Tangible Optical Chess: A Laser Strategy Game on an Interactive Tabletop

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ABSTRACT

This paper presents Tangible Tracking Table, an interactive tabletop display, and Optical Chess, a strategy game. We discuss the design and implementation of both systems and report our evaluation game play sessions with young adults, with a special focus on how the Tangible Tracking Table enhances interaction over a point-and-click interface.

Categories and Subject Descriptors

K.8.0 Games, H.5.2 interaction styles

General Terms

Design

Keywords

Game, chess, tabletop, tangible interaction

1. INTRODUCTION

This implementation of Optical Chess unites two discrete systems into one interactive tabletop game. The Tangible Tracking Table (TTT) is a physical table with a projected screen that uses cameras and visual markers to track items placed on it. This allows a game to be played on a table like board games while a computer simulates game mechanics. To demonstrate, we chose Optical Chess, a game that invokes the concept of laser beams being reflected by mirrors. Laser games [2, 3, 5] and interactive tabletops [4] are not new ideas, but this combination of the two provides valuable insight into users' interactions with such tabletops.

We demonstrated the game to young adults using both a point-and-click interface and the Tangible Tracking Table, and observed their interaction with each, noting especially the instances where interaction with the Tracking Table differed from interaction with the point-and-click interface. In the vast majority of observed instances, playing the game using the Tracking Table provided notable benefits over the point-and-click interface.

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2. TANGIBLE OPTICAL CHESS

The initial design of Optical Chess resulted from analysis of existing games and the game's four goals: (a) to be easy to learn, (b) to be very difficult to master, (c) to be strictly strategic (no random element), and (d) to lend itself to complex strategies that emerge from a simple rule set. This analysis led to the fundamental building blocks of the game: namely, that the game will feature lasers, mirrors, and a “King” that will serve as the target for the opponent.

The transition to an implementation on an interactive tabletop not only allowed the game to be prototyped relatively easily, but it also provided valuable insight into how players use the interactive tabletop to interact with a mechanically simple game.

3. IMPLEMENTATION

Initially, the game was prototyped with a point-and-click interface to ensure playability. Figure 1 shows the Graphical User Interface of Optical Chess. The circles represent Kings, the slashes (\ and /) represent Mirrors in different orientations and the triangles are symbols for the lasers. The laser beam travels in straight-line and changes its direction 90 degrees when deflected by a Mirror. A right click on the chessboard would bring up several options: add/remove Mirror, add Laser or add King in that location. Here we see that the red player just placed a Left-Facing (\) Mirror onto the chessboard. In this version, it allows up to four players to play the game.

As soon as the game's viability was confirmed, a full implementation was designed using TTT. Figure 2 shows a play session with many physical game pieces placed on the TTT. These tangible game pieces are placed and rotated on the tabletop by hands. Players can observe the paths of laser beams displayed on the TTT tabletop.

3.1 The Tangible Tracking Table

The Tangible Tracking Table is an interactive table runs on a modified version of the reacTIVision system [1], with a library of unique visual fiducial markers that can be attached to the base of tangible objects, such as Chess pieces – or, in our case, the tokens of lasers and mirrors. The table uses Diffused Illumination against a translucent surface to enable a camera to read the fiducial markers and recognize their identity (that is, which item is mapped to which marker), position and angle of rotation. This information is then passed into the simulation, and the included software places the pieces on a virtual game board and reacts accordingly.

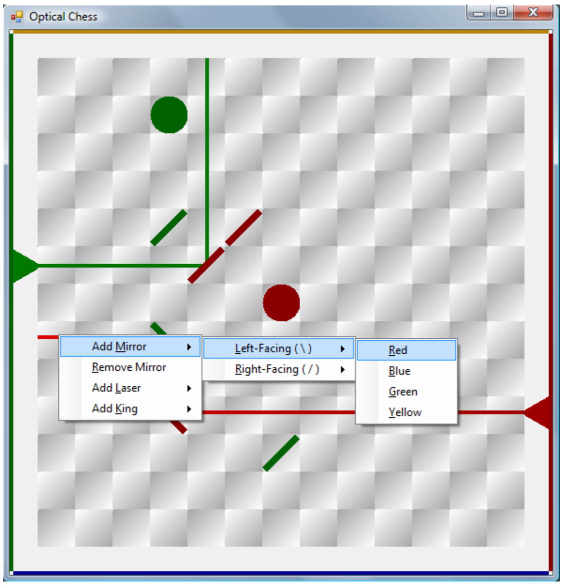

Figure 1. The GUI prototype of Optical Chess. Players use the mouse to add chess pieces on the chessboard.

3.2 Game Software

The game software was written in C# and runs in full-screen mode atop TTT (see Figure 2). The game is based on a simple grid. Every piece takes up exactly one spot on the grid, and only one piece can occupy a spot at a time. As such, the table detects the locations of all the pieces and rounds their locations to the nearest grid spot, aligning the pieces properly to the grid. The rotation of the pieces is significant as well; however, the game rules stipulate that pieces must be placed at one of only two rotation angles, and as such the game software rounds the rotation angles of the pieces to the nearest of these two angles.

The game software, in conjunction with the reacTIVision system, differentiates pieces based on the identity of their fiducial markers. There are three types of pieces, one King, one Laser and several Mirrors, and each impacts the simulation differently.

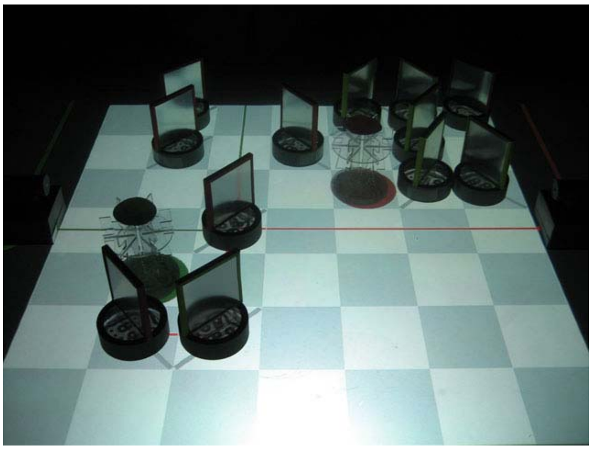

Figure 2. Physical game pieces of Tangible Optical Chess on the Tangible Tracking Table.

4. EVALUATION

Evaluations of both the point-and-click interface and the Tangible Tracking Interface versions of Optical Chess have been conducted during Open House events and informal demonstrations. More rigorous studies of the table's impact on the game are underway, but early observations show a difference between the point-and-click interactions and those with the TTT. In general, the table provided more useful feedback and allowed players to more easily understand and plan their strategy.

The most interesting finding came from observations of how interaction with the table was superior to interaction with the point-and-click interface. Several problems were observed during the play sessions with the point-and-click interface. Many players were unsure which direction to place a mirror to achieve the result they wanted, and often thought that laser pieces actually took up board space. Neither issue arose during sessions with the TTT, suggesting that players benefited from being able to see and manipulate the three-dimensional, tangible tabletop pieces to place them in intended positions with ease.

Overall, player interactions with the TTT were observed to be as simple and intuitive as interacting with a standard board game. The digital media successfully provided features - such as a visible laser beam - which are unfeasible in an actual implementation. The drawbacks at the expense of a standard board game center around physical needs, and no drawbacks were observed with regards to actual user interaction

5. DISCUSSION

While the TTT and Optical Chess provide an excellent means with which to demonstrate one another, the true strength is in the TTT's enhancement of player interaction with the game. Introducing physical pieces and a physical board greatly increased users' ability to understand and extrapolate the impact of moves on the board compared to a point-and-click interface. More importantly, the addition of a physical board increases the players' enjoyment of the game, and removes many of the barriers to gameplay in order to allow the players to focus on strategy.

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