Using Choreographic Buttons to Transform Imagery

Andrew Webb[1], Pranesh Joshi[1], Eunyee Koh[1], YoungJoo Park[1],
Randy Sappington[2], Andruid Kerne[1]
Interface Ecology Lab
Department of Computer Science[1] + Department of Psychology[2]
Texas A&M University
College Station, TX 77843, USA
{awebb, eunyee, andruid}@cs.tamu.edu, pranesh@tamu.edu, yjoo9317@csdl.tamu.edu, sappism@hotmail.com

ABSTRACT

In this paper, we present a new type of button, *choreographic button*, and an interactive art installation, *Bounce, Duck, Pogo, Dive*, to highlight features and abilities of this new type of button. A person's presence in an environment is often determined by physical movements. Emotional presence can be delivered by physical action as well. A person's movement can convey a specific meaning to other people without using overt lexical expressions such as speech or written language. A choreographic button is an affordance that visually represents possibility for interaction, captures a particular movement and triggers actions. Movement becomes associated with meaning, as it is translated into human computer interaction.

Bounce, Duck, Pogo, Dive utilizes two forms of choreographic buttons capturing the movements of jumping and crouching and generates imagery by using these buttons to control the selection and juxtaposition of images. To further encourage artistic creation in the process images within the imagery are continually changing until locked in place by a participant. We conducted a user study to determine the effectiveness of Bounce, Duck, Pogo, Dive. Results from the user study pointed to a general consensus from the participants that Bounce, Duck, Pogo, Dive is an effective and enjoyable installation for generating creative imagery.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Evaluation / methodology. H.5.2 [**User Interfaces**]: Interaction styles, Screen design. J.5 [**Arts and Humanities**]: Arts, fine and performing, Performing arts.

General Terms

Design, Performance, Experimentation, Human Factors

Keywords

Responsive environment, art installation, gesture, movement, Laban notation, iterative design.

1. INTRODUCTION

The body is the site of experience. We sense the environment, form understandings, and actuate responses. In the course of evolution, our bodies have adapted to be able to detect changes between an initial sensory state and subsequent alternate sensory states. Movement is an actuated part of people's everyday experience. Movements articulate locomotion, and also convey information regarding emotions and intentions. A gesture is a form of movement that conveys a linguistic expression without the use of vocal articulation or written language. Sign language is an example of a gestural system. Even outside of a formal linguistic structure, gesture is commonly used as a mechanism of communication between individuals. Gesture can also be applied to the interaction between humans and machines (e.g. computers). This research develops symbolic gesture (e.g. choreography) as a mechanism for expression and control in an interactive art installation.

Choreography is the creation or specification of movement in order to affect a specific intent and convey meaning. Our creative process began with particular technologies for video tracking, as well as the intention of using movement as a mode of expression and interaction. In our process, we sought to choreograph gestures, which were on the one hand expressive, while at the same time not too difficult to develop reliable recognition algorithms for. As we developed prototypes iteratively, we discovered that it is important to graphically convey the state of the gesture recognition process, in the course of its progress. Otherwise, the participant is not directly connected to the intermediate states of the system's response. Further, the physical space of the participant also needs to be clearly defined, in order to make the possibilities for interaction clear. Norman [6] associates with the term *affordance*, "the perceived and actual properties of a thing … that determine how it could be used." Thus, we developed a tight binding between the demarcation of physical space, gesture and its recognition, and graphical representations of state. We call this the *choreographic button*.

Developing a choreographic button involves three interwoven stages: (1) defining (choreographing) and recognizing the movement; (2) designing graphical affordances that represent the state of the movement; and (3) mapping changes in the state of the movement to changes in the affordances and the system. In this installation, we developed consonant imagery to convey the associated experience of movement. The visual space is broken down into a grid of cells. Each cell corresponds to an area of the physical space, which is where the participant can invoke the choreographed gestures. The system responds by transforming the imagery in the corresponding imagery grid cell.

As it becomes possible to recognize participants' gestures and associate meanings with them, it is important to understand the mappings that translate symbolic gestures in a physical space to responses in a virtual space. In a choreographic context, we have arranged the virtual space such that elements are placed in locations depending on the movements required to control them. For example, elements placed near the top of a virtual space construe a movement of jumping or moving forward in the physical space to touch the element; where as, elements placed in other locations in the virtual space suggest different movements.

2. DEVELOPING CHOREOGRAPHIC BUTTONS

The stages of developing a choreographic button are interwoven and therefore cannot be performed in sequential order. Stages are often revisited or developed concurrently.

2.1 Defining and Recognizing Movements

A person's movement arises from an inner volition that results in transference of the body or one of its limbs from one spatial position to another. One aspect of movement corresponds to the shape of the body, while another addresses changes of the position of the body across space. We want to follow and understand the continuous creation of spatial impressions through the experience of movement. The unity of movement and space can be demonstrated by comparing the single snapshots of mind with each other, and showing that the natural order of their sequences and our natural orientation in space are based on similar principles [4].

Laban [4] developed six elementary schemes that have a definite correlation with the six fundamental directions in space: up and down, left and right, backward and forward. First, a tendency to go upward is correlated with lightness. A feeling of lightness, of losing strength, corresponds with the reaching upward to the point where the arm or the body prepares to relax and to fall back towards the ground. A tendency to go down is correlated with strength. A strong, firm movement always has at its source a vital connection with the stance. Laban said it is easy to feel that every strong movement is correlated to a foothold downwards. Moving left, right, backward, and forward are correlated to flexibility and a spatial freedom of space. He also correlated quick movements with sudden tensions and contractions, and slow movements with sustain and release.

We define two choreographic buttons, one of which uses a jumping movement, while the other uses crouching. In addition to the expressive nature of these movements, each was chosen because of the simplicity provided in computationally monitoring single axis unidirectional movement (up and down). We captured the jumping and crouching movements by using one video camera for each of these movements. Modern computational resources enabled us to apply signal processing algorithms to both video streams concurrently in real time using a single computer. These two cameras are located to the side of the active choreographic area of physical space, providing a profile view (see Figure 6). The camera used to track jumping is located at floor level and provides a view of the feet. By placing the camera parallel with the plane of the floor, only one algorithm is necessary to capture the jumping because only a single rectangular area (junction between the floor and wall) needs to be analyzed regardless of the position of the feet along the floor. The other profile view camera,

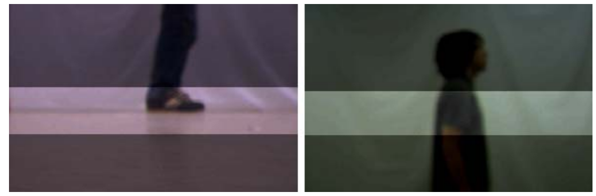

Figure 1: Profile view cameras example.

which tracks crouching, is located directly above and functions similarly to the floor camera, but with a view of the upper torso (see Figure 1).

This capture mechanism is sufficient to support choreographic buttons with a size that spans the range of the cameras. However, we desired multiple, smaller buttons, each of which is associated with a specific region of lateral space. This requires a third camera to track the position of participants. The camera that differentiates lateral positions is placed overhead, facing perpendicular toward the floor (see Figure 6). By subdividing the feed from the camera into different regions, each region can be assigned one or more choreographic buttons. By putting together the profile and overhead views, we are able to recognize different movement forms, in association with different positions. We assigned two choreographic buttons (one jumping, one crouching) to each region.

2.2 Affordances of State and Responsive Imagery

In designing a button, creating clear affordances is essential. Not knowing the current state of a button can cause great confusion and frustration for a user. The same is true about knowing where to "press." Choreographic buttons are no different in this sense. We chose the movements of jumping and crouching as the basis for integrally paired choreographic buttons. As each button pair is associated with a region of physical space, we mapped this region to a square cell in the visual space projected on a proximate wall. Each cell contains an imagery state, as well as state indicators for the associated jumping and crouching buttons. In the physical space, both choreographic buttons in the pair can be thought as sharing the same position from an overhead point of view, while they are positioned differently along the vertical axis. The crouch button of the pair can be thought of as sitting on the floor; while, the jump button is positioned over a participant's head. Selection of a choreographic button pair occurs when a participant enters the associated physical grid cell.

At the start of a session, when the button pair is not selected, the visuals projected on the wall in each cell cross fade between pairs of images from a collection (see Figure 2). There are 20 images in the collection. They are selected in a random order, which evolves independently for each grid cell. The cross fading is accomplished by rendering source and destination images with inverse progressive levels of translucence. Upon selection of a

Figure 2: Cross Fading Example

pair of buttons, crossfading is halted and the image being crossfaded in the cell is immediately rendered as opaque. In addition, a yellow border is rendered around the image to provide visual feedback to indicate that the pair of buttons is selected. In Figure 2, the image on the far left would be shown if the pair was selected during cross fading. The crouch choreographic button can perform the operation of fast-forwarding, while the jump button affects latching. Crouching activates a fast-forward operation that iteratively selects images from the collection at a rapid rate without crossfading. By standing up again, the participant can select a specific image from the collection. Jumping is a toggle action that latches or unlatches the image in the cell. Latching a cell inhibits the default action of cross fading, and the crouch action of fast-forwarding. Two icons are used as affordances to the state of latching and fast-forwarding. An icon of a lock that can be in either a locked or unlocked state provides feedback as to whether the image is latched or unlatched. A fast-forwarding button functions as an icon representing the state of fast-forwarding. The icon changes colors from gray to blue when fast-forwarding is activated. At this point, the mapping of the movements to the triggered actions becomes extremely important to designing affordances, so to continue further the mappings of movements must be developed.

2.3 Mapping Movements to State

Norman explains the manner in which human interact with systems through an Execution-Evaluation framework [6]. An interaction can be divided into two phases – the Execution phase in which a participant performs actions on the world (a system) and the Evaluation phase in which the participant accesses the state of the world, to evaluate the results of his actions. In order to minimize the gulfs of execution and evaluation, the system design should help the participant build the correct conceptual model of the system, make the right parts visible, provide memory aids to the participant, provide good feedback, and accommodate errors [6]. In our design process, we sought to integrate this perspective on interaction design, with Laban's movement schemes.

In our installation, each choreographic button maps a gesture to a set of triggered actions. When this mapped gesture is performed in the context of a choreographic button, the gesture triggers operations that change the state of the installation. As we have described, in our pairs of choreographic buttons, two triggering gestures have been developed: crouching and jumping. We also have two forms of system operation: latching and fast-forwarding. It seems appropriate to map one operation to each of the choreographed gestures. In selecting which action to map to which form of button, physical constraints and characteristics became the deciding factor. Jumping is quick and sudden, and thus well suited for a momentary state-changing operation. Latching is a toggle action that transpires instantaneously, making it a fitting action to map to jumping. Crouching, on the other hand, is a sustained movement that can last for an indefinite amount of time, which makes it an appropriate movement to map to the sustained operation of fast-forwarding.

Table 1: Mappings Between Gesture and Operation

Gesture	*Operation*
Jumping	Latching or Unlatching
Crouching	Fast forwarding

Figure 3: Affordances Example

In order to properly convey the mappings of movements to actions, certain affordances are necessary. Thus, it is important to return back to the affordances stage (2) of choreographic button development and develop extra affordances for these mappings.

2.4 Affordances of Movement and Mappings

Positioning of the latch and fast-forward icons can help afford the movement required to trigger each of those actions. We place the lock icon in the top left corner of the image and the fast-forward icon in the bottom right corner. In this way, the natural mappings imply that a physical movement in an upward direction (jumping) is necessary to toggle the latching mechanism. The same applies to fast-forwarding, where the mapping of a downward movement (crouching) is expressed by placing the icon in the lower portion of the image (see Figure 3).

In our installation, we use narrative imagery to reinforce the mappings of our choreographic button affordances. To better afford the natural mappings of jumping and crouching for the choreographic buttons, all images selected for cross fading relate in either a literal or metaphorical manner to jumping and crouching (moving up and moving down). By using images with these relationships, our intention is to help participants without previous knowledge of how the installation works to derive the appropriate movements for using the installation. These images also provide an emotional narrative for the participant to explore. Many of the images convey more than just the action of jumping or crouching, but also an emotional experience that is either extroversive or introversive. They represent heightened states that reflect personal processes of transformation. The highlighted image in Figure 4 tells two stories. One is the story of an actual person jumping out of a plane, and the other is the emotional subtext of boldly stepping out into the world and placing oneself in harm's way. The hope in providing these emotional narratives along with the affordances is that the participant will become immersed in the installation making the imagery creation experience enjoyable. As well, jumping and crouching repeatedly is a physically demanding activity; and so, we seek to create a reflective, engaging experience in which movement transforms imagery and the experience of the self. Through physical and emotional engagement, we seek to motivate the experience of the installation, itself.

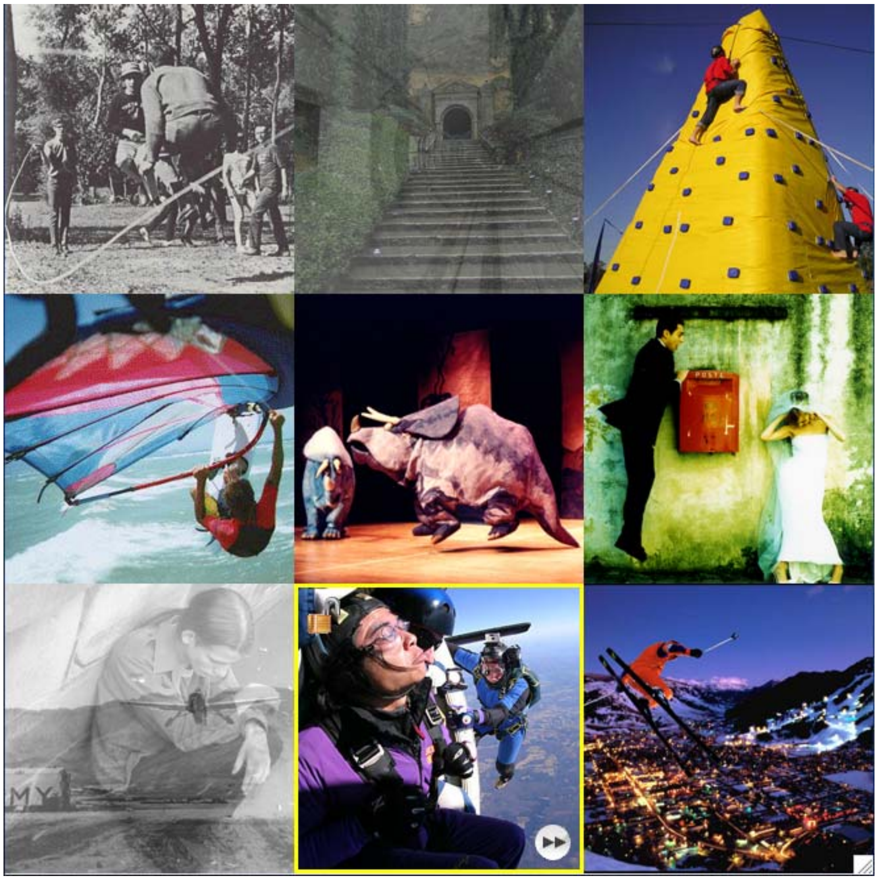

Figure 4: Movement Imagery Grid

3. BOUNCE, DUCK, POGO, DIVE

Bounce, Duck, Pogo, Dive is an interactive art installation that uses choreographic buttons and associated imagery to create imagery. The visually projected arrangement of graphical affordances of the choreographic buttons and associated imagery is referred to as the *Movement Imagery Grid* (see Figure 4). The affordances are arranged in a 3x3 grid providing a resolution that is both aesthetically evocative and creatively open while not being overly cluttered and expressively confusing. Each cell of the Movement Imagery Grid represents one pair of choreographic buttons. The responsive environment space, called the *Choreography Grid* is a 3x3 square grid marked out on the floor of the installation's physical space. Figure 5 shows an example of the both the Movement Imagery Grid and the Choreography Grid in use. Each cell in the Choreography Grid represents the movement-capturing component of a pair of choreographic buttons, which is represented graphically by an identically positioned cell in the Movement Imagery Grid. In other words, the top-left corner cell of the Choreography Grid maps to the cell in the top-left corner of the Movement Imagery Grid. As a person walks from cell to cell in the Choreography Grid, the corresponding cell in the Movement Imagery Grid becomes highlighted by a yellow border showing which choreographic button pair is selected. To avoid confusion involved with a participant being in multiple cells at once or transitioning between cells, the installation doesn't consider a participant to have moved to a new cell until the participant is entirely in that new cell. A small pause of five seconds occurs between the cross fades between pairs of images in a cell, in order to give the participant time to select an image before it changes again. In order to prevent every cell from crossfading at once, each cell begins crossfading at a different moment.

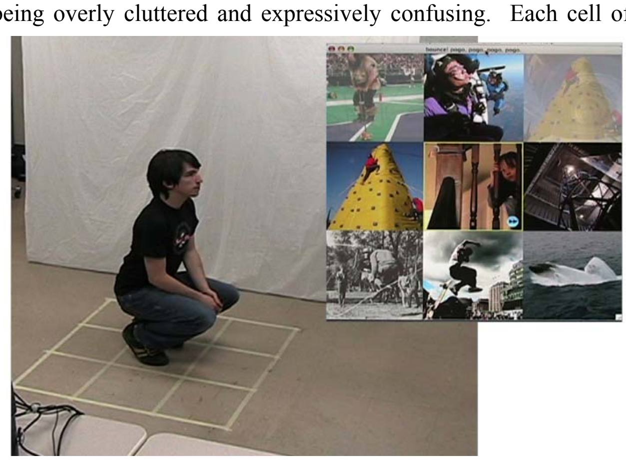

Figure 5: Example of Installation in Use

Bounce, Duck, Pogo, Dive enables the participant to effect the transformation and arrangement of images as he/she wishes to create imagery using choreographic buttons. By allowing the latch mechanism to persistently retain images in the Movement

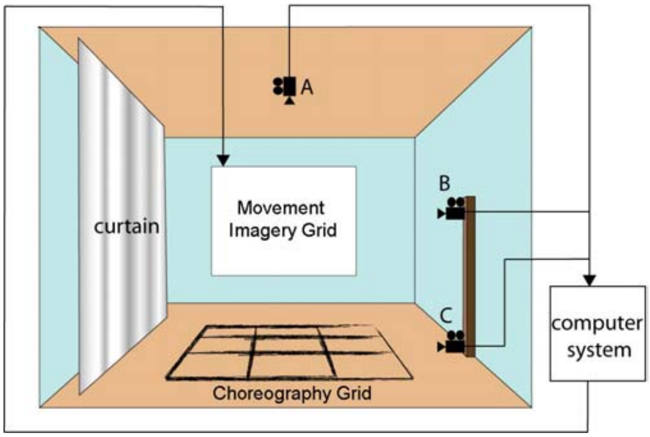

Figure 6: Installation Setup and Flow Diagram

Imagery Grid even after a person exits the installation, a sense of presence of the previous participants is imparted to subsequent participants. As well, the use of related expressive images allows for the creation of coherent imagery assemblages that contain intriguing juxtapositions, with the capacity to articulate emotional narratives.

3.1 Implementation

3.1.1 Hardware

The hardware used for this installation includes three cameras, one projector, one Apple Power Macintosh computer with dual 2 GHz G5 processors running Mac OS 10.3, a white backdrop (cloth), and a dark outfit. Figure 6 shows the rough sketch of the current installation and the flow of components.

The 3x3 grid shown on the floor in Figure 6 is the Choreography Grid that the participant uses to provide input through movement to the installation. The overhead camera A is used to capture lateral position. The white curtain is used to maintain a noiseless background at a high level of brightness for the two profile view cameras, B and C. These are used to recognize crouching and jumping, and are positioned according to the description given in section 2.1. The Movement Imagery Grid is displayed in the projection area. The movements of a participant are captured by the three cameras and fed into the Macintosh, which processes the signals from the cameras simultaneously and generates the corresponding output to the projector.

A dark outfit was developed for participants to wear. It consists of three items: a hat, a shirt, and a pair of shoe wrappers. The hat is a black, adjustable-sized baseball cap. The shirt is a large (2XL) black button-up shirt. The shoe wrappers are painter's boot covers painted black. The dark outfit is an optional design element that is only needed when a participants clothing prevents proper movement recognition. The outfit is modular, and can be worn partially, as needed.

3.1.2 Software

Max/MSP [11] and Jitter [10] were used to process the signals from the cameras, and generate triggers. The video signal from camera A is divided into a 3x3 grid by Cyclops [9]. Cyclops is a Max object that takes a video input and partitions this input into a grid. Each cell in the grid is assigned a single color. As well, one or more tracking points can be assigned to each cell to monitor attributes of a cell's color. In the Cyclops grid for Camera A (see Figure 7a), a tracking point is assigned to each cell, in which the brightness (value) of that cell is monitored. The Max patch will send out the cell number that a participant is in according to the drop in the brightness of a particular cell. Cyclops divides the signal from Camera B into a 10x10 grid (see Figure 7b). The same principle of tracking the brightness applies here. However, the computer system will only consider the data from two adjacent rows that capture the upper body of a participant in the space. At any point in time, brightness of at least one point should be below the threshold, otherwise the computer system will consider that the participant is crouching, provided that the participant is in the view of Camera A. This is because if there is no data below the threshold, we assume that only the white curtain is being seen. Camera C functions similar to Camera B except that the computer system only tracks one row of cells in the 10x10 grid (see Figure 7c), and this camera captures the feet of a participant in the space. The computer system will consider that a participant is jumping if all the tracking point values are above the threshold provided that there is input from Camera A indicating the presence of a participant in the installation space.

Java is used to implement a module that uses a tuple of three choreographic state values (p, j, c) from the above mentioned Max patch to generate the visualization (see The empty tuple is sent when no one is in the space.

Table 2). Here, p is the position or cell that the participant is currently in. The variables j and c will tell the Java module about the movement (jump/crouch) the participant has performed. p values of 1-9 indicate grid cell positions, while 0 indicates no one is in the grid at all. A tuple of these values are generated at a constant rate of 50 milliseconds by a metronome in the Max patch. Since this rate is less than the time it takes for a person to

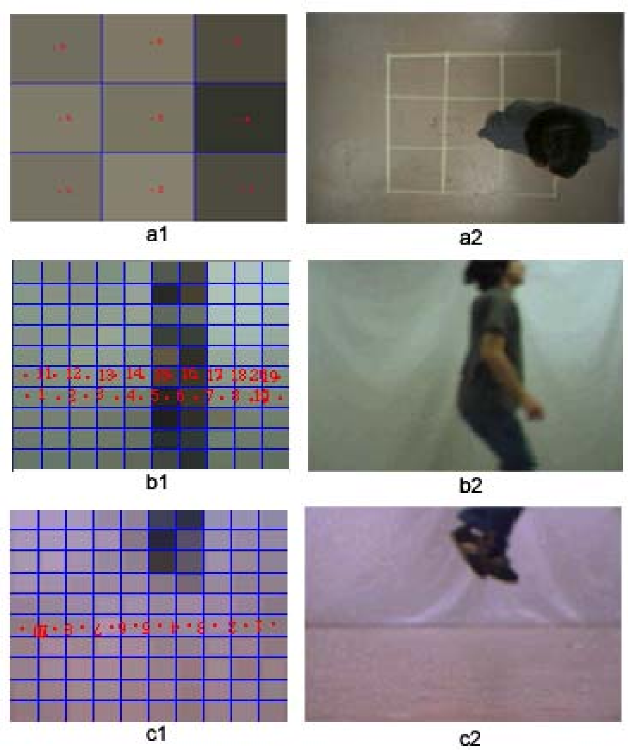

Figure 7: Cyclops Example

complete a jump or crouch, the Max patch will send multiple choreographic state tuples for a single movement. The Java module handles this issue by ignoring further movement signals after receiving the first one until it receives a walking signal meaning the movement has been completed. Essentially, this module is functioning as a state machine, which will change the state of the visualization depending on the values of the three variables. The empty tuple is sent when no one is in the space.

Table 2: State Signals

Signals	***Walking***	***Jumping***	***Crouching***	***Empty***
x (position)	1-9	1-9	1-9	0
y (jump)	0	1	0	1
z (crouch)	0	0	2	2

3.1.3 Recognition Design Issues

Several problems arise when using cameras and Cyclops to track a person's movements. A camera is unable to distinguish between the various people within its view. Therefore, a noiseless background is required to guarantee that only the movements of the participant are captured. To resolve this issue, we created a large white curtain that hangs from the ceiling to the floor and blocks out all movement except for that of the participant. The problem with a white curtain backdrop is that a participant wearing colors similar to white tends to blend into the backdrop making motion tracking difficult. We developed the dark outfit to alleviate the problems of this issue. The dark outfit places dark colors along the monitored portions of a person's body (head, shoulders, upper torso, and feet).

The dark outfit itself also introduces some design issues of its own. People come in various size, shapes, and forms, so the dark outfit needs to adapt to these variations. The outfit cannot hinder a person's walking, jumping, or crouching movements, but should instead provide affordances to encourage these movements. Additionally, the outfit in solving the previously mentioned issues must not itself create noise.

Range of the cameras is another issue. When exiting the space, Camera B and C might lose the participant before Camera A does thus causing the installation to believe the participant is crouching or jumping. The distance between Camera A, Camera B, Camera C, the grid, and the curtain must be arranged in such a manner that the participants goes out of the range of Camera A before going out of the range of Camera B and C.

4. EVALUATION PROCESS

After developing the current installation of Bounce, Duck, Pogo, Dive, we evaluated participants' experiences of choreographic buttons in order to learn about their effects. We conducted a user study to evaluate the installation so that it can accommodate a wide range of human stimuli, and thus lead to a complete experience for anyone that enters the installation space. Defining this range of experiences will lead to human-driven parameters of what constitutes presence in both the Choreography Grid and the Movement Imagery Grid, and will also provide insight on how this installation can be updated to accommodate these parameters.

4.1 Installation Evaluation

Eight (8) participants volunteered to be part of the Installation Evaluation. Following participants' evaluation of the installation, they were given a questionnaire to complete.

4.1.1 Evaluation Instrument

The following set of questions was developed as a post-evaluation instrument for the installation. Questions 1 through 5 were seven-point Likert scale questions where 1 indicated a negative response and 7 indicated a positive response to this installation. Questions 6 through 8 were open-ended questions that allowed the participants to verbally express their reactions to the installation.

1. Overall, how would you rate your experience with Bounce, Duck, Pogo, Dive (BDPD)?
2. How intuitive was the interface?
3. Do you think that the movements for this interface were appropriate for the task?
4. Did the installation hold your interest?
5. As a participant in this environment, do you feel that you had enough control over the virtual environment?
6. Would you recommend this installation to other people?
7. What improvements would you suggest for this installation?
8. Do you think that the pictures used in this installation are appropriate, given the task?

4.1.2 Procedure

Before participants enter the installation space, they will be given instructions on how to use the choreographic buttons. Once participants understand how their movements will affect what is displayed by the installation, they will be allowed to evaluate the installation for up to fifteen (15) minutes. At the end of this evaluation period, participants will be given the questionnaire consisting of five, seven-point Likert scale questions and open ended questions in which participants will rate their experience of the installation.

4.1.3 Results and Discussion

During the development of this installation, many questions were raised about the appropriate use of movement in the installation. Since there were so many of these questions, one of the primary goals of this evaluation was to determine if the controls provided in this installation were congruent with the amount of effort people thought they were putting into the installation to get a response, and if the movements weren't appropriate, to determine what movements would be appropriate for our installation.

Participants reported a positive experience overall (M_{Q1} = 5.88 SD = 0.64), and that the experience held their interest (M_{Q4} = 6.38 SD = 0.74). Participants also reported that the interface was moderately intuitive (M_{Q2} = 5.50 SD = 1.41) with movements that were appropriate for the task (M_{Q3} = 5.38 SD = 1.06). However, participants were neutral in their responses concerning how much control they had over this installation (M_{Q5} = 4.88 SD = 1.25). When compared against a neutral response of four in the seven point scale. Questions 1, 2, 3, and 4 showed a significant positive shift ($t_{Q1}(7)$ = 8.28 SE = 0.23, $t_{Q2}(7)$ = 3.00 SE = 0.53, $t_{Q3}(7)$ = 3.67 SE = 0.38, $t_{Q4}(7)$ = 9.03 SE = 0.26), but showed no change for question 5 ($t_{Q5}(7)$ = 1.99 SE = 0.44 p = 0.09).

In the open-ended questions, participants elaborated on their responses to the Likert scale questions. Participants indicated that they would recommend this installation to other people (e.g. “Yes, for fun at least”; “Yes, I found it engaging”). Participants also indicated that they would like to have more control over the installation (e.g. “Fast-forwarding was too fast. I had to repeatedly crouch to see something interesting”; “Show action history like lock picture”; “More easy control on a grid box such as forward/backward”). These comments about requested control mechanisms offer an explanation for the neutral response to question 5 of the Likert scale questions that specifically asked the participants about their level of control in the installation.

5. RELATED WORK

Laban Movement Analysis (LMA) [3, 4] is a system and language for observing, describing and notating all forms of movement. Devised by Rudolf Laban, LMA draws on his theories of effort and shape to describe, interpret, and document human movement. We embrace LMA as a philosophy of our installation, that movement reflects peoples’ innermost feelings and ways of being in the world. The current version of our installation captures only three movements, which are walking, jumping, and crouching. These three motions are mapped to a person’s neutral, extroversive, and introversive emotions, and the emotions are connected to the visualized imagery.

Schiphorst *et al.* applied Laban in the design of a touch input system utilizing directionally conductive fabric for use as “smart fabric” in wearable computing garments [12]. The participant (or wearer) uses this fabric as an interface to select interaction modes that direct data between networked garments in a wearable art installation. The garment is used to explore the interpersonal exchange of physiological data controlled and selected by the individual wearing the garment using gestures sensed by the fabric and contact between garments initiated by the wearer. These connections form the basis of person-person and person-group interactions. Our installation also uses motion and gesture to generate experiential data. The touch input system of [12] captures hand gestures such as “stroke”, “pat”, or “touch”, and they extracted the parameters, which are time, size, speed, and etc., based on LMA. Our installation captures two body-based movements, jumping and crouching.

As our installation captures body-based movements, “living-room” [1] considers the position of the participant and the orientation of the participant’s gaze to manipulate an augmented reality system. “living-room” explores interactive, space-related aspects of augmented reality in art and design fields like architecture, interior design, and scenographic design. Changing contrast, color, light saturation and other parameters of the recorded image allow the participant to transform the look of the real space and make it more similar to the synthetic world. The interactive visual imagery of our installation is also focused on an art design field. It creates animated imagery in a 3×3 grid. The “living-room” researchers used ARToolKit [8] to track the participant’s position visually and Max/MSP/Jitter to superimpose virtual objects on top of the streaming video image at the correct position with respect to the participant’s viewpoint. They implemented the “living-room” engine for running different scenarios such as initialization procedures, the rendering of the background image, socket connections to ARToolKit, and scene-change functions.

“Puccini Set Designer” [13] is an installation utilizing state-of-the-art technology to enhance the viewer’s experience of the work of Puccini. One of the innovative technologies used is Immersive Cinema. The purpose of this installation was to accentuate the viewer’s sense of participation in the process of experiencing art. The basic setup of the implementation involves five “surrogate” icons painted on the floor in the physical space that are termed the “Carpet of Light.” They represent five sets from Puccini’s opera. When a person steps in any one of the surrogates, the vertical screen in front of him displays a set of dynamic pictures. By pointing to different parts of this picture a participant can trigger a particular subset in the Puccini’s opera. Both the Choreography Grid and the “Carpet of Light” serve a similar role (spatial arrangement of buttons) in their respective systems. The choreographic button and the surrogate icon also serve a similar function while requiring different movements for use. We focus on active body-based gesture rather than hand gesture. We create a correspondence of spatial mappings between physical and graphical space. As well, in our installation the participant not only experiences art but also creates art.

Another installation in the same exhibition [13] was an interactive documentary presentation table. This installation was composed of a table, a projector, a camera, a physical object on the table and a secondary display screen. The table was used for projecting a visual map that was a menu for the participant to explore a collection of materials such as interviews, documentaries, Puccini’s places, and Puccini’s Scenographer. The participant could use a physical object in the table to point to specific menu items. This action would trigger corresponding movement on the screen in front of the table. As we did, this installation used an overhead camera, to track the movement of the object in the visual map that was projected on the table. This work captures the selection choices of materials triggered by participants; ultimately participants could create their own trail while navigating through the collection. The installation’s response could be seen on a screen in front of the participants. Our installation also creates trail of participants’ choices while they browse image collections, and the creation is made by participants’ motion tracking.

Some other related gesture-based systems are mostly capturing hand-gestures not body-gestures. Lenman *et al.* [5] presented a project that studied the use of hand gestures as a human interface system. Remote controls of electronic appliances in a home environment, such as TV sets and DVD players, were the starting point of that project. The researchers have implemented a preliminary prototype using “pie” menus and marking menus for gesture-based interaction. Another project developing a hand gesture-based interface system [2] uses the Tlib image-processing library to construct a simple and efficient interface environment allowing mouse control through pointing gestures. This system also executes commands represented by simple arm movements. The functional portion of the system sends an input signal from the MEGA-D stereo camera head, through the various segmentation and tracking systems, and finally to the gesture system. Omata *et al.* [7] also proposes a hand gesture-based direct manipulation interface that can be used for data transfer among informational artifacts. “Grasp and Drop (Throw)” allows a participant to grasp an object on a computer screen and drop it on other artifacts (i.e peripherals such as projectors or printers that are connected to the system) without the participant touching these artifacts. Using this interface, a participant can operate some artifacts in the mixed reality world in a seamless manner, and easily acquire this interaction style.

In our knowledge of these related works, most capture hand gestures and the position of the body. Our work is differentiated in that we capture active body movements and form an expressive narrative through the creation of imagery. We were able to accomplish this by choreographing a limited gestural vocabulary that was both expressive and relatively easy to design recognition algorithms for.

6. CONCLUSION

Bounce, Duck, Pogo, Dive takes advantage of one of the most common human experiences, motor coordination, to produce a less common experience, the creation of a distinct artwork. Choreographic buttons in this system were used to transform imagery. By affecting the imagery with physical movements, a participant is able to create a sense of presence that remains even after the participant has exited the installation space.

A choreographic button could potentially act as a vehicle to allow people to communicate naturally with their environment. Testament to this is our observation during the development of the installation of a child who without any prior instruction or visual feedback played in the Choreography Grid (jumped, crouched, and ran). As noted by Laban [4], children are lovers of movement and find certain joy in physical activity. The child probably had some imagined purpose for his movements in the space. Bounce, Duck, Pogo, Dive is a bridge between such movements and intentional or unintentional expression of emotional presence.

Bounce, Duck, Pogo, Dive achieves a novel way to control visual changes by using choreographic buttons. A large part of the volume of research on gesture capturing has focused on hand-gestures [2,3,6,13]; however, this system captures different movements such as jumping and crouching, which are more physically active. The system could be applicable to an education setting, which could help children to select specific words, pictures, or information upon the request of an instructor. The system can facilitate learning because it allows children to move around and act lively. These choreographic buttons could also be used to modify games such as chess or checkers that have movements that are similar to the buttons' functions. Additionally, this system is able to support the development of autonomous and intuitive command sets for gestural interaction.

7. FUTURE WORK

Both the user study and peer evaluations have brought about new ideas for improvements to the current installation. Implementing these new ideas should further improve the participant's experience with the installation.

One such suggested idea is to capture images of the participant while interacting with the installation. These images would then be incorporated into the collection of images used in the imagery. Inclusion of these images further instills a sense of presence and brings a much more personal aspect to the participants.

Results from the installation evaluation pointed to a need for more control structures within the installation. One such particular control is the ability to adjust the speed at which fast forwarding occurs. A possible solution for this functionality is to extend choreographic buttons to capture magnitude, as well as binary on/off. This can be accomplished by mapping fast forward speed to the level of intensity, as measured by how low a person has crouched.

In hopes of improving the dark outfit, a costume designer will be contracted to develop a new design for the outfit. The goals are to create an outfit that is comfortable for the participant, easy to put on and take off, interesting to look at and wear, and that provides the appropriate affordances for jumping and crouching.

We desire to have the installation function as flexibly as possible taking into account the various heights of the different participants. Our proposed solution for handling this issue is to make a motorized automated mechanism for adjusting the height of the camera responsible for capturing jumping. When a participant enters the installation space, the automated mechanism would adjust the height of the camera to find the optimal position for gesture recognition, given the current participant.

8. REFERENCES

[1] Galantay, R., Torpus, J., Engeli, M., "living-room" Interactive, Space-Oriented Augmented Reality, *Proc MM 04*, pg. 64-71.

[2] Garver, R., Vision Based Gesture Recognition, College of Creative Studies, University of California, Santa Barbara. http://www.cs.ucsb.edu/~rgarver/gesture_current.pdf

[3] Laban, R., Lawrence, F. C., *Effort: economy of human movement, second edition*, MacDonald and Evans, 2nd edition, 1973.

[4] Laban, R. *The Language of Movement: A guidebook to choreutics*, Plays inc, First American edition, , 1974.

[5] Lenman, S., Bretzner, L., Thuresson, B., Using Marking Menus to Develop Command Sets for Computer Vision Based Hand Gesture Interfaces, *Proceedings of the second Nordic conference on Human-computer interaction*, 2002, pg. 239-242.

[6] Norman, D. *The Design of Everyday Things*, Basic Books, 2002.

[7] Omata, M., Go, K., Imamiya, A., A Gesture-Based Interface for Seamless Communication between Real and Virtual Worlds, *6th ERCIM Workshop on "User Interfaces for All"*, 2000

[8] Online, ARToolKit, http://www.hitl.washington.edu/ALToolKit

[9] Online, Cyclops, http://www.cycling74.com/products/cyclops.html

[10] Online, Jitter, http://www.cycling74.com/products/jitter.html

[11] Online, Max/MSP, http://www.cycling74.com/products/maxmsp.html

[12] Schiphorst, T., Jaffe, N., Lovell, R., Threads of Recognition: Using Touch as Input with Directionally Conductive Fabric, *Proc. CHI 2005*. pg. 2234-2238.

[13] Sparacino, F., "Scenographies of the Past and Museums of the Future: From the Wunderkammer to Body-Driven Interactive Narrative Spaces, *Proc MM '04*, pg.72-79