The hybrid Agent MARCO: Multimodal Autonomous Robotic Chess Opponent

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Abstract

We introduce MARCO, a hybrid, chess playing agent equipped with a custom-built robotic arm and an emotionally expressive, virtual face presented on a small, servo-controlled display. MARCO was built to investigate the hypothesis that hybrid systems capable of displaying emotions make playing chess more personal and enjoyable. In addition, it is our aim to realize emotional contagion between man and machine in that the agent has the power to influence the human player on an emotional level and vice versa. The hardware components consist of eight Dynamixel servos, an Arduino-based control board, a 5.6 inch display, and a DGT chessboard. The software components run concurrently as separate processes. The main components are the virtual agent framework MARC, the WASABI Affect Simulation architecture, and the TSCP chess engine.

Background and related work

Robotic chess provides interesting challenges:

- Grabbing and moving chess pieces
- Turn-taking and attention tracking
- Implementation of different player strength
- Embodiment of the robotic chess interface
- Chess-Turing-Test?

Related work includes:

- Robotic cat "iCat" as chess coach [1]
- Virtual agent with robotic arm "Turk-2" [2]
- Sophisticated robotic arm "Gambit" [3]

⇨ No integration of virtual and robotic agent technology

Research questions

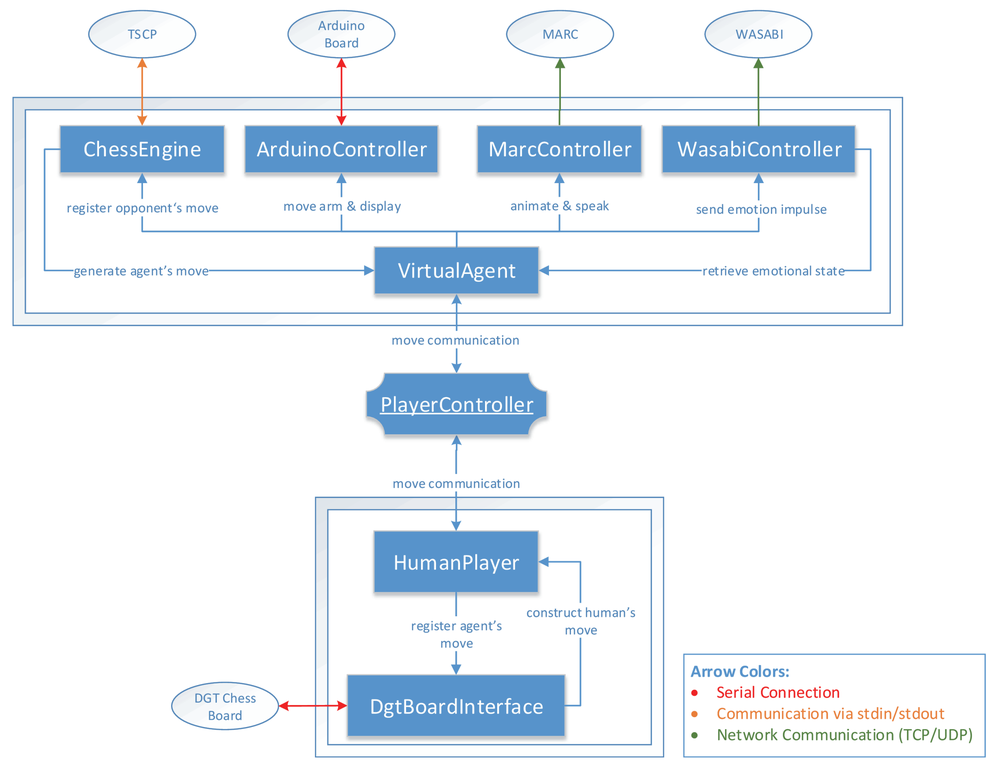
(1) Is it more enjoyable to play against MARCO (i.e. the robotic arm with the virtual agent) when the agent expresses emotions as compared to when it remains equally active but emotionally neutral?

(2) How contagious is the agent on the emotional level and which behavioral factors are best suited to maximize emotional contagion?

(3) Is the most human-like and emotional agent evaluated as more (socially) intelligent than its less complex/human-like versions?

Hard- and software components

- DGT digital chess board to detect moving pieces
- TSCP open source chess engine for position evaluation and move calculation
- WASABI emotion engine to simulate MARCO's emotions
- Dynamixel-based robotic arm to move the chess pieces on the board
- MARC software framework to create the agent's visual appearance on the pan-tilt display



Next steps

⇨ Assess and improve system robustness

⇨ Design and implement operator interface

⇨ Implement utility functions (undo, initial state setup, etc.)

⇨ Devise and conduct empirical evaluations with respect to believablitiy of hybrid agent and contagious effects

References

[1] I. Leite, C. Martinho, A. Pereira, and A. Paiva. iCat: An affective game buddy based on anticipatory mechanisms. In Autonomous agents and multiagent systems (AAMAS), pages 1229–1232, 2008.

[2] L. Sajó, Z. Ruttkay, and A. Fazekas. Turk-2, a multi-modal chess player. Intl. Journal of Human-Computer Studies, 69(7–8):483–495, 2011.

[3] C. Matuszek, B. Mayton, R. Aimi, M. Deisenroth, L. Bo, R. Chu, M. Kung, L. LeGrand, J. Smith, and D. Fox. Gambit: An autonomous chess-playing robotic system. In Robotics and Automation (ICRA), pages 4291–4297, 2011.