Network Jamming: Distributed Performance using Generative Music

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ABSTRACT

Generative music systems can be played by musicians who manipulate the values of algorithmic parameters, and their data-centric nature provides an opportunity for coordinated interaction amongst a group of systems linked over IP networks; a practice we call Network Jamming. This paper outlines the characteristics of this networked performance practice and discusses the types of mediated musical relationships and ensemble configurations that can arise. We have developed and tested the jam2jam network jamming software over recent years. We describe this system, draw from our experiences with it, and use it to illustrate some characteristics of Network Jamming.

Keywords

Generative, Network, Interaction, Ensemble, Collaborative.

1. INTRODUCTION

The control of generative music systems as a performance practice provides some unique challenges for system designers and performers alike. Not least of these is managing the degree of control or autonomy of the system because this can effect the performers sense of agency and engagement with music. In ensemble performance situations the complexity of any personal instrumental interactions is compounded by the need to negotiate social and artistic relationships with others. Add to this digitally mediated coordination between geographically dispersed ensemble members in the absence of body language cues, and you have the complex context in which we situate network jamming. The Network Jamming systems described in this paper are designed to support inexperienced musicians to experience sophisticated ensemble performances.

In this paper the issues and opportunities of network jamming will be explored, and illustrated throughout by referring to the jam2jam software that has been developed to investigate the possibilities and practicalities of jamming with networked generative music systems.

2. BACKGROUND

A range of interactive computer music practices fall under the scope of either network jamming or generative music, but only some relate to this research. Discussions of musical performance over digital networks often include concerns about audio transmission and data latency and integrity. However, these issues will not be of central concern in this paper because network jamming coordinates human-controlled generative systems as operational nodes in a network, rather than transmit audio or video between nodes. Another common concern in the literature is system synchronisation; this will be briefly discussed. A third issue, often raised about networked performance, concerns the protocols for managing control in a distributed system. This issue can be solved with social negotiation so Network Jamming system designs enable all participants to control all parameters and then let ensemble members negotiate the sharing of artistic responsibility.

Generative computer music systems deploy algorithms designed to produce music in real time. This might also be regarded as on-the-fly algorithmic composition. This discussion of Network Jamming is concerned with generative systems designed so that users directly adjust the parameters of algorithms in order to control the musical result. For the purposes of focusing this discussion, interactive music systems are excluded if they that take as input human instrumental performance requiring analysis or interpretation by the system.

By way of illustration, generative music performance systems that fit our scope are the *ReacTable* [1] and *Morph Table* [2], where ongoing sound synthesis or musical morphing, respectively, is controlled through manipulation of feducial markers on a tabletop. Similarly, using a Wii controller as an interface, Pachet [3] has transformed his interactive compositional system called *The Continuator* into a real-time generative Jazz improviser. There have also been collaborative networked composition systems, most of which are out of scope except those that operate in real-time such as *FMOL* [4].

Another interesting influence of this work is the increasingly common use of generative music systems in computer games [5]. To some extent interactive games such as *Amplitude*, *Rock Band* and *Guitar Hero*, can be seen as related, however, only a few of this class of game use generative music systems. Most rely on audio recordings as accompaniment with user gestures triggering an additional part, rather than allowing real-time variation of the backing music. Applications that do allow control over generative systems include *Music Mouse* and *M* software and the *MadPlayer* device.

3. JAM2JAM

Network jamming research focused on understanding how collaborative musical experiences can be made accessible to young people, and on what the social and educational benefits of media performance might be. The research has also been concerned with how a media performance system should be designed to be accessible and engaging. As addition to enabling music making for those with limited prior performance

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experience, network jamming systems have been found to assist users to build creative relationships with others through music improvisation, both locally and remotely.

These interests have led to the development of the jam2jam series of network jamming software as a vehicle for exploring these ideas through field trials in community arts and educational settings. The software started as a music-only application, but it now includes real-time video and image remixing, and the version discussed here is jam2jam-av. Adding video capabilities helped the network jamming activities acquire overtones of DJ/VJ night-club remixing culture that resonated with a youth audience.

Jam2jam is a generative media instrument that allows performers to control algorithmic parameters that vary the media output. Playback is automatic in jam2jam and control results from mapping continuous controllers onto algorithmic variables. In the current version, mappings are mostly one-dimensional; for example one controller effects density and another pitch range, and so on. However, at the next level algorithms may effect a number of variables or conditions depending on how that musical element is interpreted. For example, the 'density' function takes account of event duration, the function of pitch in the current harmonic context, and onset placement in the current metrical context.

Figure 1. The jam2jam-av software interface.

The graphical user interface, shown in figure 1, allows for selection of parameters using buttons around the perimeter of the display, and control of those parameters for each instrument by dragging the its icon around the screen. Accompanying video material can also be transformed and is played in the background behind the buttons and icons. The software uses a 'band' metaphor and has four instruments and a video channel that can be controlled by one or more players.

The jam2jam algorithms provide discrete control over media parameters such as pitch, rhythm, colour saturation, rotation, and so on. The ability to treat these parameters distinctly and in combination is significant for the expressive range of the system. The ability of jam2jam to record and replay video clips of performances enables reflection, sharing and critique. This jam2jam software was written in the Impromptu environment [6] and runs on Mac OSX systems.

4. COORDINATING NETWORKS

The jam2jam software allows multiple external controllers to simultaneously access parameters; for example, one performer may operate the graphical user interface and several others using appropriately setup external MIDI controllers. In addition, if multiple computers are running jam2jam they can be networked via the jam2jam server; as illustrated in figure 2. By broadcasting every client's controller movements the parameter state of all jam2jam clients remains consistent.

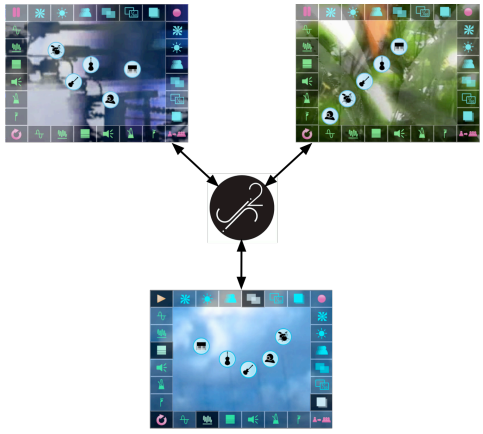

Figure 2. A simple network jamming topology.

When users enter jam2jam, they are presented with a visual indication of several 'scenes' which each contain their own musical and visual material. Scenes act like chat rooms and jam2jam allows several users to enter a scene. All those jamming in the same scene effect each other's parameter state and therefore collaborate like a 'band' during performances.

When jam2jam starts up, other networked users may have already entered the scene. If so, then 'person' icons below the scene show their presence; see figure 3. The colour of the person icon indicates whether or not they are jamming over the internet or on a local area network. At present, six scenes allow users to group themselves into six separate bands.

Figure 3. Scene selection at the jam2jam-av startup screen. The person icon indicates someone is already in scene two.

In a networked jam, an interesting aesthetic effect arises from stochastic properties of the generative algorithms. Despite the fact that parameter states remain consistent across the jam2jam clients in the same scene, there are subtle variations in the generated output. A bigger variation between nodes occurs when media are input from a microphone or camera. Because these media are local, but the transformations and effects on those media are shared, the results can vary in interesting ways between computers. Users of jam2jam that collaborate at a distance have tended to embrace this effect as a feature of the system, rather than see it as a negative, and some interesting discussions about the comparative outcomes can arise when performances at each location are recorded and shared. When groups are collaborating at one site it is typical that the output of only one computer is projected/heard and therefore the shared experience is more unified.

Network latency and responsiveness can be serious issues with networked performance. In our model of network jamming with generative systems we sidestep many of these issues, because jam2jam only transfers parameter data, rather than

audio and visual data, over the network. Therefore, network traffic is light and the operation of each client is not so dependent on receiving data in a timely manner. Jam2jam needs only to communicate a few small instructions to ensure the local experience for each node is virtually the same. Timing information is communicated over the network also, keeping all clients synchronised in tempo and metric location.

In order for gestures to be coordinated across a network of distributed performers, music playback needs to be synchronised. In jam2jam this is achieved by using coordinated universal time (UTC) and relying on the fact that modern computer clocks are very accurately set. When a client enters a jam scene they are provided with the time signature, tempo, and the UTC time and metrical position (measure and beat) of the next beat. This information is sufficient to ensure coordinated playback. Tempo change adjustments need to be similarly 'scheduled' via notifications.

5. JAM2JAM INPUT AND OUTPUT

Given that parameter control is critical to performing with generative systems, the jam2jam software has evolved to support a wide range of real-time inputs and some standard outputs, as depicted in figure 4. Audio input can come from a microphone whose signal can be treated using similar musical elements (pitch, timbre, and so on) to the music and is mixed together with the generated music for output. Video source material can come from the built-in or external camera. Parameter adjustment is possible from inputs including mouse control of the graphical user interface, external MIDI controllers, external devices sending Open Sound Control (OSC) messages, and messages sent between networked jam2jam clients via the Jabber server. Outputs from jam2jam include stereo audio and video and performances can be captured as a movie file.

Figure 4. Real-time input/output options for jam2jam-av.

In our experience the standard computer mouse, while ubiquitous, is far from an ideal controller not least because it can only control one component at a time. However, when networked in an ensemble that shares responsibility for control this is often sufficient and for use with inexperienced musicians the single-parameter constraint can assist with focusing attention. However, there is little doubt that the expressive control of generative systems is enhanced by more concrete gestures and multiple parameter control.

The range of interface options presented by jam2jam provides great flexibility in how it is used. In particular, the support for MIDI and OSC devices provide users significance choice about how they interact with the system. The OSC and MIDI mappings for jam2jam are documented allowing users to map their own controllers if they wish and for other research teams to design their own interfaces to control jam2jam.

Trials using jam2jam have explored various MIDI-based hardware control surfaces, such as that shown in figure 5, and the development of custom physical interfaces. Also trialled are interactions using iPhone applications that communicate with jam2jam using the OSC protocol. To date this is the only multi-touch surface that we have used, and while space limitations on the device can make gestures somewhat finicky we are optimistic about the possibilities presented by larger multi-touch surfaces.

Figure 5. An installation of jam2jam using five controllers, one for each of four musical parts and one for video.

6. NETWORK JAMMING ENSEMBLES

The broad range of interfacing options presented by jam2jam enables a wide variety of ensemble configurations. As a way of making sense of these options it is useful to characterize the ensemble options into three categories based on the different types of musical relationships that are formed. These categories are, a duet between one person and the computer, a local ensemble, and a remote ensemble.

The duet between performer and computer positions the generative system as more than a musical instrument; a performance which is usually characterized as solo. Rather, the generative system is assigned agency and interactions with it are like a duet. The degree of indeterminacy in a generative system is significant in experiencing the interaction as a solo or duo performance, the more indeterminate or independent the system the more 'others' appear during interaction. The requirement in many trial contexts for interactions with the jam2jam system to be noticeable by children has tended to orient individual experiences with it toward the ensemble, rather than duet, category. However, the duet metaphor does offer interesting opportunities and systems such as *O-Max* [7] and *JamBot* [8] are examples of how generative processes can be oriented toward such interactive musical relationships.

A 'local' network jamming ensemble can take a number of forms. These include groups with one computer system and many controllers, or groups with several computers connected over a local network. In addition in any case acoustic musicians and/or vocalists may also be part of the ensemble. For practical purposes, local ensembles have been the most prevalent way that jam2jam has been used. This kind of setup is conceptually similar to traditional ensembles and operates in much the same way. The generative system acts as a kind of backbone, or hub, for the ensemble but because it can be controlled by one or more performers it functions much more dynamically than a

simple backing track. Even though control may be distributed in local network jamming ensembles it is typical that sound and visual output are maintained at a single point. Given that all performers are in the one space this makes sense, however, it can also be quite useful in computer-only groups for each performer (or perhaps pairs of performers) to wear headphones connected to their own computer and so each hear and see their individual output.

A 'remote' network jamming ensemble is one where performers are geographically separated and the generative music systems communicate via a server on the internet. This type of arrangement is what typically comes to mind when the term Network Jamming is first considered in relation to collaborative performance. As with local ensembles, there can be a variety of ensemble configurations and each node may have different combinations of computing systems and acoustic musicians. In a remote ensemble that only has computer-based performers, the experience can be quite similar to the local headphone ensemble. Of course body language cues are missing, but a relationship is formed that is mediated through artistic expression. These remote ensembles provide great opportunities for people to connect with others with similar creative interests and can be particularly useful for those in remote locations. Coordination between people remains a challenge given different time zones and parallel IM or VOIP connections are often required to facilitate social exchange around the jamming activity.

Digital social networking tools, such as Facebook and YouTube, can work hand in hand with network jamming to allow the sharing and discussion of recorded performances. To facilitate the sharing and discussion of jam2jam performances, a jam2jam website has been developed (http://jam2jam.com). Here, users can share and comment on video clips of jam2jam performances. This supports the development of a network jamming community, and to ensure tight integration with the client software the jam2jam-av interface includes a button in the lower right corner that launches this site. Tehe jam2jam website has links for downloading the client software and for accessing tutorials and other support materials.

7. TESTING JAM2JAM

Trials of jam2jam have been quite extensive [9]. Several trial sites have been established around the world, mainly in educational settings. Trial sites are located in Australia, New Zealand, USA, Sweden, Hong Kong, and the UK. Data analysed from these sites is shared between them and some of the jams from these trials have been made public at the jam2jam web site.

The outcomes of the field trials indicate that users have a strong immediate engagement with controlling the generative processes and that this engagement is maintained when combined with increasingly sophisticated tasks based around the system; including tasks such as creating original material to jam with and distributing recorded jams via digital social networks. Interestingly. the satisfaction of teenage audiences is quite dependent on their interest in the style(s) of music that jam2jam supports. Therefore jam2jam supports various electronic dance music genres and classic popular music styles including reggae, blues, latin, and country.

The most popular ensemble combinations in testing thus far have been mixed ensembles, where some performers use the computer and others playing acoustic instruments and/or sing. This approach has been particularly valuable for groups with diverse levels of performance experience where participation through control of the generative system has a shallow entry-level skill requirement, but can become more complex as controller complexity is increased.

8. CONCLUSION

Performing with generative music systems opens up new creative partnerships with the computer that can vary in sophistication and expressivity. Critical to an appropriate level of challenge are the number and type of gestural controls used to mange algorithmic parameters. Connecting generative systems in a network jamming performance provides unique collaborative opportunities that can range from individual interactions with the system, to augmented acoustic and electronic ensembles, or geographically diverse jams that leverage parallel generative processes to avoid latency issues that may hamper audio streaming solutions. Whether the musical responsibilities are distributed locally or widely and between a few or many participants, it seems that network jamming can provide rich opportunities for musical expression and engagement.

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