In [1]:

```
import cv2
from shapely.geometry import Polygon

from PIL import Image
import numpy as np
import os
import pandas as pd
import matplotlib.pyplot as plt

import torch
import torchvision
from torchvision.models.detection import FasterRCNN
from torchvision.models.detection.rpn import AnchorGenerator
from torchvision import models
from torch import nn

import pandas as pd
from PIL import ImageEnhance

import torch
from torchvision import models
from torch.nn import CrossEntropyLoss
from torch.nn.functional import softmax
from torch.optim import Adam,lr_scheduler
from torch.nn import functional as F
from torchvision import transforms
from torch.utils.data import Dataset
from utils_d import *

import sys

sys.path.append(r'E:\codes\python\area51m\pytorch_deeplab_xception')

from pytorch_deeplab_xception.modeling import deeplab

os.environ['TORCH_HOME'] = r'E:\data\MODELS' #setting the environment variable

device = torch.device("cuda:0" if torch.cuda.is_available() else 'cpu')
```

In [2]:

```
os.chdir(r'E:\UCL\Dissertation\label\input_test')
```

In [3]:

```
names = os.listdir(r'E:\UCL\Dissertation\label\input')
```

In [4]:

```
image_size = (900,900)
image_size_detail = (400,400)
number_of_class_firstmodel = 8
number_of_class_secondmodel = 2

transform_deeplab = transforms.Compose([transforms.Resize(image_size),
                        transforms.ToTensor(),
                        transforms.Normalize([0.485, 0.456, 0.406],[0.229, 0.224, 0.225])])

transform_deeplab_detail = transforms.Compose([transforms.Resize(image_size_detail),
                        transforms.ToTensor(),
                        transforms.Normalize([0.485, 0.456, 0.406],[0.229, 0.224, 0.225])])

dlab2 = deeplab.DeepLab(num_classes=number_of_class_firstmodel,backbone = 'resnet').to(device)

dlab2.load_state_dict(torch.load(r'E:\UCL\Dissertation\label\trained_models\model_deeplabv3+resnet_last_90(

_ = dlab2.eval()

for p in dlab2.parameters():
    p.requires_grad = False

dlab2_detail = deeplab.DeepLab(num_classes=number_of_class_secondmodel,backbone = 'resnet').to(device

dlab2_detail.load_state_dict(torch.load(r'E:\UCL\Dissertation\label\trained_models\model_deeplabv3+resnet_a

for p in dlab2_detail.parameters():
    p.requires_grad = False

_ = dlab2_detail.eval()
```

In [5]:

```
os.listdir()
```

Out[5]:

```
['.DS_Store',
 '1130_2.jpg',
 '20200104_130511.jpg',
 '6.jpg',
 'animage (26).jpg',
 'animage (29).jpg',
 'animage (3).jpg',
 'animage (32).jpg',
 'animage (35).jpg',
 'animage (38).jpg',
 'animage (6).jpg',
 'bothwell-11-07-2019.jpg',
 'bothwell-17-07-2019.jpg',
 'bothwell1-14-8-2019.jpeg',
 'bothwell2-18-07-2019.jpeg',
 'bothwell4-14-8-2019.jpeg',
 'Thumbs.db',
 'WhatsApp Image 2019-08-28 at 15.15.49.jpeg',
 'WhatsApp Image 2019-09-08 at 14.07.58.jpeg',
 'WhatsApp Image 2019-10-05 at 10.44.07.jpeg',
 'WhatsApp Image 2019-10-05 at 15.21.03(1).jpeg',
 'WhatsApp Image 2019-10-23 at 11.41.42.jpeg']
```

In [6]:

```
dpi = 96
```

In [7]:

```
imgname1 = r'animage (6).jpg'
img1 = Image.open(imgname1)#.rotate(-90,expand = True)
plt.figure(dpi = dpi)
plt.imshow(np.array(img1))
```

Out[7]:

```
<matplotlib.image.AxesImage at 0x202048ea8d0>
```

In [8]:

```
distance_list = []
for i in names:
    img2 = Image.open(r'E:\UCL\Dissertation\label\input\{0}'.format(i)).resize(img1.size)
    res = cv2.matchTemplate(np.array(img1),np.array(img2),cv2.TM_CCOEFF_NORMED)
    distance_list.append([i,float(res.squeeze())])
dis_a = np.array(distance_list)
```

In [9]:

```
sorted_names = dis_a[dis_a[:,1].argsort()][::-1]
sorted_names[1]
```

Out[9]:

```
array(['animage (41).jpg', '0.45082834362983704'], dtype='<U50')
```

In [10]:

```
img2 = Image.open(r'E:\UCL\Dissertation\label\input\{0}'.format(sorted_names[1,0])).resize(img1.size)
plt.figure(dpi = dpi)
plt.imshow(np.array(img2.resize(img1.size)))
```

Out[10]:

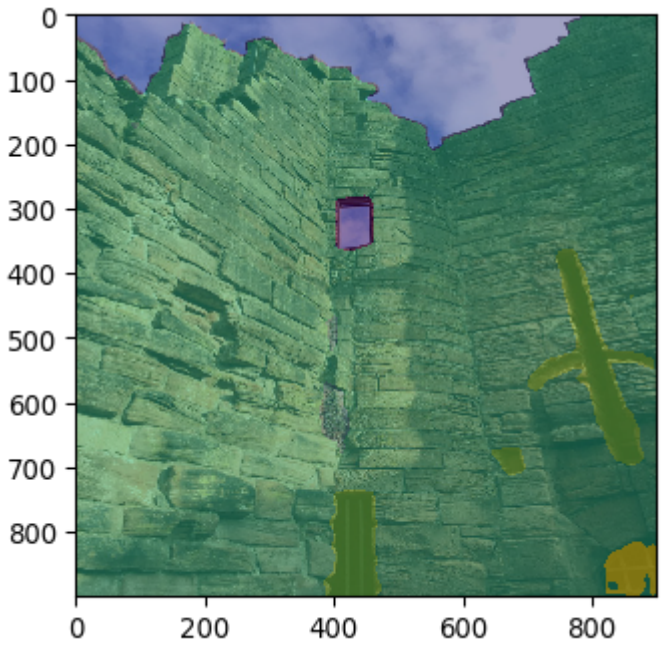
<matplotlib.image.AxesImage at 0x202049c1c18>

In [11]:

```
validation = transform_deeplab(img1).unsqueeze(0).to(device)
res= dlab2(validation,interpolate = True).squeeze()

plt.figure(dpi = dpi)
plt.imshow(np.array(img1.resize(image_size)))
plt.imshow(torch.argmax(res,axis = 0).detach().cpu().numpy(),alpha = 0.5)
```

Out[11]:

<matplotlib.image.AxesImage at 0x202049ea9b0>

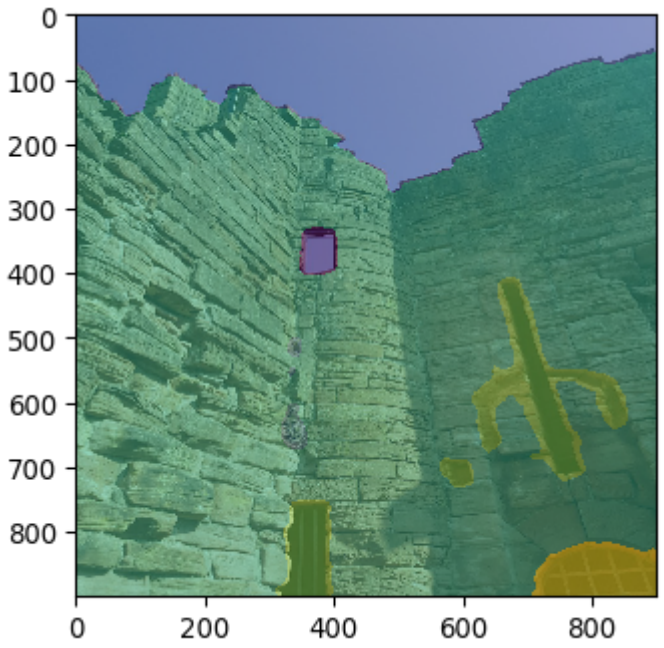


In [12]:

```
validation = transform_deeplab(img2).unsqueeze(0).to(device)
res= dlab2(validation,interpolate = True).squeeze()

plt.figure(dpi = dpi)
plt.imshow(np.array(img2.resize(image_size)))
plt.imshow(torch.argmax(res,axis = 0).detach().cpu().numpy(),alpha = 0.5)
```

Out[12]:

<matplotlib.image.AxesImage at 0x20204a7fd68>



In [13]:

```
predicted_image1 = predict(img1,transform_deeplab,transform_deeplab_detail,dlab2,dlab2_detail,3,img1.size,s
predicted_image2 = predict(img2,transform_deeplab,transform_deeplab_detail,dlab2,dlab2_detail,3,img1.size,s
```

In [14]:

```
img,area_list,polygon_list,coordinates = find_window(img1,dlab = dlab2,transform_deeplab = transform_deepla
img_,area_list_,polygon_list_,coordinates_ = find_window(img2,dlab = dlab2,transform_deeplab = transform_d
```

In [15]:

```
from shapely.affinity import scale
from shapely import affinity
def adjust_polygon(polygon):
    rotated = affinity.rotate(polygon,180,'centroid')
    flipped = scale(rotated, xfact = -1, origin = (1, 0))
    return flipped
```

In [16]:

```
plt.imshow(img);plt.axis('off')
```

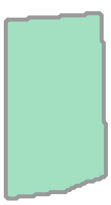
Out[16]:

(-0.5, 151.5, 207.5, -0.5)

In [17]:

```
adjust_polygon(polygon_list[0])
```

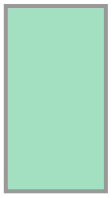
Out[17]:



In [18]:

```
adjust_polygon(polygon_list[0]).minimum_rotated_rectangle
```

Out[18]:



In [19]:

```
plt.imshow(img_);plt.axis('off')
```

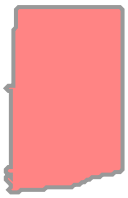
Out[19]:

(-0.5, 139.5, 207.5, -0.5)

In [20]:

```
adjust_polygon(polygon_list_[0])
```

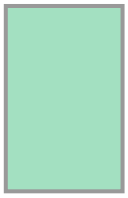
Out[20]:



In [21]:

```
adjust_polygon(polygon_list_[0]).minimum_rotated_rectangle
```

Out[21]:



In [22]:

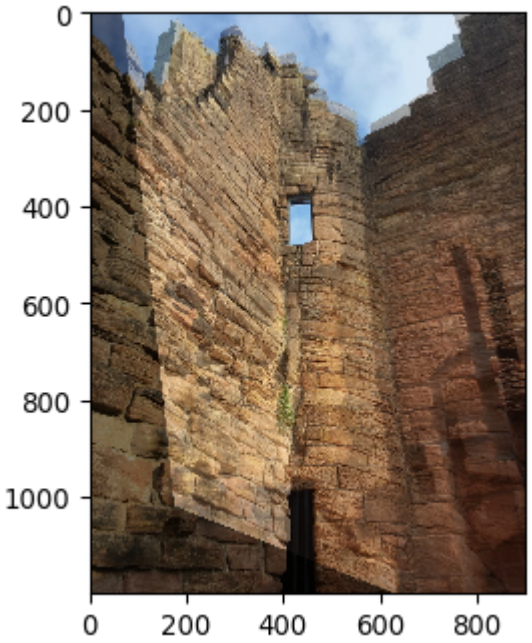
```
try:
    label1 = Image.open(r'E:\UCL\Dissertation\label\download_test\{0}'.format(imgname1.split('.')[0]+'_plants.png
except:
    label1 = Image.fromarray(np.zeros((img1.size[0],img1.size[1],3)).astype(np.uint8))
try:
    label2 = Image.open(r'E:\UCL\Dissertation\label\download\{0}'.format('.'.join(sorted_names[1,0].split('.')[:-1])+
except:
    label2 = Image.fromarray(np.zeros((img2.size[0],img2.size[1],3)).astype(np.uint8))
```

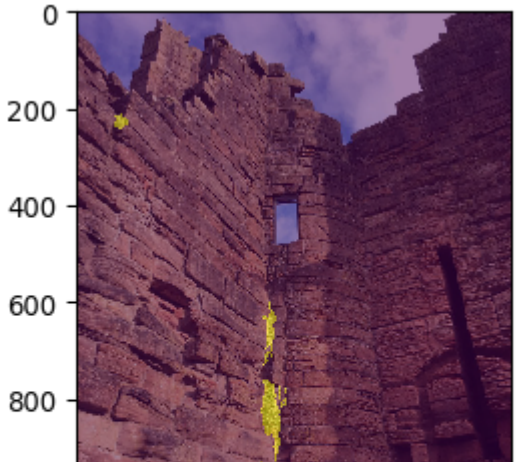
In [23]:

```
h, mask = cv2.findHomography(adjust_position(outter(polygon_list_[0],out = True),coordinates_[0][0],coordinat
                             adjust_position(outter(polygon_list[0],out = True),coordinates[0][0],coordinates[0][1]))

warped_original = cv2.warpPerspective(np.array(img2), h, img2.size)
warped_prediction = cv2.warpPerspective(predicted_image2, h, Image.fromarray(predicted_image2).size)

plt.figure(dpi =dpi)
plt.imshow(np.array(img1))
plt.imshow(warped_original,alpha = 0.5)

plt.figure(dpi =dpi)
plt.imshow(np.array(img1))
plt.imshow(predicted_image1,alpha = 0.5)

plt.figure(dpi =dpi)
plt.imshow(np.array(img2))
plt.imshow(predicted_image2,alpha = 0.5)


plt.figure(dpi =dpi)
plt.imshow(warped_original,alpha = 1)

plt.imshow(np.array(img1),alpha = 0.5)

plt.imshow(warped_prediction,alpha = 0.25)
plt.imshow(predicted_image1,alpha = 0.25)
plt.axis('off')
```

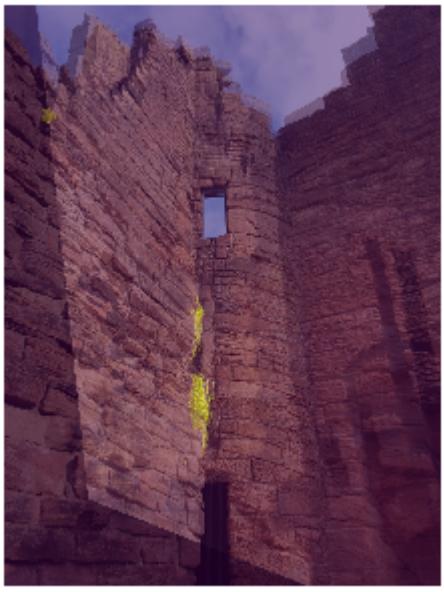
Out[23]:

(-0.5, 899.5, 1199.5, -0.5)




0
200
400
600
800


0
200
400
600
800
1000
0
200
400
600
800

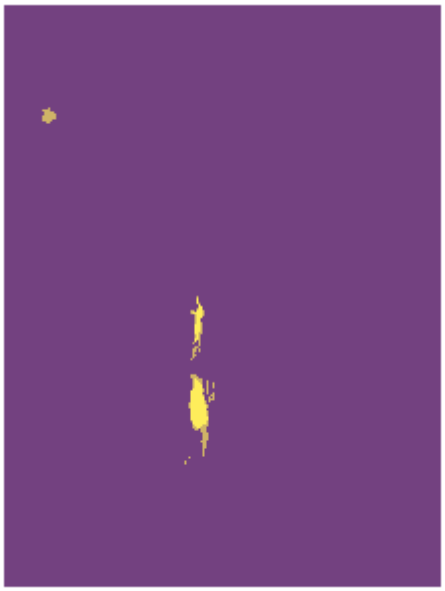


In [24]:

```
plt.figure(dpi = dpi)
plt.imshow(np.array(label1).sum(axis = 2),alpha = 0.5)
plt.imshow(predicted_image1,alpha = 0.5)
plt.axis('off')
```

Out[24]:

(-0.5, 899.5, 1199.5, -0.5)



In [25]:

```
IoU(torch.tensor(np.logical_not(np.array(label1).sum(axis = 2)==0).astype(float)),
    torch.tensor(predicted_image1.astype(float)),2)
```

0 0.9970818972682955
1 0.5102104442712393

Out[25]:

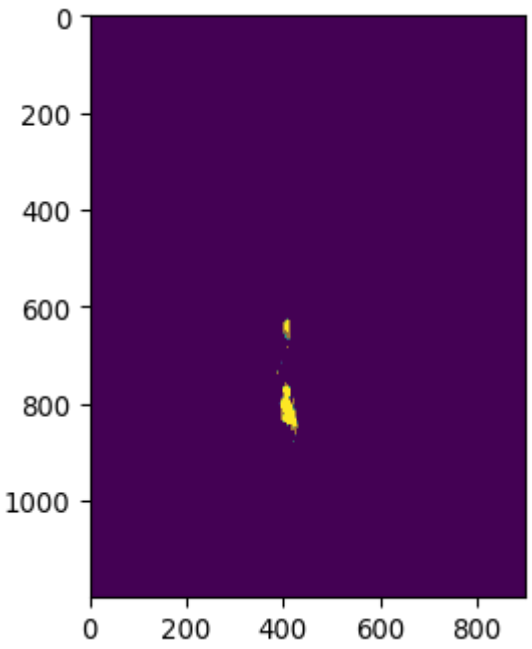
0.7536461707697675

In [26]:

```
warped_label = cv2.warpPerspective(np.array(label2), h, label2.size)

plt.figure(dpi =dpi)
plt.imshow(warped_prediction,alpha = 1)
plt.imshow(warped_label.sum(axis = 2),alpha = 0.5)
```

Out[26]:

<matplotlib.image.AxesImage at 0x2020fcab518>



In [27]:

```
h, mask = cv2.findHomography(adjust_position(outter(polygon_list_[0],out = False),coordinates_[0][0],coordina
                             adjust_position(outter(polygon_list[0],out = False),coordinates[0][0],coordinates[0][1]))

warped_original = cv2.warpPerspective(np.array(img2), h, img2.size)
warped_prediction = cv2.warpPerspective(predicted_image2, h, Image.fromarray(predicted_image2).size)

plt.figure(dpi =dpi)
plt.imshow(np.array(img1))
plt.imshow(warped_original,alpha = 0.5)

plt.figure(dpi =dpi)
plt.imshow(np.array(img1))
plt.imshow(predicted_image1,alpha = 0.5)

plt.figure(dpi =dpi)
plt.imshow(np.array(img2))
plt.imshow(predicted_image2,alpha = 0.5)

plt.figure(dpi =dpi)
plt.imshow(warped_original,alpha = 1)

plt.imshow(np.array(img1),alpha = 0.5)

plt.imshow(warped_prediction,alpha = 0.25)
plt.imshow(predicted_image1,alpha = 0.25)
plt.axis('off')
```

Out[27]:

(-0.5, 899.5, 1199.5, -0.5)


0
200
400
600
800
1000
0
200
400
600
800

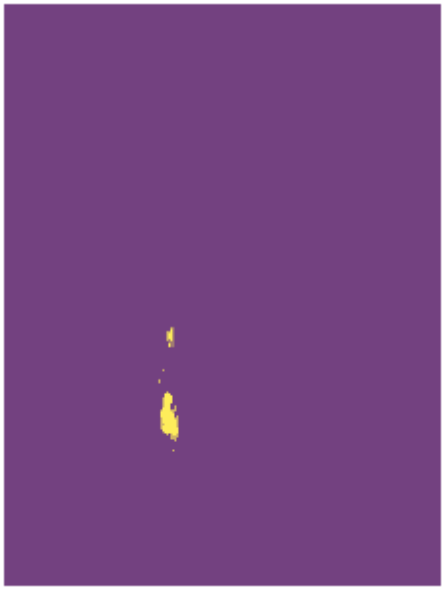

0
200
400
600
800
1000
0
200
400
600
800

In [28]:

```
plt.figure(dpi = dpi)
plt.imshow(np.array(label2).sum(axis = 2),alpha = 0.5)
plt.imshow(predicted_image2,alpha = 0.5)
plt.axis('off')
```

Out[28]:

(-0.5, 899.5, 1199.5, -0.5)



In [29]:

```
IoU(torch.tensor(np.logical_not(np.array(label2).sum(axis = 2)==0).astype(float)),
    torch.tensor(predicted_image2.astype(float)),2)
```

```
0 0.9988487951309878
1 0.6169753086419754
```

Out[29]:

0.8079120518864815

In [30]:

```
warped_label = cv2.warpPerspective(np.array(label2), h, label2.size)

plt.figure(dpi =dpi)
plt.imshow(warped_prediction,alpha = 1)
plt.imshow(warped_label.sum(axis = 2),alpha = 0.5)
```

Out[30]:

<matplotlib.image.AxesImage at 0x20233c80518>