Affective Movement in Robotic Art: Alternatives to the "Interiority Paradigm" at the Intersection Between Social Robotics and Performing Arts

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***Abstract*— This paper explores the role of affective movement at the intersection of social robotics and the performing arts. Through the analysis of projects that focus on robots' expressive movement by using theatre and dance methods, this paper points at the shortcomings of such experiments, and proposes the perspective of robotic art as a more fruitful alternative.**

I. INTRODUCTION

Human interaction with robots is more pervasive than ever, which has made the field of social robotics gain great attention. Within that area of study, movement has become a topic of increased interest, as it has been shown to offer less costly and more effective possibilities for creating a better connection among humans and robots than, for instance, appearance. Particularly, emotional and intentional movement has been prevalent in human-robot interaction (HRI); that is, social robotics has focused on how to build a robot that is able to recognise and communicate intentions and feelings to a human[1]. In order to do this, many projects have turned to the performing arts, especially theatre and dance, due to the expertise of these fields with regards to expressive movement. While the intersection between robotics and the performing arts is a fruitful field of research, I will argue in this talk that the way in which movement is currently being developed through performative methods has certain shortcomings, and that the perspective of robotic art on affective movement might open up a more interesting area of exploration for social robotics, as well as expose those aspects of theatre and dance that have being unaddressed in robotics.

II. SOCIAL ROBOTICS AND THE PERFORMING ARTS

A. Theatre and Dance in Social Robotics

Several methods from theatre and dance have been employed in social robotics with the goal of developing emotional movement in robots. Even if the range of examples is wide, they can be categorized in the following clusters[2]:

Firstly, the creation of dramatic characters. Movement here supports the creation of dramatic characters, which is intended at sustaining social interactions (Simmons et al., 2011), promoting acceptance (Anzalone et al., 2010; Jochum et al., 2016) and effectively responding to human social cues while showing intentionality (Breazeal et al., 2003). These projects tend to use theatre as a test-bed, for dramatizing concerns (Breazeal et al., 2003; E. Jochum et al., 2016; Lemaignan et al., 2012) or for feedback on early prototypes (Chatley et al., 2010; Syrdal et al., 2011). Other projects, however, instead of aiming at the creation of a performance, employ those dramatic characters to design robots that function in the wild. This is usually the case of robots that work in public spaces offering a service to humans, such as receptionists or guides (Anzalone et al., 2010; Meerbeek et al., 2009; Simmons et al., 2011). Movement in these projects, therefore, serves the purpose of developing characters in robotics, as it is understood that through movement and behaviour, robots can express personal traits and consequently show a particular character or personality.

Secondly, acting methods. In a similar vein, and closely related to the creation of dramatic characters, Guy Hoffman (2016), as well as Heather Knight and Matthew Gray (2012), have focused on acting methods as a way of incorporating theatre in the design of social robots. Heather Knight and Matthew Gray have experimented with Chekhov's psychological gestures and Guy Hoffman relies mainly on Stanislavski for his designs. In both methods, as it happened with the previous section, the authors rely on an interpretation of dramatic characters in which motive or intent drives expressions.

Thirdly, dance notation systems. Some studies try to achieve the development of emotional movement in robots by means of the notation system that Rudolf Laban developed, particularly LMA (Laban Movement Analysis). LMA provides the tools to analyse how emotional movement patterns are enacted in humans and, according to the roboticists following this method, it gives the basis to later on implement those patterns in robots (Rett & Dias 2007, Zhu et al. 2019, Sharma et al. 2013, Bacula & LaViers

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[1] Note that when I talk about robotic projects I use the term "emotional movement" and when I address robotic art I employ the term "affective movement". A full account of the differences between these two concepts is out of the scope of this paper, but I chose to keep the distinction to foreground the different perspectives that these two areas propose, being the first one more inclined to think of affect in terms of internal, clear-cut and individual emotions.

[2] Other projects have used techniques from puppetry or have focused on the creation of robot choreographies or robot comedy shows, and in some notable cases, there is an interesting shift from the interiority paradigm that I propose. However, as these projects do not focus on movement as a means of analysing, expressing and/or responding to emotional cues, they have been left out.

2020, Knight 2014, Knight & Simmons 2015, Lourens et al. 2010, Ikeuchi et al. 2018, Salaris et al. 2017, Wallis et al. 2010 and LaViers et al. 2017). The goal of the projects greatly vary, but there is a common intention in most roboticist interested in Laban. Normally, Laban notation is employed to analyse how humans convey emotion through bodily movement and how that movement can be programmed in humanoid robots. Movement here then is also used as a means to express inner intentions and emotions; it is understood to be the channel through which an interiority is expressed.

Finally, improvisational techniques. The most common way of using improvisation in social robotic projects is with a goal-oriented approach. Furthermore, this approach is usually combined with an understanding of improvisation as based on the existence, and later expression, of internal states. To say it differently, this vision of improvisation implies an autonomous sentient individual who is moved by internal states which are then expressed in movement. This can be seen in two types of projects. Firstly, in projects that try to program specific personality characteristics in robots that seemingly direct their decisions in improvised settings (Bruce et al. 2000, Meerbeek et al. 2009, Skeppstedts and Ahltorp 2018, and Magerko et al. 2010). Secondly, other projects understand improvisation from an internal perspective, inasmuch as it is considered that the somatic and embodied knowledge that permits the improvisational act are located in the inner sphere of the human individual. These projects, therefore, require human beings to access such bodily knowledge through improvisational practices and then apply it to the development of robots or use it to tele-operate robots in improvisational settings.

In two interesting cases, however, movement is employed as a way of becoming responsive and spontaneous in an interaction with others and the environment (Jochum and Decks 2019, and Wallis et al. 2010). In these experiments, the role of movement in HRI was that of an embodied conversation, rather than a tool to access an interiority.

B. The Role of Movement in HRI

As we have seen in the previous section, most social robotics participates in what I will call an "internal paradigm" with regards to movement. That is, in these projects, movement is understood to be the expression of inner, pre-determined states. This is based on the following assumption: humans are psychological beings that feel and later on express inner states (emotions, intentions, drives, etc.) through movement and behaviour. As robots are not psychological beings but need to resemble human beings in order to connect with us, goes the logic in these projects, they need to copy human expressive movements.

Even if some parts of robotic research deal with a non-internalist perspective on movement, such as the experiments focused on proxemics, the intersection of robotics and performing arts, especially when directed at developing emotional and intentional movement, tends to pivot towards this internal paradigm. With this, I am not claiming that every research falls into this paradigm, but rather that there is a great tendency to hold this view o movement. Exploring affect through bodily engagement is an interesting and useful area of research for human-robot communication which should not be merely discarded. However, it is important to address the assumptions and challenges that lie behind this interiority paradigm and find alternatives within the area of affective movement and bodily communication.

III. PROBLEMATICS OF THE INTERIORITY PARADIGM

The interiority paradigm poses three main challenges to the development of affective movement. Firstly, it is based on a particular, and often unaddressed, imaginary of a human being as a psychologised entity that possesses inner states, has access to them and can express them in movement, in the way that they desire. Such an imaginary is not only restricting other interpretations of what humans, and consequently also robots, could potentially be but it is also embedded in histories of racial and gendered discrimination, in which less than human or non-human others are devalued in terms of their inability to control/conceal inner states, or the fact that they lack a complex interiority (Atanasoski & Vora 2019).[3]

Secondly, it treats movement only as a medium, as a mediator of an interior that is supposed to precede and be of more importance than the movement itself. Therefore, there is a clear interior/exterior dynamic that is not addressed and does not account for other conceptions of movement, such as embodied approaches to cognition.

Thirdly, it is based on the assumption that in order for a successful communication and connection to take place, similarity is needed. This reduces the role of the robot as that of a human copy, therefore foreclosing material and ethical approaches to the importance of otherness and diverse corporealities.

IV. AFFECTIVE MOVEMENT IN ROBOTIC ART

As an example of how robots could be imagined beyond this interiority paradigm, I propose to turn to contemporary robotic art, and the way in which this field deals, in a performative setting, with affective movement. Robotic art, a field that seems to be at a crossroad between visual arts, performing arts and theatre, points at the potential of theatrical aspects that have not yet been addressed by social robotics. Examples will be briefly drawn from the artistic practice of Marco Donnarumma, Louis-Philippe Demers and Bill Vorn. Different in its goals and aims than social robotics, robotic artists are able to open up paths to the conceptualisation of the role of movement in an affective human-robot interaction, to the value of otherness and confrontation with the audience, and to the importance of a situated encounter. This is done mainly in two ways: through evocation and performative co-creation.

[3] This aspect has been, in a similar way, criticized by Mingon and Sutton (2021) under the name of "Western internalism". These authors claim that such a perspective of an individual, internal and bodily-separated mind justified forms of colonial justice and advocate for a 4E cognitive approach in order to overcome the same implications when working with robots.

A. Evocation

Robotic art approaches affective movement from a different standpoint than that of the expression of inner states. Instead, movement is considered from the point of view of what it evokes. That means that rather than focusing on specific psychological states (emotions, intentions, and the like) as that which needs to be expressed through specific behaviours, the viewer's perception of movement is the focus of these projects. Because of this, on the one hand, movement is understood to be part of a bigger system of meaning, that encompasses also context, scenography, narrative, as well as previous preconceptions. And, on the other hand, it foregrounds the malleability of movement interpretation, rather than univocally associating inner states with particular (human) expressions. Such a view then displaces the psychologist interpretation of movement and also moves away from mimicry or imitation, because movements that are not identical or even similar to that of human beings can, nonetheless, still evoke specific qualities that can be interpreted and understood by the audience.

As an example of this, we can turn to the work of Bill Vorn. Vorn commenced in 2006 his series called *Hysterical Machines*, composed of eight-legged robots made out of aluminium in environmental installations. Hanging from the ceiling, these creatures are immersed in a space crafted with sound and light and are equipped with sensorimotor systems, which allow them to perceive the surroundings and react to them. The machines shriek and convulse in presence of the audience, but do not always react to the humans that visit the exhibition, keeping a reactive but, in a way, alien system. The actions performed by those creatures suggest then dysfunctional, absurd and deviant behaviours (Vorn 2014), and also frame the visitors in the position of intruders or even guilty parties in the suffering of the machines. The name of the exhibition therefore only gains meaning when understood from the perspective of what that machinic movement evokes in the audience. Furthermore, by focusing on motion that moves away from the ideals of productivity, transparency and similarity in robotics, *Hysterical Machines* is able to create an affective connection in dysfunction.

B. Performative Co-Creation

Robotic art's approach to affective movement foregrounds that such an embodied communication takes place in the in-between; that is, in the moment of the encounter. In order words, robotic art treats affective movement as performative, inasmuch as the affective states that arise in the encounter are co-created by humans and robots alike. Furthermore, in specific performances that deal with robotic prosthesis, affect is conceptualised as a coupling of movement dynamics that takes place before the participants are able to reflect upon it. That is, their movement dynamics are co-created by the entity human-robot, and do not reflect pre-existing internal emotional states, which undermines the mind-body distinction in HRI, as well as the imperative of imitation for an affective communication to take place.

As an instance of this co-creation, we can look at the performance *Inferno* by Louis-Philippe Demers and Bill Vorn. The play, conceived as a participatory piece, revolve around the audience performing a dance with mechanical prostheses that cover the upper half of their body and are controlled by people off-stage. As the title suggest, the artistic framework relies on the cultural imaginary of Dante's hell and Buddhist Haw Par Villa. What is most interesting about this performance with regards to the topic of this paper is that participants can control the exoskeleton up to a point, meaning that the machine will also pose resistance and induce movements in the humans that are wearing it. The possibility of movement within this framework takes place when the humans stop resisting the machine. Instead of trying to control the prosthesis in order to make it move as they would like, the performance works with the idea of relinquishing control, and kinaesthetically attuning yourself to the machine, in order for the movement to emerge as a combination of both agencies.

Another example of this can be found in the work of Marco Donnarumma. Donnarumma is a performer and scholar who works with technology, music and performing arts, and critically engages with disability, posthumanist and gender studies. This is especially recognisable in his "7 Configurations Cycle", where each work exposes a type of embodiment deemed by him as a "configuration". A configuration is an organisation of human bodies, robotic hardware, machine learning software and microorganisms that affect each other. One of the pieces in this cycle, clearly exposes the idea of performative co-creation: *Eingeweide*. In this show, two dancers, one robotic prosthesis and one microbial cloth appear on stage. Of special relevance is Marco Donnaruma and Amygdala, the robotic prosthesis that is attached to his face during the show. Amygdala has neural networks that are adaptive to its surroundings, and thanks to its sensing system, it can react to external stimuli, such as touch, pressure or torsion. Also, as Amygdala is installed in close connection with Donnarumma's body, especially on his face, this contact is what permits these two bodies to coordinate their movements.

V. Conclusion

The contribution of this paper is two-fold. Firstly, it points to the shortcomings of the present view on emotional movement that is held at the intersection of performing arts and social robotics. Secondly, it suggests the perspective of robotic art as an alternative to the current panorama, which opens up new interpretations of what theatre and performance have to offer to social robotics. Robotic art's view on affective movement as a matter of evocation and of performative co-creation might inspire the development of sentimental machines that move beyond the requirement of being mere copies of a human interiority.

References

[1] Anzalone, Salvatore M.; Nuzzo, Antonio; Patti, Nicola; Sorbello, Rosario and Antonio Chella. 2010. "Emo-Dramatic Robotic Stewards." In Shuzhi Sam Ge, Haizhou Li, John-John Cabibihan and Yeow Kee Tan (eds.), *Second International Conference on Social Robotics*, 382-391. Berlin: Springer Verlag.

[2] Atanasoski, Neda and Kalindi Vora. 2019. *Surrogate Humanity. Race, Robots, and the Politics of Technological Futures*. Durham: Duke University Press.

[3] Bacula, A., & LaViers, A. 2020. "Character Synthesis of Ballet Archetypes on Robots Using Laban Movement Analysis: Comparison Between a Humanoid and an Aerial Robot Platform with Lay and Expert Observation." *International Journal of Social Robotics*. https://doi.org/10.1007/s12369-020-00695-0

[4] Breazeal, Cynthia. 2003. "Interactive Robot Theatre." *Communications of the ACM* 46, No. 7: 76-85.

[5] Bruce, Allison; Knight, Jonathan; Listopad, Samuel; Magerko, Brian and Illah R. Nourbakhsh. 2000. "Robot Improv: Using Drama to Create Believable Agents." *IEEE ICRA Millenium Conference. International Conference on Robotics and Automation*, San Francisco, USA.

[6] Chatley, Amiy R.; Dautenhahn, Kerstin; Walters, Michael L.; Syrdal, Dag S. and Bruce Christianson. 2010. "Theatre as a Discussion Tool in Human-Robot Interaction Experiments: A Pilot Study." *IEEE Third International Conference on Advances in Computer-Human Interaction*.

[7] Hoffman, Guy. 2016. "On Stage: Robots as Performers." *Communication*.

[8] Ikeuchi, K., Ma, Z., Yan, Z., Kudoh, S., & Nakamura, M. 2018. "Describing Upper-Body Motions Based on Labanotation for Learning-from-Observation Robots." *International Journal of Computer Vision*, *126*(12), 1415–1429. https://doi.org/10.1007/s11263-018-1123-1

[9] Jochum, Elizabeth and Jeroen Derks. 2019. "Tonight We Improvise! Real-Time Tracking for Human-Robot Improvisational Dance." *MOCO'19*, Tempe, AZ, USA.

[10] Jochum, Elizabeth; Vlachos, Evgenios; Christoffersen, Anja: Nielsen, Sally Grindsted; Hameed, Ibrahim A. and Zheng-Hua Tan. 2016. "Using Theatre to Study Interaction with Care Robots." *International Journal of Social Robotics* 8: 457-470.

[11] Knight, Heather and Matthew Gray. 2012. "Acting Lesson with Robot: Emotional Gestures." *HRI ACM*, March, Boston.

[12] Knight, Heather. 2014. "Expressive motion with x, y and theta: Laban Effort Features for mobile robots." *The 23rd IEEE International Symposium on Robot and Human Interactive Communication*, 267–273.

[13] Knight, H., & Simmons, R. 2015. "Layering Laban Effort Features on Robot Task Motions." *ACM/IEEE International Conference on Human-Robot Interaction*, *02-05-Marc*, 135–136. https://doi.org/10.1145/2701973.2702054

[14] LaViers, A., Cuan, C., Heimerdinger, M., Huzaifa, U., Maguire, C., McNish, R., Nilles, A., Pakrasi, I., Bradley, K., Mata, K. B., Chakraborty, N., Vidrin, I., & Zurawski, A. 2017. "Choreographic and somatic approaches for the development of expressive robotic systems." *ArXiv*, 1–21. https://doi.org/10.3390/arts7020011

[15] Lemaignan, Séverin; Gharbi, Mamoun; Mainprice, Jim; Herrb, Matthieu and Rachid Alami. 2012. "Roboscopie: A Theatre Performance for a Human and a Robot." *Human-Robot Interaction Conference*, Boston.

[16] Lourens, T., Van Berkel, R., & Barakova, E. 2010. "Communicating emotions and mental states to robots in a real time parallel framework using Laban movement analysis." *Robotics and Autonomous Systems*. https://doi.org/10.1016/j.robot.2010.08.006

[17] Magerko, Brian; Fiesler, Casey; Baumer, Allan and Daniel Fuller. 2010. "Bottoms up: Improvisational Micro-Agents." Conference Proceedings of *INT3 2010*. Monterey, CA, USA.

[18] Meerbeek, Bernt; Saerbeck, Martin and Christoph Bartneck. 2009. "Iterative Design Process for Robots with Personality." *AISB2009 Symposium on New Frontiers in Human-Robot Interaction*, Edinburgh: 94-111.

[19] Mingon, McArthur and John Sutton. 2021. "Why Robots Can't Haka: Skilled Performance and Embodied Knowledge in the Maori Haka." *Synthese*.

[20] Rett, J., & Dias, J. 2007. "Human-robot interface with anticipatory characteristics based on laban movement analysis and Bayesian models." *2007 IEEE 10th International Conference on Rehabilitation Robotics, ICORR'07*, *May*, 257–268. https://doi.org/10.1109/ICORR.2007.4428436

[21] Salaris, P., Abe, N., & Laumond, J. P. 2017. "Robot Choreography: The Use of the Kinetography Laban System to Notate Robot Action and Motion." *IEEE Robotics and Automation Magazine*, *24*(3), 30–40. https://doi.org/10.1109/MRA.2016.2636361

[22] Sharma, M., Hildebrandt, D., Newman, G., Young, J. E., & Eskicioglu, R. 2013. "Communicating Affect via Flight Path." *Human Robot Interaction 2013*, 293–300.

[23] Simmons, Reid; Makatchev, Maxim; Kirby, Rachel; Kyung Lee, Min; Fanaswala, Imran; Browning, Brett; Forlizzi, Jordi and Majd Sakr. 2011. "Believable Robot Characters." *Association for the Advancement of Artificial Intelligence*: 39-52.

[24] Skeppstedt, Maria and Magnus Ahltorp. 2018. "Towards a Structured Evaluation of Improv-Bots: Improvisational Theatre as a Non-Goal-Driven Dialogue System." International Joint Conference in Artificial Intelligence, Stockholm, Sweden.

[25] Syrdal, Dag Sverre; Dautenhahn, Kerstin; Walters, Michael L.; Koay, Kheng Lee and Nuno R. Otero. 2011. "The Theatre Methodology for Facilitating Discussion in Human-Robot Interaction on Information Disclosure in a Home Environment." *20th IEEE International Symposium on Robot and Human Interactive Communication*, Atlanta, GA, USA.

[26] Vorn, Bill. 2014. "The Cathartic Theatre of Robotic Art." In Ryszard W., Kluszczynski (ed.), *Robotic Art and Culture. BILL VORN and his Hysterical Machines*. Gdansk: Laznia Centre for Contemporary Art.

[27] Wallis, Mick; Popat, Sita and Joslin McKinney. 2010. "Embodied Conversations: Performance and the Design of a Robotic Dancing Partner." Design Studies 31, No. 2: 99-117.

[28] Zhu, T., Xia, Z., Dong, J., & Zhao, Q. 2019. "A Sociable Human-robot Interaction Scheme Based on Body Emotion Analysis." *International Journal of Control, Automation and Systems*, *17*(2), 474–485. https://doi.org/10.1007/s12555-017-0423-5