Connect4 Specification v7

Mechatronic Design 2011 *(Apr 17, 2011)*

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NOTE

The specifications described in this document supersede all previous specifications from lectures and publically available documents. If you are confused or are in doubt, please contact the instructors.

REVISION LOG

Apr 17, v7: Added popout rules. Adjusted final demo guidelines.
Mar 16, v6: Added protocol for popout gameplay
Mar 1, v5: Number of chips given at game start increased from 18 to 21
Feb 20, v4: Update minimum game intelligence, serial protocol refined
Feb 9, v3: Serial Protocol expanded
Feb 4, v2: Updated playing space

Goal

Build a mechatronic device capable of playing a game of Connect4.

General Project Requirements

Form

The device must be portable and should fit inside the area depicted in Figure 1 below. The maximum height allowable is 36".

Power

You may use wall power but must use a dedicated supply (such as a PC power supply) for the final product. Battery-operated devices are a possibility for greater mobility. You may not rely upon the laboratory bench power supplies to run your device.

Cost

A guideline reimbursable range for the total parts and materials cost purchased by the team is $250-$350; however, each team will create a proposed budget and negotiate a final reimbursable project cost with the instructors. NO SALES TAXES will be reimbursed. At the end of the semester, the instructors keep all parts supplied or reimbursed. These will be available for students in succeeding years.

Construction and Aesthetics

The device must be robustly constructed with nuts and bolts, machine screws, cable ties, proper soldering, etc. No prototype kits or toys may be used. Appearance matters. "Rats' nest" wiring, duct tape, bubble gum, or otherwise rickety-looking devices are discouraged not only for lack of aesthetics, but also because they tend to be less robust.

Safety

The mechanism may not damage anything with which it interacts (the Connect4 board and the opponents' machines).

Project Requirements

- The mechanism must be able to insert game chips into all of the slots in the Connect4 board.
- The mechanism must take no more than 20 seconds per move.
- The mechanism must retract from the neutral area between turns.
- The mechanism must display game playing intelligence.
- The mechanism must transmit game state to the opposing player using the given rs232 protocol.
    - Baud rate of 9600
    - No parity
    - 8 bits per message
    - 2 stop bits
    - No flow control
- You should supply tx/rx/gnd 0-5v signals. (Not DB9 24V signals)
- You will receive exactly 21 same-color chips in an open-top container.
- Chip Input
    - The chips may be dumped into the mechanism without being touched.
    - The chips may be stacked on the playing surface outside the mechanism, taking no more than 30 seconds.
- The mechanism will be allowed one minute to prepare for game play, commencing at the end of chip input.
- Performance metrics
    - Chip placement accuracy
        - Place exactly 1 chip
        - Successfully placed in slot
    - End of turn message correctly sent
        - Correct time
        - Correct message
    - Speed

        - Mechanism met “no more than 20 seconds per move” requirement.
        - Measured from receipt of game state to transmission of game state.
- Popout specific regulations
    - You have an unlimited number of chips.
        - 21 placed in hopper initially, others placed in hopper as needed.
    - You may only pop chips of your own color.
    - Game limit of 42 turns per side until declared a draw.

Mechanism Position Registration

The instructors will make available one ¾”-thick baseboard with threaded rods positioned and dimensioned as pictured in Figure 1 below. The rods can be used to secure your mechanism to a stable base and position it with respect to the keyboard. Please be aware that we cannot guarantee exact placement of the rods, as the holes will be hand-drilled. You must therefore account for a small amount (1/8”) of slop in any direction from the prescribed location.

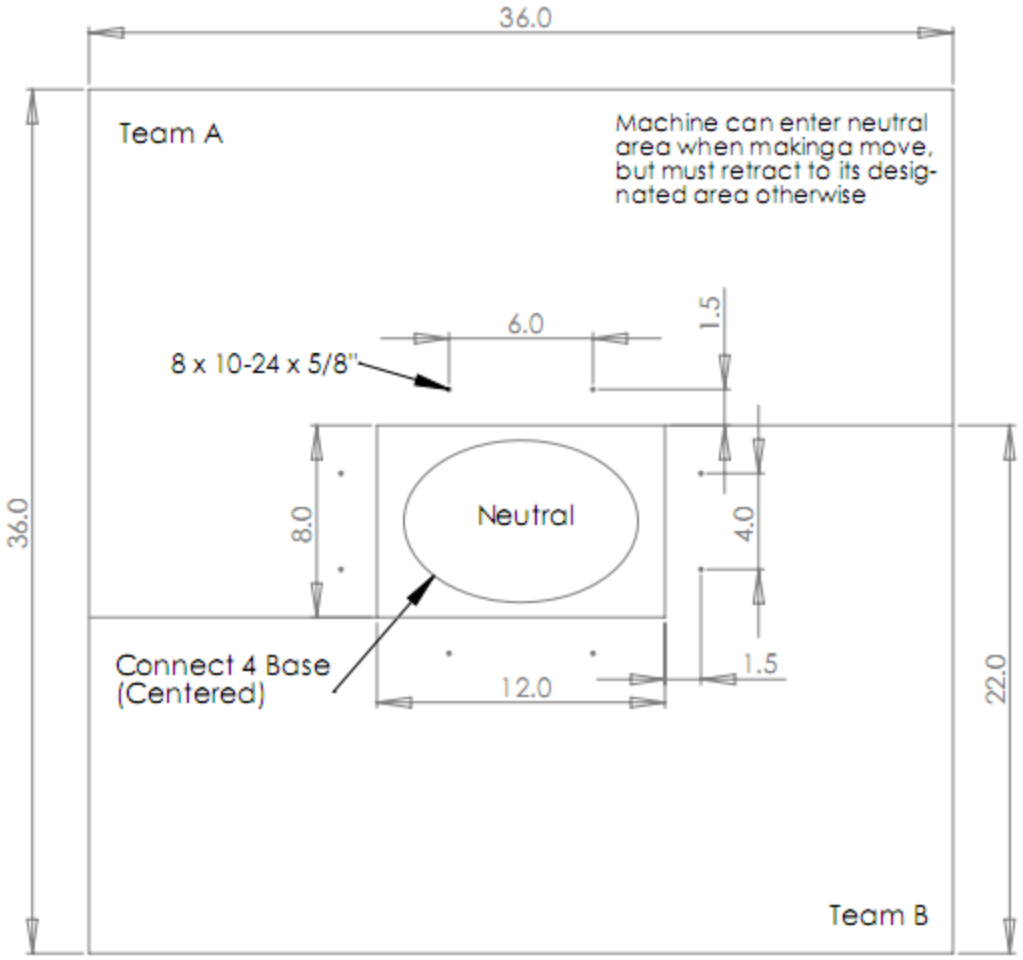


Figure 1: Playing space

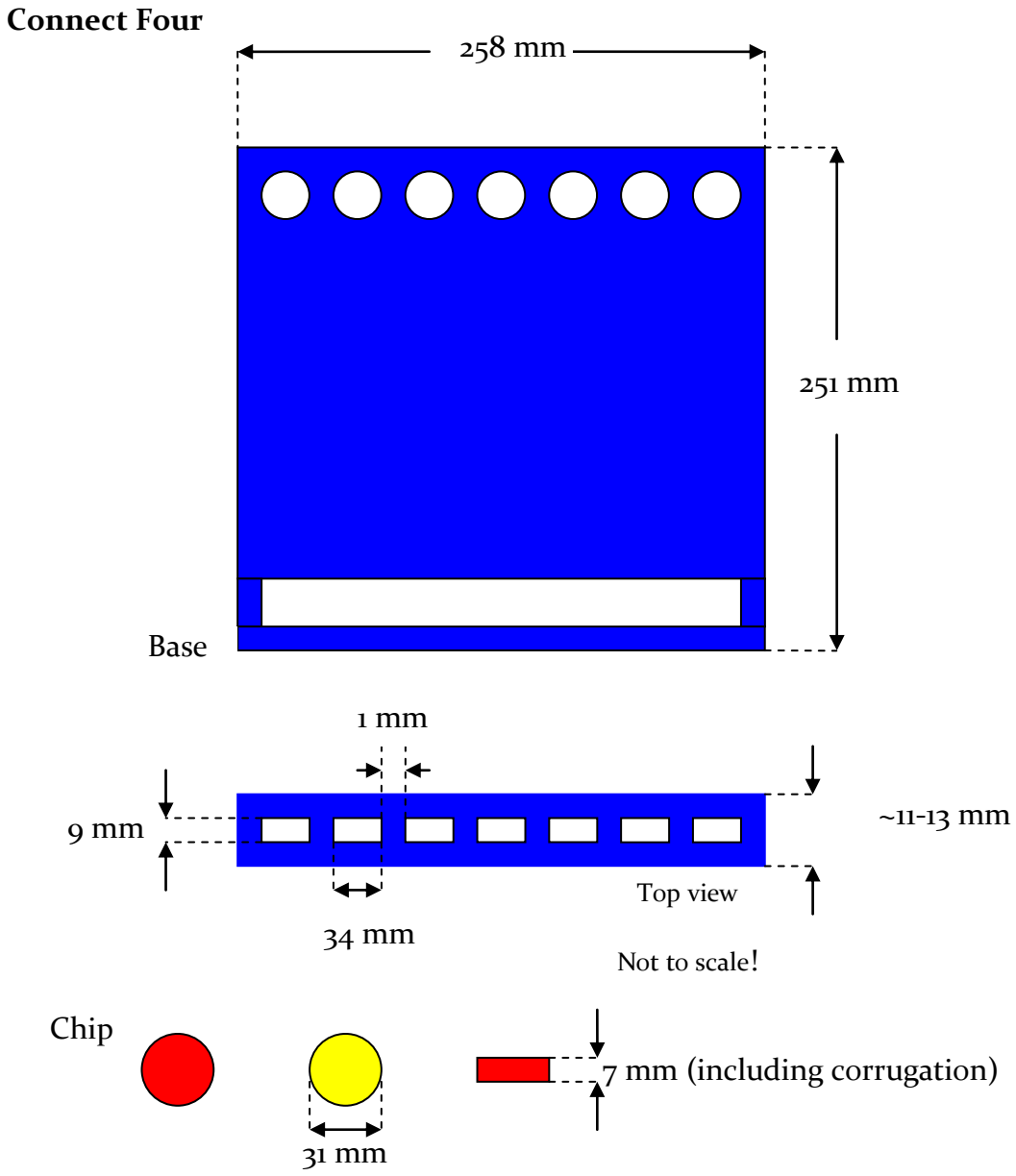


Figure 2: Various relevant sizes

Serial game-state interface

The machine communicates with the opponent's machine via an RS-232 (serial) interface with an intermediary computer controlled by the TAs. The baud rate of this interface will be 9600, with a 8N2 message encoding. The purpose of this communication is twofold; indicating the end of the player's turn, and the slot in which the chip was placed.

During play:

The main protocol consists of a single ascii byte to fulfill both requirements above. The machine sends the ascii code for the number representing the column (with respect to itself-the right side of the board) in which the chip was deposited. The columns are indexed from 1 (0x31) to 7 (0x37).

The transmission of the column indicates the end of the mechanism's turn and that the machine has cleared the neutral area.

The receipt of the column from the opponent's move commences your machine's turn and begins the turn clock.

New game:

The game commences when the TA computer sends signal 0x4E (ascii 'N' for new) to **both** machines. This signal indicates that the playing board is empty.

The signal 0x53 (ascii 'S' for start) is sent to one machine selected randomly to signal that team as the first player. 0x57 (ascii 'W' for wait) is sent to the second machine to indicate the first team is beginning the game.

Upon receipt of 0x53('S'), the turn clock starts for that machine that received the signal.

Resume game:

The signal 0x52 ('R' for resume) indicates a game board which has been setup in advance. The game state is conveyed in the following manner: 0x73 (ascii 's' for start) is sent to the team which would have placed the first chip. 0x77 (ascii 'w' for wait) is sent to the team which would have placed the second chip. After transmission of 0x73 to one team and 0x77 to the second, columns are specified as usual (0x31-0x37). An arbitrary number of columns will be sent sequentially. Each column is specified with respect to the machine which would have placed the chip.

After all columns are specified, 0x53 and 0x57 are sent, one to each machine, just as in a new game scenario.

Popout variant:

If you are playing a Popout game (defined as a game played between two parties capable and willing to play the Popout variant), you must adhere to the following supplemental serial protocol. To indicate a popout move, the machine should send 0x61-0x67 ('a'-'g'), corresponding to columns 1 through 7. This signal will be sent instead of the 0x31-0x37 signal which would be sent during a normal play.

Hex code	Ascii representation	Interpretation	Source
0x31-0x37	1-7	Column in which the transmitting machine placed its chip. Indicates end of turn and that the machine has cleared the neutral area. Column is with respect to transmitting machine (right side).	Players TA machine if preceded by 'R'
0x61-0x67	a-g	Column in which the transmitting machine popped out a tile. Indicates end of turn and that the machine has cleared the neutral area. Column is with respect to transmitting machine (right side).	Players-during a Popout game
0x4E	N	New game. Board is empty.	TA
0x52	R	Resume game. To be followed by additional commands	TA
0x73	s	Starting team during autoplay sequence in a Resume Game	TA
0x77	w	Waiting team during autoplay sequence in a Resume Game	TA
0x53	S	Starting team-clock starts upon receipt of this signal	TA
0x57	W	Waiting team	TA

Table 1: Serial Protocol Quick Reference

Coolness Factors

There are many possible coolness factors, several of which are listed here:

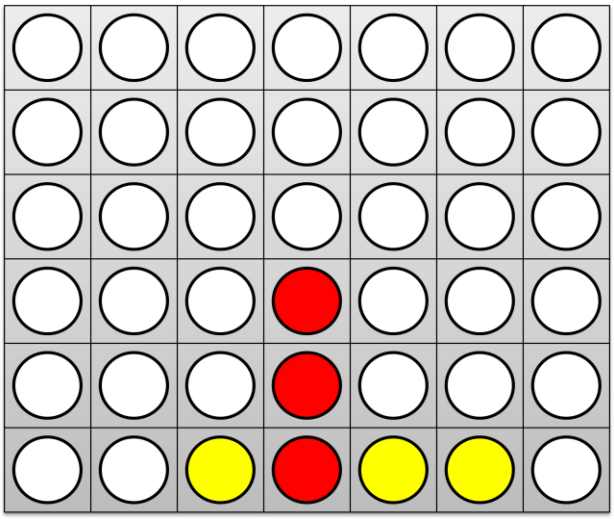
- Play Connect4 variants such as Popout
- Automatically sense game state
- Take substantially less time than allowed
- Game playing intelligence.
- Display game state.

Final Demonstration

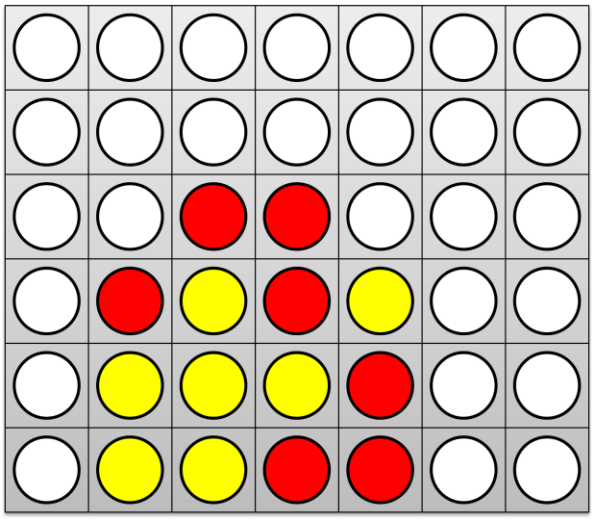
During the final laboratory demonstration, each mechanism will be assigned a sequence of tests. The first round of tests will evaluate machine functionality. We will ask that you be able to perform each necessary step to complete a single move, such as emptying the hopper, positioning the chip dispenser to an arbitrary column, and depositing a chip. Once you pass these tests, we will test your ability to intelligently play a game.

The next set of tests will use the Resume Game routine to evaluate game playing intelligence. These tests will evaluate the ability to block horizontal, vertical, diagonal, and left-one-out "3 in a rows" in 1 move, and to complete the same in 1 move. Optionally, teams may additionally specify configurations which will highlight the game playing intelligence of their machine.

In addition, the machine will play a game using the New Game routine against one of the instructors.



a



b

Figure 3: a) Vertical win/block test. B) Diagonal win/block test

Public Demonstration

During the public demonstration, teams will have the opportunity to compete against one another. There will be a single elimination tournament with seeding chosen at random. Since there are 7 teams, one team chosen at random will receive a bye for the first round. Bragging rights, and possibly extra credit will be awarded to the overall victor.

Grading

Below is a scoring rubric that the instructor team will use for the final demonstration. The six subsystems for this year's project are: 1) Chip sorter (hopper); 2) chip depositor; 3) lateral (columnar) positioner; 4) vertical (neutral zone retraction) positioner; 5) game playing intelligence; 6) serial communication. Each of these may be shown to be functional at least to some extent by itself (for example, the game playing intelligence could be shown in simulation even if the positioners and depositor aren't working), but the system only works fully when all of them are simultaneously functional and successfully integrated. At the final demonstration, be prepared to show individual or multiple subsystem functionality in case you are not able to achieve full system functionality, or unexpected failures occur that can't be quickly addressed.

Select a coolness factor that goes beyond the basic project requirements and be prepared to describe and demonstrate it at the final lab demonstration.

19-20 pts.: All subsystems work together successfully to play Connect4. Most or all project specifications are met.
17-18 pts.: All subsystems work together to play Connect4, but with some glitches that require minor manual intervention. All subsystems are functional.
15-16 pts.: Most of the Connect4 player works, with a possible major glitch. All or all but one of the subsystems is functional.
13-14 pts.: Some of the Connect4 player works, with more than one major glitch. Possibly one or two subsystems are not functional.
11-12 pts.: No ability to play Connect4 is demonstrated successfully. Multiple subsystems are not functional.
9-10 pts.: No ability to play Connect4 is demonstrated successfully. No subsystems are functional. Effort is shown at attempting to get things working.
0-8 pts.: Nothing working; little attempted.
1-2 points out of the total of 20 will be assigned based on the instructors' qualitative assessment of effort, coolness, and aesthetic and robustness factors.

Disclaimer

The instructors reserve the right to update this specification in order to keep the scope of work within the goals of the course.