Checkers Using IoT

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Abstract - *Board games have been a popular pastime among people of all ages and have been widely played. Many board game developers have been working on creating games based on artificial intelligence, such as tictac-toe and chess. However, developing and building a board game from scratch can be a challenging task, requiring a high level of programming skills to understand the graphics and physics that must be implemented in the game. The proposed research focuses on an IoT-based version of the popular board game checkers, which is similar to chess but has its own set of rules. The game is played between two players, with each player starting with 12 pieces on an 8 by 8 board. The objective of the research is to make the game more interactive for children, by incorporating a programme on board that can predict the best moves for the computer to win or lose the game. By providing children with an interactive and engaging experience, this IoT-based checkers game aims to foster their interest in technology and problem-solving skills.*

***Key Words*: Arduino Uno, Hall Sensor, LEDs, PCB**

1. INTRODUCTION

The Internet of Things (IoT) is a system of interconnected physical devices that can interact and share data without the need for human involvement. Because IoT allows us to gather information from all kinds of mediums, such as humans, animals, automobiles, and household appliances, it has been explicitly characterized as an "Infrastructure of the Information Society." By integrating electronic hardware within any physical device that may be given an IP address, including detectors, application, and networking gear. The project's objective is to develop a checkers Board game using IoT on a physical board that can predict and show the possible moves of pieces with the help of LEDs.

Internet of Things is one of the areas in computer science that can be used to create a range of intelligent games whether board games, video games or educational games that would react to a human and would not be noticeable that it is being reacted by a computer machine.

IoT is one of the fields in computer science that can be utilized to create a variety of intelligent games, including - board games, video games, and educational games that can react to human input in a natural way. One such game is checkers, a popular board game that requires strategic thinking and techniques to win. The game's mechanics involve physically moving game pieces and thus, players must understand how to move them effectively and at the right time in order to capture their opponent's pieces. Checkers consists of 24 round, coloured pieces, typically in brown and black colours. Each player starts with 12 pieces and the game is played on an 8 by 8 board. To win the game, players must capture all 12 of their opponent's pieces. Figure 1 illustrates a screenshot of the checkers board game.

2. NEED OF THE PROJECT

The need for this project on "Checkers Game Using IoT" stems from the popularity of board games among people of all ages and the ongoing development of board games based on IoT. However, the development of a board game from scratch requires a high level of skill in programming languages and an understanding of the graphics and physics that must be implemented in the game. The proposed project aims to address this need by utilizing IoT technology to create an interactive checker game that utilizes magnetic sensors and RGB(Red Green Blue) LEDs to display possible moves when a magnetic chess piece is lifted from its location. This technology will make the game more engaging for children and allow for the computer to determine the steps necessary to win or lose the game. Furthermore, the use of a power bank will make the game portable and allow for easy setup. This project not only fills the gap in the field of board games development but also will be a great educational tool for children to learn and train their problem-solving and strategic thinking skills.

3. RELATED WORK

The concept of creating a smart game board for traditional board games such as checkers and chess has been explored by various researchers and developers in recent years. One example is the work of Bogdan Berg, who created a smart game board using a microcontroller and wireless communication capabilities to allow for remote play and the recording of game statistics. This project aimed to enhance the traditional board game experience by incorporating technology and increasing the level of interactivity.

4. STRUCTURE OF THE PROJECT

In this project it is divided into two parts first is Mechanical structure and second is Electronic structure.

4.1 Mechanical Structure

4.1.1 Design

Fig. 1 illustrates the configuration of the sensor unit for the electronic checker set. The sensor is placed underneath the checkerboard and receives signals from the magnet located within each checker piece. This allows for the detection of the piece's position and function on the board. In this project, a plywood box is used that have all the structure of components.

Checkers game is developed using an acrylic sheet as a cover for the checkerboard. The board was built into a plywood box, and the acrylic sheet was used as a protective cover for the checkerboard, as well as for aesthetics. The acrylic sheet provided a durable and clear surface for the checkerboard and allowed for the use of magnetic sensors and RGB LEDs to detect and display possible moves when a magnetic chess piece is lifted from its location. This material was chosen for its transparency, durability, it's cheapness and resistance to impact which made it suitable for the game. The combination of the acrylic sheet and the plywood box also provided a sturdy and professional-looking game board, making it suitable for both personal and commercial use.

4.2 Electronic Structure

4.2.1 Project Parts

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 microcontroller. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. In this research, the Arduino Uno is utilized as the primary controller for the checkers game using IoT. Its digital input/output pins are utilized to connect the magnetic sensors and RGB LEDs, which detect the position and movements of the checkers pieces and display possible moves respectively. The Arduino Uno's programming capability allows for the implementation of the game's rules and logic, making the interaction between the physical checkers board and the player possible. In the context of checkers, the Arduino Uno can be used to control the movements of the checkers, receive input from Hall sensors, and communicate with a central device to provide real-time information about the game.

Fig -1: Arduino Uno

Hall Sensors

Hall sensors are widely used in a variety of applications, including in the field of IoT. In the context of an electronic checker game using IoT, Hall sensors can be utilized to detect the movement of magnetic checker pieces on the board. When a checker piece is lifted from its location, the magnetic field around the piece changes and this change is detected by the Hall sensor. The sensor then sends a signal to the microcontroller, such as an Arduino Uno, which processes the information and updates the game state accordingly. This allows for a seamless and interactive gaming experience, as the computer can instantly react to the players' moves and display possible moves or the outcome of the game. The use of Hall sensors in this application not only enhances the player's experience but also allows for a more accurate and efficient detection of piece movement, as compared to other methods such as optical or mechanical sensors. The use of Hall sensors and IoT technology in checkers not only enhances the playing experience but also provides a new platform for data collection and analysis. In conclusion, the combination of Hall sensors and IoT technology has significant potential for the development of innovative applications in various fields, including gaming.

Fig -2: A3144 Hall Sensor

LEDs

We utilized WS2812B LED strips as a visual indicator for the possible moves of the checker pieces on the board. The LED

strips were placed under the acrylic sheet cover of the checkerboard, which was built into a plywood box. The WS2812B LED strips are able to display a wide range of colours and are controlled by an Arduino Uno microcontroller, which receives input from the Hall sensors placed under the board to detect the movement of the magnetic checker pieces. This allows for a dynamic and interactive checkers experience, as the LED lights will update to show the possible moves of the checker piece as it is lifted by the player.

Magnets

Magnets are an important hardware component used in the development of the checkers game using IoT. These magnets are embedded within the checker pieces and are used in conjunction with Hall sensors to detect the movement and position of the pieces on the board. The Hall sensors detect changes in the magnetic field caused by the movement of the checker pieces and relay this information to the microcontroller, allowing the game to track the movement of the pieces and make decisions based on the current game state. The use of magnets in this application allows for a more accurate and efficient way of detecting the movement of the checker pieces, as compared to other traditional methods.

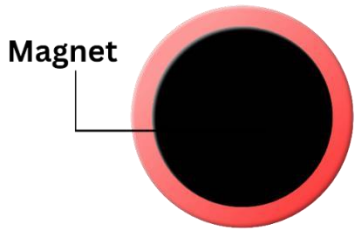

Fig -4: Piece with Integrated magnet

Resistors

In the proposed "Checkers game Using IoT" project, resistors are utilized as an essential component of the circuit on the PCB board. The use of resistors in this project is to control the current flowing through the Hall sensors, which are used to detect the movement of the checker pieces on the board. A total of 8 resistors are used in a single PCB board and there is total 4 PCB boards, with each one placed in parallel with a Hall sensor. These resistors work together with other components such as a shift register chip to distribute and control the current flowing through the Hall sensors. This ensures that the Hall sensors operate at optimal levels, providing accurate and reliable detection of the checker pieces on the board. The use of resistors in this project is crucial for the proper functioning of the IoT-enabled checker game.

Fig -3: 10k Ohm resistor

Power Supply

In the "Checkers game Using IoT" project, a 5V power supply is used to provide power to all the electronic components of the game. The power supply is essential for the operation of the game as it ensures that all the sensors, LEDs, and other components have the necessary voltage to function properly. The power supply is connected to the PCB board, which distributes power to all the components on the board. Without the power supply, the game would not be able to function, making it a crucial component of the "Checkers game Using IoT" project.

PCB

In the "Checkers game Using IoT" project, a PCB (Printed Circuit Board) is used as the foundation for the circuit design. The PCB board serves as a platform to connect and organize the various electronic components, such as the microcontroller, Hall sensors, resistors, LEDs, and power supply, that make up the game's functionality. The use of a PCB allows for a compact and organized design, as well as a stable and reliable performance. Additionally, PCB manufacturing techniques such as surface-mount technology (SMT) can be utilized to further reduce the size of the circuit and increase its robustness. The use of a PCB board in this project is a crucial element in ensuring a successful and functional implementation of the "Checkers game Using IoT" system.

Shift Registers

In the "Checkers game Using IoT" project, 74hc165 shift registers are utilized as a key component in the circuit design. These shift registers are used to control the equal current flow in the Hall sensors, which are responsible for detecting the movement of the checkers pieces on the board. The 74hc165 is a high-speed parallel-in/serial-out shift register that allows for multiple inputs to be read simultaneously and then shifted out serially. Its compact size and high-speed capabilities make it an ideal choice for this application, as it allows for efficient and precise detection of checker piece movement on the board.

Additionally, the use of shift registers in the circuit design allows for a more streamlined and organized layout of the

various components on the PCB board, making it easier to troubleshoot and maintain the device.

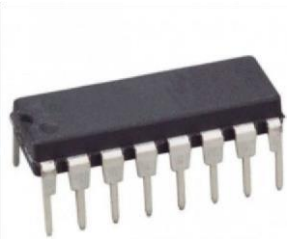

Fig -5: 74HC165 8-bit shift register

4.2.2 LEDs Assembly

In this project the 32 LEDs are connected in such a way all are above each hall sensor, shown in Fig. 6.

Fig -6: LEDs strip

4.2.3 Hall Sensors Assembly

In this project the 32 hall sensors are connected in such a way all are under each LEDs and connected in parallel in the circuit, all the sensors are controlled by the shift register that is integrated in PCB board, shown in Fig. 7. Furthermore, the parallel connection of the hall sensors and LEDs ensures that all sensors are working simultaneously and providing real-time data. This parallel connection makes the circuit highly responsive and provides accurate results. The integration of the shift register into the PCB board makes the design even more compact and efficient, as it eliminates the need for additional components. Overall, the 4 PCB boards connected in this project are a critical component of the system and play a crucial role in the detection of the movements of the checkers. The use of multiple PCB boards, along with hall sensors, resistors, and shift registers, makes this project a prime example of how advanced technology can be used to create innovative applications in the field of IoT.

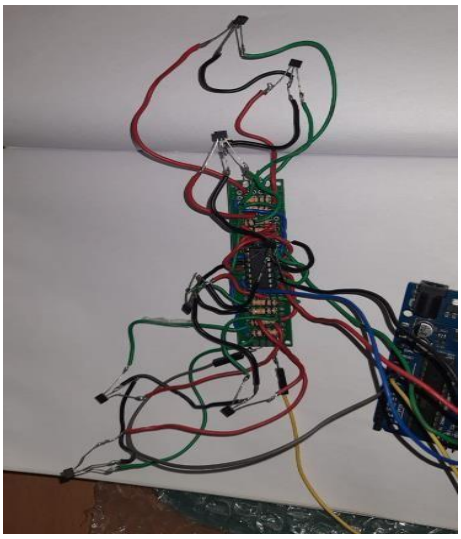

Fig -7: 8 hall sensors assembly

4.2.4 PCB Board Assembly

In this project, a total of 4 PCB boards are connected to each other in order to achieve the desired results. Each PCB board contains a number of hall sensors, resistors, and shift registers that work together to detect the movements of the checkers. The hall sensors are responsible for detecting the magnetic fields generated by the checkers, while the resistors are used to regulate the flow of electric current in the circuit. the winner of the game. The shift registers play a crucial role in controlling the hall sensors and ensuring their optimal functioning.

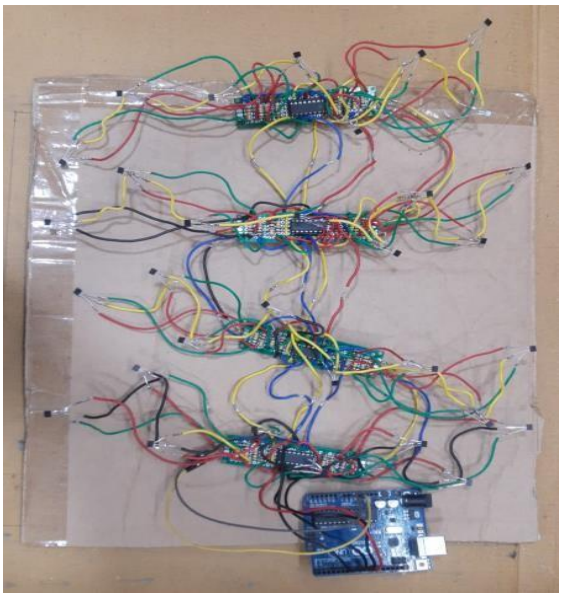

Fig -8: 4 PCB board connected.

5. FLOW CHART

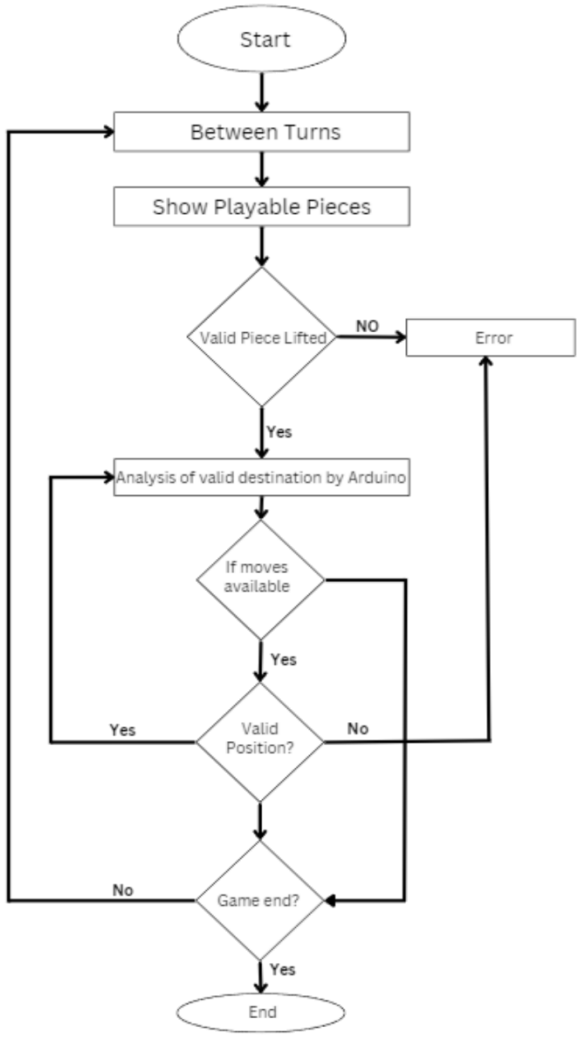

Fig -9: Flow Chart

The flow chart of checkers using IoT described as first the condition is at initial position. Going with the arrow the condition is checked between the turn and after that the direction goes to show the playable pieces on the board. If the valid piece is lifted, then the game continues if not then the system throws an error. The moves then analysed by the Arduino as it is valid or not and for that valid piece the moves are available on board or not if yes then the games continue in loop if not the board shows an error. After that the condition is checked that if the pieces or moves are available for any piece or not on board, if there is no moves or piece left then game will end but if not, the game again start from previous state. The moves are then evaluated by the Arduino to see whether they are legitimate or not, and whether they are available on the board for that valid piece or not. If they are, the game loops forward; otherwise, the board displays an error.

6. CIRCUIT DESIGN

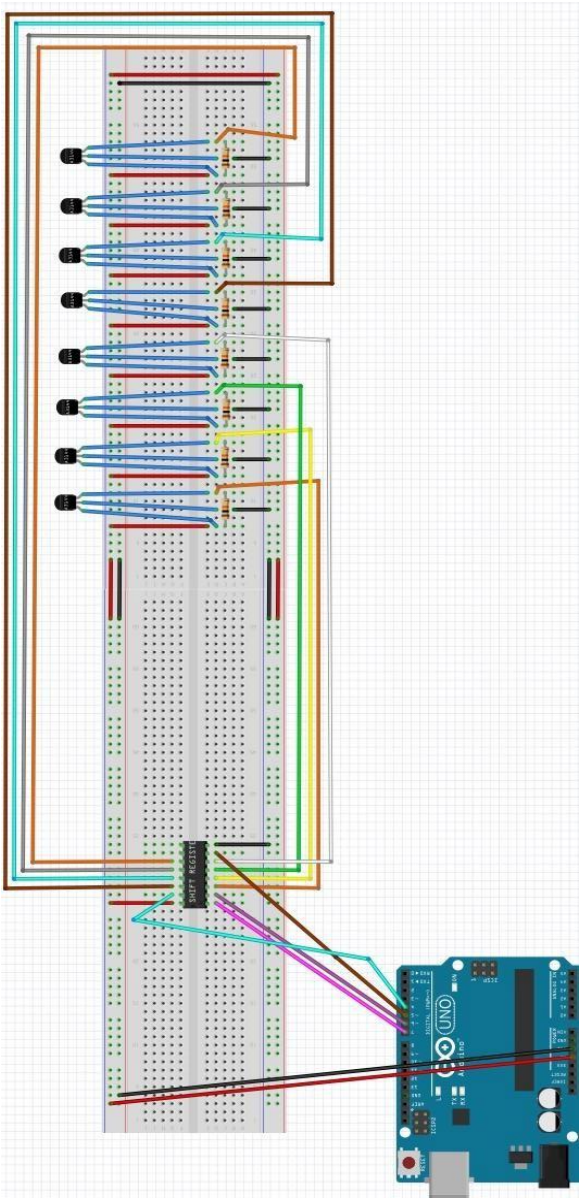

Fig -10: Circuit Design

The circuit is designed with the 8 hall sensors, 1 Arduino Uno, 1- 74HC165 8-bit shift register and 8 10K Ohm resistors. There is one clock pin, clock enable pin, load pin, data pin in shift registers and connected to the Arduino and there is parallel input and output. Pin 1,2,7, 15 are connected to the Arduino for controlling the 8 sensors via shift registers. Middle 8 pins of shift register upper 4 pins and lower 4 pins are connected to the 4 hall sensors of one side and other 4 pins are connected to the 4 hall sensors of other side. All the 8 hall sensors are connected to each 10K ohm resisters for controlling the amount of current in each sensor for proper working. And there are two other pins (1 and 2) of shift register that are connected to the Arduino for supply 5v current.

7. SYSTEM FLOW

7.1 System Flow

The system flow of the checkers game using IOT is a crucial aspect of this research. The first step in the system flow is to detect the initial positions of the pieces. This is done to keep track of the game and to ensure that each player's pieces are placed in their proper starting positions. The system then moves on to determining whose turn it is. This information is necessary to ensure that the players are aware of whose turn it is to make a move.

The system then highlights the pieces that can be moved by the player. This includes pieces that have a possible move and any opponent's pieces that can be cut by a piece of the current player. [5] If any opponent's piece is being cut by any piece of the current player, then the system will only highlight those pieces. On the other hand, if there is no opponent's piece being cut, the system will show the normal moves pieces.

Once the player lifts a piece, the system validates the chosen piece. If the chosen piece is one of the highlighted pieces, it will show all the possible next moves of that chosen piece. If the chosen piece is not a highlighted piece, the system will show an error message, indicating that the chosen piece cannot be moved.

After the player has selected a piece, they can move it to their desired location. The system then validates the move to ensure that it is a valid move. If the move is not validated, an error message will be thrown. If an opponent's piece is cut during the move, the turn will not change and it will keep on looping through the flow starting from, highlighting the possible next moves of the chosen piece. However, if an opponent's piece is not cut, the turn will change to the opponent, and the system will loop back to highlighting the pieces that can be moved by the player.

In addition, the system flow of the Checkers Using IoT project is designed to detect the change of a piece into a King piece and to update the game board accordingly. This eliminates the need for manual intervention and ensures that the game is played in a fair and consistent manner.

The system flow of the player also includes the validation of all moves, including those made by the King piece, to ensure that the game is played according to the rules. In conclusion, the system flow of the checkers game using IOT is a complex process that involves multiple steps to ensure a fair and enjoyable game.

The system must keep track of the game and determine whose turn it is, highlight the pieces that can be moved, validate the chosen piece, and validate the move. The system must also detect if an opponent's piece has been cut, change the turn if necessary, and loop back to the beginning if the game continues.

7.2 Winning Condition

The winning condition of a player in the checkers game using IOT is a critical aspect of this research. The system flow must be designed to accurately determine the winner of the game. There are three possible ways for a player to win the game.

Firstly, if all the pieces of one player are cut, the opposite player wins. [2] This means that if a player has no pieces left on the board, the other player is declared the winner. This rule is straightforward and ensures that a player is declared the winner if they have successfully captured all of their opponent's pieces.

Secondly, a timer can be integrated into the game to add an extra layer of excitement. If the time is over, the player with more pieces on the board wins. This means that if a player has captured more of their opponent's pieces, they will be declared the winner, even if the other player has some pieces left. This rule adds an extra level of strategy to the game, as players must consider the number of pieces they have, and the amount of time left to make their moves.

Finally, if the number of pieces is the same for both players, the game is a draw [2]. This means that if both players have the same number of pieces left on the board, neither player wins, and the game ends in a draw. This rule ensures that if neither player has an advantage over the other, the game ends in a tie.

In conclusion, the winning condition of the checkers game using IoT is a complex and multi-faceted process that requires the integration of advanced technology and a well-designed system flow. The system must be able to accurately detect the movements of the checkers, store information about the game in real-time, and determine the winner based on the three possible outcomes. The integration of the King piece into the system flow of the Checkers game adds an extra layer of complexity to the system but is a critical component of the system that must be designed and integrated correctly in order to accurately determine the winner of the game and loser of the game with more precision.

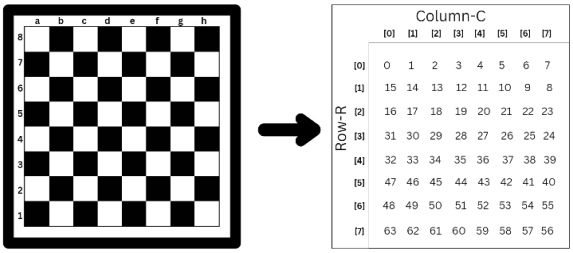

Fig -11: Checkerboard Position

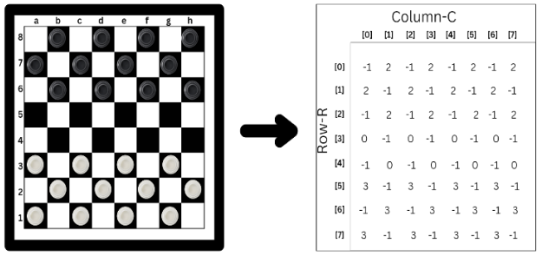

Fig -12: Board Position with Pieces

Representation of Board And Pieces		
	Values	**Color**
	2	Black Piece
	3	White Piece
	0	Black Square
	-1	White Square

Fig -13: Piece Value representation

8. CONCLUSION

In conclusion, the Checkers Using IoT project is a remarkable example of how technology can be used to enhance traditional games. The integration of IoT devices and systems provides an interactive, intelligent, and user friendly experience for players. The system flow of the game has been designed to accurately detect the initial positions of the pieces, determine whose turn it is, highlight the pieces that can be moved, validate the chosen piece and its moves, and determine the winner of the game. The game's winning condition has been defined by three possible outcomes: if all the pieces of one player are cut, if the time is over and the player with more pieces on the board wins, or if the number of pieces is the same for both players, and the game is a draw.

The Checkers Using IoT project shows how IoT technology may be used to enhance conventional games and provide players a distinctive and interesting experience. It shows the significance of integrating IoT into numerous elements of our daily lives and opens up a world of possibilities for future developments in gaming technology. The development team's ingenuity and inventiveness are demonstrated by the project's successful completion, and the prospect of further developments in this area is intriguing.

9. FUTURE SCOPE

The future scope of the Checkers game using IoT presents exciting opportunities for innovation and growth. One area of focus is the integration of Artificial Intelligence (AI) into the game. The use of AI in Checkers will allow for a more challenging and dynamic experience for players. The AI algorithm can be trained to play at a high level, allowing players to compete against a challenging opponent. This will make the game more engaging and entertaining for players of all skill levels.

Another area of focus is the integration of remote play into the Checkers game using IoT. The game can be played both on a physical board and virtually, with one player playing on the board and the other playing remotely. This opens up new possibilities for players to enjoy the game, regardless of their physical location. With the integration of remote play, players can now compete against each other from anywhere in the world, making the game more accessible and convenient.

In addition to these exciting developments, the future scope of the Checkers game using IoT will likely include advancements in game graphics, sound effects, and other sensory experiences that will make the game more immersive and engaging. The integration of new technologies, such as augmented and virtual reality, will further enhance the player experience and provide new opportunities for players to engage with the game in innovative ways. Overall, the future of the Checkers game using IoT is bright and offers a wealth of opportunities for growth and innovation. With the integration of AI, remote play, and new technologies, the Checkers game using IoT is poised to become one of the most exciting and dynamic games in the world.

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