

SMART SYSTEM PROJECT

CHINESE CHESS ASSISTANCE SYSTEM

SUMMARY

- Desire to combine Computer Vision and Artificial Intelligence to assist human.
- Automated chess is a popular topic.
- We decided to choose Chinese chess.

SUMMARY

Problem:

“Given a picture frame contains a chinese chess board, suggest the next best moves.”

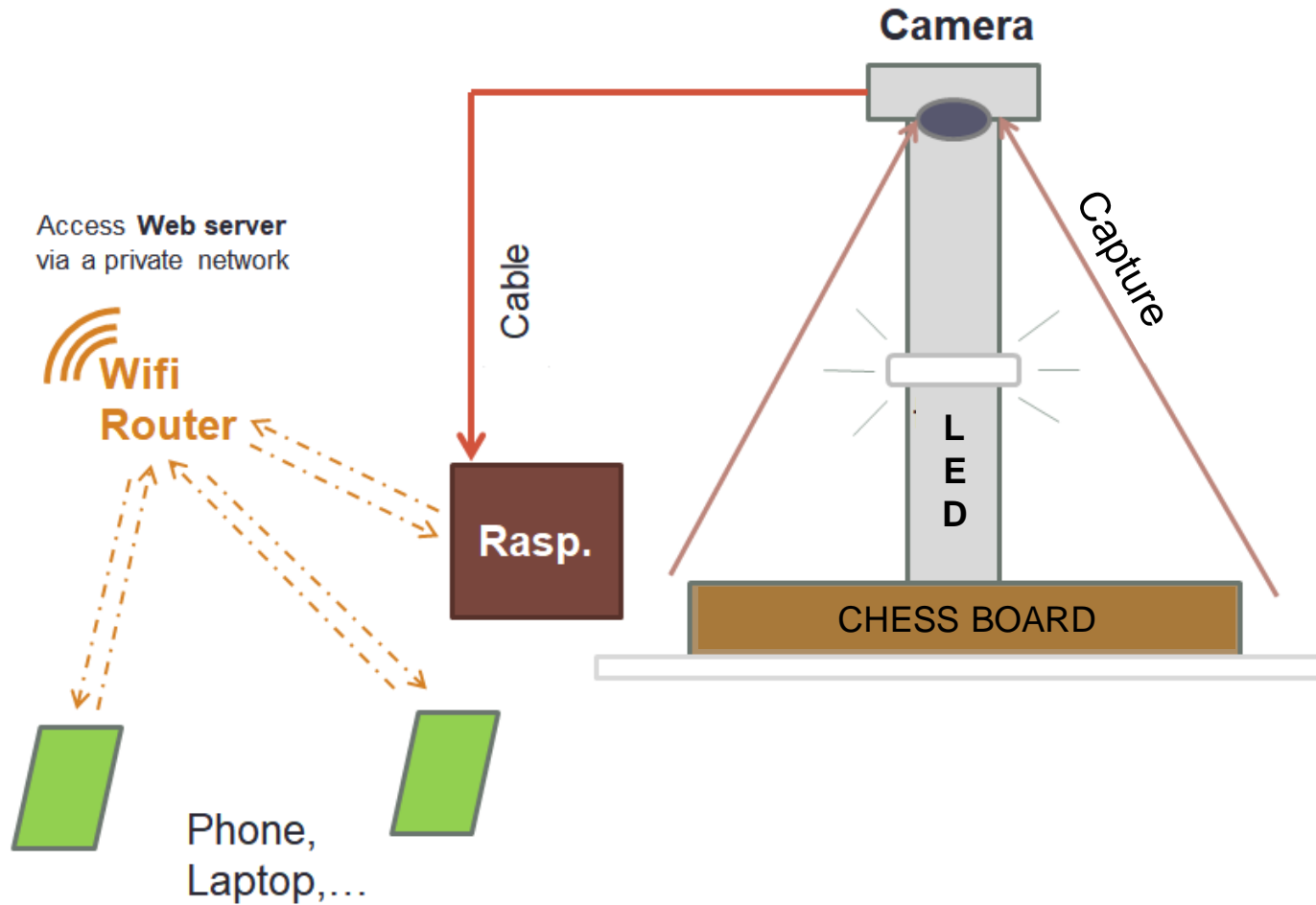
Analyze and general solutions:

- The computer understands the board (Computer Vision + classifier model)
- The computer suggests moves (Search algorithms, using a public engine)

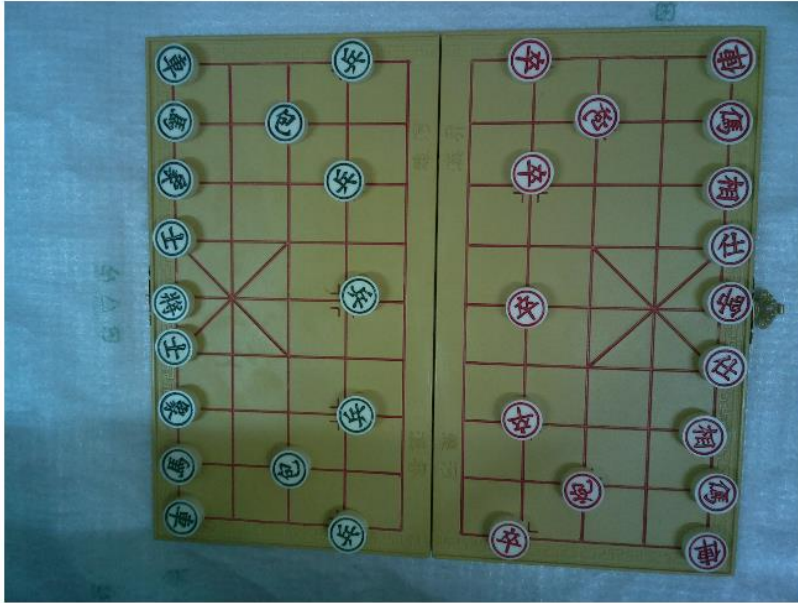
SUMMARY

We also deployed a Web server to our project to satisfied the IoT requirement made by the project management council.

SYSTEM FLOWCHART



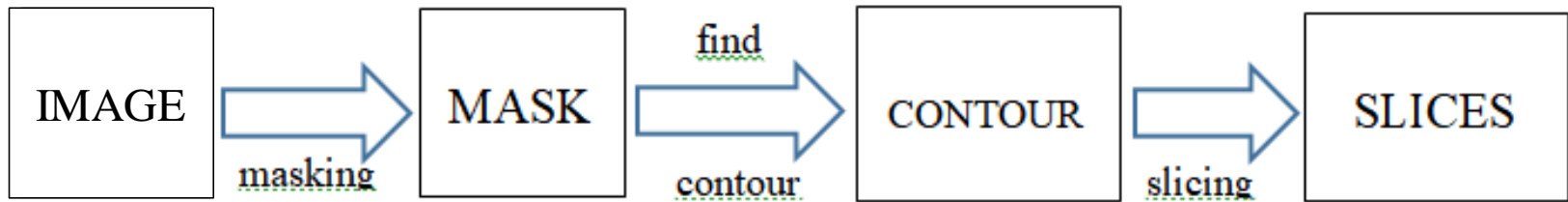
UNDERSTANDS THE BOARD



- Extract 90 of the positions of the board (Preprocess)
- Train and use a model to predict each position of the board (Classifier model)

UNDERSTANDS THE BOARD

PREPROCESS



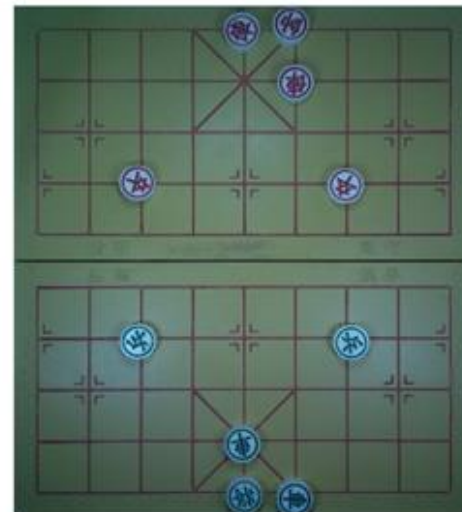
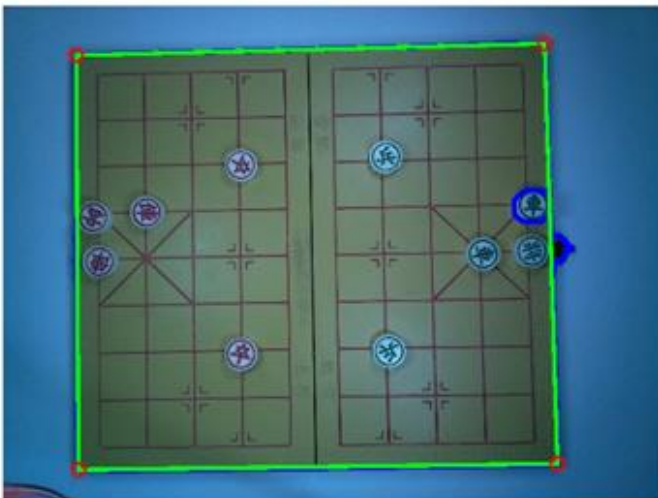
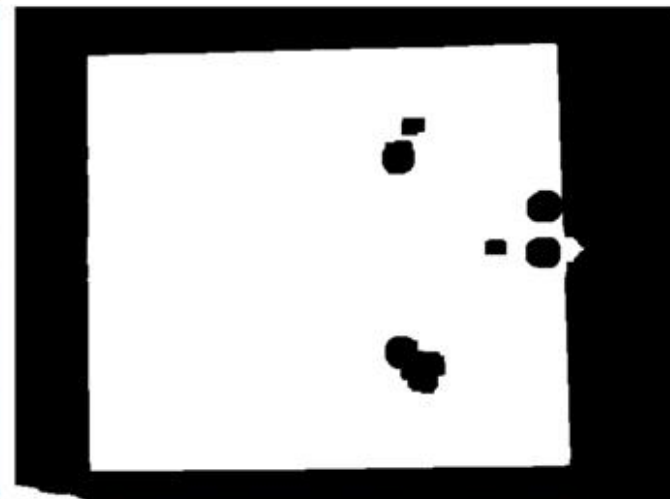
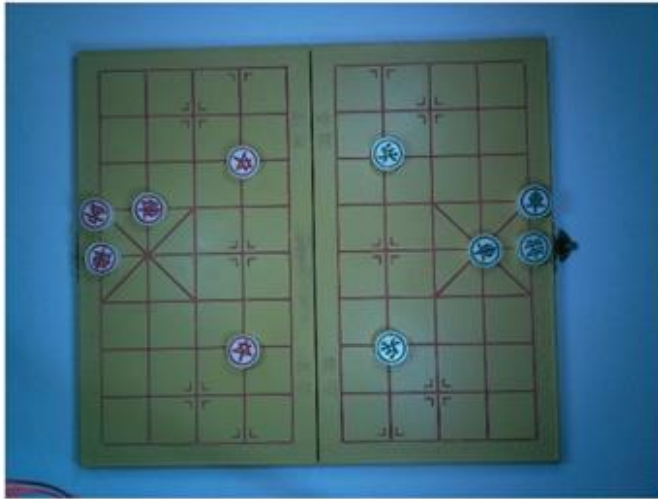
Three steps:

- Masking, find the minimum area that contains the board
- Contour, find the contour of that area
- Slicing, perspective warp the area bounded by the contour then slices it.

Use openCV library.

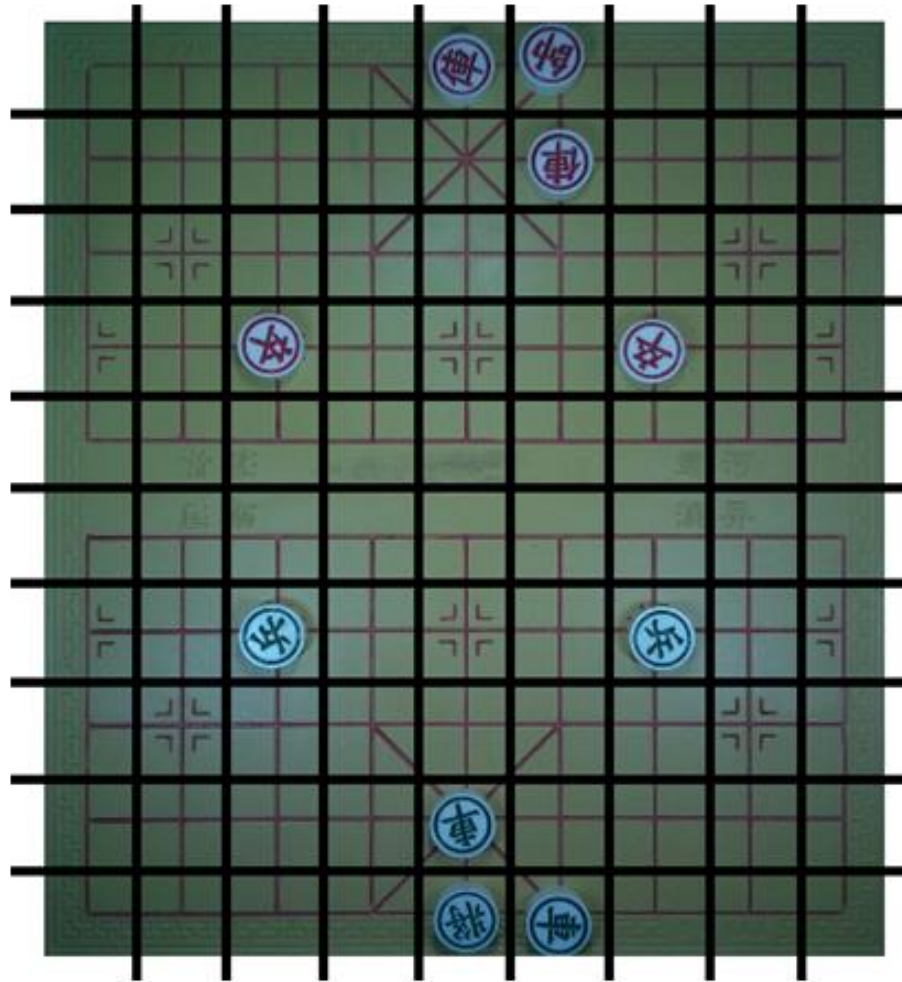
UNDERSTANDS THE BOARD

PREPROCESS



UNDERSTANDS THE BOARD

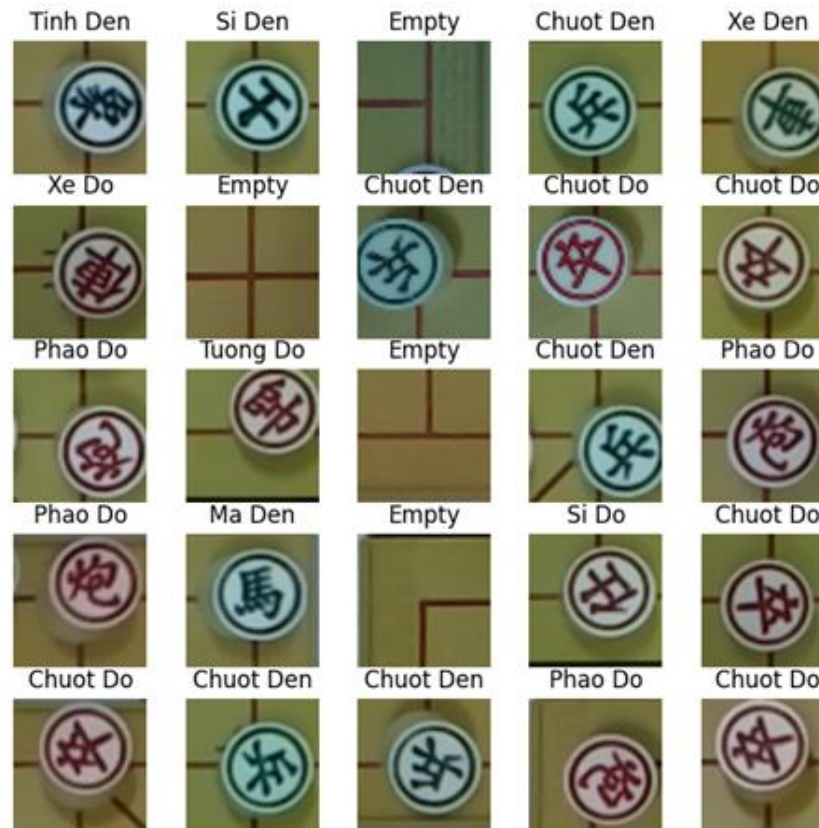
PREPROCESS



UNDERSTANDS THE BOARD

CLASSIFIER

- By executing Preprocess step on a lot of different boards, we retrieve many tiles, which will be used as dataset.
- Manual classifying: (label is in Vietnamese)



UNDERSTANDS THE BOARD

CLASSIFIER

With more than 90 different boards, we harvested a dataset with classes as follows:

Class	Số lượng
Tốt đen	424
Pháo đen	170
Xe đen	172
Mã đen	170
Tinh đen	168
Sĩ đen	169
Tướng đen	86

Tốt đỏ	419
Pháo đỏ	168
Xe đỏ	168
Mã đỏ	170
Tinh đỏ	167
Sĩ đỏ	169
Tướng đỏ	84
Ô rỗng	542

Total: **3246 sample** (pre-generation)

UNDERSTANDS THE BOARD CLASSIFIER

Because we need to classify image, we use CNN. A CNN consists of mainly 3 layer:

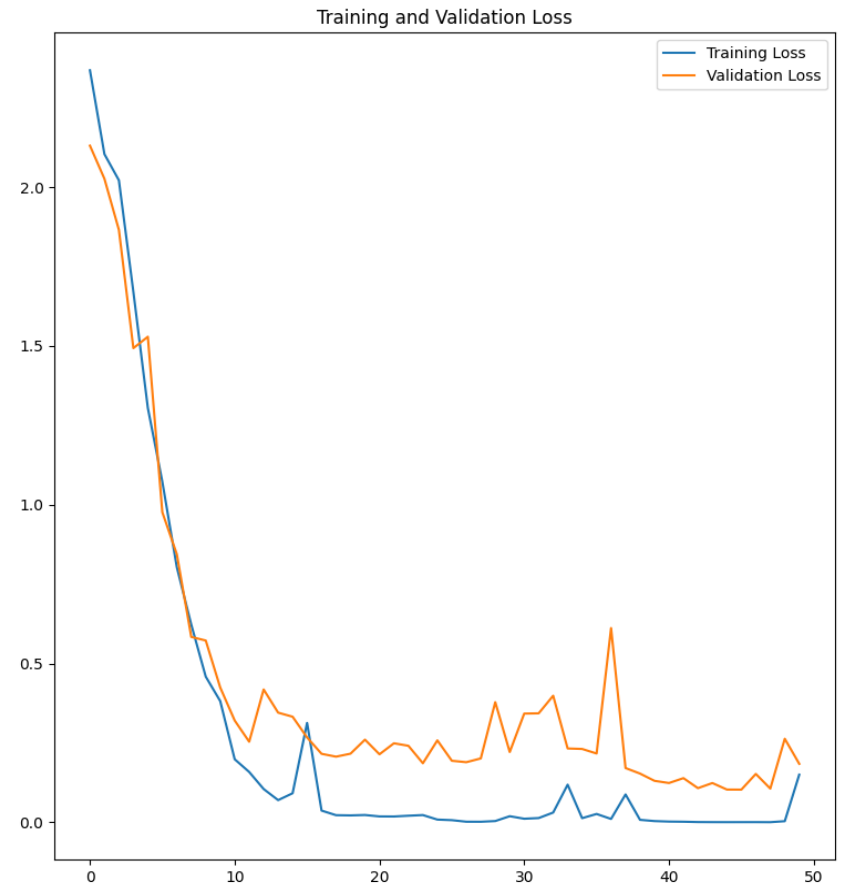
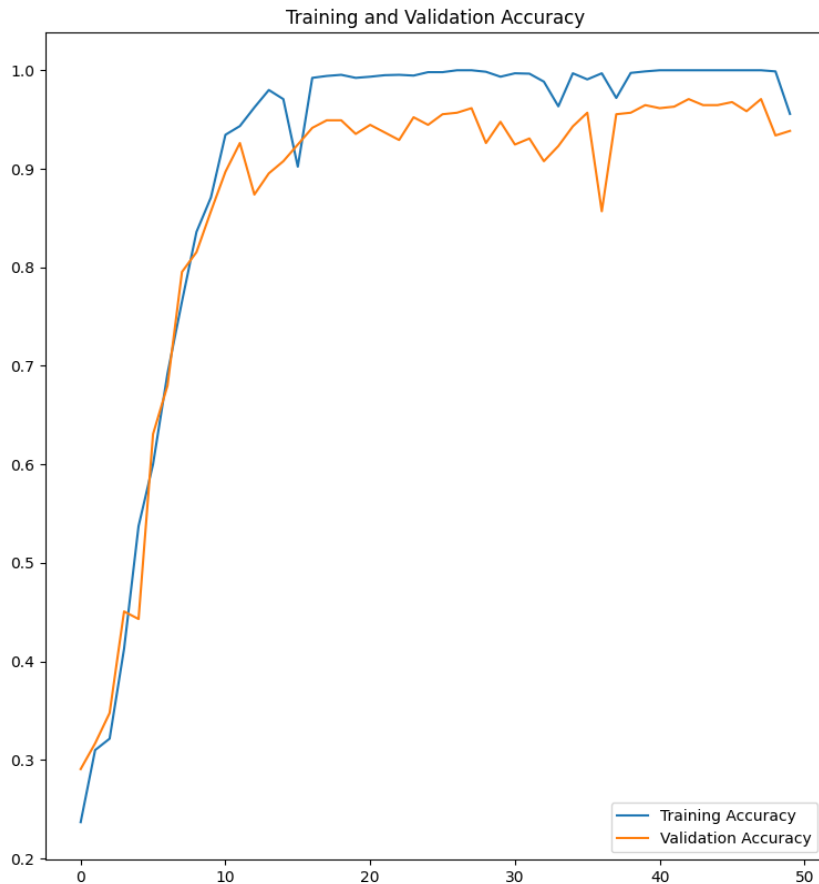
- Convolution layer
- Pooling layer
- Fully-connected layer (Dense layer)

UNDERSTANDS THE BOARD CLASSIFIER

Our model structure

#	LAYER	SIZE
1	Input	50×50
2	Convolutional layer	50×50
3	Max pooling layer	25×25
4	Convolutional layer	25×25
5	Max pooling layer	12×12
6	Convolutional layer	12×12
7	Max pooling layer	6×6
8	Convolutional layer	6×6
9	Max pooling layer	3×3
10	Fully-connected layer	15×1

UNDERSTANDS THE BOARD CLASSIFIER



Training result in the first 50 epoch (we trained 1000 epochs)

UNDERSTANDS THE BOARD CLASSIFIER

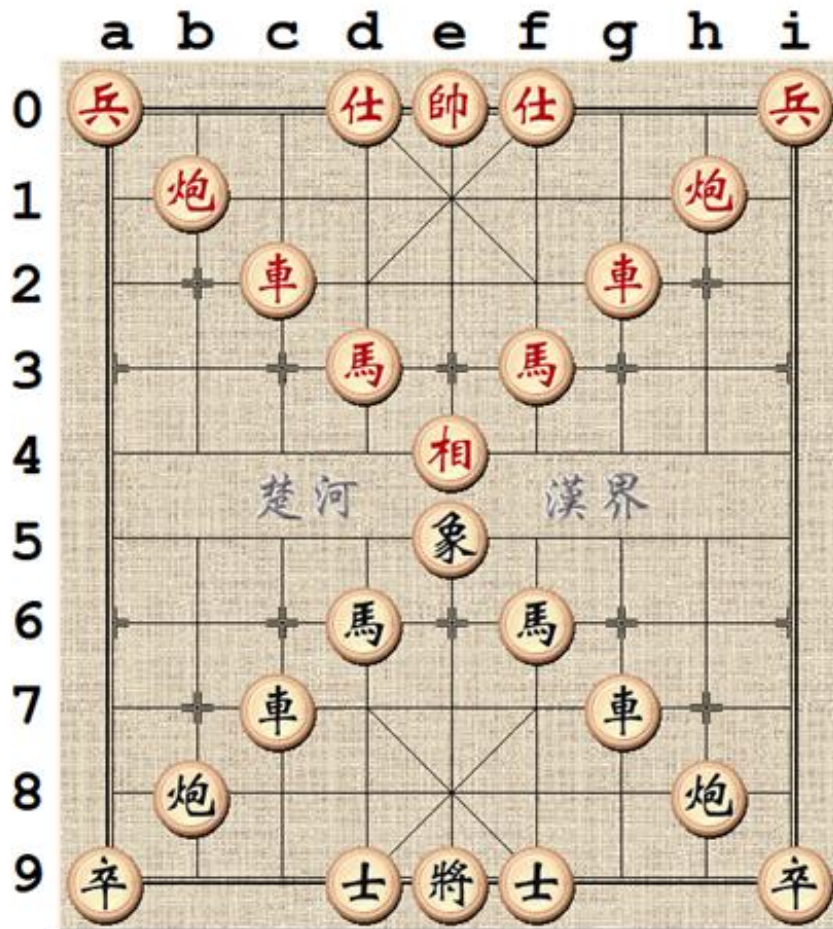


Result for classifying a small set of the final test set.

UNDERSTANDS THE BOARD

CLASSIFIER

After classified all 90 positions, we got ourself a string. We draw a virtual chessboard based on that string.



```
C--SGS--C
-P-----P-
--X---X--
---M-M---
----T-----
----t-----
---m-m---
--x---x--
-p-----p-
c--sgs--c
```


SUGGESTING MOVES

Use a [Chinese Chess Engine](#) as back-end.

When needed, call to engine to retrieve moves.

Engine uses search algorithm MTD-f, is a fast and efficient minimax algorithm.

WEB SERVER

Use module HTTP.Server of Python

Stream video using MJPEG format

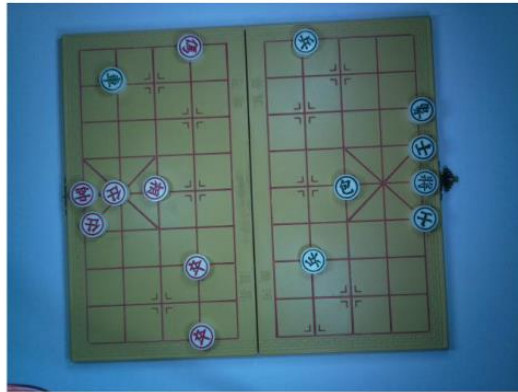
WEB SERVER

Camera

Masking

Contours

AI

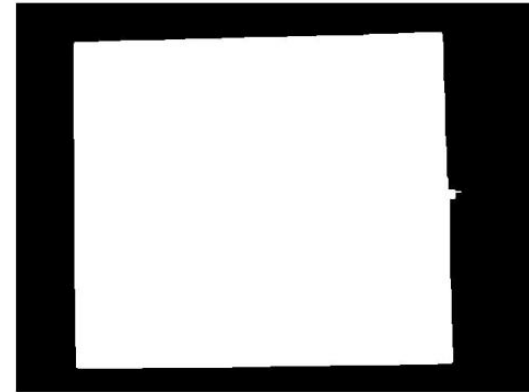


Camera

Masking »

Contours

AI

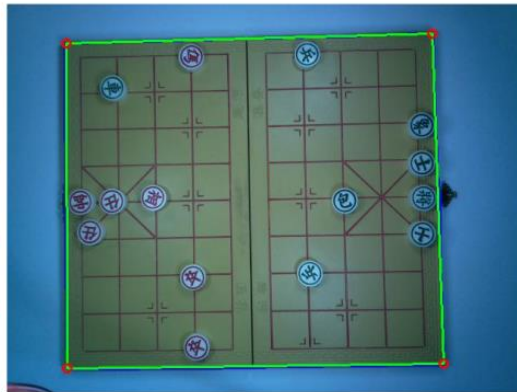


Camera

Masking

Contours

AI



Camera

Masking

Contours

AI



a6-b8 : 210
a6-b8 : 179
a6-b8 : 204
a6-b8 : 204
a6-b8 : 211
a6-b8 : 200
a6-b8 : 208

Out of think time, finished eval.

b8-b9 : 3696
b8-b9 : 3696
b8-b9 : 3696
b8-b9 : 3696
b8-b9 : 3696
b8-b9 : 3696
b8-b9 : 3696

Out of think time, finished eval.

WEB SERVER

Refresh rate or response time of the server (1 client)

Tab	Average refresh rate
Camera	0.0005s
Masking	0.1641s
Contour	0.0317s
AI	7.9535s

Tab AI consists of two task: classifying and drawing the board

Average time for classifying 90 positions: **2.7s**

Actual drawing time depends on the board's changes.

RESULT

- Preprocess works well, can detect the board successfully if:
The board's lighting is decent, board's corners are not hidden and board's edges are not too close to the frame's edges.
- Classifier model has an accuracy of 99% in testing dataset.
- Webserver can serve more than 1 client, response rate for Camera, Masking, Contour is fast. Response rate for AI is not as fast, but acceptable.