

Begin Transmission: An Audiovisual Computational System

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Abstract

Begin Transmission, a work for interactive performance, illustrates motion and conversation within a space via visuals and sound. Movement characteristics, such as the sum of all movement in a space and its location, drives the generation of sound and an ensuing visualization. In this way, *Begin Transmission* is an antenna detecting change within a space, where the interaction between human and computer is received, transcribed, and transmitted into two different sensory modalities. In a performance setting, it becomes its own agent, incorporating its own melodies and harmonies. Furthermore, a performance of this piece involving audience participation describes certain aspects of social cognition, particularly in the way that we interact with other beings in a space through body language. The system thus exists as its own being, conversing with the people that are interacting with it through musical phrases as a response to our own dialogue—body language and motion.

Author Keywords

Motion capture; frame differencing; audiovisual installation; improvisation; performance; C++; Processing; OSC; openCV.

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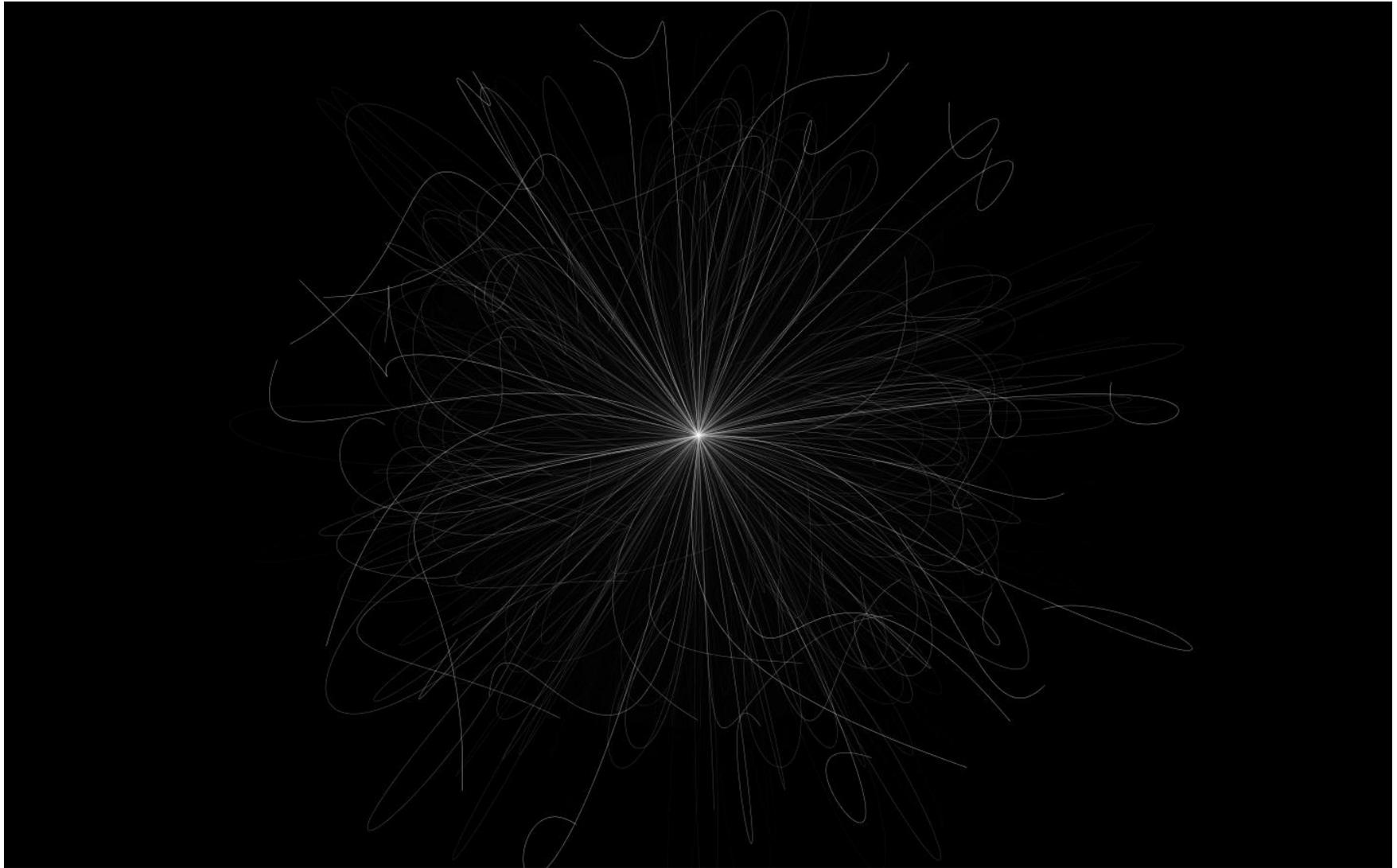


Figure 1: This is a still captured during an exhibition of *Begin Transmission*, illustrating the movement of viewers in the gallery space over approximately 40 seconds of time.

ACM Classification Keywords

B.4.2. Input/Output Devices. D.1.5. Object Oriented Programming. H.5.5. Sound and Music Computing. I.3.3. Graphics/Image Generation. I.4.m.Image Processing and Computer Vision.

Related Works

Throughout the past few decades, motion-capture systems have been increasingly utilized to drive artistic installation work and augment the performing arts, particularly in the areas of dance and music. Certain performance groups such as Aether and Troika Ranch focus on creating immersive dance experiences through live motion capture in order to augment the experience of human movement [1, 10]. Additionally, systems such as *Mocap Tango*, *Very Nervous System*, and DIEM's Digital Dance Project utilize motion capture to investigate human movement, engaging the body in an intimate conversational experience [10-12]. These works have significant implications, particularly regarding the creation of immersive and interactive environments, ranging from two-dimensional projections to three-dimensional immersive systems and have even involved virtual reality or augmented reality [3]. Similarly, *Begin Transmission* seeks to explore human-computer interaction and communication as a means of understanding social cognition and human communication through performance. It examines the spatial relationships between human and machine as well as their methods of communication (body language and sound respectively). The webcam serves as an antenna for the receipt and transmission of communication between these two agents, facilitating communication and picking up on body language and movement as a form of communication.

Motion Capture System

The mechanism of motion capture in this system, coded in C++ using the OpenCV library, is conducted through differencing of the current webcam frame with the previous webcam frame (i.e. frame differencing). By calculating this difference, change in the frames over

time can be quantified, thus yielding a computational understanding of motion. First, the incoming camera area is divided into a grid structure. After being processed through the frame differencing algorithm, the ensuing camera image is then passed through a threshold filter, where change in the frame (i.e. motion) is summed in each gridded area to achieve a total "motion value." The x and y positions of this grid area, as well as the motion value for that area, are passed by Open Sound Control (OSC) messaging to a Processing sketch, which drives the sound and visualization.

Sound

The sound is generated in this system using two triangle oscillators, a feature of the Processing Sound library. After mapping the incoming three values transmitted by OSC (x position, y position, and maximum motion value) to appropriate values, a midi note value is passed to the first triangle oscillator. Another midi note value at a 5th interval from the first note is passed into the second triangle oscillator in order to create a harmony. X and y position change the pitch of the notes and the motion value changes the amplitude (i.e. volume), where more motion on screen manifests as louder sound. Triangle oscillators were chosen due to their melodious and organic sound quality, which allows for the creation of ambient music that audibly ties into the growth of the visualization throughout the performance.

Visualization

The visualization is created through Bezier curves, drawn based on the previous frame and current frame x and y position values, as well as the previous and current frame motion value. The starting point of the curves is the middle of the presentation screen, which rotates each frame in order to create the star shape seen. The ensuing visualization is organic and simplistic in nature, meshing well with the harmonies created in the music and is in itself a being that is communicating visually through its growth and ever-changing shape.

Performance: Creative Impetus

The ADSR envelope was tweaked by the performer, Del Cook, in order to cater to the type of sound that was desired, as well as to match the general tonality of the visualization. The program lends itself to music produced in an ambient style, so the ADSR envelope was set to primarily produce long, resonant tones with very little decay. The system produces perfect fifth intervals, chosen based on the motion capture system's procedural approach; as it is not a precise interface for generating music, it relies on spontaneity that is produced through human-computer conversation. However, the sound had to have some sort of organization in order to have appeal to a listening audience. Within this system, stacking two perfect fifths together increases the likelihood that major and minor seventh chords will sound, which are tonally consonant. This performance was in essence a conversation between the performer, the audience, and the motion capture system, exhibiting particular modalities of conversation that augment our day-to-day human interactions.

Performance: Technical Breakdown

The improvisatory performance utilizes a Roland PC-200 MK II to send MIDI data along a MIDI cable to a FastLane PC/MAC MIDI Interface. The primary sound source during the performance is a Macbook Pro, which contains the software Logic Pro 9, a Digital Audio Workstation (i.e. DAW), which contains a large repository of software-based MIDI synthesizers. From the Macbook, a 3.5mm auxiliary cable connects to a TCELECTRONIC Ditto Looper, a one-button interface that takes an audio signal and loops it endlessly on command of the performer. The length of the initial loop is able to be controlled, but all subsequent loops are beholden to the length of the initial loop and allows for layering during the improvisation performance.

Furthermore, the setup utilizes a M-120 Line Mixer, which allows for balance of the volume. Finally, the mixer sends the audio signal via XLR cable to an RCF Art 500 PA Speaker, which produces the sound.

Conclusion

Begin Transmission was created to examine human-machine and human-human interaction in order to augment conversational experiences using visuals and sound. With each interaction and performance, stills are created from the visualizations that stand alone as artistic works describing the motion that occurred in a set time frame. As a performance, *Begin Transmission* is its own agent, conversing with the audience and the performers to engage the beings in the space around it.

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