



AN-NAJAH NATIONAL UNIVERSITY
FACULTY OF ENGINEERING AND INFORMATION
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COMPUTER ENGINEERING DEPARTMENT

Hardware Graduation Project:

Jackaroo automated

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Presented in partial fulfillment of the requirements for the Bachelor's degree in Computer Engineering. may 27,

2023

Acknowledgment

We would like to express our sincere gratitude to our project advisor, Dr. Manar, for their invaluable guidance and support throughout the duration of this project. Their knowledge, expertise and encouragement were instrumental in the successful completion of our graduation project. To our friends and family for their unwavering support and encouragement during the course of this project. to the municipalities who dedicated some of their time and effort to answer our questions, Finally to our beloved An-Najah National University that supported this project to make the country and the community better and to make us the students make a difference. Without them, this project would not have been possible. We are deeply grateful to everyone who has helped us along the way, and this project is dedicated to all of you.

Dedication

With great appreciation and immense gratitude, we express our heartfelt thanks to everyone who has supported us throughout this journey. Our friends and family have been our pillars of strength, and we are deeply grateful for the unwavering love and support they have provided.

We also extend our heartfelt thanks to all the authors, researchers, and experts whose works have been instrumental in guiding us through this project. Their contributions to computer engineering have been invaluable and have played a crucial role in the successful completion of our graduation project.

We are deeply indebted to all of you, and this work would not have been possible without your support. Thank you all for being a part of our journey.

DISCLAIMER

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Abstract

The project aims to develop an engaging and interactive board game inspired by the popular game "Jakaro." This board game will incorporate hardware components, including LEDs, microcontrollers, sensors, servo motors, and buttons, to enhance the gameplay experience and manage the game's state. A comprehensive user manual and technical documentation will accompany the game, providing clear instructions for setup, gameplay, and troubleshooting.

In this game, each player will be equipped with four cards, each possessing unique abilities. These cards will enable players to make strategic moves on the game board. For example, a card with the number "6" allows the player to move their game piece six spaces forward, while a card with the number "4" moves the player's piece four spaces backward. Additionally, a card with the number "5" grants the player the ability to move any game piece on the board. The objective of the game is to successfully navigate all four of one's game pieces to their designated areas before other players, thus securing victory.

By combining elements of luck, strategy, and competition, this board game offers an engaging and entertaining experience for players of all ages. The incorporation of hardware components enhances the gameplay by providing visual feedback through LEDs and enabling interactive interactions through sensors and buttons. The user manual and technical documentation ensure that players can easily understand the game's rules, set up the hardware components correctly, and troubleshoot any issues that may arise.

Overall, this abstract highlights the key aspects of the project, including the board game's concept, the integration of hardware components, and the accompanying user manual.

1. Introduction

1.1 Background

The idea for this project stems from a passion for board games and a desire to create an innovative and interactive gaming experience. Board games have long been a popular form of entertainment, providing a social and engaging activity for friends and family to enjoy together. With the advancement of technology, there has been a growing trend of incorporating electronic components into traditional board games, enhancing the gameplay and immersing players in new ways. Overall, this project represents a fusion of traditional board gaming with modern technology, aiming to provide a fun and interactive experience for players. By leveraging hardware components and comprehensive documentation, the project seeks to deliver a high-quality board game that will captivate players and bring enjoyment to their gaming sessions.

1.2 Problem Statement

Traditional board games lack innovation and interactivity, limiting players' gaming experiences. The absence of hardware integration and comprehensive documentation hinders engagement and understanding. There is a need for a modern board game that combines traditional gameplay with interactive technology and provides clear instructions for seamless gameplay. This project addresses these issues by creating a board game that integrates hardware components to enhance the gameplay and provide visual feedback.

1.3 Significance

The development of a board game that integrates hardware components holds significant significance in enhancing the gameplay experience and bridging tradition with modernity. By combining traditional gameplay elements with interactive technology, the board game offers a captivating and immersive experience for players, fostering social interaction and inspiring creativity and problem-solving skills. Additionally, the inclusion of comprehensive user manuals and technical documentation ensures accessibility, enabling players of various skill levels to easily set up the game, understand the rules, and troubleshoot any issues. This project not only provides an innovative and entertaining activity but also promotes shared enjoyment, cognitive development, and intellectual engagement among players.

1.4 Objectives and Scope

- Design and develop a hardware-integrated board game.
- Implement engaging gameplay mechanics.
- Create a comprehensive user manual and technical documentation.
- Test and refine the game mechanics based on player feedback.
- Produce a high-quality and immersive gaming experience.
- Promote the board game effectively.

2. Constraints and Earlier Coursework

2.1 Constraints

2.1.1 Budget Limitations

The project must be developed within a specified budget to ensure cost-effectiveness and feasibility. This includes considerations for the cost of hardware components, manufacturing, and production materials.

2.1.2 Technical Compatibility:

The hardware components used in the game must be compatible and readily available within the project's scope. Compatibility with microcontrollers, sensors, LEDs, and buttons must be considered to ensure seamless integration and functionality.

2.1.3 Availability of Components:

Some hardware components may be readily available, while others may have limited stock or be subject to backorders. In some cases specific components are unavailable within the desired timeframe.

2.1.2 Lack Of Domain Knowledge

as this project involves integrating hardware components into a board game. Without a solid understanding of hardware capabilities, design limitations, technical feasibility, and user experience considerations may arise. To mitigate this constraint, thorough research, learning, and collaboration with experts in hardware integration and game design are essential. Prototyping, testing, and seeking feedback from users can also help in gaining practical experience and refining the project. By actively addressing the lack of domain knowledge, the team overcame challenges and ensured a successful implementation of the hardware-integrated board game.

2.1.3 Inexperience

As this project involved designing an app from scratch for both front-end and back-end, it presented the challenge of working in a new domain and using new technologies. This led to the discovery of many unknowns and unexpected detours during the development process. We found ourselves experimenting with different approaches and solutions, some of which ultimately proved to be ineffective.

2.1.4 Lack of Data

A significant constraint in the project is the lack of sufficient data in heuristics related to the game. Heuristics are essential for balancing gameplay, creating strategic depth, and engaging players. However, the absence of adequate data poses challenges in achieving these goals. To mitigate this constraint, extensive playtesting, feedback gathering, and iteration are crucial. Seeking expert input, analyzing existing games, and utilizing simulations can also provide valuable insights and help inform decision-making in the absence of extensive heuristic data.

2.1.5 Lack of time

Time is a crucial element in any project, and its efficient management is crucial to the success of the project. The various aspects of the project such as research, testing, development, requirement gathering, planning and the time lost due to inexperience, all require time, and these time expenditures, regardless of how small they may seem, tend to accumulate rapidly. Therefore, the management of time is an essential aspect of the project, and its efficient use is vital to the successful completion of the project.

2.2 Earlier coursework

2.2.1 Electrical Circuits

This course helped us develop the skills we needed in our ability to analyze and understand different types of circuits we worked with resistors and a lot of important components in this course which we each used in order to bring our idea into life.

2.2.2 Digital Circuit Design

A vast amount of techniques that we learned in this course were used in our project whether it's debouncing that we used in our push buttons or the ASM(algorithmic state machine) which we used in our project more than one time.

2.2.3 Wireless Communication

With our project having the need to send data from Arduino to Arduino and vice versa the wireless course helped us understand the protocols and the processes that we should do in order to establish a well and functional wireless connection between different types of hardware parts in our project.

2.2.4 Critical Thinking

This course helped learn the skills and the applications that we need in order to prepare and create the paper that you are reading at the moment and gave us a good understanding on how a professional and scientific paper should look like.

2.2.5 PIC microcontrollers

This course teaches us about the design, programming, and applications of PIC microcontrollers. It covers topics such as microcontroller architecture, programming languages, input/output interfaces, communication protocols, project development, and troubleshooting. Students gained the skills to design and program PIC microcontroller-based projects for various electronic systems and applications.

3. Literature Review

Jakaro is designed with the motive of providing a user-friendly and comfortable user experience, and of course there was games that provide similar functionality, and we list them as follows :

3.1 LUDO

"Ludo" is a strategic board game where players compete to move their colored balls from the starting position to their designated areas on the game board. Players use cards to determine their moves, with each card offering different actions and effects. The game involves decision-making, as players strategically choose cards to play based on their position and the positions of opponents' balls. The objective is to strategically advance their balls while hindering opponents' progress.

3.2 What Distinguishes Jakaro From The Previous Example?

"Ludo" and "Jakaro" are both strategic board games but have distinct differences. In "Ludo," players use cards to determine their moves and actions, while in "Jakaro," tactical placement and capturing pieces are key. The board design of "Ludo" features designated areas and spaces, while "Jakaro" employs a grid layout. Both games offer engaging strategic gameplay, but their objectives, mechanics, and dynamics set them apart, catering to different preferences and playstyles.

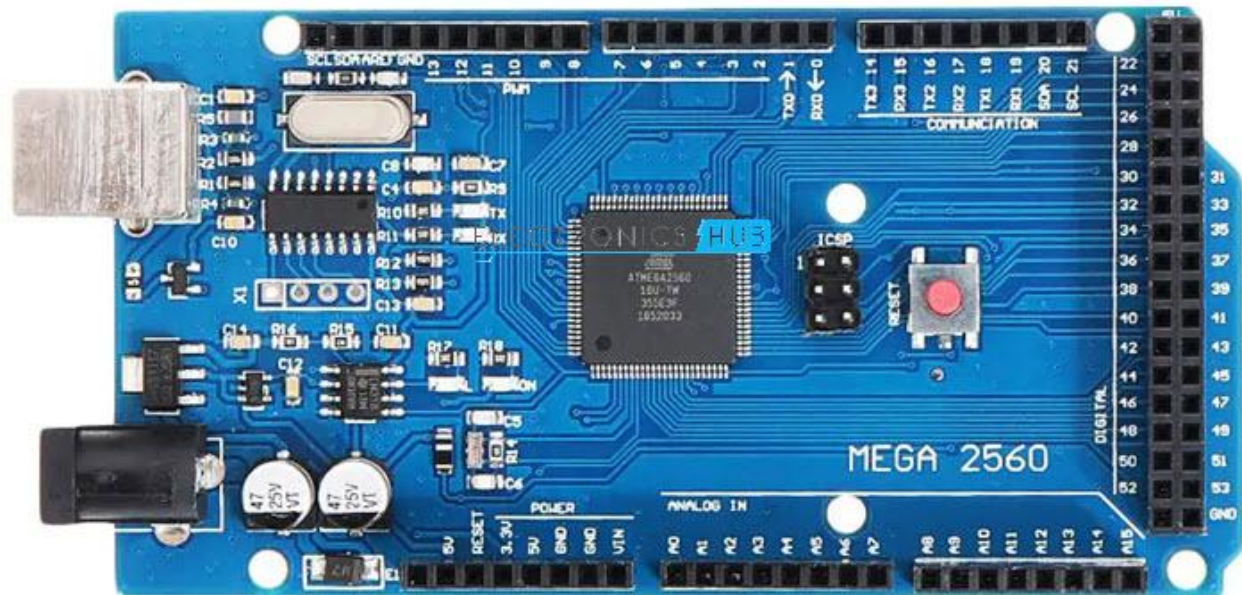
4. Methodology

The methodology employed in this project involves a systematic approach to designing and implementing the hardware-integrated board game. The following parts outline the methodology and parts used:

4.1 Equipment and Components

4.1.1 Arduino Mega

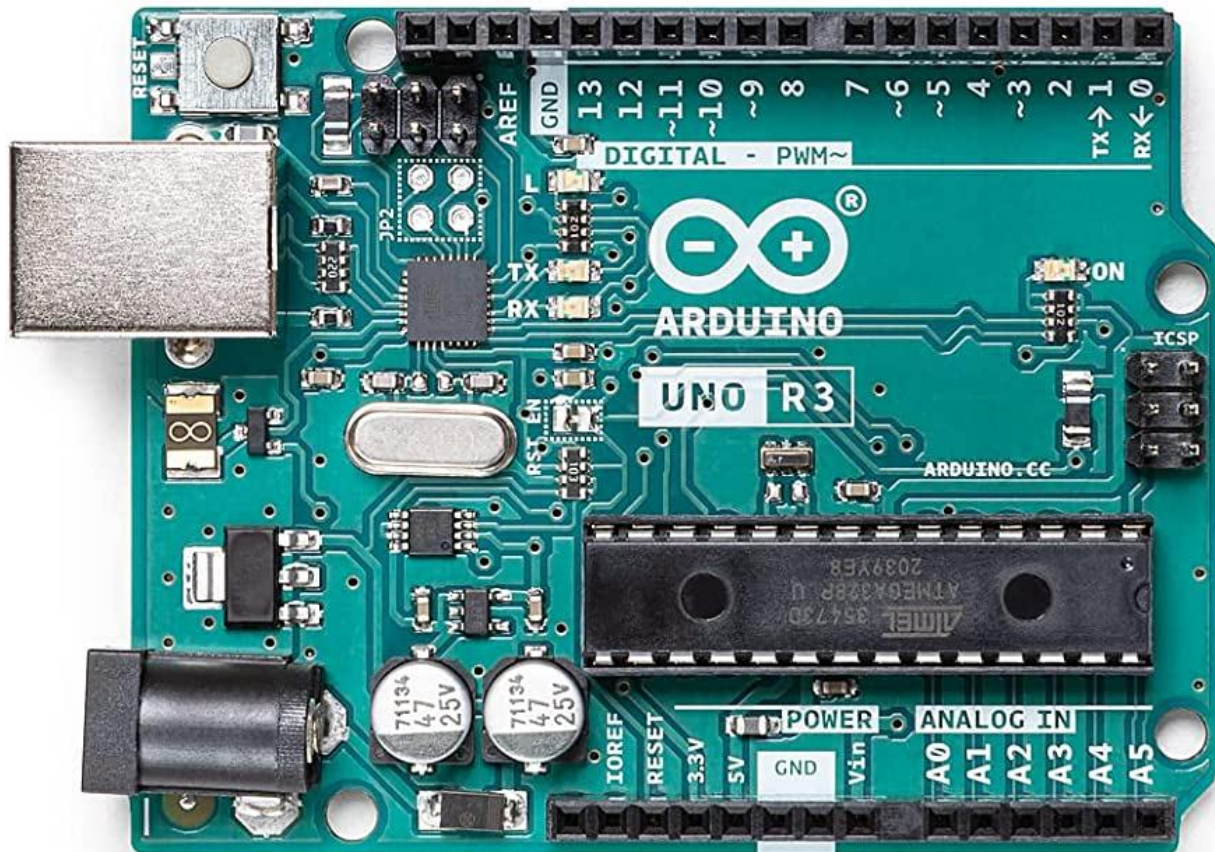
One of the most important components of our project, the Arduino is a micro-controller board based on the ATmega2560. It has 54 digital input/output pins, 16 analog inputs, 4 UARTs, It contains everything needed to support the microcontroller.



It was used in our project to connect the components together and give the game the logic it needed to play the game with others or alone.

4.1.2 Arduino Uno

The Arduino UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.



The UNO is used to move the servo motors to deal the cards for the players.

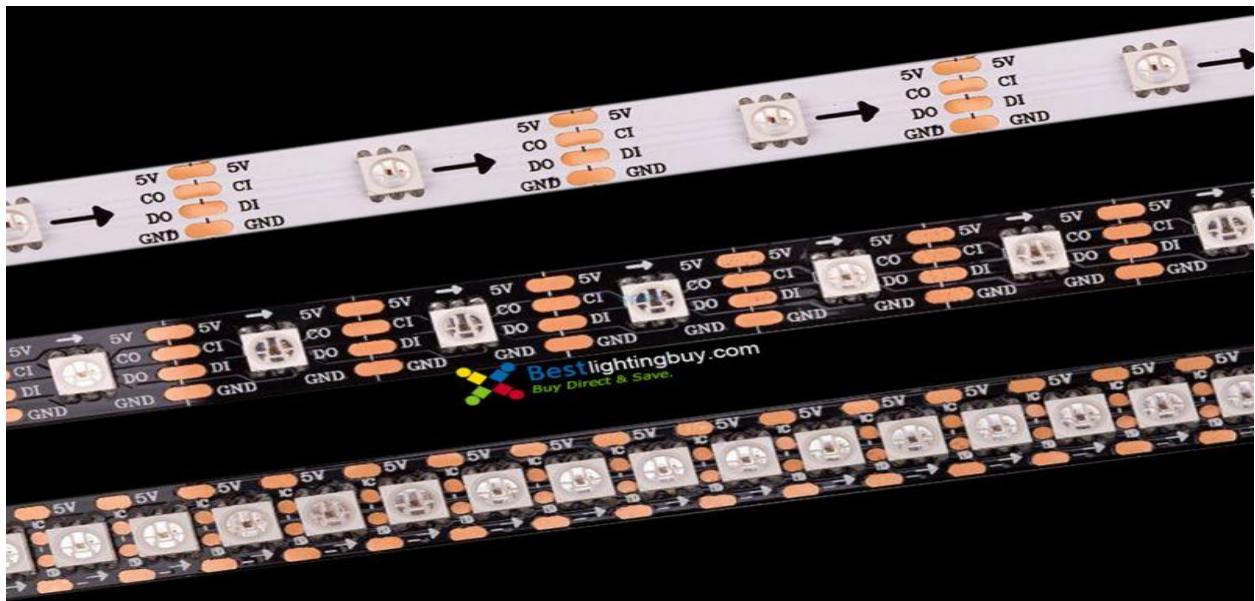
4.1.3 Power Supply S-25-5U

The S-25-5 power supply is a compact and reliable switching power supply with a 5V output and 5A maximum current. It was used in our project to supply current to the component.



4.1.4 a102 addressable LED strip

The heart of our game as it's used to represent the state of the game.



4.1.5 RFID scanner s522

The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data. We put the RFID tags on the card deck so whenever a card is put on the RFID scanner we get the value of that card.



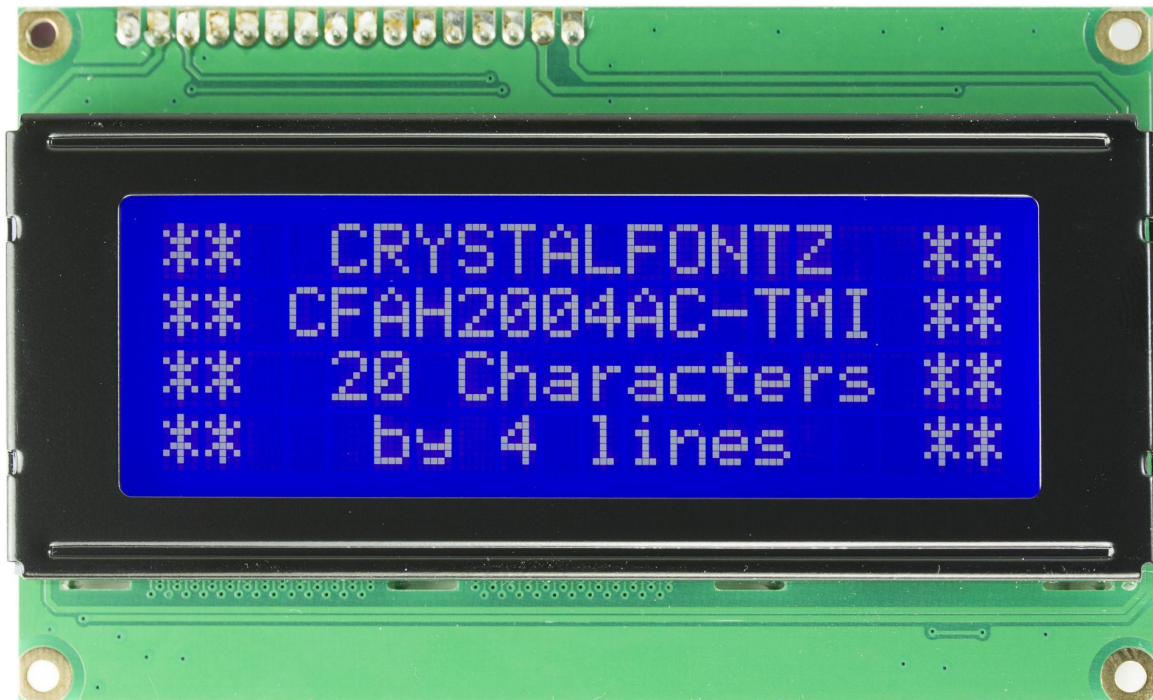
4.1.6 NFC tags

Each nfc tag represents a card in the deck so each time a card is read we get its value from the tag.



4.1.7 I2C LCD 20*4

designed for Arduino microcontrollers. It is using the I2C communication interface.



4.1.8 Push buttons



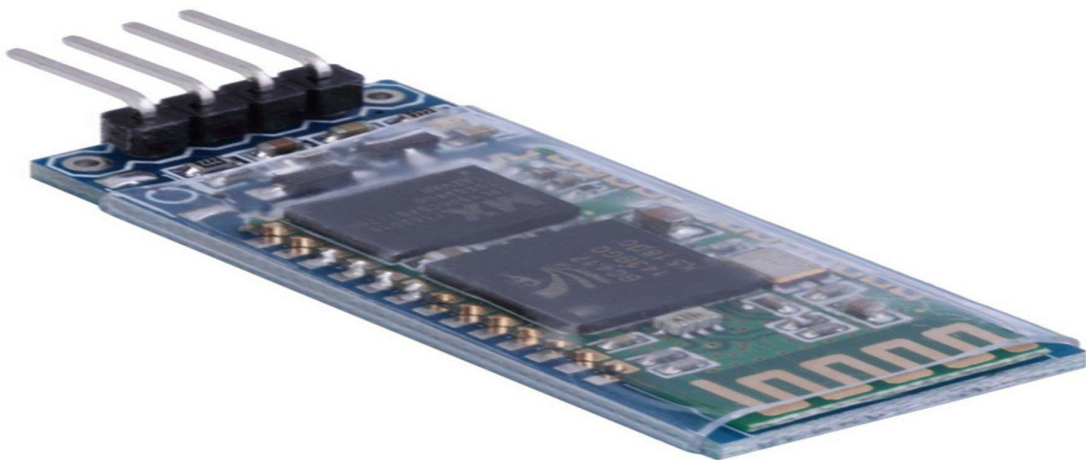
4.1.9 Servo motors

is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration.

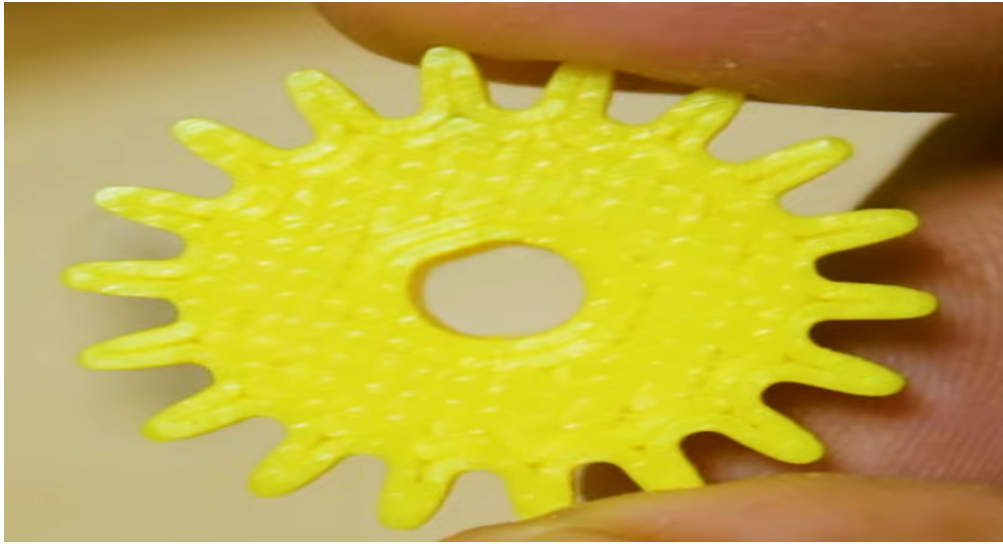


4.1.10 Bluetooth module

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration



4.1.11 3D printed gears



4.2 Components Implementation

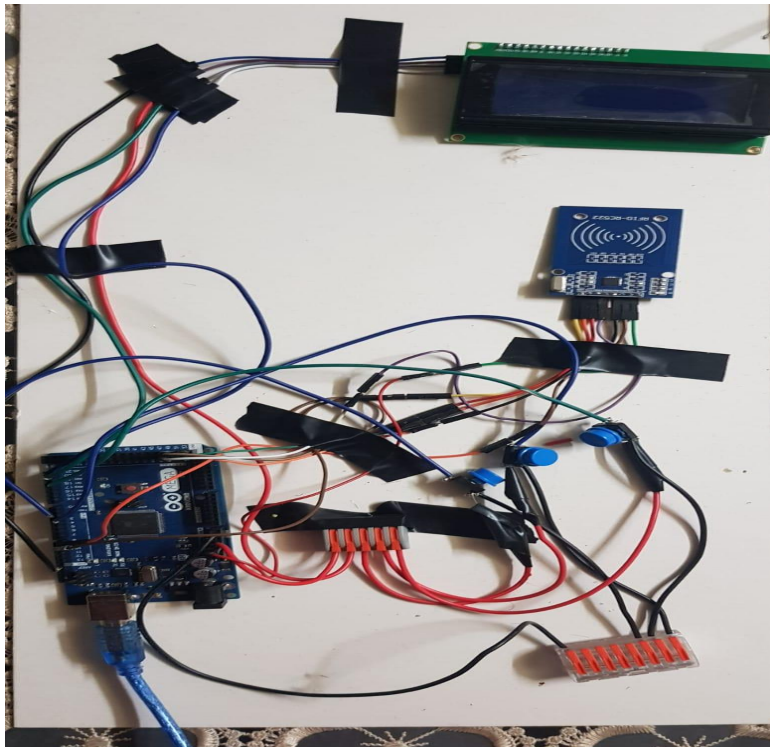
Having the components is just a fraction of the work needed now we had to test each component independently and make sure that they all work as intended which needed a lot of experience and trial and error for it to eventually work then we were able to start implementing them in our project.

4.2.1 Card trader:

One motor can be utilized for grid movement, while the other motor can be responsible for card exchange. These motors would be connected to an Arduino Uno, which would await a Bluetooth signal from the main Arduino to initiate the card trading process. This enhancement would streamline and automate the card trading mechanism, enhancing the overall gameplay experience and adding an interactive element to the game.

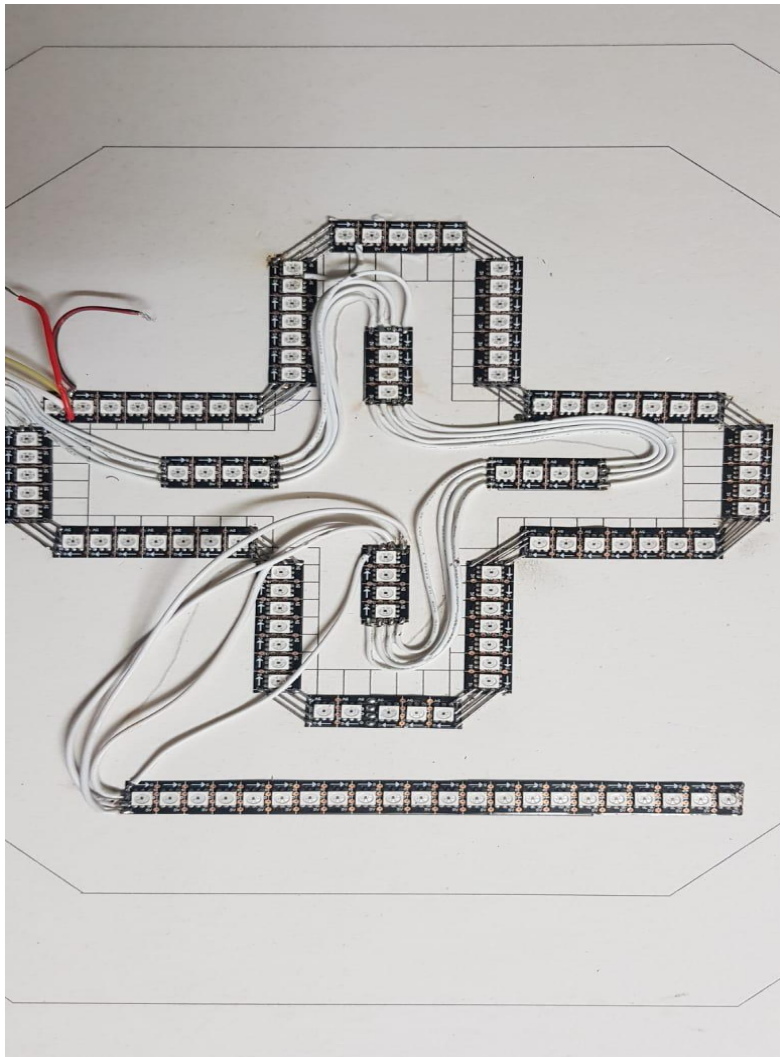
4.2.2 User input and LCD

In this part we have the Mega which is the mind of the game. We have the RFID scanner to read the cards that are played, then we have the LCD to show the state of the game and the option each user has and the push buttons to choose from these options.



4.2.3 A102 LED strip

The led strip was cut and welded to be in the shape of the Jakaro board, each LED represents a position on the board and each player has a different color to represent their marbles.



5. Results And Discussions

In the end, we can proudly state that our project offers a range of features that aim to assist players worldwide. These features include:

- Designed and developed a hardware-integrated board game that combines traditional gameplay with modern technology, incorporating components mentioned above.
- Implement engaging gameplay mechanics that offer strategic decision-making, interactive elements, and a goal-oriented experience for players.
- Test and refine the game mechanics based on player feedback, ensuring a smooth and enjoyable gameplay experience for users.

6. Conclusion & Future Work

6.1 Conclusion

In conclusion, this project has successfully developed a hardware-integrated board game that offers a captivating and immersive gameplay experience. By combining traditional gameplay elements with modern technology, the game introduces interactive features and strategic decision-making for players. The comprehensive user manual and technical documentation ensure that users can easily set up and play the game while providing troubleshooting tips. Through continuous testing and refinement, the project has produced a high-quality gaming experience, incorporating player feedback to enhance the game mechanics. Effective promotion strategies have been implemented to reach the target audience and showcase the unique features and benefits of the game. Overall, this project has accomplished its objectives, delivering a compelling board game that provides entertainment and enjoyment for players while showcasing the potential of hardware integration in gaming.

6.2 Future Work

- Expansion of Game Features: Continuously enhance and expand the game features to offer more variety and challenges for players.
- Integration of Online Multiplayer: Explore the possibility of incorporating online multiplayer functionality into the game.
- Gamification of Learning: Explore the educational potential of the game by incorporating elements that promote learning and skill development.