Playing with Soma: Speculating on the Physical Body and Somatic Practice of AI

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Abstract

Current trends in new media art and dance technology have given rise to artworks driven by motion capture (mocap) data and machine-learning algorithms that take the form of immersive media, live performance and projection-based installations. In these works, the human form is still emphasized even when heavily abstracted, and the data remains in a digital and/or virtual realm. In response to these trends, the authors explore the application of laser projections of motion trails to bring data into physical reality, thus metaphorically giving a “body” to generated movement. Somatic movement improvisations (i.e. Contact Improvisation and the Skinner Releasing Technique) will be used for training to teach the attributes of human movement rather than the vocabulary of a set dance technique.

Introduction

The field of artificial intelligence (AI) emerged from the application of techniques and methods from biological systems (e.g. evolution, neural networks and bacterial growth) to solve computational problems. Over time, multiple categories and subsets of AI have emerged with crossover applications into other disciplines. Within the new media art and dance technology realms, “AI” has come to be associated with practice and research typically making use of machine learning (ML) techniques, such as deep learning (DL). Training models require datasets of existing content, whether it be paintings, musical compositions or movement.

A common way to create a movement dataset is to record a moving human with some form of motion capture (mocap) technology. Early datasets, such as the Carnegie Mellon University Graphics Lab Motion Capture Database (2002), provide a large range of movements performed in daily life. Other types of datasets include those making use of trained dancers performing a vocabulary of movements from a set technique or improvisation (Crnkovic-Friis and Crnkovic-Friis 2016; Girschig 2019; Google 2019). While these datasets can teach the poses associated with human movement, whether intangible attributes of human movement, such as breath and energy transfer, can be passed on remain in question. This challenge is tied to the difficulty of capturing the individual nature of human movement as opposed to simple locomotor movements and pathways (Shao and Terzopoulos 2005, 20).

Human movement is inextricably tied to the “soma,” or body. When a machine generates a movement dataset, it does so without an actual body experiencing it. This places a machine in an interesting position to essentially have a reverse somatic practice or the use of movement to define a body for itself, which can be then brought into physical space. By accomplishing something that humans cannot yet do by natural means, another layer of complexity is added to the human–machine relationship.

To illustrate this concept, the authors present an artwork-in-progress, which makes use of a custom laser projector prototype to visualize mocap data generated through ML and DL models. Using the concept of "soma" as the core inspiration, improvisations using somatic movement practices (SMP) are recorded for use as training datasets. The final dataset uploaded to the prototype is generated from a two-step ML process: the first step provides a machine-generated dataset, and the second step defines the visual expression of the data, aka the machine's body. By developing a process for visualizing movement data with lasers, the authors lay the foundation for developing an interdisciplinary performance installation that challenges where human movement ends and machine movement begins.

Mocap, Human Movement and AI/ML

The origin of this project is Cassinelli's observation that to truly explore the potential of dance mocap data, ML is needed to classify movement, identify relations and extend the range of applications for the data. This observation led to speculation on what would happen if a machine were trained to produce movement data reflecting internal rather than pose-based motivation (i.e., Feldenkrais vs. ballet) and include data glitch, as used in new media art. The purpose of this approach is to provide the machine with a wider range of movement possibilities from which to generate new movement choices instead of focusing on the accurate identification and replication of human movement vocabularies. Additionally, a machine might need the option of defining its own "body" through its movement rather than an assigned avatar.

The importance of the body in human movement comes from the fact that the body dictates the movement that is generated. SMP, one of three branches of somatic practices, focuses on "help[ing] a person discover the natural movement or flow of life activity within the body (Eddy 2009, 8)." This may be accomplished through actions such as breathing, touch or contact, personal exploration, or responsiveness. Specific elements include Novel Learning Context, where the emphasis is on responding to the moment rather than "correctness" and Sensory Attunement, where the "how" is prioritized over the "what" of movement (IADMS 2009, 3–5). Historically, SMP have had a close relationship with modern dance forms (Mangione 1993, 27–28). Specific examples include Asian practices such as yoga, qigong, and various martial arts (Eddy 2009, 7), and the Eurocentric practices of Alexander, Feldenkrais, Bartenieff Fundamentals, Contact Improvisation, and Skinner/releasing techniques (IADMS 2009, 3, 7–8). New methods continue to be developed with dance artists such as Ruth Gibson (Whatley 2012, 265) and Stephanie Hutchison (Hutchison and Vincs 2013, 1), which incorporate SMP into their practice-based research involving ML.

The initial intersections of AI, mocap data and dance, however, tended to focus on recognising poses and generating new choreography. Open source projects such as OpenPose (Hidalgo *et al*. 2021) can then be used to extract key points that define shapes made by the body, which are then used to synthesize new dances using a generative adversarial network (GAN) (Lee *et al*. 2019). This kind of research has been used to create choreographic tools such as *Pathfinder* (Loclair 2017) and *Scuddle* (Carlson, Schiphorst, and Pasquier 2011, 123, 125); and for interdisciplinary media artwork *CyberBallet* (Ars Electronica 2020; CyberRäuber 2020), *Blackberry Winter* (Loclair 2019), *Future You* (Universal Everything 2019), *Kung Fu Visualization* (Shaw and Kenderdine 2016); and has led to several collaborations between dance artists and technologists. Of these collaborations, the Google projects with Bill T. Jones (Google 2019; Jones and Google Creative Lab 2019) and Wayne McGregor (Girschig 2019; Leprince-Ringuet 2018) provide public access to both mocap data and interactive tools for synthesizing new movement sequences. Both Jones and McGregor are known for their use of SMP in their movement style.

Based on the way elements such as Novel Learning Context and Sensory Attunement require a human to focus on elements such as quality of movement and motion pathways, SMP is considered preferable for training datasets for more structured dance techniques.

The use of the SMP-approach by Gibson, Hutchison, Jones and McGregor also provided evidence that SMP mocap data could be used with an ML model. For this project, the authors plan to generate the mocap dataset by recording multiple contrasting improvisations performed by a single individual. This dataset will be processed through an existing ML model that will further abstract the data into motion trail combinations determined by the machine.

The use of a human body, along with the application of ML, inevitably raises some ethical questions. Initiatives such as JUST AI (Joining Up Society and Technology in AI) uses the humanities as a lens for mapping AI and data ethics using existing literature and facilitating discussion through working groups (Ada Lovelace Institute 2020). Specific discussions centring on the impact of bodies and embodied knowledge of AI ethics are also starting to emerge (C-DaRE 2020). Although there are no clear guidelines for ethically creating an artwork of this nature, it seems that these issues should still be taken into consideration.

Defining a body is also contentious in that this is an attribute usually associated with living organisms. Susan Kozel noted in the earlier era of AI that the difference between extending the body with technology and using AI is that "an AI approach substitutes the body with a digitalized one, or sees it as a hindrance and tries to lose it entirely" (Kozel 1994, 85). She later described the experience of performing in a camera-based sensing system that blurs these boundaries because it was "sufficiently responsive and had enough 'fuzziness' in its system for me to feel as if I were engaging with a quasi- autonomous, and at times aggressive, being" (Kozel 2011, 213). The creation of digital agents using artificial neural networks to not only perform with dancers, but engage in a rehearsal process where both entities learn from each other (McCormick, Vincs and Vincent 2015, 2-3), gives rise to the question of whether more attention ought to be given to the physicality of movement generated from ML even if it is simply responding based on how it was trained using human data.

Lasers, Lines, and Artistic Expression

As the primary goal is to visualize ML-generated movement and subsequent body movements rather than develop a new algorithm or model, the authors decided to start by creating a prototype laser sculpture, making use of existing ML models where possible. The prototype could then be developed into a full interdisciplinary installation that serves as a commentary on human-machine relationships. To do this, a laser device prototype engineered by the authors will take in ML-generated mocap data and display the motion trails in 3D space. This device builds upon research on a custom laser graphics processing unit (LGPU) developed by (Haebich, Sandor and Cassinelli 2020, 1), which was, in turn, based on the "Laser Sensing Display" developed by Cassinelli and previous collaborators (Cassinelli *et al.* 2010, 3; Cassinelli *et al.* 2012, 324–25).

Fig. 1. *Smart Laser Projector/Laser Sensing Display*, 2010, Alvaro Cassinelli, Yusaku Kuribara, Alexis Zerroug and Daito Manabe. Lasers/video capture, Copyright belongs to Alvaro Cassinelli, Yusaku Kuribara, Alexis Zerroug and Daito Manabe.

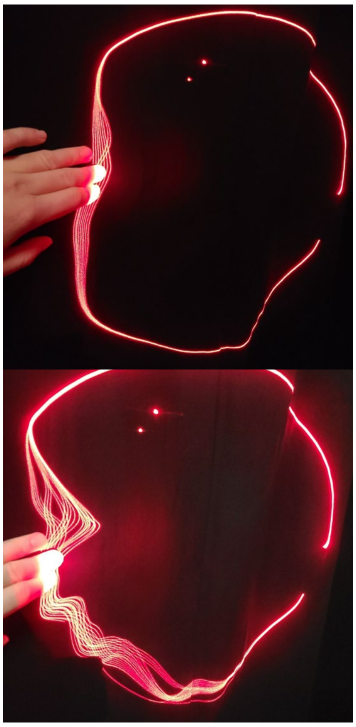

Fig. 2. *Laser Sensing Display*, 2020, Jayson Haebich, Christian Sandor, and Alvaro Cassinelli, Laser/video capture, Copyright belongs to Jayson Haebich, Christian Sandor, and Alvaro Cassinelli.

The rationale for showing motion trails rather than shapes is based on how lasers appear to the human eye as lines of light. This illusion is achieved by a persistence-of-vision effect, whereby a single point moves so quickly that the eye perceives it as a line. To achieve this effect, the laser makes use of the human visual system to display the image. By taking advantage of persistence of vision as a display method, a single laser can be assigned a unique point of data at one point in time, or a system of lasers can display all the data across a longer period. This creates a more dynamic experience compared to viewing a static image where all the visual data is displayed simultaneously. To create this projection, the hardware prototype mentioned earlier will be coupled with a custom programmed software platform to load and output a mocap dataset.

The process for transforming the initial SMP involves two steps. The first involves training a machine to generate movement. This process can be accomplished using either an RNN or the autoencoder method (Pettee *et al*. 2019, 197–98). One example of movement-specific architecture is *chor-rnn* (not to be confused with the char-rnn architectural model), which is a deep RNN that can be trained with a mocap data set to produce generative choreography (Crnkovic-Friis and Crnkovic-Friis 2016, 272) and then transforming that output with a GAN. *Chor-rnn* was used by Kyle McDonald for Rhizome and Elevenplay's *discrete figures* live performance work to create an animated AI dancer (McDonald 2018; Rhizomatiks 2020). Pettee *et al*. (2019, 197) further modified *chor-rnn* to take in three-dimensional data and make use of a mixture density network (MDN) to help process the data. The RNN model is publicly available for use and will serve as our starting point. After producing the machine-generated dataset, we will process it through a GAN to determine factors such as number of data points represented, the color, size, and shape of each data point, and the delay of the motion trail. Loclair's RayGan system used for *Blackberry Winter* is an example of a GAN that does both steps with one model (2019).

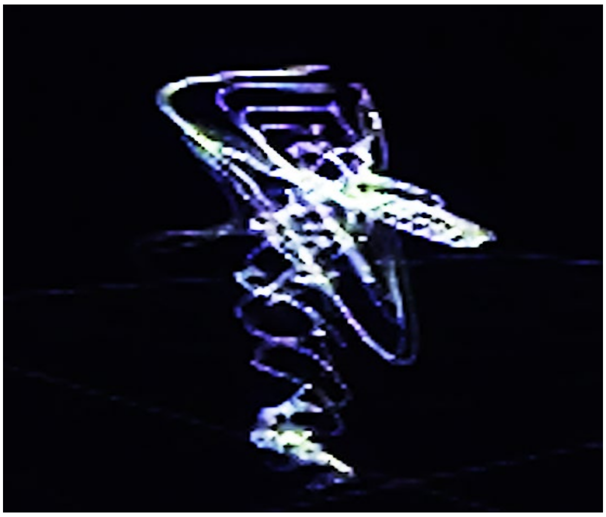

Fig. 3. *Motion trails rendered in Motive software*, 2019, Eugenia S. Kim and the Centre for Transformative Media Technologies, Video capture, Copyright belongs to Eugenia S. Kim.

To help envision what the final output might look like, mocap data recorded by Kim was visualized using the Optitrack Motive software motion trail setting, which revealed abstract lines and shapes that deviate from a human shape. This same data was then mapped to a set of particle streams in Unity, with modified elements, including colors, timing, trail decay, and number of data points. By selectively choosing which data points were rendered, it was possible to further obscure the presence of a human body. The end result was abstract animations of light that were reminiscent of the Laser Sensing Display output and therefore feasible for laser projection.

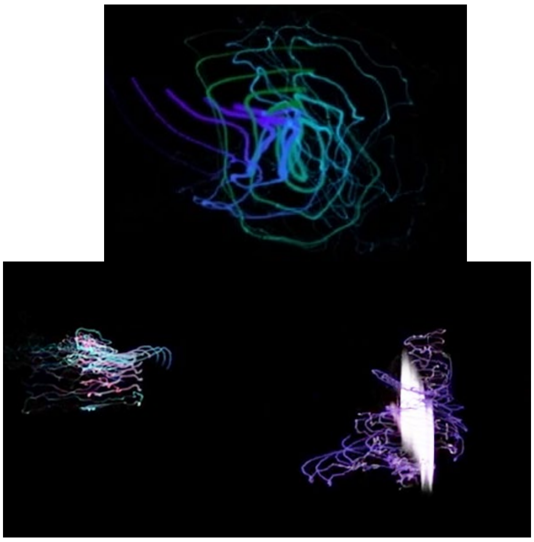

Fig. 4. *Motion trails rendered in Unity software*, 2020, Eugenia S. Kim and Andrew Crowley, Video capture, Copyright belongs to Eugenia S. Kim.

Future Directions and Conclusion

At the time of writing, the hardware prototype was completed and preparations were being made to record the datasets. After cleaning the datasets, emphasis will shift to using the modified *chor-rnn* to generate a new dataset and then identifying a GAN model to further process the data. This data will then be converted into a format usable by the prototype. For the future installation project, further possibilities may lie in interactive ML tools, such as those being produced by the 4i project group (2020). These tools are generally intended for use with movement data in immersive environments (Gillies 2019; Plant et al 2020) and maintain the interactivity and collaboration elements explored earlier by McCormick, Vinca, and Vincent through the use of an artificial neural network (2015). It is also possible to incorporate interactivity at the laser projection level, as evidenced by the previous work of the authors.

Fig. 5. *Photon*, 2015, Jayson Haebich, Laser/video capture, Copyright belongs to Jayson Haebich.

The overall intention of the authors differs fundamentally from the majority of new media and dance technology projects in that the endpoint lies in defining a body rather than selecting movement. In some ways, the project can be seen as a response to the statement "without a real body or any human spirit to complete it (McDonald 2018)." Focusing on alternative visualisation methods rather than creating custom algorithms may help the general public more easily understand the possibilities of gaining new insight into movement through a generated "body."

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Biographies

Eugenia S. Kim is an interdisciplinary creator and researcher. She is an artist for Leonardo21 and Lecturer (Performing Arts Research) at the Hong Kong Academy for Performing Arts. Kim received a PhD from the School of Creative Media of City University of Hong Kong in 2020 and holds degrees from the State University of New York at Albany and Rensselaer Polytechnic Institute.

Jayson Haebich is an artist and researcher, who is interested in the intersection of art, technology and science. He explores how space, light and forms interact to create immersive light installations and interactive experiences. His works investigate natural algorithmic processes and how they can be used to create experiences through new materialism. He has presented his work widely, including in Salisbury Cathedral, and at the Bauhaus Dessau, Somerset House, and the British Film Institute.

Christian Sandor is an Associate Professor in City University of Hong Kong's School of Creative Media, where he directs the Extended Reality Lab. In October 2020, he was appointed Augmented Reality Evangelist at the Guangzhou Greater Bay Area Virtual Reality Research Institute. Since 2000, his foremost research interest has been Augmented Reality. In 2005, he obtained a doctorate in Computer Science from Technische Universität München, Germany. Since then he has worked in leading research institutions including Nara Institute of Science and Technology (Japan), Columbia University (New York, USA), Canon's Leading-Edge Technology Research Headquarters (Tokyo, Japan), Graz University of Technology (Austria), the University of Stuttgart (Germany), and Tohoku University (Japan).

Alvaro Cassinelli was born in Uruguay and earned both a French and Uruguayan bachelor of science before pursuing his studies in France. In 1996, he received a Graduate Engineering diploma from the Ecole Nationale Supérieure des Télécom (Télécom ParisTech) and a Doctoral Qualifying Degree in Physics from the University of Paris-XI, Telecom and Ecole Polytechnique. In 2000, he received a PhD from the University of Paris-XI Orsay. From 2001 to 2015, he worked in the Ishikawa-Watanabe Laboratory at the University of Tokyo, where he co-founded and led the Meta-Perception group. He is also co-founder and organizer of the "Devices that Alter Perception" international workshop and was the first "Taller de Arte y Computación Física" in Uruguay. He is currently director of the Augmented Materiality Lab and Associate Professor in the School of Creative Media, City University of Hong Kong.