Big Tent: A Portable Immersive Intermedia Environment

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ABSTRACT

Big Tent, a large scale portable environment for 360 degree immersive video and audio artistic presentation and research, is described and initial experiences are reported. Unlike other fully-surround environments of considerable size, Big Tent may be easily transported and setup in any space with adequate foot print, allowing immersive, interactive content to be brought to non-typical audiences and environments. Construction and implementation of Big Tent focused on maximizing portability by minimizing setup and tear down time, crew requirements, maintenance costs, and transport costs. A variety of different performance and installation events are discussed, exploring the possibilities Big Tent presents to contemporary multi-media artistic creation.

1. INTRODUCTION

Large-scale immersive environments serve as compelling venues for contemporary artistic exploration and research. These activated spaces allow creators to treat the environment as an instrument, using the walls as an interactive visual canvas coupled with surround audio systems (see [5]). However the spaces are typically expensive to create, have limited accessibility, and come with elitist stigmas. These aspects restrict audiences and constrain many musicians and artists in their attempts to explore aesthetic possibilities of fully immersive spaces.

Big Tent presents a new approach, seeking to provide a portable, accessible environment for creators and audiences alike to experience inter-media art and music (see Fig. 1). Through scale and portability, the design brings possibilities of 360° surround video and audio to nearly any location, for group experiences and performances, while serving as a reliable environment for artistic exploration and research. This instrument is aimed at enabling a diversity of events, aesthetic orientations, and genres.

2. BACKGROUND

One of the primary requirements of research in any field is replicability, serving as a basis for validating and sharing findings. Aesthetic explorations of Big Tent are intended to be highly replicable, hoping to make every examination repeatable and shown again and again, just as a physical painting or a composition for orchestra. Much work in cutting-edge experimental areas either intentionally or incidentally denies or fails to honor this requirement. In fact, aesthetic research through artistic expression, which is the domain of all creative artists and musicians, can greatly benefit from embracing this model. Supporting experimental replication strengthens the field as a whole and enables more directed and connected creativity and research.

Figure 1. Big Tent performance event.

The Big Tent enables replicability by providing both a stable and predictable apparatus and technical parameters to ground artist explorations in the chaotic domain of digitally powered mixed media. Physically, Big Tent is a 40-foot diameter ring of 8 projection screens, standing 12 feet tall, with a projectable surface 128-feet around (figure 2). This is augmented with 8 channels of surround audio, and 8 channels of HD video to fill the surface. The entirety is driven by audio/visual software providing a flexible interface so artists may work and play with the environment in a creatively supportive fashion.

Artistic expression exploiting digital and computing technology has become ubiquitous with the relatively recent advent of personal computing and mobile computing. Innovative creators around the world continuously push limits, on what is potentially one of the biggest frontiers of expression today. Our laptops, tablets, and smart phones are immensely expressive tools with an artistic reach limited only by the artists' conceptual abilities.

However, the myriad approaches to tackling the aesthetic possibilities of digital technology make the codification of the field extremely difficult. Inter-media art is not only new, lacking the heritage of more traditional art practices, it is also extremely diverse and encompassing, involving elements from many other art forms. Even comparing two similar works or artists is difficult due to the differences in setup and technology employed in every case. It is as if every artist, more fundamentally, is inventing their own tools, equivalent to a painter making paintbrushes from scratch, fabricating their own canvases, and looking for the newest pigments with nearly every work. Learning from this wealth of experimentation and finding best practices is difficult.

In the field of music we look to the origination of the violin family of instruments and the aesthetic grounding this afforded as a model solution. Prior to the modern violin, string instruments were extremely diverse, with varied capabilities, tunings, playing techniques and expressive ranges. While composers worked with these instruments of diverse musical abilities the dissemination of pieces was difficult. Once the violin as we know it began to spread, with its standard tuning, playing techniques, and pitch range, composers had effectively found a uniform canvas on which to work. When Mozart wrote a piece, he could be confident it would sound the same played in disparate locations such as London and Vienna. The consistency in the instrument, the musical toolset, allowed composers to share, explore, and learn from one another's experiments (i.e. pieces), effectively mapping out the capabilities of the violin and its expressive potential (a process that continues today).

Big Tent aims to take steps in this direction as a modern music-technology instrument, providing a consistent canvas for inter-media artists to explore and work on. Due to its portability, being usable in any space with a sufficient footprint, indoor or out, and ease of construction, requiring two hours for a team of four to set it up, Big Tent may be erected as a presentational venue in both traditional and unconventional circumstances (from concert halls and art museums to parks and parking lots). In the same way that a violinist or dancer may perform in any setting they desire, Big Tent allows artists to play with location and take the instrument to the preferred environment or audience.

Other environments have been created with similar technology, but none with the portable arts-research laboratory aims of Big Tent. Scientific virtual reality (VR) systems are one such example, perhaps best exemplified by NASA's HIVE environment [1, 3], a portable VR display system. Yet, the HIVE focuses on solving different problems, being a single user experience, necessitating a fixed viewer orientation, and being prohibitively expensive to construct. The Allosphere at UCSB [4], a large-scale facility for advanced research in immersive environments provides a complete sphere of video and audio several stories tall, existing in a dedicated building. However, this space is not at all portable or flexible in application.

Artists who have created their own environments for their work include Bill Viola (who frequently works with multiple video and audio sources in fixed gallery settings), and Maurice Benayoun and his Cosmopolis (2005) [2]. Similar in concept to Big Tent, Cosmopolis involved a ring of 12 projection surfaces with surround audio, yet the design was unique to this single work with specifically tailored interaction points and not easily transferred to new locations or other pieces.

3. DESIGN PRIORITIES

The design goals for Big Tent were to create an aesthetically neutral venue for audiences of up to 60 people, supporting a broad stylistic range of music, dance, and intermedia art expression. It also must accommodate different modes of performance and communication in many different contexts, such as concerts, installations, and interactive works, presented within conventional facilities (e.g. museums and concert halls) and non-conventional spaces (e.g. parks, gyms, and shopping centers).

With the primary goal of portability, three issues are at the forefront of consideration:

1) Ease of transport: minimize equipment weight, volume, and packed footprint;
2) Ease of setup: minimize number of crew and time required to build the Tent on location;
3) Ease of tear down: minimize time to deconstruct the Tent and load it into a vehicle for transport;
4) Ease of maintenance: minimize operating costs and replacing broken equipment.

The target cost points were no more than 4 technical crew working on setup and teardown, requiring no more than 3 hours before and after an event, and using commercially available components (for cost and easy replacement).

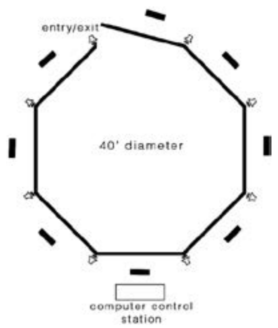

Figure 2. Big Tent layout and floor plan.

4. IMPLEMENTATION

4.1 Frame

The physical structure of the Tent is designed to balance robustness against ease of setup and transport, all while minimizing cost (Fig. 2). The 128-foot octagon framework supporting the screens is a hybrid of ¾" steel pipe and tripod lighting stands. The light stands are off-the-shelf products capable of a 12' height and load bearing of 77.1 lbs. The screens hang from a top truss ring, constructed of steel pipe resting on top of each stand. Each junction point is built out of pipe fittings allowing for any arbitrary angle, enabling both flexibility in setup, and possible configurations of the Tent in asymmetrical octagonal shapes (to account for environmental obstacles, non-square spaces, or artistic preference). Screen tensioning is accomplished entirely by elastic ties at the junctions. It was determined that this alone provided sufficient tensioning to eliminate most wrinkles, alleviating the need to add piping at the bottom of screens and subjecting the setup process to additional screen stretching, which in turn further reduces transport costs and setup time.

In order to keep the interior of the Tent completely free of wires or other visible pieces of equipment, rear video projection is used for all of the screen surfaces. The projectors selected for Big Tent are ultra-short throw Epson projectors. Each is capable of 3100 lumens and has a throw ratio of 0.27:1 (e.g. for every 0.27 feet of distance it can cover 1 foot of screen). Optimally, these projectors fill a 16’ wide screen from just a distance of 4.32 feet. This affords Big Tent to be completely setup within a 50x50-foot space, yet retaining a full 40-foot diameter internal area with less than a 5-foot ring behind the screens for equipment.

The projectors are placed on the floor and adjusted manually to fill the screens. In order to remove hotspot glare (i.e. where the projector bulb is seen through the screen) projectors cannot be directly behind a screen relative to the viewer’s eye. Thus the screens are raised 36-inches off the floor (bringing the top rim of the Tent to 12-feet). This allows projectors to aim upward and prevent visible glare to viewers inside the tent. A black cloth skirt was added below the screens to eliminate visibility of the projectors under the screens and provide a further element of definition to the temporary Tent walls.

4.2 Video

All of the projected video content is distributed from a single Mac Pro (with 12, 3.5ghz CPUs) to the 8 projectors, each displaying 1280x720 pixels. The operating system treats the 8 screens as an extended desktop, creating a single 7 megapixel surface. This allows any Mac multi-media software to use the entire projectable area.

Despite the theoretical throw ratio of the projectors, the selected model only provides plus-minus 5 degrees of vertical key-stoning, which alone is insufficient to account for the necessary placement of the projectors (below the screens). Therefore additional key-stoning is performed digitally in software (using Qlab), to provide uniform pixel size.

4.3 Audio

A robust conventional 8 channel audio system of 280 watt speakers installed in the Tent provides fully surround audio. A sub-woofer is also placed outside the Tent near one of the screen junctions and the eight speakers are set at the base of each junction with a slight upward angle. While this is not acoustically ideal, it greatly expedites setup and teardown time and assists to minimize the visual presence of the speakers inside the Tent (see Fig. 3, 4).

Audio/video synchrony is maintained simply by running both subsystems on a single computer, enabling any multichannel capable application to use the Tent. The aforementioned Mac Pro drives the audio and delivers the 7 mega pixels of video (guaranteeing a minimum frame rate of 15 frames per second).

5. PERFORMANCES

Figure 3. Interactive video and live musical performance inside Big Tent.

Testing the functionality and capabilities of this new hyper-instrument, and exploring the aesthetic potentials, has commenced through several public live performance events and installations. These events and individual artistic pieces worked with a variety of media and interaction models in an attempt to discover the potentials of Big Tent as well as identify technical issues and limitations. The variety of sources and approaches comprise the following modalities (used singly and in combination):

- One HD video shown simultaneously on 8 screens.
- One HD video shown simultaneously on all screens with different time delays and playback rates.
- One interactively generated animation displayed across all screens (see Fig. 1 & 3).
- One 720p HD video stretched across all 8 screens.
- One 2560x720 HD video repeated 4 times over all the screens.
- Many SD videos displayed concurrently in a haphazard fashion on any/all screens.
- Prerecorded surround audio.
- Live acoustic instrument performance.
- Interactive audience driven music.
- Solo dance (see Fig. 4).
- Contact improvisation, audience participation dance.

Original works created and/or adapted for the Tent using these approaches were staged in four multi-hour public concert events, an evening length interactive installation, two hour-long contact improvisation events, and a week long fixed-media installation.

Ambient light was quickly identified as an important factor in Big Tent’s performance. Rear projection is very unforgiving of ambient light present at the event location. Near total darkness is required for adequate screen illumination of projected images. In outdoor environments

Big Tent is only viable at dusk and into the night, and when indoors any light source must be low in output and focused away from the screens.

Figure 4. Dance and video in Big Tent.

Big Tent's 40-foot internal diameter was capable of accommodating an audience size of 40 to 60, even with two live performers in the middle of the space. Furthermore, the scale of Big Tent allows one to experience a presentation without the sense of confinement or lack of a peripheral depth of field characteristic of other immersive multimedia environments.

The lack of primary orientation became quickly apparent as audiences were encouraged to walk around the space. Many immersive spaces retain a notion of front and back, akin to conventional concert hall orientation, but the circular nature of Big Tent appears to dissolve this approach. Artists creating works for the space mostly abandoned the notion of primary orientation, repeating sounds and imagery around the whole space.

Audio coverage in the space was very satisfactory, given the 8.1 surround system. However, the placement of speakers at the base of the screen junctions fails to allow discreetly localized sound spatialization. A system of small satellite speakers mounted at head height or slightly above could address this issue.

While only subtle in noticeable effect, given the breadth of these projection surfaces, the general frame rate limitation of about 15fps allows an occasional degrading of continuous motion video projection. However, this design provides a very stable and elegant means of streaming to 8 digital projectors, thus addressing common video production problems of computer equipment costs and synchronization across machines. Working with the screens has been relatively transparent for artists involved thus far.

The transportability and relatively easy setup and breakdown has proven very successful. The shear portability of Big Tent has already shown itself to meet the design expectations of taking multi-media immersive presentations out into the community and away from traditional event settings. Four crew members can unpack and setup the Tent in under 3 hours, and pack it up and load it out in under 1 hour.

6. CONCLUSIONS

One of the primary limitations constraining the use of Big Tent is power consumption. With all components turned on Big Tent requires just under 30 amps of power, which is more than the average single circuit in most US buildings (15 amps is the most commonly available). Thus Big Tent requires two separate circuits or special accommodations to provide the required power for a setup and event.

One of the primary aims with Big Tent is to support out-of-doors events, yet weatherproofing is required to enable this.

Environmental light has similarly been identified as a primary challenge limiting the use of Big Tent. Due to the back projection system employed ambient light from the installation environment bleeds through and washes out the video. Typically Big Tent can only be used after the sun has set or in spaces where all lights can be turned off, relying solely upon the Tent's video projectors for all event lighting. Solutions for this may involve a second exterior tent, made of a heavy, non-light-permeable canvas, which would contain Big Tent and reduce ambient light. Similarly, much higher lumen projectors could combat ambient light, but coming with greatly increased equipment costs.

While the single-computer system configuration comes with certain advantages, it also has limitations. Currently, the most problematic is the video frame rate, which is less than desired. A target of 60 frames per second is ideal, which could be accomplished by synchronizing several computers driving two or three projectors each.

7. ACKNOWLEDGEMENTS

This project is funded by the IUPUI Arts and Humanities Institute and the Deans' Office of the IUPUI School of Engineering and Technology.

8. REFERENCES

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