AR Chess: A New Dimension for the Classic Game

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***Abstract*— This paper presents the rationale, objectives, and methodology of developing an innovative mobile application merging traditional chess gameplay with augmented reality (AR) technology. The project aims to address the demand for advanced gaming experiences, promote inclusivity, and leverage chess's educational benefits. Utilizing Unity and AR Foundation, the project seeks to enhance chess accessibility and engagement on Android devices through immersive AR features. The project's objectives include setting up development environments, developing core functionalities such as 3D modeling, game logic, and AR integration, and implementing AR features to overlay virtual chess pieces onto physical environments. Thorough testing and iterative refinement are crucial to ensure smooth gameplay, address compatibility issues, and gather user feedback for continuous enhancement. Ultimately, the project aims to revitalize interest in chess by offering an inclusive and engaging gaming experience accessible to players of all backgrounds and abilities.**

Keywords*— *Augmented Reality (AR), chess, mobile chess game, unity game engine, educational chess game, etc.

I. INTRODUCTION

Chess is a game of strategy, foresight, and tactical thinking, played on an 8x8 grid known as a chessboard. Each player commands an army of sixteen pieces, including pawns, knights, bishops, rooks, a queen, and a king, each with unique movement capabilities. The objective of chess is simple: to checkmate the opponent's king, a condition where the king is in a position to be captured and cannot escape capture. Despite its simple rules, chess offers an infinite number of possible positions and moves, making it a game of profound complexity and depth.

In recent years, the advent of technology has revolutionized the way chess is played, with the emergence of online chess platforms. Online chess games enable players from around the world to compete against each other in real time, regardless of their geographical location. These platforms offer various features, including matchmaking algorithms, tournaments, analysis tools, and the ability to play against computer opponents of varying difficulty levels.

This proposed work brings chess, a beloved strategy game for centuries, into the future with "AR Chess: A New Dimension for the Classic Game." This innovative mobile app for Android devices utilizes augmented reality (AR) technology to create an engaging and immersive chess experience.

AR Chess leverages advancements in mobile technology and AR to make chess more accessible and interactive. The traditional chess experience, while cherished, can benefit from a modern twist to attract new players and invigorate existing ones. By integrating AR, this project breathes new life into chess, making it more dynamic and visually stimulating than ever before.

Beyond entertainment, AR Chess offers educational advantages, particularly for cognitive

development. Chess is renowned for improving critical thinking, problem-solving, and strategic planning. AR features enhance these benefits by creating a visually engaging and interactive learning environment.

Furthermore, the project recognizes the power of AR to foster social interaction. In today's connected world, multiplayer games allow players to connect, compete, and collaborate with friends and fellow chess enthusiasts. By implementing multiplayer support, AR Chess aims to build a vibrant community united by their love for chess and shared experiences in the virtual realm.

AR Chess signifies a unique blend of tradition and innovation. It merges the timeless allure of chess with cutting-edge mobile technology and AR. Utilizing Unity, this project reimagines the classic game for the digital age, captivating audiences, stimulating minds, and igniting a new generation of chess enthusiasts on Android devices.

II. LITERATURE OVERVIEW

[1] The landscape of chess-related research has seen significant developments in recent years, leveraging technological advancements to enhance various aspects of gameplay and engagement. Yusof et al. (2019) present a pioneering study on Collaborative Augmented Reality for Chess Games in Handheld devices, focusing on augmenting immersion through augmented reality and fostering collaborative interfaces for multiplayer engagement. Their utilization of Vuforia AR SDK for the development and implementation of Photon Unity Networking for online play marks notable strides in merging technology with traditional gameplay, eliciting positive user feedback regarding the collaborative AR experience.

In a similar vein, [2] Su et al. (2014) delve into the realm of artificial intelligence (AI) by implementing chess game intelligence on mobile robots. Their study encompasses AI implementation tailored for chess, incorporating movement scenarios for mobile robot interaction, and designing control interfaces to maneuver robots effectively. A critical aspect of their work lies in the development of an evaluation algorithm to assess AI performance, marking a crucial step toward enhancing the intelligence of chess game systems.

[3] Panchal et al. (2021) contribute to this field by exploring chess move prediction using Deep Learning Neural Networks. Their research underscores the application of advanced techniques such as the Minimax Algorithm and Convolutional Neural Networks (CNN) for analysis, coupled with training on large datasets to bolster prediction accuracy. Notably, their evaluation against Stockfish AI for benchmarking purposes and employment of pre-computation techniques for efficient move prediction showcase strides towards leveraging machine learning for chess gameplay optimization.

Furthermore, [4] Faêda et al. (2018) undertook a semiotic study on Virtual Reality (VR) games and simulations, amalgamating various techniques to enhance virtual reality gaming experiences. Their research, which involves the utilization of an extensive training dataset and application of deep learning, underscores a holistic approach towards improving performance and evaluating VR applications. By combining methodologies and leveraging deep learning, Faêda et al. contribute to the evolving landscape of VR gaming and its implications for chess and beyond.

[5] Deep Learning in Chess explores the application of deep learning techniques in chess to enhance chess engines' performance and players' experience. The study investigates various neural network architectures, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), for analyzing chess positions and making intelligent move predictions. It discusses different training methodologies such as supervised learning with labeled game data and reinforcement learning techniques like deep Q-learning.

[6] Augmented Reality Chess: A Case Study focuses on implementing augmented reality (AR) technology to enhance the traditional chess experience. The study explores integrating AR with chess gameplay, allowing players to interact with virtual chess pieces overlaid onto the physical board using smartphones or AR headsets. It discusses design considerations including intuitive piece movement and real-time tracking of physical pieces. It presents user feedback, highlighting advantages such as dynamic and engaging gameplay, and explores educational applications for teaching chess strategies interactively.

III. PROPOSED SYSTEM

The main aim of the proposed system is to overcome these challenges by developing a (unity) Android-based augmented reality chess game that enhances accessibility, engagement, and inclusivity, thus making chess more accessible and

enjoyable for players of all backgrounds and abilities.

In response to these challenges, this project aims to develop an Android-based augmented reality (AR) chess game using Unity. The objective is to create a platform that transcends traditional limitations, fostering inclusivity and enhancing engagement for players of varying backgrounds and abilities.

The main goal of the proposed systems is to emphasize the development environment, focusing on setting up necessary tools and resources for smooth progress, and develop core functionality including 3-D modeling, game logic, and AR integration using Unity, implement AR features to overlay virtual chess pieces onto the physical environment for an immersive experience, ensure compatibility across various Android devices through thorough testing and refinement, address learning challenges and promote inclusivity by providing educational benefits and accessibility options, create engaging gameplay experiences to attract new players and reinvigorate interest in chess, advance technological competence by exploring Unity and AR technologies for game development, foster social interaction and community engagement through multiplayer support and combine tradition and innovation to create a compelling gaming experience that captivates audiences on Android devices.

IV. METHODOLOGY

A. Project Planning

Unity Game Development: Utilize the Unity game engine as the primary development platform for creating the Android-based augmented reality chess game. Leverage Unity's robust features and cross-platform capabilities to develop a high-quality gaming experience.

Augmented Reality Integration: Implement augmented reality features using Unity's AR Foundation package to overlay virtual chess pieces onto the physical environment captured by the device's camera. Utilize ARCore for Android devices to ensure seamless AR experiences.

Game Logic Implementation: Develop game logic using C# scripting within the Unity environment. Implement algorithms to manage the rules, mechanics, and state of the chess game, including piece movements, game progression, and win conditions.

User Interface Design: Design intuitive user interfaces using Unity's UI tools to control the presentation layer of the game. Create menus, buttons, and visual feedback elements to enhance user interaction and navigation within the game.

Accessibility and Customization Features: Incorporate accessibility options such as dyslexia-friendly fonts and color-blind-friendly visuals to cater to diverse user needs. Provide customization options for interface elements to allow users to personalize their gaming experience.

Educational Resources Integration: Develop tutorials, guides, and learning materials within the game to assist players in learning and mastering the rules and strategies of chess. Provide interactive tutorials and real-time feedback to enhance the educational value of the game.

Platform Optimization: Optimize the game for performance and compatibility on Android devices. Conduct thorough testing across various Android versions and screen resolutions to ensure smooth operation and a consistent user experience.

B. Project Design

Fig 1. Block Diagram

User Interface: This refers to the visual elements that users interact with to play the game. This includes menus, buttons, a chessboard visualization, and a way to see and interact with the virtual chess pieces in the AR environment.

Augmented Reality Module: This module creates the augmented reality experience. It uses the device's camera to capture the real world and then superimposes virtual chess pieces onto that view.

User Input Handling: This component captures user input from touch gestures on the screen to interact with the virtual chess pieces in the AR view.

Game Logic: This component handles the core gameplay logic of chess. It includes the rules of the game, such as how pieces move and capture each other, as well as determining win conditions.

Accessibility and Customization (Optional): This section includes features that allow users to customize the game interface or adjust settings to improve accessibility for users with disabilities.

Networking (Optional): This section refers to the optional functionality that allows users to play chess with other players online.

Educational Resources (Optional): This section refers to the optional functionality that allows users to access educational resources within the game, such as tutorials or guides about how to play chess.

Platform Compatibility: This component ensures the game runs smoothly on different Android devices.

Goals: This section refers to the overall objectives of the project, such as creating an engaging and educational chess game that is accessible to a wide range of users.

C. Algorithms

Mini Max Algorithm

At the heart of chess technology is the minimum-maximum local search of the game room. This technique tries to minimize your opponent's points and maximize your points. Check all possible movements at each depth (or called "ply" in computer tree terminology) and use static map scoring routines to determine leaf points. These points are distributed throughout the tree and we can choose the best movement at all depths. The larger the tree, the better decisions we can make (because the algorithm can see more progress). The branching factor is typically 25-40 per node (35 on average). The following shows the example of such a search tree of the minimax algorithm. We can see that the algorithm finds a path with the highest possibility of winning the game (with heuristic value 3)

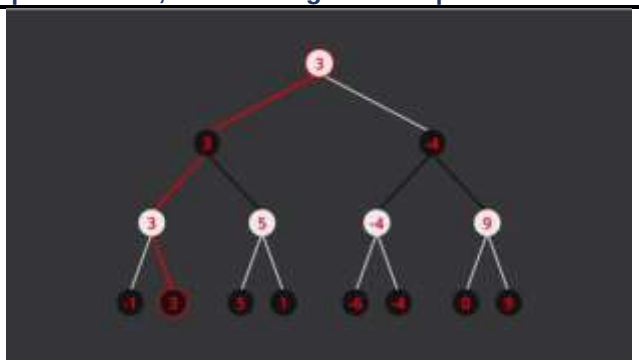

Fig 2. Mini Max Algorithm

Alpha Beta Pruning

This common cleaning routine is used to significantly reduce the time of minimax search space. We can track the worst and best behaviors of each player and use these behaviors to completely avoid the branches that can give you worse results. This cut provides the same movement as using the mini-max (that is, no loss of accuracy). Ideally, we can double the depth of your search tree without increasing search time. Sorting can be performed by checking every possible move point to a single expected position. The most intuitive way would be to rank the highest and lowest, but not always the best. Most movements are small wins and losses. Therefore, the sorting is based on the absolute value of the movement point (the smallest one is displayed first). The minimum-maximum average branching factor in chess is about 35, but with pruning and alpha-beta sorting, the program gets about 25 branching factors. The following shows an example of an alpha-beta pruning algorithm where the unnecessary branches are avoided from searching.

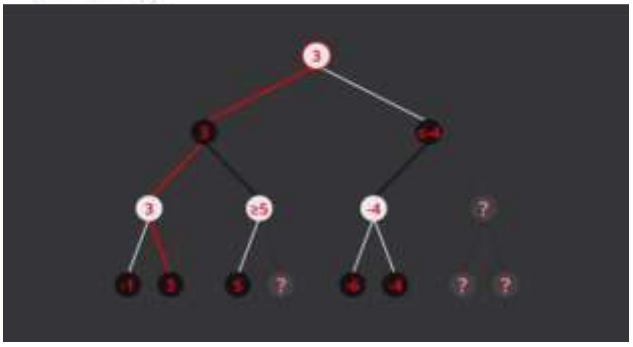

Fig 3. Alpha Beta Pruning

D. Result and Discussion

Our project represents the culmination of meticulous design and programming, resulting in a digital adaptation of the traditional 8x8 chessboard. With painstaking attention to detail, we've crafted visually stunning chess pieces and user-friendly interface elements accessible via the main menu. Through adept utilization of C# scripting, every aspect of the chessboard, from piece movement to

game logic, has been finely tuned to offer players an authentic and immersive gaming experience, true to the time-honored rules of chess. Beyond facilitating player-versus-player matches, our implementation includes an advanced AI opponent, allowing players to sharpen their skills against a challenging computer adversary. Looking ahead, we're actively exploring avenues to enhance immersion, such as incorporating dynamic sound effects and broadening accessibility through compatibility with AR and VR technologies. Moreover, we're committed to implementing multiplayer functionality to foster seamless player-versus-player interactions. Through our dedication to innovation and detail, our project stands at the forefront of digital chess gaming, promising an unparalleled experience that captivates and challenges players of all skill levels.

V. ADVANTAGE

Inclusive Design: This AR chess app promotes an inclusive gaming experience by catering to a variety of user needs and preferences. Built-in accessibility options and customizable interfaces ensure everyone can enjoy the game, regardless of background or ability.

Cognitive Boost: Chess is known to enhance cognitive function, improving memory, problem-solving skills, and critical thinking. This AR version provides a fun and engaging way to stimulate the mind and promote cognitive development.

Immersive AR Experience: By integrating augmented reality technology, the game creates a dynamic and interactive environment. Virtual chess pieces overlay the real world, boosting realism and engagement for a unique gaming experience.

Building a community: The multiplayer functionality fosters a strong chess community. Players can connect, compete, and collaborate with others who share their passion for the game, potentially leading to lasting friendships and social connections.

Appeals to All Ages: This AR chess game bridges the generation gap by combining classic chess gameplay with cutting-edge technology. It appeals to a wide range of age groups and demographics, offering a familiar game in a fresh and innovative format.

VI. DISADVANTAGE

Device Requirements: The performance of AR applications can vary significantly based on a device's hardware. Modern devices with advanced cameras and sensors are more likely to deliver a seamless AR experience. Conversely, devices with outdated technology may struggle to support AR functionalities effectively.

Connectivity Considerations: The immersive nature of multiplayer AR experiences necessitates a robust and reliable network connection. Players should ensure they have a stable internet connection to avoid interruptions and maintain the synchronicity of the gaming experience.

Energy Efficiency: Due to the intensive processing power required by AR applications, they can consume battery life at a faster rate. Gamers should be aware of their device's battery capacity and may consider playing while connected to a power source or managing the duration of their gaming sessions to conserve energy.

VII. SCOPE

The development and implementation of an Android-based augmented reality (AR) chess game, aims to enhance the accessibility, engagement, and inclusivity of traditional chess gameplay. The project utilizes the Unity game engine and AR Foundation package to integrate cutting-edge augmented reality features into the classic chess game. Key objectives include emphasizing the development environment setup, implementing core functionality such as 3D modeling, game logic, and AR integration, and conducting thorough testing and refinement. The game's features include overlaying virtual chess pieces onto the physical environment, providing multiplayer support for social interaction, and offering educational resources for skill development. The scope encompasses hardware and software requirements, user interface design, game logic implementation, accessibility features, performance optimization, quality assurance and testing, regulatory compliance, documentation, and project management. Overall, this project aims to deliver an immersive and inclusive gaming experience that combines the timeless appeal of chess with the innovative capabilities of augmented reality technology on Android devices.

VIII. CONCLUSION

The development of AR Chess represents a fusion of traditional chess with modern technology, aiming to tackle challenges in accessibility and engagement while honoring the game's essence. Through the utilization of Unity and AR technologies, our project strives to deliver an inclusive, immersive, and educational gaming experience tailored for Android devices. Drawing on insights from collaborative AR interfaces, AI implementation, move prediction through deep learning, and studies on VR gaming, our approach integrates diverse methodologies to craft a captivating platform. By promoting social interaction, enhancing cognitive skills, and appealing to players of all ages, AR Chess highlights the potential of augmented reality to reinvent timeless games for the digital era. Looking ahead, our project's comprehensive design, spanning user interface, game logic, accessibility features, and educational resources, underscores our dedication to excellence and innovation in mobile gaming.

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