

Initial Project Proposal

Year: 2024 **Semester:** Spring **Project Name:** Dungeon Crawler Board
Creation Date: October 10, 2023 **Last Modified:** October 10, 2023

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1.0 Description of Problem:

Since the first commercial selling of the role-playing game Dungeons & Dragons in 1974, role playing games have risen in popularity[1]. Although there can be no doubt that there remains a devout fan base, there is an entire subset of people who find the world of Dungeons & Dragons (D&D) fascinating, yet they do not participate in playing the game. Around 70% of people surveyed say they play board games at least once a week[2]. However, it is noted that at the same time a survey in 2022 reported that about 64% of people have never played a role-playing tabletop board game[3]. This non-participation was attributed to the nature of the game requiring lots of imagination and effort to keep track of battles and attributes. Thus, it can be hard to find enough people willing to play let alone have the will to go through the effort to play yourself. On the other hand, it was observed by our team that a video game, Baldur's Gate 3, released last August, has done remarkably well. Baldur's Gate takes the math and effort of imagination off the players, while still being based on D&D. The game has sold over 5.2 million copies including early access purchases with over 2.7 million copies sold in just two weeks after the official release[4]. The video game managed to let people enter and join the world of D&D who have never even considered playing the actual tabletop role-playing game on which it is based. Our team imagined that there must be some sort of in-between form that would increase the accessibility of D&D as if they were playing an easily learned board game with friends.

2.0 Proposed Solution:

Our project is a physical game board that allows a game master to customize the map, introduce obstacles, enemies, and rewards, and simulate a game for multiple players to enjoy. The rules and setup of the game will be roughly based on Dungeons and Dragons. The full end goal of this project would be to create a board that could accurately simulate the dungeon crawling experience in D&D. Our final design end goal is to implement a basic function of D&D, with limited rules, classes, and dynamics between the players and the environment. This board is not to replace D&D and similar imaginative games, but rather supplement it, though it will have its own rules so it can be played independently. The goal is to create a user-friendly take on dungeon crawlers. Using this game to simulate D&D takes away from the confusing game tracking and calculations required for regular role-playing games, allowing the player to focus on

the imaginative aspect of the game while the game board tracks everything else. The goal would be to give access to a market for people who want to get involved in D&D-style games but are not interested in the difficulty of tracking the game with an experienced dungeon master. See Appendix 1 for a sketched diagram of the proposed solution.

3.0 ECE 47700 Course Requirements Satisfaction

3.1 Expected Microcontroller Responsibilities

Our microcontroller is expected to receive the initialized map from a laptop using a USB, upload the map information to the board using an array of RGB LED strips, control and update the LEDs based on actions taken in the game, record player position with Hall effect sensors, display prompts on an OLED, receive inputs from a keypad for taking actions, and detect player tokens and movements using Hall effect sensors. A future implementation of our microcontroller's functions could include a speaker that plays custom sounds to highlight different actions in the game.

3.2 Expected Printed Circuit Responsibilities

Our PCBs are expected to incorporate our microcontroller, RGB LED strips, an OLED, a keypad, Hall effect sensors, a USB input, on board memory for storing saved or initialized maps, as well as the future possibility of custom audio files, and power and voltage regulation, specifically for dependency on an outlet for drawing power. A future implementation of our PCBs' layout could include a speaker.

4.0 Market Analysis:

To create this product, the board would need to be marketed towards regulating agencies as well. This would consist of ensuring the safety of the device. The CPSC would have a stake in the product as a regulatory agency responsible for the regulation of toys[5].

Dungeons & Dragons players are the obvious target market as the game board is inspired by D&D itself. The board we propose to create is meant to be an additive to the traditional D&D experience if the users so desire. The board will allow D&D players to see their battles in physical form to allow for strategic battle gameplay opposed to purely imaginative gameplay. The board will also allow the automation of the math required during a fight. The only input needed is the result of a dice roll (a nostalgic bit left for D&D players). From there the board will account for the attributes of each player's character and adjust the score rolled and health of fighting characters. The D&D market is steadily growing seeing a market sale jump of 33% during 2021[6]. A board such as ours could be a vital addition to a role-playing D&D experience especially given the revitalizing interest in recent years.

This board is not only targeted at those who have played D&D. The board game market size was estimated to be 18.93 billion dollars globally in 2022[7]. With an industry this large there is a large audience that we want to appeal to. The board will be designed in a manner that people with no prior experience of D&D and role-playing games can also sit down and enjoy a fun

experience fighting through dungeons. The goal is to make a D&D-like experience as easy as sitting down to play any other board game. Those who have not had the courage and perseverance to play classic D&D may find this game much easier to learn and instantly have fun with our project. This game is proposed as one where strategy is to be implemented by the players. Thus, the target audience is rated for middle school age and above. However, the dungeon crawler is also meant to be fun for older adults as well with no advised upper age limit. Given such an inclusive target audience, the product is one that will naturally be made in a product manner to appeal to retailers and board game distributors.

5.0 Competitive Analysis:

There is a large market for electronic board games and accessories for role playing games like Dungeons and Dragons. Many competitors have utilized similar ideas to ours, involving magnetic detection of game pieces, outputting information to an online interface, and updating the characteristics of game pieces during gameplay. However, none of these products use all the systems included in our design. Our design is based more on a traditional grid-style game board and includes a built-in input interface that many of these game boards do not include. We will have to work around the sensor designs the most, as Hall sensors and RFID sensors are very popular among pre-existing products. Our goal with our design is to combine the best parts of these systems into a design that is clean, affordable, and easy for new players to use.

5.1 Preliminary Patent Analysis:

There are several pre-existing patents that address the desire for an electronic game board that can detect piece movement like a traditional board game. Several of these patents also provide character customization, third party online interfaces, and game displays. These patents are detailed below.

5.1.1 Patent #1:

Patent Title: “Contactless Detection System Of The Position Of Objects On A Surface”

Patent Holder: Enrico Garofalo

Patent Filing Date: January 7th, 2020.

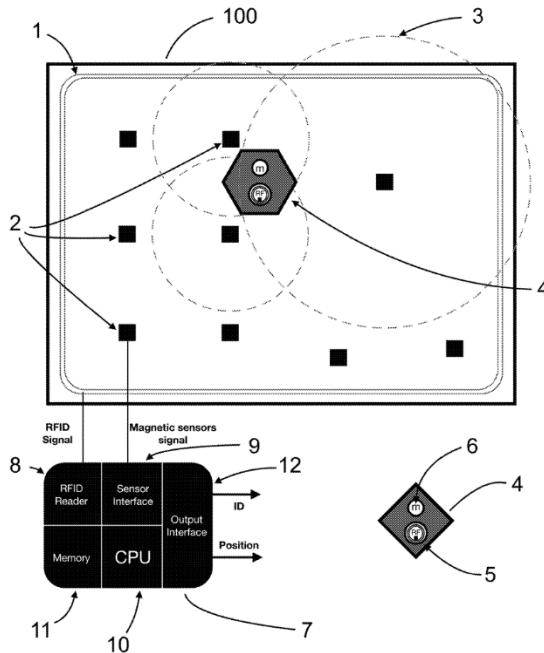


Figure 1. Contactless Detection System Diagram

This patent is one of the patents used by the commercial product Teburu, which will be discussed in section 5.2[8]. It describes a system that integrates RFID and magnetic sensing within the surface. An object with an RFID tag and magnet is placed on the surface, and an RFID antenna under the surface detects the identity of the object based on its tag. After identification, the system detects the most newly excited magnetic sensor under the board to determine the identified object's position. The control electronics in the system include the RFID antenna, an interface for acquiring the magnetic sensors' positions, a CPU to process data, a memory to store positional data, and an output interface to transmit the data to a third-party device. This approach is very similar to our magnetic sensing and data export approach, and the use of RFIDs is an interesting solution to identifying specific pieces on the board. However, this approach lacks any type of board customization that we will provide in our design.

5.1.2 Patent #2:

Patent Title: “Computerized Game Board”

Patent Holder: Pinhas Gilboa

Patent Filing Date: July 25th, 1995

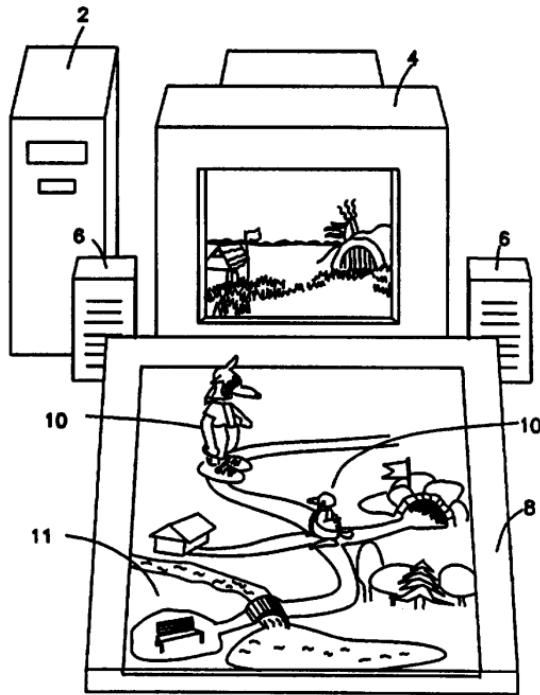


Figure 2. Computerized Game Board Diagram

This patent describes a board game system where an apparatus can discreetly detect the orientation and position of a toy figure on a game board and trigger an audio/visual response to the toy's position[9]. An excitation coil is placed under each cell of the game table, and each game piece has a transponder. The coils generate query signals received by the game pieces, then the transponders send out signals to an antenna associated with the game board. The coils are associated with rows and columns to determine the x and y positions of game pieces on the board. While this patent is nearly 20 years old, its system for position identification is unique, simple, and innovative. A downside to this system compared to Teburu's patent is the heightened complexity of the transponder signal system. An RFID system would be easier to set up and manage rather than transponders, which would increase marketability for a commercial company. This design also requires a more extensive setup for players. Our design seeks to limit unnecessary complexity by only involving the online interface at the start and end of gameplay.

5.1.3 Patent #3:

Patent Title: "Board Game with Dynamic Characteristic Tracking"

Patent Holder: Michel Martin Maharbiz, Steve Jaqua, Theodore Morichau-Beauchant

Patent Filing Date: September 7th, 2011

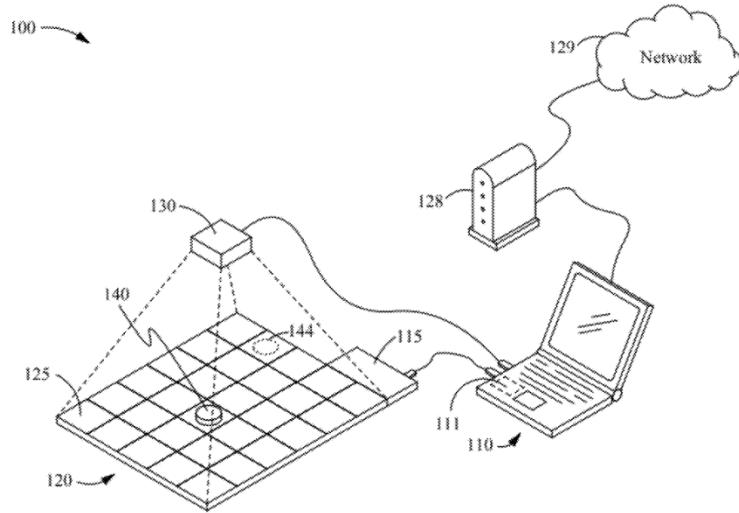


Figure 3. Dynamic Characteristic Tracking Diagram

This patent describes an electronic board game where game objects have globally unique identifiers with associated characteristics that can be altered during gameplay[10]. Individual game pieces and terrain pieces are detected by identifying sensors under the board, and a projected layout of the game is updated based on player and terrain piece positions. The history and characteristics of individual game objects are also recorded in memory to allow for saving and loading games. The player can also interact and alter virtual versions of the game pieces on an online interface. This product takes Tebaru's sensing capabilities and adds the map customization that we seek to add in our own project. The downside to this design is the added complexity of setup with the projector, rather than integrating the display into the board. However, the added map and game piece customization provided by this product gives it an edge on Tebaru and other competitors.

5.2 Commercial Product Analysis:

Several companies have already developed frameworks for combining the physical and digital world for board games. There are many game board products involving interactive electronic game boards, web interfacing, and displays already designed for Dungeons and Dragons players. However, most of these products specialize in one or two of the aforementioned features and do not offer the amount of customization and control provided by our dungeon crawler board design. In addition, a lot of these products, even those with less features and lower quality, are expensive. By the end of this project, our goal is to offer a product that combines all the best features of the market's best competitors in one condensed, affordable package.

5.2.1 Commercial Product #1:

Vonset L6 Smart Electronic Chess Board

Price: \$358.00



Figure 4. Vonset L6 Chess Board

The L6 Smart Electronic Chess Board is the latest electronic chess board made by Vonset. Vonset primarily focuses on developing chess computers and electronic chess for both leisure and for chess training[11]. The board features a magnetic chess board, magnetic chess pieces, a keypad interface, an audio system, and a lithium rechargeable battery with USB-C connection. The magnetics built into the board would allow the piece positions to be trackable, and the keypad interface would enable the player to select different game modes and different training setups for practice. In addition, the board's squares light up to highlight piece positions, potential moves, and a hint system when competing against a computer. The computer's difficulty can be altered based on training levels or the player's ELO. In comparison to our product, this board offers a

wide selection of difficulties and multiple built-in game modes, while our board requires more workload for the player. However, our board is applicable to a wider range of games and game types, allowing for more freedom of gameplay.

5.2.2 Commercial Product #2:

The Dungeon Display

Price: \$1,602.52 (\$1,713.12 with charger)



Figure 5. CraftyKobolds Dungeon Display

The Dungeon Display is a product by CraftyKobolds that is designed to display maps for role playing games on a large TV screen embedded into the board[12]. The display board features an HDMI input to connect to a computer, a plexiglass covering to protect the display, and a wooden frame for stability. Most of the functionality of this display board lies in the pre-built TV screen, in particular the HDMI inputs and the power system. The HDMI functionality is primarily to use the display board as a split screen with the connected computer. Optionally, the consumer may

purchase a version of the board that holds four USB-C charging ports for keeping player's phones or tablets charged while they access their own character sheets and info. This board offers a high-quality display, rather than a grid of LED squares, but it offers no features for player interaction with the board or its associated game. It essentially offers the same functionality as a standard game board, aside from the USB-C chargers.

5.2.3 Commercial Product #3:

Teburu

Price: \$262.93 (game and system included)



Figure 6. Teburu Game System

Teburu is a multi-patented gaming system made by Xplored that combines physical and digital systems in one board game experience[13]. The board is built with embedded RFID antennas, a main PCB board, and a layer of sensors. The game pieces each have a built-in magnet, an RFID tag, and a smart board with LEDs. The sensors in the board detect player positions based on the magnets built into each of the miniatures. The RFID antenna and tags serve to update player status, levels, and experience to each miniature, allowing players to replay the game while retaining character stats. The LEDs at the base of each figurine light up in response to player movement and player turns. The board sends info between a web interface and phone apps to keep track of game status, player stats, and player info, and to display map information to

players. We are the most interested in the magnetic sensor capabilities, as Hall sensors are our primary plan for tracking player movement. Unfortunately, Teburu's sensor system is patented, so we will need to work around this in our design. The primary difference between this board and our proposed solution is the ability for players to design and upload their own maps to the board. Our board will have a broader application to several types of role playing games, while Teburu is limited to a specific map design.

5.3 Open Source Project Analysis:

5.3.1 Open Source Project #1:



Figure 7. Electronic Chess Board

This project, while it has nothing to do with D&D, uses the same concept that we plan to use with RGB LED and Hall effect sensors. In this design, they used a custom PCB to connect an array of LEDs and Hall effect sensors to interact with magnets on the chess pieces. The input from the sensors and the output to the LEDs is processed using a teensy development board. This project also uses an LCD display which we will use to display options to the user. They communicate to the LCD using I2C, which is similar to our plan for the project. This project will provide good inspiration for us when we design and implement our game board. This could be useful and replaced with the logic of our game system to control the LEDs the way that we wish to control them[14].

5.3.2 Open Source Project #2:

Open5e is an open source API which is implemented based on the D&D 5e ruleset. This API includes information about different characters, classes, spells, combat and much more that is involved in the D&D rule system. We will likely be creating our own D&D class system using C++, but this API will provide inspiration about how to approach the implementation of the wide range of rules and customizability involved with D&D. This API includes a class system for the different categories of rule sets in D&D. Along with creating our own class system for our game board, we could supplement this by getting information from this API and then loading that onto our on-system memory while we load on custom maps. At a minimum this project will provide guidance while we create our software architecture for the D&D ruleset[15].

5.3.3 Open Source Project #3:



Figure 8. Grid Map Display

Zenva is a YouTube channel that creates open source code for projects as a way to facilitate teaching coding concepts[16]. In this video, the creator shows how to code a grid map in C++ using embedded vectors. He highlights different concepts in creating classes for different tiles, defining important traits for developing a playable game. The larger series focuses on developing a fully software-developed game, whereas our project will implement a physical game board and not require any sort of graphics libraries for creating maps or sprites. The starting code the

creator provides as well as the general concepts will help give our project a basis to start on, but we plan on going more in depth into developing the functionality of tiles and how that will define our mock D&D game board.

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Appendix 1: Concept Sketch

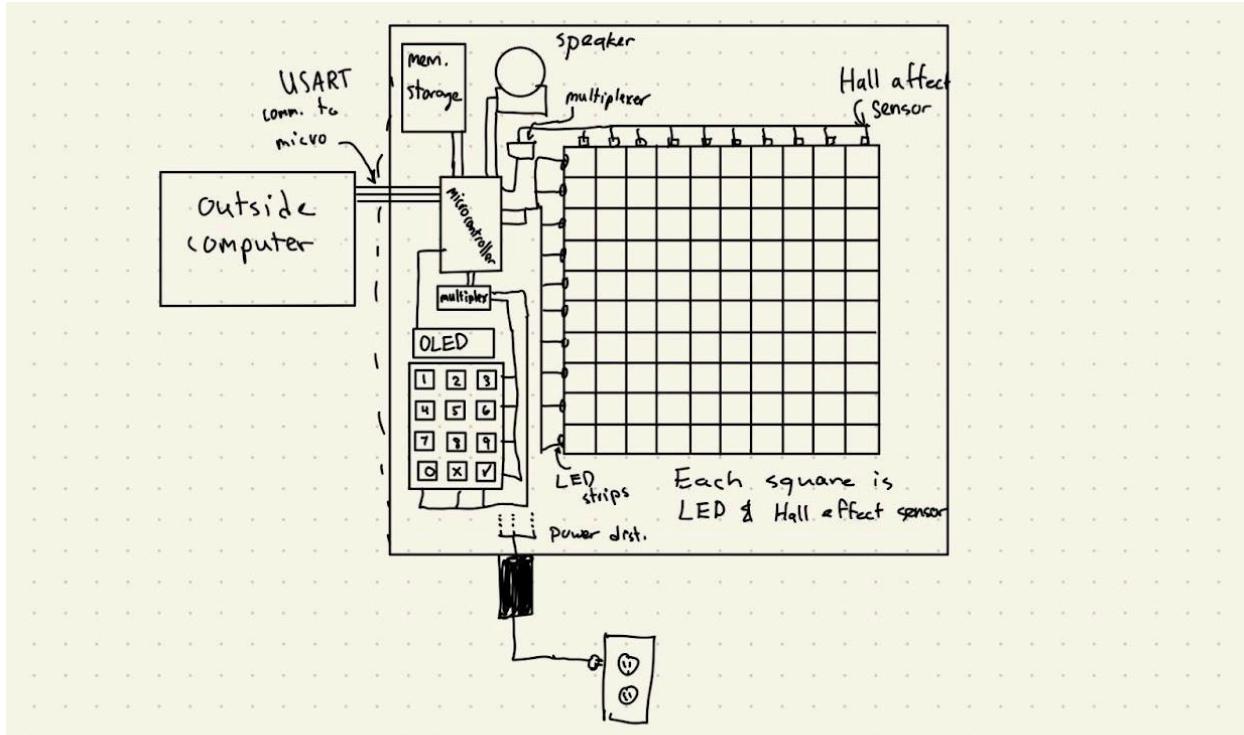


Figure 9. Initial Functional diagram containing a keypad, microcontroller, OLED display, speaker, on system memory, square or hex RGB LED display, Hall effect sensors, and everything needed to connect these. Everything included inside the black square will be connected on a grouping of custom PCBs.