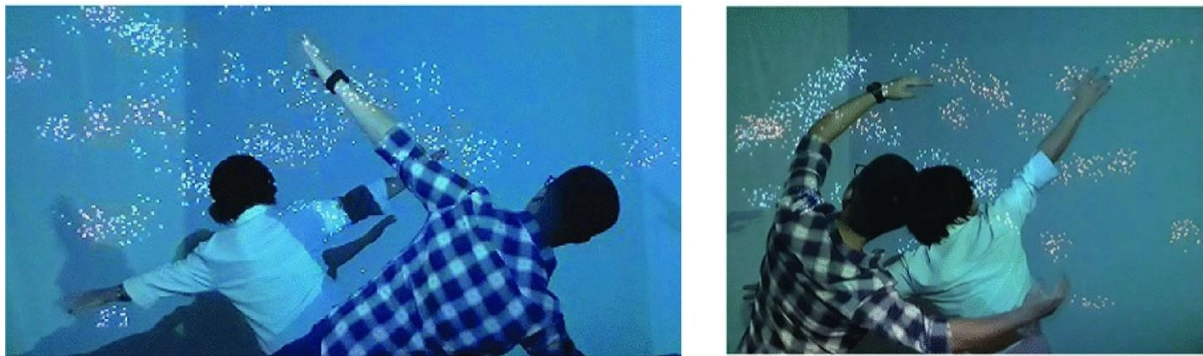


Figure 2 "SELFHOOD" installation

however does not classify them into categories. It translates the user's body into an abstract point cloud and creates music depending on different movement factors for example speed. Tracking different movement factors is also present in the installation "Iamascope" [6]. Here, the user controls the music by moving their body parts and depending on what body parts move, different music is triggered.

The installation "SoundSculpt" [7] however has a different approach where the user has to perform specific gestures which are inspired by making pottery to sculpt the music. Here, the user can move their hands horizontally and vertically to carve out and change different characteristics of the music. This however resulted in many unforeseen gestures from the participants which could not be interpreted. To conclude, the body position is often used to have the user explore the space, whereas specific body movements are interpreted so that the user can use the installation more as an instrument and create their own music. Important to note that, installations that demanded very specific gestures or tried to categorise the movement encountered more input that could not be interpreted correctly. However, leaving the mapping between movement and music more abstract limited the control the user had with the created music.

#### 2.1.1.2. Interactions between users

In addition to single-user interactions like body position and movement, many installations also use the interactions between users to create richer music tracks and highlight interpersonal interactions. For one, multiple user interactions are used to increase the amount of music that is created from the installation like in the installation of Birchfield et al. [8]. Here, multiple users

can move in front of the installation simultaneously and create multiple soundtracks that play together. In the installation “Mix and Match” [3], multiple user interactions also lead to multiple soundtracks being played. However, in this installation, the users have to collaborate with each other and plan together which music tracks they want to mix together.

In the installation “Selfhood” [5] the sounds that are created by the different users do not only play simultaneously like with the previous installation, but they influence each other. When a user comes close to another user, the sound point clouds that represent them interact and mix and therefore create original sounds. The installation “Recycled Soundscapes” [2] also mixes the user input from multiple users by having multiple instruments where people can input sound. This sound is then echoed to the other instruments and is remixed.



Figure 3 "Recycled Soundscapes" installation

Some installations try to foster more human-human interaction by having their main goal to visualize the relationship between people like the installation “Responsive open space” [9]. The users can only create music by interacting with other users and not with the installation itself. The group behaviour is analysed and turned into music based on factors like passiveness, conformity or team formation. The topic of human-human interaction is also a part of the installation “Handjabber” [10]. By interpreting the interpersonal non-verbal gestures that one does while communicating, these are turned into music. Its goal is to highlight the gestures that do not have a specific meaning but are present in most conversations.

To summarize, multiple-user interactions are for one user to create a richer musical experience by having multiple simultaneous interactions and highlighting interactions between users and visualising different group dynamics. However, the listed installations have often not stated whether the interaction between users is understood by the users. Thus, the consequences of the different types of interactions between users on the user experience are unclear.

### 2.1.2. Visual Feedback

To support the interaction from the user, interactive installations use visual feedback to complement the auditory aspects with the varying relationship between sound and visualization. The installation “SoundSculpt” [7] implements a very direct mapping between



Figure 4 "Soundsculpt" installation

sound and visualization by visualizing the sound as a shape inspired by clay. This shape then changes depending on the user input and can be moulded through get users' gestures. In the installation "GAVIP" [11] each sound is also represented by a shape which in this case is a bubble on the wall that appears or disappears depending on if the sound is played. The user testing however highlighted that this representation is very limited as it does

not visualize the different sound characteristics that can be changed through user input opposite to "SoundSculpt" where the user can see each change immediately.

In many installations, the user motion is mirrored as visual images like in the installation "Selfhood" [5]. The user is turned into a point cloud that is projected onto the walls. This point cloud follows the users' movement and visualized the sound that the user makes by moving. Additionally, when multiple users interact, their representative point clouds mix on the wall. The public interactive installation of Birchfield et al. [8] also mirrors the person's movement on the interface but displays it as water rippling on the surface. Like in "Selfhood", the visualizations from different users interact. In the installation of Birchfield et al. [8] interactions between users create new ripples on the displayed water surface whereas interactions in "Selfhood" result in mixed point clouds which change the colours of the points.

In the installation "Iamascope" [6], the user gets turned into art by creating a kaleidoscope-like image from the camera image of the user. Through this, the user can see what movements influence the sound in what way. Some installations also use visual feedback to make the experience more immersive. One

example of this is the installation "Kuatro" [12]. Here, supporting images are displayed on the walls that move depending on the users' input. The installation "Sound Labyrinth" [1] also projects images on the wall that fit the sounds and therefore create an immersive environment. It additionally mirrors the user's gestures onto the wall to



Figure 5 "Kuatro" installation

make the user a part of the environment. To conclude, visual feedback is used to visualize the sound and therefore make the sound manipulation more clear and to create a more immersive




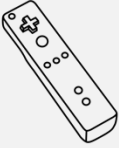
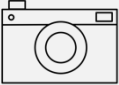
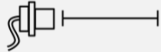

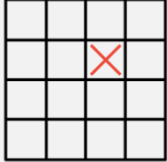

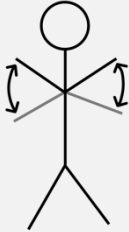
environment for the user to improve the user experience. The researchers however often did not test different types of visualizations. Hence, different visualizations could have visualized the sound better and more research is needed to evaluate what visualizations are best for what application.

### 2.1.3. Music Mapping


Music mapping describes how the installations use and change the music or sound depending on the user input. Many installations include sound from natural environments in the sound design. The installation “GAVIP” [11] uses the sound of water drops, where the user can trigger individual water drops and change the volume and speed through their head position. The public interactive installation of David Birchfield et al. [8] chose to use sounds from its environment that adjusts depending on the time of day to reduce noise pollution as it is situated outside. In the installation Sound Labyrinth [1], the sound design starts with realistic sounds, but these change into synthetic sounds when the user explores the installation and walks deeper into it. The synthetic sounds can then be changed by the user through body movement. The installation “Responsive Open Space” [9] mixes electronic, and instrumental music with historic quoting and lets the user influence for example the harmonics, style, rhythm and tonality. The installations “Mix and Match” [3] and LoopJam [13] both let the user act as a DJ and mix different music loops. In “Mix and Match” multiple users can trigger different zones for different instruments like drums, guitar and vocals and mix them with other loops. In LoopJam, the speed of the music is changed by the speed of the users. To conclude, the installations often use sounds from the environment or music tracks that can be mixed and let the user influence factors like speed, volume or pitch.

### 2.1.4. Technology

When looking at the technology that has been used in interactive music installations, it becomes apparent that the most common technologies used are cameras or the Kinect. These are most often used to track body position and movement. Especially the movement is either directly translated into a visualization or analysed and classified. For more exact movement input, the WiiRemote is used to for example detect specific hand gestures. To get an overview of the different technologies and how these sense body actions, a table has been designed:

|  |  |  |   |   |   |
|--|--|--|---|---|---|
| <p>Body action\ Technology</p>   | <p>Kinect</p>   | <p>WiiRemote</p>  | <p>(infrared/thermo) Camera</p>                    | <p>Proximity sensor</p>  | <p>Microphone</p>  |
| <p>Position in space</p>      | <p>Position in space translated to 2D grid to control speed of music [13], Kinect tracks entering, exiting and how user moves in space [12], [1]</p> |  | <p>Camera above grid drawn in floor [3], [9], camera detect pink balloons that are attached to users head to track position [2]</p> | <p>Sensor checks whether user approaches and wants to interact [8]</p>                                      |   |
| <p>Hand movement</p>        |  | <p>Gyroscope for distance and accelerator for triggering music control [6]</p>                     | <p>Camera check horizontal and vertical hand movement [7]</p>   |   |   |
| <p>Whole-body movement</p>  | <p>Different speeds of movement is sensed and then changes the music [1], motion and body is tracked and</p>   |  | <p>Camera image cut up into segments → amount of change per segment changes music [6], camera track</p>                             | <p>Multiple sensors on a grid that track whole body [8]</p>   |   |



|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  | visualization of body is projected on wall [5] |  | movement and classifies it into categories [4] |  |  |
| Sound<br> |  |  |  |  | Users can make sound into interfaces which then gets saved and layered with other sounds [2] |

## 2.2. Diversity at Music Festivals

When looking at music festival line-ups, it becomes apparent that they have a diversity problem. A study by female:pressure [14] looked at electronic music festivals worldwide and reported that even though the proportion of female artists is rising, the line-up often mostly consists of cis-men. For example in European

music festivals from 2020 to 2021, the proportion of male artists is at 53% whereas the proportion of female artists is only 31%. They also found that these differences increase with the festival size. Looking specifically at Dutch festivals the proportions were the following: 18.5% female, 74% male, 0.6% non-binary, 6.4% mixed and 0.7% unidentified. According to their study, publicly funded festivals and festivals with female

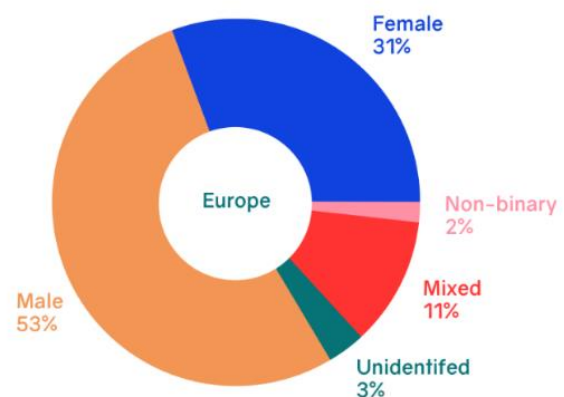


Figure 6 Gender proportions at European music festivals [14]

artistic directors tend to have more equal proportions. They also highlight that in addition to the gender imbalance, festivals often have a problem with ableism, ageism, and racism. This is further supported by a report by 6 AM's [15]. Their analysis of the lineup of popular American festivals in 2021 shows, that at most festivals the lineup is dominated by male, non-LGBTQ+, white artists.

A study from Hannah Van Amburgh [16] looked at possible reasons for this inequality with the example of American music festivals. A possible reason is that festivals often target a young female audience and therefore pick male musicians according to the heteronormative assumption that women want to see male artists. The study also found that female and male headliners are also treated differently by the media. Female artists were often more commented on based on their appearance and fashion, not their music when compared to male artists.

### 2.3. Bias in AI Recognition Technology

As AI recognition technology is more widely used in society, concerns emerge about possible biases in these AI algorithms. A study on two facial recognition algorithms found that the classifier worked better on light-skinned and male faces [17]. The difference between error rates for male and female faces was between 8.1% and 20.6%. Comparing light and dark-skinned photos, the difference in error rate was between 11.8% and 19.2%. This algorithmic discrimination stems from biased datasets that are used for training the AI models. In addition to race and gender, other non-demographic attributes also have an impact on the accuracy of facial recognition algorithms [18]. Attributes like hairstyle, hair colour, face shape or facial abnormalities can influence the accuracy negatively and need to be paid attention to when developing less discriminatory algorithms. However, not only facial recognition algorithms have internal biases. Studies have shown that speech recognition software works worse for female speakers or speakers with a dialect [19]. Additionally, when looking at the application of AI in the medical field example new problems emerge. Skin cancer detection algorithms are for example trained mainly on pictures of white skin [20]. To summarize, with every application of AI recognition technology one must be aware of the inherent biases that come with these technologies.

### 2.4. Stakeholders

#### 2.4.1. André Kodde

André Kodde is a Media artist from Amsterdam. He studied Media art at the Academy for Art and Design in Enschede and Fine Arts at the Sandberg Institute. From 2009 to 2013, he worked on the project Msquare4 [21], which is a new virtual museum model, that explores the autonomy of art.

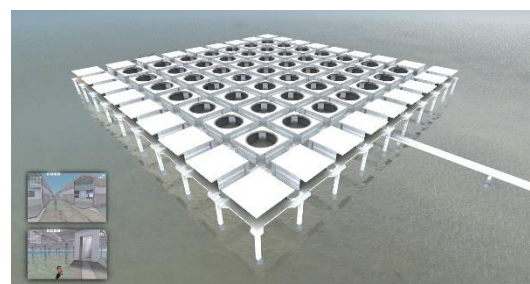


Figure 7 Msquare4 museum

Every room is a square in a grid, that is adjacent to 4 other rooms. The visitors can freely move through the rooms and the goal was to guide the visitor solely through the art. Another project of his is the Tricycle project that was presented

at the Kunstvlaai: Festival of Independents [22]. The installation consisted of multiple tricycles that can be driven by children. By screaming, the children could move forward and the child who screamed the loudest won.

#### 2.4.2. Music festivals

As the final installation is supposed to be displayed at music festivals, it is important to look at why music festivals should be interested in including these types of installations and touch on the topic of diversity. Even though festivals are a place for leisure, they can also be a driving force for social change. Festivals can serve as a space for people to discuss and engage in topics they would not have otherwise. However, because of the increased commercialization of festivals, fostering social change has to be a conscious effort when organising festivals [23]. A study by Swartjes and Berkers [24] looked at how festivals in Rotterdam deal with diversity. Festival organizers were questioned on their views on the diversity problem. Most of them were aware of the problem and felt the need to address it as festivals could be a place for visitors to get in touch with the topic of inclusivity. The advantages of more diversity according to the festival organizers were that it could attract more audience groups and increase the enjoyment of the audience. However, the festival organizers also mentioned that having high diversity is often not feasible, because the main focus is on the music and they do not want to engage in “quota politics”. The study also showed, that even though the festival organizers were aware of the diversity problem, most only mentioned age, ethnicity and gender as the cause of exclusion, but were less aware of the exclusion of artists based on their sexuality, disability or religion.

### 2.5. Related Work

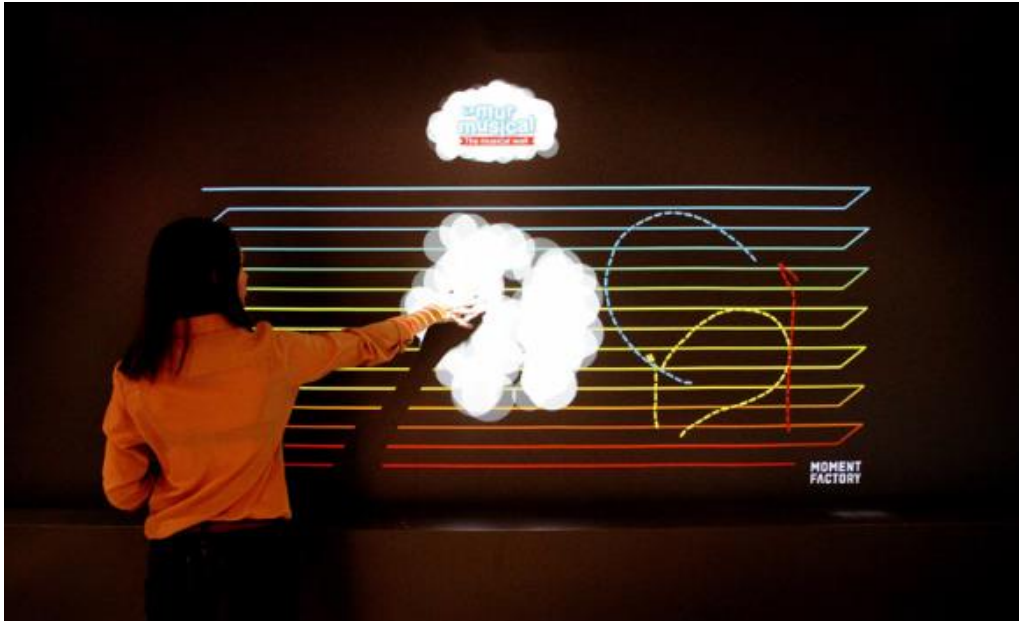
To get an insight into the already existing installation that might be similar to the final product of this project, three different categories of related work have been looked at. First, general music installations were researched, followed by festival installations and finally installations that also address the topic of diversity.

#### 2.5.1. Music Installations

For the category of music installations, interactive installations were searched for that use the user input to create music or different kinds of sound.

##### *2.5.1.1. moment factory: interactive musical wall*

The interactive music wall by moment factory is an interactive multimedia installation that was invented for hospital waiting rooms to improve the mood of visitors and especially young patients and to make a hospital visit more enjoyable [25].



*Figure 8 interactive music wall by moment factory*

It consists of motion sensors and light projectors that project a rainbow plane on a black wall. The user can interact with the installation with their fingers, which results in music and colourful lines and shapes.

#### *2.5.1.2. I am Sound*

The installation “I am Sound” by Tamiko and Christopher Reiserer addresses the topic of surveillance and face tracking [26]. The user's face is turned into music by projecting it onto multiple aluminium plates. For each plate, the image is analysed and translated into music. This music is then played through Piezoelectric transducers that are attached to the individual plates. Additionally, changes in the positions of facial features are measured which alters the played music.



Figure 9 User interacting with the installation "I am Sound"

## 2.5.2. Festival Installations

Under festival installations fall all installations that are designed and displayed at festivals independent of the type of user interaction and music used.

### 2.5.2.1. Track\_48N10E

At the Modular Festival, the sound installation Track\_48N10E is displayed [27]. This installation used the GPS position of the user to let the explore the space through sound. By walking around the environment with the web-based installation on their smartphone, the user can explore a changing soundscape. This soundscape is calibrated to the specific environment and based on the amount of nature in the surroundings.

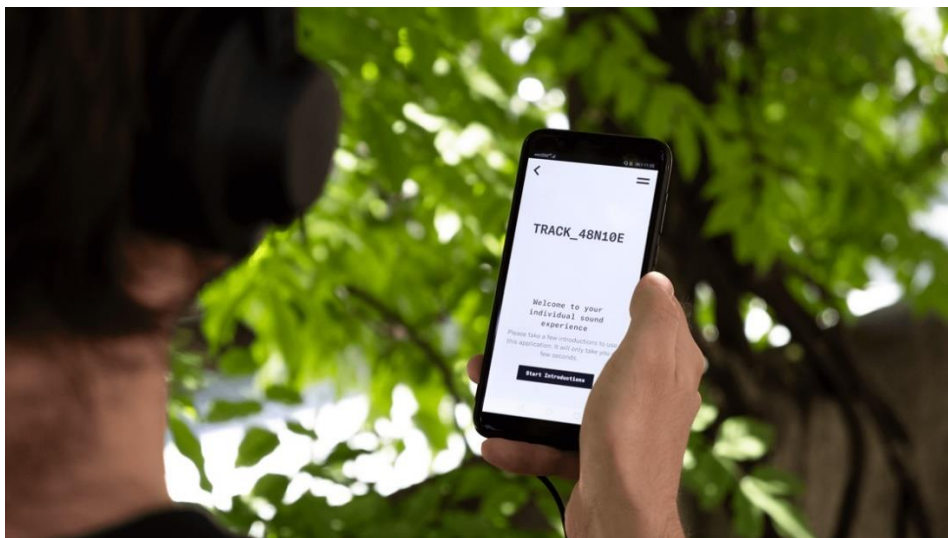


Figure 10 Sound installation Track\_48N10E

### 2.5.2.2. *The Cube*

At the Decibel Festival in Seattle, the interactive dance installation “The Cube” was displayed [28]. To interact with “The Cube”, one has to dance in front of it. The installation then mirrors the movements on the cubic screens. Up to three people can interact with it at the same time and dance together. Additionally, the movement of people that are in a different physical space can be projected onto the screen to create a virtual connection between people through dance. “The Cube” was built using projectors and Kinect sensors as the main technology.



*Figure 11 The installation "The Cube" and people interacting with it*

### 2.5.3. Installations on the topic of diversity

The last category of installations that address the topic of diversity includes installations whose main goal is to raise awareness on the topic and do this through mapping the user's interaction to music.

#### 2.5.3.1. *Social Painting - Embrace the differences*

The installation “Social Painting” is a project of the Bauhaus University Weimar and the Aalto University [29]. It consists of an interactive projection space that invites visitors to reflect on the topic of discrimination.





*Figure 12 Visualization of the installation Social Painting*

The visitors first get separated based on their appearance like eye or skin colour. The people who belong to the majority of the appearance factor get assigned a circle and the minority is assigned squares. The circles can move freely and colour in the space. The square however can only move in one direction and turn all colours into grey. To encourage squares and circles to interact, their cooperation results in emojis that are drawn on the floor. The motivation for this project was to engage with the topic of discrimination playfully and artistically to encourage interaction between different groups and invite exchange and open communication.

#### *2.5.3.2. Mix and Match*

The installation “Mix and Match” is an interactive music installation that invites its user to collaboratively create music [3]. The goal of the installation is to increase social sustainability at music festivals. The installation consists of an interactive floor that is divided into trigger zones on which the users can walk. Each trigger zone corresponds to a sound loop of drums, guitars, bass or vocals.

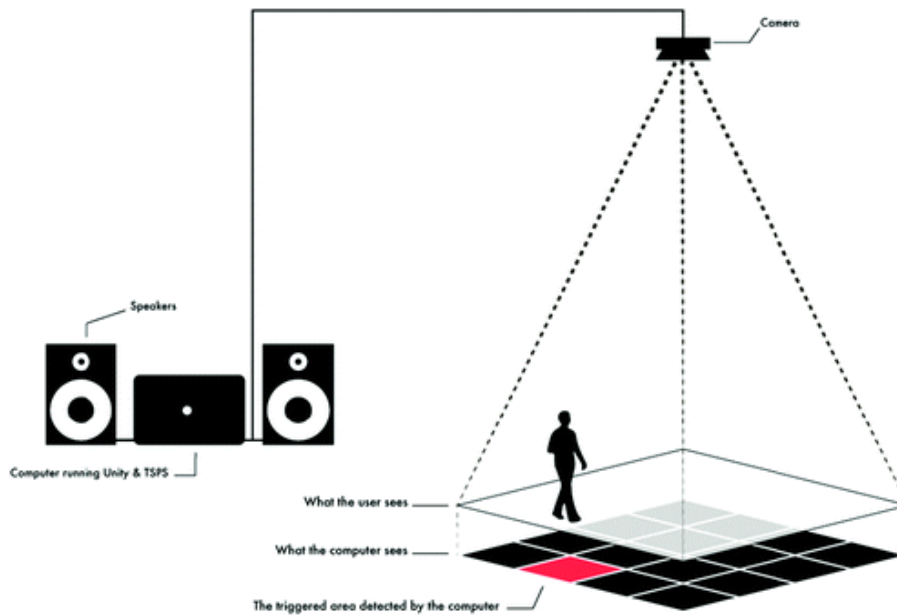


Figure 13 Illustration of the installation "Mix and Match"

Multiple users can interact with the installation at the same time. By standing on different trigger zones, new music loops are mixed inviting the users to interact with each other and collaborate on what type of music track they want to create.

## 2.6. Conclusion for Project

To summarize, the literature has shown that most installations use the user's body position or motion as the main input for the interaction. The user can either explore the environment of the installation by walking around or elicit different sounds by making gestures or moving their body. Some installations additionally allow multiple user inputs to enrich the created music. Taking this further, in some installations the interaction between users is highlighted and mapped to music to encourage interpersonal interactions. Lastly, visual feedback is often used to support the music or sound. The visual feedback can create a more immersive environment and with that improve the user experience or visualize the user input to make the music manipulation more visible. For this project, both position and body movement will be used and, as the topic is to encourage diversity, meaningful interactions between users are important. Additionally, the literature has shown that meaningful mapping between visualization and music is needed to increase usability and understanding.

Another aspect that is important for this project is outdoor durability. Projects like "Mix and Match" have shown that considering the outdoor setting is important when choosing the technology, as this installation had difficulty being displayed outside because the projected floor was not visible anymore.



As the project is set at festivals, looking at other festival installations has helped to adapt the requirements for the specific setting. The interaction should be quickly understandable and a strong visual aspect is important to attract the crowds.

## Chapter 3: Methods and Techniques

The design process of this project is built on the design process for creative technology by Angelika Mader and Wouter Eggink [30]. This design method builds on an iterative design process that goes through 4 phases.

The first phase is the Ideation phase which starts with the problem statement that is given by the client, namely André Kodde. Through client interviews, the starting requirements and ideas are found out. Additionally, related work is looked at and background research on interactive music installations and festival installations is done to establish the context of the project. The goal of this phase is to have a more specific project idea with the problem requirements. For this project, the focus is also put on sketching out simple prototypes early to evaluate early ideas. Additionally, a brainstorming session and an interview are organised with the artist.

In the second phase, the Specification phase, multiple prototypes are designed to establish the desired user experience and what technology is suitable for the AI recognition algorithm and the music creation. Here, frequent evaluations and feedback moments regarding these prototypes with the artist André Kodde are important to improve the prototypes. For this project, this phase will start early and run simultaneously with the first phase as developing and testing prototypes frequently is very helpful when designing the user experience of interactive installations.

In the Realization phase, the methods of design engineering will be applied to design the end product based on the

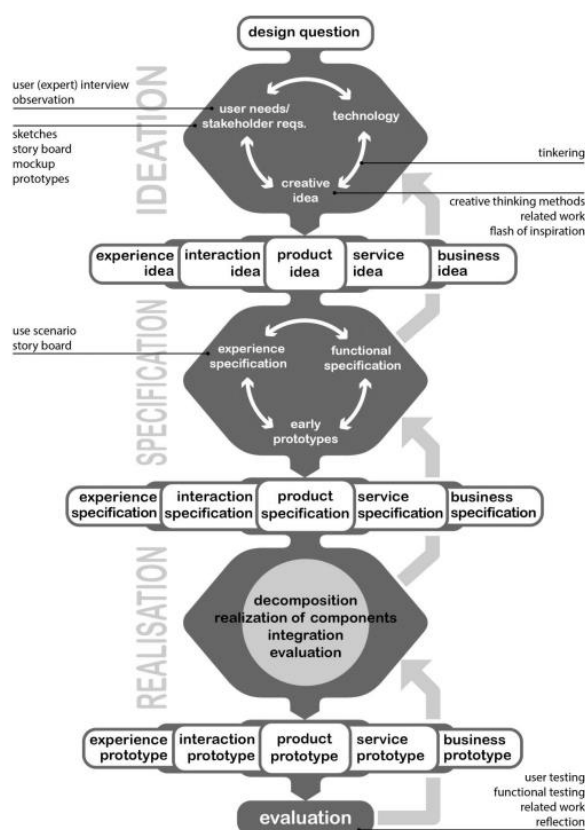


Figure 14 Illustration of the design process for Creative Technology

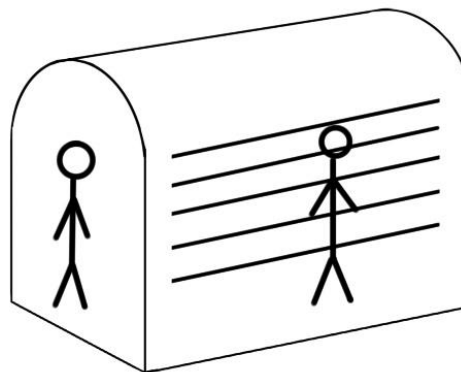
requirements. In this phase, the needed components will be acquired and put together to have a product that can be evaluated. This includes the camera, screen, material that is needed to make the installation suitable for outdoors and possibly lights, and other design elements.

This Evaluation happens in the fourth phase, where it is tested if the original requirements are met. For this project, a research experiment is held where participants are observed while they are interacting with the product. Afterwards, they will be asked to answer open questions regarding their experience. Ideally, also the early prototypes will be tested in experiments to observe the user experience.

## Chapter 4: Ideation

### 4.1. Informal Stakeholder Interview

On 21.2.2023 from 11 to 12 o'clock in an office on the University of Twente campus, the first informal interview was held with the main stakeholder André Kodde with the supervisor present. The goal of this first conversation was to exchange first ideas and get an initial impression of the requirements. Questions were prepared to start the interview, but as the main focus was to gain insight into the first ideas, the interview was not structured significantly. The interview was not transcribed, but notes were taken during the session.



*Figure 15 First installation idea: User walks into a tunnel and head is music note*

The first idea that was brought up was a type of tunnel the user walks in and in which the user's head gets turned into a musical node. Multiple users would then enter the installation one after another and build up the music. The individual tones the users create would be repeated like in a loop station each being a different part of the final music.

Another idea was to have an interactive floor, where the user's position and movement are turned into sound waves. The problem with this idea is that interactive floors are not suitable for outdoors and tend to break from repeated use.

As a simple first prototype, the idea was brought up to have the users draw musical notes with fingerprint on a large canvas that are then turned into musical notes.

The main requirements that evolved throughout the conversation were that the installation would need to be suited for outdoors, have a maximum setup time of 2 hours, be easily transportable and work in the festival setting. In addition to the requirements, questions came up that need to be explored. It is unsure whether multiple users will interact with the installation at the same time or one after another. Also, the type of music the installation will create is not decided yet.

## 4.2. First Prototype

As the first prototype, a simple loop station was programmed in Python. The goal of this prototype was to test out the functionality of a video-controlled loop. This loop-station idea emerged from the first informal stakeholder interview and the prototype was supposed to visualize the idea further and test its usability.

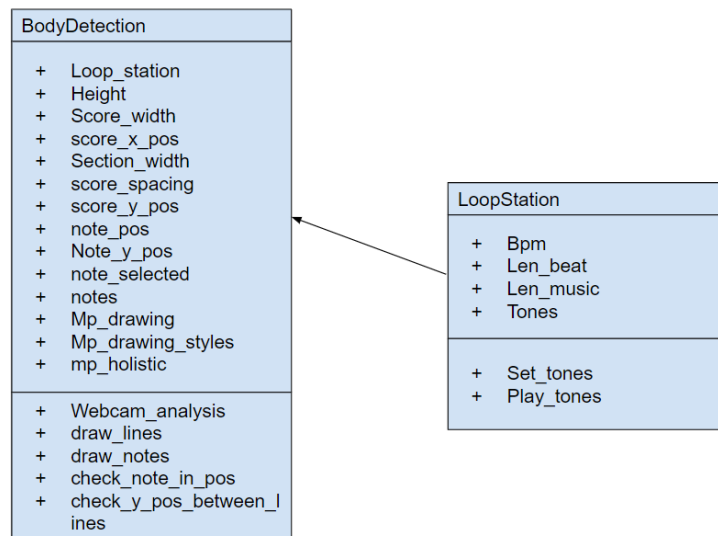


Figure 16 Class Diagram of the first prototype

The user can select the notes that should be played with their face. These are then played on a loop on an eight-beat count. After some time, the selected notes get reset so the user can select new notes.

The prototype uses the OpenCV library [31] for image manipulation and reading the camera image. Additionally, the MediaPipe library [32] was used for body recognition. As sound, simple sine waves were created in the frequency of the music notes. Additionally, short tones play for each beat.

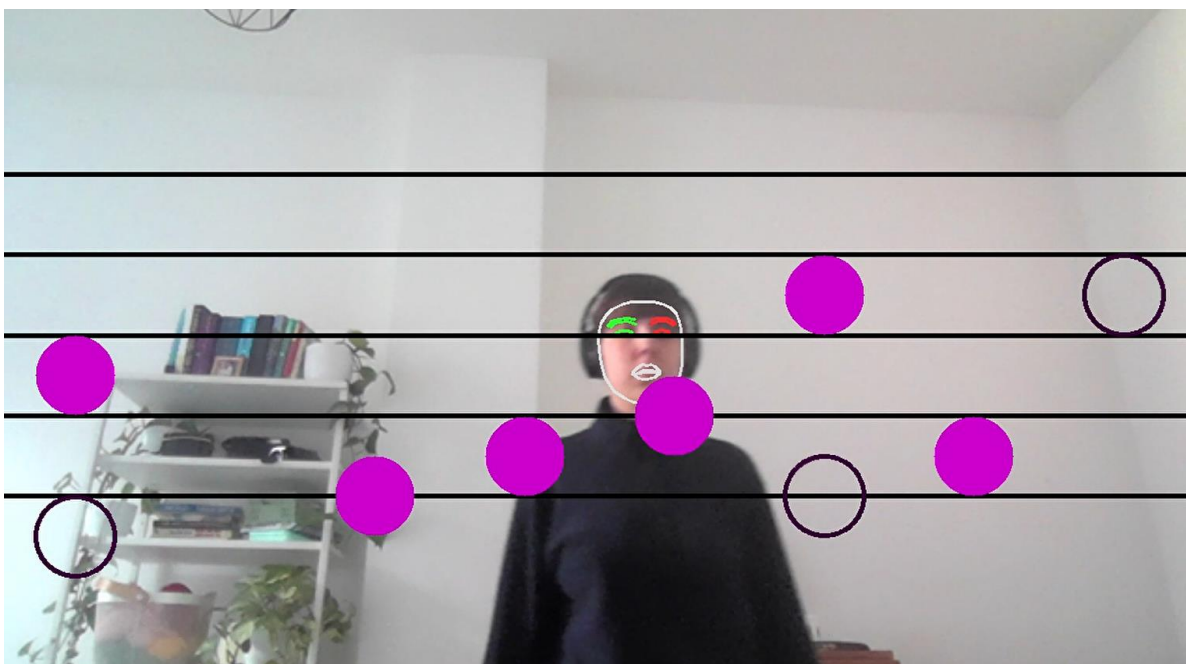


Figure 17 Screenshot of the first prototype

### 4.3. Brainstorm

On 6.4.2023 from 10 to 11 o'clock at the DesignLab at the University of Twente Campus, a brainstorming session was organized with the supervisor and the artist André Kodde. In preparation for this session, a mind map of the different factors of the installation was made and some installation ideas were brainstormed which can be found in the appendix. The session was not transcribed, but notes were taken during the brainstorming session.

To start the session, the first prototype was shown. Thereafter, possible layouts of the installations were brainstormed. One important aspect that came up was the amount of control the actors should have and how much should be predetermined in the program. Here, the artist preferred to have as much control as possible for his actors, so that they can for example change the music, the

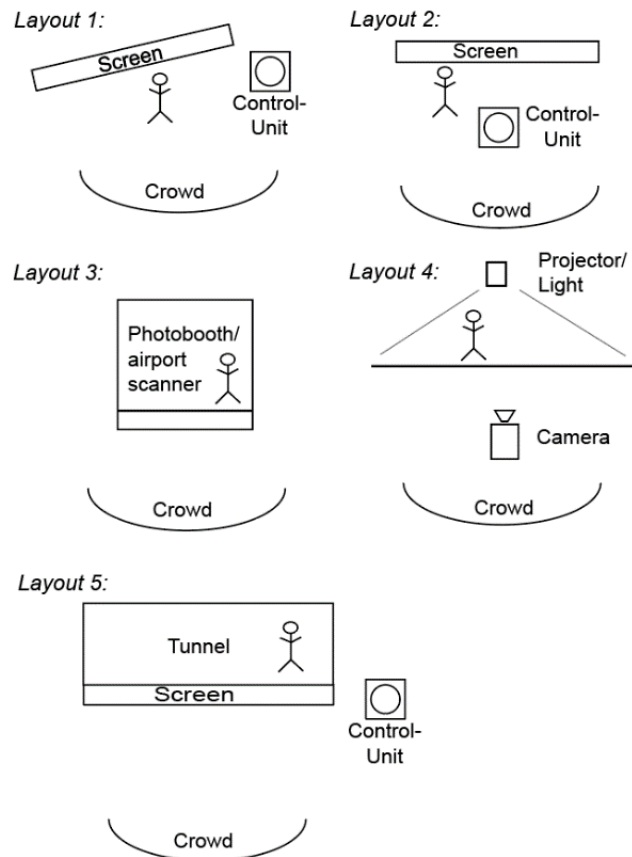


Figure 18 Possible Installation layouts (original drawings in Appendix)

factor on which the installation discriminates or how the music is played depending on the festival and crowd. Finally, it was agreed on a first design using layout 5 which consists of a tunnel, a screen and a control unit for the actors. The actors would here choose people that should walk through the tunnel and make music. From the outside, one can then see how the people walk through the tunnel and hear how they influence the music. To test this first idea, it was decided to test a first prototype at Maker Faire in May. This prototype will be a continuation of the first prototype with changes in the created music and a bigger screen.

### 4.4. Maker Festival Installation

The second prototype was an improvement of the first prototype as it had improved interactions, music, and control and could detect a part of the user's appearance. The user had more control over which notes they want to select, multiple instruments were integrated and the bpm and amount of beats in one track could be changed. Additionally, the system detected and displayed the colour of the user's shirt.

#### 4.4.1. Setup

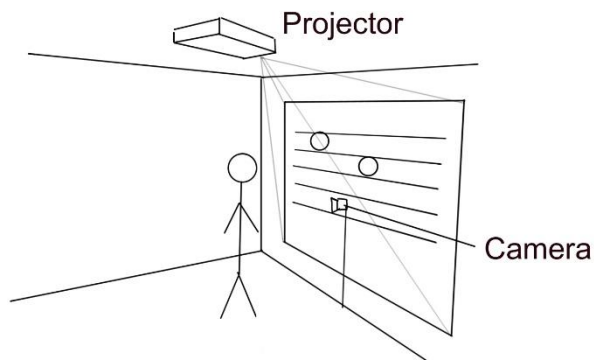


Figure 20 Setup of the Maker Festival Installation

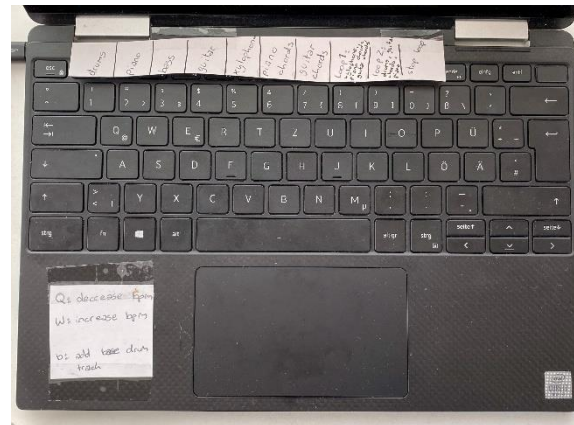


Figure 19 Overview of control keys on laptop

This prototype consisted of a projector, a camera on a Tripod, a laptop and a Speaker. The software consisted of the main control programme which was written in Python, and an Ableton file. The Python script handled all user interaction and Motion tracking using the library MediaPipe. Additionally, the data in which notes should be played were sent through LoopMIDI [33] from the Python script to Ableton.

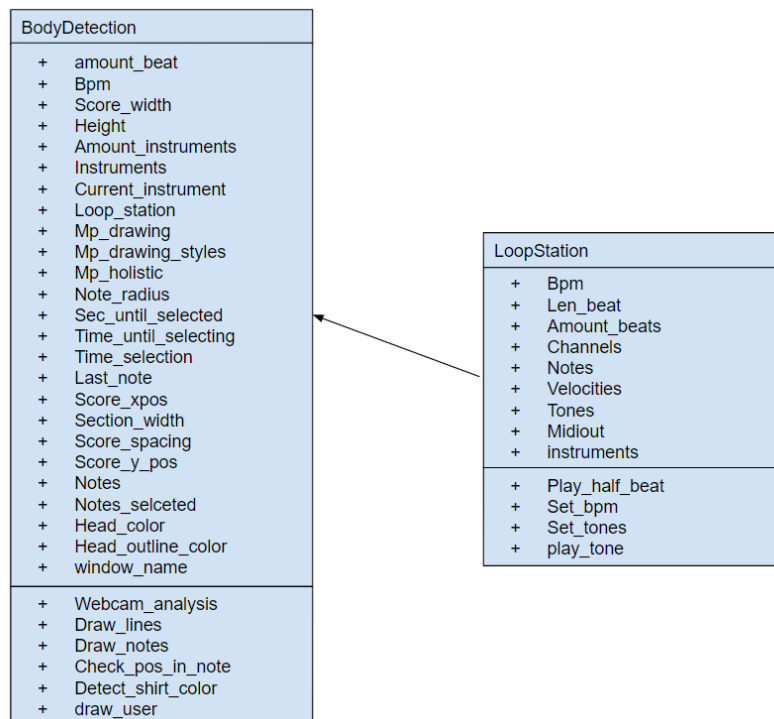


Figure 21 Makerfaire prototype class diagram

Using the laptop keys, one could then change the current instrument and reset the tracks. Additionally, the BPM could be increased or decreased and a base drum track could be played.

This prototype was located in an indoor studio with other installations at the Festival and a researcher was present the whole time to explain the interaction and control the music through the control keys on the laptop.

#### 4.4.2. User Scenario

When a user walks in front of the camera, their face is detected and a circle in the colour of their shirt is drawn around their face. If the face is over the position of a possible note, a grey circle appears on the position of that note. If the face stays at that same position for a short amount of time, a yellow ellipse appears that shows the time it takes to log in the note. Once the note is logged in, it appears as a filled-out circle in the colour of the user's shirt. A time line runs through on an 8-beat count and when it crosses a note, the note is played. When the instruments change, the notes of the previous track are shown with a lower opacity and the music of all tracks is layered.

#### 4.4.3. Limitations

Even though this prototype was already a large improvement from the first, some limitations were still present. For one, only one person could be detected at once and if multiple people were standing in front of the camera, it would switch between their faces back and forth. Also, the controls still could be improved and a screen would have worked better in the lighting conditions than the projector. Additionally, the program started to slow down sometimes resulting in the music not being on the beat at times.

#### 4.5. Conclusion

Throughout the process of ideation, multiple prototypes were developed based on client interviews and brainstorming sessions. These prototypes were then either informally tested or tested in a formal experiment. This process with multiple iterations was very beneficial for this project as it was helpful to work out the specific user experience and narrative the installation should aim to create. Additionally, the early test with possible technologies made later developments easier and quicker. Especially the testing of the first full prototype at the Maker Festival resulted in many helpful findings that will aid the final product. It showed that the Setup can stay similar to the last prototype as the users understood well how to interact with the installation. However, the type of interaction needs to be adapted to the final context and made more direct. The delay before locking in the note that was implemented in the Maker faire prototype was good for the context as it allowed for more control on the side of the user. However, for the final installation, the interaction should be quicker and the interaction type should allow the users to simply walk through the installation without having to wait for a note to log in. Additionally, the testing showed that multi-person interaction is needed especially for



festivals. Most users were expecting to be able to interact as a group and wanted to work together to create a music track. For the final product, this is important to know as music festivals are a social environment and people will also try and interact with the installation as groups. Additionally, the testing showed that using a projector is problematic because of the lightning conditions. As the final setup needs to have good visibility to attract visitors and be readable in festival conditions, a screen should be used instead of a projector. Finally, the last prototype showed that the music needs improvement. It should be easier for the user to create good-sounding music without having any prior music knowledge. Additionally, the music track should be longer to not sound so repetitive. To conclude, going through multiple rounds of prototyping and testing was very beneficial for this project and a good strategy for the Ideation phase.

## Chapter 5: Specification

Based on the findings from the Background research and the Ideation, the Specification for the final product has been developed. These will be divided into the setup at festivals, the desired user experience and the music. Finally, the technical and design requirements will be listed based on priority.

### 5.1. Setup

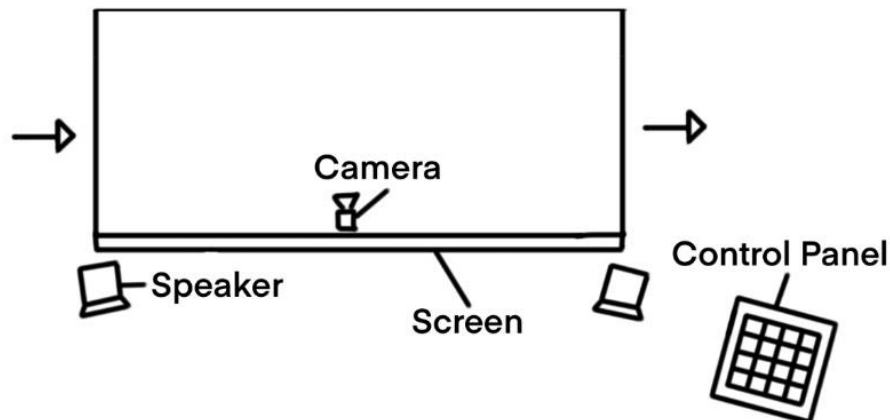


Figure 22 Top view of installation setup

The final setup will be situated outdoors at music festivals and will consist of the following components. The main installation will be a tunnel that has a screen connected to the front of it. A screen has been selected over a projector as it works better in varying lighting conditions and thus creates more readable visualisations also in brighter light. Inside the tunnel will be a wide-angle camera that captures all user movement and appearance as they walk through the tunnel. Additionally, loudspeakers are needed to play the music. Next to the tunnel, a control panel will be placed with which the actors can control the installation and the music.

### 5.2. User Experience

The installation will be situated at a public spot on the music festival grounds to allow people to walk by and a crowd to form. The actors will then pick festival visitors from the crowd. They will then walk through the tunnel and turned into a music track. Before placing music notes with their head, the user is “scanned” by the installation. Before they walk through the music score, the actors pick the

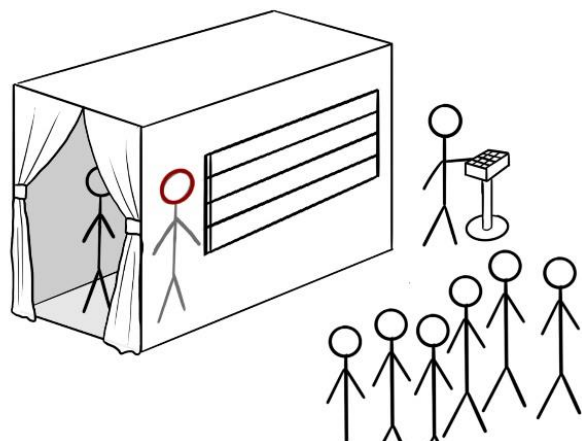


Figure 23 Installation setup with visitors walking through the tunnel

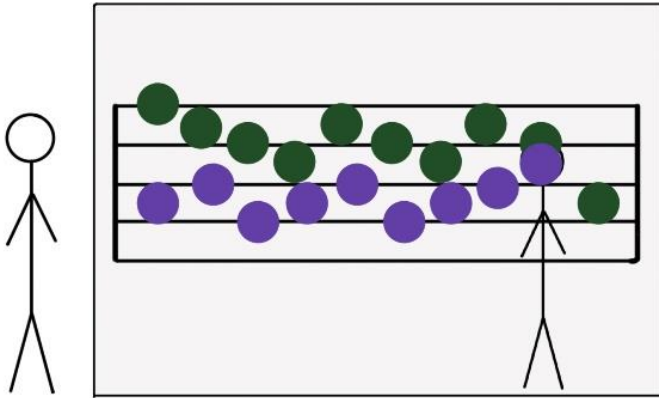


Figure 24 Installation screen visualization

instrument, the sound of the instrument and what colour the notes will be. Then the user will be asked to walk through the tunnel and create their music track. By changing the position of their head, the user can compose their own music track and decide what tones are played. Here, only one note can be played per beat to not overcrowd the music track.

The music tracks from different visitors are layered and played simultaneously to create a complete song. Multiple visitors can walk through the tunnel at the same time to create multiple tracks simultaneously. The screen displays visualisations that show the music tracks from all visitors that are currently played. This way, the audience can try and figure out why the specific music track resulted from the users. Additionally, a time bar will run through the music score to show what beat is currently played.

### 5.3. Music

The music of the final installation will be an improvement of the last prototype to better the overall sound of the music by taking some control away from the user. A base track will be prepared that plays throughout the whole time to make it more cohesive. The users can then create up to three tracks that are layered on top of the base track. These three tracks are for the drums, melody and bass. For each track, a base framework will be prepared. Based on this framework, the user can then create the track through their user input and their appearance. For the drum track, the drum pattern should be pre-determined. The user can then influence the sound of the drum pattern with their appearance and their user-input. The notes, the user selects, determine the volume of lower and higher drums. High notes, therefore, lead to louder hi-hats and lower notes lead to louder kicks. For the bass and melody track, the length of the notes, or rhythm, and which notes can be played is predetermined. The user input then determines the pitch of the notes that are played. For all tracks, the actors should be able to change the sound of the tracks based on the user's appearance.

Additionally, the track length should be long enough to not create very repetitive-sounding music. Thus, the track should be more than 8 beats long. The music should also be created in a way that allows external artists to change the sound of the tracks to adapt them to their specific context. This means that the music should be solely created in Ableton.

## 5.4. Requirements

### 5.4.1. Must have

| <b>Technical Requirements</b>             | <b>Design Requirements</b>  |
|---|---|
| Visual element                            | Allow actors to interact with users and control experience (4.3.) |
| Outdoor durability (4.1.)                 | Address the topic of diversity at music festivals                 |
| Create music that changes with user input | React on user interactions  |
| Control unit for the actors (4.3.)        |   |
| Sense user interactions                   |   |

### 5.4.2. Should have

| <b>Technical Requirements</b>     | <b>Design Requirements</b>            |
|-----------------------------------|---------------------------------------|
| Video controlled                  | Visual feedback for user interactions |
| Set-up time of max 2 hours (4.1.) | Intuitive interactions                |
| Screen of 3 by 5 meter (4.3.)     | Short learning curve                  |

### 5.4.3. Could have

| <b>Technical Requirements</b>        | <b>Design Requirements</b>                                  |
|--------------------------------------|---|
| Not recognize actors as input (4.3.) | Music that can be adapted to specific music festival (4.3.) |
|                                      | Allow different music playing options (linear, loop) (4.3.) |
|                                      | Different rhythm/ music for different cultures (4.3.)       |

### 5.4.4. Won't have

| <b>Technical Requirements</b> | <b>Design Requirements</b>                          |
|-------------------------------|---|
|                               | Solely rely on music changes without visualizations |

## Chapter 6: Realisation

Based on the specifications, the final product was created focusing mainly on the software. A python programme was developed that uses human detection, creates a visualization with OpenCV and communicates to Ableton. The music was created in Ableton and can be adapted to different contexts independently from the python script. This final installation implements internal discrimination as an optional feature as the evaluation of the previous prototype showed that analysing colours through the camera image is not exact and very dependent on the lightening conditions. Therefore, it is advised to let the actors control the mirrored discrimination and make it part of the show. For this, the final product adds the option to change the sound of the individual tracks and add audio effects. Thus, the actors can then adapt the music for specific users.

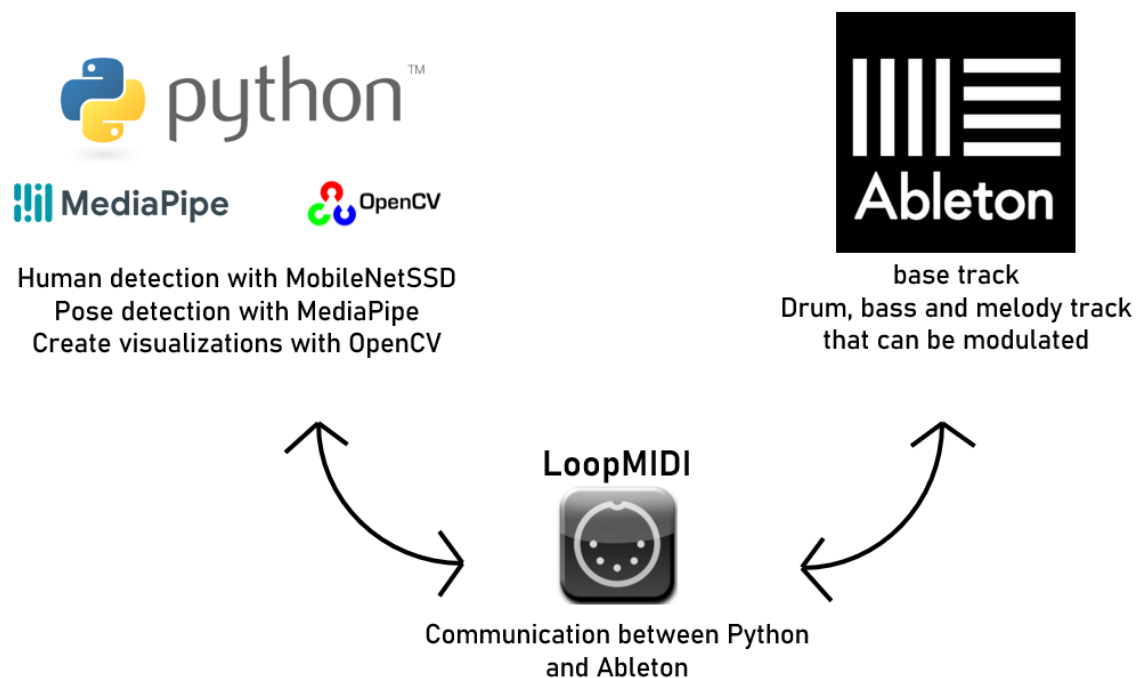


Figure 25 Interplay between programs

## 6.1. Python Program

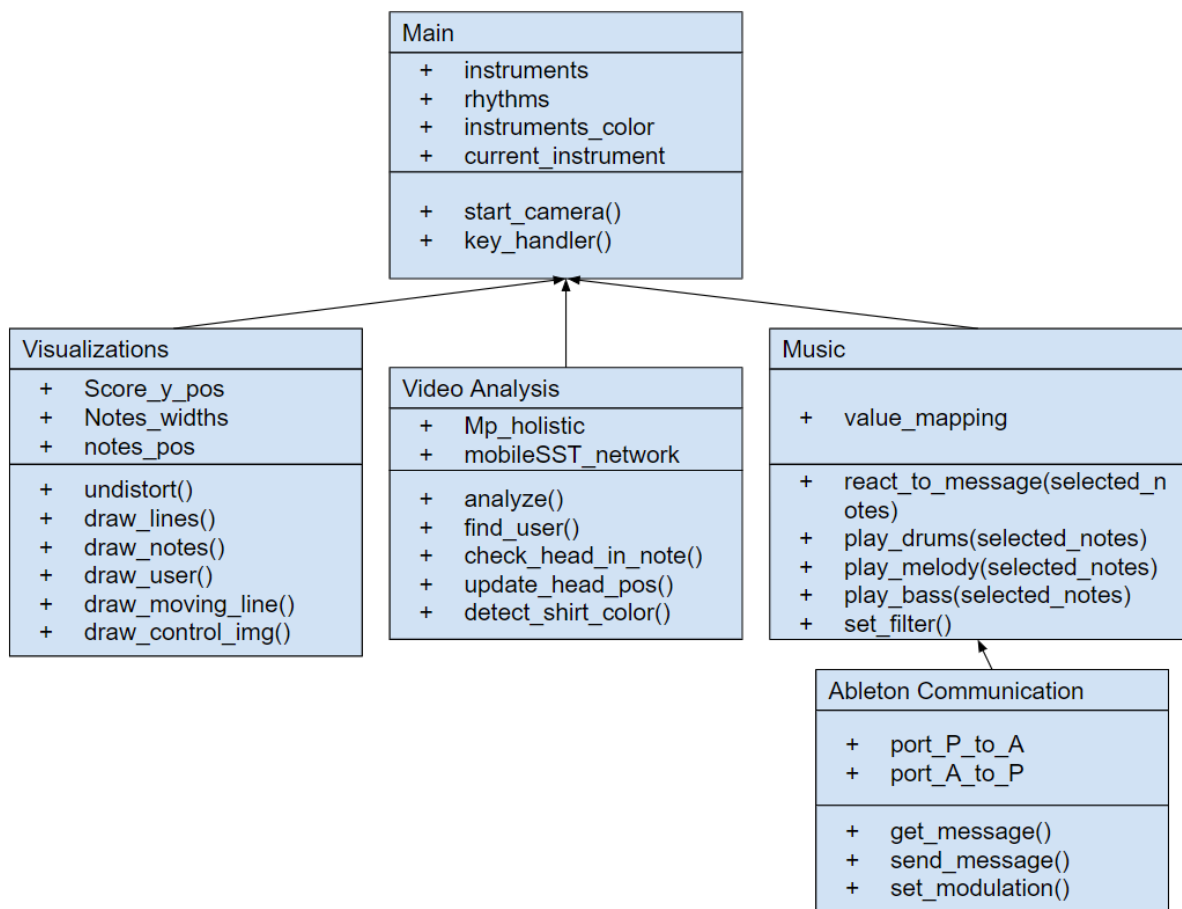


Figure 26 class diagram (only includes most important values for better readability, the full class diagram can be found in the appendix)

The python program was divided into five different classes. The tasks are divided into visualization, video analysis, music, Ableton Communication and the main class, which combines all previous classes.

### 6.1.1. Main class

In the main class, one can set the dimensions of the score and the colour the notes for each instrument should have. Additionally, one must input the rhythm for each instrument, meaning what note lengths the predetermined tracks for each instrument have in Ableton. This is used to be able to update the pitch or volume of the individual tracks depending on when a new note starts and to create fitting visualizations for each instrument. One can also decide, whether the user's appearance should be analysed and the shirt colour should be visualized on the screen. In the main function "start-camera()", the program then reads the camera images and calls the other classes to analyse the image and create the corresponding visualizations. Here, the video analysis is only called on every second frame to improve the performance of the overall program. For frames where the image is not analysed, the previous

values for head position and size are used in the visualization. At the end of each run-through, the music object is called to check if values, like the pitch or volume, of the currently playing tracks need to be updated. Additionally, the main class also handles the control key input. As a placeholder for the final control panel, the keyboard keys are used to control which instrument is played and how the instruments sound. With keys 1-3, the instrument can be changed, keys 4-6 change the colour and sound of the instrument and keys 7-9 can reset the individual tracks of each instrument.

### 6.1.2. Video analysis

The Video analysis is done similarly to the last prototype using MediaPipe. However, to accommodate multi-user interactions, first individual people are detected using mobileNetSSD. For each detected person, the program then analysed the body positions using MediaPipe.

MobileNetSSD [34] is a Single Shot Multibox Detector that can detect multiple objects in one image. Unlike alternative programs, mobileNetSSD is optimized for mobile devices and therefore has better performance and quicker reaction time. First, a pre-trained neural network is loaded. With the neural network users are then detected and it is determined where the users are inside the frame. Then it crops individual images out of the main frame for each user that can then be analysed in the next step with the MediaPipe Library.

MediaPipe [32] is a Machine Learning library by Google that is optimized for mobile devices and therefore is more lightweight than its alternatives. This project uses the Pose landmark detection from MediaPipe [35] which can detect landmarks on the human body. This Pose analysis is applied to each cropped image of a person on the screen. From these results, the nose position is used as the head position and the head width is calculated from the distance between the ears for the visualization. With the head position, this class can then check if the head is at the position of a possible note. For each instrument, the column and row positions of each possible note are calculated.

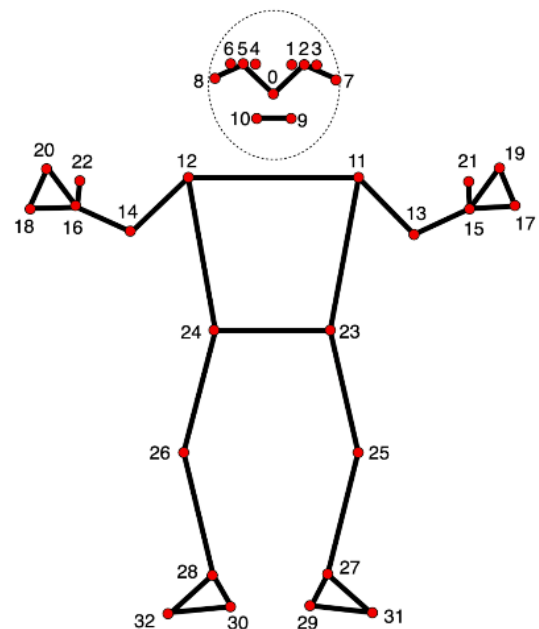


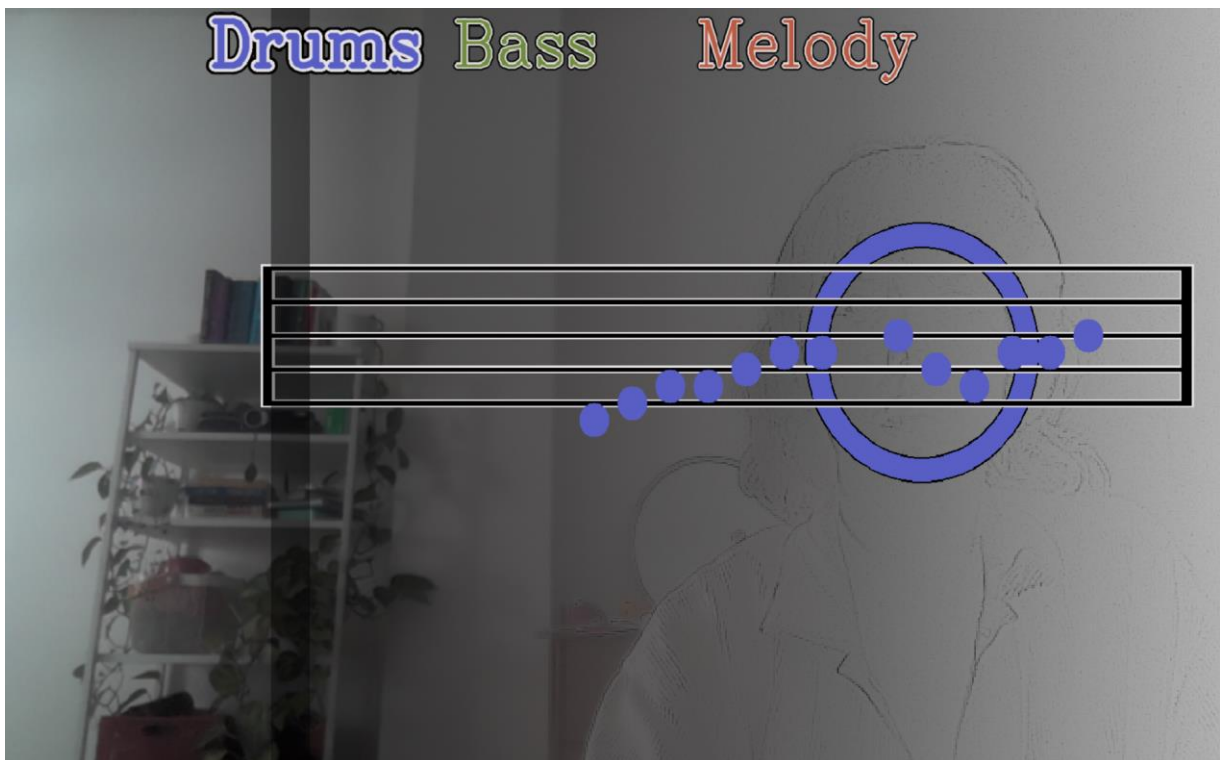
Figure 27 Landmarks of MediaPipe Pose

When the face is on the music score, the script determines in which row and column the face is and thus determines what note is selected on which beat. This information is then saved in a

list of all selected notes for each instrument. For each beat only one note can be selected, meaning when a new note is selected, the note for that specific beat is overwritten.

Additionally, one can analyse for example the shirt colour of the user. For this, the image of the user is cropped down to the upper body. Then the dominant colour of this image is determined [36] and forwarded to then visualization class to visualize the person's shirt colour on the screen. This is however very dependent on the lightning conditions and has been shown to be not very exact in tests.

### 6.1.3. Visualization



*Figure 28 Visualization screen*

The Visualization class adds the music score, the music notes and the user visualization onto the camera image. The music score has a larger margin on one side which leaves space for the user to walk into the installation and be detected before drawing music notes. The notes are drawn in the colour of each instrument and show which notes are currently selected. For the user, a circle is drawn around their face in the colour of the instrument they are currently creating the track for. Additionally, a convolution filter is added onto the background in a gradient to create the feeling that the user disappears into the installation the further they walk into it. The text at the top of the screen shows the possible instruments in their specific colour. The instrument that is written in bold font is the currently selected instrument.



| on/off | change | reset |               |
|--------|--------|-------|---------------|
| 1      | 4      | 7     | <b>Drums</b>  |
| 2      | 5      | 8     | <b>Bass</b>   |
| 3      | 6      | 9     | <b>Melody</b> |

*Figure 29 information panel*

Additionally, the visualization class creates an information panel that shows an overview of the possible keyboard inputs. Here the actors have the possibility to switch between the different tracks, change the colour and sound of each instrument and reset the track of each instrument.

#### 6.1.4. Ableton communication

The Ableton communication class opens two ports. The first port is for sending messages to Ableton and the second is for receiving messages from Ableton. Additionally, this class has 2 functions to receive and send MIDI messages through these ports. These messages are made up of information on the message type, the channel, and two values. Lastly, this class has a function with which MIDI values in Ableton can be mapped to specific channels which is explained more under “Python-Ableton communication”.

#### 6.1.5. Music

The music class uses the sending and receiving functions from the Ableton communication class to send out the correct MIDI message for the current beat. For this, the correct mapping between the note positions and the MIDI message values is set for each instrument. Then for each beat, the script gets the selected notes for each instrument and sends the corresponding MIDI messages. If a note is selected, the value for pitch or volume is sent and if not, the instrument is turned off. Additionally, audio filters can be turned off when the actor wants to change the look and sound of an instrument.

## 6.2. Ableton



Figure 30 Ableton set

The Ableton set consists of the melody track, the bass track, and the drum track, which is divided into low and high drums and the background track. All tracks are written in F minor and have a techno sound. The melody is a simple wavetable with 8<sup>th</sup> notes. The bass track is made with the Basic FM house Bass pre-set of Ableton with 16<sup>th</sup> notes where the pitch can be changed every second note. The low drums are a mix of kicks and claps and the high drums are made with high hats. The background track is made up of a drum track with cabasa sounds, organ chords and a simple low wavetable track.

## 6.3. Ableton- Python communication

For the communication between Ableton and Python, two MIDI ports were created using LoopMIDI [33]. The first port is for messages from Ableton to Python and the second is for messages from Python to Ableton. To be able to receive and sent MIDI messages, the Python library rtmidi [37] is used.

| My loopback MIDI ports |            |                   |
|------------------------|------------|-------------------|
| Name                   | Total data | Throughput / sec. |
| loopMIDI Port A to P   | 0          | 0 Byte            |
| loopMIDI Port P to A   | 0          | 0 Byte            |

Figure 31 LoopMIDI ports overview

### 6.3.1. Port overview

For each port, messages can be sent on 16 different channels. To keep messages for different purposes separated, the following port division was implemented:

|   |                                     |
|---|-------------------------------------|
| 0 | Melody notes from Python to Ableton |
|---|-------------------------------------|

|    |  |
|----|--|
| 1  | Bass notes from Python to Ableton                  |
| 2  | Low drums volume values from Python to Ableton     |
| 3  | High drums volume values from Python to Ableton    |
| 4  | Turn melody on/off from Python to Ableton          |
| 5  | Turn bass on/off from Python to Ableton            |
| 6  | Drums audio effects on/off from Python to Ableton  |
| 7  | Bass audio effects on/off from Python to Ableton   |
| 8  | Melody audio effects on/off from Python to Ableton |
| 15 | Rhythm from Ableton to Python                      |

### 6.3.2. Ableton to Python

To keep the instrument changes that are sent from the python script on the beat, a tempo track has been created in Ableton that sends information on when a new beat has started.



Figure 32 Tempo track

The pitch of the notes on this track tells the Python script what beat is currently played so that the instruments can be changed accordingly. Meaning, whenever the python script received a message from this track that a note is turned on or off, the instrument's pitch or volume is changed depending on what notes the user has selected for that specific beat. These messages are sent on the Ableton to Python port on channel 15 and are received by the Midilin port in the python script.

### 6.3.3. Python to Ableton

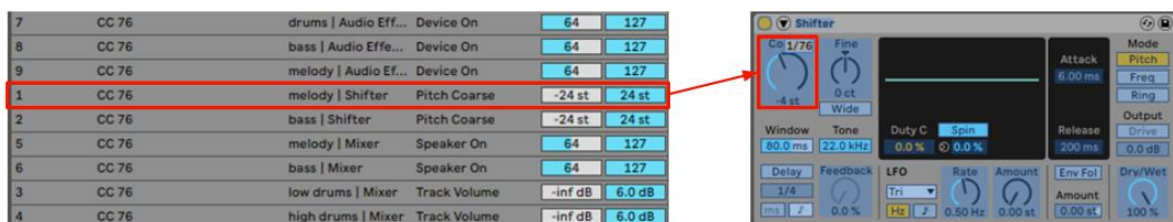


Figure 33 MIDI mapping

The message from Python to Ableton changes the pitch and volume of the instruments, turn the tracks on and off and turns audio effects on and off. This is done via MIDI mapping. The individual values in Ableton are mapped to specific MIDI values and channels which can then be changed by MIDI messages from the Python script. For the bass and melody track, a pitch shifter was mapped and for the drums, the volume of the low and high drum track was mapped

to a MIDI value. For all three tracks, the on/off button and audio effects were also mapped individually to a channel.

## Chapter 7: Evaluation

### 7.1. Evaluation of the Maker Festival Installation

To test the first full prototype, an initial research experiment was conducted at the Maker Festival 6.-7. May 2022 from 13 to 16 o'clock at XPO, Stroinksbleekweg, Enschede. The goal of this research experiment was to test out the interactions and usability of the prototype and answer the following research questions:

RQ1: Is it necessary for multiple users to be able to interact with the installation at the same time?

RQ2: How long should one track be?

#### 7.1.2. Participants

The participants consisted of the visitors to the Maker Festival in Enschede. All ages were included however the majority consisted of children under 12 years. As vulnerable participants were part of the experiments, attention was paid to having the parents or other guardians present. Additionally, the participants could decide freely if they wanted to interact with the installation and for how long.

#### 7.1.3. Procedure

The installation was set up indoors in a studio at the Maker Festival. Additionally, to the components mentioned in Chapter 4, a white backdrop was set up to increase the visibility of the projected program. In the studio, multiple installations were displayed and the participants were free to walk around and choose what they want to interact with. The researcher was present the whole time to explain the installation and its



*Figure 34 Setup at Maker Festival*

purpose, help when problems or questions arise and control the music through the control unit. The participants were observed throughout the whole experiment but were not asked questions or needed to fill out a survey.

#### 7.1.4. Findings

The following observations were made during the interaction between users and installation. Firstly, to answer the first research question, many participants wanted to interact with the installation with multiple people at a time. After explaining that the installation could only detect one face at a time, most participants understood to interact with it one after another. However, the first intuition for many was to place notes together and stand in front of the camera with multiple people.

Regarding the general usability, most participants understood the interactions. However, for younger children, it was harder to stand in one place for a longer period of time to place a note on the music score. They either wanted to dance and jump around or once they were told to stand still, they did not move at all anymore. Older participants were observed to try and plan what notes they want to select to create a melody.



Figure 35 user interaction at maker festival

Because of that, they also wanted to delete notes or redo the track, of which only redoing was possible with the current installation.

Regarding the second research question, an 8-beat track seemed optimal for the specific situation as it did not leave too many notes to select. However, this short track became repetitive quickly. When the track length was increased to 12 beats, it already sounded less repetitive but especially younger children were overwhelmed with the amount of notes that could be selected. Additionally, the music was still very simple and the notes were directly mapped to notes played in the selected instrument. This way it was harder to create good-sounding music as the participants had a lot of control over the created tracks. Considerations could be made on the prepared music and base tracks.

The technical setup worked well enough for the context. However, it was observed that the camera was very sensitive to changes in the lighting which sometimes made the visualizations less clear. Also, the detection of the shirt colour was not very exact and changed depending on the lights and where the participant was standing.

To conclude, the research experiment brought a lot of helpful findings and possible improvements to the prototype. Mainly, the interactions need to be reconsidered, the environmental conditions need to be controlled more and the music needs to be improved.

## 7.2. Final prototype evaluation

To test the final product, hallway testing was set up on June 20<sup>th</sup> 2023 from 10 to 15 o'clock. The goal of this evaluation was to observe people interacting with the installation to determine whether the interaction is understood and to observe the user experience. Resulting from the earlier background research, a design factor of interactive music installation was if the installation is used like an instrument or rather serves as an experience. So, to classify the final installation, an open question was also asked concerning this differentiation. Additionally, questions were asked to clarify the thought process the user has while interacting, determine the level of planning people have for the created music and the amount of perceived control. The last factor of control is especially important for later uses of the installation as the artist wants to play with the perceived control the algorithm of the installation should have on the user. Here, a baseline is set through this evaluation as the current installation does not change the music for each individual user, meaning more control is on the side of the user. Thus, the research questions that were addressed in this evaluation were the following:

RQ1: How do the users plan the music track they are creating?

RQ2: Do the users experience the installation as an instrument or as an experience?

RQ3: Who do the users perceive to have control over the outcome?

### 7.2.1. Participants

The participants were university students and employees. One exclusion criterion was the age as only participants above 18 years were included. Additionally, only participants that could consent for themselves were asked to participate. The participants were free to choose when to participate and could end the evaluation at any time. As the installation was displayed in a public space, the participants were found by asking people that are walking by whether they want to participate. In total, 18 participants took part in the study.



### 7.2.2. Procedure

The installation was set up in the hallway of the Designlab at the University of Twente Campus. The setup consisted of a large screen, a camera and a laptop. In the beginning, the installation was set up so that the user would walk in front of the screen similar to the Maker faire prototype. This however led to people walking by being detected and



Figure 37 second setup from the back



Figure 36 second setup from the front

interfering with the installation. Thus, the setup was changed so that the users would walk behind the screen and spectators could see the visualizations from the front closer to the final planned setup using a tunnel. However, the user could still see themselves on a smaller screen behind the main screen.

Each user test took about 10 minutes. It started with a short briefing where the context of the evaluation was explained. Then, the participants were asked to read the information letter and fill out the consent form. Additionally, possible questions were answered. Then, the participants were asked to interact with the installation alone or in small groups while the researcher observed. If consent was given, photos were taken of the interaction. Finally, the following open questions were asked about the interaction:

- What was your thought process while interacting with the installation?
- How did you plan the music track you were creating?
- How did previous or following music tracks/ people interacting influence your interaction/ planning?
- Did the installation feel like an instrument or like an experience?
- How much control do you think you had throughout interacting with the installation?
- Who do you think has the final say on how the music sounds? The designer, the Installation or the participant?

### 7.2.3. Findings

To analyse the findings of the evaluations, the answers to the open questions were analysed and similarities were identified. Additionally, interesting and outstanding answers were



searched for. Finally, the observations were analysed especially for tests with multiple participants as they are closer to the final user experience.

#### *User experience and music planning*

To answer the first research question, the participants were asked about their thought process regarding interacting with the installation and if and how they are planning the music tracks they are creating. Concerning the thought process, some participants stated that they had no specific thoughts. They were curious about how it worked and were just trying to figure out the interaction. Here, participants stated that they tried to plan their interaction more after they had tried it out once as they were then more secure in how it works. One participant also stated that it helped them to first watch someone else interact so that they then knew how it works. Also, a differentiation arose between participants that had music knowledge and participants that did not. For participants that did not have any music knowledge, the interactions needed more guidance and the participants were interacting less deliberately, focussing more on making smooth lines rather than a good music track. Participants with music knowledge did not need much explanation, recognized the visualization and were thinking more deliberately about what music track they are creating. Some participants were also irritated that their faces is always detected and they, therefore, could not choose when a note is played. They also noted that it is hard to make the music they wanted to make and that the interaction is not precise enough. Finally, some participants said that they felt like they had the wrong height for the installation and could not reach all of the notes.

Concerning the question of how they planned the music track they are creating, many said that they did not have a plan and were placing the notes randomly. Many participants also stated that they focussed on dividing the notes equally between high and low and making patterns. Some participants said that they focussed more on their movement than on the music and were trying to dance to create their tracks. Participants with music knowledge often stated that were trying to plan out the individual tracks but did not always succeed. They wanted for example to create a good rhythm with the drums, keep the bass in the background and create an interesting melody by showing the range of notes. Here, only a few participants were taking into account the previous or following music tracks when creating their music tracks. These were then trying to match them up or not make the same shape for all tracks. One person also tried to match the drum and bass track and have the melody track opposite that.

#### *Differentiation between instrument and experience*

When asked if the installation feels like an instrument or like an experience, almost all participants said that it felt like an experience. Only one person said it was like an instrument because it was a tool to create something. The other participants reasoned that as they did

not have control over the individual instruments and did not choose when which track is selected, it cannot be an instrument. They felt like they would need more control for it to feel like an instrument. One participant compared it to splashing paint on a canvas instead of taking a brush to paint which would be the metaphor for an instrument. Multiple participants also stated that they were lacking the physical aspect an instrument normally has and controlling it solely with their movement and body feels more like an experience.

### *Perceived Control*

Concerning the amount of control the participants felt like they had, most participants said that they had limited control and would rank it as a 4-6 on a 10-point scale. They noted that with more practice the control would increase as the interaction was a bit unclear in the beginning. They also said that they would want to be able to decide when notes are placed to have more control. People with more music knowledge also said that they would want more options of control other than pitch like for example being able to place multiple notes on one beat or change the sound of the instrument. When asked whom they feel has the most control over the music between the designer, the installation and the participant themselves, the answers were mixed. Some said the designer has a lot of control because they chose the sound for the different tracks and chose which instruments can be played. Many participants said that the installation had a lot of control because the sound comes from the installation and the user only can pick the notes. Also, participants felt like the algorithm of the installation could pick what each note represents and therefore has control over it. Participants that said that they themselves had the final say on how the music sounds, reasoned that they would be no music without them and three tracks are enough to create a unique music track. Some participants also said that because they could change a track and improve it, they have already created, they had more control over it.

### *Observations*

Finally, observations of the interaction gave more insight. Participants were trying out a lot of different movements to place the notes. They were jumping, or switching between walking slow and fast. Here, the delay in the system became more apparent as the users were not detected when they moved too fast. They were also trying to place notes below and above the score which the system does not support. A distinction could also be made between participants that were looking at the screen and participants that were looking in their walking direction. When the participant was looking at the screen, they were planning their interaction more and had more variance between the note heights. When the participant was looking in the direction they were walking, they were often creating more linear tracks. When multiple people interacted with the installation at the same time, it could be observed that they were deciding together who should be on which track and were trying to make tracks that fit together.



*Figure 38 A group of people interacting with the installation*

### *Conclusion*

Thus, to answer the first research question, the way people plan their interaction depends on their prior music knowledge and the amount of planning changes when they have tried it out a few times or have seen other people use it. People often concentrate more on the visualization and try to make nice patterns instead of imagining the music that is created. Regarding the second research question, almost all participants said that the installation feels like an experience which is in line with the goal of the product as it is meant as an artistic installation. The reasons people stated were, that they did not have enough control for it to be an installation. Additionally, many participants said that the physical aspect of an instrument is missing and using movement as the input fits more to an experience. Lastly, participants mostly agreed that they had limited control because for one the interaction was not very precise and because they could not choose when notes would be placed. However, participants disagreed on who has the final say on how the music sounds. Here, some participants felt like they had control, because there would be no music without them and they

have enough freedom to create a unique music track. Other participants felt like the music was too predetermined from the designer or the installation and for them to feel more control, they would want to choose the instruments.

## Chapter 8: Discussion & Future Work

The main research problem of this project is to create an interactive music installation that uses the user's movement and appearance and turns it into music. As the final setting is supposed to be music festivals, the requirements for this context like outdoor durability and easy usability need to be thought of. The goal of this installation is to raise awareness of the problem of discrimination at music festivals.

The evaluation and background research show that using face detection as the main user input works well and leads to a short learning curve. However, as the visualizations are close to music notations, users with no prior music knowledge had a harder time figuring out the interaction. Thus, the visualizations might need to be improved or the amount of instructions need to vary depending on the user. The visualizations are different from most other installations mentioned in the background research which used more abstract visualizations. This therefore shows a different approach for the visualizations of interactive music installations which increases the feeling of control the users have when they recognize the visualizations. Another comparison to other installations that can be made is how it deals with interpersonal interactions. The evaluation supports that when a group of people interacts with the installation, they work together and make group decisions on how they want to create the music. However, this is more indirect compared to installations where the interpersonal interaction is directly mapped and turned into music.

Additionally, it is important to note that this project mainly focusses on the software part of the installation, meaning the final setup with a tunnel has not been tested yet because of the time constraint. Also, technical limitations were encountered when using the human detection algorithms which have led to delays in the program. Thus, either better hardware or different detection algorithms should be used when continuing this project.

### 8.1. Limitations

During the process of this project and the evaluations, limitations have been encountered that need to be mentioned. Firstly, it was not possible to test the installation in its final setting, namely a music festival. Because of this, one can only try to derive from the results from the evaluation of how the installation would work at music festivals. The hallway testing already shows that the installation makes people curious and works well when a group of people interact and observe it. Additionally, the hallway testing highlights that the tunnel design is beneficial as otherwise, people in the background would interfere significantly with the interactions. However, the specific conditions of a music festival regarding, for example, the lighting, the background noise or overall festival culture could not be replicated in the

evaluation. Also, the group of participants in the evaluation are not representative of music festival visitors as they consisted mainly of university students.

Another drawback of the evaluation is that it was not tested with the actors of the artist that would create a show around the installation. Working with actors would influence the user experience and engagement. Additionally, the actors would also make it possible to address the topic of discrimination at music festivals as they would control the type of music each user can make. With this arises another limitation as the topic of discrimination has not been addressed yet sufficiently through the installation. Technical limitations have shown that implementing the detection of user appearances in the software is not feasible as it is very inconsistent and dependent on lighting conditions.

## 8.2. Future Research

Even though throughout the scope of this project many aspects have been explored and evaluated, more future research is needed to further develop this installation. For one, the user experience needs to be worked out and evaluated including actors that create a show around the installation. For this, it also needs to be evaluated how the topic of discrimination at music festivals is best addressed and made part of the show. Additionally, the current installation needs to be improved for the outdoor setting of music festivals and different technologies need to be tested to find the best options for these outdoor conditions. The current research already showed that a screen works well in the context, however, the setup has not yet included the tunnel the users are supposed to walk through. Another aspect that should be improved is the music. As the music is kept separate from the rest of the software, adapting it to specific contexts is easy and allows for someone with more music knowledge to come in and develop music for the installation. Here, testing is needed to figure out what mappings between user input and music are best. Finally, the visualizations could be improved and built upon by, for example, including an animation of the user being turned into a music note to improve the understanding of how the interaction works.

## Chapter 9: Conclusion

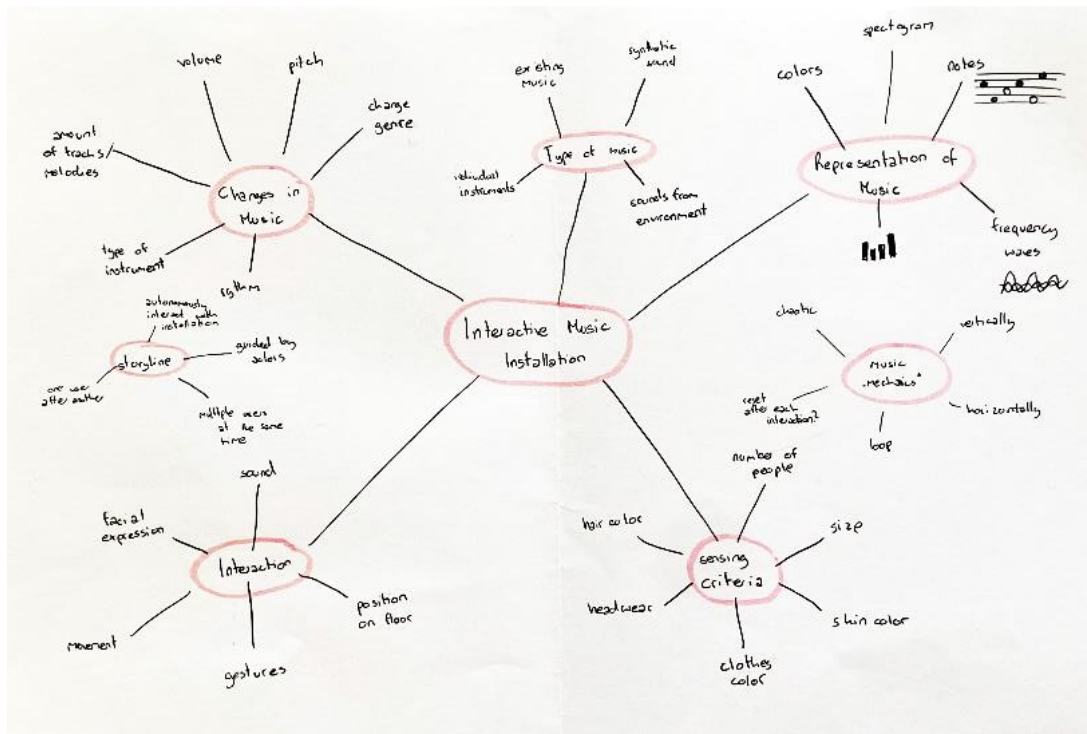
The starting point of this project was the idea of the artist André Kodde to create a video-controlled music composition tool for music festivals that touches upon the topic of discrimination at music festivals. This idea was developed into an interactive music installation that uses face detection as the main user input. Literature research and research on related work was then done to get insight into the typical user interaction types, visual feedback, music mapping, and technology used in existing interactive music installation to answer the sub-research questions. Additionally, background research was done about the context of music festivals, the problem of discrimination at music festivals, biases in AI recognition technology and the artist.

According to the design process for Creative Technology, the project was then moved into the ideation phase with a strong emphasis on creating multiple prototypes to determine the suitable technology and user interaction. Additionally, stakeholder interviews and brainstorming sessions were held to work out the final plan for the installation. In total, two prototypes and the final installation were developed. The second prototype and the final installation were evaluated at the Maker Festival and in a hallway testing setup. The final installation consisted of a screen, a camera that detects the user's position and movement and music that is created in Ableton. The user can create three different tracks by placing notes with their face on a music score. The final idea is that the actors of the artist create a show around the installation and with that address the topic of discrimination in music festivals by controlling what type of music each user can create.

The evaluation showed that the installation engages visitors to create music themselves with their bodies with a short/steep learning curve which was the main goal of this project. When groups interact with the installation, the visualizations and different types of tracks invite people to work together and create a music track together. An interesting result from the evaluation was the differentiation between if the users perceive the installation as an instrument or an experience. Almost all participants categorized it as an experience based on the amount of control they felt like they had, the lack of physical feedback or because they are using movement as input. This distinction can be especially helpful when developing the user experience of this installation or other music installations.

Finally, based on the findings, the product of this project can in future be used and improved by the artist to create a show around it and raise awareness on the topic of the lack of diversity at music festivals which was the main research question of this project.

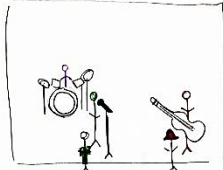
# Appendix



Appendix 1 Mind-map that was prepared for the brainstorming session



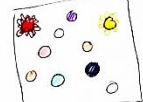
→ move infant of instrument to make music



→ can only use instrument when you have specific hair color / clothes color

clothes


→ dots correspond to music tracks



→ can only be activated by someone that has clothes in that color

body height

→ can only play all instruments when there are people with different height




→ head movement is turned into music waves

→ different amplitudes = different rhythms / music tracks

→ dots visualization

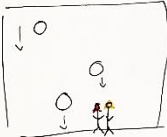
input: gender & skin color



→ can then only access some of the music


→ % corresponds to the position of artists in festival lineup because with same gender & skin color

→ makes "fall" from top



→ can only be activated by 2 people with different hair/skin/clothes color

users are turned into music bars




→ move infant of bars to make music

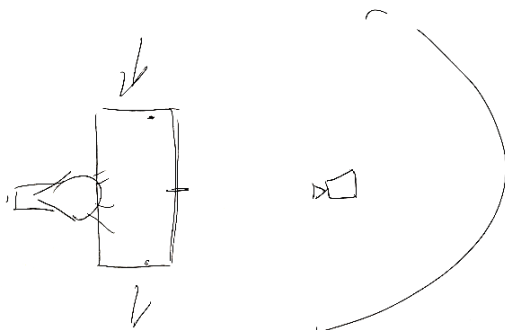
→ men have higher bars → more range to make music

body movement

→ can create more diverse music if the move in very different ways

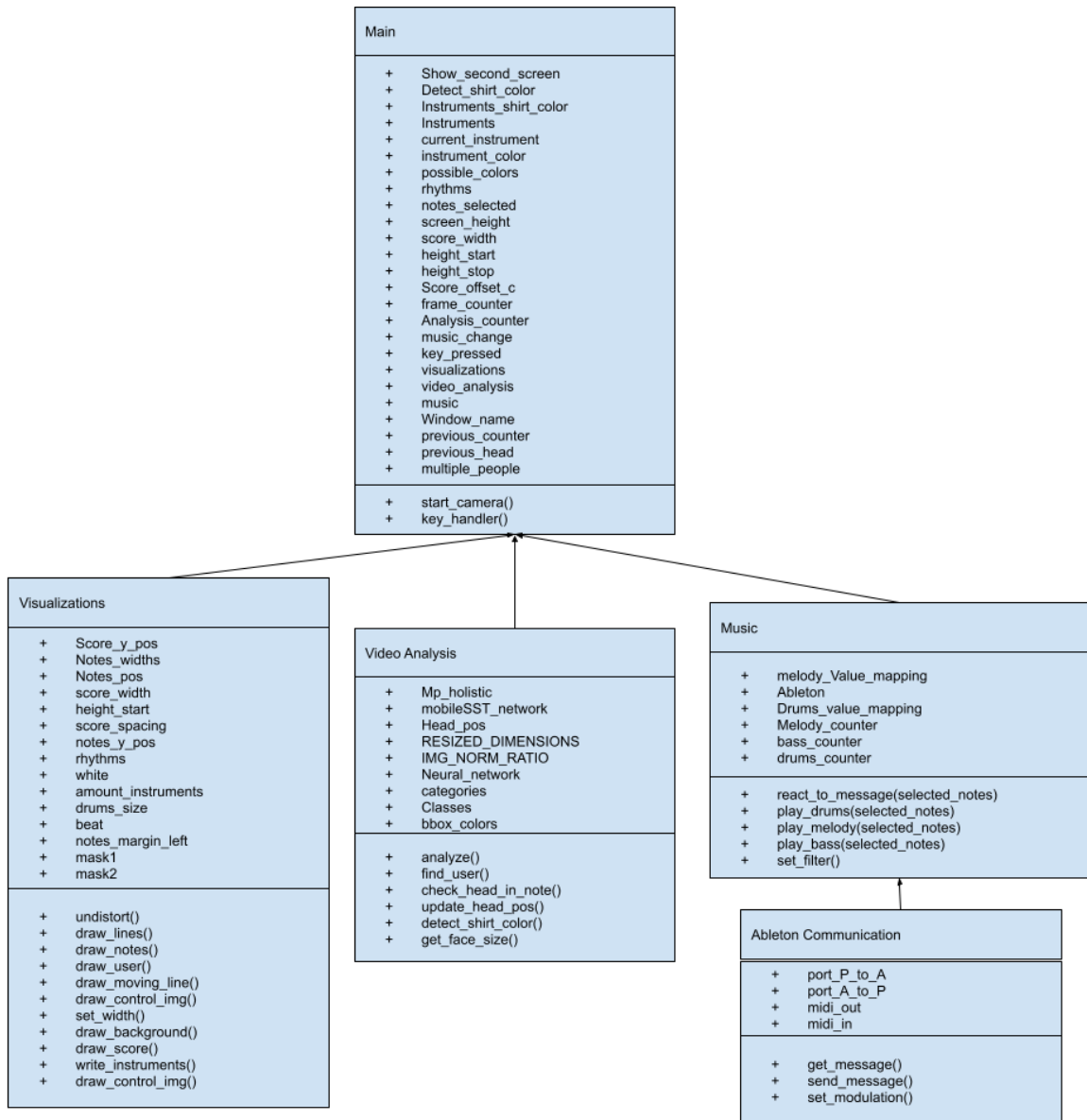


Appendix 2 Installation ideas that were prepared for the brainstorming session



Appendix 3 brainstorm: possible layout 1





Appendix 6 Complete class diagram

## **Information Letter for “Video controlled music composition tool”**

This research is for a Graduation project that has the goal to create an Interactive Music Installation for music festivals. During the session, you will be asked to interact with the installation alone or in small groups.

Some aspects that you should be aware of is that you will be observed by the researcher, ending in a questionnaire. If you feel comfortable with it, photos will be made during the experiment, but it is not a requirement for participating in the experiment. These photos will be used in my Graduation thesis and not published anywhere else.

The research project has been reviewed by the Ethics Committee Information and Computer Science and possible risks are that one feels uncomfortable with the music that is being created by the installation. If this situation occurs, you are free to stop the experiment at any time.

Your participation is and will remain voluntary at all times and you can refuse to continue the research and end your participation at any point during the research. You can also refuse afterwards, within 24 hours, to have your data used for this research by contacting the researcher. The research lasts for a maximum of 30 minutes.

### **Contact of the researcher:**

Camilla Scholz, [c.scholz@student.utwente.nl](mailto:c.scholz@student.utwente.nl)

### **Contact Information for Questions about Your Rights as a Research Participant**

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: [ethicscommittee-CIS@utwente.nl](mailto:ethicscommittee-CIS@utwente.nl)

**Consent Form for Video Controlled Music Composition Tool**  
YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

| <i>Please tick the appropriate boxes</i>   | Yes                      | No                       |
|--|--------------------------|--------------------------|
| <b>Taking part in the study</b>  |                          |                          |
| I have read and understood the study information dated 20.06.23 or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction. | <input type="checkbox"/> | <input type="checkbox"/> |
| I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.         | <input type="checkbox"/> | <input type="checkbox"/> |
| I understand that taking part in the study involves an observed experiment followed by questions.  | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>Use of the information in the study</b>   |                          |                          |
| I understand that information I provide will be used for a Graduation Project.   | <input type="checkbox"/> | <input type="checkbox"/> |
| I understand that personal information collected about me that can identify me, such as my name and possible photographs, will not be shared beyond the study team.                                  | <input type="checkbox"/> | <input type="checkbox"/> |
| I agree that my information can be quoted in research outputs  | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>Consent to be photographed</b>  |                          |                          |
| I agree to be photographed. Note that being photographed is not mandatory for participating in this experiment   | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>Future use and reuse of the information by others</b>   |                          |                          |
| I give permission for the survey and questionnaire answers that I provide to be archived anonymised in the Graduation Thesis repository so it can be used for future research and learning.          | <input type="checkbox"/> | <input type="checkbox"/> |

**Signatures**

|                     |           |      |
|---------------------|-----------|------|
| Name of participant | Signature | Date |
|---------------------|-----------|------|

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

|                 |           |          |
|-----------------|-----------|----------|
| Camilla Scholz  | Signature | 20.06.23 |
| Researcher name |           | Date     |

**Study contact details for further information: Camilla Scholz, c.scholz@student.utwente.nl**

**Contact Information for Questions about Your Rights as a Research Participant**

your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: [ethicscommittee-CIS@utwente.nl](mailto:ethicscommittee-CIS@utwente.nl)

**UNIVERSITY OF TWENTE.**

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