Many-Person Instruments for Computer Music Performance

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ABSTRACT

In this paper we explore the concept of instruments which are played by more than one person, and present two case studies. We designed, built and performed with Feedbørk, a two-player instrument comprising two iPads which form a video feedback loop, and Barrel, a nine-player instrument made up of eight Gametrak controllers fastened to a steel industrial barrel. By splitting the control of these instruments into distinct but interdependent roles, we allow each individual to easily play a part while retaining a rich complexity of output for the whole system. We found that the relationships between those roles had a significant effect on how the players communicated with each other, and on how the performance was perceived by the audience.

Keywords

Many person musical instruments, cooperative music, asymmetric interfaces, transmodal feedback

1. INTRODUCTION

The landscape of musical collaboration has been drastically altered by the emergence of computer music. New methods by which musicians can play or perform together include telematic performances, networked ensembles such as the Hub, and laptop and mobile phone orchestras [5, 12, 14, 10]. The players in these cases range from being globally distributed to sharing a physical space with one another. We have explored a related but even more localized type of collaboration, where instead of playing instruments together in an ensemble, multiple people work together to operate a single instrument. Parallel efforts have been made to create collaborative interfaces that are transparent to players and audiences, such as Weinberg's Beatbugs [16, 15]. Our focus, however, is on the concept of symmetric vs asymmetrical interfaces and how we can create opportunities for fun, cooperative and expressive play by unevenly distributing the control of an instrument across its players. This echoes the findings of Jordà in [8], where complex and exciting expression was found to result from the interplay between essential and interactive roles.

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Figure 1: Barrel in performance by the Stanford Laptop Orchestra (SLOrk).

Very few many-person instruments have been created, computer or otherwise. The organistrum was an early form of hurdy gurdy which was designed to be played by two people, one of whom would turn the crank while the other manipulated keys which changed the pitch of the strings. These two roles are completely distinct in their physical actions but thoroughly interdependent in how they change the sound. They show the potential for intimate collaboration that a single instrument designed for asymmetric control by multiple players can provide. The Tooka, a sensor-laden tube into which two players blow simultaneously to make sound, in this case via symmetric interfaces, provides another example of an instrument which cannot be played to its full effect by a single person [3, 2].

Feedbørk is controlled asymmetrically by two people, while Barrel is controlled by nine people, eight of whom operate completely symmetric interfaces. This allowed us to study how differences in scale and player relationships affect the engagement of performers and audience members. To accentuate the collaborative aspects of these instruments, we focused on several design ideas: inter-performer awareness and feedback, visual elements, and emergent complexity. In this paper, we explain how these ideas manifested in each instrument, and attempt to extract some design principles for many-person instruments that might be useful to future experimentation.

2. FEEDBØRK

2.1 Description

Feedbørk is an instrument that is made up of two iPads which both route their front-facing camera feeds straight to their screens. This means that when they are pointed at one another, a video feedback loop is created. One iPad captures the image of the second, which itself is capturing the image of the first, and a recursive image is created of iPad screens trailing off into infinity. This video feed is projected from one of the iPads onto a large screen behind the performers [11]. (Figure 2)

Touching the screen of either iPad sends control data in OSC format over the network to a laptop which is generating audio. Additionally, bursts of color appear under the performers' fingers on the screens of the iPads. These splashes of light flow into the video feedback loop and reinforce the impression of time recessing back into the projected image. Finally, the video feed is analyzed using the OpenCV computer vision library to find various features, including a rough approximation of the distance between the two iPads and the current visual recursion depth, and these values are also sent to the laptop via OSC. (Figure 3)

2.2 Mapping and Performance

In our performances with Feedbørk, audio is synthesized by ChucK [13] code that is controlled via touch gestures on the iPad screens. A single finger can be used to play melodic notes or chords, while multi-touch gestures control the drum loop by modulating parameters such as density and randomness. All of these sounds are routed through reverb and a beat-synchronized feedback delay effect.

With only these sonic elements in place, we would have created a barely-interesting touch-based virtual instrument. The key to Feedbørk is in how the relative orientation of the two iPads changes the appearance of the video feedback loop, and in how that visual element is used to manipulate the sound of the instrument. The audio feedback delay and reverb levels are completely dependent on the visual impression of a feedback loop. When the iPads are exactly aligned by the performers, an "infinite tunnel of light" appears on the projector, with flashes of color traveling down it each time a note is played, as the image bounces back and forth between the cameras. Correspondingly, the sonic environment changes to harmonize with the visuals, letting each sound trail off slowly, echoing at the same rate as the camera's frame-rate. Additionally, the brightness of the video image proportionally affects the volume of the drone and synthesized tones. The result is that the audience perceives the combined audiovisual stimulus as a cohesive whole [6].

To actually perform with the instrument, the authors put one iPad face-up on a small table and one player holds the other iPad over it facing downwards. This player controls the visual aspect of the performance, causing different amounts of video feedback to occur, allowing the feedback to "blow out", and manipulating the relative orientations of the screens to create kaleidoscopic patterns. The other player controls the sonic elements of the performance, touching both screens to trigger notes and chords and to control the drums.

Because of this asymmetric control distribution, both players have a smaller set of inputs available to them. However, the interdependent relationship of the audio and visual output mean that the two players are constantly engaged in communication of their intentions and ideas through their physical movements. The resultant performance is complex and dynamic while retaining a kind of synaesthetic clarity, wherein acoustic and visual sensations are at all times cohesive. The authors have played a great deal of music together in more traditional collaborative settings (drums and guitar, etc.). They found that playing and performing Feedbørk provides a sense of cooperation and a coherence of output that exceeds that of their other musical experiences. They ascribe this to the physical closeness that is involved in playing the instrument, and in the intermodal nature of its performance, which necessitates close attention to be paid both visually and aurally.

3. BARREL

3.1 Description

Barrel is an instrument which is controlled directly by eight symmetric operators. Each of these players is tethered by both of their hands to a steel industrial barrel, manipulating Gametrak controllers that are duct-taped to the barrel. These controllers each contain two 3D position sensors that are connected to the players' hands by auto-spooling wires. The wires give the operators a range of motion of about eight feet in any direction. Each operator's Gametrak controller is connected to an individual laptop orchestra station which includes a laptop and hemispherical six-channel speaker array. Each laptop synthesizes audio independently, resulting in highly spatialized sound generation. Standing atop the eponymous barrel is the ninth player of the instrument, who has no direct physical connection to any sensor or interface. Instead he controls the other performers, "playing" them by using gestures to direct their movements. (Figure 4)

With this instrument, we explored a more complex control scheme than that of Feedbørk. By creating a locally distributed interface we turned eight players, enough for an entire ensemble, into completely symmetric operators of a single instrument, more akin to the arms of a living organism than autonomous performers of individual instruments. The ninth player serves as the central nervous system: a highly asymmetric relationship to the other musicians. His interface is simple: without physical connections to the instrument, he may gesture in predetermined or freeform ways to his operators, one at a time or in groups. Each operator also has a highly constrained set of inputs that they may provide to their controller. Yet due to their number, the actions of all these performers combine to create a complex system, with its own non-linearities and behaviors for players to learn and master.

Some insight into the instrument's design can be found by contrasting the central player of Barrel and a traditional conductor, whose language of movement share some outward similarities. While a conductor may direct their ensemble or even individual players freely, the result will always be restricted to interpretations of the score which is being performed. In Barrel's case, because of the simplicity of each operator's interface, the central player may direct every aspect of the operator's output via agreed-upon gestures, or he may push the operator into unexplored territory by exaggerating or abandoning entirely those preordained physical communications. The conductor of a traditional ensemble does not have this degree of expressive and improvisational power because his gestural language cannot be suitably mapped onto the complex interfaces of each player's instrument.

3.2 Mapping and Performance

One might imagine a great number of musical mappings which could be used to perform with Barrel's 16 3D position sensors. Out of all those possibilities, the mapping that we created is extremely simple. Each operator can play a

Figure 2: Feedbørk in performance by the authors.

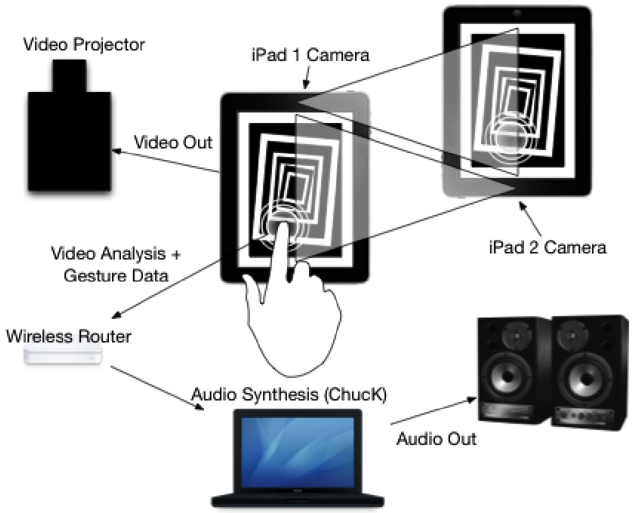

Figure 3: Feedbørk instrument schematic.

single repeating note. The pitch of this note is determined by their distance from the barrel, and the loudness of the sound is controlled by how high their hands are raised. By moving their hands further apart or closer together they can make their note more legato or staccato, respectively, as it repeats. To combine these notes into higher level musical structures, we designate the eight operators into two groups which stand roughly together to the left and right of the barrel, which is center stage. The central player then uses each of these two groups to play chords by raising the operators from kneeling positions to standing and back again. While he is doing this, he is also controlling each group's distance from the barrel, moving them inwards and outwards to control the distribution of pitches in the chords. This is all done extremely slowly, and in an alternating pattern between the left and the right groups, which creates a highly spatialized audiovisual experience.[1] Because each operator's sound source is located just behind them, the panning of the instrument's sound serves along with the movement of the performers as a focal point for the audience members' attention and emotional response [4]. The scene on stage is evocative of some kind of slow-motion worship ritual, as the players continually stand and kneel at the will of an elevated central figure on whom their gaze is continually fixed. (Figure 1)

In our piece, Barrel accompanies a soloist who is positioned front and center on the stage, using another Gametrak controller to manipulate an arpeggiating synthesizer which is synchronized in key and tempo with the chord notes. This additional level of collaborative hierarchy poses an interesting contrast with our new instruments. Only the traditional musical factors of timing and pitch tie the sound of the solo instrument to that of Barrel, and there are comparatively limited levels of feedback: only sight and sound cues, with no direct interdependence between the two instruments' output. The experience of collaborating within both of these contexts simultaneously serves to highlight the level of communication and cooperation that is possible within a many-player instrument [1].

4. CONCLUSIONS

We have explored the concept of many-player instruments and discussed two case studies, Feedbørk and Barrel. Designing and implementing these instruments has yielded some realizations which we hope will help to guide the development of new collaborative instruments. We found that by splitting the control of these instruments into roles which are interdependent and complementary[2], we were able to create potential for rich and constructive interplay between even inexperienced players, while still allowing learned mastery [9]. We saw that asymmetric interfaces were highly suited to small numbers of players, while symmetric roles were ideal for larger groups of players. Additionally, we showed that by incorporating visual and physical modes of interaction, engagement among both performers and audience members was increased dramatically.

Such many-person instruments allow us to explore new aspects of musicianship, where no individual player has complete control over the output of their instrument. This calls into question the very definition of an instrument, and whether an ensemble is itself an instrument. Our approach could be seen in a negative light as diminishing the contribution of each individual musician, but we see it instead as increasing the importance of communication and trust between the musicians. We look forward to further exploring this class of instrument to bring more people together through creative cooperation, and hope that this form of collaboration might eventually find its way into more traditional musicmaking contexts.

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[1]Reference points for the sound of Barrel are Steve Reich's *Electric Counterpoint I (Fast)* which inspired our chordal sounds, and Takashi Yoshimatsu's *Age of Birds*, which inspired the full-stage back-and-forth panning.

[2]These properties can perhaps be seen as analagous to the relationship between the strings and soundboard of an acoustic guitar.

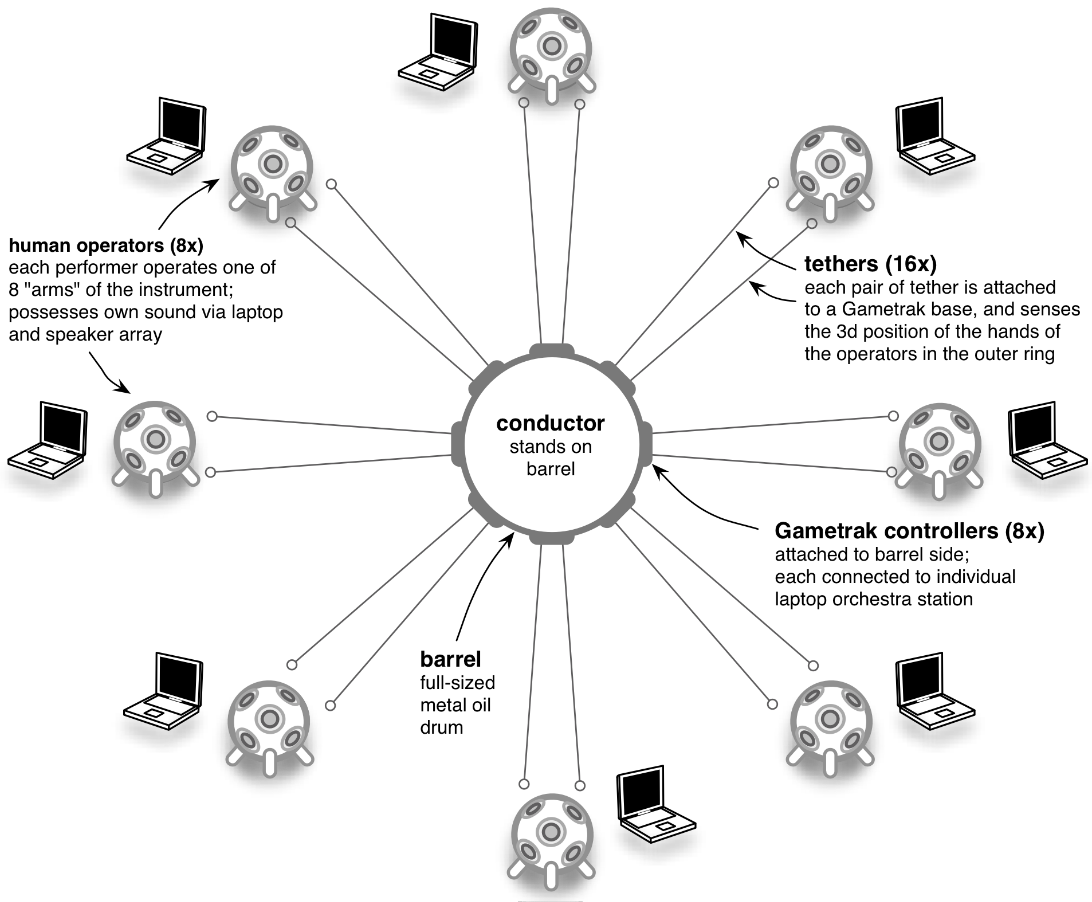

Figure 4: Barrel instrument schematic.

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APPENDIX

A. VIDEO LINKS

Barrel: `http://www.youtube.com/watch?v=y2BSJuDZ234`
Feedbørk: `http://www.youtube.com/watch?v=ADF-7pcjqp4`