An Augmented Reality Chess Comparison of Ease of User Input

Kalen Muller*

Colorado State University

Abstract

Augmented Reality (AR) is a technology that has been around since the early 1990's but in several applications it has not gotten widespread adoption of it's use. One such challenge facing AR is the ease of translating a user's action into a computer system for processing. The software and experiment developed in this research approach that problem adapting natural gestures that users are already inclined to make in a fixed space as the input to a computer through tracking the result of that movement. Using this prototype shows promise in an easier method of user input comparing the lower time to take an action and error rate to other similar studies.

Index Terms: H.5.2 [Information interfaces and presentation]: HCI—User interfaces;

1 Introduction

Chess is a useful tool for testing human computer interactions, utilizing new methods of getting human input translated into logic that a computer can assess and react to. This user input in many of the previous studies of augmented reality assisted chess have relied on using a mix of fixed camera locations, a pre-set chess board, QR codes, and or Near-Field Communication (NFC) chips [2, 5, 8]. This results in an experience that would require a non-negligible amount of set up prior to receiving the benefits from an AR assisted chess game restricting out many users. This study's approach to this problem is to use the static nature of a chess game to lower the number of unique materials required to translate the human action of moving a chess piece to the computer action of processing that data and assisting the human user.

Investigating ease of user input is important as to get people using augmented reality systems, the systems must be both accessible and simple to utilize. There is benefit from AR systems as in Rafal Wojciechoiwski's research on the AR's effect on learners' attitudes he stated,"we found that perceived usefulness and perceived enjoyment had a similar effect on attitude toward using image-based AR environments" [8]. This demonstrates the importance of making AR features more accessible as the more useful these features are perceived, the better the reception to utilizing AR. It has been also shown that majority of game users prefer iconic game pieces used when playing board games [1]. Familiar tools are shown to be a method to increase user perception of a game, by using as the input it can help lower that barrier of entry as mentioned above. The goals of this project will be to take advantage of the interaction with the real-world actions that are natural to users to make to harness the tools provided by augmented reality systems. With that to provide computer assistance to a normal chess game without unnecessary changes to the board.

*e-mail: kmuller@mail.colostate.edu

2 Related Work

2.1 Previous Studies

There are several studies that have been done in the past looking at creating an augmented reality version of chess. For instance, the ART-Chess study approached a similar question of the existing user interactions for AR chess being difficult and unfamiliar. To solve this they used a unique tabletop, pieces, and an AR headset to allow a person user to play against an AI with simulated pieces [5]. This allows for the user to play a game of chess on a table as if they were against another player on the other side with benefits such as alerts when checkmates occur. This is a case where most of the enhancements seem to be contradictory with the AR nature of the game they are setting up. Rather than use the changes in the real world we are fighting against those motions and moving to a point where a VR chess game would be more practical. What is the benefit of moving the pieces? is the question that arises. Another instance of this AR chess implementation looks to approach this question by having a remote AR chess game where each side has their own pieces as tangible and their opponents in AR. [3] This allows each user to have the haptic feedback of moving their own chess pieces while still having the benefits of AR. This approach bridges the gap of AR and real world changes but requires substantial non-standard materials to operate.

A similar study uses image recognition software to detect the state of a chessboard to avoid adapting items that are not typically included in a chess game. This translates a live image of a game to both recognize the board and various pieces in the game through training a Convolution Neural Network (CNN) to identify these objects. [4]. The result of this was a valid piece prediction rate of 93.45 percent and a time of 3-4.5 seconds from capture to results. This does create a more adaptable system for different chess boards and environments but at a cost of both time training the algorithm and speed.

Another study done by Marios Bikos creates an AR chess game using bare-hand pinch gestures to control the piece movement on a virtual board [2]. This board is made up of markers for the cameras to recognize and simulate the pieces on top of to play. This study had an error rate of less than three out of thirty moves, with an average move time of 3.72 seconds for moving a piece. This creates a baseline of comparison to test user ease of access against other methods of input.

2.2 Technology

While the technology at use is impressive in both cases, they both seem to be augmenting reality further away from having any impact on reality in favor of a purely virtual game of chess. In this research the focus is on the real movements taking place and utilize the already human natural input of moving a chess piece as the input to an AR system

For the input method an image recognition and comparison system will be in place for the detection of changes to the chess board. For the image recognition portion there has been previous work done using a You Only Look Once (YOLO) detection approach to locating objects from an image. This is done by "A single convolutional network simultaneously predicts multiple bounding boxes and class probabilities for those boxes." [6] By doing both creating bounding boxes and labeling objects in them without having to run through the image twice this can be a quick and efficient tool used for AR input. For AR chess the application would be used to allow a computer to recognize a chess board then allow for processing the board state as a source of user input.

Another method used in past for chess board inputs is an optical tracking system of user hand movements. The report done by Karen Schrier used a specialized glove to record user had movements and translate them to an VR chess game. [7] It is mentioned that they ran into issues with high complexity backgrounds as well as loss of immersion over the displaying of pieces over users rather than being able to simulate holding.

3 Methodology

The software designed takes advantage of the static nature of the chess board to develop an approach to recording user changes by utilizing image comparison in favor of the methods described in the research papers above. The static nature in question is the fact that when a chess game starts a computer can know every piece location as it will be the same as any previous games. Using a stationary camera image comparisons can be used to detect changes to the game state. This does create a requirement of the camera must be set up to capture exactly the corners of the board in its snapshot as this is done through compressing the array showing areas of high change. This is implemented combination of Python with NumPy, and cv2 for the image comparison process. In this design there is no image recognition that could be used to locate the board and create the starting map of the game. The camera will be able to determine a before movement state and an after-movement state through detecting when there are 1-1 differences in the board. Comparing these two we will be able to know which piece moved then update the computer with the new data read in. This will accommodate the primary focus of the project of using normal actions as an input to an AR system.

Participants Five participants were selected all of which have at least basic knowledge of how to play chess on a physical game board. This is determined prior to selection through verifying that users knew the rules and moves available in chess. Subjects were selected from volunteers willing to participate in the experiment. It was their first time using the chess system designed for this study.

Apparatus The experiment design for this project is a static mounted camera aiming at a test area containing chess board in a game starting position. This camera reads in data from the chess board and relays it to a connected computer. This computer processed what changes are occurred on the chessboard and outputs the data that is being read in from the board to the console. The experiment will be monitored by a proctor recording any discrepancies between the move the user made and computer recorded. The software in place on the computer was as mentioned above.

Procedure Subjects played one game on white side against a chess bot of a static difficulty between users. This chess bot was not built into the software but run separately by the proctor. Subjects were given the goal to play to win one game of chess, with a 15 minute time limit against the bot. Two limitations of the software were told to players, place pieces as close to the center of the squares as possible and ensure when moving a piece that majority of their hand was over the board. The proctor made the moves according the the chess bot used on the physical board. The proctors moves were not be taken into account with the data collected as to avoid an experienced user swaying usability. Users made as many turns as they were able in the time given. Variability was expected between how many moves each user completes, so the time was calculated from when their hand entered the board to when the system registered the move as complete.

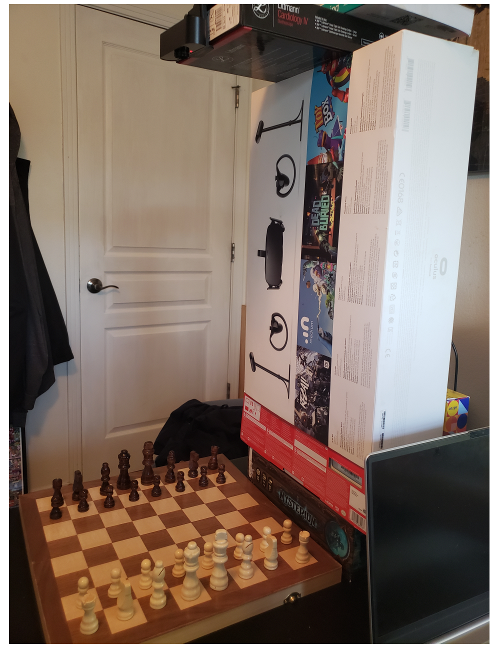

Figure 1: Setup used in testing with participants. Proctor is seated on right side running program and making moves for white side, while participant sits on left

Design Though the procedure above data was collected for each user on how many moves were made, time taken for each move, and number of misinterpretations to what the computer recorded to their actual move. Data on time from pieces picked up to placed and read into the system was collected to serve as a comparison point to the similar studies mentioned above for comparing ease of use. In addition to this users opinions on the ease of user were informally collected after. The measure of success is be a combination of the time taken for each move and error rate of the program to determine the viability of this as a method of data input to a computer.

4 Results

4.1 Feedback

Running the experiments above there was positive feedback regarding the usage of the software. Several of the users described the experience as a normal game of chess which was the goal of the study. Two comments were recorded on the interference of the camera mount, as the design could be improved to be less of an obstacle. One obstacle encountered by the users was difficulty in giving a definitive answer of if the ease of use of this method was higher, as the lack of other methods for them to compare with. Overall from the user feedback it was concluded the method of moving the pieces on the board was intuitive and natural. This shows promise in regards to the study by Rafal as the more enjoyable of using an AR interface the higher overall attitude to adopting augmented reality systems. [8]

4.2 Data

On average between the 5 users there were 30 (30.4) moves made by them in the 15 minute time span with a range of +/- 10 moves from that average from user to user. On average it took the subjects 2.79 seconds to grab a piece, make a move, and the system to record it occurred.

Errors were recorded several times. Three of the users had an instance where a piece was incorrectly recorded as moving to a nearby square, and one user had an instance where the system thought a piece was moved when in reality it had not. In total out of 152 moves recorded 5 were done in error resulting in a 3.29 percentage error rate. When this occurred we had to restart the game in most cases as of currently the prototype doesn't have a method to manually input moves.

4.3 Comparison

Comparing these results to those of the previous studies mentioned earlier the Data does show promise as an easier and more efficient method of inputting. The AR chess game using pinch gestures as the method of user input has an error rate of 10 percent compared to this methods 3.29 percentage and a time spent of 3.72 seconds to move a piece to 2.79 seconds. By these metrics there is an improvement in the image capture and comparison method used here to AR gestures. This could be improved as well as currently the system sleeps for 1 second between captures as to be less resource intensive but visibly this was adding more time between piece movements and computer record updating.

As stated in the goal of the project was to have no modifications to the board which was achieved. This system would work on any chess board where the camera can be centered above and has reasonable distinction between tiles and colors. This is a large improvement to the related works using QR codes and NFC tags as the ease of access to this is much higher in comparison.

5 Conclusion

This project was created to test a potential method of inputting user data into a computer through comparing the results of the actions take. In that aspect the software was a success measuring the results of the several test subjects there is promise in using this method to input data. Users found the system familiar to use and the statistics show improvement when compared to similar studies. From the data collected it is clear this is a viable form of transferring real world actions into a computer.

The next steps from here would be translating the data collected here into an AR interface. This project focused on the human interaction to get data into the computer and now that the data is loaded it can start to be processed in ways to assist the user. This is the element that previous studies have exemplified in, and would have the most to gain through an improved method of user input. [5] [2] Potential developements from here would be assisting the user in making moves, or enforcing the rules of the game. The limits encountered include the required positioning of the camera and board, and lack of reliable error tracking. Subsequent studies would be able to improve on these factors that would keep this research from applying to wider applications than a chessboard.

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