Kaberobot Kalev

G04

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Introduction

Our team's objective was to make a checkers-playing robot that a human player could play against. The main goal was to make the robot as invisible as possible, not to have a giant gantry running over the board, but to make it seem like the checker's table itself was playing against us.
Our solution is to have a small XY plotter moving an electromagnet under the table that would be able to manipulate the checkers' pieces from below the table. The positioning of the pieces is achieved using an overhead camera

The project's difficulty stems from many of the custom pieces that had to be built or printed out; everything except the electronics and some mounting hardware is either sawed out of wood or 3d printed.

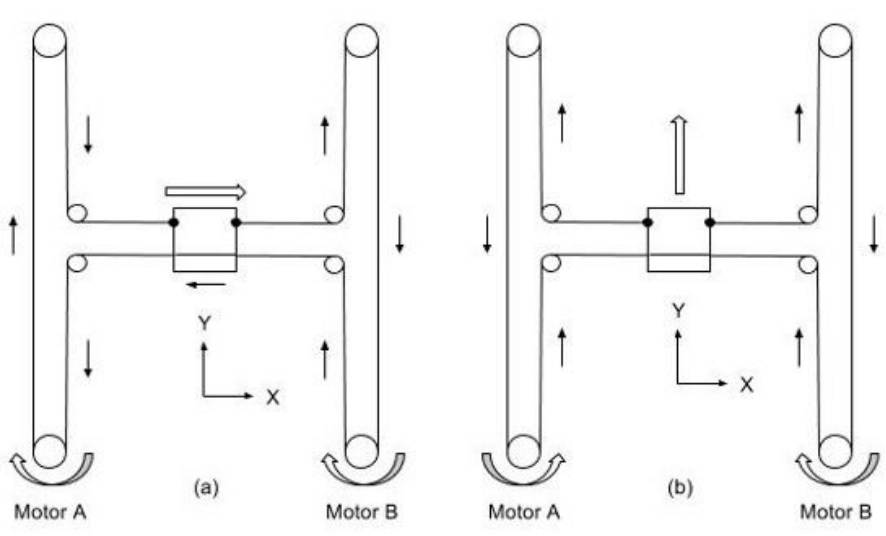

Figure 1. *H-Bot Diagram*

Algorithm

We have a small python script that uses the detected board to calculate the robot's next move, which it chooses and sends the necessary commands to the Arduino using a serial connection. The script considers the current board position and calculates the robot's movements so as not to interfere with other pieces.

Rules of the Game

- Pawns move one space diagonally forward only, but can capture diagonally forward or backward.
- Queens move any number of spaces forward or backward
- Queen must stay to the first square after jumped piece
- It is mandatory to capture pieces if possible
- When a pawn reaches the last row, it promotes to a queen. However, if a pawn reaches the last row while jumping and can jump more pieces backwards, it does not promote and continues jumping as a pawn.

Hardware

Two stepper motors move an electromagnet under the board using an H-bot system (Figure 1). One long timing belt connects the steppers and has the magnet attached to it. Movement in X and Y directions is achieved by turning the stepper motors in the same or opposite direction, turning only one moves the magnet diagonally. Motors are each controlled by a motor driver which is in turn controlled by an Arduino Nano microcontroller. The pieces have ferromagnetic metal inside so the electromagnet can move them. The whole system is powered by a 12V battery.

Image recognition

For board detection using the camera, we use the image we get from the overhead camera. The checkerboard corners are detected using the OpenCV library. The board corners are, in turn, used to perspective transform the board into a 480x480 px image containing a flattened checkerboard. We use the resulting image to iterate through all the 60x60 px squares and use RGB thresholding to detect the piece colour in the respective squares.