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Automated Chess Boards: A Comprehensive Review and Analysis of Technology and Applications

Om Kuklani, Seeyog Kapadne, Arsh Patne, Jahan Chaware , Prof. Kopal Gangrade

[1]*Om Kuklani Department of Computer Engineering SCTR's Pune Institute of Computer Technology Pune, India*
[2]*Seeyog kapadne Department of Computer Engineering SCTR's Pune Institute of Computer Technology Pune, India*
[3]*Arsh Patne Department of Computer Engineering SCTR's Pune Institute of Computer Technology Pune, India*
[4]*Jahan Chaware Department of Computer Engineering SCTR's Pune Institute of Computer Technology Pune, India*
[5]*Kopal Gangrade Assistant Professor Department of Computer Engineering SCTR's Pune Institute of Computer Technology Pune, India*

Abstract - — *Chess - a classic game that brings out cognitive thinking, solving strategies, planning skills, potential downsides, developing perspective, etc. The project aims to build an efficient way to build an automated chessboard. The chess board consists of 2 rotators which would handle the movement of the chess pieces on the board. For the software part we would use an SDK file for the rules used for chess pieces. The algorithm used in most of the applications is the min-max algorithm but to increase time efficiency we would use alpha-beta pruning. For false moves, we are going to show a big cross using LEDs glued beneath the board. The difficulty would arise if the chess piece were trapped from all sides by other pieces, for that we would have to increase the size of the board and decrease the size of the chess pieces. The additional feature of the chess timer can also be provided using Arduino sensors. Building a proper Automated board to carry out things similar to chess.com like saving user's game data, chess clock, wrong move indicator and setup of difficulty level. By using various software and hardware elements we would be able to build an accurate gameplay which would be efficient.*

Key Words: **Artificial Intelligence, Internet of things, Light emitting diode**

1.INTRODUCTION

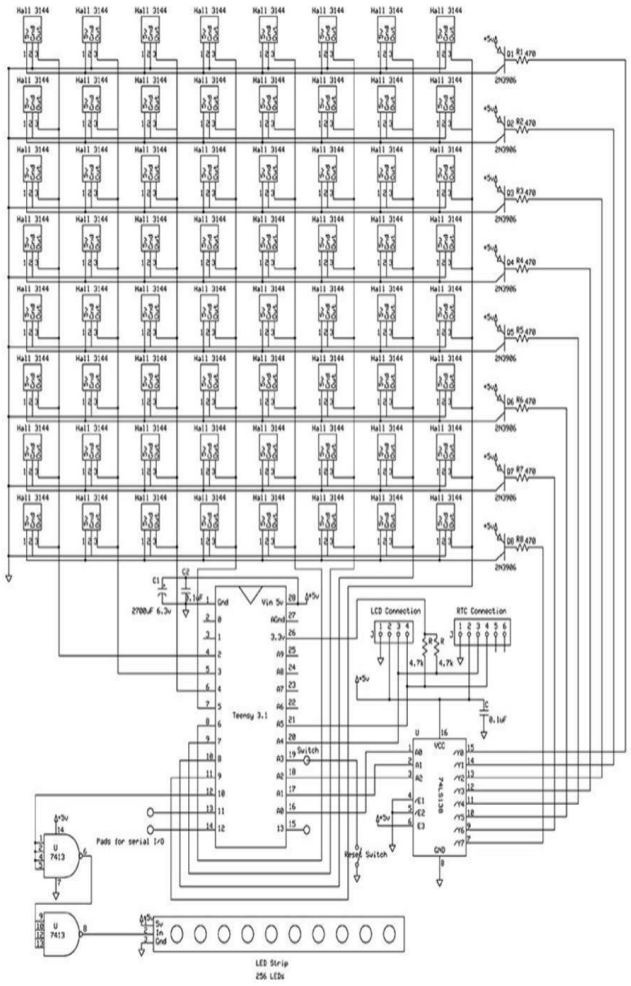
The sport of chess, an undying contest of intellect and method, has captivated the minds of fanatics for centuries. Its rich history, complicated dynamics, and enduring enchantment have made it an excellent subject for experimentation and innovation. In recent years, the integration of synthetic intelligence (AI) with the conventional game of chess has given an upward push to a brand new era in chess-related generation, mainly with the development of independent chess boards. These boards are no longer the best goal to maintain the essence of the game however additionally try to make it greater interactive, exciting, and handy in a hastily evolving technological panorama. Chess, with its origins dating back to ancient India, has been an image of intellectual prowess and strategic questioning. The sport's tricky regulations and unforgiving gameplay have examined the mettle of endless gamers over a long time. However, while the basics of chess continue to be unaltered, the gear and systems for experiencing it have evolved considerably. The integration of AI into the chess world marks a thrilling chapter in this evolution. This paper explores the convergence of AI technology and the classic recreation of chess through the development of a self-sufficient chess board that competes against human gamers. It seeks to emphasize the historical significance and enduring complexity of chess, at the same time as also dropping light on the developing function of AI in the modern-day era. The mission's primary objective is to offer an autonomous chess revel in, one that no longer most effectively upholds the traditional spirit of the sport but also provides a layer of innovation and excitement that units it other than current chess systems. The proposed self-sufficient chess board is anticipated to be a 12"x12" marvel of the era, geared up with a circuit that interacts with the pieces on the board. LEDs incorporated into the board will function as a visible guide, illuminating the moves of the opponent. The goal is to create an immersive and dynamic revel in, remodeling the two-dimensional chessboard into an interactive battleground of wits. In addition to enhancing the solo chess experience, this venture envisions the implementation of a multiplayer mode, allowing human gamers to engage in interesting 1v1 matches with the AI performing as a referee and manual. By placing a chess piece at the board, the corresponding LED lighting fixtures will remove darkness to indicate available movements, offering clean instructions for players. This study's endeavor bridges the timeless allure of chess with the current era, promising to make the game greater interactive and enjoyable for players of every age and talent stages. With a focus on enhancing the player's connection to the game, our mission aspires to create a self-sufficient chess board that represents a harmonious fusion of culture and innovation, establishing new avenues for the timeless sport of chess in the digital age.

2 Literature Survey

[1] The paper titled "A Practical Interactive Chess Board with Automatic Movement Control" by Chattriya Jariyavajee, Arnon Visavakitcharoen, Preeyaphond Sirimaha,

Booncharoen Sirinaovakul, and Jumpol Polvichai presents an innovative interactive chessboard that combines the traditional chess game with technology. The authors have developed a chessboard with an automatic movement mechanism for each chess piece, providing an exciting and tangible gaming experience. The board employs an Arduino microcontroller to control the movement of the pieces. A graphical interface allows players to make their moves, which are then executed by the board. The paper also discusses the hardware setup, including the use of stepper motors and a linear actuator with a magnet to control the chess pieces' movements. This interactive chessboard offers a unique and engaging way to play chess that bridges the physical and digital worlds, enhancing the gaming experience. [2] The paper titled "Automated Chess Playing with a Robot Manipulator" by Dimitrija Angelkov, Natasa Koceska, and Saso Koceski presents a system for automating chess games using a robot manipulator. In this innovative approach, a computer vision system continuously monitors the chessboard and tracks the movements of pieces. A customized chess engine implements the game's rules, evaluates the board position, and computes the robot's next move using the alpha-beta search algorithm. The research aims to contribute to the development of automated robotic games and explores non-standard human-computer interfaces, combining elements of chess, robotics, and computer vision. The system's reliability and success rate are demonstrated through testing against human players, showing promising results. [3] The paper, titled "Implementation of the Automatic and Interactive Chess Board" and authored by Allen R. Mendes, Atur M. Mehta, and Bhavya H. Gohil, discusses the development of an innovative automated chess board system called Chess Automated. This system offers three gameplay modes: one-player mode against a computer with automated piece movements and voice feedback, two-player mode allowing users to play chess over the internet with physical boards, and a unique Chess for the Blind feature enabling visually impaired individuals to play chess. The hardware platform employs Arduino Mega ATmega 2560, a sensing membrane keypad, hybrid stepper motors, servo motors, motor and LED driver ICs, and RGB LED strips to enable precise and interactive movements of chess pieces. The paper details the input and output cycles of the system, including voice and visual feedback, making it accessible to visually impaired users. Furthermore, it describes how the system supports online gameplay. Future improvements, such as adding LCD displays and voice-controlled features, are also outlined, making this technology applicable beyond chess for other board games or applications like CNC machines or 3D printers. [4] The paper titled "Autonomous Chess Playing Robot," authored by Prabin Kumar Rath, Neelam Mahapatro, Prasanmit Nath, and Ratnakar Dash, describes the development of a chess-playing robot aimed at creating a realistic interface between a human player and a computer chess engine. This autonomous chess robot combines an open-source chess engine, Stockfish, with a CNC-controlled XY slider mechanism for moving chess pieces on a physical board. An overhead camera tracks the moves made by the human player, and Stockfish provides the best move suggestions, which the robot carries out physically. This system not only allows for interactive and engaging chess gameplay but also has the potential for use in professional chess matches and remote training sessions. The paper details the mechanical and software components, emphasizing vision-based piece detection and move tracking, ultimately creating a bridge between the digital and physical aspects of the game. [5] This paper, titled "Chess Playing AI" and authored by Gaurav Parihar and Raghavendra R, discusses the application of artificial intelligence in the game of chess. The authors highlight the significance of AI in simulating human-like thinking and strategic decision-making in chess. They introduce a system with two distinct AI players, each employing different tactics and algorithms. The Minimax Algorithm and the Monte Carlo Tree Search Technique are utilized to enhance the AI's gameplay. This approach allows for faster move generation and offers opportunities for both players and AI to learn and adapt from each other. The paper emphasizes the potential of such AI to improve chess evaluations and gameplay. It also provides references to related work in the field of AI-driven chess systems. [6] In the paper titled "Literature Survey of Chess Engines," authored by Anushka Nair, Kanksha Marathe, and Prof. Su- varna Pansambal, the authors delve into the world of chess engines and their continuous evolution. They emphasize that despite the remarkable progress in chess engines, most of them are fundamentally based on the MinMax algorithm. The paper discusses the significant role played by hardware and graphical user interfaces in enhancing these engines. It also highlights the development of various chess variants, such as Surakarta and hexagonal chess, which bring fresh perspectives to the game. The authors explore how these engines aim to improve their Artificial Intelligence, and they discuss different approaches, including genetic algorithms and evolutionary systems. This survey provides a comprehensive overview of the diverse strategies employed in the world of chess engines. [7] The paper titled "An Improved Chess Machine based on Artificial Neural Networks" by Diwas Sharma and Udit Kr. Chakraborty presents an innovative approach to developing an intelligent chess engine using Artificial Neural Networks (ANNs). Unlike traditional chess engines that rely on brute-force searching techniques, this paper explores the use of ANNs to assist and suggest possible moves in chess. The authors propose a hybrid system that combines ANNs with tree search techniques to substantially reduce the computational cost of finding the best moves in chess. Their approach involves training the neural network using patterns and moves from human grandmasters, allowing the system to imitate the strategic thinking of human players. Through testing, the system shows the capability to hint at valid moves, making it a promising tool for enhancing chess playing and potentially improving game strategies. [8] The paper titled "Professional

AI Chess Board: Autonomous Chess Board (Human Vs. Robot)" by Kalpesh H. Zurange, published in the International Journal of Engineering Research Technology (IJERT), discusses the development of a self-playing chess board that utilizes artificial intelligence (AI) to provide an interactive and realistic chess experience. This innovative system employs AI algorithms, sensors, and motors to control the chess pieces' movements, allowing individuals to play against the AI opponent, and bridging the gap between the physical and digital chess-playing experiences. The paper highlights the advantages of this approach, such as reducing screen time, improving memory, and enhancing the quality of chess training for players. The system utilizes technologies like Arduino Mega and Raspberry Pi3, along with a Stockfish engine, to provide a professional and engaging chess experience. The paper also addresses technical aspects like the H-Bot configuration and reed switch matrix. This work represents a significant step in the fusion of AI and traditional board games, such as chess, to enhance the overall gaming experience. [9] The paper titled "The Role of Chess in Artificial Intelligence Research" by Robert Levinson and a panel of researchers discusses the significance of chess in AI research. It emphasizes the richness of chess as a problem-solving domain and its ability to accurately measure progress through competition. Chess is recognized as a valuable test bed for various AI techniques, including machine learning, knowledge representation, and uncertainty management. The paper highlights the importance of learning from chessplaying experiences and patterns, which aligns with cognitive models of human play. However, it suggests that chess research is becoming increasingly engineering-focused, with a need to shift the focus back to scientific exploration. Additionally, it mentions that chess, while valuable, has certain limitations, and other domains like Go could provide more complex reasoning challenges for AI. The authors propose the idea of adapting chess to create new games with similar advantages for AI research. [10] The paper titled "Chessbot: A VoiceControlled Chess Board with Self-Moving Pieces" by Nino U. Pilueta, Hon- eylet D. Grimaldo, Moises F. Jardiniano, and Manuel Garcia presents Chessbot, an automated chess board that combines various technologies and techniques, including voice command recognition, x and y plotting, artificial intelligence algorithms, and a mobile application. Chessbot operates in three modes: one-player, two-player, and a special mode for blind players. Through rigorous testing, the system demonstrated excellent performance in voice command recognition (90 [11] The paper titled "Intelligent Chessboard Using IoT" by Tejas Shah, Deepak Chaudhari, Ashutosh Kshirsagar, Aboli Doiphode, and Prof. M. R. Mahajan presents an innovative approach to the world of chess by combining modern technology. The authors have created an intelligent chessboard that allows people to play chess remotely, overcoming geographical distances. This board integrates artificial intelligence, machine learning, image processing, and a robotic arm with four degrees of freedom. It functions by capturing images of the chessboard, processing them for piece identification and classification, and then reflecting the AI's move on the physical board via the robotic arm. The system also employs the Sunfish chess engine for move calculation. The paper highlights the potential for future enhancements in chess piece recognition and the prospect of enabling real-time, remote, two-player gameplay. This intelligent chessboard bridges the gap between traditional board games and modern technology, making chess accessible and engaging for players of all ages.



Hardware Architecture

CONCLUSIONS

"A Practical Interactive Chess Board with Automatic Movement Control" is groundbreaking research that combines physical movements with computer technology for interactive chess gaming. The hardware setup is well-designed and offers potential for future exploration in interactive board games using rotators. Additional features like a chess clock using sensors and the keen movement of pieces are taken care of. The paper could benefit from more

detailed evaluations and a chess engine, but its contributions could lead to more interactive and engaging gaming experiences. Automated Chess Playing with a Robot Manipulator is another innovative approach to chess gaming, integrating robotics and computer vision technology. The research showcases a practical implementation with promising evaluation results but could benefit from more detailed evaluations. This work could inspire future research in human-robot interaction and create more engaging gaming experiences.

SOFTWARE REFERENCES

1. [1] The paper mentions that the chess game interface is created using Python. The software displays the current game state to the player, highlights allowed move locations, and waits for player input. After the player selects a move, the software calculates the piece movement steps and sends the corresponding commands to the Arduino.

2. [8] Stockfish Engine is a free, open-source chess engine that analyzes chess positions and calculates the best moves. It's available for Windows, Mac, Linux, iOS, and Android.

3. [11] Sunfish Engine Sunfish is a simple, but strong chess engine, written in Python, mostly for teaching purposes. Without tables and its simple interface, it takes up just 111 lines of code! Yet it plays at rating 1800-1900 at Lichess.

HARDWARE REFERENCES

1.[1] The movement mechanism is a combination of precise stepper motor control, a linear actuator with a magnet for capturing and releasing chess pieces, and the central control provided by the Arduino microcontroller. The software interface allows players to select and move pieces, with the system accurately carrying out the physical movements on the interactive chessboard.

2. [8] The system employs an "H-Bot" configuration, involving two rotary drives connected by an H-shaped timing belt, enabling movement along two linear axes in a gantry-like setup.

3. [11] The paper employs a robotic arm that uses servos for actuation. It's modular in design, allowing for flexibility in the number of joints, and it's controlled by an Arduino Uno. The robotic arm is used to pick up and move pieces just like a human being.

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