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Exploring Choreographers' Conceptions of Motion Capture for Full Body Interaction

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We present the results of a group interview of choreographers aimed at understanding their conceptions of how movement can be used to in live performance. This understanding intended to inform research into full body interaction for live performance and other more general full body interfaces. The results of the interview suggest a new way of conceiving of interaction with digital technology, neither as a representation of movement, not as an interface that responds to movement but as a means of transforming movement. This transformed movement can then serve as a starting point for a dancers responses to transformations of their own movement thus setting up an improvisational feedback loop.

motion capture, dance, full body interaction

1. INTRODUCTION

This paper describes preliminary work aimed at informing research into full body interaction interfaces aimed at live performance. We aimed to ground this technology research in a better understanding of choreographers' conceptions of movement and interaction. We have chosen choreographers because they work closely with human movement and therefore have a very rich understanding of it. Using this understanding is vital to creative full body interfaces for performance but can also inform the development of full body interaction in other domains, which will inevitably become more common with the next generation of real time motion capture devices such as the Microsoft Kinect™.

2. RELATED WORK

The use of Motion Capture in the context of live performance has been explored in a variety of artistic domains. It has been used to control music and sound (see ? and ? for recent and early examples respectively) as well as with animation (see ?) and graphics (see Downie (2005)).

Different modes of interaction have been suggested, from direct gestural control (see ?), to a more general analysis of performer movement (see ?), to the use of software agents (see Downie (2005)). What we have not found is an approach explicitly grounded

on performers and choreographers conceptions of the use of motion capture in their artistic practice.

3. CHOREOGRAPHERS' CONCEPTIONS OF THE MOVEMENT AND MOTION CAPTURE

In order to explore choreographers' conceptions of movement as it relates to Motion Capture and motion tracking technology we conducted a group interview. Eight MA Choreography students were invited to take part in a Motion Capture workshop using the OptiTrack™ optical motion capture system. They were given an introduction to the technology in the morning, facilitated by four digital artists with prior experience of the technology. At the end of the morning's workshop a group interview was conducted to understand their responses to the technology and how it might be used in practice. A number of themes arising from the analysis of the interview are presented below.

3.1. Representation vs Transformation

The motion capture system used included software that provided a straightforward visualisation of the movement using a skeletal representation of the human body. Most participants (with the exception of one feature discussed below) were not interested in the skeleton: "It's not that useful to me to just ... get the skeleton". It seemed superfluous: "why do I want a representation of what the body can

do?”. This lack of interest seems to stem from the fact that choreographers already have a good understanding of human movement and are able to easily perceive features of the movement that are revealed by motion capture: “it’s not giving you any more information, by watching the skeleton body, than watching someone dance”. Another problem was the limitations of the skeleton representation. In contemporary dance the spine and the pelvic region are more mobile than in everyday movement and other forms of dance. This means that a skeleton with only three segments for spine did not allow for a sufficiently detailed representation of the movement.

This feeling meant that simply having a different representation of human motion, that still looks like human motion is of little use. Most participants saw the potential of the technology not as a means of representing movement but as a means of transforming it: “I think how it can transform to something else is more interesting to me.” The ability to map movement into other forms was a recurrent theme of the interview, but it was clear that the concept of transformation is complex and can serve many purposes.

3.1.1. Remediation

One of the most basic transformations was the ability to map dance onto different media that can be used in live performance such as music or visual projections. The control of lighting was a typical example: “I’m interested in light... I was wondering how the data could be used in the way of creating *in the moment* lighting that would follow the dancer or work with the dancer, just depending on the points.” This inspired much enthusiastic talk, especially about the use of sound/music as a responsive medium. There was a desire to place a dancer’s movement at the centre of and in control of all of the elements of a performance, and motion capture seems to give that possibility. This demonstrates one of the most fruitful uses of motion capture in live performance, but in itself does not reveal the important concepts as it does not answer the question of how the mapping is done: “In order to do that you’ve got to decide what you want to transform it to...”

3.1.2. Abstraction

Whereas the human-like skeletal representations were of little interest, the participants were attracted to simpler more abstract representations of the movement, such as the marker positions: “I was much more interested in just, the dots moving than interpreting the dots...”. This interest seems to stem from an interest in “the possibilities of the abstraction” in representing human movement. Mapping onto new media can therefore allow the audience to perceive the movement but abstracted

from the human body. A popular theme was to use the marker positions to draw traces of the dancer’s movements over time, providing a means of displaying temporal data but also an analogy with visual arts and drawing.

3.1.3. Creation of new meanings

Abstraction was partially an aesthetic choice, participants were interested in the visual appearance of abstracted motion. However, there was also an interest in using more abstract representation to make available information that would not otherwise be available. For example, displaying links between two dancers in a duet: “If there are two dancers could you define with lines... the distance between the dancers” displaying “not them but the spaces between”. This kind of augmented display could display explicitly to an audience information that is implicate in the original performance.

Other participants went further and considered the possibility of creating new meanings that were only possible with motion capture representations of movement. An abstract display made it possible to create forms that did not appear possible in human movement and to use performance specifically to create these forms. For example, two of the participants had performed a duet in motion capture with the specific aim of giving the appearance of a single form that combined both their movements: “we were playing with mixing up the body parts making you forget it’s a particular body part - loses it’s humanity”, “I was really excited about making this hybrid creature. There were certain points where points disappeared...”. This kind of work was seen as a way of going beyond the bounds of the human body and into impossible bodies. “the imaginary body and the uncanny ... she was doing stuff that you cannot really recognise as human”. This raised the possibility of using motion capture data as a means of allowing a human performer to become inhuman: like an animal or even a seemingly random pattern. Depending on the movements of a dancer the pattern of dots could shift between states of appearing completely human to ones in which the human form dissolves.

This kind of fundamental transformation could be used to invoke deeper concepts and identity than the surface images. For example, one participant described a project in which “every dancer has a kind of solo self-portrait ... a digital image which is like a representation of the self.” She saw one potential of motion capture to be to “map the unconscious into the virtual ... a print of the unconscious of the dancer”. We may therefore interpret part of the power of abstract to be that it allows performers to transcend the outward appearance of the human

form but still use their movement to explore elements of their identity and affect.

3.1.4. Interpretation and selection

As we have seen the concept of transformation and mapping was central to the discussion. However, one choreographer picked up on a subtle aspect of mapping performance data. It concerned the human perception of the performance and how we as humans naturally focus on and interpret parts that are interesting to us. "There is a performer on the stage doing some movement and we are not actually looking at the whole all the time, we are selecting information and we read meaning from that ... all this information is too much... my interest is more on what is more visible and what is less visible." The innate human ability to interpret movement is partially lost when mapping that movement onto other more abstract forms. What this participant has identified is the need for a level of cognition and of interpretation of the movement data before it can be meaningfully mapped into some other domain. To construct an isomorphic relationship between two different forms of expression, the data needs to be interpreted and reconstructed.

3.2. Interaction and feedback

As we have seen, the transformations of movement described above could all be used as a means of displaying to an audience aspects of a performance that is not immediately apparent. However, there was also an interest among participants in having dancers interact with the displays of their own movement. The displays would respond to the movements of the dancer, but the dancer could in turn respond to the displays creating an improvisational feedback loop.

3.2.1. Scores

Several participants noted a similarity between the visual traces of motion capture and techniques that they already used. They often used abstract visual "scores" as a starting point for choreography. "We've done a lot of work with score and making images and then interpreting images. it would be cool to make something, record it and then try to use that as a response recording of the lines." The scores described are not formal notations but abstract drawings that are open to interpretation. This means motion capture traces could well serve as scores: "it's pretty much like a score to me, the data we have." A dancer would thus be able to create a score with his or her movement and then continue to respond to that score. This could either be an immediate, interactive part of live performance or a longer term tool for choreography.

3.2.2. Doubling

Another important theme was that a visual display could become a partner that the dancer could perform a duet with. As the display is a representation of the dancer it becomes "a self portrait of herself that she will dance with". This idea of dancers dancing with their own double was a theme of great interest to some participants.

Several of the participants showed a high level of interest in the mode of interactivity brought about by errors in the skeletonisation algorithms. As the participants danced and moved in the motion capture lab, the tracked points and estimated skeleton position were displayed on a projection screen, allowing the participant to observe the tracking in real time.

On the one hand, there was often a disparity between the actual skeletal position and the estimated skeletal position (due to the inaccuracies of the system, exaggerated no doubt by the 'unusual' movement of the dancers). But on the other hand, there was still a clearly perceived association between the movement of the dancer and the projected skeleton. These two factors combined to give the dancers a sense of true interactivity. "the mannequin figure and [the] cloud of points, trying to interact with each other but some times the mannequin would be upside down on its head... a collaboration between the programme and the person almost like they are dancing together."

The term 'interactive' needs to be properly distinguished from 'responsive'. Haque (2006) argues that an interactive system 'should be in some sense circular', that is, the experience is a two way phenomenon; both parties are reactive to each other. Using the tracked points of the body to draw in 3d space, is on the whole, a responsive activity (ignoring any affect the drawing might have on the dancer). Paine (2002) presents a model of interactivity based on the human conversation, specifying that it concerns an exchange and sharing of ideas, with relationships 'deepening over time'. Both Paine and Haque's ideas about interactivity imply 'agency' within the system. That is, a level of cognition, that mediates a reciprocal adaptive exchange. What our participants engaged with was obviously not actual cognition on the part of the computer (we were working with demos - example applications), but we would argue that the glitches in the software combined with the easily perceived association of movement, gave the impression of a layer of cognition which made the interaction more rewarding and engaging than witnessing a linear set of relations, such as drawing points. One participant described the experience as

“almost like they were dancing together, but in a dysfunctional way”.

A similar idea, was the suggestion of a delay on the output of the drawing of points. “[Y]ou could be looking at the monitor and respond to what you were doing 5 minutes ago”. Although the idea of cognition is even less convincing in this case, the interaction despite being linear and uninterpreted, would be distanced or abstracted from the performers input in a temporal sense, affording a more engaging and interactive experience.

4. DRAWING DANCE

Following the workshop described above the students were asked to work on a project that represented the ideas they had discussed. The result was a software platform and performance that enabled a dancer to perform a duet with an artist. The movements of the dancer were motion captured and displayed on a large scale projection either as points or as traces, lines of movement over time. The artist was able to draw on the same projecting screen using a graphics tablet. Figure 1 shows examples of the traces produced. This displayed the use of abstraction in displays of movement, as discussed above. The dots representing the dancer were abstract but often very recognisably human (top left in figure 1). The artist was able to interpret this movement in a freer and more abstract way. When the dancers movements were represented as traces the result was less recognisable as human movement but became an object of interest in its own right, effecting the kind of fundamental transformation we have described.

As both dancer and artist were able to view each other's traces in real time they were able to respond to each other creating an interactive improvisation. The movements of the dancer provided a drawing that the artist was able to enhance while lines of the artists drawing served as an improvisational score for the dancer to move to. Thus the two participants were able to create a feedback loop and interactive duet of the type described above. An interesting feature of this work is that the initiative of the performance moved fluidly between the dancer and artist. Some times the dancer lead, with the artist representing her movements, while at other times the artist lead with the dancer using the resulting drawing as a score. This exchange of initiative was freely improvised, resulting in a conversational structure to the piece.

This piece also illustrated another theme of the discussion, the role of human interpretation and selection. A vital part of the work is that the artist

created the drawing based on her own interpretation of the movement, and therefore used her human ability to perform relevant selective attention to human movement. This made possible simple and clear figures that contrasted to the overwhelming complexity that often resulted from complete traces of motion capture data.

5. IMPLICATIONS FOR FUTURE TECHNOLOGY DEVELOPMENT

The purpose of this research has been to investigate how choreographers' conceptions can inform the development of new technologies for full body interaction. A new generation of low cost, markerless technologies exemplified by the Microsoft Kinect™, is becoming available. These are likely to make full body interaction methods ubiquitous. Live performance is a particularly fruitful and interesting domain for full body interaction as it allows for a high degree of experimentation and, as we have seen, dancers and choreographers have a particularly rich understanding of human movement. We believe live full body interaction for live performance to be an important and interesting area in its own right, but the freedom of experimentation and rich understanding of movement is also likely to be a source of novel concepts and techniques for full body interaction in other domains.

The interview described above provides a number of concepts that suggest new ways of thinking about full body interaction.

5.1. Transformation

A key finding of the interview we conducted was that our participants were not particularly interested in motion capture as a means of representing movement. Nor were they interested in using the body for a traditional interface in which particular movement trigger particular commands, in fact this possibility was barely mentioned. What emerged was a new conception of interaction in which technology serves as a means of *transforming* movement. This transformation is interesting as it can display meanings that would not otherwise be apparent. Examples of these transforms include:

- visual abstractions of the movements, which are interesting in themselves as visual forms
- remediation of the movement to other modalities such as sound or lighting
- display of information implicit in the movement, such as relationships between two dancers
- creating impossible, inhuman bodies from human movement.

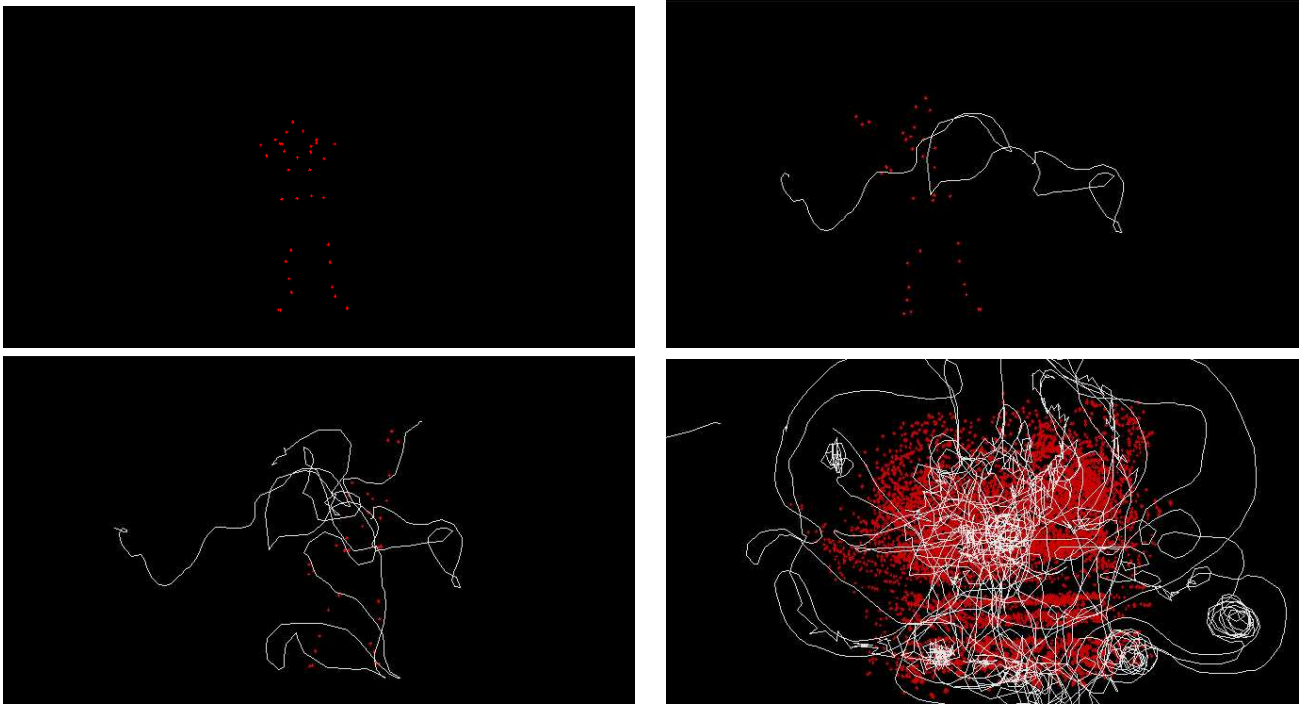


Figure 1: Examples of traces produced by the interaction improvisation between a dancer and artist

This notion of transformation suggests a new approach to interaction that is only made possible by full body tracking interfaces. Such an interface does not have to be constrained by prior models of interaction, for example, gestures triggering commands. The diverse modes of transformation that we have described provide a means of using digital technology to create new meanings and identities from movement. This is a potentially powerful tool for live performers, but it is also provides a potentially fruitful new way of thinking about full body interactions in other domains such as video gaming.

5.2. Glitches, cognition and agency

Much of the discussion focused on transformational effects that were artefacts of the motion capture process and displays, rather explicit features. Displaying marker positions as 3D points made possible a range of emergent transformations dependent on the movements of the dancers. More tellingly the errors and glitches in the skeleton tracking gave the appearance of a failed robotic duet that was of great interest to participants. The dancers, with their movements were able to imbue what were essentially bugs in the system with a narrative and emotional feel. This was also apparent with the participant who was interested in using motion capture data as a virtual map of the unconscious of the dancer. There was no suggestion that surface features such as marker positions could actually act as maps of deep psychological

features, however, the dancer was able to use these abstract representations as a way of expressing deep feelings.

Since the errors in the tracking system provoked the most interesting mode of interaction, it suggests that future work should focus on a genuine layer of cognition, to control and perhaps even construct the mappings from the dancers movement into some form of output. This should allow the system to move towards the modes of interactivity suggested by Haque (2006) and Paine (2002).

Knowing *what* you want to transform (or map) the movement data into is only half of the challenge, since the actual methods of transformation are just as important. It is often tempting to try to arbitrarily 'plug in' values from the movement into the chosen output (in fact this method appears to be quite a common approach). However, we argue that this surface approach is akin to reinterpreting a text as music by directly interpreting letters as notes - the meaning of the is lost through transformation. The issue is that only the most surface features are used in the transformation. The data in its original form must be interpreted and understood at a high level before it is transformed into high level concepts of the output form. Then, implementation specific methods can be used to concretise these high level output concepts into something tangible.

Thus there is an important challenge to automatically interpret and understand movement. As described

above, human viewer naturally perform and selective interpretation on movement that allows them to access deeper meanings. Even implementing basic elements of this interpretation is likely to require state of the art statistical pattern analysis techniques that currently not available in a form that can be used by live performers. A key research challenge is therefore to develop methods for real time pattern analysis of human motion data, but to do so in a way that is grounded in the conceptions and working practices of choreographers and performers so that it becomes a genuine tool under their artistic control.

5.3. Interdisciplinary research

This brings us to our final point. Research into full body interaction must be done in a truly interdisciplinary manner. It requires complex technical methods that are currently only usable by specialist computer scientists, but these methods must be used in a way that works within live performance. The research presented here has been an initial attempt to ground technology research in an understanding of artistic practice. However, it does not go far enough, by using the interview methods of standard qualitative research, we risk treating choreographers as "subjects" of research. For interdisciplinary research to succeed computer scientists and choreographers must act as co-researchers in a fully participatory process. Each must bring their specialist understandings to the research process and each must strive to understand the conceptions and working practices of the other. What we have presented here is a starting point for this process, but there is much further to go.

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