COLOURsound

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Final Year Project Report

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Abstract:

The idea for this project was to construct a software application which uses hardware inputs to allow a user with disabilities to perform music by triggering musical loops using said inputs. The idea came about from a project proposal from Conor Brennan which detailed how Enable Ireland had procured a variety of different pieces of hardware which are aimed at aiding disabled users and he proposed someone do a project using said equipment. The original plan was to incorporate some of this hardware into the project, but this idea had to be abandoned due to Covid-19 restrictions. It is from this point on that the project began to focus on two entirely different inputs that were accessible at home, both of which will be discussed in detail throughout this report.

The report is divided into four stages: research, design, implementation, and the final chapter being testing/results. The project works as intended but possible further work that could be carried out could be the construction of a hardware controller/controllers that integrate into the application and a larger feature set with more possibilities for creativity, like a synth that can be controlled via the hardware inputs.

Acknowledgements:

I would like to thank both my project supervisors for the year, Shane Byrne, and Conor Brennan. They always set me down the right path and made achieving my goal for the project a reality. Without this continuous support throughout the year the construction of this project would not have been possible, and I would like to thank them both for their input and their time throughout this difficult year.

Paul Comiskeys input and encouragement throughout the year helped tremendously and it was always nice to hear that he had a genuine interest and shared with me excellent feedback that was taken on board to further improve ColourSound.

IADT as a college and the numerous lecturers I have encountered throughout my four years have all helped me to get to this stage and I hope this project and report showcases the various skills I have learnt throughout my time at the college.

I truly appreciate anyone who takes the time to read this report and hope that it can communicate my thoughts and experiences with building this final year project.

Table of Contents:

Research Chapter

1 Introduction:

The aim of this project is to create a standalone application that allows a user with a physical disability and his/her carer can make use of two different hardware inputs to allow the user to create and perform music. This application will give someone with a physical disability the chance to create their own music using inputs that suits their needs.

This report will focus on the area of assistive technology which refers to "any device or system that helps to improve the functional capacity of people with disabilities" (NCSE, 2020). This area has different subgroups which have different names, but this report will mainly focus on Assistive Technology in relation to music, commonly known as "Assistive Music Technology". Assistive Music Technology (AMT) describes the use of devices and software that make the process of making music accessible to users with disabilities.

The advancements that have been made in technology make AMT more accessible than it has ever been. "The digital revolution hasn't just made music-making easier or faster: it's made it possible." (Thomas, 2012)

This research report will cover all the different technologies, methods and reasoning that go into creating a software that in conjunction with different inputs, aid people with physical disabilities to express themselves and create music for themselves.

2 Technology:

This project will make use of a visual programming language called MAX to create a software application which has two hardware inputs that can be used to trigger musical loops.

2.1 Hardware Inputs:

The inputs being used for this project are Buzz Controllers (See 8.2 for detailed description) and a webcam. These inputs were chosen because they offer accessibility to potential users who may not have fine motor control skills and cannot use traditional instruments. Descriptions of these inputs and how they were implemented into the application can be found in the implementation chapter of this report.

2.2 MAX/MSP:

MAX/MSP is a visual programming language that allows users to create interesting music and media devices. The program itself is currently developed by a San Francisco-based company named Cycling '74.

As MAX relies heavily on the visual aspect of programming the user can add "objects" to their patch which for example can produce sound waves, objects that can give random values and other objects such as dials and sliders which provide a User Interface (UI) for things such as volume and panning. All these objects can be connected using a modular system that allows the user to connect patch cords from one object to another which in turn opens a realm of possibilities to allow the user to experiment with even the most basic of objects.

Patches that are created in MAX can also be mapped to inputs such as MIDI controllers or other types of inputs such as joysticks and switches. The values from these inputs can also be mapped and scaled inside of MAX to perform certain functions such as button switch turning on and off effects, a joystick controlling the dry/wet of a reverb and even a camera that can track a colour and output its X and Y coordinates to a synthesizer. Scaling of inputs can be done entirely in MAX which can help with making some inputs more suitable for music performance and creation.

MAX also works well with video, be it a live feed from a camera or just a pre-recorded video. The option to use video opens a lot of possibilities as well as it does not rely on an input device that has to be physically held but instead can track motion which can be used to create sound.

All the possibilities for interactivity and extremely customisable patches are what makes MAX so powerful and why it is the programming language that has been chosen to create this project as it will allow for the user to connect a specified input to the software and let them create music using the input that works well for them.

3 Applications:

Assistive Music devices and software come in various forms so that they can meet the different needs of the user who wishes to create music. They can be used in institutions such as Enable Ireland or Drake Music Organisation but can also be used at home.

From studying the literature on assistive music technology, it becomes apparent that two types of users exist within the spectrum with overlapping similarities. "On one hand you have what may start purely as music therapy but can awaken a real talent within somebody who otherwise may never have had that opportunity. Alternatively, we could be dealing with an established musician, who due to an injury, is suddenly projected into the category of 'disabled'" (Thomas, 2012). Many different disabilities exist from cerebral palsy, dyspraxia, and autism just to name a few and there's also people who have maybe suffered an injury and cannot play and perform like they used to. Assistive music devices are all about opening new possibilities for these people to explore the world of music and to be creative in a manner that works for them.

The above quote exemplifies the variety of users within the community and the need for a variety of different inputs to accommodate the needs of different people. An example of a potential user could be someone with limited fine motor skills. This potential user could find it difficult to learn and play traditional musical instruments such as the guitar, drums or piano but this user could maybe make use of a few button switches that could allow them to trigger drum sounds using the switches. The portability of the switches and the computer needed to trigger the samples is also a huge positive as well as they can be set up in such a manner that the user can easily access them and can be positioned easier than say trying to move a drum kit around to suit them. The use of the button switches can also bypass the need to use drumsticks which a user lacking in fine motor skills might also find difficult to hold and use correctly. The type of hardware controller used in this project is discussed in detail later in this report.

4 Requirements:

Music creation for people with disabilities is an area that is becoming more accessible and will hopefully continue to expand as the years go on. The last few years have seen a rise in devices and software that have opened new avenues for disabled users to explore and express themselves.

4.1 Similar System 1:

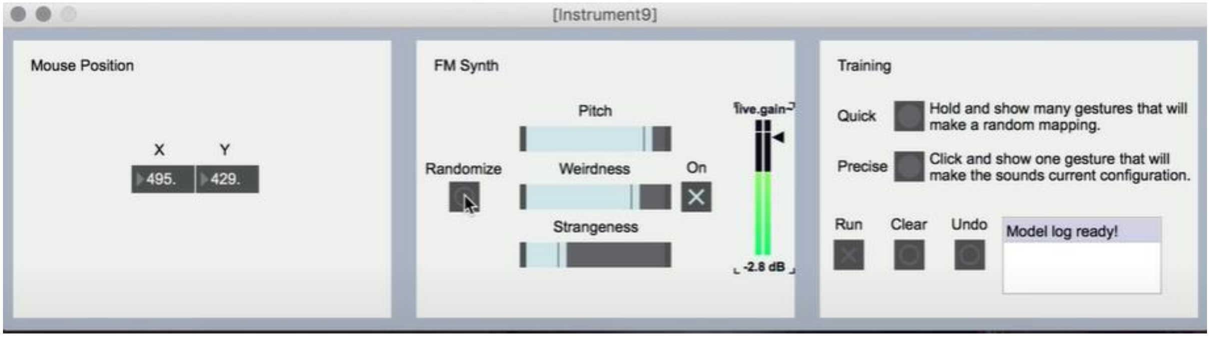
A similar system would be the Skoog from SkoogMusic (See figure 1). The Skoog is a musical instrument that has been built from the ground up to be customisable and offer ease of use to people with disabilities. It is a soft cube with tactile buttons on each side of the cube and the user can press these buttons and move the device itself to produce and manipulate the sounds coming out of the Skoog software. The Skoog connects to iOS devices such as iPad and iMac running a bespoke software from Skoog via micro-USB or wirelessly. The software has a range of different sounds that the user can play with and is more than enough to allow anyone with a disability to express themselves as they see fit.

(Figure 1 - Skoog from SkoogMusic – (SkoogMusic, 2020)

4.2 Similar System 2:

Sound Control from Music Forge is another interesting software in the realm of AMT. Sound Control is a "free software that can be used by anyone to create new musical instruments using their choice of movements, sensed with a variety of off-the-shelf devices (including webcam, Leap Motion, micro: bit, mouse, microphone, etc.).

Sound Control uses machine learning to enable users to create new musical instruments by demonstrating examples of motions and sounds, so no programming or musical expertise is necessary" (Music Forge, 2020). This is an entirely free software that has been built using MAX/MSP and runs as a standalone application which allows the user to use a wide variety of inputs from basic ones most people would have such as a webcam or a mouse (See Figure 2) to other more specific ones such as Leap Motion and the relatively cheap micro: bit.



(Figure 2 - Sound Control from Music Forge) - (Music Forge, 2020)

Some of the features included are the ability to control pitch and speed of a sample using the micro: bit tilt, use a webcam to track a specified colour which in turn will control a mixer and it also has a plethora of built-in sound modes such as a sample player, FM synth and a granulator. A wide variety of inputs are covered with this software and the numerous sound modes help to allow the user to experiment and have fun with the software.

4.3 Similar System 3:

Soundbeam is another assistive music device and was prototyped in 1984 by Edward Williams and has been commercially available since 1989 from a company called Electronic Music Studio (EMS). The device itself makes use of an ultrasound sensor and switches to create MIDI messages that control different sounds. See figure 3 for an example of a typical Soundbeam set up.

(Figure 3 - Soundbeam Demonstration) – (SoundBeam, 2020)

The ultrasound sensor can sense how far away the user's hand is from the physical device and for example could be used to play notes on a software piano, the closer the hand the lower the note and the further away the hand is the higher the note on the piano. The switches can be used for a variety of different things such as to trigger notes, chords, or drum loops. The newest version of Soundbeam from EMS also includes a touchscreen device that can be used to assign different instruments and sounds to the sensor and the switches and comes included with numerous soundscapes that have instruments and samples already loaded into them, this allows an ease of use to the device that makes it a great tool for anyone interested in assistive music technology.

"The importance of making the performer feel they can initiate something. That is, the idea of cause (the musician performing a gesture) and result (a pleasing musical sound) is central to the development of the Soundbeam." (Kimberlee G.K & George T., 2015). This quote does a great job of exemplifying how important cause and effect are when working with disabled users not just for the Soundbeam but for any form of assistive music.

4.4 Requirements:

1. Knowledge of inputs including their uses for example how they might work from a musical standpoint and how easy they are to use.
2. Proficient understanding of MAX to allow for the software to be designed.
3. Understanding of the range of users and what disabilities exist within the community.

5 Conclusion:

A lot of research has been done in this starting phase of the project and will help tremendously with building the application and will hopefully alleviate some issues that could arise due to not having some formal research done before attempting to build the software.

Another area of interest is the idea of collaboration between disabled users from a musical standpoint. Much of the focus of music therapy is on the carer and a single user but there is also the opportunity to have multiple users performing and creating at the same time. An example of this would be the group Technophonia (Thomas 2012). This group allows disabled users to perform using their assistive technology alongside a more traditional ensemble playing instruments such as the violin etc. In a particular performance one user was using a Skoog, another using Soundbeam and finally someone using Brainfingers. This performance showcases not only disabled musicians collaborating with one another but also with musicians who do not have a disability. Collaboration is a huge part of making and performing music and it is important to make it a possibility for all musicians, disabled or not.

A quote that stands out is the following “it's key to develop a set of considerations to use when making a new instrument. This can be done by evaluating cases of pre-existing adaptive musical instruments and how they were developed, as well as by surveying some of the literature about adaptive music technology” (Kimberlee G.K & George T., 2015). What this exemplifies is that there is a need to take into consideration what other devices have done to enable users with disabilities and by studying other devices and literature in this area a well-rounded and competent device/software can be created.

Design Chapter

6 Introduction:

This section of the report will focus on the process of designing a music performance device for users with disabilities. This section will touch on the software and hardware used and the design considerations behind the device. Skills learnt throughout the Creative Media Technologies course are being implemented in the creation of this device. An in-depth explanation of the final MAX patch can be found in the implementation chapter.

7 Design Considerations:

“Computer music technology opens new possibilities in the design of new musical instruments for physically disabled musicians” (Kimberlee G.K & George T, 2015)

Musical performances can be an incredibly rewarding thing and for users with disabilities it could really inspire them to explore their creative side using music. “The power to make something happen, the vital ‘that was me!’ experience, can function as the foundation stone for further learning and interaction.” (Swingler, Tim & Brockhouse, John. 2009).

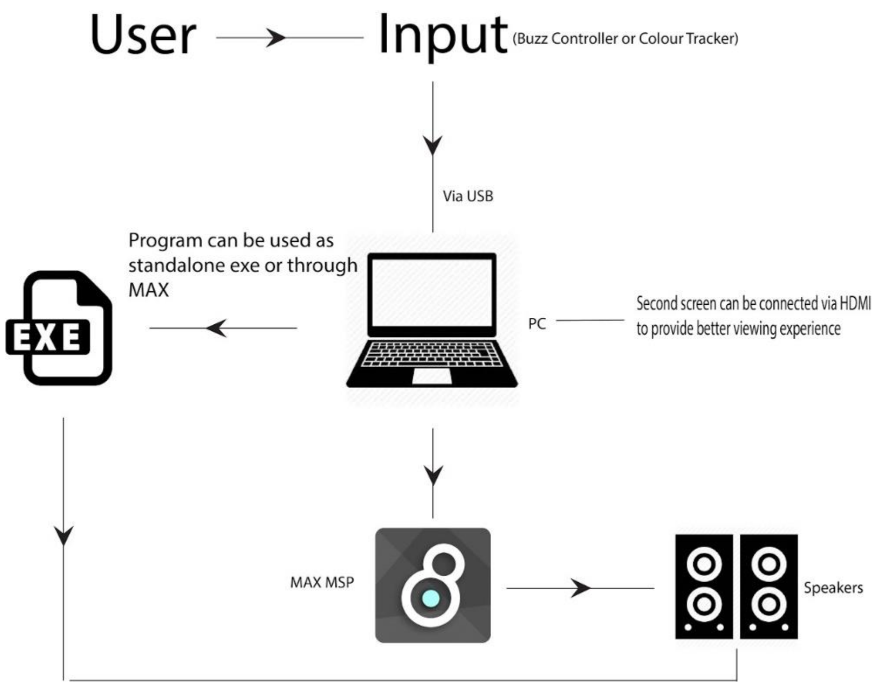
With the advancements in technology over the last few decades such as cheaper and more reliable hardware and software it has opened a realm of possibilities and new ways to approach the art of music performance.

Most musical instruments require great amounts of hand to eye coordination and fine motor skills to perform with, but a musical performance does not have to rely on traditional instruments such as the piano and guitar, with modern technologies new ways to perform music have become much more viable as discussed in similar systems section in this report.

The primary goal of the proposed device is to allow a user to perform by triggering loops using the controller in a user-friendly interface which is set up so that the user and his/her carer can easily perform and be creative. Much thought has gone into making this a simple device to set up and to use and the use of colour also helps to accommodate the user.

8 Operation:

8.1 Basic Operation:



8.2 Inputs:

8.2.1 Input 1 - Buzz Controller:

(Figure 4 - Buzz Controllers Used for Project)

The Buzz controllers (See figure 4) themselves feature four coloured face buttons and one large button on top. The controllers are like the wide variety of adaptive switches on the market and the colours on the controllers are useful for memorising what colour plays which loop.

The Buzz controllers must be connected to a PC via the included USB cable. The whole Buzz Controller setup consists of four controllers that all connect to a hub which is then fed into the computer using the USB. They run off the power from the PC, so they do not need to be plugged into the mains which makes set up easier and adds portability. Once they are connected the carer can then start up the application which will run without the need to have MAX.

Once the software is up and running the Buzz controllers are automatically recognised and the user can begin to perform. If the PC that is being used has internal speakers, they can be used but if not an external set of speakers will be needed and must be connected to allow for the music to be heard.

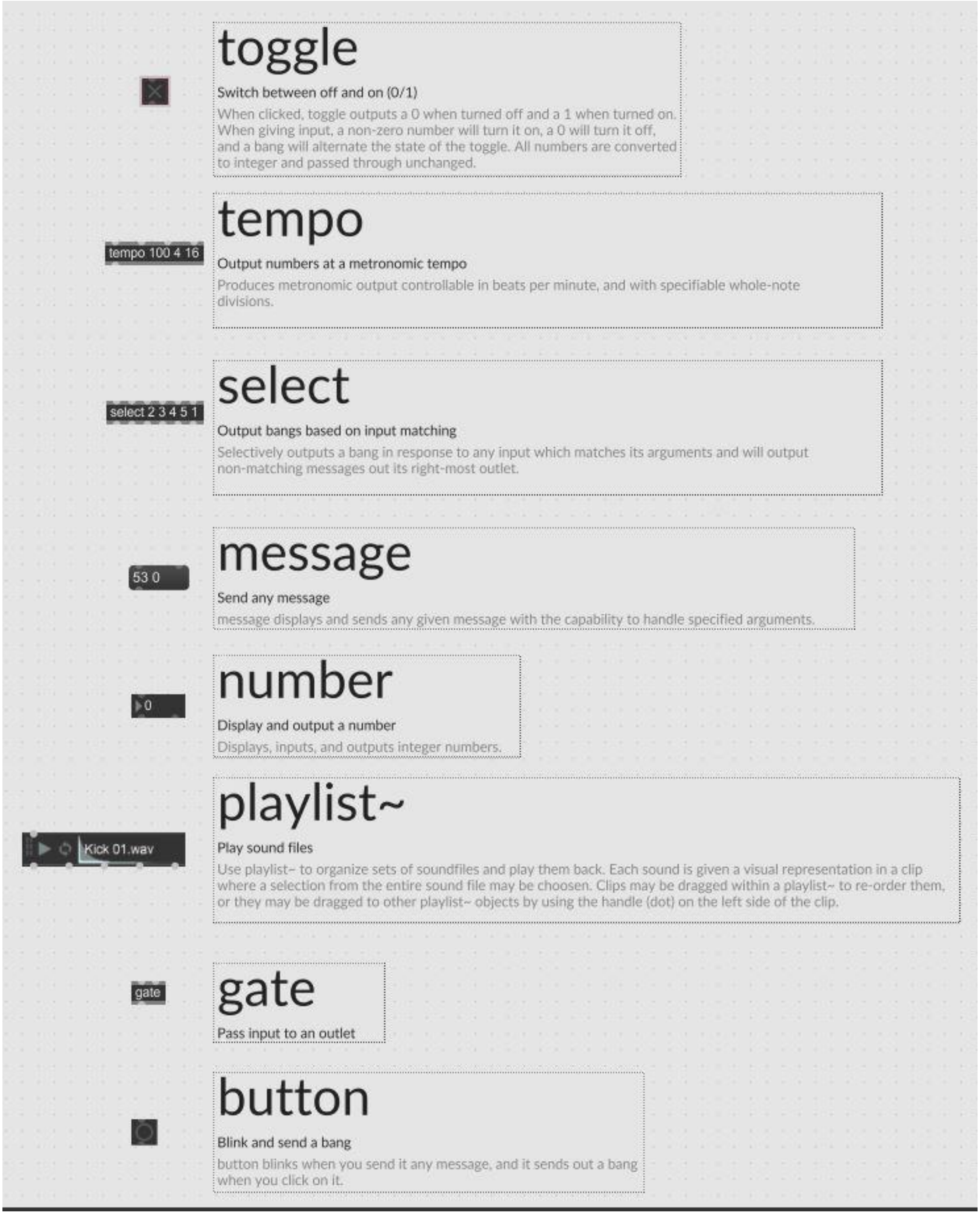
8.2.2 Input 2 - Colour Tracker:

The software also consists of a colour tracking section that can make use of a webcam/camera and can track specified colours when they appear in view of the camera. For example, a user could hold up an orange object which in turn will trigger the bass loop.

Due to having more than one input option an input selector has been included to allow the user to choose which input to use.

8.3 Software Operation:

The software itself consists of a sequencer which when started will play a musical loop on repeat and the user(s) can trigger different loops using the buttons on the Buzz controller, such as drums and bass, every time the sequencer repeats. Ensuring that the performance is in time is why the software is organised in this way. This will be much more pleasant to the user/s and carer as opposed to trying to get the user to play a sequence of notes etc, which would be difficult for anyone let alone a disabled user. Visual feedback will be provided by colour appearing on the screen after a button has been pressed and corresponds to a specific musical loop. Blue is for drums and green is for percussion, this makes it easier to remember each loop. Multiple loops can be triggered at the same time allowing for a lot of creativity in how the users perform. A diagram of some of the most common MAX objects used in the project can be seen below in figure 5.



(Figure 5 – Commonly Used MAX Objects)

The current prototype of the device consists of:

1. A Sequencer that plays on loop and is used so that triggered samples play in time with each other at a BPM of 100.
2. Buzz controllers that are used to trigger loops.
3. Colours appear on screen that correspond to the button on the controller that is pressed.
4. Make use of a built-in webcam to trigger loops. (works by using a colour picker beforehand and when that colour is detected by the camera the loop is triggered)
5. Presentation mode has been used to give the MAX patch a cleaner more user-friendly look but is subject to change as the patch does.

9 Components:

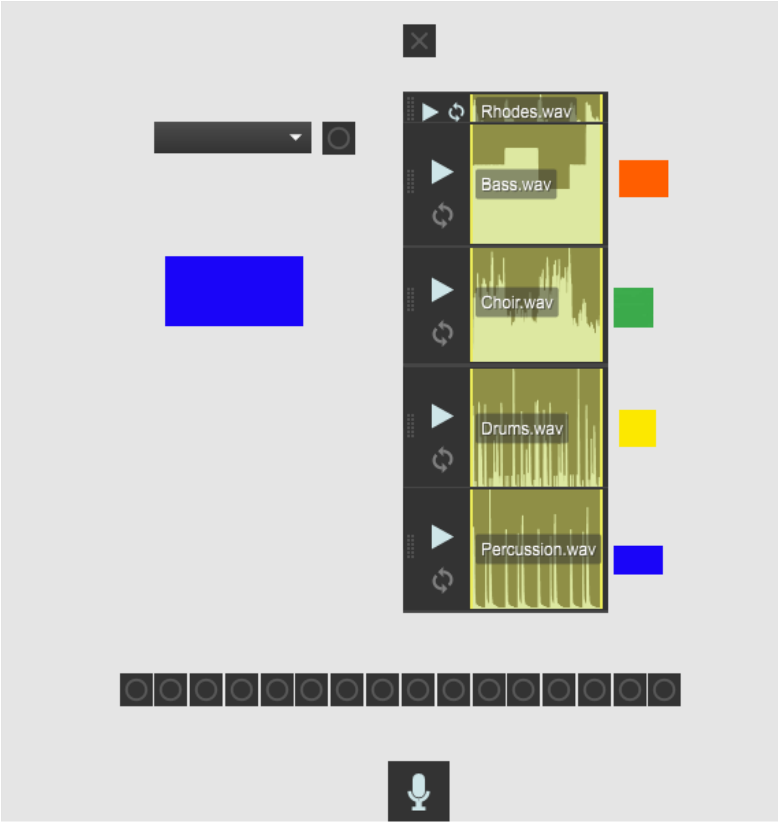
Item	Quantity	Purpose
Buzz Controller	4	Used to allow the user to trigger samples
Computer	1	Used to run the application and for the Buzz controllers to connect to it to feed the input to the application
Webcam	1	Used to trigger samples by tracking colours

10 Software Design:

To perform the processing of the users inputs a patch has been created in MAX 8 which will recognise the input and play the corresponding sound in time with the sequencer in the patch allowing for said input to trigger in time with whatever other loop is being played.

10.1 MAX Patch:

Below are two images of the patch in one of its early iterations which will hopefully give a better understanding of how the device looks and works in conjunction with the Buzz controllers and the users.



(Figure 6 - Early Iteration of Buzz Input in Presentation Mode inside of MAX)

Above in figure 6 is a snapshot of this iteration of the patch. Presentation mode in MAX was used to create this GUI and the patch has all the functionality but it just hides any of the unnecessary parts of the patch which could possibly confuse the carer or users.

(Figure 7- Entire Patch of an Early Iteration Inside of MAX)

Figure 7 is the whole patch in one of its early iterations and will be explained in depth in the implementation chapter. It is quite apparent that the patch is large and far from user friendly, but the use of presentation mode will alleviate this issue.

This prototype contains:

1. 5 different loops (yellow waveforms), the main one being a Rhodes piano loop that when triggered will always play. This is the loop the users will build their performance off.
2. 4 sequencers (top) which are used so that the loops can only be triggered in sequence with each other which helps to keep the rhythm of the piece of music.
3. Human Interface object (far left) which is used to read the inputs from the Buzz Controller, and it also has a section which sends these inputs to the corresponding loop so that they may be triggered.
4. A colour tracking section (far right) has also been implemented. This is used to trigger loops using colour that can be detected by the camera.
5. Coloured squares (bottom part) are used, and they will pop up on screen when a loop is triggered and correspond to the colour pressed on the Buzz controller.

A detailed explanation and description of each of these components can be found in the implementation chapter.

11 Conclusion:

This section of the report focused on the idea behind the device, how it came about and why, as well as a basic insight into how the project functions. All the necessary components of the project were talked about, from a software and hardware perspective and how they all work in practice.

Most of the design aspect of this project revolved around the software side and a detailed description of the MAX patch can be found in the implementation chapter.

Implementation Chapter

12 Introduction:

The focus of this chapter of the report centres around how the various prototypes were implemented and the changes and issues with each iteration up until the final version. A detailed description of the MAX patches can be found in this chapter, with reference to what objects were used and the way in which they are all connected.

13 Prototype 1:

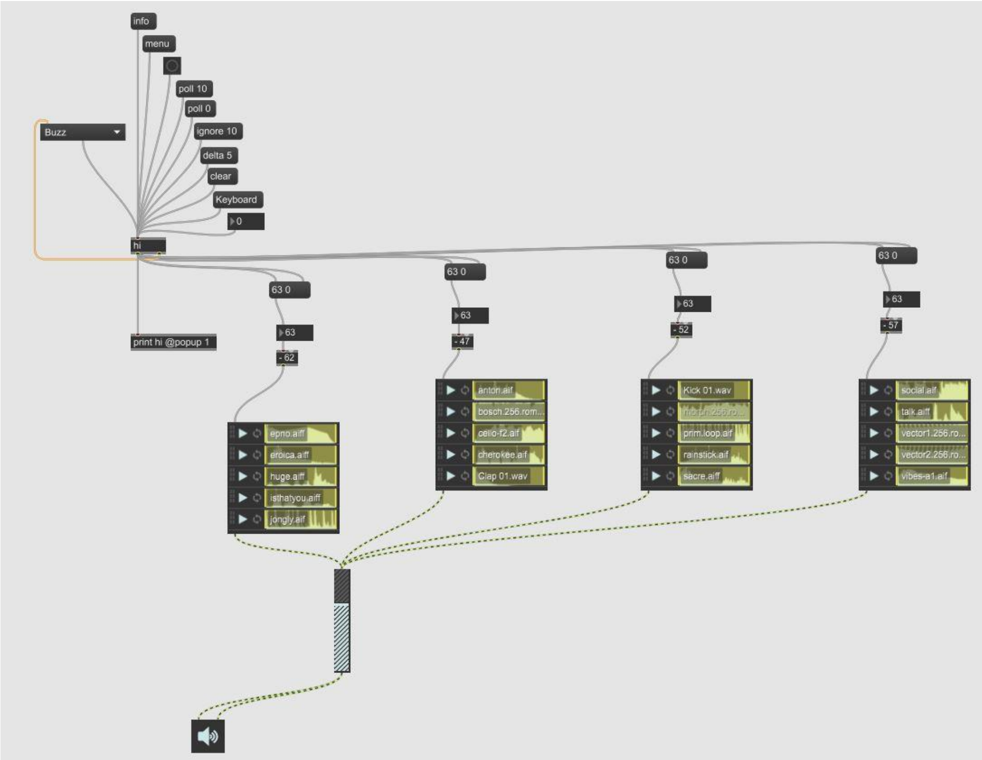
The first prototype that was constructed was very basic in functionality but laid much of the groundwork for what was to come further down the line. This prototypes functionality consisted of using the four Buzz controllers to trigger samples, albeit without a sequencer which meant results from a musical standpoint were not satisfactory. No colour tracker was present in this prototype.

13.1 Hardware:

The hardware for this prototype consisted solely of the PC needed to run the MAX patch and the four Buzz controllers which have been mentioned previously in this report (see figure 6).

13.2 Software:

An image of the MAX patch for this prototype can be seen below in figure 8. Brief explanations of each patch will be given to give an understanding of the functionality of each prototype and how this functionality is achieved.



(Figure 8 - First Prototype Patch)

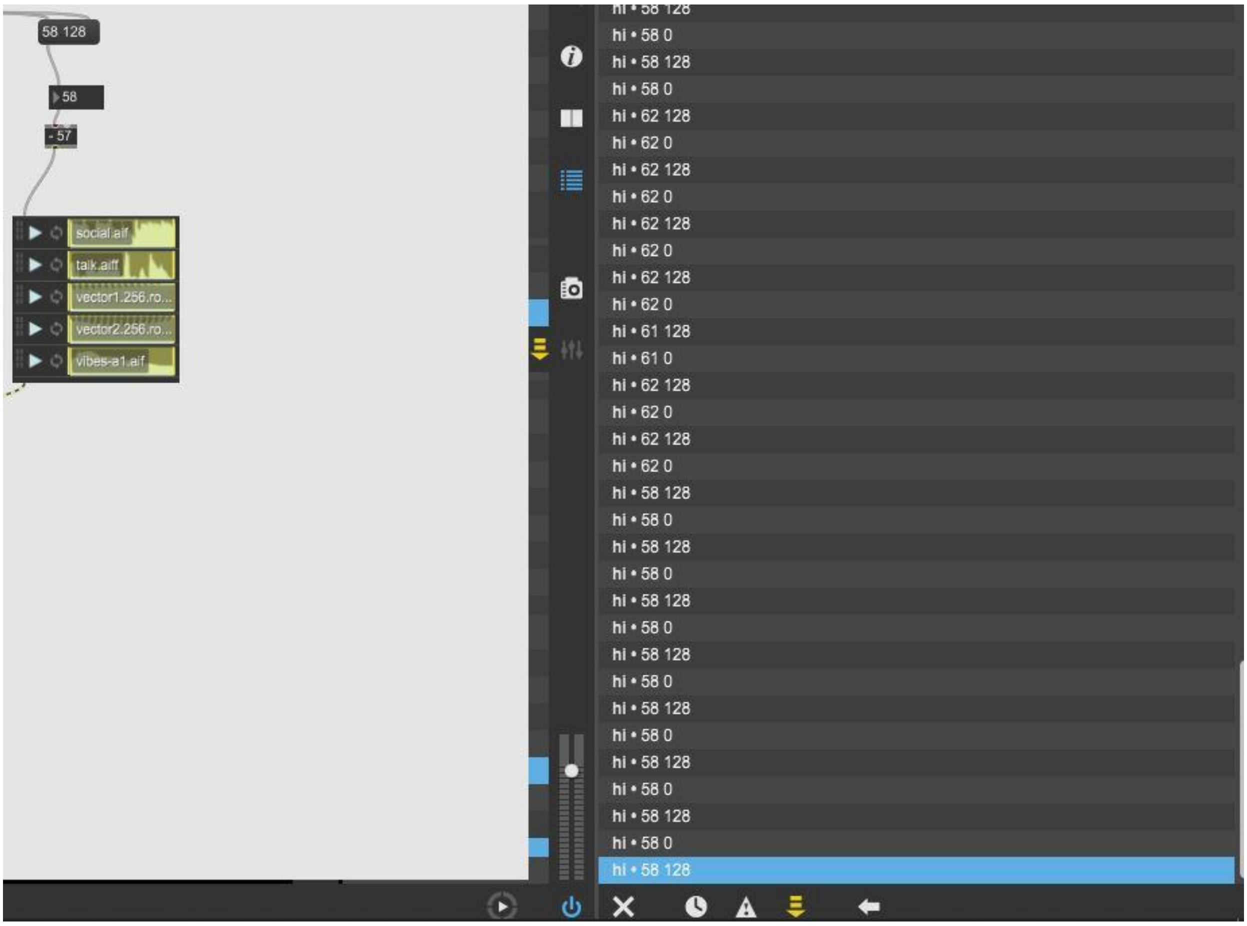
The Human Interface object in MAX is used to recognise the Buzz controllers and receive and process the inputs coming from the controllers. These inputs are then being outputted as a number value, these number values are connected to a row of five musical samples and trigger the sample when a button is pressed on the controller. A simple subtraction object is used to for each controller.

13.3 Features:

- Buzz controllers were recognised inside of MAX and values were being read from the controllers.
- Could trigger five musical samples per Buzz controller. Samples consisted of drum loops, drum hits and random one shots such as a piano etc.
- Volume of patch could be controlled using a slider inside of the patch.

13.4 Issues:

There were a couple of issues with this prototype aside from the lack of functionality. For example, when a sample was triggered with a button pressed it would trigger the sample twice which caused a stuttering effect when triggering samples, this was due to the value being sent twice once with a velocity of 0 and then again with a velocity of 128. This problem was alleviated in the second prototype with the use of the select object which filtered values coming from the controllers. See figure 9 for an image of the issue.



(Figure 9 - HI Object Output Issue)

Another issue was that the musical samples being triggered were stock ones included with MAX and they did not work together well from a musical standpoint, but the idea of this prototype was to get the controllers working and to implement better sounds in later iterations of the project.

14 Prototype 2:

The second prototype contained a lot more of the functionality that can be found in the final prototype. It consisted of two separate patches one being an updated Buzz controller patch with a sequencer and colours that would appear on screen which corresponded to the colours on the Buzz controllers when they were pressed. The second patch consisted of a colour tracker which allowed the user to use a webcam to assign the musical samples to different colours and the patch would trigger the sample when said colour is detected by the camera. The bulk of the code of the project will be explained in this prototype, with the final prototype expanding on this prototype only from a visual and interface point of view.

The sequencer that was added was a massive improvement on the previous prototype and allowed for the musical loops to be triggered in sequence together ensuring they stayed in time which produces a vastly superior musical piece as opposed to randomly triggering them. The loops used in this prototype were all created in Ableton Live and are 4 bars long at 100 beats per minute (BPM) in the key of C Major. Each controller contains a drum, bass, percussion, and choir loop assigned to the four front buttons of the controller. Each controller contains a variation of these loops which allows for a bit of creativity and variety between the loops.

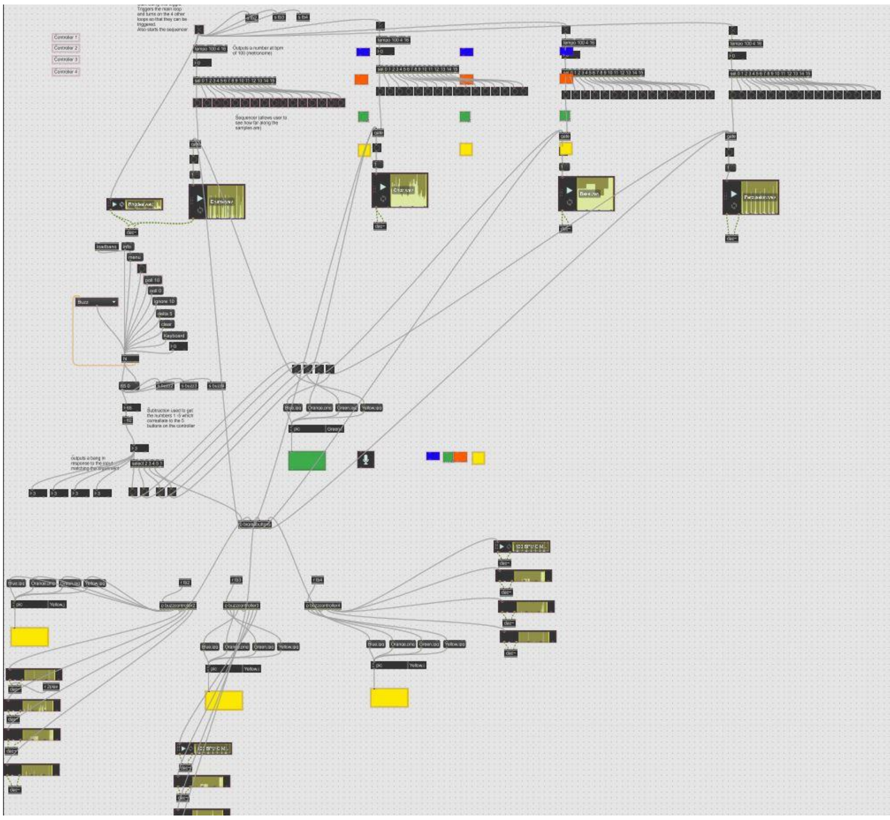
Presentation mode was added to these two patches which gives them a GUI (Graphical User Interface) making the patch much easier to use. Presentation mode allows you to add only certain aspects of the patch i.e., the sequencer and loops etc. to a separate viewing mode and arrange them in such a way to create a simple GUI as opposed to the quite messy view in the editor of MAX which contains numerous objects and hundreds of wires connecting them all.

14.1 Hardware:

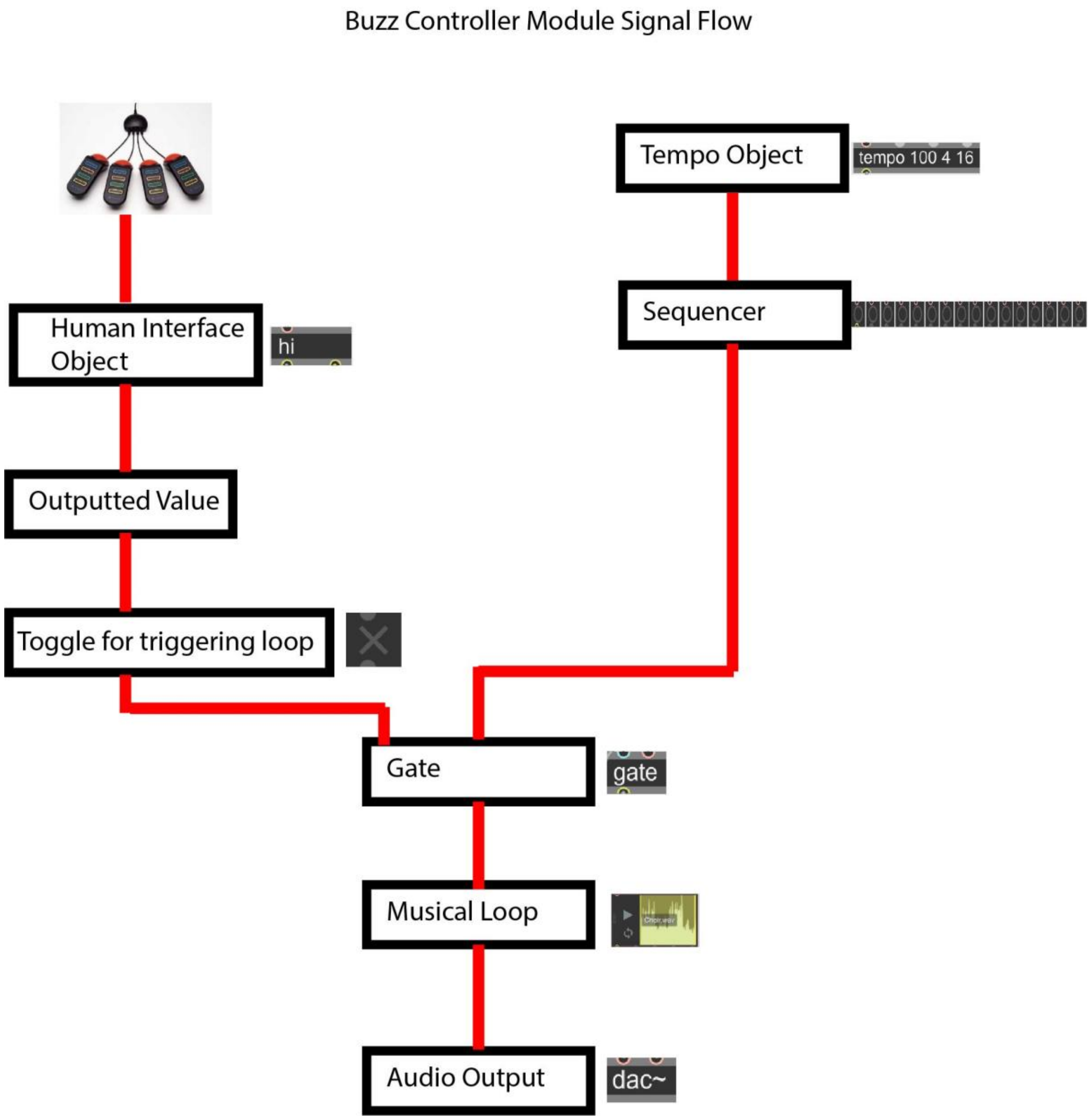
The hardware used was the same as the previous prototype (See 13.1 Hardware) but with the webcam of the PC added in which is being used to track colours as they appear in view of the webcam.

14.2 Software:

As mentioned above this prototype consists of two separate MAX patches which at this stage had not been combined into one patch. The first of these patches is the improved Buzz controller patch. See figure 10 for an image of the entire Buzz patch and figure 11 for a basic flowchart of the signal flow of the Buzz patch.

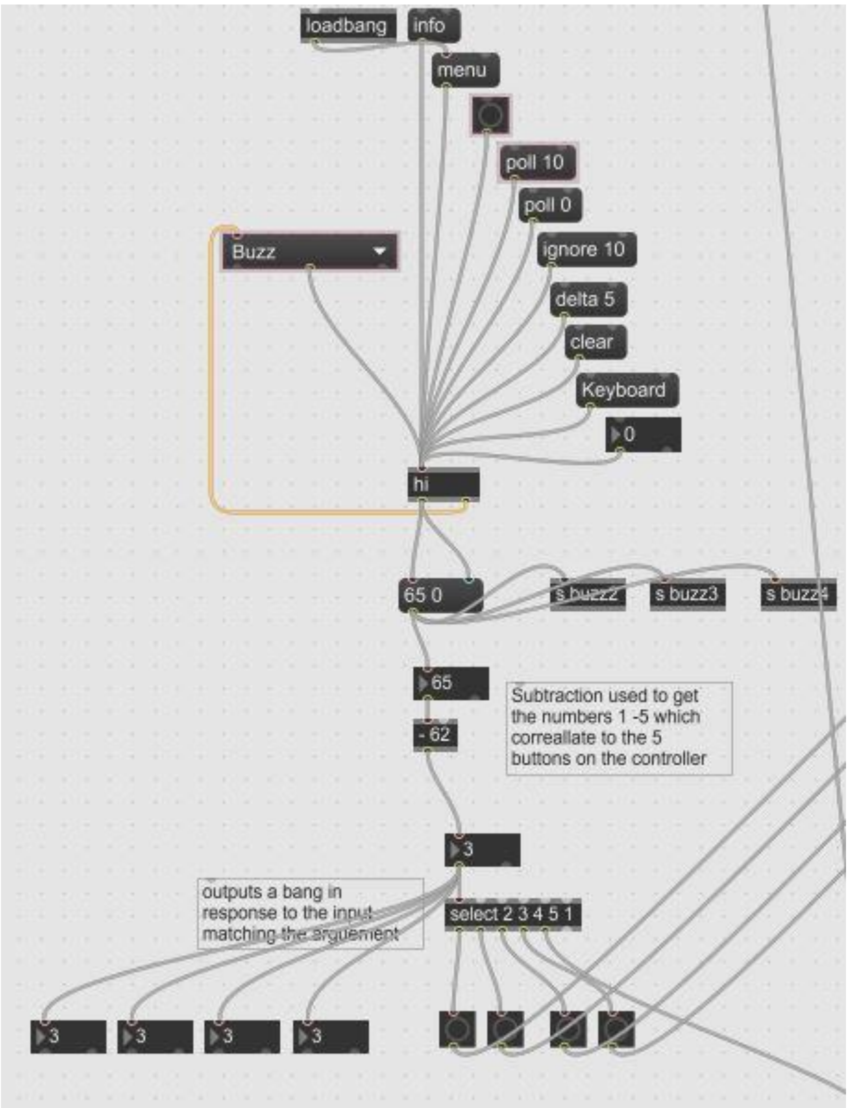


(Figure 10 - Entire Buzz Input Patch)



(Figure 11 - Buzz Controller Module Signal Flow)

As mentioned in the previous prototype one of the issues was the samples triggering twice when a button on the controller was pressed, this was alleviated by using the select object which can be seen in figure 12. This object outputs a bang (sends an “on” message in MAX) based on the input matching which means when the value from the controller matches whatever values are in the select object an “on” message is sent to the loop which will trigger it. See figure 12 for the updated Human Interface section of the patch and figure 13 for the various select objects used (which correspond to the number of different controllers being used).

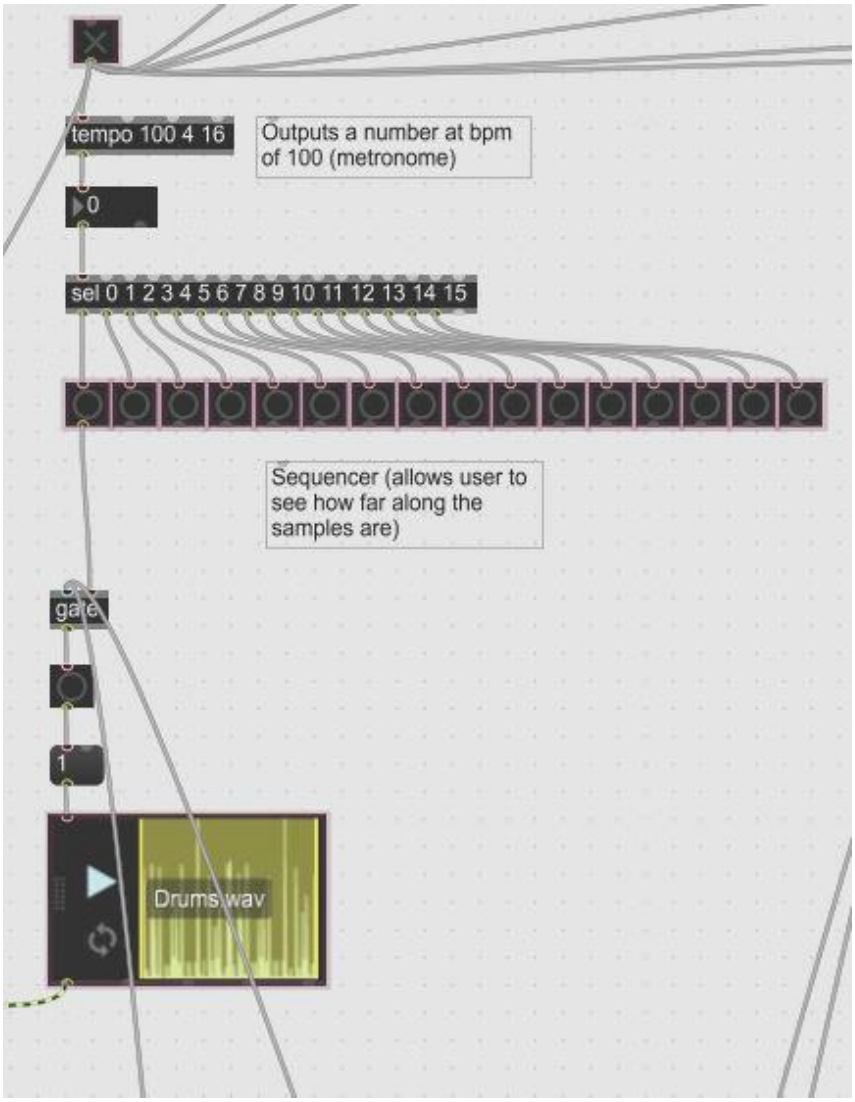


(Figure 12 - HI Section with Buttons)

(Figure 13 - Various Select Objects Used)

The above section of the patch is reading the values from the controller and sending them to the various loops throughout the patch but these loops cannot be triggered until the sequencer is at the beginning, this sequencer will be explained below and will hopefully provide more context and understanding of the patch.

Figure 14 below shows the sequencer for one of the loops, in this case a drum loop. Each of the loops have their own sequencer which are all connected to each other which in turn keeps the loops playing in time together.

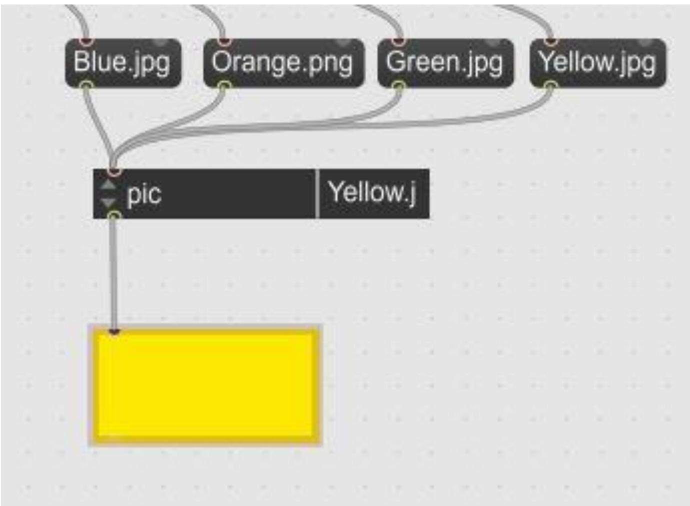


(Figure 14 - Tempo, Sequencer and Gate Section)

The tempo object at the top is outputting a number between 0-15 (16 numbers) at a BPM of 100, this equates to 4 bars in musical terms which is what all the loops are lengthwise. This number is then going into a number object which is just displaying said value. Another select object is being used so when the number objects value matches that of the select object a bang will be sent. The row of buttons (16 of them) connected to the select object turn on when the value is passed through the select object.

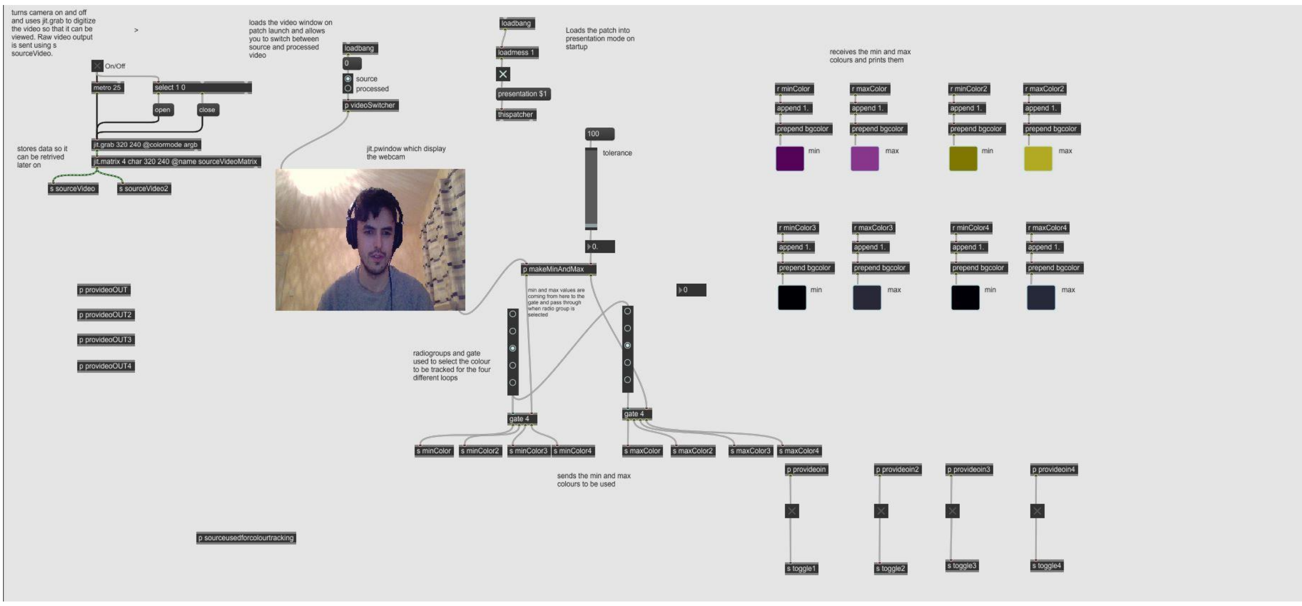
In figure 13 only the first button is connected to the gate object below the row of buttons, when the very first button is active this opens this gate and, in this example when the button on the controller that corresponds to the drum loop is pressed it passes through the gate which then sends a number object with the value of 1 to the drum loop which in turn plays the loop. This is just one of the sequencers and how it triggers a loop but the same concept applies to all the loops and this explanation is just to give an understanding of how the loops are triggered in conjunction with both the sequencer and the controller.

The values outputted from the controllers are also being sent to various JPEGs of which there are four of. Blue, Orange, Green and Yellow. These JPEGs will appear on screen whenever the button they are assigned to is pressed. These JPEGs are triggered using message objects which load the image specified into an fpic object which displays the image. An image of this section of the patch can be seen in figure 15.

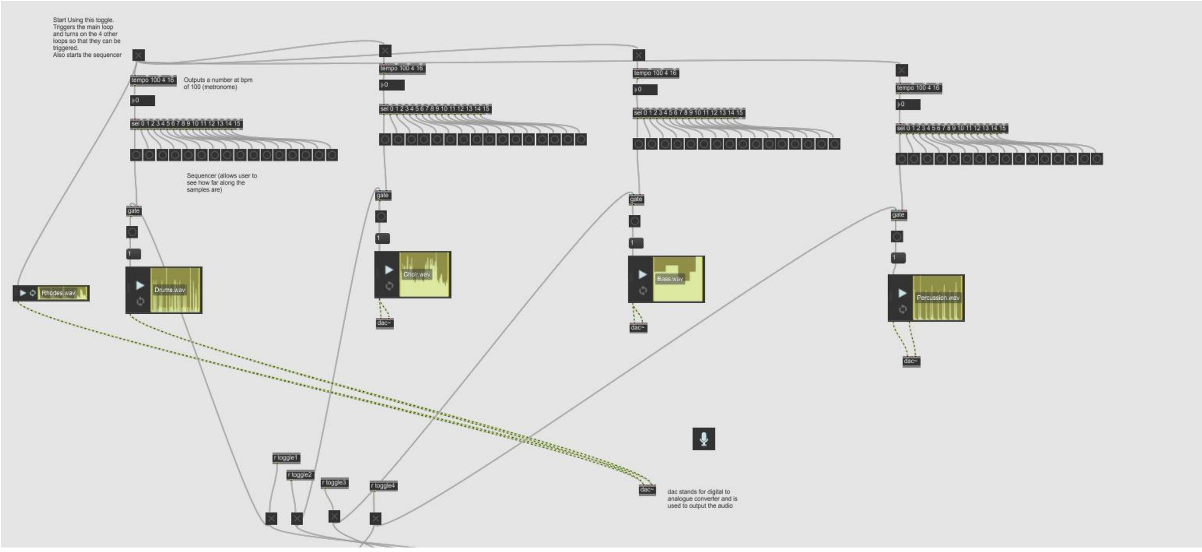


(Figure 15 - fpic Object)

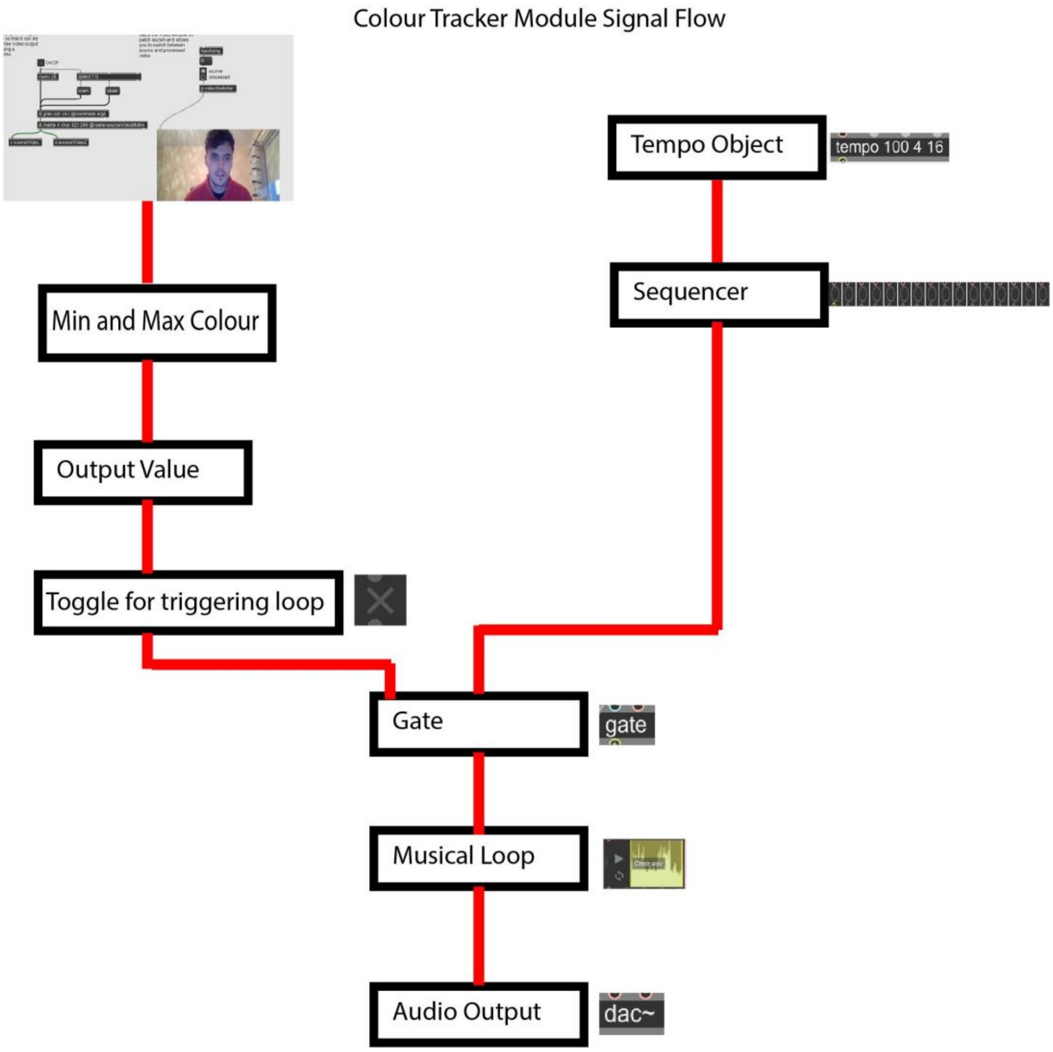
The second patch that was mentioned previously is the colour tracker. Figure 16 is an image of the colour tracking section, figure 17 is an image of the sequencer and loops connected to said colour tracker and figure 18 is a simple flowchart of the signal flow of the colour tracker patch.



(Figure 16 - Colour Tracking Section)



(Figure 17 – Sequencers)

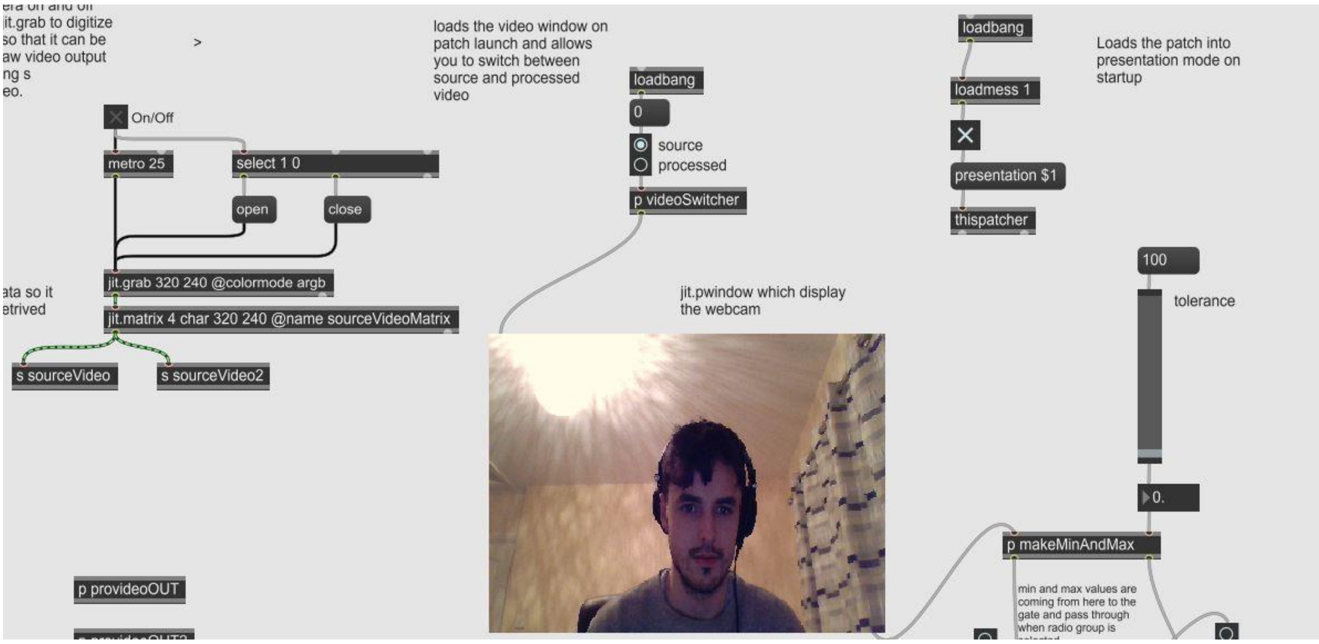


(Figure 18 - Colour Tracker Module Signal Flow)

The colour tracker has been adapted from a Polish MAX user named Pawel Janicki who posted his version of the colour tracker on the MAX forums. The forum post can be found at this link "https://cycling74.com/forums/colour-tracking-with-a-webcam-in-jitter/". Pawel's version of the patch was adapted in this prototype so that loops can be triggered when the colour being tracked is present and four different colours can be tracked independently corresponding to the four different music loops.

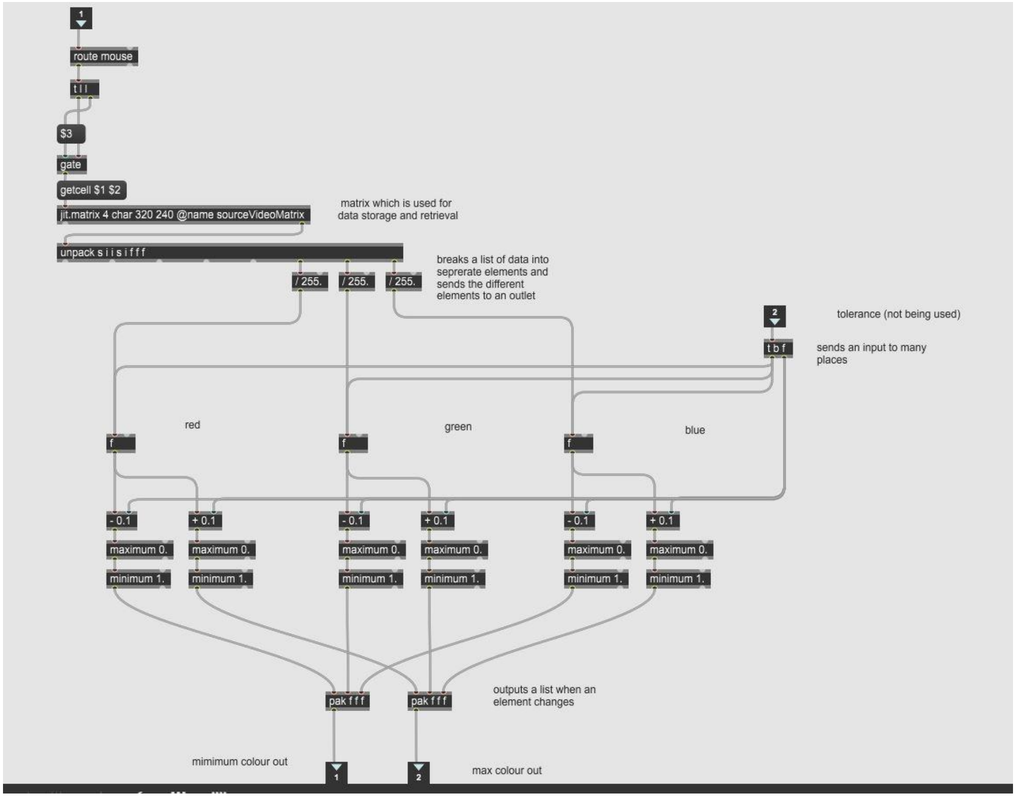
The signal flow chart in figure 18 should do a good job of visualising the different sections of this patch. The user holds up an object, for example a yellow sheet of card and then clicks the colour on the webcams output. This colour is assigned to whatever loop has been selected beforehand and the triggering of the samples works almost the same as the Buzz patch except the coloured objects are triggering the loops instead. The triggering of more than one loop is possible by holding up multiple objects that have been assigned previously.

Figure 19 below shows how the webcams output is being loaded and displayed in MAX. It makes use of two Jitter objects (objects used for real time audio-visual work) which are used to load the camera's output and store information from it that can be called upon later. The camera's output is being displayed within the patch using a P.window object.



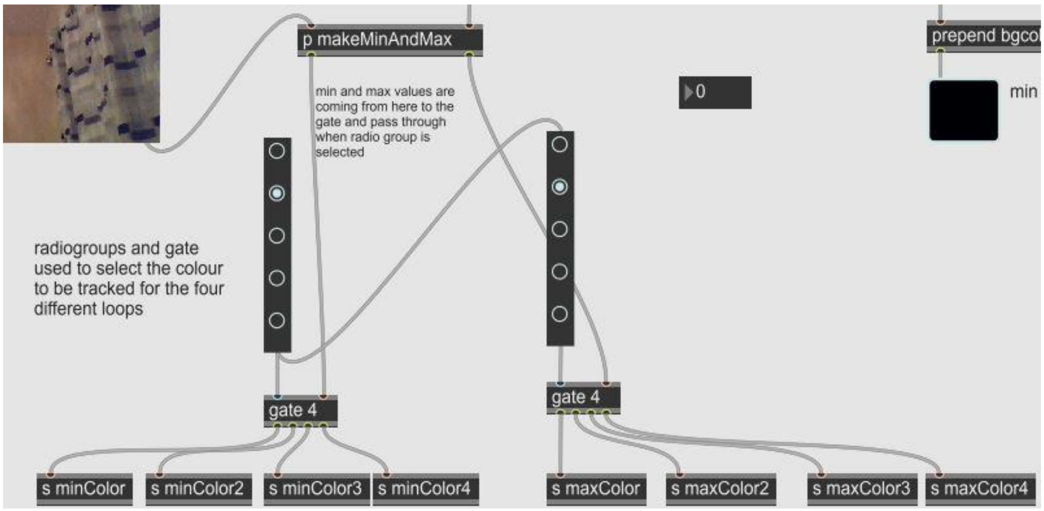
(Figure 19 - Webcam Section With P.window Object)

The output of the camera that is being displayed using the P.window object is connected to a sub patch (a patch within a patch) which is finding the minimum and maximum of the colour selected. This section of the patch is virtually unchanged from Pawel's original version and is using some maths to find values for red, green, and blue for the selected colour and the outputting a minimum and maximum of the specified colour. The minimum is the selected colour at its darkest possible shade for it to be detected and the maximum is the colour at its brightest shade for it to be detected, this aids in the tracking of the colour as it provides a range in which that colour can be detected and within certain lighting conditions a colour can change slightly depending on the lighting in the room as the object changes position. See figure 20 for an image of this sub patch.



(Figure 20 “Min and Max” Sub patch)

The way in which each of the four loops are assigned to certain colours is done by using a radio group object in conjunction with a gate. In figure 21 there are two radio groups (the vertical rows of buttons). For example, when selecting the first colour and the radio group is set to the second button (first button is redundant but cannot be removed due to the way MAX behaves) this opens the gate and allows for the min and max of the first colour to pass through the gate.

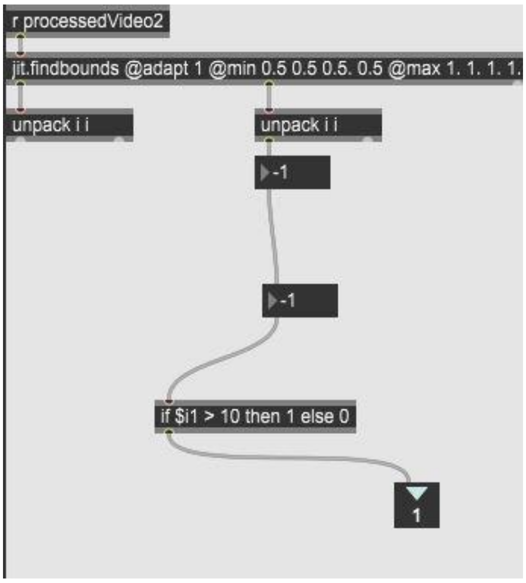


(Figure 21 - Radio Group and Gates sending Minimum and Maximum Colours)

Once these minimum and maximum colours have passed through the gate, they are then received into a panel object which displays the colours so that the user is aware the colour has been assigned and can get a visual representation of what colour is being tracked. See figure 22 for an image of this section of the patch.

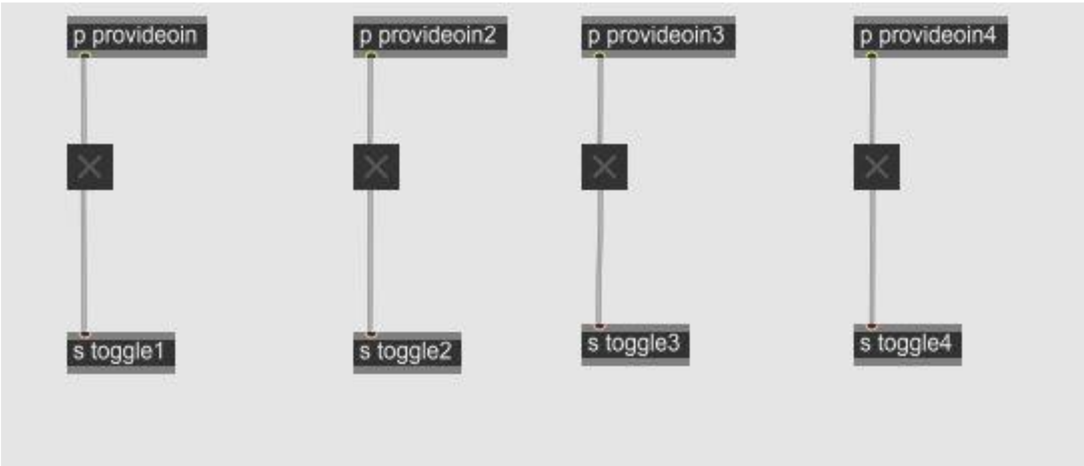
(Figure 22 - Panels That Display Min and Max)

These min and max values are then being sent to a sub patch which can be seen in figure 23. This sub patch is using a jit.findbounds object to find where said colour that is being tracked is on the screen and then producing a value for that position. In the image of the sub patch a number object can be seen with this value going into a conditional statement. When the colour is not being detected this number object has a value of -1 but when the colour is visible to the camera this value will rise, the conditional statement object is saying that if the value from the number object is greater than 10 then output a 1 but if it is less than 10 output a 0. The conditional statement object is then connected to an outlet which allows for the 1 or 0 message to be sent from this sub patch.



(Figure 23 - jit.findbounds Sub patch)

These 1 and 0 messages are being sent to a toggle which said toggle is then being sent down to the sequencer and loops and works much in the same way as the Buzz patch. If a colour is being detected by the colour tracker, then the toggle is turned on for that loop. This toggle is being sent using the send object which allows you to send a message and receive it elsewhere without the need for wires (This was done to clean the patch up a bit). The toggles for the loops that are receiving the four s toggle objects can be found at the bottom of figure 24.



(Figure 24 - Toggles for Sequencer)

14.3 Features :

Buzz Controller Patch

- All four Buzz controllers could be used to trigger music loops.
- Sequencer was added to enable all the loops to be in sync with one another.
- Colour corresponding to button pressed appears on screen. Adds feedback to the user so they know what button they have pressed.
- 16 unique musical loops were created in Ableton Live and were implemented into the patch.

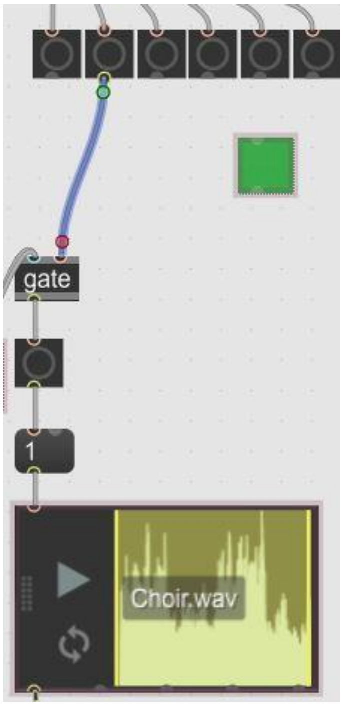
Colour Tracker Patch

- Colour Tracker implemented with webcam. Could detect when a colour appears in view of the camera.
- Could assign four music loops to four different colours and trigger these by holding them in view of the camera.
- Multiple loops can be triggered simultaneously with the different colours.

As mentioned previously the Buzz controller and Colour Tracker patches talked about in this prototype were two separate patches that were not connected whatsoever but in the next and final prototype these patches were combined into a single patch with an interface. Presentation modes (GUI) were created for these two patches at this stage of the project, but they will be talked about in depth in the next prototype as much of the work done on the final prototype was visual changes and interface improvements.

14.4 Issues :

Quite a few issues were encountered in this prototype while building it, but most were alleviated during its construction. One such issue was trying to track more than one colour and assign them. The radio group and gate shown in figure 21 helped to alleviate this problem. Another issue was sometimes the loops were triggering late but this was due to a faulty connection from the button sequencer to the gate for some of the loops, the second button was connected to the gate which was what was causing this delay in triggering. See figure 24 for an image of this wiring error.



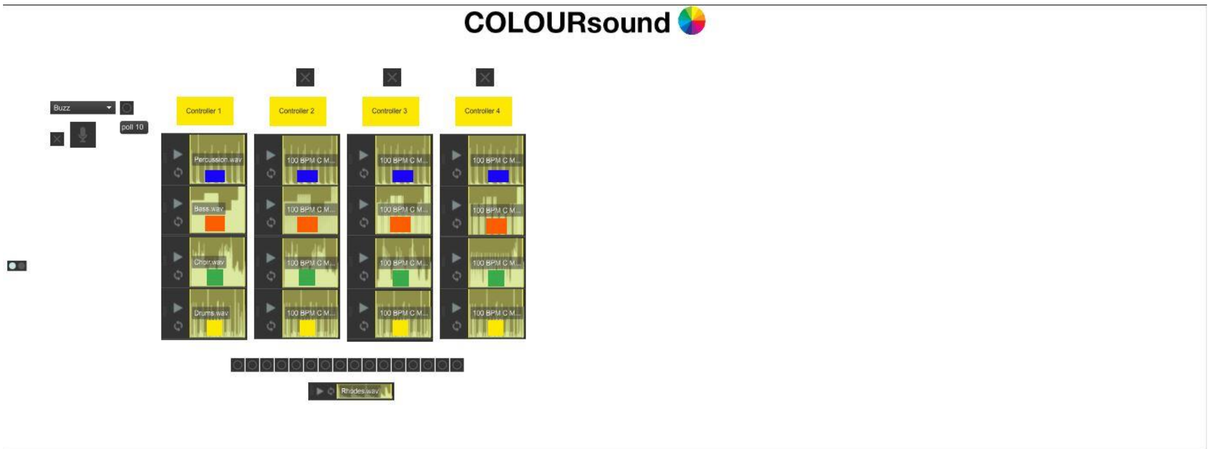
(Figure 24 - Wiring error in Sequencer)

The major issue or better yet lack of functionality with this prototype was the fact that the two patches were separate and could not be accessed from the one patch. The lack of an easy-to-use interface was also a problem, but both these issues were fixed in the next prototype.

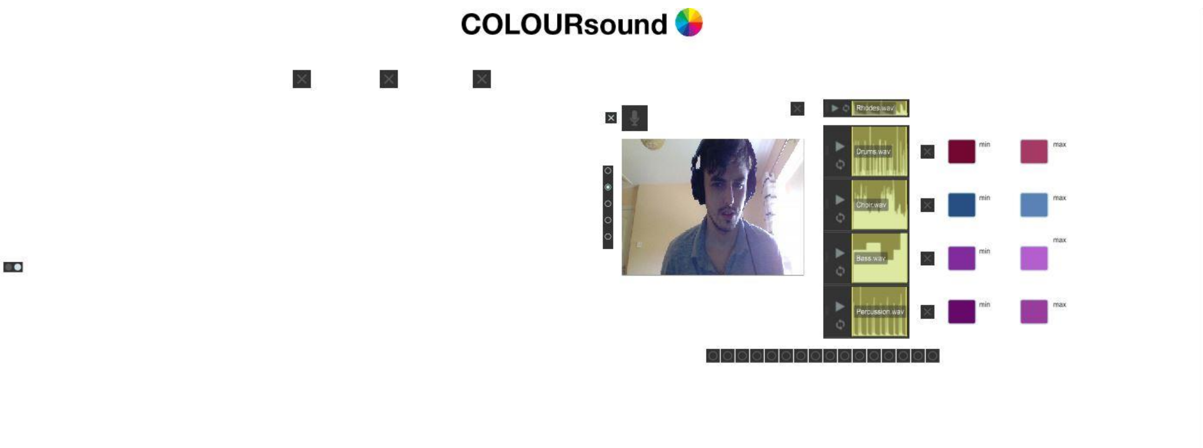
15 Final Prototype :

The final prototype (also the finished version of the product) combined the two fully functional patches talked about in the previous prototype into a single patch with an easy-to-use interface. The final prototype was also exported from MAX into its own standalone .EXE file that does not need MAX whatsoever to run, this was an important development as it will allow anyone to use the project without the need to have MAX to run it. Descriptions of the GUI and how the patches were connected will be discussed and explained in the following headings. See Figure 25 and 26 for images of the patches in their GUI.

When the .EXE is loaded the user will be presented with the logo of the project and a matrix ctrl object which allows the user to switch between the two methods of input. For the Buzz controller input buttons were added to change how many controllers are being used and are appearing on screen, with a simple press of a toggle object which can be seen above the music loops in figure 25 the user can then change how many users there is and what controllers are to be used while performing.



(Figure 25 - Buzz Input in Standalone .EXE)



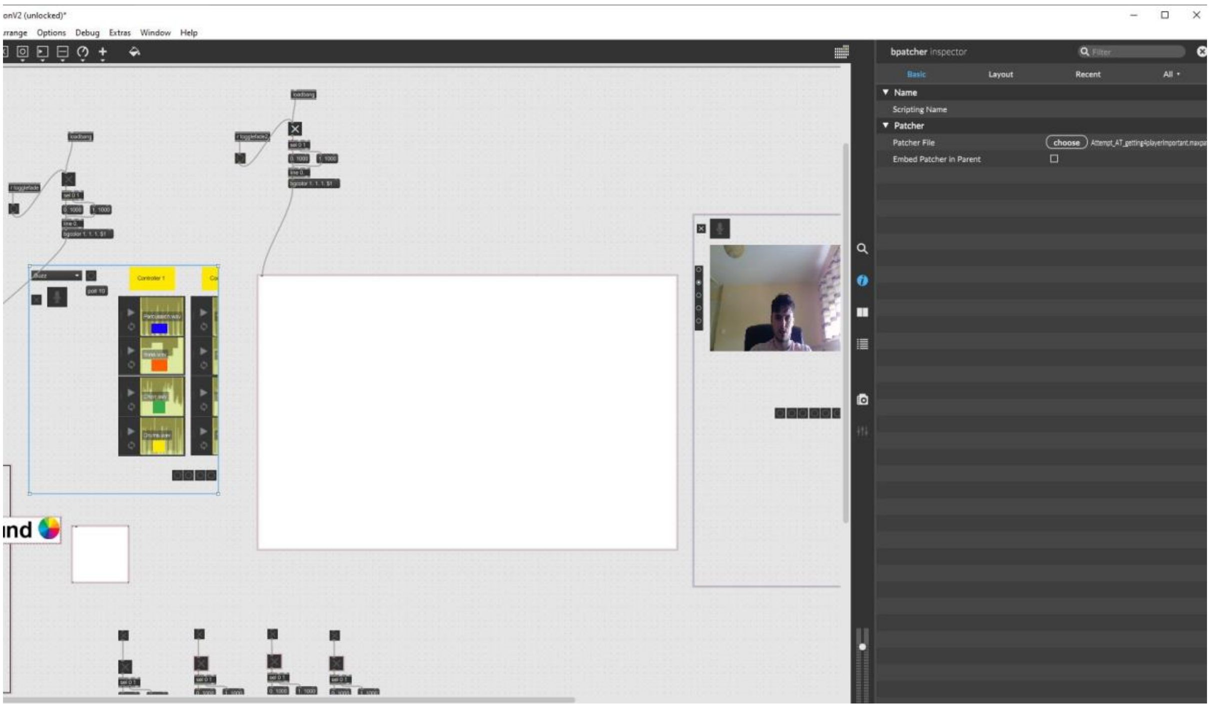
(Figure 26 - Colour Tracker Input in Standalone .EXE)

15.1 Hardware :

Hardware remains the same from the previous prototype (See 13.1).

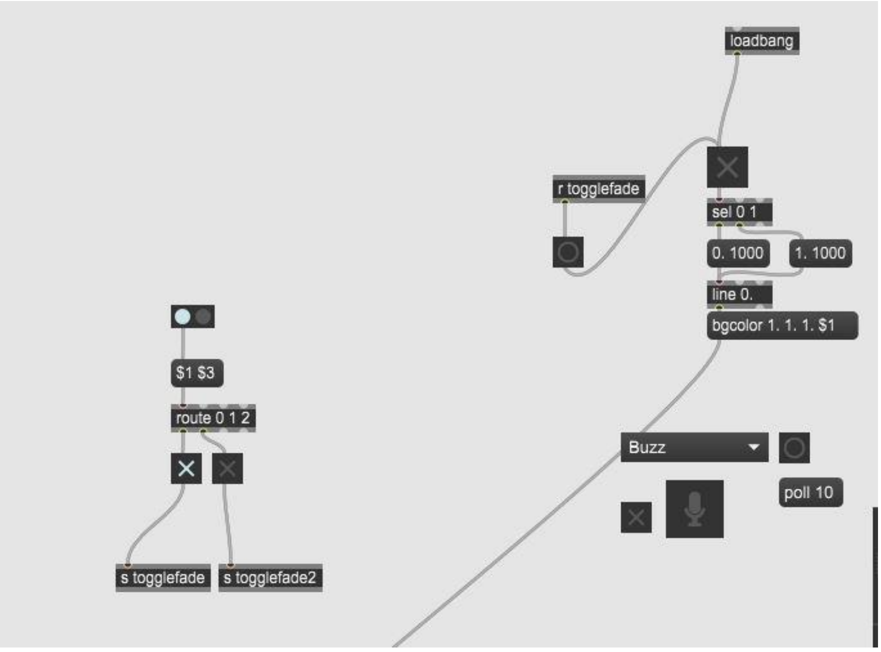
15.2 Software :

As mentioned previously the Buzz and Colour Tracker were two separate patches. The way these patches were brought together was relatively simple. A new blank patch was created which would form as the new one with both the inputs inside of said patch. The separate patches were added into this main one with the use of the bpatcher object, which can load a MAX patch from a different location and have it run inside of another patch. See figure 27 for an image of the Buzz controller patch being displayed with the use of a bpatcher (Inspector panel on right side of screen shows the location in which the Buzz patch is located).



(Figure 27 - bpatcher Setup)

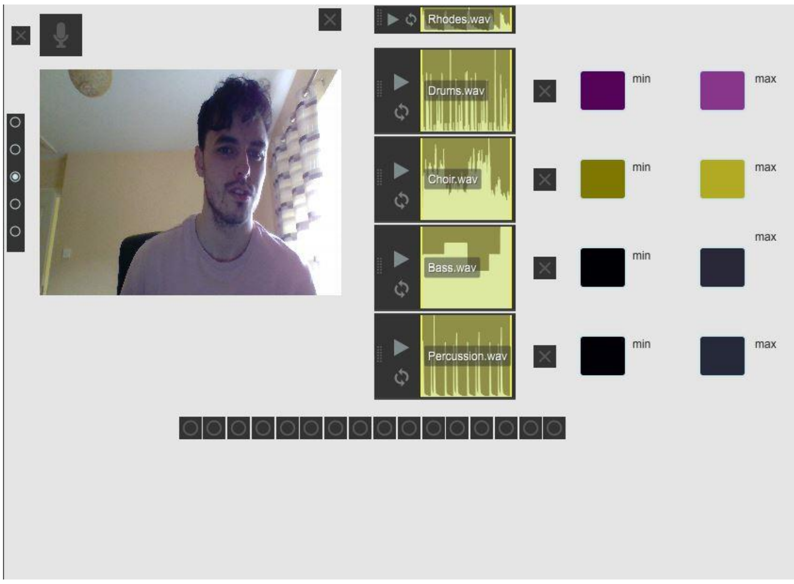
Once the two inputs had been added to this new patch a panel object was added over the top of them which is connected to a series of objects which allow it to fade from white to transparent and vice versa. This is used to hide the bpatcher objects when they are not in use and are done with a simple matrix ctrl object which gives two buttons that toggle between the two inputs. See figure 28 for an image of the matrix (left) and the fade function (right).



(Figure 28 - Matrix ctrl and Transparent Panel Objects)

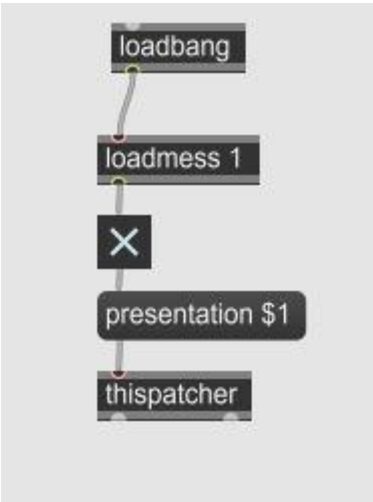
Once the appropriate objects had been added to presentation mode and the transparent to white panel objects were working correctly the patch was organised and everything was positioned in such a way to make using the application as easy as possible. Figure 29 and 30 below show how the two input modes looked in presentation mode in their respective patches before being added into the main patch.

(Figure 29 - Buzz Input Patch Presentation Mode)



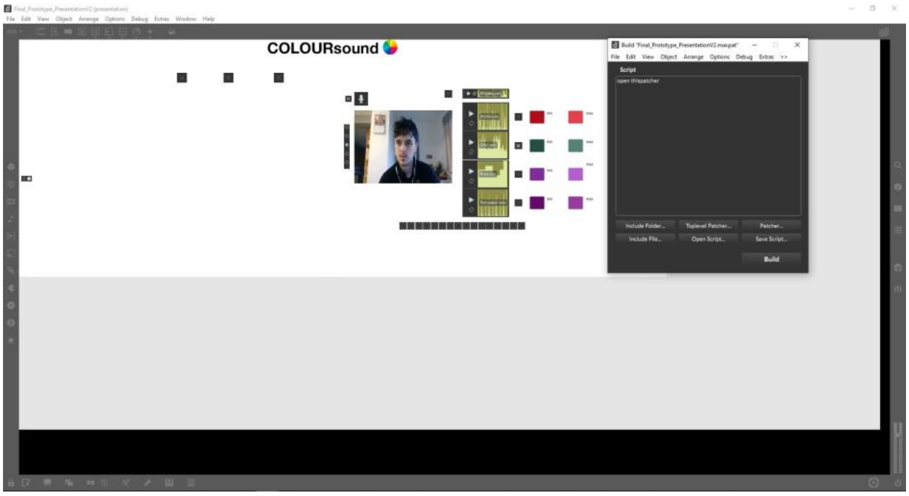
(Figure 30 - Colour Tracker Input Patch Presentation Mode)

A loadbang (when the patch is loaded it sends an on message) was also being sent to this patcher object telling the patch to automatically load into presentation mode upon launch. Figure 31 is an image of these set of objects.

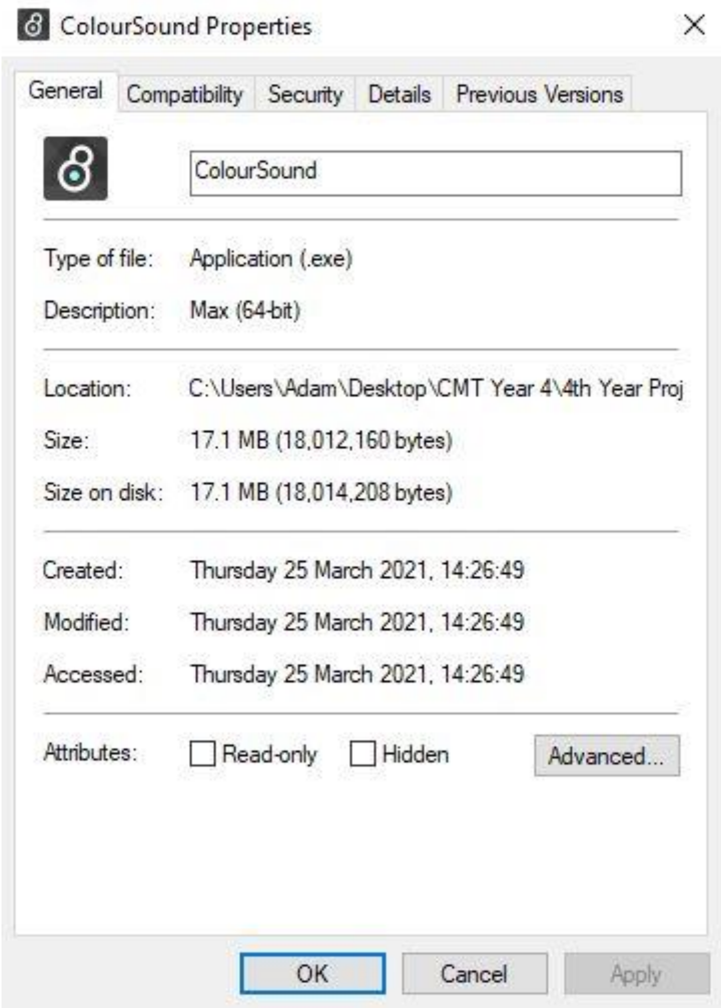


(Figure 31 - Loadbang into Presentation Mode)

Exporting the patch as a standalone .EXE was done completely inside of MAX; no external software was required for this process. The build collective/application feature which can be found under the file dropdown is used to save the patch as its own standalone. Figure 32 is an image of the menu for this collective/application function inside of MAX and figure 33 is an image of the .EXE file it creates.



(Figure 32 - Build Application Menu)



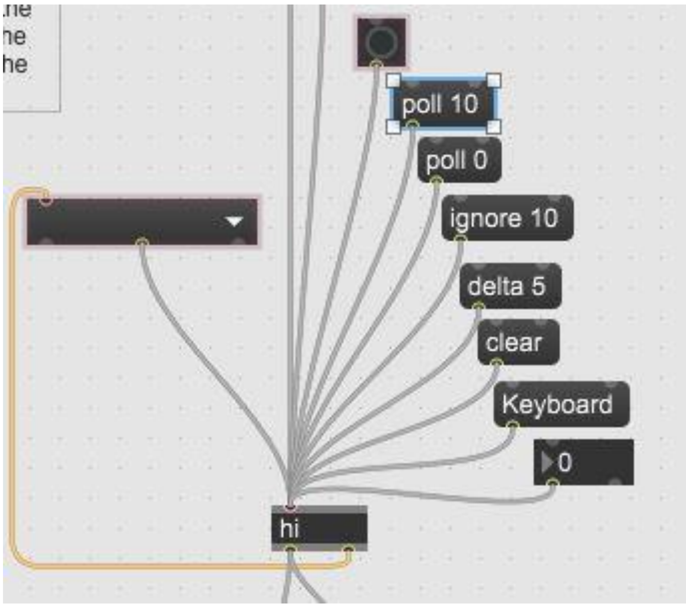
(Figure 33 - .EXE of Application)

15.3 Features :

- All functionality from inputs included in the previous prototype (See 14.3).
- GUI/Interface which allows the user to switch between the two inputs.
- Users can now add or remove users from the Buzz input section.
- Runs as standalone .EXE so can be used without the need for MAX.

15.4 Issues :

An issue that was present and cannot be alleviated due to the way the Human Interface (HI) object in MAX works is that the poll 10 message object connected into the HI object must be pressed 2 - 3 times for MAX to start recognising the input from the controller therefore this message object has been included in presentation mode of the patch. See figure 34 for an image of this object connected to the HI object.



(Figure 34 - Poll 10 Message Object)

The biggest issue is the colour tracker works best when in ideal lightning conditions and these conditions will be discussed and explained more in depth in the testing and results chapter that follows this section.

Testing and Results Chapter

16 Introduction :

Due to the nature of this project being mostly software based and making use of already existing consumer products as the inputs, strenuous testing of components did not have to take place, but software was tested and the conditions in which the application works best were also tested.

This section of the report will hopefully provide an insight into the various tests that took place throughout the development of the application.

17 Hardware Testing :

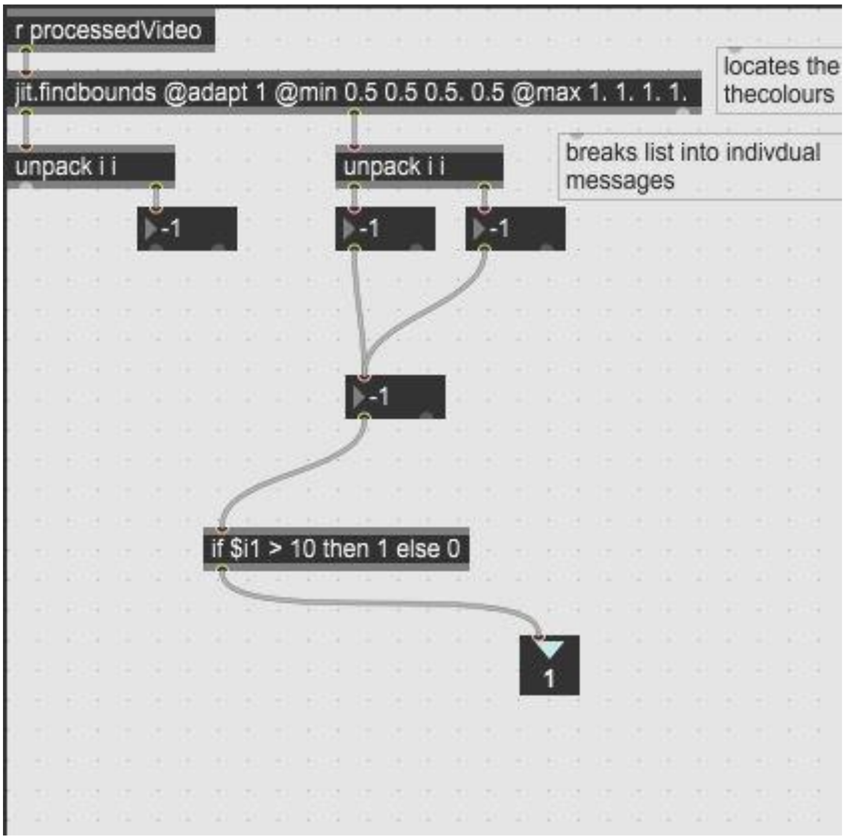
The hardware used for this project besides the PC needed to run the application were the Buzz controllers and the webcam built into the PC. These are pre-built pieces of hardware and did not need to be constructed using electrical components. Despite this, multiple times throughout the project these two pieces of hardware were tested to see if they are working as intended and if they are working within MAX correctly. The way in which the Buzz controllers were tested was by connecting the USB to the PC and reading the values being outputted by each individual controller from the Human Interface object to see if they are as desired and the camera was tested by checking the output of it in the P.window object to ensure it looked as intended.

18 Software Testing :

This section of the report outlines the various tests carried out regarding software. A few sections of the MAX patch had to be tested and altered to provide a better result.

18.1 Unit Testing :

Figure 35 below displays the sub patch which is used to find the dimensions of the colour being tracked and output a numerical value which is used to turn the trigger for an audio loop on.

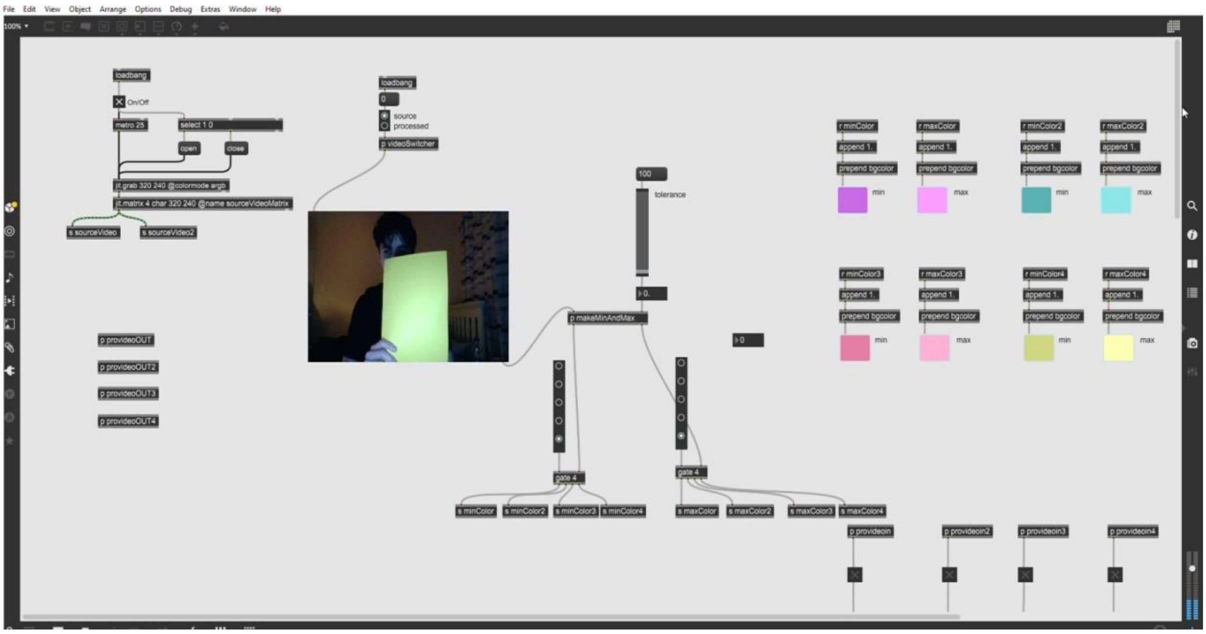


(Figure 35 - Sub patch Used to Find Dimensions of the colour being tracked)

The object labelled "if $i1 > 10 then 1 else 0" is a conditional statement which is used to send an on message through the outlet of the sub patch out to a toggle. When the number object above the conditional statement is above 10 then the on message is sent. This was used to smooth out the value slightly to give a better experience for the user as previously the toggle would jitter whenever the colour its tracking was detected, which produces an unwanted result.

A lot of testing went into the ideal lighting conditions needed for the colour tracker to work correctly, with it being tested in different rooms but due to the nature of Covid 19 testing in other locations with different lighting scenarios was not possible. In all the images used in this report where the output of the webcam can be seen are taken when the application was being used with a natural source of lighting present in the room such as the light coming in from a window (See Figure 26 and 30). It became apparent early on when the colour tracker was being used in a room late at night with artificial light coming from the light in a room that this light would throw off the colour tracking capabilities. This is due to how the lighting in the room affected what the colour looks like on the webcam. Colours such as blue and purple ended up looking quite similar in these lighting conditions which caused issues such as toggles being triggered by accident due to how similar the colours looked and sometimes the lighting conditions caused the colours to not be tracked whatsoever which can be seen in figure 36.

The tolerance slider seen in figure 37 can also be used to change how dark or bright the minimum and maximum of the selected colour being tracked is and can be used to help alleviate some of the issues caused by subpar lighting conditions, but it is not able to completely fix the issues caused. It is recommended to use the colour tracker in more natural lighting conditions as this will produce the best results and makes sure the tracking works as intended.

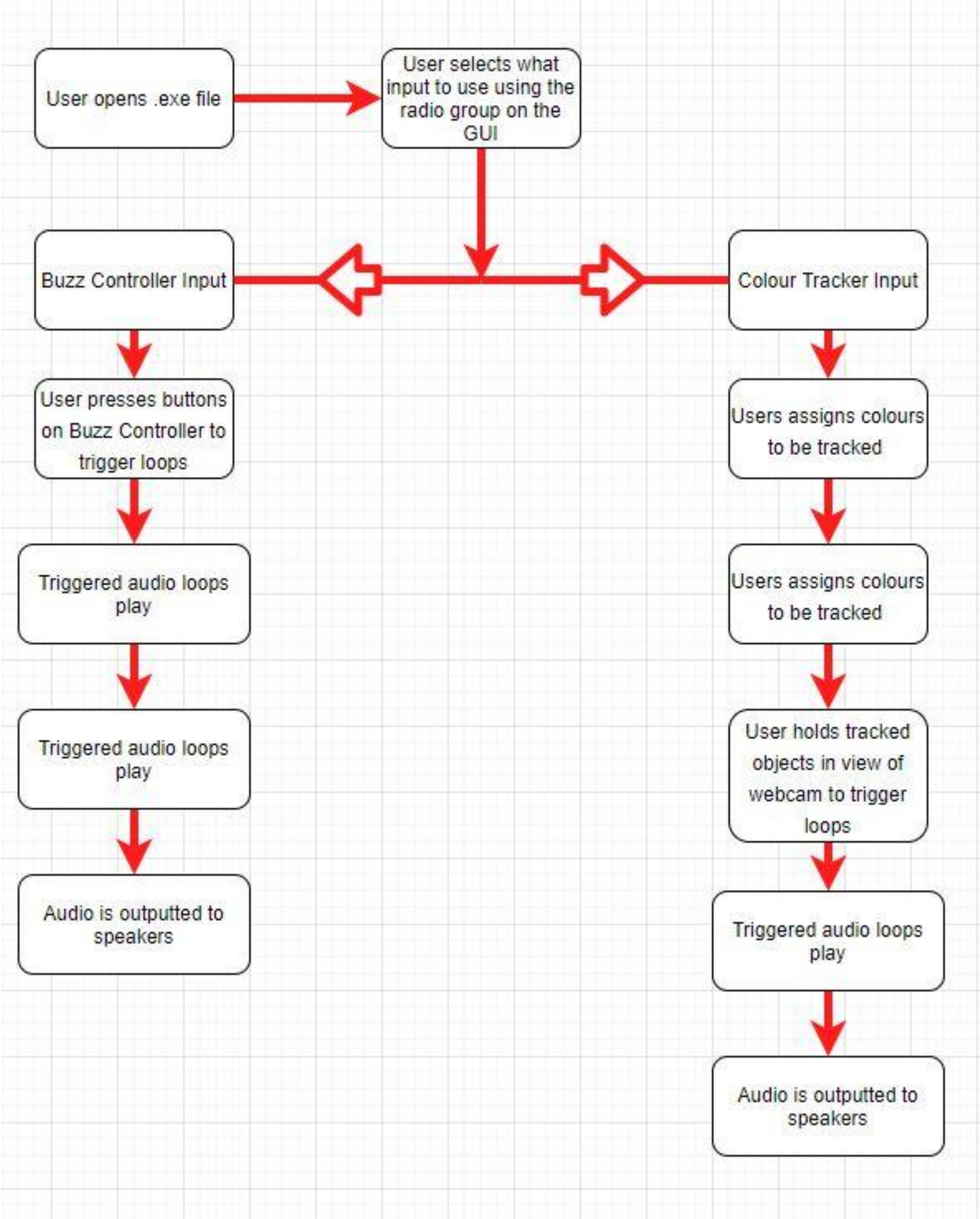


(Figure 36 - Yellow Page not being tracked due to lighting conditions)

(Figure 37 - Tolerance slider used to change how dark or bright the minimum and maximum of the selected colour being tracked is)

18.2 Systems Testing :

Figure 38 below is a flow chart of the expected outcome of using the application.



(Figured 38 - Expected outcome of code in conjunction with hardware and user inputs)

The MAX patch was rigorously tested to find any faults in it that we would cause the patch to break down. Pressing multiple buttons on each of the four Buzz Controllers was done to see if it caused any lag spikes with the performance but no such issues occurred, all the JPGs used were checked to see if they correctly correspond to the colour of the button on the controller, all the sequencers were looked at to ensure they were all triggering at the same time and kept in sync with each other.

Figure 38 above is the expected outcome of the project, software and hardware working together. This diagram was referenced throughout the testing stage to ensure the application was working as intended and was helpful in realising how it should all work together.

18.3 User Testing :

Due to Covid-19 and the vulnerable nature of the possible user of this project rigorous users testing could not take place but a special needs assistant in a primary school had the opportunity to test the project. The application was presented to her with a brief explanation of how it works and what it is capable of and then the special needs assistant used the application for around 15 minutes. She was happy with the way it performed and found it easy to use and understand. She commented on how she thinks it is something that could be used with a child who has a disability and remarked that it could be a way for such children to express themselves through music.

Unfortunately, more testing could not be done to get feedback on whether the project is interesting for such users but the feedback that was received was reassuring and the project worked as intended during this test.

18.4 Conclusion :

It is quite hard to visualise any of the errors or results that might have occurred when testing this application due to the nature of MAX being a visual programming language. Although, images have been included such as figure 36 which shows the colour tracker not working in subpar lighting conditions and in figure 35 an example of a change in the MAX patch that improves the overall user experience is shown which should help to visualise some of the testing that occurred. The appropriate steps were taken during the testing phase to ensure the desired outcome of the project that had been set out in its conception at the beginning of this report.

19 Final Conclusion :

This report has detailed the construction of the ColourSound project from its conception to its final iteration. The ColourSound application in its final form is a standalone .EXE that is aimed at allowing users with disabilities to perform music with two different disabled friendly inputs. The project's aim from the beginning has been to offer an alternative to the traditional way of performing music and to offer an easy-to-use introduction to the world of music to people who might not have previously been able to do so, all without the need for expensive and difficult to learn equipment and software. The project could be used in various environments such as at home, in school or in conjunction with a disabled organisation who could possibly find a use for the ColourSound project. It is unfortunate that due to Covid-19 this project could not be demonstrated and used by its potential user base but when everything returns to normal this project could possibly be something that inspires users to create and perform music.

The research section of the report covered all the different technologies, methods and reasoning that go into creating a software that in conjunction with different inputs aid people with physical disabilities to express themselves and create music for themselves. The design chapter detailed the software and hardware used and the design considerations behind the device. The implementation chapter of the report centred around how the various prototypes were implemented and the changes and issues with each iteration up until the final version. Detailed descriptions of the MAX patches that were created for this project were also discussed in this section.

Finally, the testing and results chapter talked about the various tests that took place to ensure the project worked as intended and any changes made to the project to ensure these positive results were mentioned.

Numerous different skills were learnt and improved upon in the process of creating this project. The main one being a whole new language of coding (MAX) had to be learnt from scratch but with guidance from my supervisors at IADT the necessary proficiency needed to create such a project was attained. Time management skills were improved upon and meeting the deadlines throughout the year was possible due to this skill being slowly but surely improved. Good Communication skills were necessary as this project was built entirely at home but communication from supervisors was excellent and aided in the creation of ColourSound.

Lastly, this project can personally be considered a success as what was set out at the start of the year has been achieved and the final iteration of ColourSound is a showcase of the skills that have been learnt in the four years of Creative Media Technologies in IADT, not just from a technical standpoint but also since this project was built entirely at home with hardware that was readily available. In an ideal world this would not have had to occur but considering the circumstances a decent attempt was made at creating such a project.

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Appendix :

CMT (DL835) Student Projects
20/21 – Home working and Covid-19
'Low Risk+'

Standard Risk Assessment Template
For activities carried out in the School of Creative Technologies facilities **and at the student's home.**
These are projects where all Hazards are Ranked as a 3rd Rating.
See Risk Rating Matrices on Pages 10 and 11.

Project Risk Assessments and the methodology are needed to comply with the Safety, Health and welfare at work act 2005 and all other relevant Legislation. This document is based on the 'Joint Risk Assessments' procedure – IADT – December 2010.

The document has been updated to now include:

- Home working risk identification and control – highlighted in italics
- Covid-19 risk identification and control – highlighted in bold
- The Low Voltage Directive, LDV (previously in a separate document

PLEASE NOTE: HOME-WORKING AND COVID-19 HAS RAISED THE LEVEL OF THE RISK OF HOME WORKING AND LAB WORKING, SO THAT THE LOW RISK TEMPLATE IS NOW OF A LEVEL IN BETWEEN THE LOW AND MEDIUM RISK LEVEL AS DEFINED IN THE PREVIOUS ACADEMIC YEAR.

PROGRAMME/YEAR:

STUDENT NAME	**SUPERVISOR:** Dr. Sivakumar Ramachandran
DIGITAL SIGNATURE: Adam Harvey	DIGITAL SIGNATURE:

DATE: 20/04/2021	DATE:

By signing this assessment, it is agreed by all parties that:

- The student has taken part in the relevant class session and/or seen the accompanying powerpoint presentation
- The full facts relating to the health and safety aspects of the project have been declared by the student
- All parties are fully aware of the safety risks
- All parties will implement the control measures detailed, in order to reduce the contribution of the hazards to the level of the risks detailed.

Location of Work:	*Relevant Campus facilities such as the laboratories, and at the student's home*

Brief RELEVANT Details of project: 20 words, highlighting the current drawn from the power supply and any processes that may be dangerous in the lab or at home.	None.

Step 1: Initial Hazards Identification

Risk Assessment No.	INITIAL HAZARD
1	Electrocution
2	Fire
3	Cutting injuries
4	Drilling injuries
5	Heavy equipment
6	Burn Injury
7	Fumes

Step 2: Risk Assessment Forms

(Start Overleaf)

Significant Hazard and consequences:	**1. Electrocution**

Who might be exposed to the hazards:	*Students, staff and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	*Develop projects that consume low current (less than 1A) and use batteries or well-maintained AC/DC conversion units, particularly for the home environment.* Circuit design must include features that will minimise likelihood of electrocution of anybody, when in an unsafe mode, e.g. use of fuses and circuit breakers *in lab and home devices and supplies*. Short circuits should be identified and removed before the testing stage. Cable and insulation should be checked before testing stage. Power supply equipment should be PAT tested on a regular basis in the lab. *Faulty power supply equipment at home should be identified and repaired by a qualified electrician before being used again.* *Liquid* sources should be kept away from the project, when in operation. Components, whether connected to power supplies or not, should be fully discharged before inspections – isolated from power supplies, are commenced. Eg discharge capacitors greater than 50µF via a 100Ω resistor. Be aware of the locations of first aid kit and fire extinguishers, *in the laboratory or in the home; familiarise yourself and* use these items if suitably competent/trained. *Be aware of actions that need to be taken in the event of electrocution, such as calling emergency services, resuscitation, and wearing insulation if touching the person electrocuted.*

Significant Hazard and consequences:	**2. Fire**

Who might be exposed to the hazards:	*Students, staff and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	Maintain tidy work practices on benches, the laboratory environment and *household surfaces.* Keep combustible materials, eg paper, plastic, away from heat sources, such as soldering irons. Stow heat sources away safely when not in use, eg use a sturdy soldering iron stand. Circuit design must include features that will minimise likelihood of a fire, when in an unsafe mode, e.g. use of fuses and circuit breakers. Short circuits should be identified and removed before the testing stage. Suitable cable and insulation should be used, with a safety margin on the rating and size. *Liquid* sources should be kept away from the project, when in operation. Be aware of the locations of first aid kit and fire extinguishers, *in the laboratory or in the home; familiarise yourself and* use these items if suitably competent/trained. *Put in place measures that make the home working area is fire separated from other parts of the home, make that place relatively free of combustible materials, ensure there is some form of smoke detection in place, ensure there is a clear path to the nearest exit of the house.* In the event of a fire, leave the laboratory/building *or household working area/home* in an orderly manner, and sound the fire alarm if it has not already automatically activated.

Significant Hazard and consequences:	**3. Cutting injuries**

Who might be exposed to the hazards:	*Students and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	Maintain tidy work practices on benches/ laboratory environment *and on household surfaces*. Develop projects with the minimum requirement for cutting any jagged edged in the final manufactured item. Use of quality, maintained tools and clamps if necessary. Use of a cutting board and goggles. Clear a space around the cutting area before commencing work. Tie back hair and loose clothing from the cutting area. Remove jewellery. Be aware of the location of the first aid kit *in the laboratory and at home* and use the kit if suitably competent/trained.

Significant Hazard and consequences:	**4. Drilling injuries**

Who might be exposed to the hazards:	*Students, staff and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	*In the laboratory*, only use the drill equipment if training, given by staff, has been undergone. *At home, follow all manufacturer's instructions in using a drill.* Use of quality, maintained drilling equipment and goggles. Secure drill bit and table. Use the drill guard. Check all fastenings are complete before switching on the drill machine. Drill machine *and equipment* should be tested and checked on a regular basis. Develop projects with the minimum requirement for cutting any jagged edged in the final manufactured item. Use of quality, maintained tools and clamps if necessary. Use of a cutting board and goggles. Clear a space around the cutting area before commencing work. Tie back hair and loose clothing from the cutting area. Remove jewellery. Be aware of the location of the first aid kit *in the laboratory and at home* and use the kit if suitably competent/trained.

Significant Hazard and consequences:	**5. Heavy equipment**

Who might be exposed to the hazards:	*Students, staff and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	Maintain tidy work practices on benches and the laboratory environment. Undertake heavy lifting only if suitable advised and/or trained. Correct posture and lifting procedures. Use mechanical lifting aids where possible and appropriate. One or more persons to be involved in lifting or supervising the lifting of heavy equipment. *Take help from a household co-habitant where necessary, appropriate and possible.* Clear a space around the lifting area before commencing work. Tie back hair and loose clothing from the cutting area. Remove jewellery. Use protective footwear, and also headwear if necessary.

Significant Hazard and consequences:	**6. Burns**

Who might be exposed to the hazards:	*Students and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	Maintain tidy work practices on benches and the laboratory environment. Only use soldering irons and other hot-works appliances if training, given by staff, has been undergone. Keep combustible materials, e.g. paper, plastic, away from heat sources, such as soldering irons. Stow heat sources away safely when not in use, eg use a sturdy soldering iron stand. Cable and insulation should be checked before using soldering irons, or electrically powered hot-works appliances. Use gloves, goggles and other personal protection equipment where necessary. Use cooling equipment, such as wet sponges for soldering irons. Do not allow water from any source to penetrate electrical cables and wires. *Let members of the household know you are using a hot device. Keep soldering irons and other hot devices away from children and vulnerable adults.* *Make the sure the device is placed stably on the working surface, away from combustibles including mains cables, particularly that belonging to the device.* Tie back hair and loose clothing from the cutting area. Remove jewellery.	

	Be aware of the locations of first aid kit and fire extinguishers, *burn gel and plasters, in the laboratory and at home,* and use these items if suitably competent/trained. In the event of a fire, leave the laboratory/building *or household working area/home* in an orderly manner, and sound the fire alarm if it has not already automatically activated. Electrically powered hot-works equipment, such as soldering irons, should be checked and tested on a regular basis. *If found to be faulty, particularly at home, tt should be repaired by a competent electrician before being used again.*	

Significant Hazard and consequences:	**7. Fumes**

Who might be exposed to the hazards:	*Students and household members.*

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	Use fume extraction equipment, eg. for solder fumes. Keep laboratories *and household working areas* well ventilated. Take frequent breaks from activities generating fumes, *in the open air*. Employ a higher level of control measures when an individual suffers from a respiratory condition, such as asthma, taking advice from a GP**. In particular, take advice from a GP before you use a device which generates fumes, particularly if you have or have had a respiratory condition or disease such as Covid-19.** Solder fume extraction equipment and other similar items, should be maintained checked and tested on a regular basis.

Significant Hazard and consequences:	**8. Infection of Covid-19**

Who might be exposed to the hazards:	**Students, Staff, and household members.**

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	**Follow ALL government guidelines, those from the Health Services Executive and the Health & Safety Authority. Keep updated daily on changes to these guidelines via their authorises websites.** **<u>These include, and interpreted thus, but not limited to:</u>** **Use personal protective gear for the face, such as a recommended mask for a professional environment, or a close fitting vizor, or both, in the lab,** **Be aware of all laboratory provisions for Covid-19 safety.** **Be aware of the Covid-19 safety station in the laboratories – containing hand sanitiser, blotting paper, disposable gloves. Use these items before commencing the lab session, during if necessary and afterwards especially if food is consumed before and after the lab session. At home, set up an equivalent Covid-19 station, and use the equipment as you would in the lab.** **<u>It is expressly forbidden to eat in the labs, and it is recommended to do the same at home.</u>** **Wipe down all surfaces before, during (if compromised) and after the lab sessions and at home, including touch points such as door and equipment handles.** **Do not touch the face, head unless the hands are clean with sanitiser.** **Cough into your elbow if necessary or into a tissue which you should then dispose of the tissue in the flip-top bins in the lab and wash your hands with soap or use hand sanitiser.** **Keep more than 2m in distance from anybody else in the laboratory. Navigate yourself around the lab to avoid close contact.** **Keep laboratories and household working areas well ventilated.** **Take frequent breaks from activities generating fumes, in the open air.**

	Employ a higher level of control measures when an individual suffers from a respiratory condition, such as asthma, taking advice from a GP. Take advice from a GP before you use a device which generates fumes, particularly if you have or have had a respiratory condition or disease such as Covid-19. **Enter and leave the lab in an orderly manner, ensuring social distancing, even in an emergency, such as a fire incident.** **Follow the regulations of disposal or high temperature cleaning, relating to your personal protective equipment.**

Additional Hazards and Control Measures to be identified here, in the same format as the preceding sections. Paste in more pages if necessary:

Significant Hazard and consequences:	

Who might be exposed to the hazards:	

Proposed Control Measures – to be written in conjunction with project supervisor and revised at key project milestone dates	

Risk Rating Matrices

By looking at the hazard and asking how many people will be exposed to it, decide on the probability of an incident/accident occurring.

Example: Take an extension lead trailing along the floor up against the wall. The extension lead is a hazard and if it is in an office with one person working in it the probability and likelihood is "improbable" (see table No.1) because the lead is along the wall. However, if the lead is in a corridor with 200 people walking by there is a chance that someone could kick it out from the wall accidentally and create a greater probability/likelihood of a loss occurring thus upping its rating to "remote".

When this is done you must decide on the seriousness of the loss, using the four columns on the left side of the Table No.2 below.

Example: Firstly taking the one person office example from above the possibility/likelihood is "improbable "but the result might be a "minor injury" e.g. scrape or a bruise. This gives us an "acceptable risk no action required" If we were to put the lead on a building site across an unguarded stairwell with 50 people using it the result is now possibly "fatal". This gives us a "1ST rank action".

Table No. 1:

PROBABILITY/LIKELIHOOD	DESCRIPTION
Likely/frequent	Occurs
Probable	Not Surprised. Will occur several times.
Possible	Could occur sometimes.
Remote	Unlikely, though conceivable.
Improbable	So unlikely that probability is close to zero.

Table No. 2:

	LIKELY	PROBABLE	POSSIBLE	REMOTE	IMPROBABLE
Fatal	1st	2nd	2nd	3rd	
Major Injury/ permanent disability	2nd	2nd	3rd		
Minor Injury	3rd	3rd			
No Injury					

By using the matrices above we now have an action needed ranking system. This means we can prioritize the hazards depending on their ranking.

Table No. 3:

	1st rank actions - requires measures to be put into place within a few hours
	2nd rank actions - requires measures to be put in place within a few days
	3rd rank actions - requires measures to be put in place within a few weeks
	4th Rank action – requires measures to be put in place within a few months.

Taking all this information and pooling it in the Initial Hazard Identification log we can now prioritise the hazards in the left hand column "Risk Assessment No." This number will appear on the top left of the risk assessment forms for easy referencing.

Low + Risk Project – Risk Rating Summary

Risk Assessment No.	INITIAL HAZARD	Probability	Ranking
1	*Electrocution*	*Possible*	*3rd*
2	*Fire*	*Possible*	*3rd*
3	*Cutting injuries*	*Possible*	*3rd*
4	*Drilling injuries*	*Possible*	*3rd*
5	*Heavy equipment*	*Possible*	*3rd*
6	*Burns*	*Possible*	*3rd*
7	*Fumes*	*Possible*	*3rd*

'Low Voltage Directive' Compliance Statement.

DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (codified version) (Text with EEA relevance)

Otherwise known as the Low Voltage Directive (LVD).

If the electrical aspects of your project have a voltage between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current, for voltages at the **electrical input or output** (not internally), then you are signing to **confirm that it complies with all the safety requirements of the LVD**. You must read the LVD and analyse your project before signing, taking advice where necessary.

Student name: Adam Harvey

Digital signature:

Date: 20/04/2021

Project supervisor or delegated representative who is an engineer by discipline:

Name:

Digital Signature:

Date: