Functional Specification

Year: 2020 Semester: Fall Team: 22 Project: Social Distancing Chess

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Functional Description** |  | x3 |  |  |
| **Theory of Operation** |  | x3 |  |  |
| **Expected Usage Case** |  | x3 |  |  |
| **Design Constraints** |  | x3 |  |  |
| **Writing-Specific Items** | | | | |
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| **Formatting and Citations** |  | x1 |  |  |
| **Figures and Graphs** |  | x2 |  |  |
| **Technical Writing Style** |  | x3 |  |  |
| **Total Score** |  | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

*Relevant overall comments about the paper will be included here*

1.0 Functional Description

A “Social Distancing Chess” kit enables two users with a shared interest in chess to compete with one another using two linked, physical chess boards. The boards communicate with both each other and the user, allowing seamless, real-time play to occur. The board indicates the proper board state to its user after the other user has made their move. Users are expected to move the opponents’ pieces to the correct positions before taking their own turn. This device would allow players to use a physical chessboard, providing a more concrete, traditional experience than software based remote chess systems.

2.0 Theory of Operation

One key principle behind basic operation of the device is magnetic properties inherent in magnetic fields. Each piece on the chess board will be fitted with a permanent magnet, which will be oriented with either the positive field facing down for one team, or the negative field facing down for the other. We have planned for a hall effect sensor to be placed below every space on the board so that when a piece is moved into position, the hall effect sensor will be able to check simply the direction of the field at its location in order to determine what team has moved a piece there. Using this aspect, coupled with software keeping track of these changes across the whole board, will allow the system to keep a database storing locations for each piece.

Once a move has been made, the microcontroller can format the move and send it via a Bluetooth connection or wired connection to a paired smartphone running a custom app. Bluetooth is in consideration because the two chess boards and smartphones would typically be very close together, and it would leave the smartphone available for internet communication through the app to another unit running the same system. A wired connection is in consideration because it might be simpler to set up, with less potential for confusion when a phone is inadvertently taken away from the device.

As far as communicating between the boards, the network connection can be very simple, as each message can be made very short with algebraic chess notation5. Assuming that each system already knows the orientation of all of the pieces ahead of a move, as long as it knows what piece has moved into what location, the rest of the board can remain unchanged, leading to fast and light network traffic between the two devices, keeping transmission time very low.

3.0 Expected Usage Case

The intended usage case for our product is for two stationary users to use the product to play chess with each other at independent locations. The product is not designed with portability in mind and cannot be reliably operated if not stationary. The product is intended to appeal to all ages. There are few references for the age ranges of casual chess players, but it can be safely assumed that, due to the requirement of using a mobile phone, the expected range for our product would be 13-45. This is consistent with the average range of chess grandmasters1 which, while not the intended audience of our product, has a clear overlap with the audience of our product.

4.0 Design Constraints

4.1 Computational Constraints

The Social Distancing Chess Boards will need to be able to recognize all valid moves for any chess piece according to how the board is laid out, as well as a simple two dimensional matrix of the chess board and where all the pieces are currently placed. This chess engine (rules that each piece must follow as well as rules for how pieces can get taken off the board) must be stored in non-volatile memory while the board state can be stored in very little volatile memory. The boards will need the capability to send board data to a smartphone device where our app will receive the information and send it to the other player’s smartphone app by sending information to a central, dedicated server over HTTP which in turn contacts the opponent. The information will go from the opponents app to the connected board where the previous piece positions will be compared to the new piece positions to signal the opponent to manually move the correct pieces. No part of the chess boards would require an extremely fast clock speed since the chess moves can expect to have at least a few seconds between them.

4.2 Electronics Constraints

Each chess board will have 64 Hall effect sensors detecting the presence of a magnetic field from the pieces as well as polarity. This will need to be multiplexed down to a small enough number of voltage detecting inputs to be plugged into our microcontroller using a 6 bit bus. A USB TTL Serial connection will be required to plug in a smartphone and send data between the two devices. 64 RGB LEDs will be illuminated in different colors to signal where pieces should be moved or where they can be moved to, and must be multiplexed with a 6 bit bus. Lithium ion batteries powering each of the boards will be hooked up to power the microcontroller. An external charging port will be present, which can recharge the lithium ion battery with a one cell battery charger6.

4.3 Thermal/Power Constraints

The majority of users will operate the project within their own homes. That said, since it is battery powered, it is possible that some users will take it outside for a quick game. It is assumed that, due to the “fun” nature of the project, this will occur during “fair weather,” where the temperature outside does not differ significantly from the temperature indoors. Therefore, the operating temperature of “Social Distancing Chess” is targeted to range from 50 ℉ to 110 ℉.

The board is expected to operate off of rechargeable batteries. According to FIDE rules3, a regulation chess match is expected to take a maximum of 165 minutes, so the maximum battery length is targeted to be three hours. That said, if a pair of users wants to walk away from the board and put their game on hold, they should connect the board to the charger first. The full recharge time is targeted to be 30 minutes, allowing users who do not want to keep it constantly on the charger a short break from chess action between games.

4.4 Mechanical Constraints

Mechanically, this would be best described as a large rectangular prism. Each square of the actual chess board needs to be big enough to accommodate easily differentiable pieces, as well as LED indicators. A common size for chess boards seemed to be around 1.5 feet per side4 for the square surface, and we would add around an inch of depth to accommodate for the electronics beneath the board. This device would typically be used in a stationary fashion for longer periods of time, so mobility is not a huge factor of design, but it should be light enough to move around between games. It should also be durable enough to handle normal wear and tear, but aggressive treatment would not be recommended.

4.5 Economic Constraints

The budget is approximately $400 (depending on our choice of microcontroller and batteries) for building the product. Costs could be reduced by ordering parts in bulk for large-scale assembly. We will need to allow users to communicate to our hosted service through their phones. Amazon Web Services offers a low-power server for free for one year and $10/month following the first year. Amazon Web Services also offers scalability with the option to increase the power of our server on demand. It can be anticipated that we will not require an AWS server that costs more than $20/month for the foreseeable future. A similar product, the Square Off chess board, costs $450 per single unit2. We are offering two boards for roughly the same price as their single product. However, our construction materials are less expensive. In this way, we have a pricing advantage with regards to our main competitor.

4.6 Other Constraints

No other constraints are relevant for this project.

5.0 Sources Cited:

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