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Mayflower and The Seven Seas: Sonification of The Ocean

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Mayflower & The Seven Seas: Sonification of The Ocean

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ABSTRACT

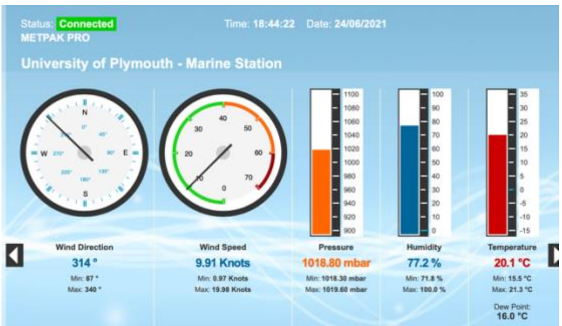
Created in conjunction with the Marine Institute at the University of Plymouth, the intention of this project was to use data transmitted by the on-board sensors of the Mayflower Autonomous Ship (MAS), to manipulate specially created pieces of music, based on sea shanties and folk ballads. Technical issues and Covid delays forced a late change, and the project was switched to using data from the university's weather stations. This paper will illustrate how the music was produced and recorded, and the software configured to make the musical pieces vary and evolve in real-time, according to the changing sea conditions, so that the public will be able to view the current conditions and listen to the music evolve in real-time.

1 Introduction

This project presents an approach for dynamic adaptive modification and mixing of music, based on real-time environmental weather data. With the intention being to promote engagement with the sea, the environment and to draw attention to the changing conditions of the world's oceans, it was decided to create music that would be as accessible as possible to the general public. Music created by sonification processes can often be rather abstract and perhaps difficult to listen to and it was deemed desirable to avoid this, by using familiar songs and presenting them in a relatively recognisable format.

Delays (both due to technical issues with the MAS and the continuing Covid situation) would mean that the project would be amended late in the process. It was decided that the project would be presented at Conference Of The Parties (COP) 26 - the upcoming UN climate change conference. Therefore, data from the university's weather stations around Plymouth would instead provide the data for sonification.

Figure 1.0 University of Plymouth Marine Station web feed



2 Methodology

Data streams from the university's Marine Station's API (Application Programming Interface) are transmitted into Cycling 74's Max/MSP, which then processes and modifies the data, converting it into

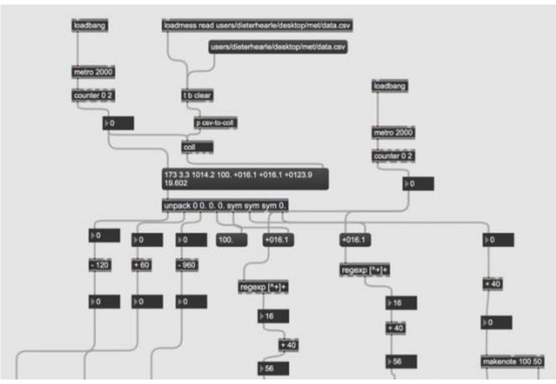
MIDI note and controller data. This data is then sent into Apple’s Mainstage, which plays back and manipulates specially recorded audio files, that were created with Apple’s Logic Pro digital audio workstation.

2.1 Receiving and Processing Data (Max/MSP)

The data source originates from the Mount Batten weather station, operated by the University of Plymouth. To access this data stream, a shell script that grants access to a continuously updating .csv file from the weather station API was used, which is then fed into Max/MSP.

A Max/MSP patch was created and the link to the csv file was loaded into a *coll* object, which facilitates the storage of numerical data. From the *coll* object, the data is then processed into a message box and displayed as a group of numbers. The *unpack* object is then used to separate the numerical data into individual streams. The resulting numbers being output can vary considerably in size, range and rate of change, so various modifying and scaling operations are used on each data stream to convert the output numbers to integers in the 0-127 range that MIDI uses (and that Mainstage expects to receive). These values are then sent into *noteout* and *ctlout* objects that will enable MIDI data to be transmitted into Mainstage.

Figure 2.1 Part of the Max/MSP patch showing how the data from the weather station API is processed into MIDI data.



2.2 Writing and recording the music (Logic Pro)

Seven pieces of music, based on sea shanties and 18th century folk ballads were selected as the basis for the musical pieces, as their nautical theme would suit the aesthetic of the project. These pieces are based around simple melodies and repetitive structures, so would work well within the ‘live looping’ nature of the proposed music system. Being mostly 200+ year-old compositions, they are public domain and therefore royalty-free, which enabled the use of elements from several different songs with the project, whilst eliminating any licensing issues. Numerous versions of the lyrics for each song exist, so some care was taken to select versions that did not contain any sexual language, or potentially offensive phrases.

The process began with sourcing MIDI files of the selected songs, which were then analysed and simplified to create a basic piano backing track that was used to record the vocals to. These piano parts would also be used to extrapolate the other instrumental lines that would be added later in the composition process.

A single female singer was used for all the songs, with numerous takes of each song being recorded to provide multiple layers and harmonies, as the budget did not allow for using more than one vocalist. With the vocals recorded, edited, and arranged, the next step was to select the instrumentation for each piece and to write and orchestrate these parts. It was intended that all the pieces would share a similar aesthetic, reminiscent of a modern film soundtrack, so a combination of traditional and contemporary instruments would be employed. These would be provided by various software instruments, with Native Instrument’s Kontakt software sampler hosting the orchestral libraries that would supply the strings, brass, woodwinds, and percussion sounds. In addition to these, various software synthesisers were utilised to add a modern feel to the pieces, by supplying some additional bass, lead, and pad parts, as well as a number of electronic sound effects.

Additionally, audio recordings of marine life, mostly pilot whales, sperm whales and dolphins, as recorded at sea by the Marine Institute were also incorporated. These consisted mostly of a series of rhythmic clicks and other percussive noises, and these were edited and processed in Logic Pro to provide some interesting rhythmic sounds that could be layered with instruments.

All the pieces were recorded at a base tempo of 75 BPM, as it had been decided after some experimentation, that the tempo data transmitted from Max/MSP would be continuously variable from 40 to 120 BPM. It was felt that this was the best tempo range to provide noticeable variation to the music, whilst still allowing the songs to be recognisable. Each piece would be laid out as a 16-bar section that would loop cleanly. This standardisation of form would allow seamless transitions between the different pieces when they were triggered consecutively.

After all the instrument parts had been written, orchestrated, and recorded, the seven pieces were arranged and mixed inside the same Logic Pro project. This approach allowed for easy comparison of the constituent parts of the different pieces, ensuring that they sounded similar and like parts of the same suite. This also allowed the sharing of effects busses and master processing between pieces, to further help with creating a homogeneous sound. Once the arranging and mixing process was complete, related 'stem' groups of instruments were identified and these were then rendered out as stereo WAV files.

2.3 Playback and Real-time Manipulation (Mainstage)

Each piece would be configured as a separate patch inside a common Mainstage concert file. This would allow MIDI program change commands sent from Max/MSP into Mainstage every 16 bars to select which piece would play, selected at random and triggered at regular intervals by a master clock inside Max/MSP. This same master clock pulse, its speed controlled by an incoming data stream from the weather station API, was also used to generate MIDI clock information, which was transmitted into Mainstage to control the master tempo. Thus, the smooth triggering of consecutive pieces, and the overall tempo of the whole system would be controlled by the same control signal.

Within the separate patches for each piece, each stem was assigned to a separate Quick Sampler instrument. Each of these was configured to follow tempo, so that the stems would respond to real-time tempo changes correctly. All the Quick Samplers within a patch would be set to the same MIDI channel but assigned a different MIDI note number between 60 and 72 (C3 to C4). Max/MSP would randomise the number of MIDI note on messages being sent to the patch, which would ensure that every time the piece was played it would trigger different combinations of stems, thus sounding different to the previous occasion. As well as note off/on and pitch bend commands, each piece would respond to up to three MIDI continuous controllers, which would be used to control assignable parameters, such as reverb/delay send amount, filter cut-off frequency etc.

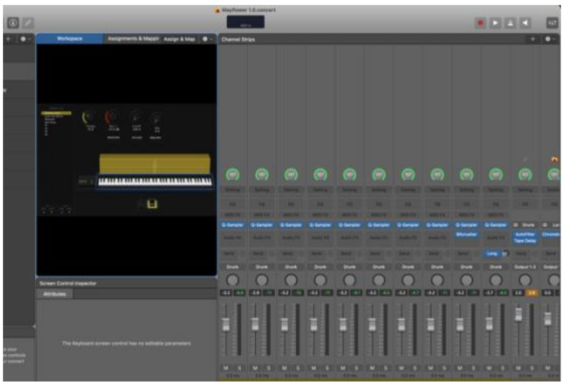
After some experimentation a standard mixer set for each patch was arrived at, consisting of a long reverb on an aux send exclusively for the vocal stems, a low-pass filter for the whole mix, and a quarter note delay for the whole mix with a high feedback value. As every stem was assigned its own mix fader, adjusting the relative levels of each instrument was an easy task and could also be automated too, if required.

Pitch bend data would be sent from Max/MSP and this would vary the pitch of each piece in real-time by +/4 semitones. This is achieved by setting every Quick Sampler instrument in a patch to use the same pitch bend range, and as MIDI pitch bend data is received globally by all instruments set to the same MIDI channel, consequently every individual element of each piece would change pitch in the same way. Additionally, because all the Quick Samplers were set to follow tempo, the timing of the pieces would remain unchanged when pitch bend commands were received, allowing the independent control of pitch and tempo from separate controllers.

During the initial experimentation phase the most satisfying results were achieved by mapping the following weather parameters, to these controllers in each Mainstage patch.

- Wind direction was assigned to pitch. This was because the wind direction remains constant for several seconds but can change suddenly and dramatically for a second or two, before returning to its previous value. This created some interesting sudden changes in the music, but still allowed a sense of 'home' pitch to be maintained.
- Wind speed was assigned to low-pass filter cut-off frequency. This was chosen because wind speed is the second most dynamic of the weather parameters and dynamic modulation of a low-pass filter can be an interesting effect.
- Pressure was assigned to the vocal reverb auxiliary send. This parameter changes very slowly but can be scaled easily to change rapidly, by adjusting the number of decimal places that Max/MSP reads from the .csv file.
- Humidity was assigned to the whole-mix delay, again with the same scaling system as the pressure parameter.
- Temperature was assigned to tempo. This was chosen because, whilst relatively large changes can occur over the course of a single day, this usually changes quite slowly. Quite rapid variations can happen as dramatic changes in the weather occur, e.g. clouds clearing and being replaced by sunshine.

Figure 2.0 A Mainstage patch of one of the pieces.



3 Conclusions

Although still at the experimental stage, (at the time of writing) the current configuration has been found to deliver satisfactory results, both from a technical and aesthetic perspective. After much experimentation, the software was made to work smoothly, and test audiences enjoyed the music.

The standard arrangement and tempos, along with the emphasis on standardised song sections at the writing and recording stage, facilitated smooth and seamless transitions between the pieces. The automation of parameters such as effects sends also helped to smoothly segue the individual pieces together, by extending reverb and delay tails across the transitions between pieces. A great deal of work was required within Max/MSP to find methods to scale the data streams, to prevent the sudden jumping of parameters, as this could potentially cause rather jarring changes to the music that audiences may have found difficult to listen to. The constant, but relatively gentle pitch and tempo changes provided some interesting colour, whilst retaining an overall sense of musicality. Those parameters could easily be exaggerated through scaling though, if the intention was to create more dynamic and dramatic music.

This system is very much open-ended and allows for a huge amount of customisation, not only in how the data streams are interpreted and processed in Max/MSP, but also how the musical parameters of the Quick Samplers and effects can be configured in Mainstage. Even swapping the control sources for two parameters can yield drastically different results, dramatically changing the sound of the music being output.

The system can easily be adapted to use input data from any appropriate source, with only a small amount of modification to the input and scaling parameters in Max/MSP. Whilst our test set-up used MIDI note on/off messages, program change, pitch bend and up to three continuous controllers, this was because it was tailored to the number of parameters that our data source provided. This could be expanded to any number of input sources, mapped to any number of musical parameters.