ART-Chess: A Tangible Augmented Reality Chess on Tabletop

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Abstract
Chess is a traditional board game that is still popular. Several works have been done to make its gaming experience richer using augmented reality technology. But the proposed user interactions to move the chess pieces are still unfamiliar and not appealing to chess players. To answer this issue, we propose ART-Chess, a tangible augmented reality chess on tabletop. Using a camera-aware tabletop, the recognition of markers is made easier, which allows a human player to use real chess pieces. The game is augmented, thanks to an AR headset, with 3D virtual chess pieces.

Author Keywords
Augmented Reality; Tangible User Interface; Tabletop; Chess

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User interfaces.

Introduction
Virtual reality (VR) technology is becoming mainstream. After being a non-stater innovation in the last century, it will become available to general public in a few years. Indeed, major companies are or will propose soon products to the consumer market. Notable VR headsets are Oculus

Rift (Facebook), Project Morpheus (Sony), Gear VR (Samsung) or Vive (HTC). The game industry will not miss the boat, and is already focusing its attention towards the use of VR in computer games. Nevertheless, traditional games, such as chess, checkers, card games and board games are still popular and appealing for the general public [14].

The field of *pervasive games* has emerged a few years ago. It aims at "bridging computer entertainment game back to the real world" [15]. Among others, augmented reality (AR) is a popular approach: it allows the player to keep in touch with the real world while enhancing the reality and the gaming experience with virtual content.

One of the limitation of augmented reality games may be the interaction of the user with the virtual content. Tangible (graspable) [13] paradigm allows to overcome such limitation. It specifies that the user may be able to physically grasp or manipulate the virtual content.

In this paper, we present ART-Chess, an augmented reality and tangible tabletop chess game. This platform allows a human to play against an artificial intelligence (AI). The player will use real chess pieces while the AI chess pieces will be virtually created and displayed to a headset system. For this purpose, we leverage an existing camera-aware tabletop and a AR headset camera to propose a simple gaming environment without external camera or projector.

Related works

There are few works that propose AR based chess. Most of them are projects that leverage the well-known AR library ARToolkit [2].

The major limitation of these prototypes is the user interaction, especially how the player move his chess pieces. Several ways have been proposed to address such interaction. In [4], simple printed markers are used, and the player has to move them with his hand. [6] used the same approach, but icons of the chess pieces are printed on the tags allowing the player to know which chess piece he is manipulating. Nevertheless, moving plain piece of paper may not be appealing. In [3] and [1], they propose to use a tag-based paper stick to move the markers on the board. [5] leverages the infrared sensor capability of a Wiimote to select positions of a move. The two latter interaction are not natural for chess players. In [11], a smartphone is used to move the chess pieces: the player select a chess piece and the destination case on the screen of his device. As the player uses the tactile screen, one may wonder why not directly play on a chess smartphone application with a 2.5D view.

Using physical pieces seems to be a relevant alternative. As stated in [12], even if neither iconic nor symbolic pieces affect the understanding of the game or the gaming experience, iconic play pieces are preferred. Thus, real chess pieces seems to be the straightforward solution to please a chess player. Henceforth, it boils down to the recognition of the chess pieces. In [16], the authors propose to avoid the use of markers. Computer vision techniques is used to recognize simple pawns in a board game, and they are augmented with visual effects. But players can occlude pawns with parts of their arms during interaction.

Another limitation is the complexity of the gaming environment setup: external camera or projector are often used to process markers detection or project virtual content on gaming surface [14].

Prototype

ART-Chess consists in two components:

- a main application for a camera-aware tabletop
- an application for an Android device (tablet, smartphone or AR headset)

The communication between these two application is managed using Bluetooth.

For the tabletop, a Samsung SUR40 has been used. The choice of this tabletop was motivated by the fact that it runs with Microsoft PixelSense [7]. Using a layer the PixelSense technology allows to detect various contact types such as fingers, blobs and tags. Consequently, it is easy to detect and recognize chess pieces with markers attached underneath (see Figure 1). Each chess pieces have an unique marker that allow the tabletop to detect and recognize the exact position of the chess pieces on the surface.

Regarding the Android application, two platforms have been chosen. First, the Unity3D [10] has been used to create the virual reality. Chess piece, light, device camera and piece animation can easily be handled using Unity3D. Second the Qualcomm Vuforia [8] platform is leveraged for the AR functionalities. Vuforia is a "vision-based augmented reality software platform". It has an object recognition feature that allow to target, among others, images or user-defined markers. The current prototype uses four QRCode as targets to place the virtual chess pieces on the chessboard (see Figure 2). VR headset such as Google Cardboard or Espon Moverio BT-200 can be used along with the Vuforia platform.
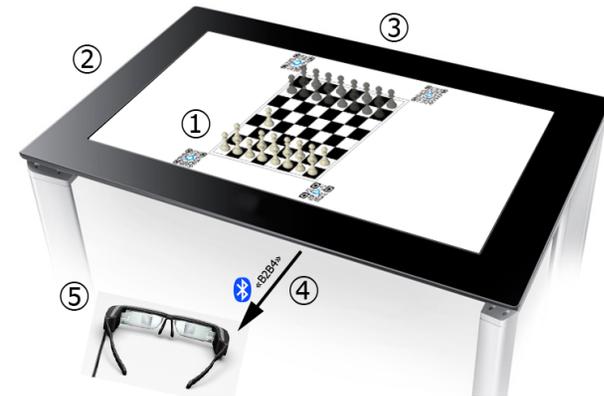

Figure 1: Markers attached underneath a knight and a pawn chess pieces.

Figure 2: Virtual chess pieces are placed upon detection of at least one of the target QRCode.

Figure 3: Game play of ART-Chess.

A game of chess using ART-Chess is as follows. First the player starts a new game. A communication channel between the tabletop and the Android device is opened using Bluetooth. Then, the player places the physical white chess pieces on the chessboard. The tabletop application checks if the pieces are correctly positioned. When the 16 chess pieces are set, a "start" message is sent to the android device. Figure 3 illustrates the main steps of a game:

1. The player makes his move.
2. The tabletop detects the new position of the chess piece, and deduces the move. It checks the validity of the move to continue.
3. The AI [9] decides its own move.
4. A message with the selected move is sent to the Android device via Blutooth.
5. The Android device analyses the received message, and adapts the virtual scene consequently (piece movement or removal) .
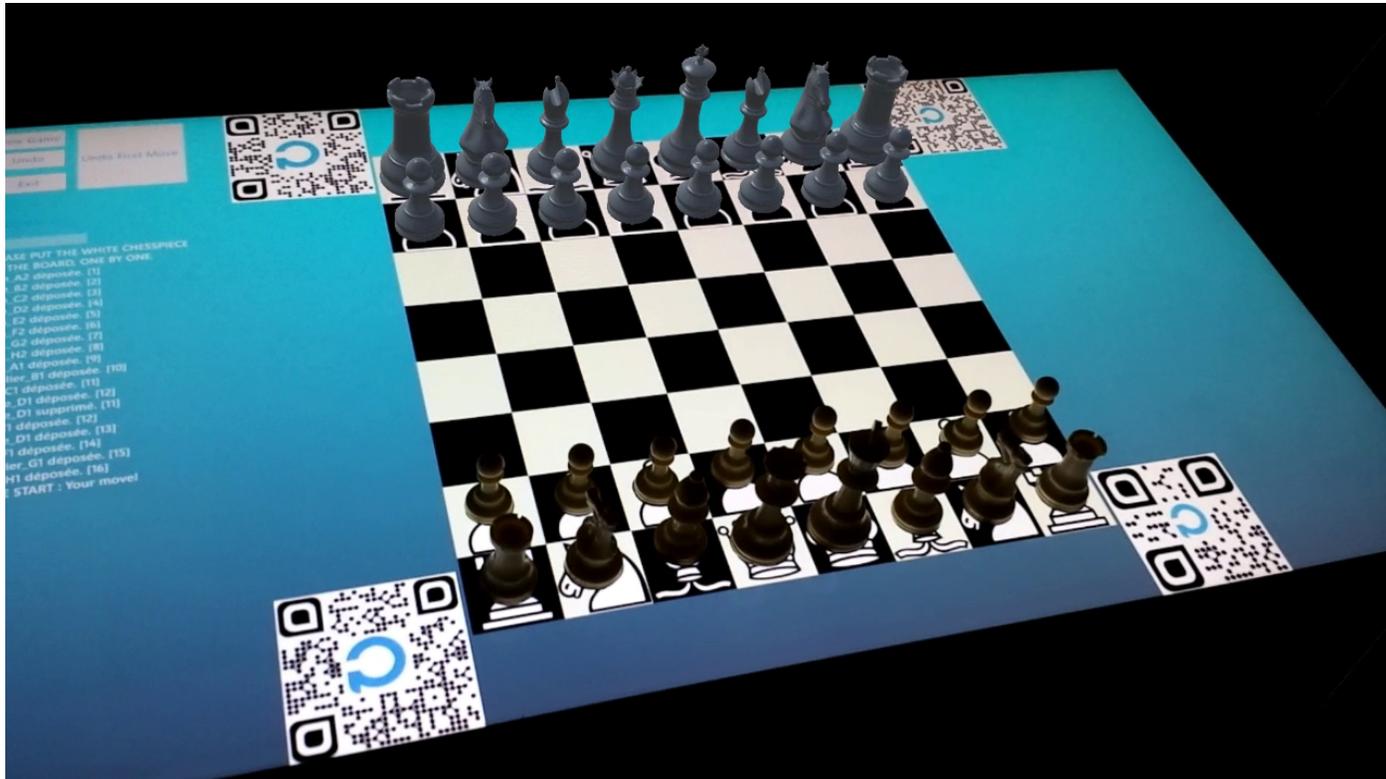
Figure 4: Interface of ART-Chess tabletop application. The human player white chess pieces are real (bottom side of the chessboard) while the AI black ones are virtual (top side of the chessboard). A textual feedback is displayed to the player at the left of the screen for the chess pieces initialisation and the moves during the game. An audio feedback is also given.

The game ends when a checkmate or a draw is detected. Figure 4 illustrates the view of the tabletop application through the Android device.

Conclusion and Future work

We have presented ART-Chess, a tangible augmented reality chess on tabletop. Using a camera-aware tabletop, the recognition of markers is made easier, which allows a human player to use real chess pieces. The game is augmented, thanks to an AR headset, with 3D virtual chess pieces. Overall, ART-Chess is perceived well, and the gaming experience is appealing.

Several ideas to improve the prototype can be considered. First, the possibility for others human to join the game as spectator, even after the start of the game. Second, the possibility of a remote human vs. human game. This will allow distant players to enjoy augmented chess. Finally, one can easily think about a richer experience in terms of chess piece custom models and animations (such as in the Harry Potter or the Star Wars movies).

Acknowledgements

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