Building a Chess Playing Machine
Part 0

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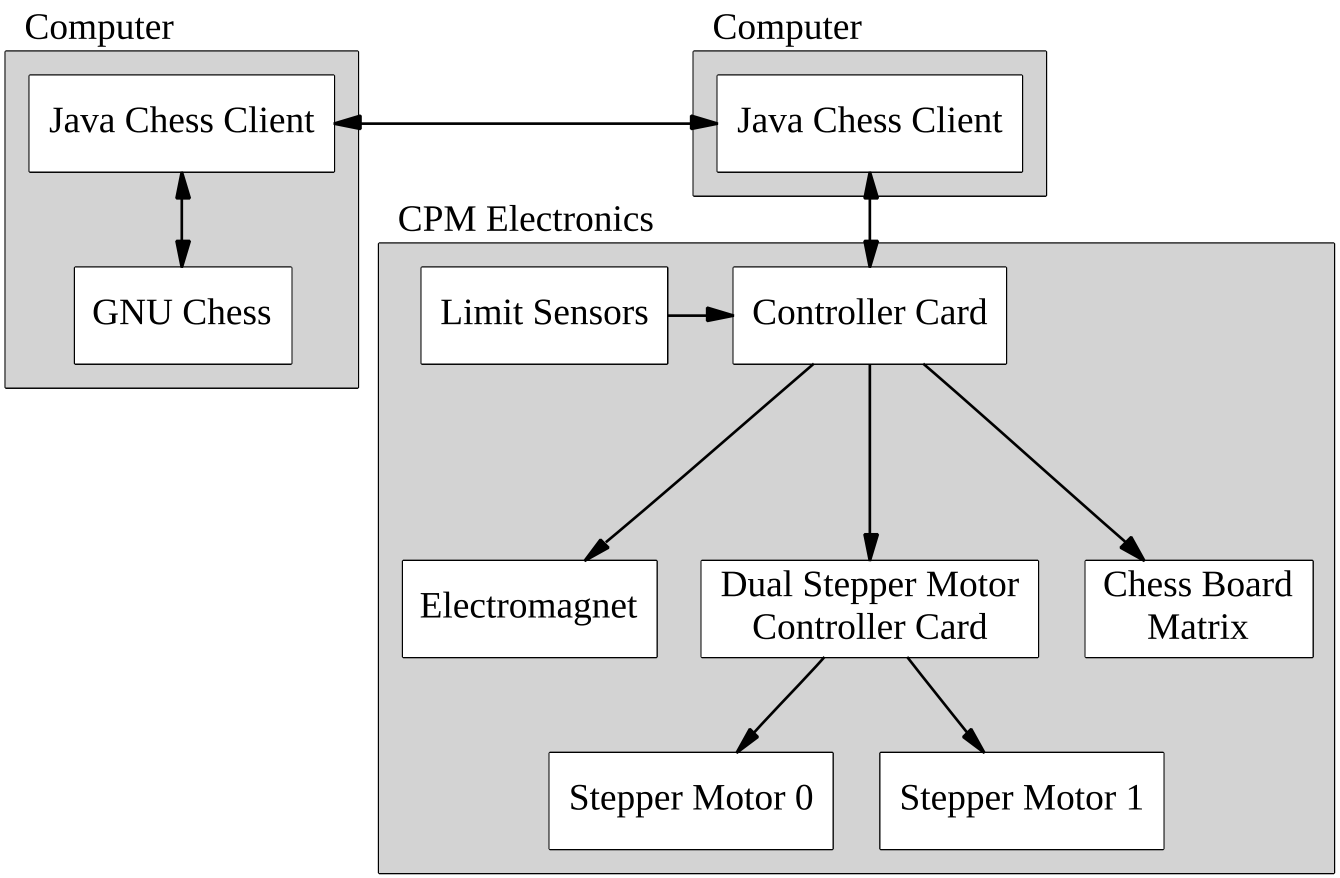
Abstract

The chess playing machine (CPM) is an exercise in computer automation as well as an attempt to give one advantage back to the human player by putting the game on a physical chess board. This project is basically a robotic extension to a personal computer running the GNU Chess program. The computer is then able to detect a human move and respond by mechanically moving a chess piece.

This colloquium will describe the progress already made on the CPM and plans for its completion. Subtopics will include information on making circuit boards at home, working with stepper motors, and some of the difficulties of linear motion. The current capabilities and deficiencies of the project will be demonstrated.

Project home page: http://shiva.rootuser.net/CPM

System Overview



Basic Functionality (Movement)

- Java Client receives a move from the opponent.
- The move is converted into a list of one or more chess piece movements which are sent to the microcontroller.
- The microcontroller translates the chess piece movements into sequences of motor steps, directions and magnet operations.

Basic Functionality (Detection)

- Each chess piece has a magnet on the bottom.
- The plexi-glass board contains an embedded matrix of Hal-effect sensors.
- While a motor movement is not being executed the microcontroller scans the matrix of Hal-effect sensors. A representation of the state of the chess board is kept in memory and is compared with new scan results.
- Upon detecting a change in the chess boards state a message is sent to the Java Chess Client.
- Java Chess Client converts board changes into chess moves and sends the results to the opponent.

Dual Stepper Motor Controller

- Outputs: Two 5 line unipolar stepper motor ports.
- Inputs:
  - Enable (low)
  - Two motor direction lines
  - Two step lines

  Power:
  - 24v Motor Supply
  - 5v Logic Supply

  Functionality:
  - Isolates logic circuitry from stepper motors.
  - When enabled pulsing a step line high then low causes the corresponding motor to turn one step.
  - Both motors can be operated simultaneously.

Controller Card

- Atmel AT90S2313 AVR Risk Microcontroller
  - Up to 10 MIPS at 10MHz
  - 128 Bytes of SRAM
  - 2K Bytes of Flash Memory
  - 2K Bytes of EPROM
  - On board UART (Serial port interface)
  - 8 and 16-bit timers
  - 15 programmable I/O lines
- 82C55A I/O Expander - Nets 12 more I/O lines.
- RS232 driver/receiver

Chess Board Matrix

- 12 x 8 = 96 matrix of Hal-effect sensors
- The extra 32 squares, 16 on each side of the board, are for storing captured pieces. At the finish of a game the CPM can then reset the board.
- There is no way for the microcontroller to detect which piece is which, so only one piece may be removed from the board at a time.
- A 16-bit demultiplexer selects one of the 12 columns. The outputs from each of the eight rows then indicate which squares on the selected column are occupied.
- By scanning the matrix 100's of times per second detection appears instant.

Java Chess Client

- Operates in one of three modes.
  - Chess Board - Client can connect into a chess server, find an opponent, and play a game.
  - GNU Chess Bot - Connects to a server and accepts all challenges, using GNU Chess to decide moves.
  - CPM Interface - Connects CPM into a chess server allowing network or local play.
- Uses Java RMI (Remote Method Invocation) to communicate with the chess server.
- If two CPMs are ever built they could play each other from any where in the world using this software.

Misc.

- Limit Sensors - These two sensors enable the microcontroller to find position (0,0) on the XY-Table.
- Electromagnet - Switched on and off by relay.
- Power Supply - Provides 5v (logic), 20v (stepper motor), and 50v (electromagnet).

To Do

- Assemble detection circuitry.
- Print, etch, drill, and solder controller board.
- Write detection code.
- Solve jumping knight and captured piece problem.
- Fix magnetic problems.
- Complete CPM Java Interface.
- Increase power to stepper motors.

Making Circuit Boards at Home

- Layout PCB with Eagle for Linux from CADSoft. The free version is somewhat limited. (fig 0)
- Print PCB layout on Press-n-Peel toner transfer paper with a laser printer.
- Iron Press-n-Peel on to copper clad board and peel away.
- Agitate board in warm etchant solution until all of the exposed copper is removed.
- Rinse board and scrub off toner.
- Set board in warm TIN-IT solution for about 5 mins. This leaves a thin coat of tin on the copper traces which reduces oxidation and increases solderability
- Drill board.
- Solder on components.

Stepper Motors and Linear Motion

- General goals of a linear motion system:
  - Predictability
  - Repeatability
  - Accuracy
- The Stepper Motor (fig 1)
  - Operate by alternately charging sets of coils with in the motor. Fixed magnets on the motors axle turn to the charged coil.
  - Each step is a precise number of degrees.
  - Errors in accuracy are not compounded by repeated use.
  - Much more difficult to control than standard motors.

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Figure 0

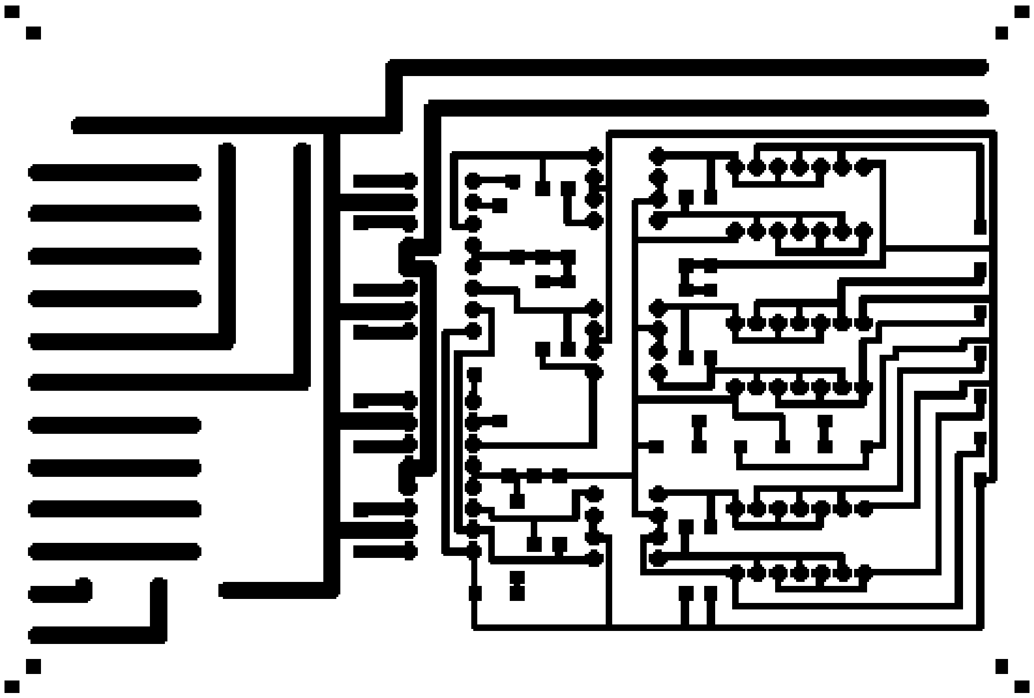

Figure 1