Human Impression of Humanoid Robots Mirroring Social Cues

Di Fu†, Fares Abawi†, Philipp Allgeuer and Stefan Wermter

†These authors contributed equally to this work.

Knowledge Technology, Department of Informatics, University of Hamburg

www.knowledge-technology.info

Introduction

Mirroring non-verbal social cues such as affect or movement can enhance human-human and human-robot interactions in the real world [1]. The robotic platforms and control methods also impact impressions of human-robot interaction. However, limited studies have compared robot imitation across different platforms and control methods. Our research addresses this gap by conducting two experiments comparing human impressions of **affective mirroring** between the iCub and Pepper robots, and **movement mirroring** between vision-based iCub control and Inertial Measurement Unit (IMU)-based iCub control. Through these investigations, we aim to enhance the alignment of robotic affordances with human interaction preferences.

Research Questions

RQ1 How do different robotics platforms, specifically the iCub and Pepper robots, compare in affective mirroring (Experiment 1)?

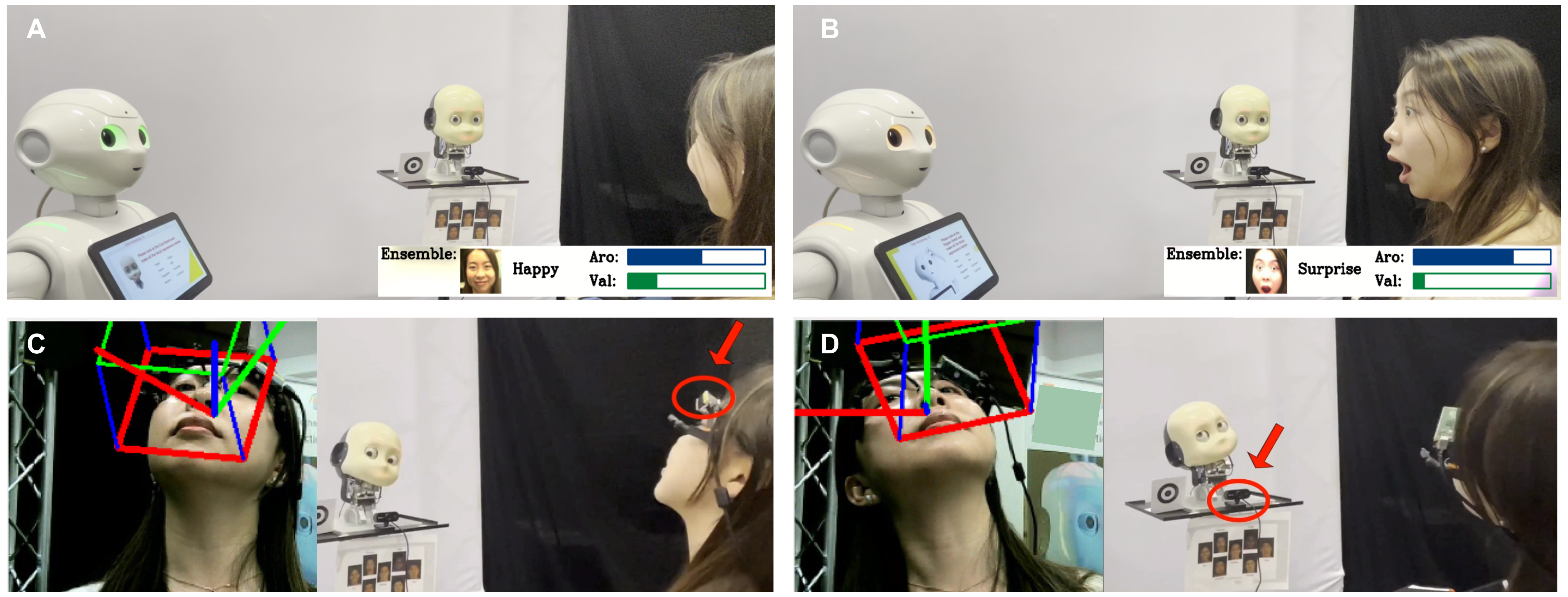
RQ2 How do various robotic control methods, especially vision-based controlled and IMU-based controlled methods, impact the iCub robot's performance in movement mirroring tasks (Experiment 2)?

References

[1] Jamy Li, Wendy Ju, and Cliff Nass. "Observer Perception of Dominance and Mirroring Behavior in Human-Robot Relationships". In: *ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. ACM, 2015, pp. 133–140.

[2] Fares Abawi, Philipp Allgeuer, Di Fu, and Stefan Wermter. "Wrapyfi: A Python Wrapper for Integrating Robots, Sensors, and Applications across Multiple Middleware". In: *ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. ACM, 2024.

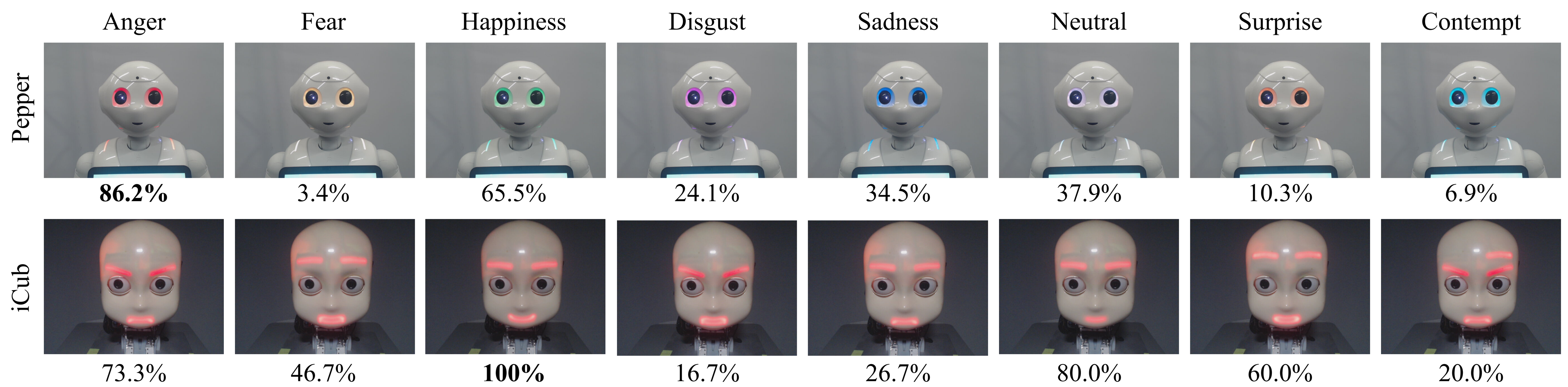
Study Design



Experimental set-up within different conditions: A) The iCub mirroring facial expressions; B) The Pepper affectively signaling through LED color changes; C) The iCub mirroring head movement based on IMU readings. The red circle shows the IMU; D) The iCub mirroring head movement based on a vision-based model. The red circle shows the camera.

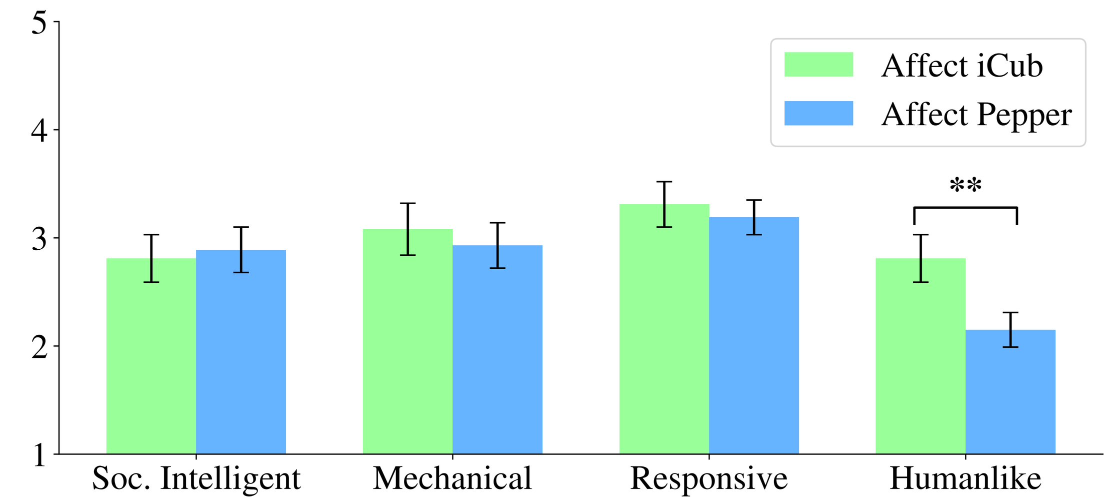
- Participants performed each of the four (two per experiment) mirroring tasks in random order.
- Human impressions of the robots was measured on four dimensions—Socially Intelligent, Mechanical, Responsive, and Humanlike.
- Our self-developed **Wrapyfi** [2] framework was used for managing the task order, transmitting data between models and robots using various middleware, and orchestrating the experimental pipeline.

Results

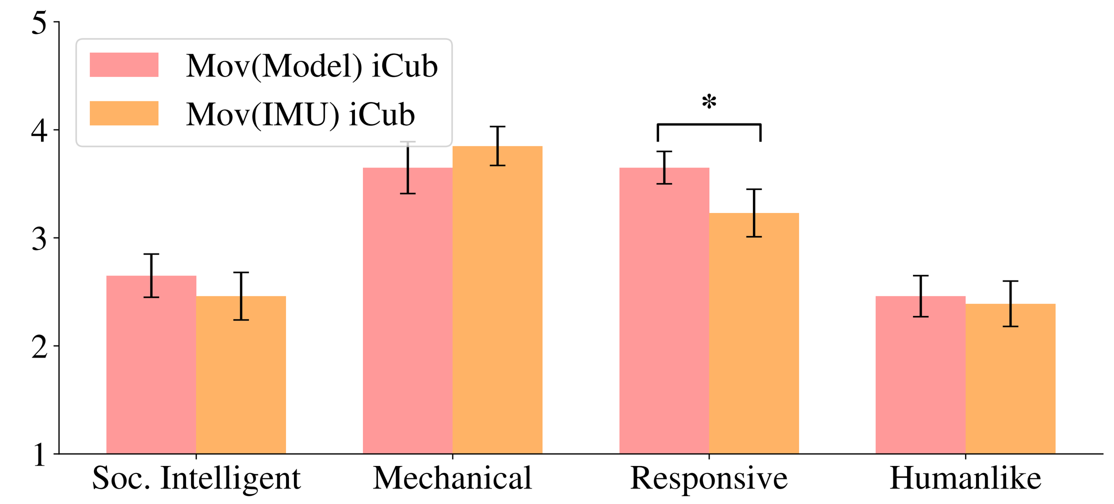


Eight emotion categories mimicked on the Pepper (Top) and iCub (Bottom) robots in the form of affective signaling and robotic facial expressions, respectively. Results of the human study are reported below each image in terms of the average accuracy in matching each affective signal or facial expression to any emotion category: Anger, fear, happiness, disgust, sadness, neutral, surprise, and contempt.

Results



The iCub was perceived as more humanlike than the Pepper when mirroring affect.



A vision-based controlled iCub outperformed the IMU-based controlled one in the movement mirroring task.

$*$ denotes $.01 < p < .05$, and $**$ $.001 < p < .01$

Conclusions

We showed that robotic platforms and control methods played an essential role in mirroring during HRI. It may guide future humanoid robot design decisions aligning with human needs.

Acknowledgements

The authors gratefully acknowledge partial support from the German Research Foundation DFG under project CML (TRR 169).

Full Paper & Demo

Paper

Demo