Internet Connected Chessboard

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1 Introduction

1.1 Objective

Chess is a board game that is centuries old. In the modern age of computers there have been many online applications created to allow players to compete against one another despite being in different parts of the world. Looking at a computer screen for extended periods of time can cause fatigue in the eyes and mind, both of which are essential tools for any chess player.

To solve these problems, we plan to create a chessboard that maintains the ability to play opponents over long distances while eliminating the need for a computer screen to play the game. Our goal is to allow players to regain the physical interface of a chessboard to reduce strain on their eyes. To accomplish this, our board will interface with a PC to send and receive data about the current state of the game.

1.2 Background

Playing online chess is extremely easy. One only has to have an internet connection and a computer to play. Some people may not like staring at a screen, as it takes away from the experience. We want to change that by creating a smart chessboard, which takes away the computer, but still allows people to play each other remotely.

Players just beginning to learn the game of chess may find it difficult to find other players to compete against. Playing the game of chess online can look and feel quite different than when playing on a board. Allowing beginners to consistently improve their skills with the board will help them to learn the game faster because they will not need to learn about the interface that comes with an online version of the game.

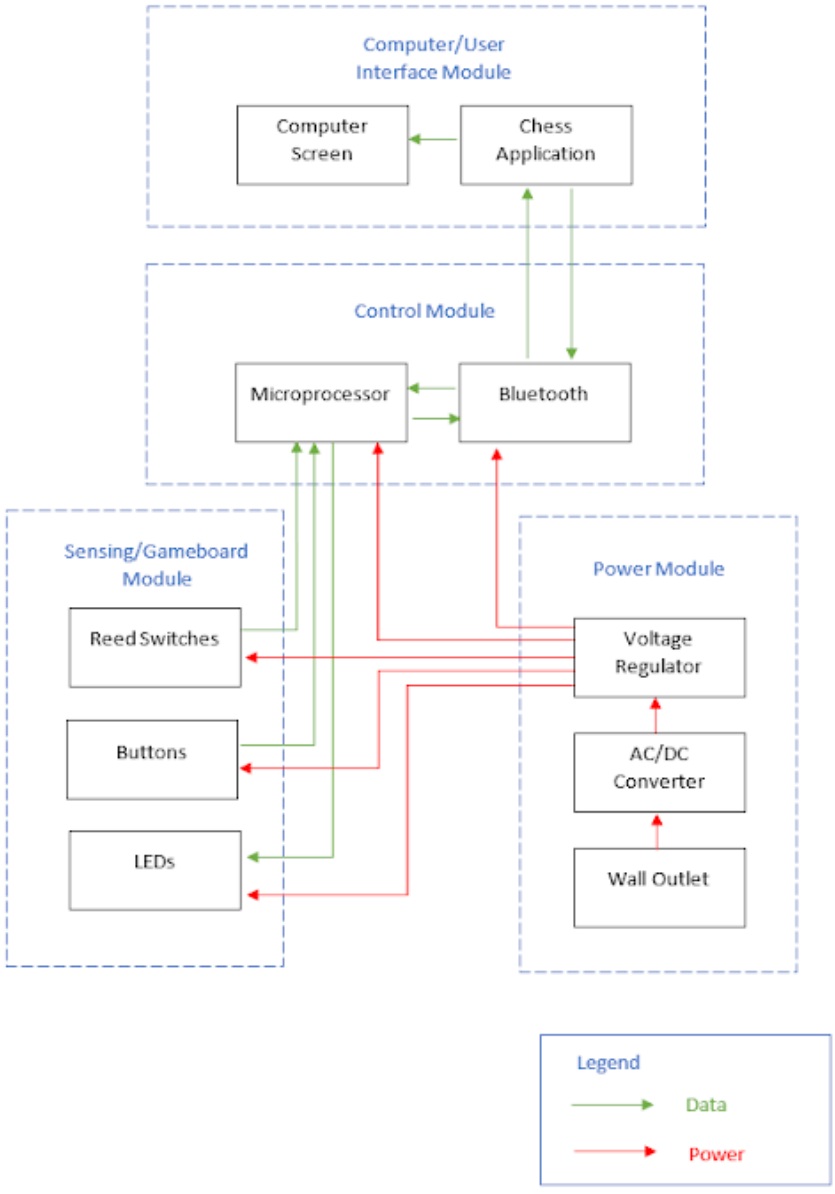
1.3 High-Level Requirements

1. The chessboard must be able to sense the location of the player's pieces and send this data to a PC with 100% accuracy.
2. The chessboard must be able to receive data from the PC about the location of the opponent's pieces and display this data on the chessboard accordingly with 100% accuracy.
3. The chessboard and pieces must maintain a similar feel to existing, high-quality chess sets.

2 Design

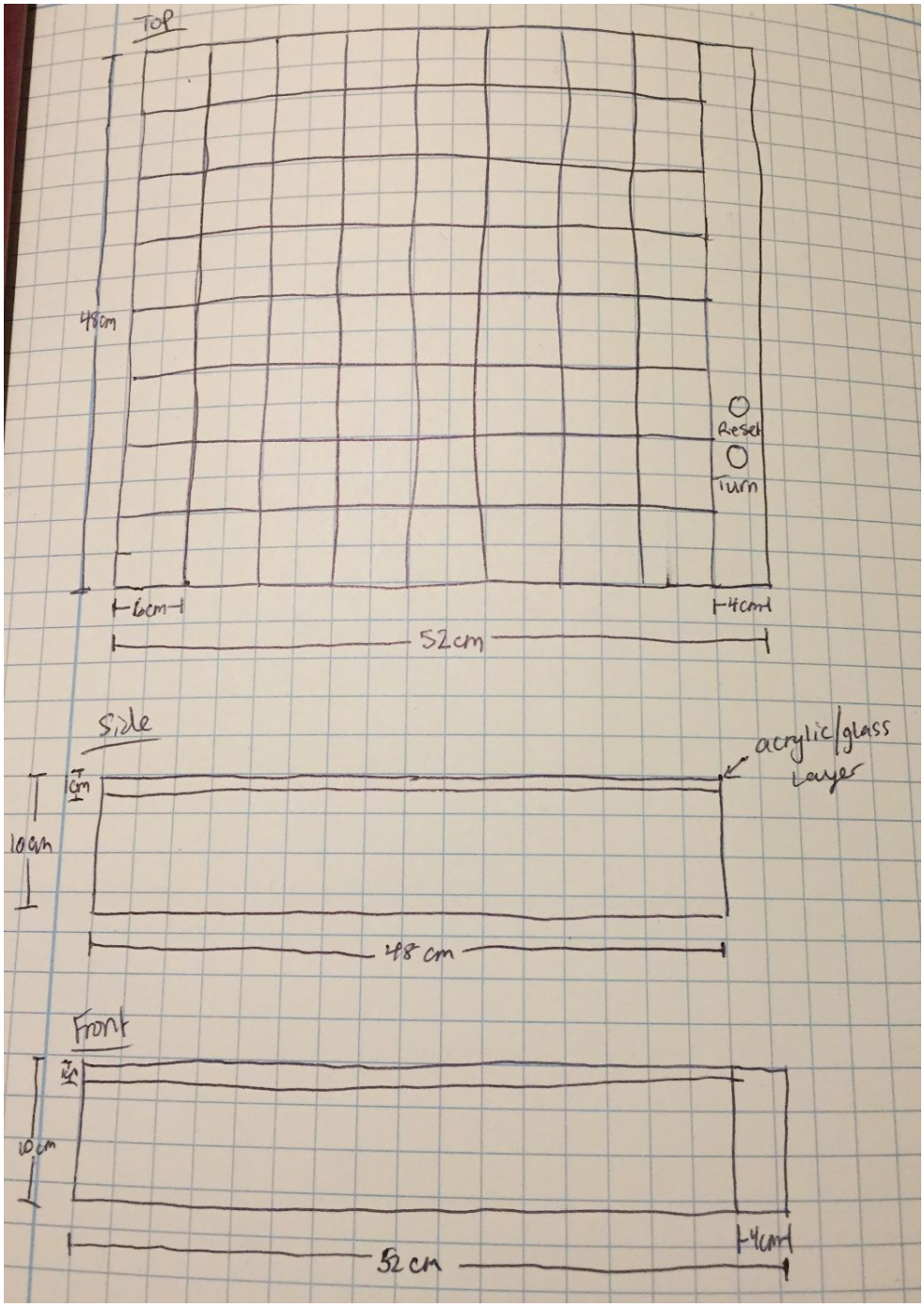
Our design will consist of 4 main modules: the power supply, the game board, the control, and the computer. The power supply is used to ensure that the entire system is powered continuously throughout a game. The game board will be the physical interface that the player interacts with. Chess pieces will be free to move on the surface as with a regular chessboard. The reed switches are used to detect a piece. If there is no piece above a spot, the reed switch will not be activated. The control module is used to process and transmit all the information from the board and send it to the PC. Similarly, the PC will send information about the game state to the control module, which will activate LEDs when necessary.

2.1 Block Diagram



2.2 Physical Design

Our physical design will mimic a professional chessboard as closely as possible. The recommended size of the base of a king is 75-85% the size of the square [1]. Assuming we make individual squares a size of 6cm, that allows for a king base size of 4.5-5.1cm. There will be two buttons to the side of the board to allow for reset and changing whose turn it is. A thin, translucent layer of acrylic will be what the chess pieces will be placed on top of. This layer allows for the LEDs to shine through while still hiding the underlying electronics.



2.3 Functional Overview

2.3.1 Control Module

- **MCU**
  The microcontroller will accomplish most of the work for our project. It will take readings in from the reed switches, convert this to locations of pieces, and send this data to the Bluetooth module. It will receive data from the Bluetooth module and translate this to lighting up certain LEDs if necessary.

- **Bluetooth**
  The Bluetooth module will handle all the communication between the PC and the gameboard. It will send/receive data to/from the MCU and send/receive data to/from the PC.

2.3.2 Sensing/Game Board Module

- **Reed Switches**
  The reed switches will be used to determine where the pieces are on the game board. When there is no piece above the space, the switch will be in an “OFF” state which means it will be sending a low voltage reading. When a piece is above a space the switch will activate to an “ON” state and send a high voltage reading.

- **Buttons**
  The buttons will be used to manually reset the game board and change the player that is moving a piece (in the case of a glitch where a player’s turn is skipped).

- **LEDs**
  The LEDs will be used to help indicate where the opponent has moved his piece and indicate if an illegal move has been made by the player.

2.3.3 Power Module

- **Voltage Regulator**
  The voltage regulator will be used to convert the DC voltage to the appropriate voltage needed by the rest of the components. It will also contain an isolating circuit to prevent any power surges from damaging components on the gameboard.

- **AC/DC Converter**
  The AC/DC converter will be used to convert the wall outlet voltage (50-60 Hz AC) to a DC voltage that can be used by our system.

- **Battery Charger**
  The wall outlet will be used to provide power to the components of our system.

2.3.4 Computer/User Interface Module

- **Chess Application**
  This application will process the data it receives from the bluetooth controller, it will send data to a cloud, so that the opponent will receive the move registered on the smart chess board.

- **Computer screen**
  The screen will display the chess board in a digital format. It will receive information on what the opponent has done. Tentatively, we want to connect the smart chessboard to another smart chess board, but due to the costs involved we believe we will have to stick with displaying information to a computer screen.

2.4 Block Requirements

2.4.1 Control Module

- **MCU**
  1. 128 KB of flash memory
  2. UART interface to connect to Bluetooth module
  3. I2C interface to connect to reed switches
  4. 3.3V operating mode

- **Bluetooth**
  1. UART interface
  2. 3.3V operating mode
  3. Connection range of at least 15m
  4. Bluetooth version 4.0 – BLE capable

2.4.2 Sensing/Game Board Module

- **Reed Switches**
  1. Switch from the effects of a magnet from <10 cm away
  2. Allow for switching based on polarity of magnet
  3. Must be small enough to fit within a 4.5 x 4.5 cm square

- **Buttons**
  1. Pressable buttons
  2. Responsive

- **LEDs**
  1. 10-20 mA current pull
  2. Individually addressable RGB channels
  3. Bright enough to show through opaque acrylic

2.4.3 Power Module

- **Voltage Regulator**
    1. Regulates input voltage of converter to 3.3V ± 5%
    2. >75% efficiency

- **AC/DC Converter**
    1. Convert 120V 60Hz AC signal to 5V ± 5% DC signal
    2. Safety circuit in the case of power surge

- **Wall Outlet**
    1. 120V 60Hz AC signal (standard wall outlet in the U.S.)

2.4.4 Computer/User Interface Module

- **Chess Application**
    1. Save the current game state
    2. Send game state to Bluetooth module
    3. Receive updates about game state from Bluetooth module

- **Computer screen**
    1. Display game state

2.5 Risk Analysis

The control module poses the greatest risk to successful completion of this project. One of the main goals of the project is to gain successful communication between the gameboard and PC so that the player can compete against others from across the world. The control module must be able to take the readings from the sensors and transmit this data to the PC and vice versa to successfully accomplish this goal. The Bluetooth communication between the gameboard and PC does not need to be instantaneous, but it needs to be fast enough to allow a player to make moves as quickly as they wish.

Another concern with the control module is how the MCU will determine which player is making a move. If the player on the board attempts to make two moves in a row, the control module must warn the player and freeze the state of the game until it is returned to the appropriate condition. Similarly, the MCU must determine if the opponent's pieces are in the correct location on the board before allowing the player to move.

To facilitate robust communication between the gameboard and PC, a firm handshake between the software on the PC and the hardware of our game board must be established.

3. Ethics and Safety

Our smart chess board is limited by its sensors on board, and its interface with the internet. As a result, there is not much room for misuse. One minor problem which could arise through intentional misuse if our project were to go out into the industry would be manipulation of the game state. A player could potentially make illegal moves through manipulation of software. This would violate ACM's code of ethics section 1.3 "Be honest and trustworthy" [2].

We aim to adhere as much to ACM’s code of ethics especially 1.2 “Avoid harm to others”, so the device is made very safe, there are no sharp edges, dangers of fire hazards or any other major harmful side to the project [2].

Sources

[1] “Chess Size Guide,” The Regency Chess Company [Online]. Available: https://www.regencychess.co.uk/size_guide.html. [Accessed Feb. 7, 2019].

[2] Acm.org. (2016). *ACM Code of Ethics and Professional Conduct*. [Online] Available at: http://www.acm.org/about-acm/acm-code-of-ethics-and-professional-conduct [Accessed Feb. 6, 2019].