Chapter 18

A Visualization Approach for Analyzing Decision-Making in Human-Robot Interactions

Madhavi Godbole
https://orcid.org/0009-0009-6105-4583
Apolisrises Inc., USA

Tirupathi Rao Bammidi
https://orcid.org/0009-0008-7834-4096
Mphasis Corp., USA

Anil Kumar Vadlamudi
Aryadit Solutions, USA

ABSTRACT

In an era where human-robot interactions are becoming increasingly integrated into our daily lives, gaining insights into the decision-making processes of robots is paramount. This chapter introduces an innovative visualization approach designed to cater specifically to the analysis and comprehension of decision-making mechanisms in human-robot interactions. This methodology combines cutting-edge visualization techniques with valuable insights from the field of robotics, creating an intuitive platform for users. This platform allows for a transparent and accessible understanding of the underlying mechanisms that govern robot behaviour. The significance of transparency in robot decision-making cannot be overstated. It fosters trust between humans and robots, which is essential for effective and seamless collaboration across various environments. By offering this level of transparency, this approach paves the way for more harmonious interactions between humans and their robotic counterparts, whether it's in industrial settings, healthcare, or everyday life. The visualization techniques employed in this approach enable users to dissect and interpret the intricate decision-making processes of robots. This includes understanding how sensors, algorithms, and environmental data contribute to the actions taken by robots. By gaining insights into these processes, users can better predict and anticipate robot

DOI: 10.4018/979-8-3693-1355-8.ch018

behaviour, which is crucial for ensuring safety and efficiency in human-robot collaborative tasks. Also, this approach bridges the gap between the complex inner workings of robots and the human operators who interact with them. It promotes trust, enhances collaboration, and empowers users to harness the full potential of human-robot partnerships. As we continue to integrate robots into our daily lives, understanding and visualizing their decision-making processes will be instrumental in achieving seamless and productive interactions.

INTRODUCTION

As the 21st century progresses, the presence of robots in our daily environments becomes ever more pronounced, heralding a transformative phase in the way we live, work, and interact (Osa, 2020). This shift isn't confined to mere standalone machines performing specific tasks. Instead, it manifests as intricate human-robot interactions (HRI) that permeate various spheres of our lives, from the intimacy of our homes to the vastness of industrial complexes (Ead & Abbassy, 2018; Fabela et al., 2017). Historically, human-robot interactions were reserved for controlled environments, where parameters were fixed and variables were limited (Elaiyaraja et al., 2023). Fast forward to today, and the landscape has dramatically changed (Jabari et al., 2022). Robots are now integral to dynamic settings, marked by unpredictability and an array of complex variables (Li et al., 2017). In such a milieu, it is not just about ensuring that robots carry out tasks efficiently; it's about the very essence of interaction (Biswas et al., 2015). How do humans perceive a robot's actions? Can we anticipate a robot's next move, and can a robot understand our intentions? These are pivotal questions that determine the success and efficacy of HRI (Jiang et al., 2022).

The quest to decode the intricacies of HRI is not one-dimensional. It draws from a confluence of diverse disciplines, each offering a unique lens to view the puzzle (Sun et al., 2021). Robotics lays the foundation, providing the technical framework that powers these machines (Zhao et al., 2021). However, to truly grasp the nuances of interaction, we delve into the fields of psychology, which offers insights into human perceptions and responses (Qu et al., 2012). Cognitive science further unravels the layers, shedding light on the processes governing human understanding and prediction (Liu et al., 2021). And then there's sociology, which contextualizes these interactions within the broader fabric of societal norms and structures (Lin et al., 2021). Together, these disciplines underscore a salient point: HRI is a dance of perceptions (Gear & Petzold, 1984). It's about the physical and the intangible; the overt actions of a robot and its perceived intentions; the tasks it performs and the emotions it evokes; and not to forget, the bonds - subtle yet profound - it forms with its human counterparts (Abd & Zaboon, 2021).

The implications of this multifaceted understanding are profound (Tan et al., 2021). It's not just an intellectual endeavour to satisfy academic curiosities. The stakes are real and have tangible outcomes (Alam et al., 2022). Designing robots that seamlessly fit into our world is not just about technical prowess; it's about creating entities that resonate with us, that we trust, and that we can coexist (Soltanian et al., 2010). It's about ensuring safety, not just in the physical sense, but in the emotional and psychological domains too (Bhardwaj et al., 2023a; Krishna Vaddy, 2023). It's about social acceptability, ensuring that as robots become ubiquitous, they do so in a manner that aligns with our societal values, norms, and expectations (Li et al., 2017).