VISIRImageFusionPyTorch

February 26, 2023

[59]:
```
import numpy as np
from imageio import imread

import torch
import torch.nn
from torchvision.models.vgg import vgg19
import numpy as np
from sporco.util import tikhonov_filter

import torch
from torchvision.models.vgg import vgg19
import matplotlib.pyplot as plt
%matplotlib inline

import warnings
warnings.filterwarnings("ignore")
```

[60]:
```
#load images
gray = imread('Duine/thermal/7401i.bmp')
ir = imread('Duine/visual/7401v.bmp')
```

[61]:
```
device = torch.device("cuda") if torch.cuda.is_available() else torch.
 ↪device("cpu")

def lowpass(s, lda, npad):
    return tikhonov_filter(s, lda, npad)

def c3(s):
    if s.ndim == 2:
        s3 = np.dstack([s, s, s])
    else:
        s3 = s
    return np.rollaxis(s3, 2, 0)[None, :, :, :]

def l1_features(out):
    h, w, d = out.shape
    A_temp = np.zeros((h+2, w+2))
    l1_norm = np.sum(np.abs(out), axis=2)
    A_temp[1:h+1, 1:w+1] = l1_norm
    return A_temp

def fusion_strategy(feat_a, feat_b, source_a, source_b, unit):

    m, n = feat_a.shape
    m1, n1 = source_a.shape[:2]
    weight_ave_temp1 = np.zeros((m1, n1))
    weight_ave_temp2 = np.zeros((m1, n1))

    for i in range(1, m):
        for j in range(1, n):
            A1 = feat_a[i-1:i+1, j-1:j+1].sum() / 9
            A2 = feat_b[i-1:i+1, j-1:j+1].sum() / 9

            weight_ave_temp1[(i-2)*unit+1:(i-1)*unit+1, (j-2)*unit+1:
↪(j-1)*unit+1] = A1 / (A1+A2)
            weight_ave_temp2[(i-2)*unit+1:(i-1)*unit+1, (j-2)*unit+1:
↪(j-1)*unit+1] = A2 / (A1+A2)

    if source_a.ndim == 3:
        weight_ave_temp1 = weight_ave_temp1[:, :, None]
    source_a_fuse = source_a * weight_ave_temp1
    if source_b.ndim == 3:
        weight_ave_temp2 = weight_ave_temp2[:, :, None]
    source_b_fuse = source_b * weight_ave_temp2

    if source_a.ndim == 3 or source_b.ndim == 3:
        gen = np.atleast_3d(source_a_fuse) + np.atleast_3d(source_b_fuse)
    else:
        gen = source_a_fuse + source_b_fuse

    return gen

def get_activation(model, layer_numbers, input_image):
    outs = []
    out = input_image
    for i in range(max(layer_numbers)+1):
        with torch.no_grad():
            out = model.features[i](out)
        if i in layer_numbers:
            outs.append(np.rollaxis(out.detach().cpu().numpy()[0], 0, 3))
    return outs

def fuse(vis, ir, model=None):
    npad = 16
    lda = 5
    vis_low, vis_high = lowpass(vis.astype(np.float32)/255, lda, npad)
    ir_low, ir_high = lowpass(ir.astype(np.float32)/255, lda, npad)

    if model is None:
        model = vgg19(True)
    model.cpu().eval()
    relus = [2, 7, 12, 21]
    unit_relus = [1, 2, 4, 8]

    vis_in = torch.from_numpy(c3(vis_high)).cpu()
    ir_in = torch.from_numpy(c3(ir_high)).cpu()

    relus_vis = get_activation(model, relus, vis_in)
    relus_ir = get_activation(model, relus, ir_in)

    vis_feats = [l1_features(out) for out in relus_vis]
    ir_feats = [l1_features(out) for out in relus_ir]

    saliencies = []
    saliency_max = None
    for idx in range(len(relus)):
        saliency_current = fusion_strategy(vis_feats[idx], ir_feats[idx],␣
↪vis_high, ir_high, unit_relus[idx])
        saliencies.append(saliency_current)

        if saliency_max is None:
            saliency_max = saliency_current
        else:
            saliency_max = np.maximum(saliency_max, saliency_current)

    if vis_low.ndim == 3 or ir_low.ndim == 3:
        low_fused = np.atleast_3d(vis_low) + np.atleast_3d(ir_low)
    else:
        low_fused = vis_low + ir_low
    low_fused = low_fused / 2
    high_fused = saliency_max
    return low_fused +  high_fused
```

[62]:
```
plt.figure(figsize=(6, 6))
fused =  np.clip(fuse(gray, ir), 0, 1)
fused = np.rint(fused * 255).astype(np.uint8)
plt.imshow(fused, 'gray')
plt.axis('off')
plt.title('Fusion')
```

```
/tmp/ipykernel_211155/317246417.py:4: DeprecationWarning: Function
sporco.util.tikhonov_filter is deprecated; please use function
sporco.signal.tikhonov_filter instead.
  return tikhonov_filter(s, lda, npad)
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  return tikhonov_filter(s, lda, npad)
```
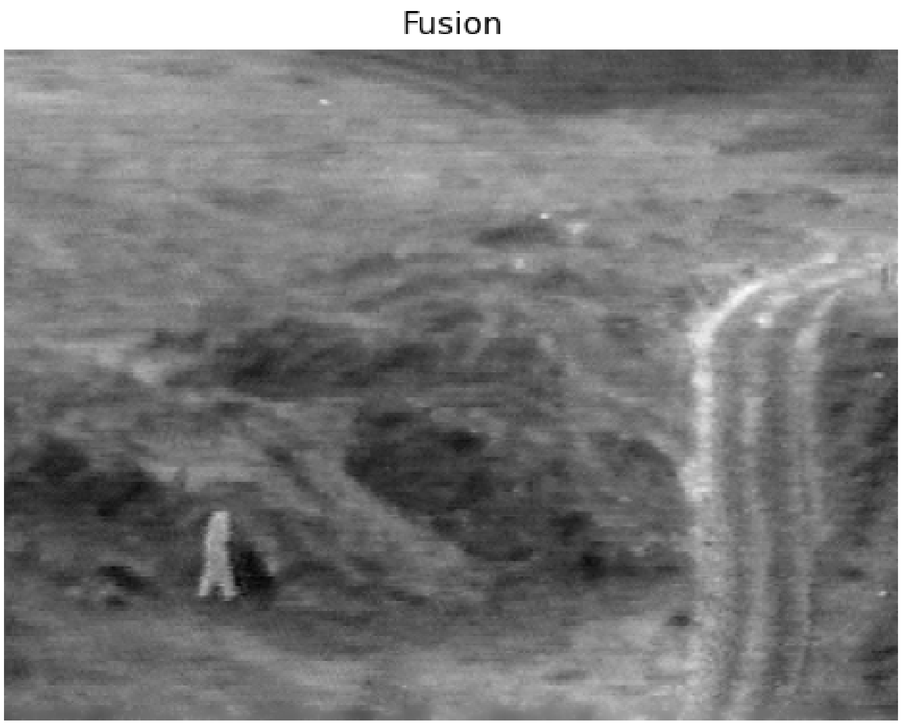

```
[62]: Text(0.5, 1.0, 'Fusion')
```



```
[64]: #saliency  model
      npad = 16
      lda = 5
      graylow, grayhigh = lowpass(gray.astype(np.float32)/255, lda, npad)
      irlow, irhigh = lowpass(ir.astype(np.float32)/255, lda, npad)

      grayhigh3 = c3(grayhigh)
      irhigh3 = c3(irhigh)

      model = vgg19(True).cpu().eval()

      gray_in = torch.from_numpy(grayhigh3).cpu()
      ir_in = torch.from_numpy(irhigh3).cpu()
```

```python
relus = [2, 7, 12, 21]
unit_relus = [1, 2, 4, 8]

relus_gray = get_activation(model, relus, gray_in)
relus_ir = get_activation(model, relus, ir_in)

gray_feats = [l1_features(out) for out in relus_gray]
ir_feats = [l1_features(out) for out in relus_ir]

saliencies = []
saliency_max = None
for idx in range(len(relus)):
    saliency_current = fusion_strategy(gray_feats[idx], ir_feats[idx],␣
  ↪grayhigh, irhigh, unit_relus[idx])
    saliencies.append(saliency_current)

    if saliency_max is None:
        saliency_max = saliency_current
    else:
        saliency_max = np.maximum(saliency_max, saliency_current)

    plt.imshow(saliency_current, 'gray')
    plt.axis('off')
    plt.show()

plt.imshow(saliency_max, 'gray')
plt.axis('off')
plt.show()
```

```
/tmp/ipykernel_211155/317246417.py:4: DeprecationWarning: Function
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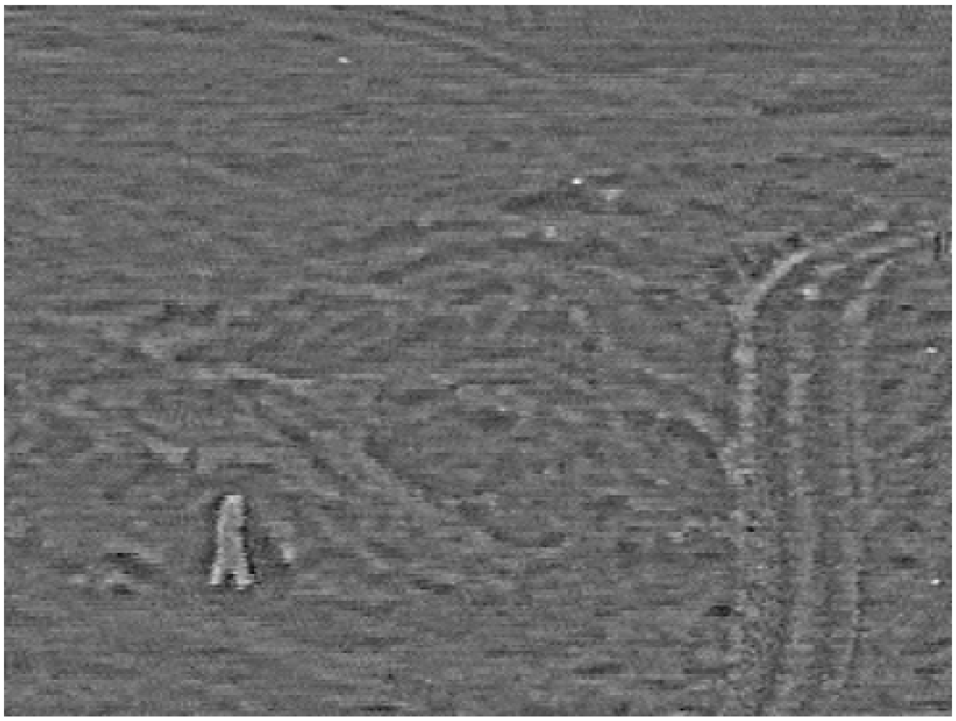
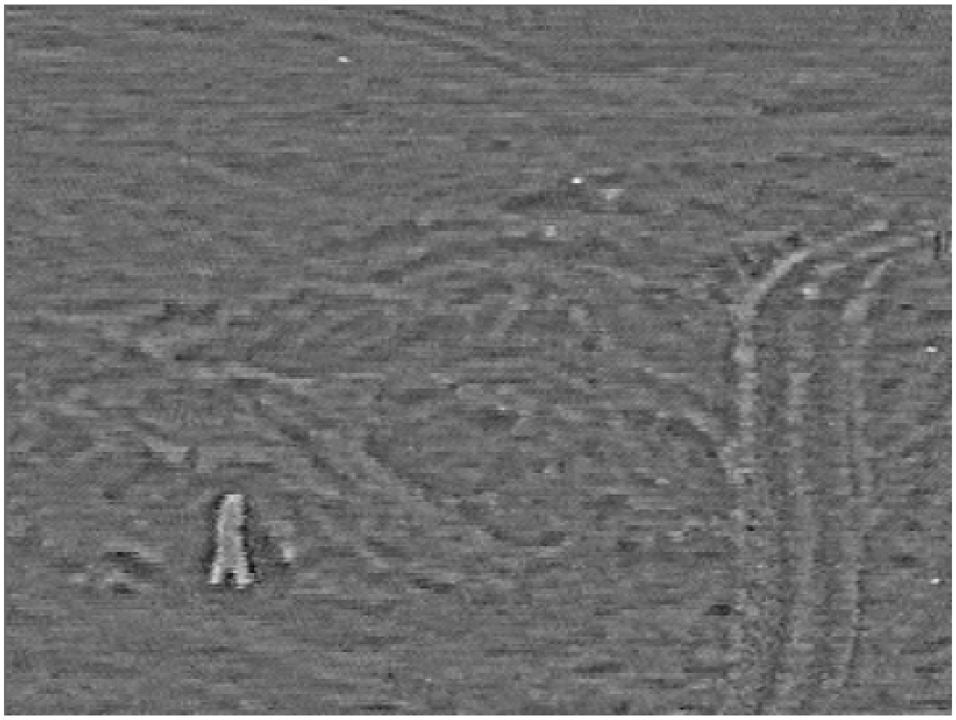
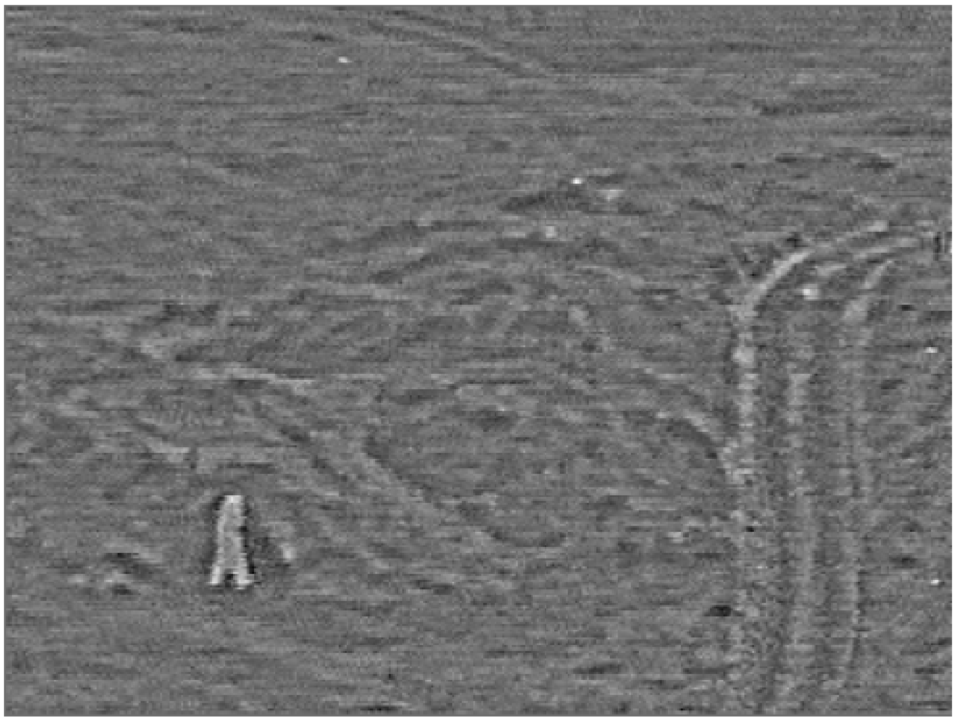
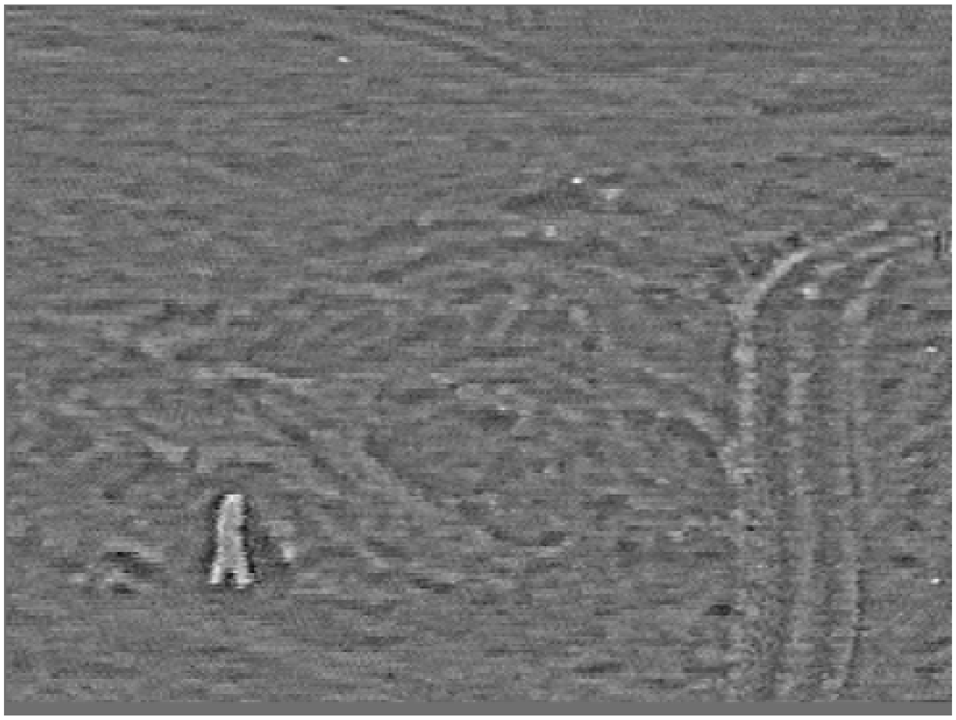
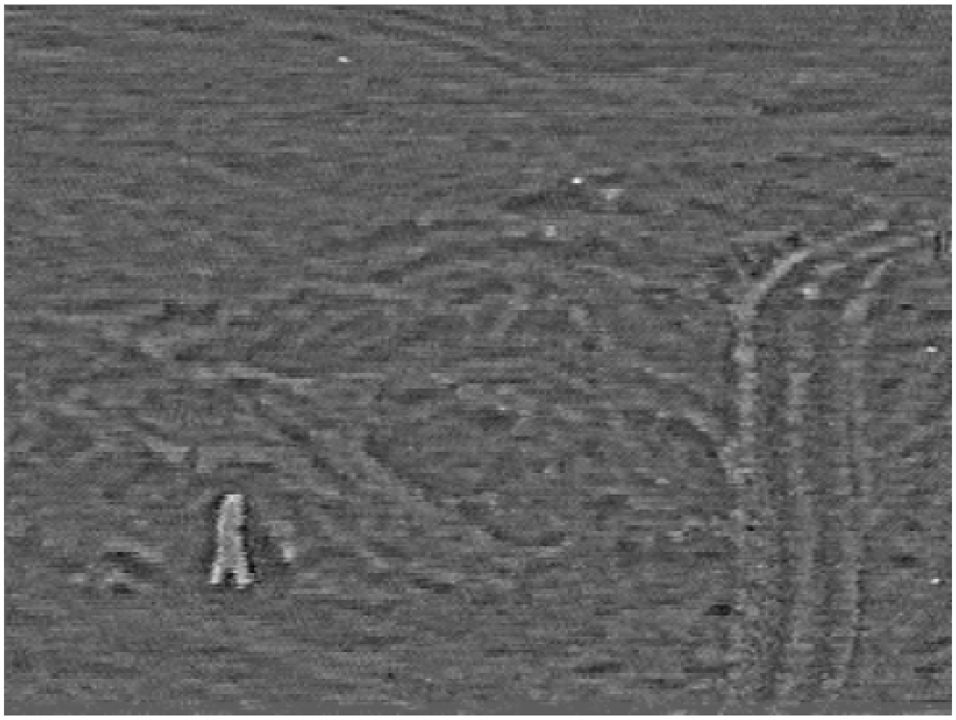









```
[66]: low_fused = (graylow + irlow) / 2
      high_fused = saliency_max

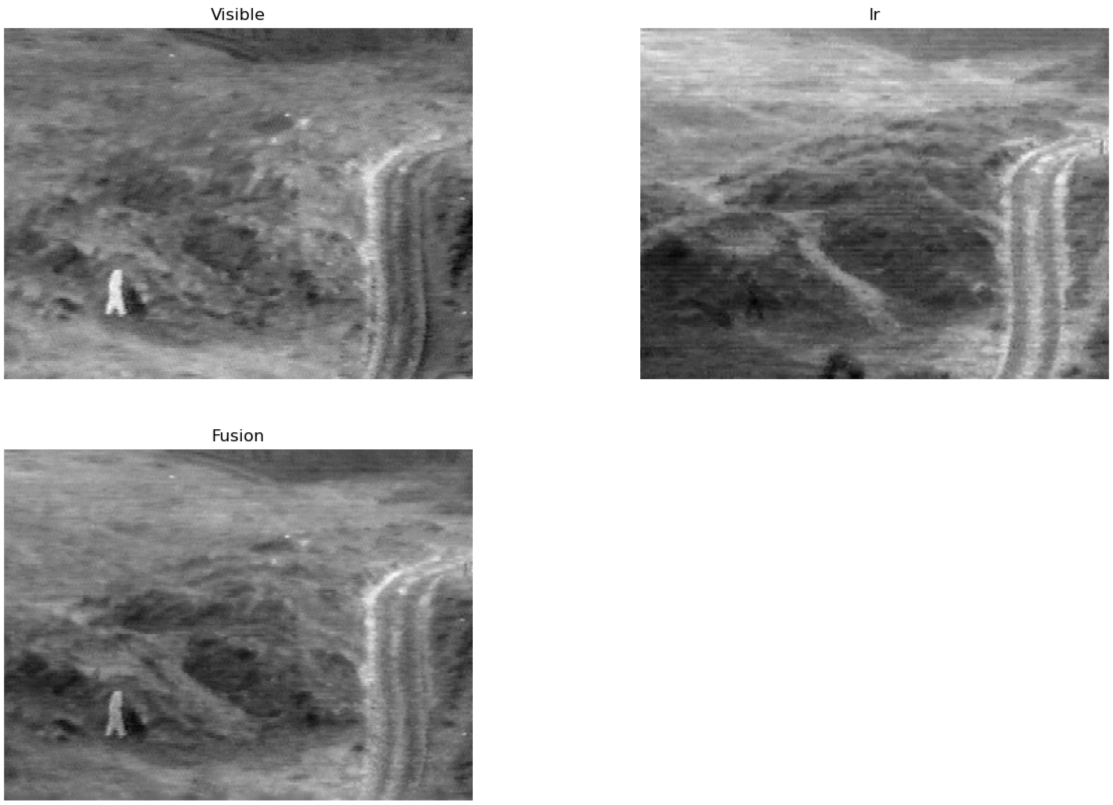
      fusion =  np.clip((low_fused + high_fused), 0, 1)
      fusion = np.rint(fusion * 255).astype(np.uint8)

      plt.figure(figsize=(15, 10))
      plt.subplot(2, 2, 1)
      plt.imshow(gray, 'gray')
      plt.axis('off')
      plt.title('Visible')

      plt.subplot(2, 2, 2)
      plt.imshow(ir, 'gray')
      plt.axis('off')
      plt.title('Ir')

      plt.subplot(2, 2, 3)
      plt.imshow(fusion, 'gray')
      plt.axis('off')
      plt.title('Fusion')
```

```
[66]: Text(0.5, 1.0, 'Fusion')
```


Visible
Ir
Fusion

[ ]:

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