The hybrid Agent MARCO

Demo description

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ABSTRACT

We present MARCO, a hybrid, chess playing agent equipped with a custom-built robotic arm and a virtual agent's face displaying emotions. MARCO was built to investigate the hypothesis that hybrid agents capable of displaying emotions make playing chess more personal and enjoyable. In addition, we aim to explore means of achieving emotional contagion between man and machine.

Categories and Subject Descriptors

I.2.9 [**Computing Methodologies**]: Artificial Intelligence—*Robotics*

General Terms

Chess; Robotics; Human-agent interaction; Hybrid agent; Affective Computing

1. INTRODUCTION

Our robotic system combines ideas from several previous research projects that enabled humans to play chess against the machine. "Gambit", for example, is an engineer's solution to an autonomous chess-playing robotic system [8]. Although it does not feature an anthropomorphic design, it includes a "natural spoken language interface" to communicate with the human opponent. It outperformed all robotic opponents at the 2010 AAAI Small Scale Manipulation Challenge, but no data on human players' enjoyment is available. An emotional iCat was programmed as a chess opponent as well [7], but this robotic chess system depended on the human player's assistance to move its chess pieces. A 'hybrid system" similar to ours is called "Turk-2" [9] and features an abstract talking head together with a simple robotic arm.

Our MARCO system combines[1] a rotating display that presents a virtual agent's face with a custom build robotic arm to resemble an autonomous opponent for chess. The virtual face can express a variety of emotions that are driven by the WASABI affect simulation architecture [4] in combination with the TSCP chess engine [6].

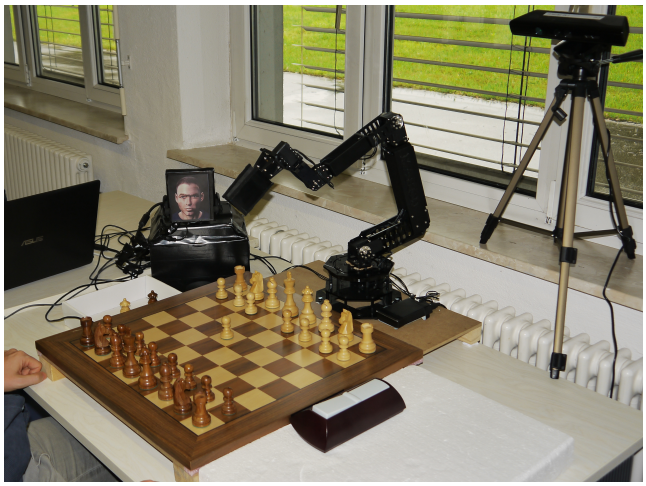

Figure 1: The pan-tilt-roll agent display, the robotic arm, the digital chess board with a chess clock, and a Kinect sensor for human player tracking

2. SYSTEM DESCRIPTION

The complete setup is presented in Figure 1. The hardware used comprises a 5.6 inch pan-tilt-roll display to present the virtual agent's face, a robotic arm to move the chess pieces, and a digital chess board (DGT USB Rosewood) with a digital chess clock. A Kinect RGBD camera is used by the "NovA - Nonverbal Behavior Analyzer" [2] to track the human player's nonverbal behavior for online and offline analysis.

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ICMI'14, November 12–16, 2014, Istanbul, Turkey.
ACM 978-1-4503-2885-2/14/11..

[1]See `https://www.becker-asano.de/media/video/RoboChessICMIDemo.mp4` for a video of MARCO.

Figure 2: The virtual agent expressing *anger*, *neutral*, and *joy* (left to right)

The pan-tilt-roll display features a physical resolution of 640×480 pixels at 16bit color depth. It is mounted in upright orientation at a height that gives the impression that the virtual agent could potentially overlook the complete chess board. Three Dynamixel AX-12A servos are connected to an Arduino-based control board to change the display orientation during the game along all three axes. Thus, the agent can look up from the board into the human player's direction or even physically "shake its head".

The robotic arm is based on the "WidowX Robotic Arm Kit Mark II" [1] available from Trossen Robotics. The rotational base remained unchanged, but the arm itself was extended and the gripper modified. Five Dynamixel servos of four different families move the robot's arm. For the base and wrist two MX-28 servos are used. An MX-64 servo moves the robot's elbow and an MX-106 servo its shoulder. The gripper is opened and closed by an AX-12A servo. The gripper jaws were built to grab the Staunton chess pieces on the DGT board regardless of their height or size. With a maximum reach of $550mm$ the robotic arm can pick and place all pieces on all 64 squares of the $480mm \times 480mm$ DGT tournament chess board.

The software architecture behind MARCO consists of five main components that are linked together to form the chess playing agent:

- The DGT board connected via USB to detect moving pieces
- The TSCP chess engine for position evaluation and move calculation
- The emotion engine WASABI to simulate MARCO's emotions
- The robotic arm to move the chess pieces on the board
- The MARC framework to create the agent's visual appearance on the pan-tilt-roll display

The main information flow originates, on the one hand, from the DGT chess board detecting when pieces are lifted or put down, and, on the other hand, from the chess engine that calculates MARCO's next move based on the updated board information. The result is sent as movement commands to the robotic arm and the virtual agent receives a behavior description expressed in terms of the behavior markup language (BML) [11].

The MARC framework [5] is used to animate the virtual agent, which is displayed on the pan-tilt-roll display next to the robotic arm. Emotional facial expressions (see Fig. 2 for examples) that are part of the BML description are processed by the MARC framework to create lip-sync animations of emotional verbal utterances. Thanks to the integration of the open-source text-to-speech synthesis OpenMARY [10] the agent's emotion also influences the agent's auditory speech. A very similar technical setup was used to realize an empirical study on the effect of emotions displayed by the same virtual agent during a memorization task [3].

3. SUMMARY

We introduced MARCO, a chess playing hybrid agent equipped with a robotic arm and a rotatable screen displaying a virtual agent capable of emotional facial expressions.

This setup is inspired by previous agent systems that (more or less successfully) enhanced the chess playing experience. We believe that our hybrid agent enables us to study how virtual and robotic parts can be best combined to achieve and study emotional contagion between man and machine in the context of chess. Therefore, we aim to analyze for differences in a human player's nonverbal reactions to the hybrid agent using the "NovA" framework [2].

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