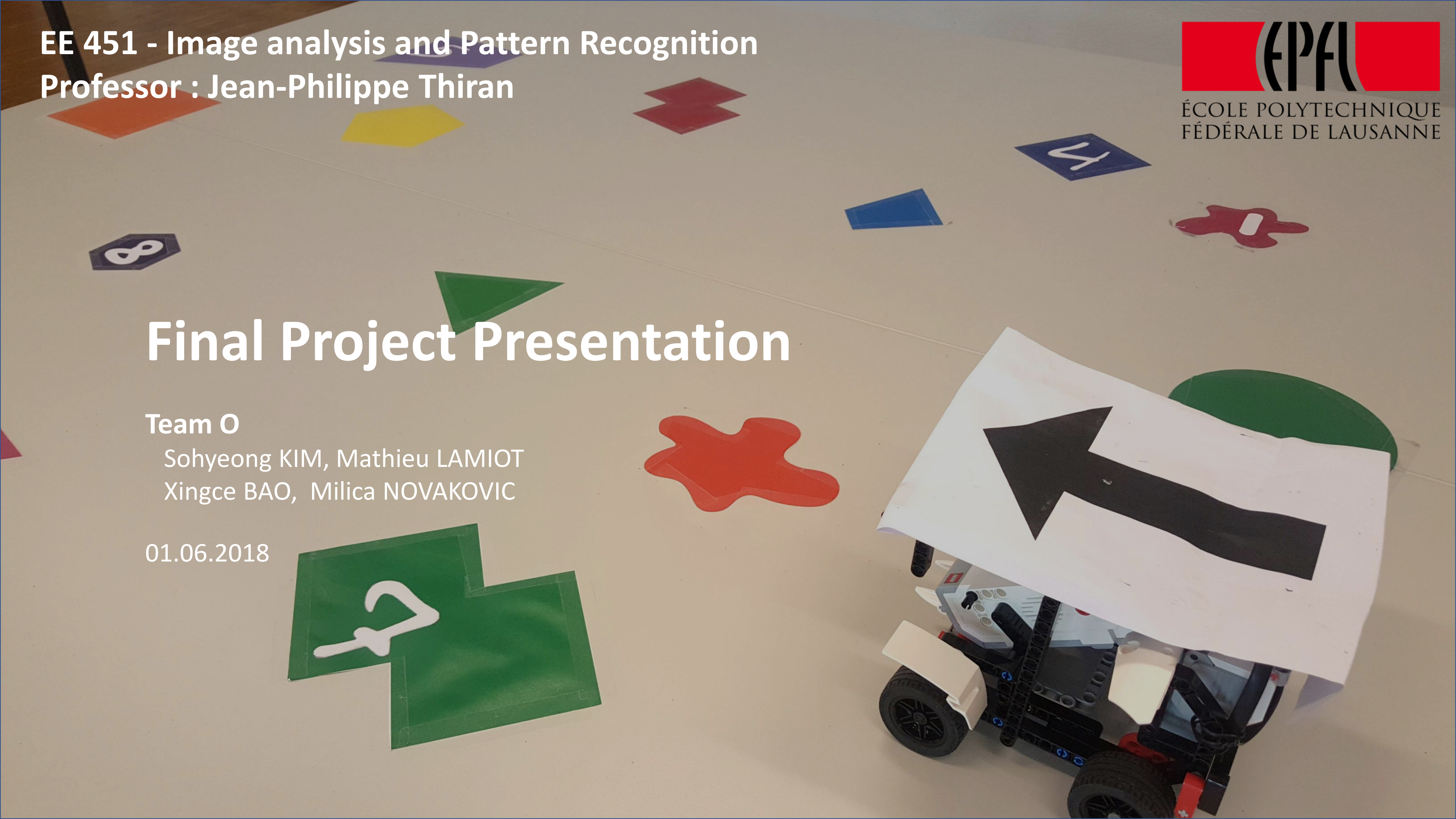


EE 451 - Image analysis and Pattern Recognition
Professor : Jean-Philippe Thiran

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

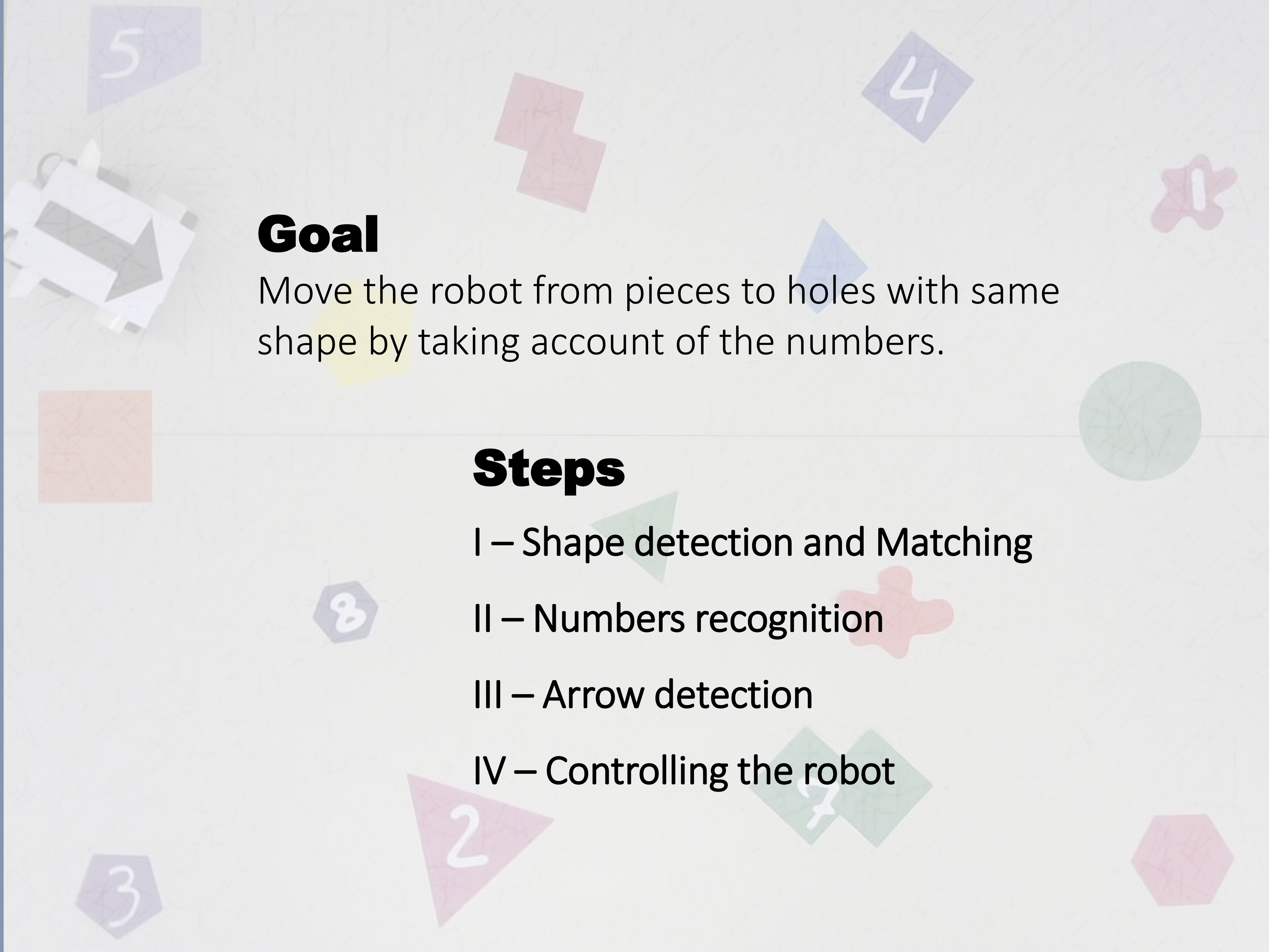
Final Project Presentation

Team O

Sohyeong KIM, Mathieu LAMIOT
Xingce BAO, Milica NOVAKOVIC

01.06.2018

Overview



Goal

Move the robot from pieces to holes with same shape by taking account of the numbers.

Steps

I – Shape detection and Matching

II – Numbers recognition

III – Arrow detection

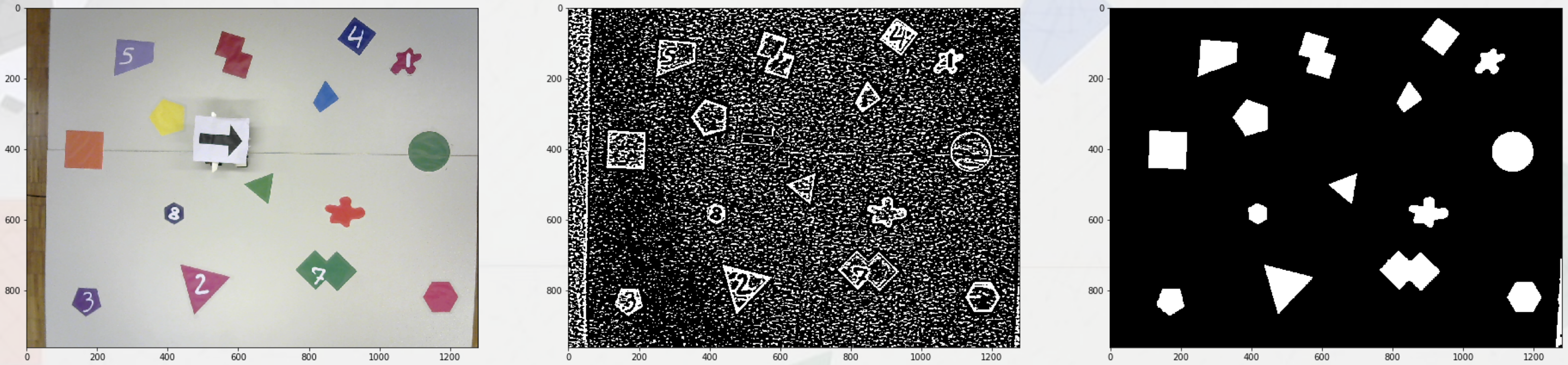
IV – Controlling the robot

Step 1

Shape detection and Matching

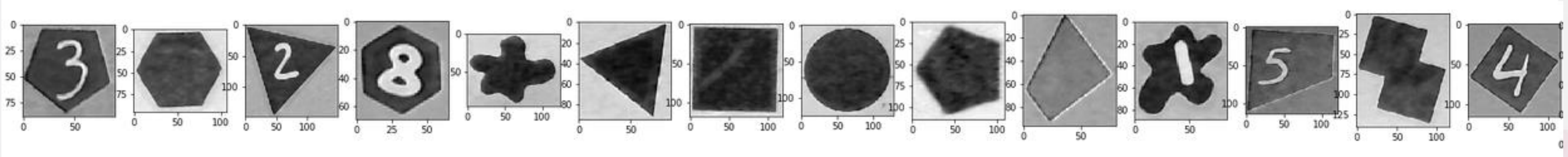
Preprocessing

- *Adaptive thresholding*
- *Morphological Process(Closing and Opening) : Remove un-relevant objects*



Segmentation

- *Count white pixels* inside the objects: **Piece or Hole**?
- **Find circle** with *compacity*

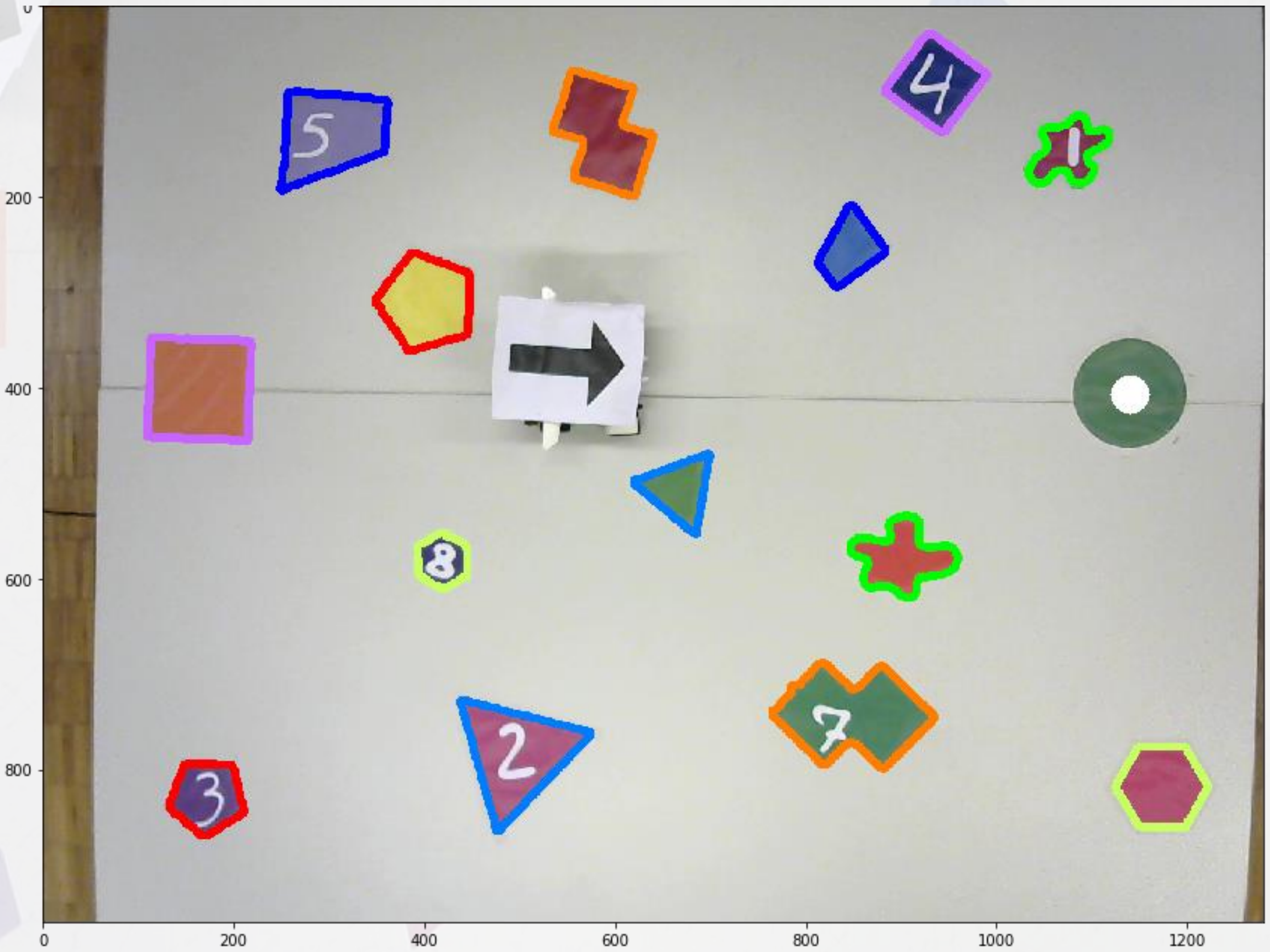


Step 1

Shape detection and Matching

Matching

- *Use contours of the objects*
- Based on n*umber of edges* and *Hu moments*



Step 2

Numbers recognition

MNIST Data Pre-processing

- **Objective** : for rotation invariant model
- Zoom to a random ratio from 0.7 to 1.0
- Rotate to a random angle

Neural Network

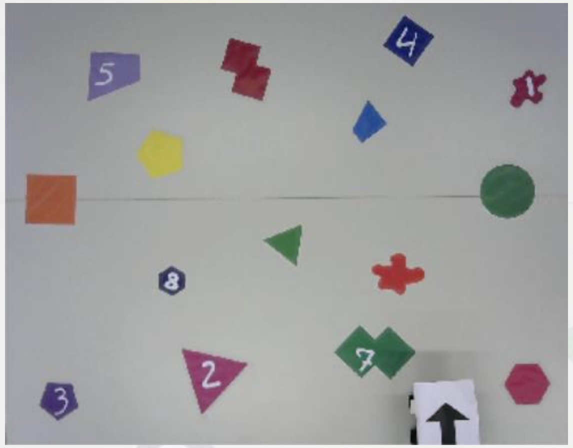
```
conv2d(filters=32,kernel_size=(5,5),padding='same',activation=tf.nn.relu)
conv2d(filters=32,kernel_size=(5,5),padding='same',activation=tf.nn.relu)
max_pooling2d(pool_size=(2,2),strides=(1,1))
batch_normalization()
dropout(rate=0.25)
conv2d(filters=64,kernel_size=(3,3),padding='same',activation=tf.nn.relu)
conv2d(filters=64,kernel_size=(3,3),padding='same',activation=tf.nn.relu)
max_pooling2d(pool_size=(2,2),strides=(2,2))
batch_normalization()
dropout(rate=0.25)
flatten()
dense(256,activation = tf.nn.relu)
batch_normalization()
dropout(rate=0.5)
dense(9)
softmax()
```

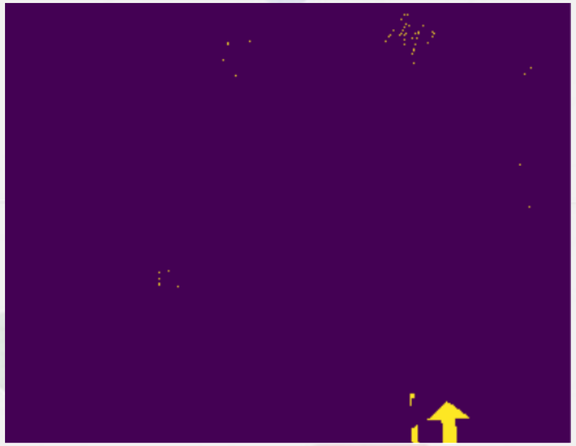
Step 3

Arrow Detection

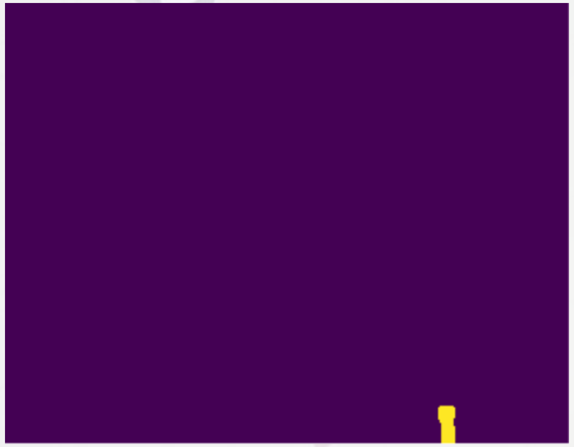
Retrieving the arrow

- *Threshold* for **black pixels**
- *Opening* to **erase artefacts**
- *Region Growing* to **retrieve the arrow**

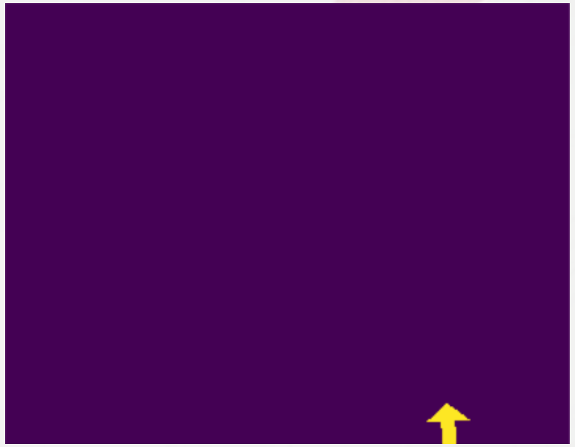




1



2



3

Step 3

Arrow Detection

Obtain position and angle

- **Position**: Mean of the pixels
- **Angle**: µ-moments and quadrant checking

$$\alpha = \frac{1}{2} arctg \frac{2\mu_{1,1}}{\mu_{2,0} - \mu_{0,2}}$$

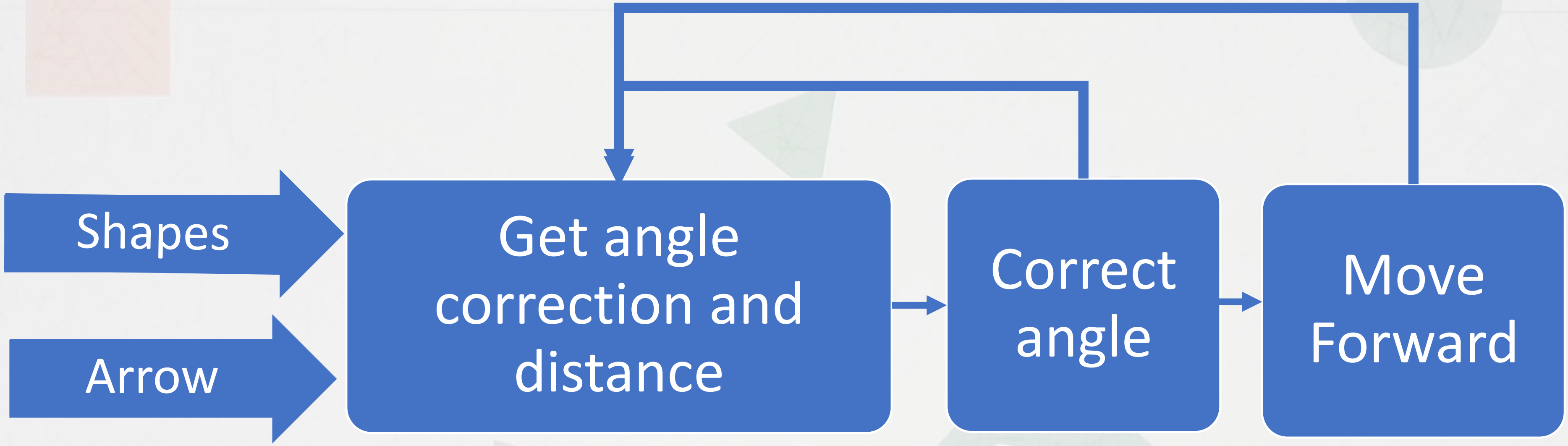
Step 4

Controlling the robot

Going to one shape(destination)

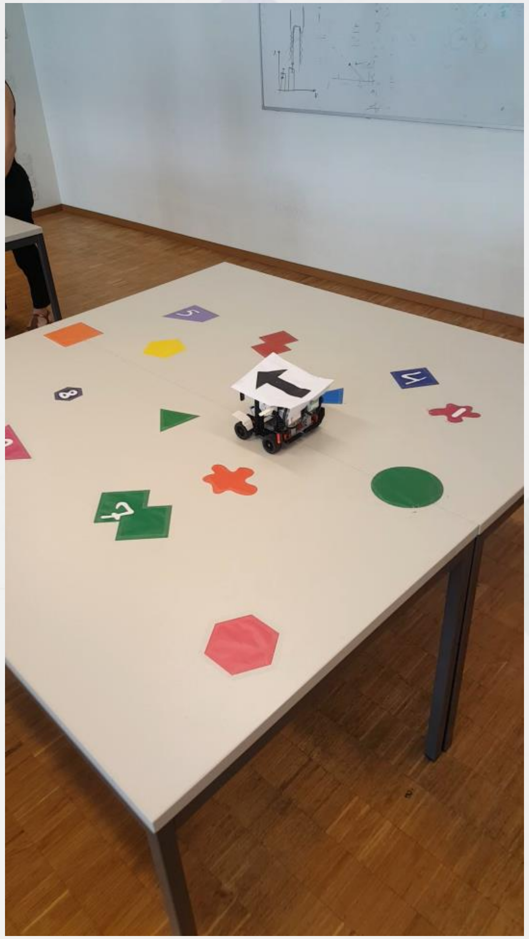
- Select a target
- Get arrow location and its angle
- Apply angle correction until it is good enough
- Move forward

Repeat above until the robot is close to the destination



DEMO

Video Recording
of the Demonstration



Real Demonstration & Question