Chess to Impress

Brett Levenson, Matthew French, Luke Cohen

Introduction

The purpose of this project is to enable a user to play against an automated opponent. Chessbot uses computer vision to determine the state of the board and the moves by the player. It then determines the next move using a chess solver. Finally it finds an optimal collision free path for the arm to follow, and then executes the move. The robot should be completely autonomous from the start of the game to the end with minimal setup.

Objectives

In order for this project to be successful, we have determined the below criteria to be required:

- Determine which piece was moved and to where
- Decide on a reasonable chess move to counter the user's move
- Able to plan a path for the arm that is collision free
- Capable of executing the collision free path
- Can pickup and place pieces without knocking over any other pieces

Methods

- In order to determine the piece that was moved, we utilize the clock timer so that the camera can capture a frame after each turn By then tracking the position of the pieces from a known starting state, we can use the deltas between images to reconstruct the state of the board at any turn without needing to perform advanced piece recognition.
- To maneuver the arm, we can assume that there is a maximum height that no pieces exceed, in which we can define a collision free zone for the arm to travel through. From this safe zone, we just need to lower down at the correct coordinates to pickup and drop the piece being moved.

Robotic System Pipeline

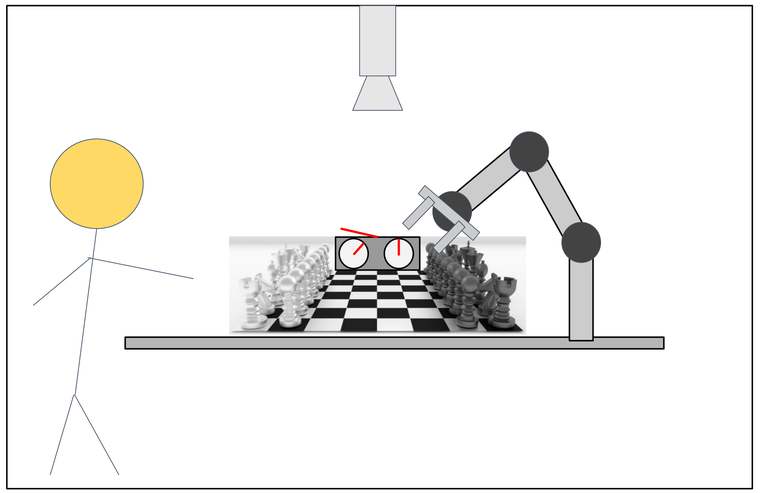

Figure 1 *The above figure shows the complete system with the robotic arm positioned opposite the player. The camera is located above the board and points down.*

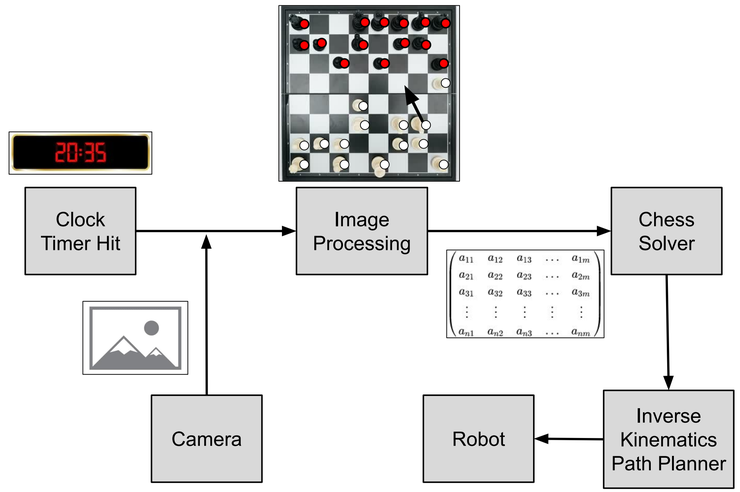

Figure 2 *The system architecture as a block diagram. The robot will hit the clock timer, use the camera to analyze the board, poll a chess solver to determine a move, and use inverse kinematics and a path planner to perform the move.*

Milestones

We have identified a few milestones to guide our progress through this project:

1. Achieve full control of robotic arm, defining values and limits of motion
2. Implement inverse kinematics to move robot arm to specific location
3. Use imaging to determine grip on piece
4. Use path planning algorithm to move piece from one space to another
5. Add in chess solver to determine optimal AI move

Challenges

- Analyzing the board to determine which piece was moved and to where based off two images
- Applying chess solver to determine next move
- Using imaging to determine grip on pieces of various shape and orientation
- Correct kinematics to ensure robotic arm moves the correct piece without knocking over others

Applications

Though the use case for this project is specific, we believe that the robot can be adapted for other applications. For example, while our end goal is autonomy, along the way we plan to test the arm by manually determining its path. This has accessibility applications. We could also expect that the arm could be adapted to play other games or do other tasks.