iCat, the Affective Chess Player

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Abstract. This demo presents "iCat, the Affective Chess Player", a social robot that is capable of playing chess against a human opponent. The chess game is played on a physical electronic chessboard that detects the board state and sends it to the computer. The goal is to enable children to play with iCat, in a scenario in which the character's affective state is influenced by every move the player makes. Each move is evaluated by a chess engine using the mini-max algorithm. After the value of the evaluation function is returned, an emotion model based on the emotivector anticipatory mechanism is used to determine iCat's affective reaction. By looking at iCat's expressions, children experience in learning to play chess is enhanced, since they know that when they make a good or a bad move iCat will respond accordingly.

1 Introduction

Social robots are robots especially designed to interact with people, helping them to perform tasks in several environments. Social robots, as well as other virtual characters, must have the ability of expressing emotions, so interactions with humans will be more believable, natural and enjoyable.

Chess is an ancient social game in which two real opponents battle in a black and white 64 square board. Computerized chess is primarily played on a computer screen without any social interaction, discarding the social possibilities of the traditional chess game, in which players are able to interact.

Since emotional information exchanges are very important in human social interaction and communication, the aim of our work consists on creating the behaviour of chess a player that can socially interact with a human opponent.

2 Content

2.1 Demonstration setup

iCat is the world's first available plug-and-play robot capable of mechanically rendering facial expressions [2]. It was designed to simulate Human-Robot interaction under the perspective of social robotics. The iCat research platform is a platform developed by Philips that comprises both the iCat robot and a software platform called Open Platform for Personal Robotics (OPPR) [3] that allows the development of new applications for iCat.

In our demonstration, iCat will be the opponent of a human player in a chess match played on an electronic chessboard provided from DGT Projects [4]. The goal is to enable children to play against the character, in a scenario in which the character's emotive behaviour is influenced by the game state. Children may then interpret the characters affective behaviour and by that acquire additional information to better understand the game. In Fig. 1, the demonstration set-up is portrayed.

Fig. 1. The demo set-up

2.2 Technical content

An overview of the architecture is depicted in Fig. 2. We have created a module that runs under the OPPR platform (iCat-Chess Module) which is composed by two main parts: "chess" and "emotion". The chess system contains the interface with the electronic board and a chess engine [8] used to evaluate the board state and by that return the iCat's move. The emotion system is responsible for managing the character's emotional state and receives information from the chess system. The animation module is an existing module of the OPPR platform that blends the pre-scripted animations and behaviours requested in the iCat-Chess module.

The electronic board and the iCat are connected to a computer through a USB interface. The current state of the electronic board is interpreted by a chess evaluation function. The outcome of that evaluation function is the main stimulus to iCat's emotional behaviour.

The character's emotion system has two main components: emotional reactions and mood.

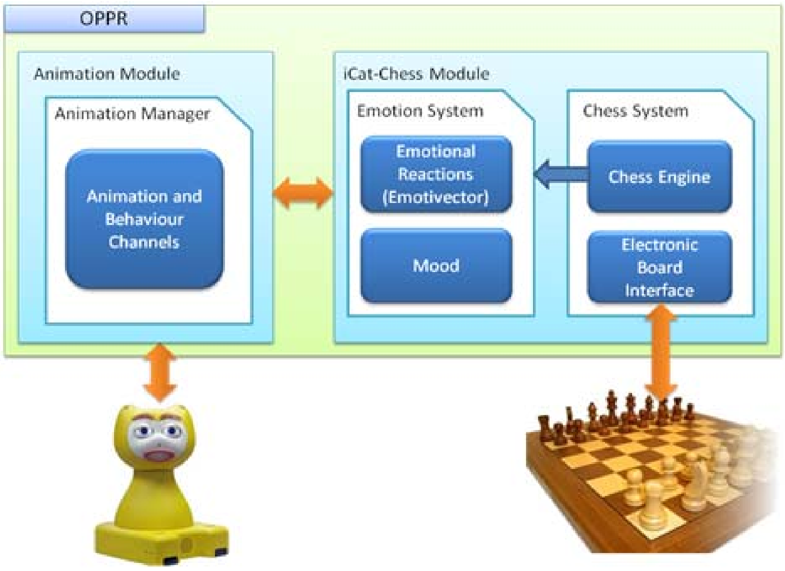

Fig. 2. System Architecture

Emotional reactions are triggered every time iCat's opponent makes a move. They are computed using the emotivector model, an anticipatory mechanism coupled with a sensor, that: (1) uses the history of the sensor to anticipate the next sensor state; (2) interprets the mismatch between the prediction and the sensed value, by computing its attention grabbing potential and associating a basic qualitative sensation with the signal; (3) sends its interpretation along with the signal [5]. The prediction of the next sensor state is based on the moving averages algorithm [6], which purpose is to smooth a data series and make it easier to spot trends. Depending on the values sent by the chess system, different elicited sensations are selected. The selected sensations will then pass to the animation module, where they are transformed into a predefined animation that reflects an emotion (e.g. sad, happy, surprised…). We used the animations provided form the OPPR platform because they have already been submitted to tests which verify that users perceive those emotional expressions on iCat's embodiment [1]. For example, if iCat has a small advantage in the game (in terms of material or position of the pieces) and suddenly its opponent commits a mistake that allows the iCat to capture her queen, the triggered sensation will be a "stronger reward", which will lead to an emotion of surprise (the sensation is better than we were expecting).

Mood is a relatively lasting affective state. It is less specific, often less intense and thus less likely to be triggered by a particular stimulus or event. Moods generally have either a positive or negative valence effect and are longer lasting [7]. We represent iCat's mood as a valence variable that ranges from -100 to 100. The value of this variable depends on the outcome of the evaluation function of the board state and therefore it also changes when the opponent makes a move. However, this change is done progressively and without abrupt variations. If iCat is winning, valence values are positive (100 means that iCat will soon checkmate its opponent), whereas negative values appear when iCat is in a least favorable position than its opponent (-100 means that iCat is going to lose). Mood uses two predefined facial expressions, a “happy” and a “sad” face, each one corresponding to one of the limits of the valence variable. Again, these two parameterizations are based in the animations existing in the OPPR platform. The “happy” face, as defined in the parameterization, is displayed when valence is 100. The facial expressions for the remaining positive valence values are computed by interpolation of that parameterization, resulting in happy faces with smaller intensities. When the valence value is close to zero, the facial expression tends to become neutral. The same happens to the negatives valence values, this time employing the “sad” face parameterization.

While emotional reactions have duration of at least ten seconds, mood is always present. Even though, in the absence of new stimuli, the facial resultant facial expression tends to become neutral, due to the decay of the valence variable.

2.3 Storyboard

iCat can play an entire chess game from the beginning or start from a predetermined position. Both scenarios are possible to present in this demo. Fig. 3 shows the main steps of an interaction with iCat.

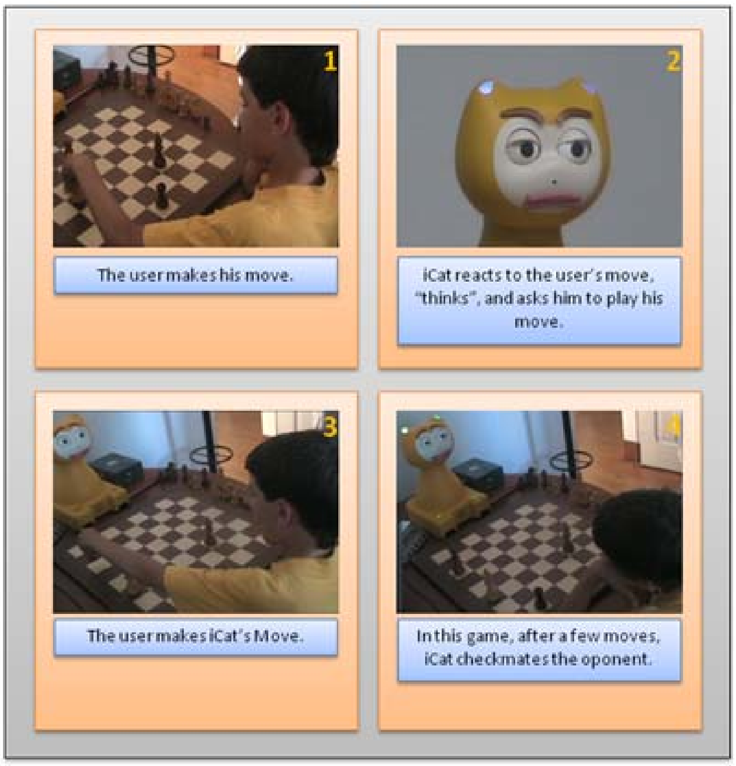

Fig. 3. User playing with iCat

3 Conclusions

This demo presents a social robot that plays chess and engages the user by expressing its affective state during the game. One of the significant advantages of our emotion model is that it can be applied to any other game or task that uses evaluation functions, since all the signals needed to compute the model can be predicted.

In the demo, we expect users to interact with iCat and interpret its emotional cues to better understand the game and thus to improve their chess skills. The use of anticipatory mechanisms increases character's believability, allowing for a more engaging experience for the user. This factor positively affects the likeability of the character, increasing user's attention to the game and motivation to interact with iCat.

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