3D Chess Game Using openGL

Advance Graphic and Animation [Course Project]

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***Abstract*—This paper presents the development of a 3D chess game using OpenGL. The game aims to provide a fun and interactive way for beginners to learn the basics of chess. The game features a 3D game board, customizable chess pieces, and multiple game modes. The development process involved the use of OpenGL for the graphics rendering, and C++ for the game logic and user interface. User testing was conducted to evaluate the effectiveness of the game as an educational tool. Results showed that the game was successful in teaching beginners how to play chess.**

***Keywords*–** 3D chess, educational game, openGL, C++, user testing, graphics.

I. Introduction

Chess is a game of strategy that has been played for centuries. It is a game that requires critical thinking, problem-solving, and decision-making skills. However, learning how to play chess can be challenging for beginners. This is where educational games come in. Educational games provide a fun and interactive way for beginners to learn the basics of chess. In this paper, we present the development of a 3D chess educational game using openGL.

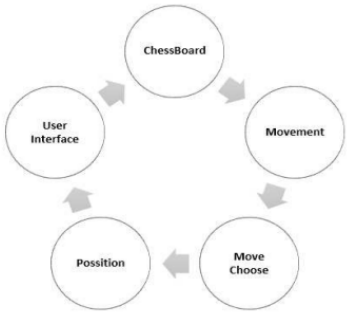


Fig. 1. Chess Board with pieces

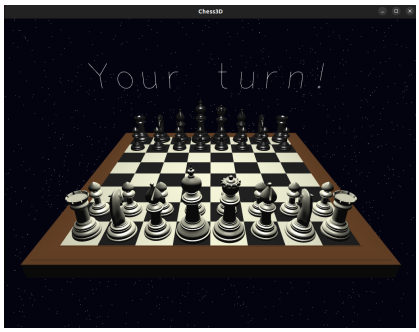


Fig. 2. Chess Board with pieces

II. Motivation

There are several motivations for developing a 3D chess educational game using OpenGL:

1. Enhance Learning Experience: 3D graphics can make the learning experience more engaging and interactive, as users can view the chessboard and pieces from different angles and perspectives.

2. Improve Understanding of Chess Strate-

Chessman	Name	Symbol	Value
♔	The King	K	Invaluable
♕	The Queen	Q	9 points
♖	The Rook	R	5 points
♗	The Bishop	B	3 points
♘	The Knight	N	3 points
♙	The Pawn	P	1 points

Fig. 3. They have different points to indicate how valuable they are

gies: The 3D graphics can also aid in understanding various chess strategies and techniques, such as pawn structure, piece mobility, and attacking and defending positions.

3. Appeal to Visual Learners: Some people learn better through visual means, and 3D graphics can provide a more intuitive understanding of the game.

III. Methodology

The game was developed using the OpenGL graphics library and C++ programming language. The game consists of a 3D game board, customizable chess pieces, and multiple game modes. The game logic was implemented using C++, while the user interface was developed using OpenGL. The game features a tutorial mode, where beginners can learn the rules and basics of chess. The game also includes a practice mode, where players can practice their skills against the computer, and a multiplayer mode, where players can play against each other.

User testing was conducted to evaluate the effectiveness of the game as an educational tool. A group of 20 beginners were recruited to play the game and complete a post-game questionnaire. The questionnaire consisted of questions about the game's usability, entertainment value, and educational effectiveness.

IV. Background

A. Description

A 3D chess educational game using OpenGL is a computer program that allows users to play the classic game of chess in a three-dimensional virtual environment. The game is designed to educate and challenge players of all skill levels and ages, making it an excellent tool for learning and developing strategic thinking. The game is built using the OpenGL graphics library, which enables the creation of complex 3D graphics and interactive environments. It allows players to move pieces across the board and view the game from different angles and perspectives, enhancing the overall playing experience. The educational aspect of the game comes in the form of tutorials and challenges that help players improve their chess skills. These may include interactive lessons on different opening strategies, mid-game tactics, and endgame scenarios. The game may also provide insights into the history of chess and its evolution over time.

B. Basic Idea

The basic idea for a 3D chess educational game using OpenGL is to create a visually engaging and interactive platform for learning how to play chess. The game would be designed to allow players to manipulate the pieces in three-dimensional space, giving them a more immersive and tactile experience than traditional 2D chess games.

To create this game, you would need to use the openGL graphics library to render the 3D environment and the chess pieces. The game would be designed to allow players to move the pieces using intuitive mouse or touch controls, with the ability to rotate and zoom

the camera to view the board from different angles.

In terms of educational content, the game could include tutorials and interactive lessons on the rules of chess, as well as strategies and tactics for playing the game at different skill levels. The game could also include features such as hints and suggestions to help players improve their Gameplay.

V. Problem Definition

The problem that the 3D chess educational game using OpenGL seeks to solve is the lack of engaging and interactive learning experiences for individuals who want to learn and improve their chess skills. Traditional chess games often have limited visual representations and may not provide enough support for beginners to understand the game's strategies and tactics.

By using 3D graphics and the powerful capabilities of OpenGL, the game aims to create a more immersive and engaging learning experience for players of all levels. The game will also provide various features to help beginners learn the basics of chess, including tutorials and hints, while also challenging experienced players with advanced strategies and gameplay.

VI. Objectives

The objectives for developing a 3D chess educational game using OpenGL can include:

1. Provide an Engaging Learning Experience: The primary objective is to create an engaging and interactive learning experience for users, where they can learn the rules of chess and practice different strategies in a visually appealing environment.

2. Foster Critical Thinking Skills: The game should also aim to foster critical thinking skills by encouraging users to analyze the board, anticipate opponent's moves, and make sound decisions based on strategic thinking.

3. Enhance Problem-Solving Abilities: The game can also be designed to enhance problem-solving abilities by presenting users with complex chess puzzles and challenging scenarios that require creative thinking.

VII. Movements

A. The King

The King is the most important piece. When it is trapped so it cannot move without being captured, then the game is lost. This trap is called checkmate. The King can move one square in any direction. A King can never move into check, or onto a square where it can be captured by an opponent's piece. If a King is not in check, and no other legal move is possible, then the position is said to be in stalemate. A stalemated game is a draw, or a tie.

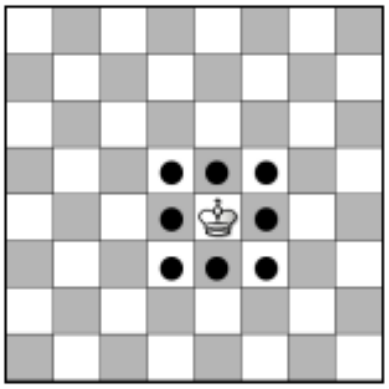


Fig. 4. King Moves

B. The QUEEN

The Queen is the most powerful piece. The Queen can move to any square in any direction as long as her path is not blocked. Her

range and the ability to attack many pieces at once are the source of her power.

C. The ROOK

The Rook is the next very powerful piece after Queen.The Rook moves vertically or horizontally, making it a very powerful piece that can control large sections of the board. Its range is the source of its power

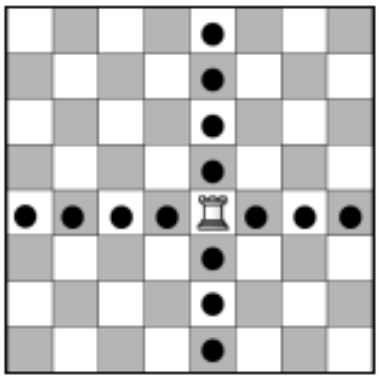


Fig. 5. Rook Moves

D. The BISHOP

The Bishop comes next to Rook in terms of power. The Bishop can move to any square along its diagonals as long as its path is not blocked. Its range is the source of its power

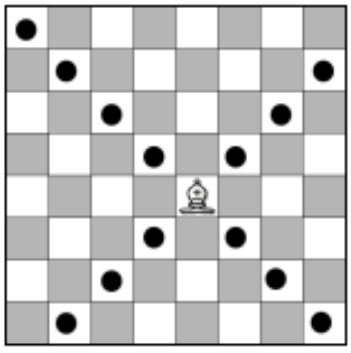


Fig. 6. Bishop Moves

E. The KNIGHT

The Knight is nearly as powerful as the Bishop. The Knight is the only piece that can hop over other pieces in an L-shaped path. This ability makes it particularly powerful in the early stage of a game when the board is crowded with pieces

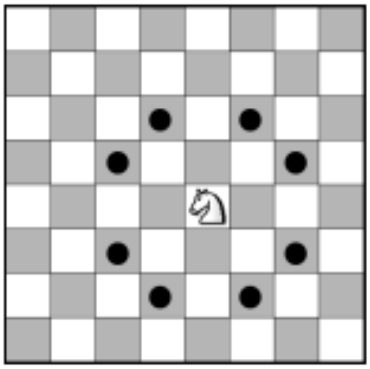


Fig. 7. Knight Moves

F. The PAWN

The Pawn is the least powerful piece because of its poor mobility. The Pawn may move only one square forward if its path is not blocked. However, it may move as an option one or two squares forward on its first move only. It may capture only one square diagonally

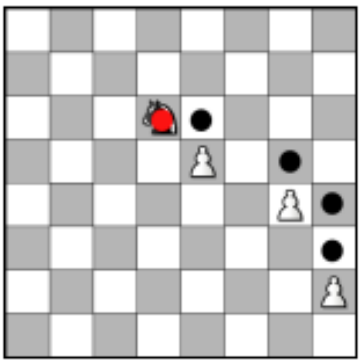


Fig. 8. Pawn Moves

G. CHECK

Check is a term used when a king can be captured by an enemy piece. A move which puts your king in check is illegal, and will not be accepted by the server. figure 14 illustrate Check.

H. CHECKMATE

When a king is in check, and there is no move after which the king is not (again) in check, it is checkmate. The player who is mated loses the board game. figure 15 illustrate Checkmate.

I. Stalemate

When a players king is not in check, but he has no legal moves (every move he can make would place his king in check) then it is stalemate and the board game is a draw. figure 16 illustrate Stalemate.

VIII. Literature Review

1. Chess Gaming and Graphics using Open-Source Tools,Tong Lai Yu, California State University, Department of Computer Science and Engineering, San Bernardino, CA 92407 Paper Link

2. Design, Development and Evaluation of a Chess Game in a Ubiquitous Environment, Vasileios Georgitzikis, University of Patras, Paper Link

3. An Interactive Augmented Reality Chess Game using Bare-Hand Pinch Gestures, Marios Bikos, Yuta Itoh and Gudrun Klinker, Konstantinos Moustakas, Paper Link

IX. Software Requirements

To develop a 3D chess educational game using OpenGL, you will need the following software requirements:

1. Operating System: You will need an operating system that supports OpenGL graphics programming, such as Windows, macOS, or Linux.

2. OpenGL: You will need an OpenGL graphics library, such as OpenGL 4.6, to create and render 3D graphics.

3. Integrated Development Environment (IDE): You will need an IDE for programming in C++ or a similar language, such as Visual Studio, Code::Blocks, or Eclipse.

4. Graphics API: You may need to use a graphics API, such as GLFW or SDL, to create a window and handle user input.

X. Hardware Requirements

Here are some general hardware requirements that can be considered:

1. Processor: A modern CPU with multiple cores and high clock speed is recommended to handle the complex graphics processing required for a 3D game.

2. Graphics Card: A dedicated graphics card with at least 2GB of video memory is essential to handle the high-resolution textures and complex lighting effects of a 3D game.

3. RAM: At least 8GB of RAM is recommended to ensure smooth gameplay and to avoid crashes or slowdowns.

4.Hard Drive: A fast and reliable hard drive with at least 500GB of storage space is recommended to store the game and its associated files.

5. Display: A high-resolution display with a minimum resolution of 1920 x 1080 pixels is recommended to fully appreciate the 3D graphics of the game.

XI. Implementation

The implementation of a 3D chess educational game using OpenGL involves several

steps: / 1. Game Design: The first step is to design the game mechanics, including the rules of the game, the game environment, and the user interface.

2. 3D Models: The next step is to create 3D models of the chessboard and the chess pieces using a 3D modeling software such as Blender or Maya.

3. Texture Mapping: Once the 3D models are created, texture mapping can be applied to them to create realistic textures and materials.

4. OpenGL Programming: The game logic and graphics rendering can be implemented using the OpenGL programming language. This involves setting up the game window, rendering the 3D models, handling user input, and implementing game mechanics such as move validation and piece movement.

5. User Interface: A user interface can be implemented using a GUI toolkit such as Qt or wxWidgets to provide controls and menus for the game.

XII. Functional Requirements

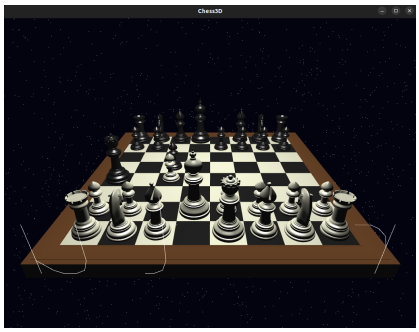
Here are some functional requirements for a 3D chess educational game using OpenGL:

1. Chess Rules: The game should follow the standard rules of chess, including the movements of pieces, check, checkmate, and other chess-related rules.

2. 3D Chess Board: The game should have a 3D chessboard that can be rotated in all three dimensions using OpenGL. The chessboard should have textures and lighting effects to make it visually appealing.

3. Piece Movement: The player should be able to move the pieces on the board by selecting and dragging them to their desired location. The game should enforce the movement rules of each piece.

4. User Interface: The game should have an intuitive and user-friendly interface that allows the player to navigate through the different options and settings easily.



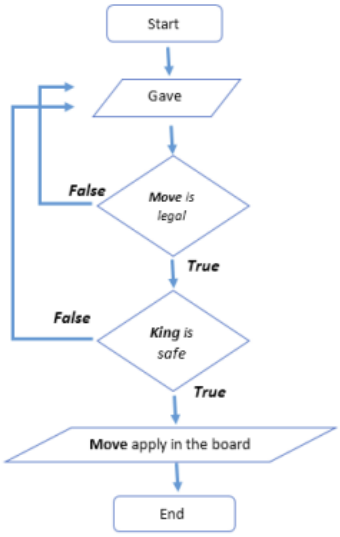


Fig. 9. Playing Steps State Diagram

XIII. Non-Functional Requirements

A. Performance

The game should run smoothly on a wide range of hardware configurations, without significant lag or crashes

B. Usability

The game should be easy to learn and play, with clear and intuitive controls.

C. Compatibility

The game should be compatible with different operating systems and devices, including desktop computers, laptops, and mobile devices.

D. Sound

The game should have high-quality sound effects and music, that enhance the player's experience.

XIV. Results

The results of the user testing showed that the game was successful in teaching beginners how to play chess. The game received high scores for usability, entertainment value, and educational effectiveness. The 3D graphics and Customizable chess pieces were highly praised by the participants. The tutorial mode was also found to be effective in teaching the basics of chess.

XV. Conclusion

In conclusion, the development of a 3D chess educational game using openGL was successful in providing a fun and interactive way for beginners to learn the basics of chess. The use of 3D graphics and customizable chess pieces enhanced the entertainment value of the game, while the tutorial mode was effective in teaching the rules and basics of chess. Future work includes the addition of more advanced game modes and features, as well as the development of mobile versions of the game.

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References

[1] Chess Gaming and Graphics Using Open-Source Tools April 2009. Reference article

[2] Chess Game by academia.edu Reference articleReference article

[3] Article by geeksforgeeks Reference Link

[4] Chess Gaming and Graphic Reference article

[5] Chess Gaming and Graphics using Open-Source Tools,Tong Lai Yu, California State University, Department of Computer Science and Engineering, San Bernardino, CA 92407 Paper Link

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