Movement as foundation for social human-robot interaction

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ABSTRACT
Movement has had an instrumental role in the evolutionary history and development of all life. This paper argues that movement also should be instrumental when designing robots, in order to ensure a better user experience in social interaction between humans and robots.

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Phenomenology; Evolution; Natural design; Human-robot interaction; Robots; Artificial intelligence; Movement.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous, I.2.9. Robotics: Kinematics and dynamics

INTRODUCTION
In the 1980s Moravec [7] pointed out how problem-solving AI's easily mimic competent adult humans, yet robotic systems rarely achieved the bodily coordination of a four-year-old child. He argues the reason for this to be the qualitative difference between the relative performances of eye-hand systems and the reasoning systems: "Amateur quality high level thinking can be done by an efficiently organized system doing 108 instructions/second while average quality perception and action re-quires 1011 instructions/second" [7:220]. This can thus be viewed as an introduction to the notion that robotics and artificial intelligence could learn from nature and evolution. This notion was further adopted by Brooks [2,3] who used this as a basis for his robotics development attempting to develop robots of insect-level intelligence. Focusing on the role of the body in the development of artificial intelligence, Brooks established two cornerstones of this new approach within the development of AI: situatedness and embodiment. In this approach the physical design of the robot, as well as its physical placement within the environment would be instrumental to its behavior within it.

This position paper takes a brief look at the instrumental role movement had for the evolutionary development of all life and suggest using it to inform the design of robots, especially when considering social robots, as movement itself is a cornerstone in sociality.

BACKGROUND
In his book, *Restless creatures*, author Matt Wilkinson [10] argue that movement itself is the main driver of the evolution of life. It endeavors backwards through time, describing why humans move about in the world so differently from our closest relatives, chimpanzees, before eventually ending up describing the slow and intricate mechanisms behind the first movement made by life in a blind attempt at gaining advantage. Through the description of movement in single-celled organisms, and how movement was used to drive evolution forward in sometimes radically different branches of survival and reproductive strategies, Wilkinson argues that movement itself is an integral part of all life.

The actions of the different organisms take place on what Gibson [5] called the ecological scale, thus humans' everyday experience take place on a human scale. This means that everything we experience in our daily lives—and have throughout history—are the things we can sense directly by our sensory apparatus. While biologists use instruments such as microscopes to discover life forms that are difficult to place on one or the other category, human observation of how animals and plants are different from each other within the environment we inhabit. On this scale we are used to think of those things that move in specific manners to be other organisms and perceive them as such. The patterns of movements we can recognize through seeing the environment are manifold.

It is likely vision has a great significance for how we categorize things in the environment: The evolution of vision has had no small part to play in the form and behavior of current life forms, especially that of animals [8]. Before eyes, animal predation would have been possible only through close encounters, and, therefore, a process largely dependent on randomness and many animals relied on grazing to acquire their nutrition. The evolution of eyes laid the foundation for active predation, furthering the adaption of other animals to be altered in a direct response to being seen. One part of this adaption is through visual expression, and the other is behavior. Most relevant to this discussion is the behavioral adaptation, as animals need to be adapted to not only have a specific behavior themselves, but to see and understand the behavior of others and react to this.

A part of our brains is therefore reserved for perceiving motion, as specific patterns of motion represent actions and behavior—and in our everyday experience, only animals have behavior. Yet, this part might be over eager to see patterns of behavior where there is none. Perception of animacy can be described as the inclination of humans to attribute animacy and agency to non-living objects, and it is similar to the phenomenon of anthropomorphism. Classical studies on the subject, such as Heider and Simmel [6], show that humans will not only perceive the movements of geometrical shapes as a sign of the shape's agency, but also assign them motive along with personality. Though the observers know that the shapes are lifeless, it does not stop us from seeing them as alive [4].

In attempts to find the perceptual mechanisms that trigger this perception of animacy and causality, some have hypothesized that the trigger comes from observing the movements alone, while others believe we use cues from both movement and nearby environment, such as obstacles and other near-by agents, or that the agent's goal or intention must be evident [8]. In a review of both classical and contemporary studies on the subject, Scholl and Tremoulet [9] argue that even if researchers within the fields of neurology and psychology are not yet sure of the neuropsychological mechanisms for this phenomenon, there can be no doubt about it being a real phenomenon. Blakemore et al. [1] found that contingency (i.e., a motion happening because of another motion) had an effect on how much people perceived animacy in objects.

DISCUSSION

The separation between the animate and the inanimate is, to the everyday observer, an easy one to make and most people will agree that there a clear and intuitive separation between the living and everything else, and between those life forms that move in the environment and those that don't.

This positions our perception and understanding of robots in a very curious place, as many robots are inanimate objects that in spite of not being alive move within the environment. Not only that, but many robots appear to have their own intentionality thanks to the human tendency of perceiving animacy.

Because movement is an integral part of all life, it is also a cornerstone for human everyday life and behavior. Everything that happens in our life happens in … to the environment and the other animate and inanimate objects within it. All interactions we have with each other must involve movement of some kind, and one can thus argue that movement is also inherently social. Through this perspective, we find that though robots are not alive, and even if they do not attempt to mimic any living thing, their movement within physical space itself become inherently social.

CONCLUSION

Brooks [2,3] and his team used principles borrowed from evolution in order to design and develop intelligent robots. They started with simple behaviors and became more advanced by applying one layer at a time.

In the same manner, Wilkinson describe how life started out with very simple mechanisms for moving that through both evolutionary baby steps and leaps, led us to the various natural design we see today. As all life in its current form—either microscopical like bacteria or microscopical like ourselves—is affected by movement in some form or another, movement itself should be viewed as a cornerstone in all social interaction. Therefore, movement should also be considered a vital element when designing robots and discussing the dynamics of human-robot interaction.

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