Vishynoid - The Chess Playing Robot

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Introduction

- **Vishynoid** is a chess playing robot which we built during our ITSP 2014 is named after the Indian Chessmaster **Vishwanathan Anand**. Built on **Beaglebone** as its SBC it uses cameras mounted on static frames to identify human moves. It has a strong and powerful self developed **Chess Engine** integrated into it which uses several advanced mathematical and logic algorithms to compute upto 6 depths of moves.The movement of the pieces by the computer is done using a **Robotic Gripper** that is maneuvered on the chessboard by a **X-Y localization** system through a series of shafts, pulleys, bearings and stepper motors.

Skills Acquired

1. **Artificial Intelligence** - Developed the Chess Engine using OOP.
2. **Algorithm Optimization** - Optimized the Engine to achieve greater depths.
3. **Image Processing** - Real Time checking of Board Status and Human Moves.
4. **Process Threading** - Parallel Processing of IP and AI threads.
5. **Micro-Controllers** - Efficient Usage of BeagleBone Black.
6. **Mechanical Framework** - X-Y maneuring systems using shaft-coupled pulley systems.

Materials & Specifications

- BeagleBone Black Rev B
- USB Camera
- Stepper Motors
- Servo Motor
- T2.5 Pulleys

Artificial Intelligence

- **Value Based Priority Allocation of Moves**
  - Values are alloted to the board observed when a piece is moved according to thenumber and relative positions of the pieces.
  - The board with the maximum damage ie. Highest Priority is chosen as a Optimal Move.
- **Min - Max Algorithm**
  - An alternating node based algorithm used under recursion to minimize opponent score and maximize user score.
  - Recursion Based implementation and hence less Memory Intensive.
  - An abstraction of Iterative Deepening also added.
- **Alpha - Beta Pruning**
  - Pruning the search tree for moves if the child *nodeScore* is less(more) than its mother provided the nodeType is max(min).
  - Helps in reducing the number of recursions and helps achieve greater depths.

Image Processing

- **Corner Detection and Square Allocation**
  - Detection of the 81 corners of the square board.
  - Allocation of 64 regions of interests (ROI) to check for piece presence.
- **RBG Colour Detection**
  - Detection of the RGB value at the center of the 64 ROIs.
  - Estimation of Piece Presence at the center using averaged data sets.
  - Board Colours chosen to meet the detection needs.

Introduction

- Special Thanks to **Mr. Deepak Logic** for helping us with the mechanical part of the project which seemed to be a gigantic task at first but later turned out to be a fun-filled job under his guidance.

Mechanical Frame

- **Gripping Mechanism**
  - A plastic gripper with two degree of freedom is used with a servo motor.
  - A extended hook helps in the gripping of small pieces as well.
- **X Axis Movement**
  - Powered by Stepper Motor, transmitted through chrome rods and synchronized by Pulleys.
  - Primary Movement of the localization system.
- **Y Axis Movement**
  - Stepper Powered Movement using parallel rods on a mounted movable frame.
  - Secondary Movement of the localization holding the gripper.

Results: Image

Figure 1: Vishynoid.

Results & Outputs

- **Chess Engine Move Times**

Search Depth	MaxMove Time	MinMove Time
Depth =1	0.1412	0.562
Depth =2	0.5681	0.910
Depth =3	0.9271	0.296
Depth =4	0.9271	0.296

Table 1: Chess Engine Move Time Parameters

- **Image Processing Parameters**
  - Edge Detection Threshold = 25% Dark.
  - Corner Deection Threshold = 64% Opaque.
  - RGB Evaluation Threshold = (0,65,255).
- Mechanical Parameters
  - Accuracy = 1mm.
  - Ideal Stepper PWM = 100.
  - Average Placing Time = 7sec.
  - Max Handleable Piece mass = 200gms.

References

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