Robot as embodied agent? A phenomenological critique

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Abstract. The problem of embodiment recurs several times in the contemporary debate in diverse disciplines, such as philosophy, neuroscience, and robotics. In particular, it is possible to define robots as (physical) embodied AI (Artificial Intelligence). From a philosophical point of view, this description opens a series of problems, such as: is the robotics embodiment comparable to the human one? In this paper, I will dig into this question by analyzing the robotics body compared with Embodied Cognition and the phenomenological tradition. Specifically, I will use the distinction between Körper and Leib as an epistemological pathway to dig into robotics. This essay wants to prove that the composite nature of the notion of the body, highlighted by phenomenology, is able to interpret the potentialities and limitations of robotics systems.

Keywords: Embodied Robotics · Phenomenology · Body.

1 Introduction

"Cognitive scientists have much to learn from Merleau-Ponty". This sentence introduces the essay titled "The challenge of Merleau-Ponty's Phenomenology of embodiment for cognitive science"[1]. Interestingly, the warning of a cognitive science "guided" by Merleau-Ponty implies open challenges in front of us. Dreyfus and Dreyfus faced with the problem of a practical way of integration analyzing the concept of intentional arc and maximum grip; nevertheless, the idea of a "phenomenological-informed" cognitive science implies the need to reinterpret the history of cognitive science highlighting new perspectives. Specifically, this idea is very interesting in relation to Embodied Cognition, a flourishing research program in the last decade of the XX century. Embodied Cognition [2] is a research field in cognitive science that rediscovers the importance of the body for cognition; in this perspective, it has a direct (genetic, perhaps) link to Merleau-Ponty and phenomenology. For example, Merleau-Ponty argues that "Insofar as, when I reflect on the essence of subjectivity, I find it bound up with that of the body and that of the world, this is because my existence as subjectivity [= consciousness] is merely one with my existence as a body and with the existence of the world, and because the subject that I am, when taken concretely, is inseparable from this body and this world"[3]. Identifying an in-depth relationship between consciousness, body, and the world will prove to be a keyword for the development of the research program; for this reason, the french phenomenologist is recognized, de facto, as one of the significant inspiring and influencing philosophers for Embodied Cognition. So, on the one hand, it seems evident that at least a part of cognitive scientists refers directly to Merleau-Ponty; nevertheless, on the other hand, it is questionable in which ways the "phenomenological-inclined" cognitive science hinges upon the notion of bodiliness in phenomenology. This issue is particularly relevant when we examine the application of Embodied Cognition to contexts of use, such as robotics. In this perspective, the contribution wants to argue that "also roboticists have much to learn from Merleau-Ponty and phenomenology" deepening how it is possible and why this perspective is relevant. To achieve this goal, I assume the enactive paradigm [4] as a form of Embodied Cognition that defines cognition as body-environment dynamics involving the living body, sensorimotor capacities, and actions. It is particularly relevant for robotics since several researches develop enactive models for robots. The enactive paradigm has been repeatedly applied to developing solutions for human-like cognition in robotics [5][6]. But, why is it necessary to discuss phenomenology in relation to robotics?

The main reason is that, in literature, it is possible to identify a deep link between enactive approach and phenomenology. For example, Thompson writes "once science turns its attention to subjectivity and consciousness, to experience as it is lived, then it cannot do without phenomenology, which thus needs to be recognized and cultivated as an indispensable partner to the experimental sciences of mind and life." [7]. In the above quote, Thompson recognizes three essential passages: 1. The role of phenomenology as an essential component in research on subjectivity and consciousness, 2. based on this, an inter-disciplinary interest in phenomenology, and 3. The application of phenomenology to different contexts. For this reason, a more in-depth investigation of the phenomenological and robotics body is (at least) appropriate as current systems aim to incorporate cognitive systems that simulate the structures of the human being.

In particular, this essay wants to deepen the topic of body, aiming at analyzing how and why we need to re-consider the phenomenological approach in the field of robotics. In order to achieve this goal, the paper is structured as follows. Section 2 provides a brief overview of the meaning of the body in robotics. Then, in section 3, I examine the distinction between the phenomenological and functional approach to the body, defining it as a key concept to deepen an inquiry into robotics. Finally, I address the benefits and the limits of a phenomenological-inclined approach to robotics (section 4).

2 The body in robotics

If we accept that robotics has a lot to learn from Merleau-Ponty and that this means, primarily, addressing the question of the embodiment, then we need to start from the question, "what is a robot?" Specifically, it is necessary to investigate the importance of a more comprehensive answer to the definition of robots instead of a functional-based description in which the focal point is the functionality and the technical equipment.

In the contemporary debate, robotics is often described as the technology of the future as [8] affirms [1].From a technical point of view, a robot is a physical entity capable of acting in the real world through sensors (S), which are the basic units to receive information from the environment, and actuator /effectors (A) that are able to respond to sensory inputs and achieve goals. The two phases, detection and action, are controlled by an overall system called controller (C) [9].

These three components are also listed as essential in the two main definitions of robotics, such as [10][2] and [11][3] . Comparing the two definitions proposed, it is possible to highlight three common ideas: 1. the idea that a robot is a physical entity capable of acting in the real world, 2. the fact that this machine is designed to do a particular job, 3. the idea that the purpose of this machine that is fulfilled autonomously or in coordination with humans.

In sum, the physical body and its ability to move and act in a natural environment are considered critical features of identifying the robot properly, contrasting with AI systems. In this sense, it is possible to broadly speak about the body in the context of robotics because it seems obvious to talk about robots as embodied agents. So, naively and somehow, there is a connection between robotics and the body. From the above, the body, defined as a physical element, is necessary to realize the goals of robotics, even though this idea does not necessarily imply an influence of the body on cognition.

Nevertheless, the definition of the robot as an embodied agent is consistent with the European perspective; in a previous version of the document titled A definition of Artificial Intelligence: main capabilities and scientific disciplines [4] robotics is defined as a "embodied AI" because it is a form of Artificial Intelligence that acts in the physical world. Following this pathway, even those who, such as Andrea Bertolini, criticize the lack of a clear definition of robotics because every attempt is described as a "pointless exercise", identify the idea of bodiliness as a

[1] the growing trend is also confirmed by the International Federation of Robotics (https://ifr.org/free-downloads).

[2] Robot is defined as "(1)a machine equipped with sensing instruments for detecting input signals or environmental conditions, but with reacting or guidance mechanisms that can perform sensing, calculations, and so on, and with stored programs for resultant actions; for example, a machine running itself; (2) a mechanical unit that can be programmed to perform some task of manipulation or locomotion under automatic control" [10].

[3] He defines the robots as "a smart machine that does routine, repetitive, hazardous mechanical tasks, or performs other operations either under direct human command and control or on its own, using a computer with embedded software (which contains previously loaded commands and instructions) or with an advanced level of machine (artificial) intelligence (which bases decisions and actions on data gathered by the robot about its current environment)"[11].

[4] https://digital-strategy.ec.europa.eu/en/library/definition-artificial-intelligence-main-capabilities-and-scientific-disciplines

critical idea for a description of robotics. He proposed a classification for robots considering various criteria, such as 1. Embodiment, 2. Level of autonomy, 3. Function, 4. Environment, and 5. Human-robot interaction. Thus, he affirms that a robot is "a machine which (i) may either have a tangible physical body, allowing it to interact with the external world or rather have an intangible nature—such as software or program, (ii) which in its functioning is alternatively directly controlled or simply supervised by a human being, or may even act autonomously in order to (iii) perform tasks, which present different degrees of complexity (repetitive or not) and may entail the adoption of non-predetermined choices among possible alternatives, yet aimed at attaining a result or providing information for further judgment, as so determined by its user, creator or programmer, (iv) including but not limited to the modification of the external environment, and which in so doing may (v) interact and cooperate with humans in various forms and degrees." [12].

So, it is possible to highlight a convergence into the notion of the body as a first and immediate descriptive trait for robotics. It emphasizes the body according to dynamic, transformative roles in natural/physical settings. In a general sense, starting from this consideration, it seems possible to conclude that the term embodiment, in the case of robotics, refers to the possession of a body [5] which is capable of moving and acting (physical embodiment). From a philosophical point of view, this consideration implies the necessity to deepen the topic of embodiment.

3 From functional to phenomenological perspective on body

The problem of embodiment recurs several times in the contemporary debate in diverse disciplines as it is recurrent in many fields of research, as cognitive science [4], psychology [14], neuroscience [15], and robotics [16]. In this last research field, in parallel with the "naive" idea that the notion of body is relevant to robotics (section 2), has been affirmed the idea that the body is not only the physical correlation necessary for the performativity of robotics but that the body determines (and not only is determined by) cognition. Indeed, since the 90s, in robotics, it is emerging the "Embodied Turn", which revalues the body dimension for artificial intelligence systems as cognition is considered embodied. The Embodied Turn completely disrupts the "Cartesian inheritance" [17] that builds upon a clear dualism between mind and body in order to emphasize a synergetic integration of the two dimensions and a revaluation of the role of the body. So, embodiment holds that cognition occurs through the body, which thus assumes a role of primary importance. In the field of AI, this assumption is declined in the form "intelligence always requires a body" [17] [6]. Pfeifer argues that,

[5] In this sense, it is possible to recognize the importance of "having a body" for robotics [13].

[6] In 1998, Kerstin Dautenhahn affirms "Life and intelligence only develops inside a body" [18].

since the mid-1980s, the concept of embodied intelligence has been introduced in AI to indicate a clear contrast with the classic symbol processing method. The change of approach is mainly motivated by the inability to process symbols of "deepen our understanding of many intelligent processes" [17] as this perspective lacked in enhancing the interaction between the system and the environment. From an engineering point of view, the error of the classic method was found in central representational modeling, which produces structural limits in the synergistic management of the system. In direct contradiction, Rodney Brooks [16] proposes a parallel architecture that does not require a central computer to perform actions. From a theoretical point of view, intelligence is released from the concept of representation and is firmly anchored to a structural coupling between the body and the environment [19][20][21]. Based on this consideration, it is possible to argue that robotics, specifically after the Embodied Turn, can be described according to the framework of Embodied Cognition because it emphasizes the positive and direct role of the body for artificial agents. For example, Kerstin Dautenhahn clarifies that the robotics body is "adapted to the environment in which the agent is living." [18]. So, cognition is situated in the world, and the environment is more than just an input. From this statement, the researcher derives the fact that it is necessary to study intelligence as a phenomenon of a complex system, "embedded and coupled to its environment" [18]. In this perspective, the emphasis on bodiliness highlights the thesis of Embodied Cognition, which argues that mental states depend on the body and its properties. Specifically, as Shapiro notes, the central idea of robotics embodiment is the Replacement. "Proponents of Replacement deny that cognition lends itself to any useful sort of computational description; they similarly question the utility of a concept that is central both to connectionist and computational theories of mind: representation." [2]. Thus, the replacement hypothesis denies a computational-inspired approach, which is grounded in symbols, internal representation, and computation. So, the idea behind is to build open systems which interact with the environment in a fruitful way. In this sense, in line with [22], it is possible to stress the fact that this perspective could be framed in the weak (embodied cognition) thesis, which emphasizes the positive role of the body for cognition, but it does not entail a phenomenological instance. In conclusion, in robotics, embodiment means human activities in the body tending towards the need to discuss the boundary between mind and body again. It does so by "incorporating" the mind into a body that becomes the engine of action and cognition in the world. If, on the one hand, it is a substantial revolution against the classical paradigm, it is also doubtful the phenomenological background of this idea. In conclusion, the perspective of the AI introduces the concept of embodiment and expresses the need for possession of the body (physical embodiment) in order to have an open exchange relationship with the environment.
Despite the theoretical and practical urgency of this shift in robotics,the embodied perspective for robotics misses something [7]; specifically, I agree with [24] arguing that " the "complete agents" built by embodied AI are cognitive agents

[7] see also [23][19][20][21].

that lack a biological-like bodily organization and, thus, a body in the proper sense. Despite its focus on living organisms, embodied AI still misses a deep understanding of the role played by the biological bodily organization in generating a form of cognition that, far from performing extrinsic problem-solving, continuously addresses the problem of maintaining the system's coherence in an ever-changing environment, by charging external perturbing events with internally generated operational meanings that support effective self-regulation". Specifically, declining this critique following a phenomenological approach, there remains an underlying ambiguity between two opposing views of the concept of body, namely the phenomenological character of Leib, "what we are" and the functional anatomical character of the Körper, "which belongs to us"[13]. Despite this, the embodied breakthrough in robotics does not call into question the deterministic principle of a body as a neurophysiological machine but argues that cognitive states have a body component (physical embodiment). Based on this analysis, in the following section, I am going to argue that physical embodiment does not represent the best way to develop cognitive systems.

4 A phenomenological inclined approach to robotics

The reference of robotics to the notion of body is tangible, understanding it as a physical structure that binds the action and determines the goals of the system in the surrounding environment. This has primary consequences from the epistemological point of view because, taking up Damiano's criticism, the interpenetration of the robot-environment system takes place at a functional and goal-oriented level, but does not imply any biological-like organization. Expanding the argument, we can say that not only does robotics functionally address the surrounding environment, but it also fails to grasp the phenomenological value of the body.
Embodiment has a deep root in the phenomenological movement since it was the first philosophical movement to develop a paradigm that revalued the bodily role of experience, for example, in the reflection of Husserl and Merleau-Ponty. For this reason, it is mandatory to deepen the idea of a living body, which is rediscovered, in the contemporary debate, by phenomenology[25]. As Zipoli Caiani argues, in phenomenology, "the notion of embodiment overlaps with the rebuttal of what is usually considered the Cartesian dualistic conception of the mind"[26]. In opposition to the dualistic paradigm of Descartes, phenomenology reconsiders the concept of the body as the place par excellence of the experience.

I argue that phenomenology is useful to talk about robotic systems since

1. phenomenology does not deny the physical dimension of the body (relevant for robotics), which has its own peculiar aim;
2. phenomenology highlights a human-world systemic approach that characterizes cognition, showing a clear break with the cognitive models of current robots.

4.1 Body between humans and robots

The notion of body is central and relevant both to the founder of phenomenology, Edmund Husserl, and to Maurice Merleau-Ponty, already mentioned in this paper. Husserl distinguishes between two bodily forms, Körper and Leib. The first form represents the physical notion of body, which we have seen is also present in robotics; on the contrary, the Leib represents the animated and living body. The relationship between the lived and the physical body is described by Husserl as an intimate fusion. Thus, in Husserl, experience is given through a material thing (Ding); nevertheless, the experience is also characterized by a living body, which has peculiar characteristics[27], defined as a first-person approach. In line with the duality of the body expressed by Husserl, Merleau-Ponty also recognizes the duality of the body. The peculiarity of the French phenomenologist lies in making the body, intended as flesh, the focal point for phenomenological analysis. In a (ideal) line of continuity with the dichotomy of Körper and Leib, Merleau-Ponty delineates a distinction between an objective and a subjective intensity concerning the body. He traces the first form of objectivity of the body in mechanical physiology. In this objective mode, the body-object, as pars extra partes, and its components establish only external and mechanical relations both concerning the movement and the functional relationships. In this analysis, a "linear dependence of the receptor on the stimulus" is established to explain the behavior. A 1:1 structure is created in which each stimulus element, coming from outside or local parts of the body, corresponds to one and only one element of the general body receptor. This one-to-one function collides with a serious problem in the reality of the perceived experience. In a very poetic way, the French philosopher wonders, paraphrasing, if I cannot find in the body the threads that the internal organs send to the brain and that are instituted by nature to give the soul the possibility of feeling its body?[3]. The body, therefore, can be seen as a machine with linear dependence; This objective and physical aspect of the body seems to fully describe, from a theoretical point of view, the development of robotics after the Embodied Turn. As stated earlier, the Embodied Turn in robotics aims at the ultimate abandonment of a centralized computational strategy in favor of a distributed system embedded in the environment. Nevertheless, in order to achieve this goal, it is not necessary to abandon a functional perspective on the body. Specifically, despite recognizing the body's role in robotics, in any case, the mechanistic interpretation of the body for which it is a (neurophysiological) machine remains. For example, Brooks modifies the work setting and the internal organization of the robot, but this does not affect the notion of the body or its structure[16].

4.2 A phenomenological structure for artificial systems?

On the contrary, the notion of Leib or own's body refers to the phenomenological understanding of cognition that necessarily relates the subject to the world. For Merleau-Ponty-Ponty, the phenomenologically own's body is not a physical or physiological structure but a living incarnate res; "One's own body is in the world just as the heart is in the organism: it continuously breathes life into the visible spectacle, animates it and nourishes it from within, and forms a system with it."[3]. This means conceiving experience not as a collection and analysis of data but as a system that develops vitally in the continuous interaction of the subject with the environment. This node brings out a first and crucial question that takes us back to robotics, from what is cognition made if it is not conceivable as data collection? We can take, for example, the case of a service robot that changes the context of use, for example, the house in which it works; every new environment implies a specific training phase through a trial and error process for the root. Can we argue that the same happens for human beings if put in a new environment? Following Merleau-Ponty, we can say that the same thing does not apply to the human being, whose action in the world is determined by the bodiliness, called body schema. The body schema is not a "mere result of associations", a mechanism that, in turn, we can say characterizes robotics, but rather " global awareness of my posture in the inter-sensory world, a "form" in Gestalt psychology's sense of the word."[3]. This refers not only to the spatiality of the body but also to knowledge as that, inevitably, is located as phenomenological.

To comprehend the phenomenological difference in cognition, the example of Merleau-Ponty of the organist is emblematic. "The example of instrumentalists demonstrates even more clearly how habit resides neither in thought nor in the objective body, but rather in the body as the mediator of a world. It is said that an experienced organist is capable of playing an organ with which he is unfamiliar and that has additional or fewer keyboards, and whose stops are differently arranged than the stops on his customary instrument. He needs but an hour of practice to be ready to execute his program. Such a brief apprenticeship prohibits the assumption that new conditioned reflexes are simply substituted for the already established collection, unless, that is, they together form a system and if the change is global, but this would be to go beyond the mechanistic theory since in that case the reactions would be mediated by a total hold on the instrument."[3]. As explained before, the robot processes the surrounding environment from time to time according to a computational and non-systemic process. Thus, the point of distance and detachment is clear, and perhaps also the direction that programming for robotic cognitive systems should take in order to develop more and more human-like structures.

In conclusion, the points mentioned above are helpful in defining a "phenomenological inclined" approach to robotics dealing with the limits of robotics and the unseen resources of phenomenology for robotics systems. Based on these two approaches, we can trace the epistemological difference between the principle of "testing", proper to robotics, compared to the "feeling", which regards human beings. Assuming that the phenomenological ideas, of Leib and body schema, can apply to robotics, the question remains: why is the difference between two meanings of bodiliness relevant to robotics? In line with Metzinger,[28] from an engineering point of view, it seems possible to conclude that there are no scientific ontological limits to the reproduction of the salient aspects in artificial agents [8]. Current robotic developments seem to blur the distance between human beings and artificial things through the development of bio-inspired systems. This reasoning is based on two principles, that phenomenology call into doubts[30]:

1. The absence of formal constraints that render futile the attempt to build sentient robots,
2. the human being must be fully explainable in computational terms, that is, it must be ascribable to functional analysis.

5 Conclusion

We have seen that the concept of the body is relevant to describing robotics, but its meaning is not apparent. Specifically, it must be contextualized in light of embodied cognitive science and phenomenology. We can speak of an embodied agent in the case of robotics, as I proved above, according to a non-phenomenological meaning of the term, which highlights the positive role of a body embedded in an environment for cognition. This idea is called physical embodiment. Nevertheless, a question remains open: is this meaning consistent with the phenomenological approach? Based on the distinction between Leib and Körper, I deny the consistency because embodiment robotics, which we can summarize as having a body, does not entail the living body and the body schema, which are the main ideas of the phenomenological approach. In conclusion, the essay attempts to prove that the difference between Leib and Körper defines two diverse realms from an ontological and epistemological point of view. Even if we can talk about robotics as embodied AI, the robotics bodiliness concerns a functional perspective and an objective meaning of the body; on the other hand, phenomenology shows an innovative resource to reflect on diverse ways to develop robotics systems.

References

1. Dreyfus, Hubert L., and Stuart E. Dreyfus. "The challenge of Merleau-Ponty's phenomenology of embodiment for cognitive science." Perspectives on embodiment: The intersections of nature and culture (1999): 103-120.
2. Shapiro, Lawrence. Embodied cognition. Routledge, 2010.
3. Merleau-Ponty, Maurice. Phenomenology of perception. Routledge, 2013.
4. Varela, Francisco J., Evan Thompson, and Eleanor Rosch. The embodied mind, revised edition: Cognitive science and human experience. MIT press, 2017.
5. Sandini, Giulio, Giorgio Metta, and David Vernon. "The iCub cognitive humanoid robot: An open-system research platform for enactive cognition." 50 years of artificial intelligence. Springer, Berlin, Heidelberg, 2007. 358-369.
6. Vernon, David, Giorgio Metta, and Giulio Sandini. "The icub cognitive architecture: Interactive development in a humanoid robot." 2007 ieee 6th international conference on development and learning. Ieee, 2007.

[8] Other researchers argue that 'There is no known law of nature that forbids the existence of subjective feelings in artifacts designed or evolved by humans"[29].

7. Thompson, Evan. Mind in life: Biology, phenomenology, and the sciences of mind. Harvard University Press, 2010.
8. Gates, Bill. "A robot in every home." Scientific American 296.1 (2007): 58-65.
9. Mataric, Maja J. The robotics primer. MIT press, 2007.
10. Rosenberg, Jerry Martin. Dictionary of artificial intelligence and robotics. John Wiley and Sons Inc., New York, NY (1986).
11. Angelo, Joseph A. Robotics: a reference guide to the new technology. Westport: Greenwood Press, 2007.
12. Bertolini, Andrea. "Robots as products: the case for a realistic analysis of robotic applications and liability rules." Law, innovation and technology 5.2 (2013): 214-247.
13. De Vignemont, Frederique. "Habeas corpus: The sense of ownership of one's own body." Mind and Language 22.4 (2007): 427-449.
14. Thelen, Esther, and Linda B. Smith. A dynamic systems approach to the development of cognition and action. MIT press, 1994.
15. Damasio, Antonio R. Descartes' error. Random House, 2006.
16. Brooks, Rodney A. "Intelligence without representation." Artificial intelligence 47.1-3 (1991): 139-159.
17. Pfeifer, Rolf, and Josh Bongard. How the body shapes the way we think: a new view of intelligence. MIT press, 2006.
18. Dautenhahn, Kerstin. "Embodiment and interaction in socially intelligent life-like agents." International Workshop on Computation for Metaphors, Analogy, and Agents. Springer, Berlin, Heidelberg, 1998.
19. Ziemke, Tom. "What's life got to do with it." Artificial consciousness (2007): 48-66.
20. Ziemke, Tom. "What's that thing called embodiment?." Proceedings of the annual meeting of the cognitive science society. Vol. 25. No. 25. 2003.
21. Ziemke, Tom. "The body of knowledge: On the role of the living body in grounding embodied cognition." Biosystems 148 (2016): 4-11.
22. Giannotta, Andrea Pace. "Corpo funzionale e corpo senziente. La tesi forte del carattere incarnato della mente in fenomenologia." Rivista internazionale di Filosofia e Psicologia 13.1 (2022): 41-56.
23. Di Paolo, Ezequiel A. "Organismically-inspired robotics: homeostatic adaptation and teleology beyond the closed sensorimotor loop." Dynamical systems approach to embodiment and sociality (2003): 19-42.
24. Damiano, Luisa, and Pasquale Stano. "Synthetic Biology and Artificial Intelligence. Grounding a cross-disciplinary approach to the synthetic exploration of (embodied) cognition." Complex Syst 27 (2018): 199-228.
25. Lanfredini, Roberta. "The Mind–Body Problem in Husserl and Merleau-Ponty." Mind, Values, and Metaphysics. Springer, Cham, 2014. 471-482.
26. Caiani, S. Zipoli. Mindsets. Conceiving Cognition in Nature. Mimesis International, 2014.
27. Husserl, Edmund. Ideas pertaining to a pure phenomenology and to a phenomenological philosophy: Second book studies in the phenomenology of constitution. Vol. 3. Springer Science Business Media, 1989.
28. Metzinger, Thomas. The ego tunnel: The science of the mind and the myth of the self. Basic Books (AZ), 2009.
29. Chella, Antonio, and Riccardo Manzotti. Artificial consciousness. Andrews UK Limited, 2013.
30. Corti, Laura. "Towards a quanto-qualitative biological engineering: the case of the neuroprosthetic hand." The Quantification of Bodies in Health: Multidisciplinary Perspectives. Emerald Publishing Limited, 2021.