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Luminous Chessboard

ECE445 – SENIOR DESIGN PROPOSAL

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Introduction

Title

Chess is a popular board game with a long history for which the chessboard and pieces are usually made of wood or plastics. These years with the fast development of the techniques of mobile computer, chess is often played on a touch screen without real chessman pieces. However, we believe the feeling of moving a tangible chessman piece is irreplaceable. So that we are willing to make efforts to combine the benefits of the two by designing a chessboard computer with real board and pieces which can “see” what is happening and can give computed feedback.

There also is a positive expectation of the market because according to our research, none of the existing chess computer actually is able to recognize the pieces. Most of them achieve this function by memorizing the pieces’ starting positions and tracing them. This process is very likely to be interrupted by a manual mistake.

Objective

Goal

The goal of our project is to design an electronic chessboard that can recognize chessman pieces and is equipped with a lighting system showing potential moves with an AI algorithm.

Functions

Once a piece is picked up, the chessboard should light up the available positions it can go, and indicate good moves and bad moves with different colors of LEDs, and afterwards detect the move the player conducts. The AI algorithm will be simple and be able to look one or two steps ahead.

Benefits

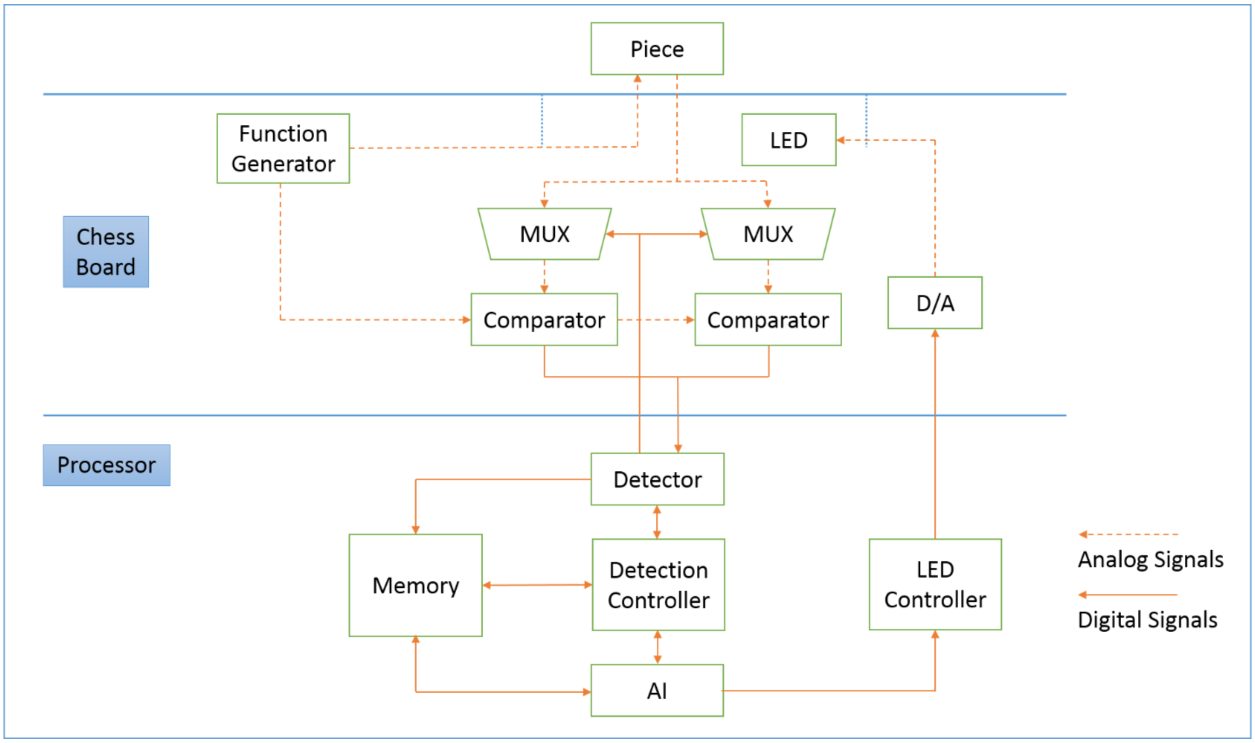
- Direct instructions for rookies
- Extra fun

Features

- ❖ Recognize pieces
- ❖ Warnings for bad moves.
- ❖ Glowing.

Block Diagram

The chessboard are made up of 3 parts, the chessman pieces, the chessboard, and the processor installed inside the board.



Chessman Piece

A chessman piece has a 4-pin socket inside it so that it can be plugged onto the board squares. Inside the chessman, we build a circuit which may consist of wires and diodes that can transfer the input pulses waves to the output port to be detected. Different circuits indicate different types of piece. These pieces act as “black boxes” for the board to recognize.

Board

Function Generator

It will output a pulse signal and an inverse pulse signal to the ports on each square on the chessboard. The signals are also used as a reference for the comparators.

LED

One of the main feature of the chessboard is to indicate good and bad moves with lighting system. The feature may be implemented by installing 64 LEDs under the squares of the chessboard. Every LED consists of two diodes and can give off three colors of light. These LEDs are controlled with 128 binary bits.

D/A

This is a circuit that uses transistors to control the currents to make sure the LEDs are working well. Binary signals which are high or low voltages are connected to the base of transistors.

MUX

MUXs are used to select the chessman piece output waves which come from the square location that the Detector is trying to recognize. The select bits are provided from the Detector.

Comparator

In the comparators, the received output waves are compared with the original pulse wave. With the comparison of 2 to 4 cycles, the Detector is able to tell if the output wave is the original pulse, or an inverse one, or always low/high.

Processor

Detector

The Detector is scanning the 64 squares. By obtaining and reading the output waves from the squares, it can recognize the connections in the pieces thus can tell what they are.

Detection Control

This detection controller receives information from AI and look specific positions to recognize a “move” or an “undo” and so on. Once a move is recognized, it gives that information to AI as a feedback. The Detection Control is also in charge of controlling the scanning of the Detector.

AI

The AI algorithm is a program that will look one or two steps ahead to predict good and bad moves.

LEC Control

This block translates the “good move” and “bad move” information from AI into binary bits, namely, it outputs the 128 bits that control the currents into the LEDs.

Memory

We will use a built-in memory of the processor to store the chessman pieces numbers which hopefully are four bits each, corresponding with the LED control bits and their address bits. Also the programs are stored in and ran with this memory.

Requirements and Verification

Requirements:

- LEDs response in least 1 sec.
- LEDs need to light up at the right places.
- The chessboard won't have heating problems for least 4 hours.
- The processor can consistently sensing the situation on the chessboard.

Verifications

Chessman Piece

The 4-pin socket inside the piece need to be well connected in 12 different ways in order to differentiate the kinds. Therefore, the diodes need to be tested if they are working properly. We will connect diodes in both directions and test the current.

Function Generator

The function generator needs to consistently generate signal. We will connect the signal generator to the oscilloscope and check if correct signal is transferring. Then we will connect the function generator with the circuit on the 4-pin socket and test if different piece has different signal.

LED

The current through LEDS need to be small enough so that LEDs won't burn. We will connect LEDs with transistors and measure the current.

MUX

MUXs are used to select the chessman piece output waves which come from the square location that the Detector is trying to recognize. Therefore, we will plug it on the bread board and keep switching the selection bits and test if the MUX responses fast and accurate.

Comparator

Comparator is the part we use to recognize piece by comparing received signal with origin signal from the function generator. We will connect comparator with signal generator on the bread board and test if it can work properly, and we will test the result with all 12 piece circuits.

Processor

For processor part, we will debug the program on the computer. But the main test cannot be performed until the PCB board is finished. All we can do before installed on the PCB board is to enter all possible inputs from chessboard and see if the program gives the correct output.

Memory

Memory is the part we store the information about the chess rules. We will randomly write something into it and check if we can read it when a specific input is sent into processor.

Tolerance Analysis

The most important part in our project is the LED. In order to make our project work, it has to correctly receive the signals from the processor all the time. Also, LED circuit needs to reduce the current down to the safe working level of LEDs. We will use transistors for each LED, and calculate the desired parameters of transistors. After calculating, we will use bread board to test how well LEDs perform under 10V voltage supply.

Cost and Schedule

Cost

Labor

Members	Payment/hour	Working hours	#weeks	Total (2.5)
Qianliang Liu	$30	12/week	10	$9000
Ke Ma	$30	12/week	10	$9000

Parts

Name	Price	Quantity	Cost
4-pin dip socket	$0.2	128	$25.6
Multi-color RGB LED	$1.59	64	$18.5
PIC18F14K50 microcontroller	$1.53	8	$12.24
PCB	0		
Miscellaneous (resistor, capacitors, mux, wire, diode)	$30		$30

Total cost

$18085.34

Schedule:

Week	Assignment	Member
2/11	Researching on parts	Ke Ma
	Circuit layout design	Qianliang Liu
	Mock design review	All
2/18	Sign up for Design review	All
	PCB design	All
2/25	Calculating parameters for the LED circuit	Qianliang Liu
	Testing LED circuit on bread board	Ke Ma

	Other parts testing	All
3/4	Order PCB board for the first trail	All
3/11	Testing hardware connection	All
3/25	Programming into the PIC chip	All
4/1	Debugging	All
4/8	Final test and verify	All
4/15	Demo	Qianliang Liu/ Ke Ma