DEC13-10: Design Document

DEC13-10

Matt Dresser
Jordan Jacobson
Riley Swindell
Allison Thongvanh
Blake Vermeer

Client

Joseph Zambreno

Table of Contents

Introduction

Project Summary

The purpose of this project is to have chessboard that can play against a person autonomously. A microcontroller interacts with the engineered chess surface and individual pieces, detecting human movements, moving the computer AI's pieces at the appropriate time, and determining capture and end-game conditions. A configuration application will allow capture and broadcast individual games and allow the board to be remotely reset.

System Overview

Functional Requirements

After discussion with our client, the following items are this projects functional requirements:

- Piece movement system must be unobservable by players and passer-bys.
- Base must contain piece movement system such that the system can be revealed.
- Piece movement system must move fluidly, quickly and quietly.
- User interface must allow players to choose AI skill level.
- User interface must allow players to save and reset games.
- User interface must allow players to undo moves.

Non-Functional Requirements

After discussion with our client, the following items are this projects non-functional requirements:

- Base and pieces must not be overly large.
- User interface must be comparable to computer/game console chess games
- Pieces controlled by AI and piece movement system must move seemingly magically.

Schematics/Architectures

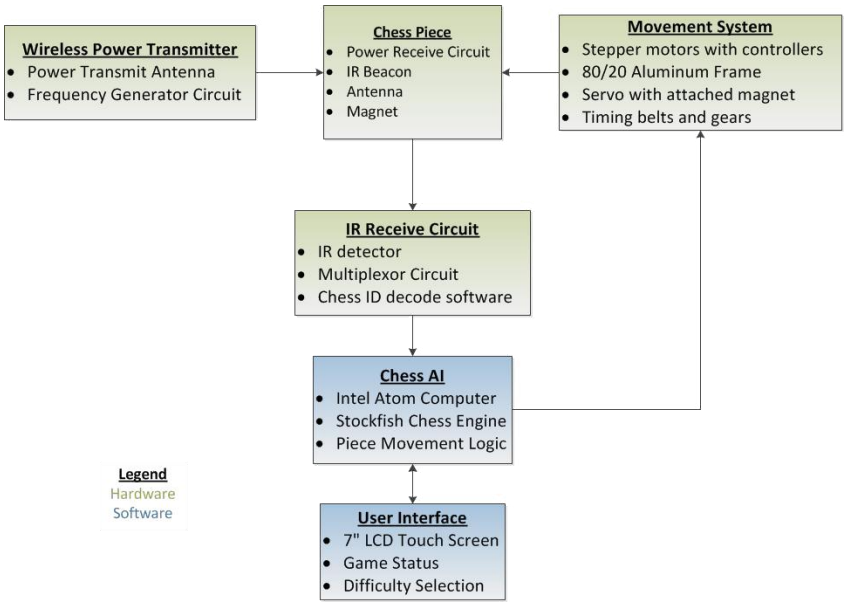

Fig. 1 Flowchart of full systems' interactions

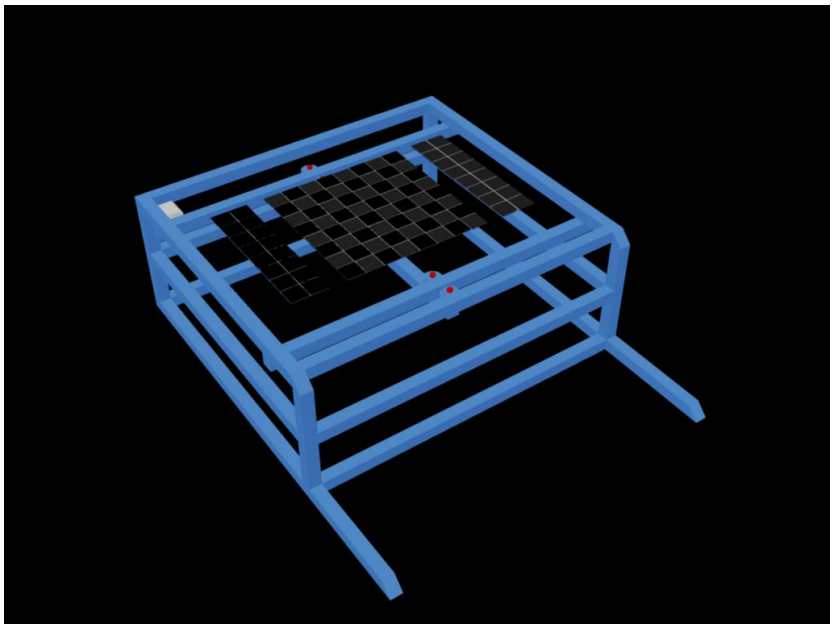

Fig. 2 AutoCAD rendering of movement system design

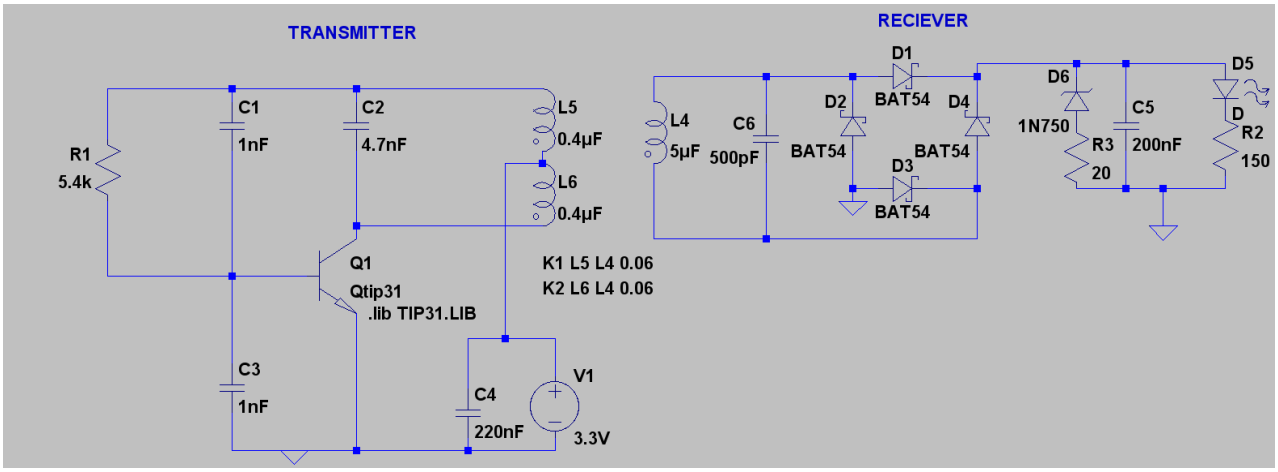

Fig. 3 Power transfer circuit schematic

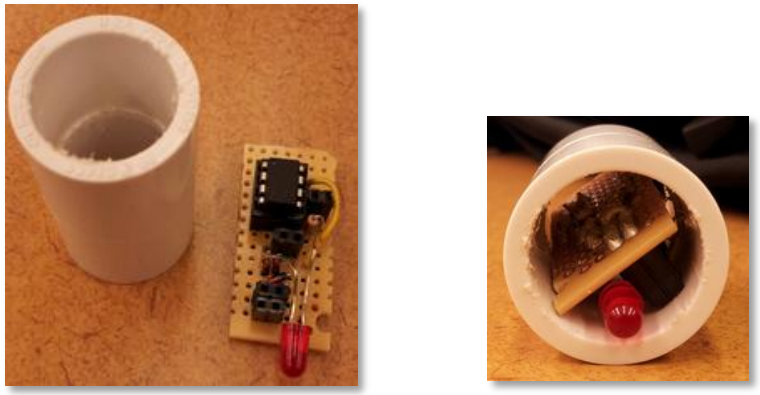

Fig. 4 Receiver Circuit Prototype

Design Details

Note- All temperatures are in Fahrenheit

User Interface

After discussion with our client, the following items are this projects user interface requirements:

- Ability to display a 2D chess board that represents the physical boards current state
- Display menus to allow user to choose difficulty level
- Have ability to give the user an interface to interact with the chess AI and board

Based on the requirements given we have designed our interface to be displayed on a 7" LCD touch screen. On an Atom board running Windows 7, we have an interface on which observers of the touch screen start a game, choose an opponent difficulty level, end a game, save a game, review moves, and view the current state of the board (as indicated in the figures below).

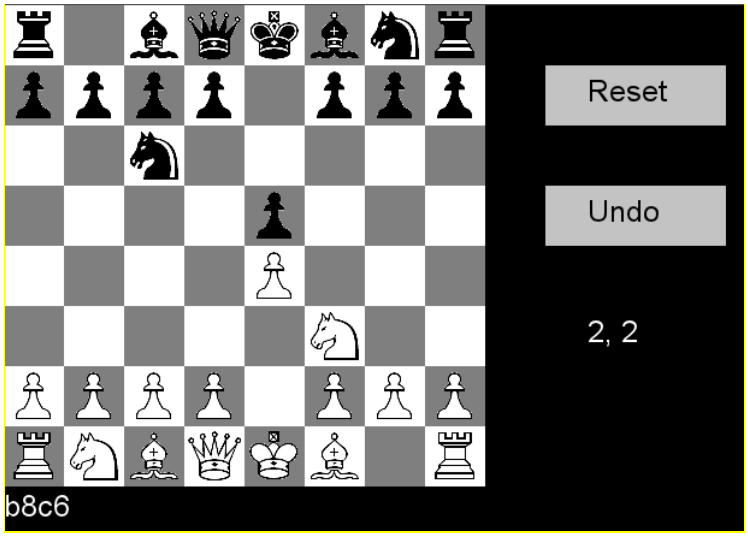

Fig. 5 User Interface Prototype

Fig. 6 User Interface Start Screen Prototype

I/O Specifications

- Chess Piece Identification
  - Pieces transmit their ID by pulsing infrared LEDs at a certain frequency
  - Piece identification circuit will output ~5V if piece is detected, 0V if not.
  - Maximum receiving circuit input voltage – ~5V @ 70°
  - Typical receiving circuit input voltage - ~3.3V @ 70°
  - Minimum receiving circuit input voltage – TBD @ 70°
  - Current draw – TBD @ 70°
- Universal Chess Interface
  - Communication protocol that enables the chess AI to interface with the board
- Universal Serial Bus (USB)
- UART
- Wi-Fi

Hardware Specifications

- Chess Piece Circuit
  - Maximum input voltage – ~5V @ 70°
  - Typical input voltage - ~3.3V @ 70°
  - Minimum input voltage – ~1.3V @ 70°
  - Current draw – TBD @70°

- Transmitter Coil Circuit
  - Typical input voltage - ~9V @ 70°
  - Maximum input voltage – TBD @ 70°
  - Minimum input voltage – TBD@ 70°
  - Diameter of Coil - ~1.87”in
  - Inductance - ~0.744µH
  - Resistance - TBD @ 70°
  - Capacitance - ~TBD

- Receiver Coil Specifications
  - Diameter of Coil - ~.75”in
  - Inductance - ~55.7µH
  - Resistance – TBD @ 70°
  - Capacitance – TBD
  - 50 turn coil

Software Specifications

After discussion with our client, the following items are this projects software specifications:

- Use universal chess interface as our protocol of choice when interacting with the board and chess AI
- Communicate over USB to interface with microcontroller
- Ability to interface with Wi-Fi
- Determine current state of the chessboard (piece location & possible moves)
- Push chessboard information to user interface to be displayed
- Take menu data from user interface and push it to the computer for processing

Implementation Challenges

Inductive Power Transfer

The amount of power transferred is highly dependent on the load resistance. We are using a microcontroller to blink an IR LED on the chess pieces. When the LED is on, the load resistance is decreased, which lower the voltage over the load. When the LED is turned back off, the voltage across the load is increased again. This was causing problems with the operation of our microcontroller and causing voltage spikes. To overcome this challenge we connected a dummy load to another pin of the microcontroller and alternating between switching on the LED and switching on the load. This keeps the load impedance consistent which in turn keeps the voltage across the load constant.

Transmitting Coil Design

To make a high quality inductor, the wire has to be a fairly low gauge and wound in a long spiral. This causes the inductor to physically take up a lot of space. The space where we need to fit the transmitter coil is fairly space constrained. Therefore, our inductor design will create a lower quality coil. This challenge can be overcome by creating a more efficient transmitting circuit and tuning the receiving circuit to resonate at the frequency at which the transmitting circuit is operating at. This will increase the overall efficiency of the power transmission and compensate for the lower quality of the transmitter inductor.

Movement Speed

A major functional requirement given was that the piece movement system must move fluidly, quickly and quietly. The mechanical base design must be built such that the movement system can move a piece diagonally across the board in 4 to 5 seconds. Due to this requirement, the base design has undergone many changes. The first design used stepper motors to rotate threaded rods (like a screw driver to a screw) to move a platform in the X direction. After finding that the threaded rod system was too slow due to the pitch of the rods, the second design used Acme rods—similar to threaded rods but inherently designed for CNC machines. However these rods were made more for precision than the speed desired. Currently the design features an 80/20 aluminum frame, with timing belts in place of rods. These timing belts allow the movement system to move a piece faster than the previous screw-based designs.

Risks

There are a few risks associated with this project. One of these risks is that the magnetic fields generated by the inductive power transmission circuit will interfere with the capacitive touch screen. This could cause the chess board to operate sporadically and not properly respond to user input. To mitigate this risk we can mount the screen in a metal enclosure to help shield it from magnetic interference.

Project Details

Standards

For this project we are following the guidelines of several different standards.

- IEEE 802.11g/n standard for WIFI communication with other computers and routers to connect to the Internet.
- IEEE 1801-2009 standard for labeling the power components of the circuits.

Expected Deliverables

After discussion with our client, the following deliverables were decided on with the following features:

- An automated chess board
    - Touch-screen user interface for configure and monitoring the game.
    - Enclosure that will have removable side to reveal the inner workings of the chess board.
    - Near silent operation.
    - Aesthetically pleasing.

Cost

The costs of the project so far are as follows:

Item	**Cost**
Intel DN2800MT Motherboard	$98
Elo 7” Touch Screen	$250
4GB DDR3 RAM	$30
32GB SSD	$40
65W Power Adapter	$45
Wood and Hardware material	$50
2 Stepper Motors	$40
1 Servo	$15
Total:	**$568**