SENIOR DESIGN I

FALL 2023

Dr. Lei Wei

Initial Project Document — Divide and Conquer

INTERACTIVE CHESS BOARD FOR BEGINNERS

Group 6

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Project Description

Board games are a great way to spend time with friends and family. Like all new games, beginners learn how to play from a manual, or they might be lucky enough to have a player present that has played the game before and can coach them through a game. Some games rely more on luck while others depend on strategy. Chess is one of those board games that relies heavily on strategy. Professional chess players can often see 10-15 moves ahead and plan their actions accordingly when playing a match. For beginners though, they do not have that much experience to predict their opponent's moves, especially when they do not know the basics of the game yet. For chess beginners, having that extra person present to help guide them would be ideal, but that is not always possible. Our group wants to create a physical board that helps teach beginners the basic rules of chess and possibly build on it to further teach them basic chess theory.

This interactive chess board will mainly focus on teaching beginners how each piece moves around the board. When a player lifts a certain piece, the board will light up specific squares to show the player which spaces that piece can move to. To identify a particular piece, we plan to use optical sensors that will detect reflected light coming from a white light source underneath each square. The white light source will be fed through fiber optic cables that are positioned optimally to provide enough light to be reflected towards the optical sensors. The bottom of every piece will be specifically color-coded so that when the sensor reads the reflected light, it will determine which piece was selected based on the wavelength detected. Once a specific piece is picked up, the software and programming will then activate the LED array underneath the board by reading the last known value in that square. The LED array will show the player every possible square on the board that piece can move to.

To build upon these basics, we want to be able to utilize a chess engine that will know which moves are better compared to others. By programming the color of the LEDs, we plan to designate certain colors for which moves are most optimal, which moves are least, and which moves are neither. This will truly allow the players to visually see their options. Another major reason we plan to program the color of the LEDs is to teach new players how to set up the board before the game. We plan on using the same color-coded system used underneath each piece for piece identification/detection as the way to show the new players so they can learn where each piece is supposed to start in the game.

Currently there are multiple versions of this idea in the market. Some of the companies of these projects include Square Off, ChessUp, and Chess House. The prices overall range from $139 to $300. The board from Square Off is the best portability wise because the board is actually a mat that can roll up. The lights are also subtle, and the board can be paired via Bluetooth to a smartphone for a chess engine. The ChessUp board is closer to what our project wants to accomplish because it makes use of different colored lights on the board to signify which moves are better compared to others. There is also a companion app for smartphones with this board as well. The Chess House board is an interactive chess board, but it is more geared towards single players. The Chess House board has built-in levels of varying difficulty that players can play against and improve. There are not any lights on this board but instead there is a little screen that shows the opponent’s moves. The pieces can still be detected when they are picked up and placed.

There was a senior design project from summer 2018 to fall 2018 that is very similar to our project idea. In the previous senior design project, the team used a combination of switches and resistors for piece detection and identification. The reed switches would close when a piece, that has a built-in magnet, was placed directly on top of it. Each piece also had a unique resistor in it so when it was moved, the equivalent resistance would change, and the microcontroller would detect and identify that change. There were some issues with that project that we wish to improve on. Some of the main issues dealt with piece identification and detection. The reed switches that were used were not consistent and they faced challenges of getting consistent readings of which piece was moved due to noise or poor contact.

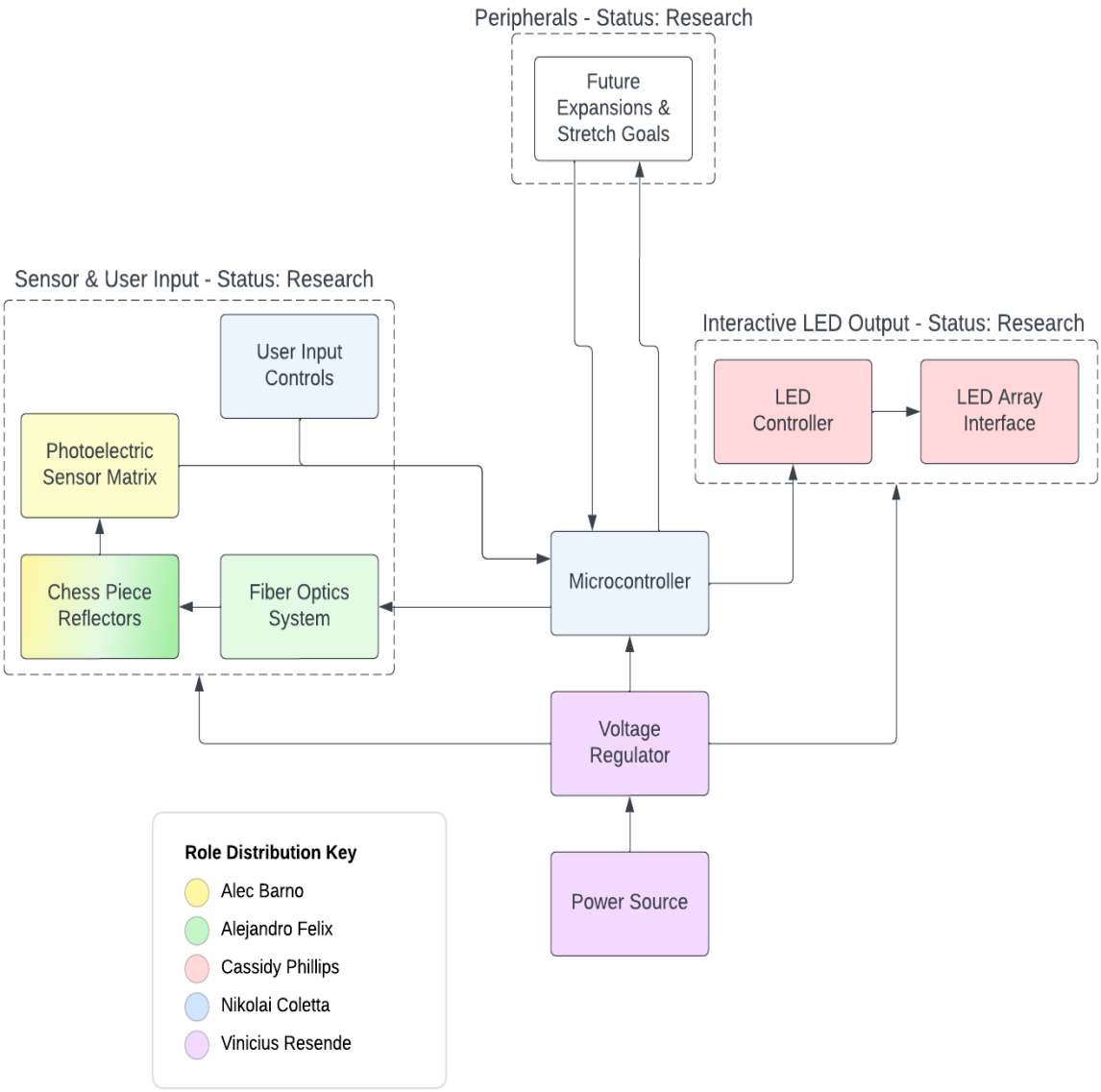
Our goal with this project is to improve upon the previous projects' issues and limitations. We believe that incorporating optics into the project will enable us to create a chess board that is more consistent when detecting and identifying pieces. Using optics will also enable faster detection of the pieces and a quicker response from the programming and software to provide the users with a smoother gameplay experience.

Engineering Specifications/Requirements

1. The chess board will have enough power for 6 hours of playing time.
2. The chess board will have a delay of no more than 5 seconds.
3. The chess board will be able to detect and identify each of the 6 different kinds of pieces.
4. The chess board will be able to have each of the 64 squares be able to light up individually and also collectively during a game.
5. The chess board will be portable and rechargeable.
6. The chess board will be able to show each and every possible move that each chess piece can make during a game.
7. The chess board will be able to show the players how to properly set up the game.
8. The chess board will have 64 fiber optic cables to provide white light evenly to each square.

As of right now, our plan is to choose specification #2, #3, and #4 as our project's demonstrable specification/requirements. We believe that these specifications are the core principles and objectives of our project.

Hardware Block Diagram



Hardware Descriptions

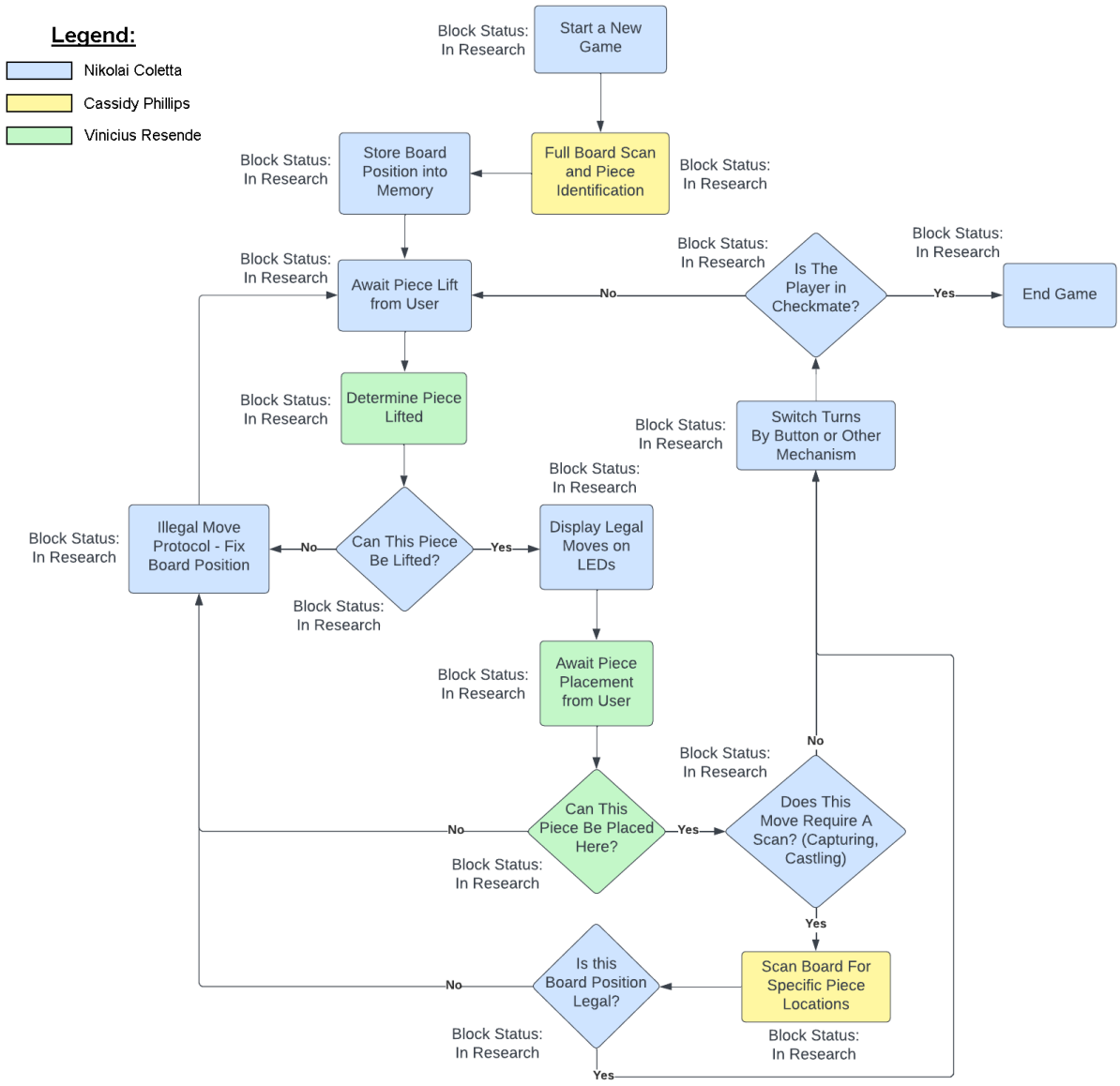
This section will provide a description and overview of the project's hardware components focusing on the core infrastructure of our design in a manner to simplify understanding of the device's working principles and streamline the design process.

With the convenience of the user(s) in mind, a rechargeable battery would be the ideal power source for this project as it allows the device to operate without being tethered to a fixed power source, such as a power outlet. Batteries provide flexibility and portability, ensuring uninterrupted operation when it would otherwise be incapable of running. Along with it, a voltage regulator will be required to keep voltage consistent and stable during the device's operation regardless of system load or battery voltage output. This will prevent damage to sensitive electrical components due to overvoltage, prevent undervoltage conditions that can lead to improper operation or data loss, and increase overall power efficiency and battery life. This component pair will work to provide power to the microcontroller, sensors, LEDs, and any other components within the circuit.

To provide the system with the information it requires to operate, a matrix of photoelectric sensors will be in place to read the wavelength of the light from the fiber optic system underneath the board that is reflected by the bottom of the chess pieces and, from there, be able to verify the position of each individual piece in play. This group, labeled "Sensor & User Input" will act as the main source of data collection for our processing functions along with any other manual input from the user interface, such as signals to start or pause the game. Meanwhile, the components listed in the "Interactive LED Output" block will serve as the main form of interaction between the user and the board. Each square in the board will be able to individually light up to communicate different things to the player(s) during the game to convey helpful information to beginners.

To connect all these together, the microcontroller serves as the central processing unit for the design. It will receive and process data from all the sensors and inputs, as well as handle any logic and decision-making in a centralized manner to optimize system performance. It will also interface with any peripherals or additional components that should be integrated in the project at a future date, that are not essential for the device's operation but provide additional functionality.

Software Flowchart



Budget Estimates

	Parts	Price per part ($)	Quantity	Cost ($)
1	LED's	$0.07-3	65	$4.55-195
2	Sensors	$0.10-3	64	$6.4-192
3	Power supply	$30-110	1	$30-110
4	PCB	$40-120	2	$80-240
5	Microcontroller	$20-40	1	$20-40
6	Chess board material	$7-25	1	$7-25
7	Chess pieces set	$2.50-60	1	$2.50-60
8	Fiber optic cable	$0.30-2	64	$19.2-128
	Total			**$169.65-990**

Milestones

Fall 2023		
Description	Time	Dates
Project ideas	3 weeks	August 21- September 8
Project Division	1 week	September 9 – September 15
Initial project documentation		September 15
Research on past projects	3 weeks	September 16 – October 7
Individual writing	4 weeks	October 8 - November 2
60-page draft		November 3
Design and Development prototyping	4 weeks	November 4 - November 26
Documentation Review and Purchasing Components	1 week	November 27- December 4
Final Documentation		December 5

Spring 2024		
Description	Time	Dates
Testing of component	1 week	January 8 - January 14
Building prototype	8 weeks	January 15 - March 10
Testing prototype	3 weeks	March 11 – March 31
Finalizing the project	2 weeks	April 1 – April 14
Final Documentation and Presentation	2 weeks	April 15 – April 28

Work Distribution Table

	Alec	Alex	Cassidy	Nikolai	Vinny
Piece Identification	Primary	Secondary		Secondary	
Fiber Optic System	Secondary	Primary			
Software			Secondary	Primary	Secondary
Microcontroller			Secondary	Primary	Secondary
Power	Secondary	Secondary			Primary
PCB Design			Primary	Secondary	Primary
LED Array	Secondary	Secondary	Primary		
System Fabrication	Primary	Secondary	Secondary	Secondary	Secondary

When deciding on work distribution for our project, one of the main goals was to aim for a majority of the group (minimum of 3 out of 5 people) to have a role in each specific task so that there are at least 2 “backup” people to help the person with the primary role in a specific task. We believe this is the best way to ensure that every task in the project will be created in the best way possible through a “majority rules” idea. Another point of clarification about our work distribution table is that for system fabrication, everyone in the group will have either a primary or secondary role for that task because everyone in the group will have input and make decisions about how our project should be built, how the design/aesthetic of the board will be and how putting together all of the components inside the board will occur.