In [1]:
```
import os
import numpy as np
import pandas as pd
import cv2
import imutils
from PIL import Image
import skimage.measure
from pyzbar.pyzbar import decode
import matplotlib.pyplot as plt
import matplotlib.patches as patches
import tensorflow as tf
import argparse
```

In [33]:
```
def get_files(folder_path, ext=[], return_full_path=False):
    _files = [f for f in os.listdir(folder_path) if os.path.isfile(os.path.j
    if return_full_path:
        _files = [os.path.join(folder_path, f) for f in _files]
    return _files


def get_msers(gray):
    mser = cv2.MSER_create()
    regions, _ = mser.detectRegions(gray)
    hulls = [cv2.convexHull(p.reshape(-1, 1, 2)) for p in regions]
    return regions, hulls


def extract_features(hull):

    mask = np.zeros(gray.shape, np.uint8)
    mask = cv2.drawContours(mask, [hull], -1, 255, -1)

    mean_intensity = cv2.mean(gray, mask = mask)
    area = cv2.contourArea(hull)

    (x, y), (width, height), angle = cv2.minAreaRect(hull)
    aspect_ratio = max(width, height) / (min(width, height) + 0.01)

    features = {'mean_intensity': mean_intensity[0],
                'area': area,
                'aspect_ratio': aspect_ratio,
                'angle': angle,
                'length': max(width, height)}

    return features


def classify(feats):
    # if feats['mean_intensity'] < 100 and feats['area'] > 1500 and feats['a
    if feats['length'] > 100.0 and feats['aspect_ratio'] > 10.0:
        return 1
    else:
        return 0


def get_rotated_cropped_image(image, rect):

    (x, y), (width, height), angle = rect
    img_copy = image.copy()

    box = cv2.boxPoints(rect)
    box = np.int0(box)
```

```
    Xs = [x[0] for x in box]
    Ys = [y[1] for y in box]
    x1 = min(Xs)
    y1 = min(Ys)
    x2 = max(Xs)
    y2 = max(Ys)

    center = (int((x1+x2)/2), int((y1+y2)/2))
    size = (int(x2-x1), int(y2-y1))

    rotation_matrix = cv2.getRotationMatrix2D((size[0]/2, size[1]/2), angle-

    cropped_barcode_reg = cv2.getRectSubPix(img_copy, size, center)

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(cropped_barcode_reg)
    plt.title("getRectSubPix")
    plt.show()

    cropped_barcode_reg = cv2.warpAffine(cropped_barcode_reg, rotation_matri

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(cropped_barcode_reg)
    plt.title("warpAffine")
    plt.show()

    cropped_width = width
    cropped_height = height

    cropped_barcode_reg_tight = cv2.getRectSubPix(cropped_barcode_reg,
                                                  (int(cropped_height), int(
                                                  (size[0]/2, size[1]/2))

    if cropped_barcode_reg_tight.shape[0] > cropped_barcode_reg_tight.shape[
        cropped_barcode_reg_tight = cv2.rotate(cropped_barcode_reg_tight, cv

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(cropped_barcode_reg_tight)
    plt.title("Final Crop")
    plt.show()

    return cropped_barcode_reg_tight


def get_barcode_region(hulls, save_detection_results=False, file_name=None):

    selected_hulls = []
    for index, hull in enumerate(hulls):
        features = extract_features(hull)
        if classify(features) == 1:
            selected_hulls.append(hull)

    if len(selected_hulls) == 0:
        return np.zeros((256, 256), np.uint8)

    mask = np.zeros(gray.shape, np.uint8)
    mask_all = cv2.drawContours(mask, selected_hulls, -1, 255, -1)

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
```

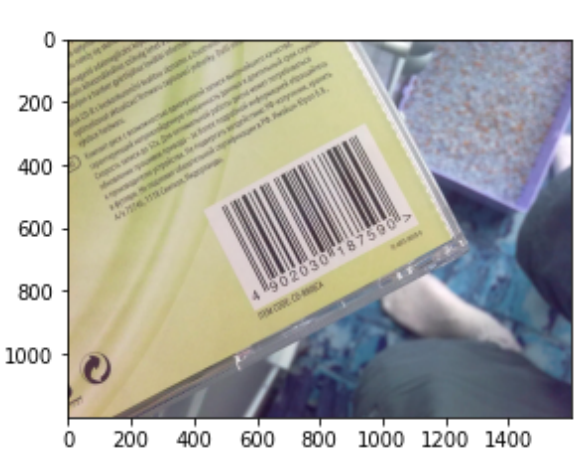
```
    axs.imshow(mask_all, cmap="Greys_r")
    plt.title("1. Classification Output")
    plt.show()

    kernel = np.ones((5,5), np.uint8)
    mask_d = cv2.dilate(mask_all, kernel, iterations=10)

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(mask_d, cmap="Greys_r")
    plt.title("2. Dilated Mask")
    plt.show()

    cropped_barcode_regions = []
    labeled_image, count = skimage.measure.label(mask_d, connectivity=2, ret

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(labeled_image)
    plt.title("3. Connected Components")
    plt.show()

    for label in range(1, count+1):
        mask_i = np.zeros((labeled_image.shape[0], labeled_image.shape[1]),
        mask_i[labeled_image == label] = 1
        area = np.sum(mask_i)
        if area > 2500:
            contours, hierarchy = cv2.findContours(mask_i, cv2.RETR_EXTERNAL

            # Plot
            contours_image = np.zeros((gray.shape[0], gray.shape[1], 3), np.
            contours_image = cv2.drawContours(contours_image, contours, -1,
            fig, axs = plt.subplots(1, 1, figsize=(5,5))
            axs.imshow(contours_image)
            plt.title("4. Contours, Component={}".format(label))
            plt.show()

            rect = cv2.minAreaRect(contours[0])

            # Plot
            box = cv2.boxPoints(rect)
            box = np.int0(box)
            contours_image = np.zeros((gray.shape[0], gray.shape[1], 3), np.
            contours_image = cv2.drawContours(contours_image, [box], -1, (0,
            fig, axs = plt.subplots(1, 1, figsize=(5,5))
            axs.imshow(contours_image)
            plt.title("5. Rotated BB, Component={}".format(label))
            plt.show()

            cropped_barcode_reg = get_rotated_cropped_image(gray, rect)

            _cropped_barcode_regions = [cropped_barcode_reg,
                                        cropped_barcode_reg[::-1,:],
                                        cropped_barcode_reg[:,::-1],
                                        cropped_barcode_reg[::-1,::-1]]

            cropped_barcode_regions.extend(_cropped_barcode_regions)
            if save_detection_results:
                selected_contours.append(contours)

    return cropped_barcode_regions


def get_barcode_region_cnn(model, gray, tile_size=(64,64), save_detection_re
```

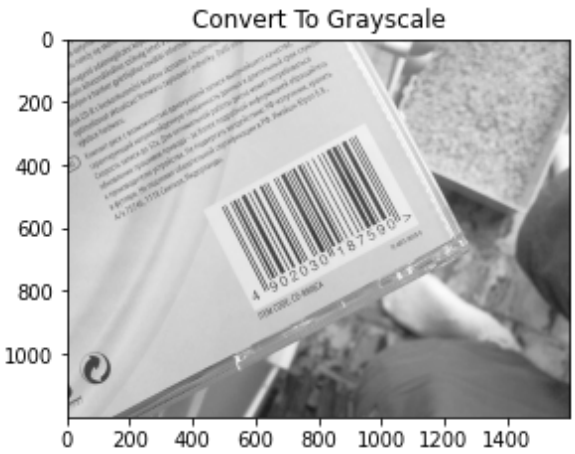
```
    _gray = gray.copy()
    _gray = _gray.astype(np.float32)
    _gray /= 255.0

    H = tile_size[0]
    W = tile_size[1]
    slices = dict([((x,y), np.expand_dims(_gray[y:y+H,x:x+W], axis=2)) for y

    positive_coords = []
    negative_coords = []
    mask = np.zeros(gray.shape, np.uint8)

    for index, (x,y) in enumerate(slices):
        sz = slices[(x,y)].shape
        if sz[0] == H and sz[1] == W:
            if classify_cnn(model, slices[(x,y)]) == 1:
                mask[y:y+H,x:x+W] = 1
                positive_coords.append((x,y))
            else:
                negative_coords.append((x,y))

    if len(positive_coords) == 0:
        return np.zeros((256, 256), np.uint8)

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(mask, cmap="Greys_r")
    plt.title("1. Classification Output")
    plt.show()

    kernel = np.ones((5,5), np.uint8)
    mask_d = cv2.erode(mask, kernel, iterations=10)
    # mask_d = cv2.dilate(mask_d, kernel, iterations=10)

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(mask_d, cmap="Greys_r")
    plt.title("2. Dilated Mask")
    plt.show()

    if save_detection_results:
        save_detections(gray, positive_coords, negative_coords, tile_size, o
        plot(mask, os.path.join("../results/debug/", "detection_mask_" + fil
        plot(mask_d, os.path.join("../results/debug/", "detection_mask_dilat

    # kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (5, 5))
    # closing = cv2.morphologyEx(mask, cv2.MORPH_CLOSE, kernel)

    cropped_barcode_regions = []
    # N, labels = cv2.connectedComponents(mask, 4, cv2.CV_32S)

    if save_detection_results:
        selected_contours = []

    labeled_image, count = skimage.measure.label(mask_d, connectivity=2, ret

    # Plot
    fig, axs = plt.subplots(1, 1, figsize=(5,5))
    axs.imshow(labeled_image)
    plt.title("3. Connected Components")
    plt.show()

    for label in range(1, count+1):
```

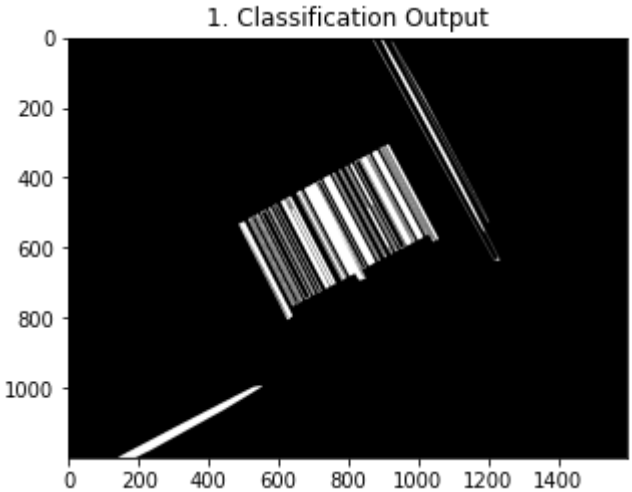
```
        mask_i = np.zeros((labeled_image.shape[0], labeled_image.shape[1]),
        mask_i[labeled_image == label] = 1
        area = np.sum(mask_i)
        if area > 2500:
            contours, hierarchy = cv2.findContours(mask_i, cv2.RETR_EXTERNAL

            # Plot
            contours_image = np.zeros((gray.shape[0], gray.shape[1], 3), np.
            contours_image = cv2.drawContours(contours_image, contours, -1,
            fig, axs = plt.subplots(1, 1, figsize=(5,5))
            axs.imshow(contours_image)
            plt.title("4. Contours, Component={}".format(label))
            plt.show()

            rect = cv2.minAreaRect(contours[0])

            # Plot
            box = cv2.boxPoints(rect)
            box = np.int0(box)
            contours_image = np.zeros((gray.shape[0], gray.shape[1], 3), np.
            contours_image = cv2.drawContours(contours_image, [box], -1, (0,
            fig, axs = plt.subplots(1, 1, figsize=(5,5))
            axs.imshow(contours_image)
            plt.title("5. Rotated BB, Component={}".format(label))
            plt.show()

            cropped_barcode_reg = get_rotated_cropped_image(gray, rect)

            _cropped_barcode_regions = [cropped_barcode_reg,
                                        cropped_barcode_reg[::-1,:],
                                        cropped_barcode_reg[:,::-1],
                                        cropped_barcode_reg[::-1,::-1]]

            cropped_barcode_regions.extend(_cropped_barcode_regions)
            if save_detection_results:
                selected_contours.append(contours)

    if save_detection_results:
        save_selected_detections(selected_contours, mask_d, os.path.join("..

    return cropped_barcode_regions


def show_barcode(cropped_barcode_reg, outpath=None):
    fig = plt.figure()
    ax = fig.add_subplot(1, 1, 1)
    ax.imshow(cropped_barcode_reg, cmap='Greys_r', vmin=0, vmax=255)

    if outpath is not None:
        plt.savefig(outpath)
        plt.close()
    else:
        plt.show()


def get_ground_truth_barcode(file_name):
    with open(file_name, 'r') as file:
        data = file.read()
    return data


def load_model(model_dir, epoch):
    model = tf.keras.models.load_model(os.path.join(model_dir, "{0:02d}.h5".
    return model
```

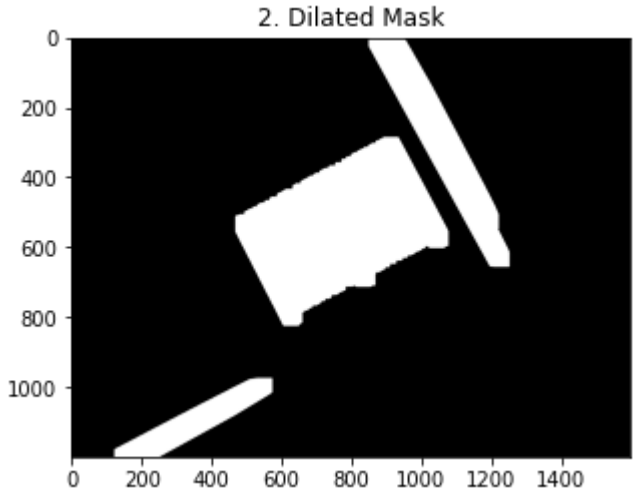
```
def classify_cnn(model, image):
    p = model(np.array([image]), training=False)
    return np.argmax(p[0])
```

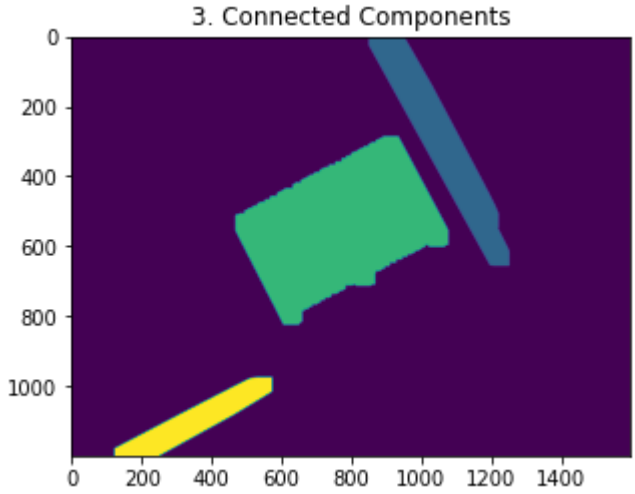
In [35]:
```
image = cv2.imread(os.path.join("../data/BarcodeDatasets", "Dataset1", "0510
gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

fig, axs = plt.subplots(1, 2, figsize=(10,20))
axs[0].imshow(image)
axs[1].imshow(gray, cmap="Greys_r")
plt.title("Convert To Grayscale")
plt.show()

regions, hulls = get_msers(gray)
cropped_barcode_reg = get_barcode_region(hulls)

# _model = load_model("../models/barcode_detector", 192)
# cropped_barcode_regions = get_barcode_region_cnn(_model, gray, tile_size=(
```

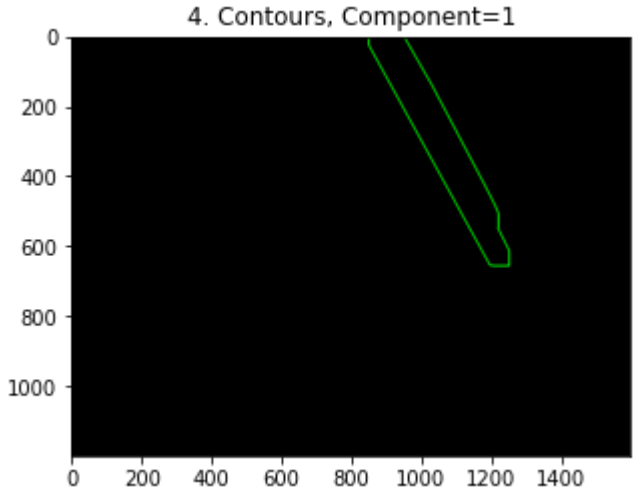


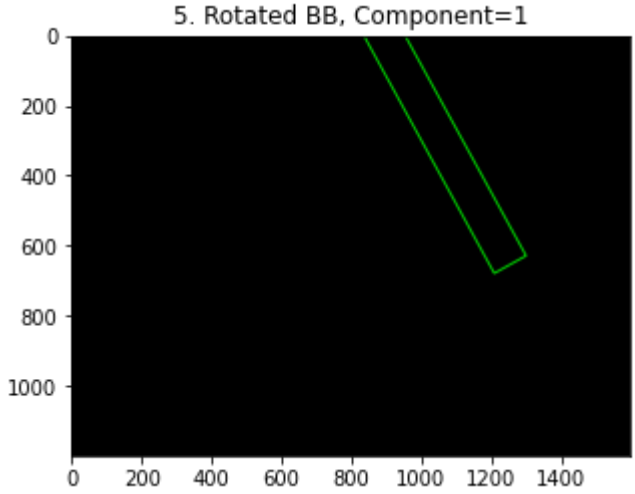


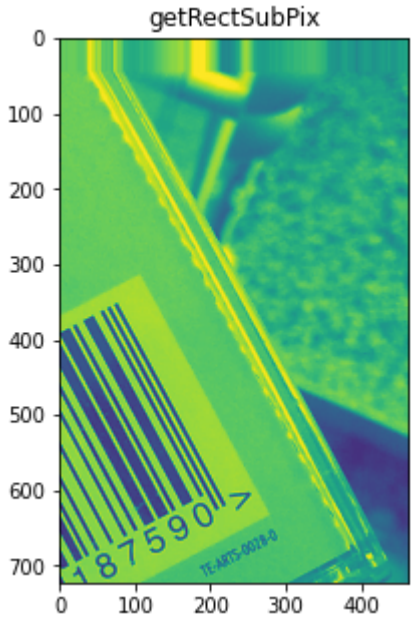


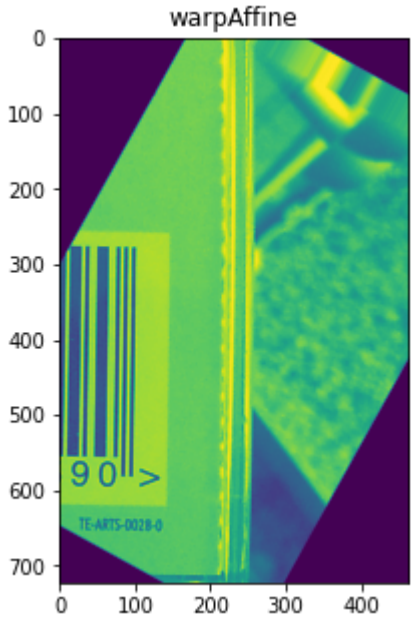

2. Dilated Mask
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400

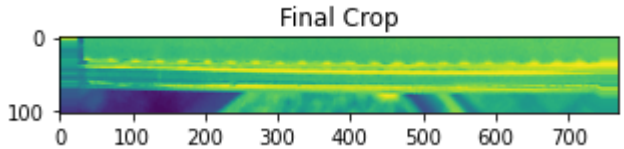

3. Connected Components
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400

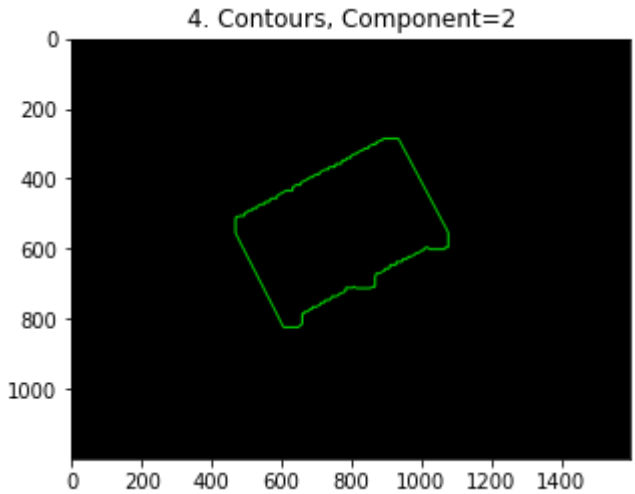

4. Contours, Component=1
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400

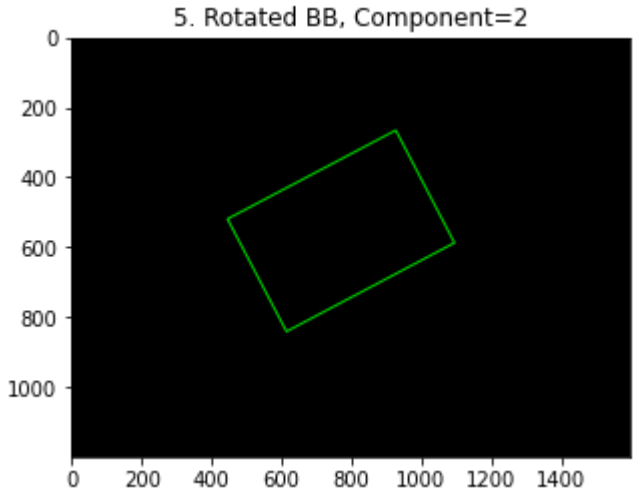

5. Rotated BB, Component=1
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400

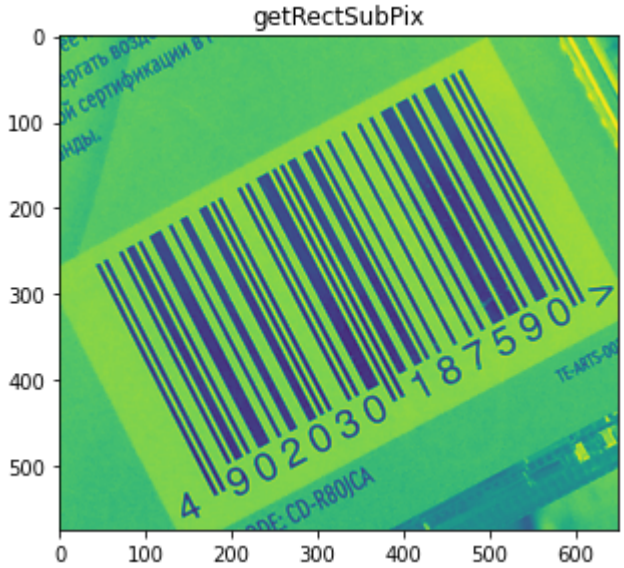

getRectSubPix
0
100
200
300
400
500
600
700
0
100
200
300
400

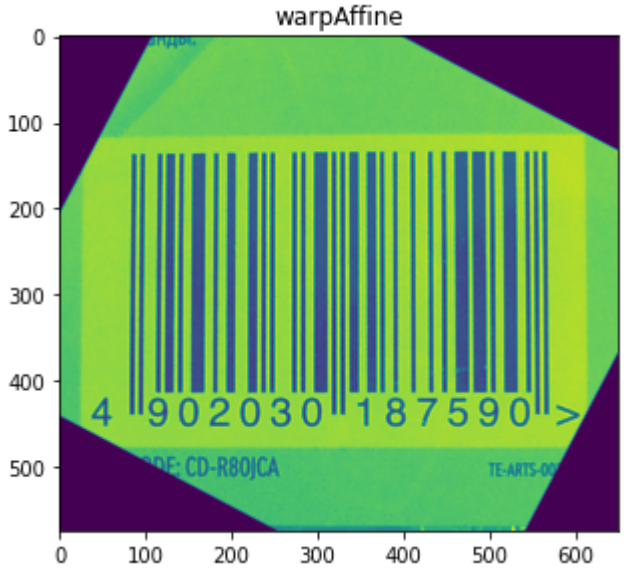

warpAffine
0
100
200
300
400
500
600
700
0
100
200
300
400

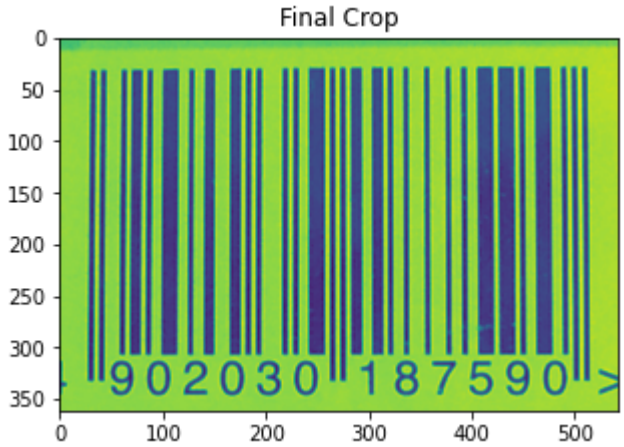

Final Crop
0
100
0
100
200
300
400
500
600
700

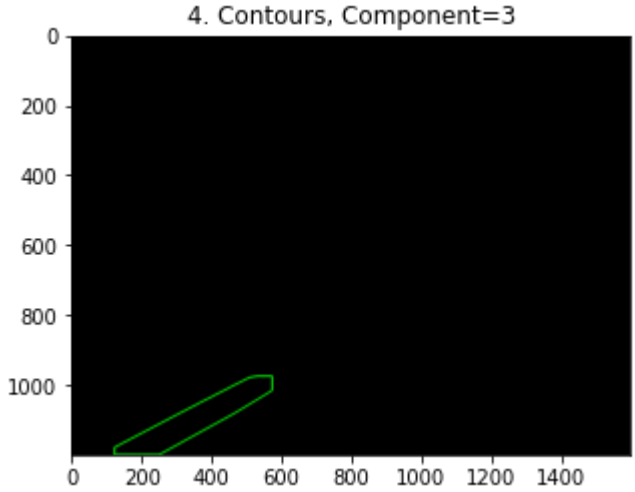

4. Contours, Component=2
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400

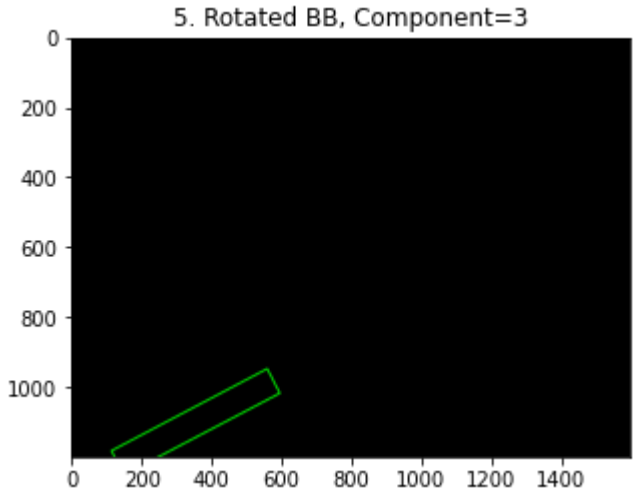

5. Rotated BB, Component=2

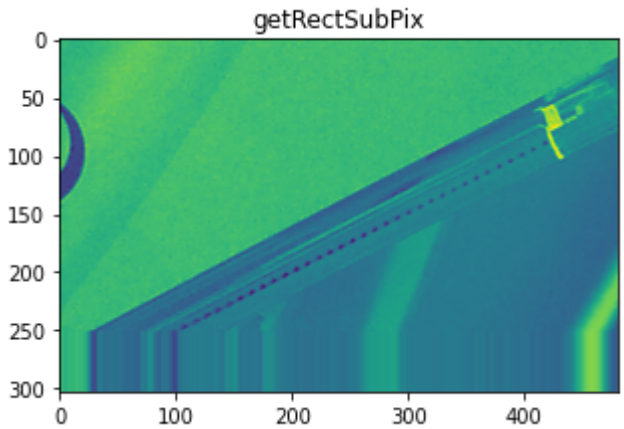

getRectSubPix

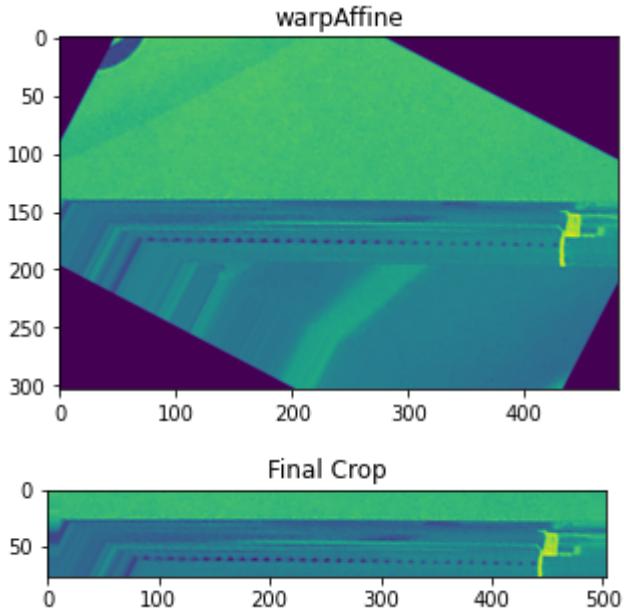

warpAffine


Final Crop
902030 187590


4. Contours, Component=3


5. Rotated BB, Component=3


getRectSubPix


warpAffine
0
50
100
150
200
250
300
0
100
200
300
400

Final Crop
0
50
0
100
200
300
400
500

In [ ]: