EyeChess: A Tutorial for Endgames with Gaze-Controlled Pieces

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Introduction

Advances in eye tracking have enabled the physically challenged to type, draw, and control the environment with their eyes. However, entertainment applications for this user group are still rare. We present EyeChess: a PC-based tutorial to assist novices in playing endgames.

The EyeChess software generates a virtual chessboard with the standard configuration of 8 by 8 squares (Figure 1). A square is 64 by 64 pixels in size. The chessboard thus occupies a screen area of 512 by 512 pixels. The 32 chess pieces have a dot in the center to facilitate gaze focus; otherwise, they have a common appearance. For the same purpose, the squares on the chessboard are also labeled with dots. The taken pieces appear in the frame on the right. The field above the chessboard is used for providing instructions and other information.

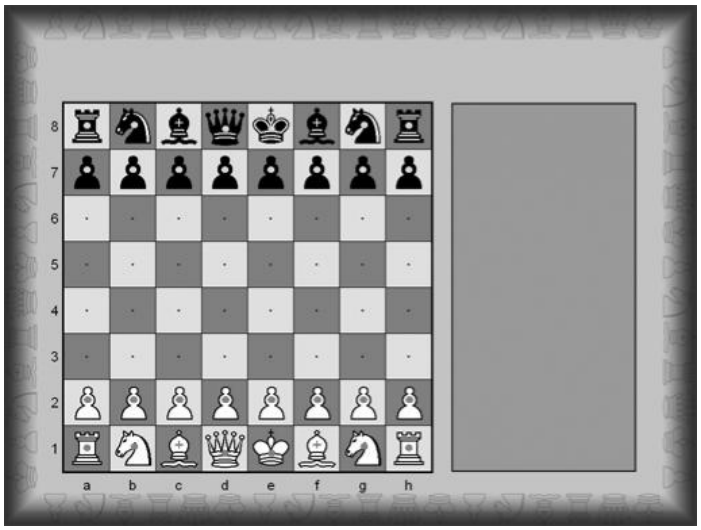

Figure 1. Virtual chessboard

To make a move, the player first selects a piece and then its destination square. After a piece has been selected, the square being looked at is highlighted according to the validity of the move for that piece. A square with a green highlight indicates a valid move, whereas red denotes invalidity. The square being looked at is highlighted with a pop-up border effect (Figure 2).

After the destination square has been chosen (as indicated by a light-yellow background), the application performs an animated piece movement from the previous position to the new one (Figure 3).

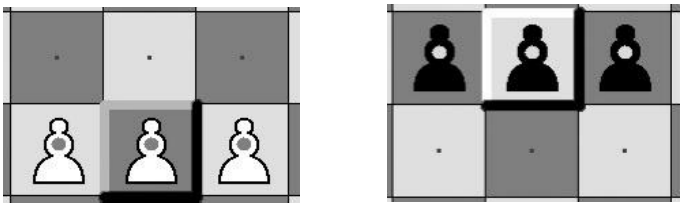

Figure 2. Highlighting with a 3D effect to indicate the active position

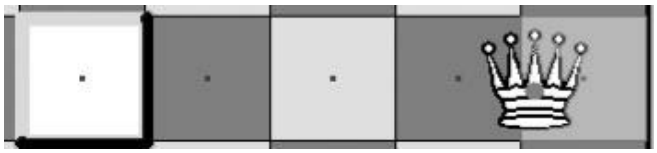

Figure 3. Animated movement of the piece

If the player does not know how to proceed, or starts making mistakes, the tutorial provides a hint. This shows up as a blinking green highlight when the gaze points at the right square.

The EyeChess software supports three methods for selection of pieces: dwell time, blink, and eye gesture (i.e., gazing at off-screen targets). Pilot experimentation revealed that the participants preferred dwell time to the other two techniques. Moreover, since playing chess involved a significant cognitive load, dwell time had to be sufficiently long. Based on the observations from the pilot study, we adopted 1.8 seconds for dwell time.

To evaluate our EyeChess tutorial, we conducted a small-scale user study.

Method

Four unpaid volunteers (1 male, 3 female) participated in the evaluation study. All were students at the University of Tampere with normal vision. Two participants had prior experience with eye tracking technology. All participants were novices in playing chess.

The experiment was conducted on a Pentium IV 3.06 GHz PC with a 19-inch LCD monitor with a resolution of 1024 x 768. A remote eye tracking system Tobii 1750 from Tobii Technologies served as the input device.

Participants were first provided with the guidelines in writing about how to select and move the pieces as well as the form of feedback delivered by the EyeChess tutor. Then, they had to play a series of 20 endgames. In each endgame, the player always started first and was to checkmate Black King (Blacks being played by the computer) in three moves. After calibrating the eye tracker, two endgames were given to the participants to practice before the recording session began.

Results

The average solving time was approximately 71.4 seconds. However, 78% of the time (56 s) was spent on finding the first correct move. The second and third moves took 9.6 s and 5.8 s, respectively (Figure 4).

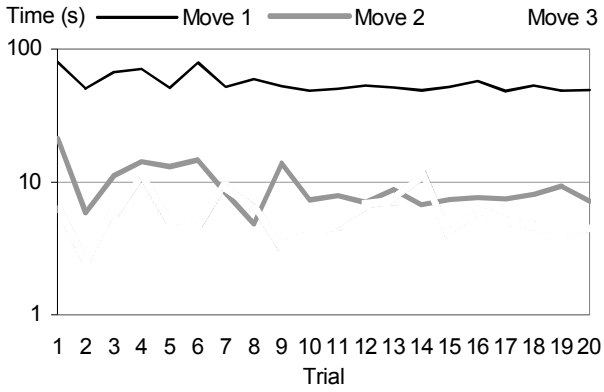

Figure 4. Task completion time vs. endgame number

Out of all attempts to make a move, 18% were wrong. As expected, the greatest portion of those (34%) was related to the first move. Meanwhile, only 6% and 1% of the attempts were wrong while making the second and the third moves, respectively (Figure 5).

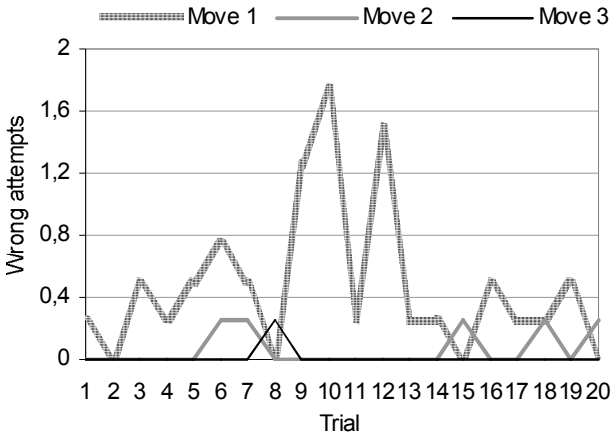

Figure 5. Percentage of wrong attempts vs. endgame number

In 9% of the trials, the participants made two or more mistakes while attempting to make the first move. They then all made use of the hint (blinking square) provided by the tutor. Nobody made two or more wrong attempts after they had found the first correct move.

Conclusion

Preliminary evaluation of the system revealed that dwell time was the preferred selection technique. Participants reported that the game was fun and easy to play using this method. Meanwhile, they found both the blinking and eye gesture methods quite fatiguing. The tutorial was rated helpful in guiding the decision-making process and training the participants.

In the future, we plan to extend the prototype to a fully-fledged game with an opponent: a computer or another player over the Internet.