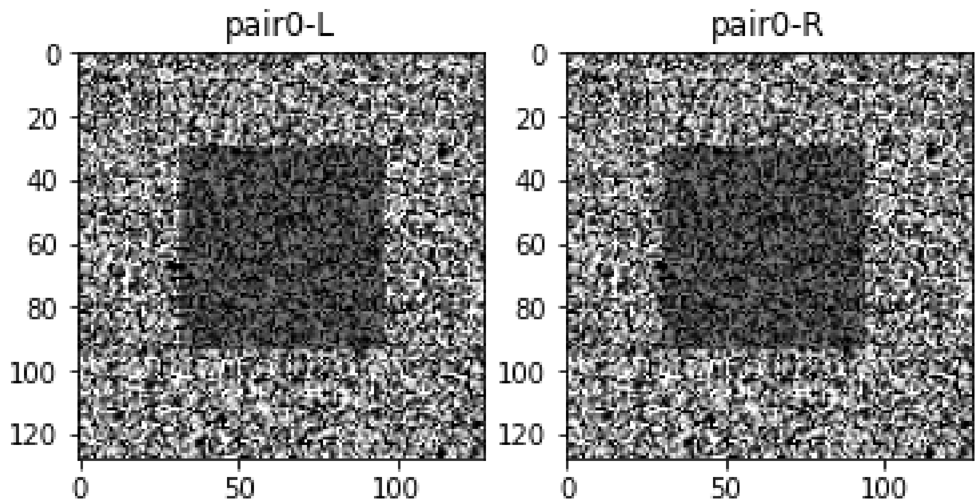
ps2

June 13, 2021

[1]:
```python
import os
import numpy as np
import cv2
import matplotlib.pyplot as plt
from scipy.signal import correlate2d
import math
from google.colab import files


from google.colab import drive
drive.mount('/content/drive', force_remount=True)

## 1-a
# Read images
L = cv2.imread('/content/drive/My Drive/computer vision/assignments/assignment4/
↪input/pair0-L.png', 0) * (1.0 / 255.0)  # grayscale, [0, 1]
R = cv2.imread('/content/drive/My Drive/computer vision/assignments/assignment4/
↪input/pair0-R.png', 0) * (1.0 / 255.0)



fig, ax = plt.subplots(1, 2)
ax[0].set_title('pair0-L')
ax[0].imshow(L, cmap='gray')
ax[1].set_title('pair0-R')
ax[1].imshow(R, cmap='gray');
```

```
Mounted at /content/drive
```

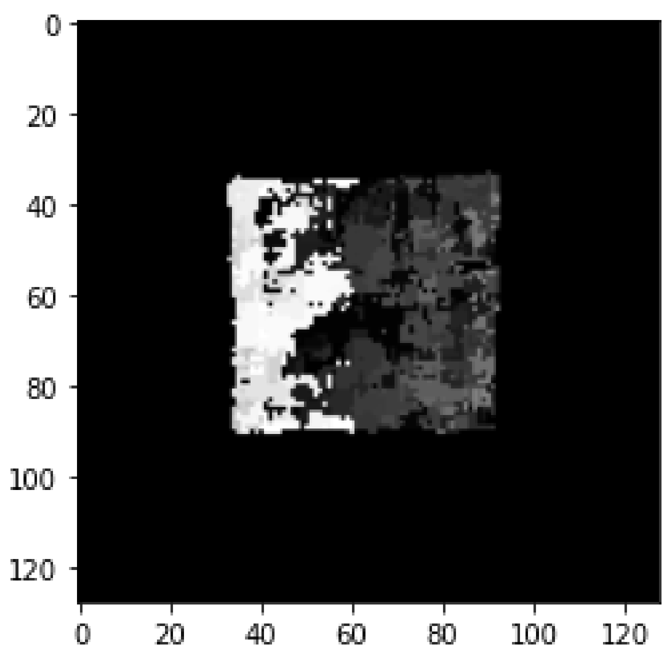



```
[ ]: def disparity_ssd(L, R):

        """Compute disparity map D(y, x) such that: L(y, x) = R(y, x + D(y, x))

          Params:
          L: Grayscale left image
          R: Grayscale right image, same size as L

          Returns: Disparity map, same size as L, R
          """

        # the size of the window we compare
        window = 11
        max_offset = 100

        # left image and right image should have the same shape
        assert(L.shape == R.shape)

        #choose L/R arbitrary since they have the same shape
        hight, width = L.shape

        min = math.floor(window/2)
        max_w = width - math.floor(window/2)
        max_h = hight - math.floor(window/2)


        # initial
        res = np.zeros((hight, width))
        for x in range(min, max_w):
```

```
    for y in range(min, max_h):
      w1 = L[y - min : y + min, x - min : x + min]
      dis = float('inf')
      for i in range(max_offset):
        w2 = R[y - min : y + min, x - min - i : x + min - i]
        if w2.shape == w1.shape:
          d = np.subtract(w1, w2)
          d = np.power(d, 2)
          best = np.sum(d)
          if best < dis:
            dis = best
            res[y, x] = i


  return res
```

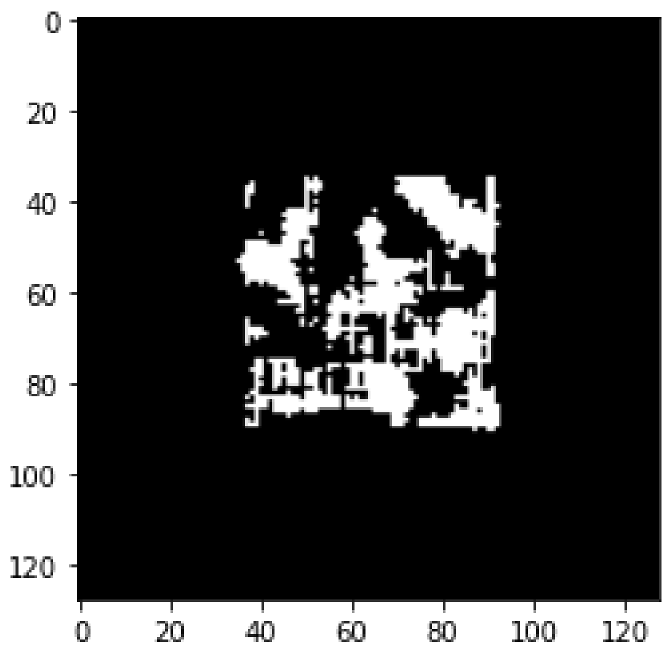
[ ]:
```
D_L = disparity_ssd(R, L)

plt.imshow(D_L, cmap='gray')
# plt.savefig('ps2-1-a-1.png')
# files.download("ps2-1-a-1.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee426e190>

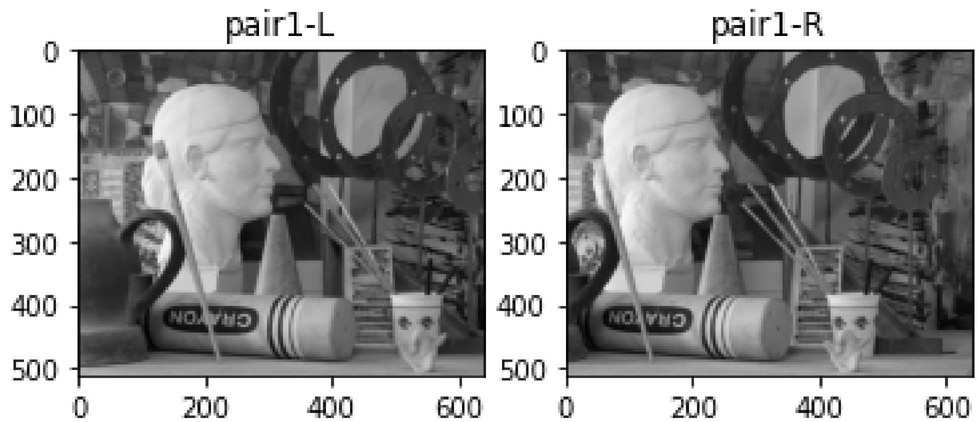


[ ]:
```python
D_R = disparity_ssd(L, R)

plt.imshow(D_R, cmap='gray')
# plt.savefig('ps2-1-a-2.png')
# files.download("ps2-1-a-2.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee42ef910>

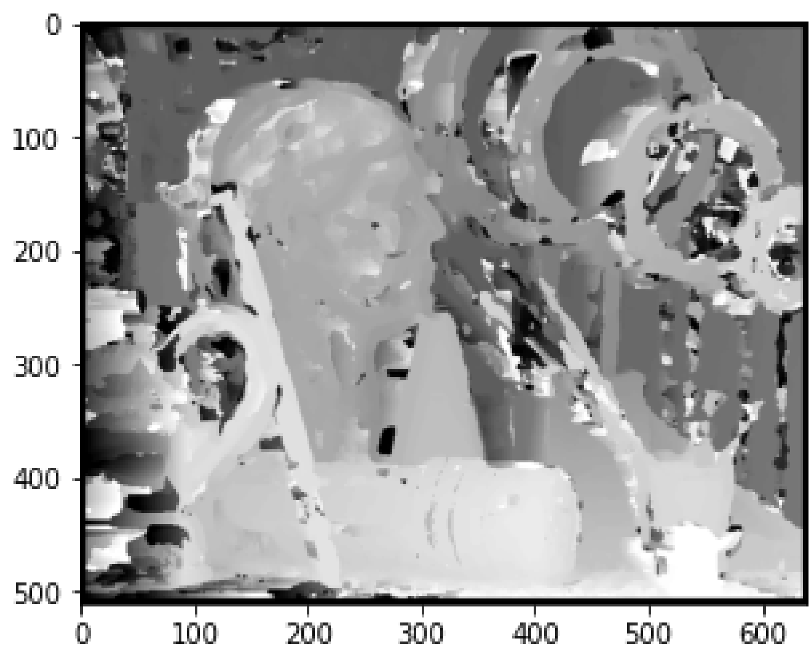


[ ]:
```python
real_img_L = cv2.imread('/content/drive/My Drive/computer vision/assignments/
 ↪assignment4/input/pair1-L.png', 0) * (1.0 / 255.0)
real_img_R = cv2.imread('/content/drive/My Drive/computer vision/assignments/
 ↪assignment4/input/pair1-R.png', 0) * (1.0 / 255.0)


fig, ax = plt.subplots(1, 2)
ax[0].set_title('pair1-L')
ax[0].imshow(real_img_L, cmap='gray')
ax[1].set_title('pair1-R')
ax[1].imshow(real_img_R, cmap='gray');
```



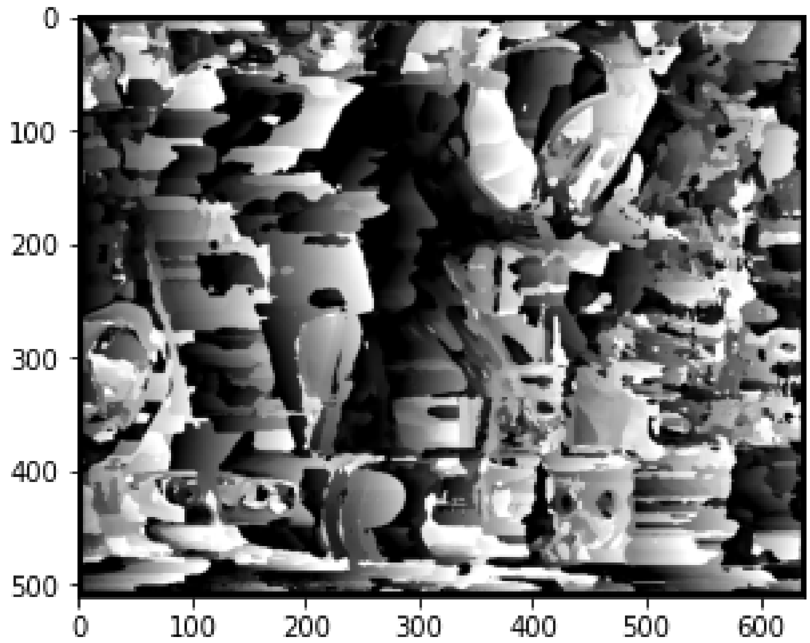
[ ]:
```
D_real_L = disparity_ssd(real_img_L, real_img_R)

plt.imshow(D_real_L, cmap='gray')
# plt.savefig('ps2-2-a-1.png')
# files.download("ps2-2-a-1.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee4678590>



[ ]:
```
D_real_R = disparity_ssd(real_img_R, real_img_L)

plt.imshow(D_real_R, cmap='gray')
# plt.savefig('ps2-2-a-2.png')
# files.download("ps2-2-a-2.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee4471c10>

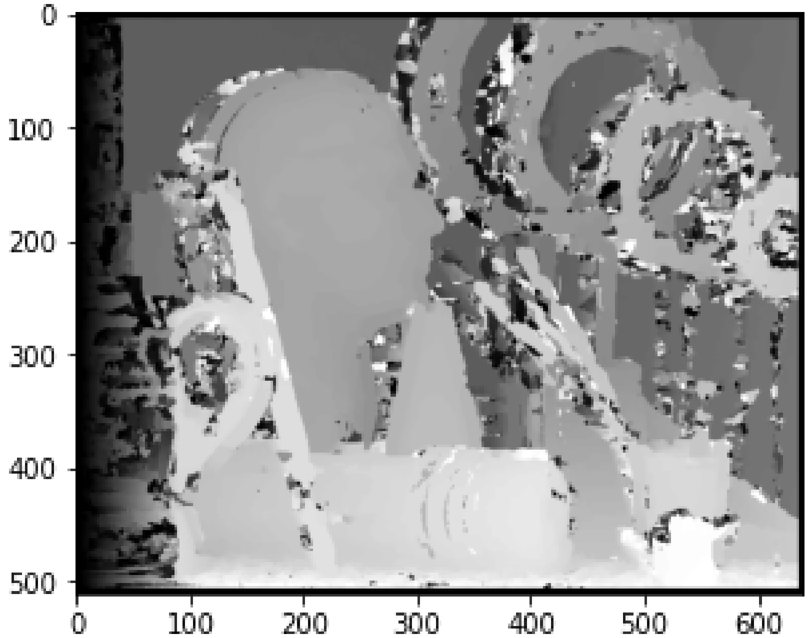


[ ]:
```
def disparity_ncorr(L, R):

  """Compute disparity map D(y, x) such that: L(y, x) = R(y, x + D(y, x))

    Params:
    L: Grayscale left image
    R: Grayscale right image, same size as L

    Returns: Disparity map, same size as L, R
    """

  window = 11
  max_offset = 100
  L = L.astype(np.float32)
  R = R.astype(np.float32)

  assert(L.shape == R.shape)
```

```
    # Initial
    min = math.floor(window/2)
    hight, width = L.shape
    max_w = width - math.floor(window/2)
    max_h = hight - math.floor(window/2)


    res = np.zeros((hight, width, max_offset+1), np.float)
    for y in range(min, max_h):
      for x in range(min, max_w):
        fac = x - min - max_offset
        if fac < 0:
          w1 = L[y - min : y + min + 1, x - min : x + min + 1]
          w2 = R[y - min : y + min + 1, : x + min + 1]
          res[y, x, : fac] = np.fliplr(cv2.matchTemplate(w2,w1 , cv2.
↪TM_CCOEFF_NORMED))
        else:
          w1 = L[y - min : y + min + 1, x - min : x + min + 1]
          w2 = R[y - min : y + min + 1, fac : x + min + 1]
          res[y, x, :] = np.fliplr(cv2.matchTemplate(w2, w1, cv2.
↪TM_CCOEFF_NORMED))

    factor = 1.0 / max_offset
    d = res.argmax(-1) * factor
    return d
```

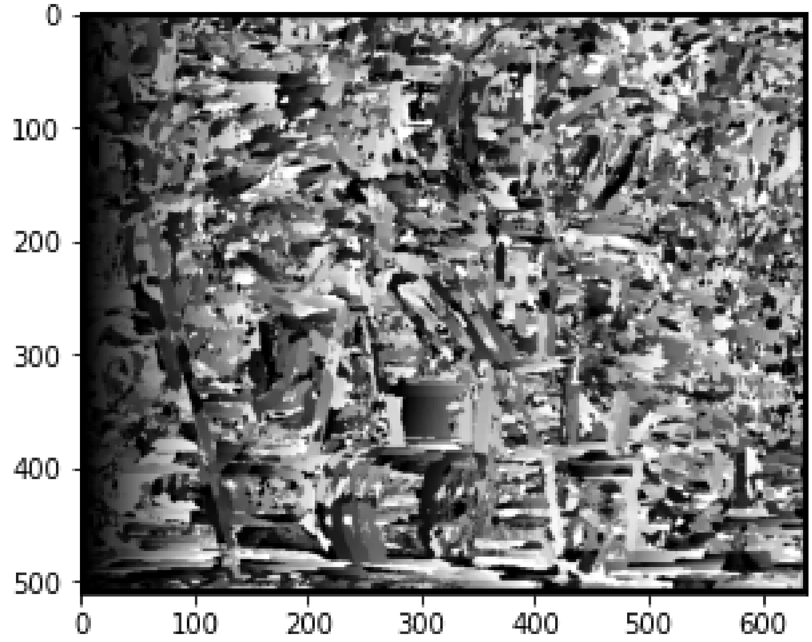
[ ]:
```
N_real_L = disparity_ncorr(real_img_L, real_img_R)

plt.imshow(N_real_L, cmap='gray')
# plt.savefig('ps2-4-a-1.png')
# files.download("ps2-4-a-1.png")

# it seems to work faster with the norm
```

[ ]: <matplotlib.image.AxesImage at 0x7efee4153d10>

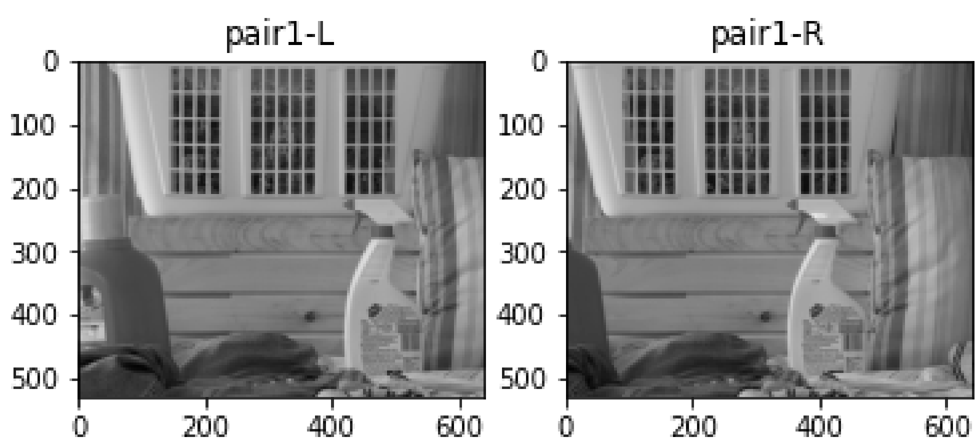


[ ]:
```
N_real_R = disparity_ncorr(real_img_R, real_img_L)

plt.imshow(N_real_R, cmap='gray')
# plt.savefig('ps2-4-a-2.png')
# files.download("ps2-4-a-2.png")

# it seems to work faster with the norm
```

[ ]:
```
<matplotlib.image.AxesImage at 0x7efee40c0b50>
```

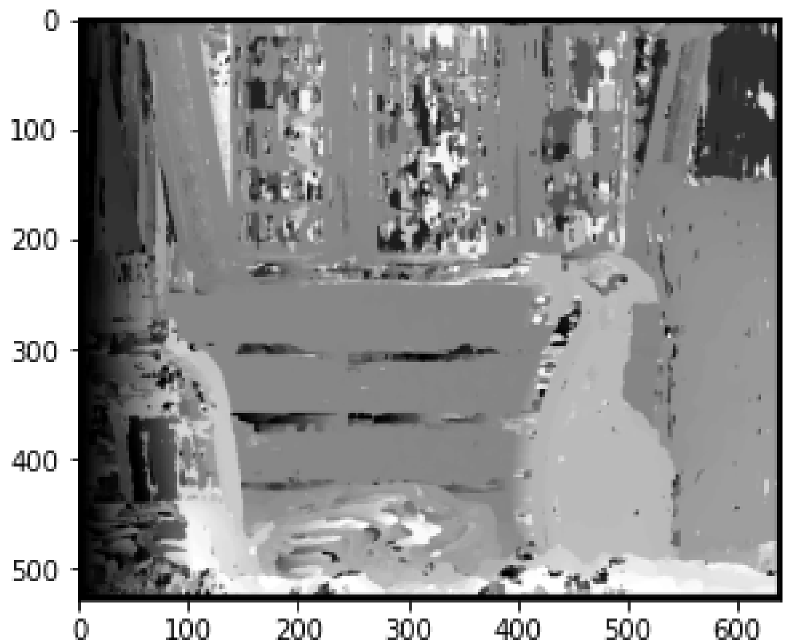


[ ]:
```
real_img_L2 = cv2.imread('/content/drive/My Drive/computer vision/assignments/
↪assignment4/input/pair2-L.png', 0) * (1.0 / 255.0)
real_img_R2 = cv2.imread('/content/drive/My Drive/computer vision/assignments/
↪assignment4/input/pair2-R.png', 0) * (1.0 / 255.0)


fig, ax = plt.subplots(1, 2)
ax[0].set_title('pair1-L')
ax[0].imshow(real_img_L2, cmap='gray')
ax[1].set_title('pair1-R')
ax[1].imshow(real_img_R2, cmap='gray');
```



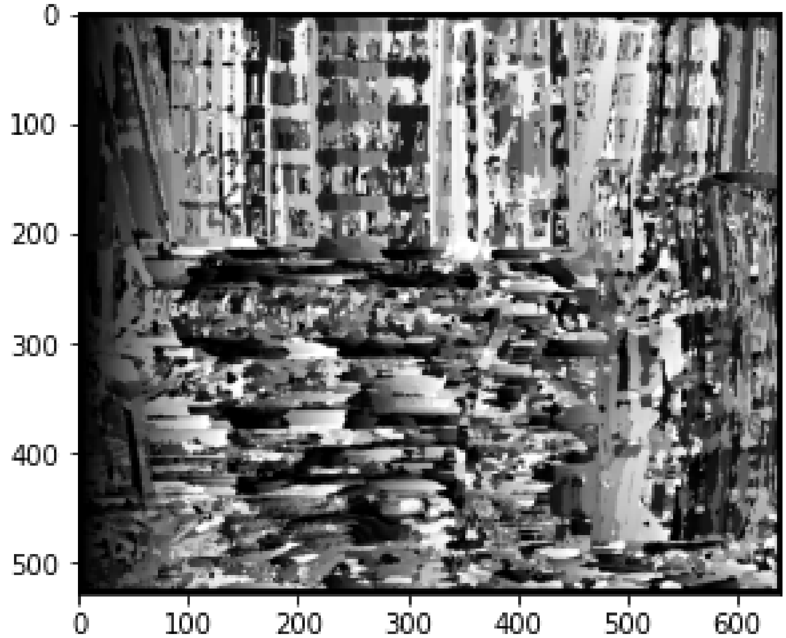
[ ]:
```
N_real_L2 = disparity_ncorr(real_img_L2, real_img_R2)

plt.imshow(N_real_L2, cmap='gray')
# plt.savefig('ps2-4-b-1.png')
# files.download("ps2-4-b-1.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee3eb8110>



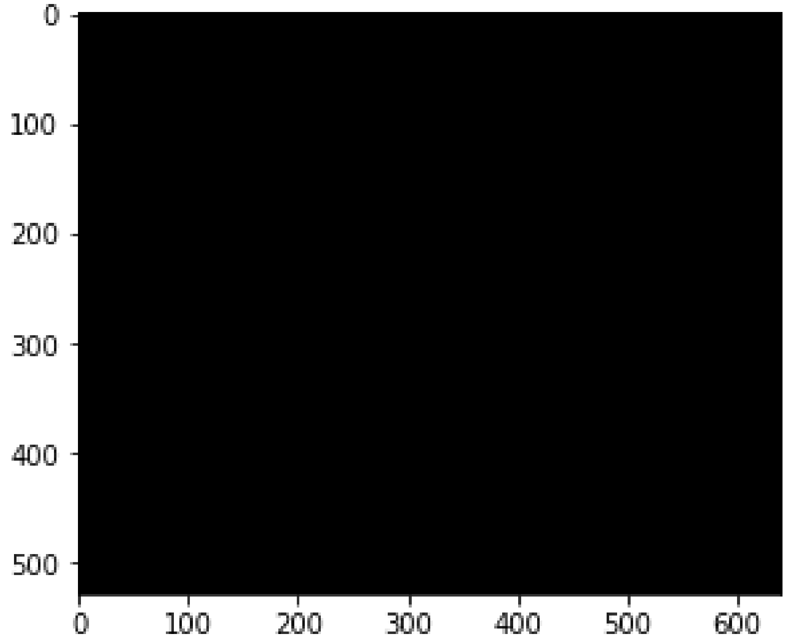
[ ]:
```
N_real_R2 = disparity_ncorr(real_img_R2, real_img_L2)

plt.imshow(N_real_R2, cmap='gray')
# plt.savefig('ps2-4-b-2.png')
# files.download("ps2-4-b-2.png")
```

[ ]: <matplotlib.image.AxesImage at 0x7efee3e212d0>



[ ]:
```
N_real_L2 = disparity_ncorr(real_img_R2, real_img_R2)

plt.imshow(N_real_L2, cmap='gray')
# plt.savefig('ps2-4-b-2.png')
# files.download("ps2-4-b-2.png")

# same image for left and right should give us
# 0 at all pixels because it will find
# the exact same window at the other image
# that is why we get black image
```

[ ]: <matplotlib.image.AxesImage at 0x7efee3e0d550>



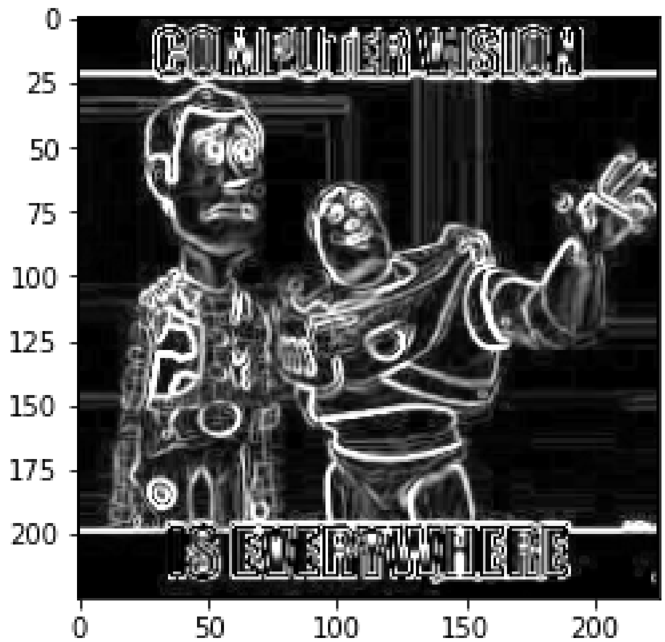
#left to right works fine, but from right to left does not work that well, the difference between without norm and with norm is mainly in the runtime, and we get much noisier pictures than the groundtruth.

[191]:
```
# I used wikipedia to write this code
def edgeDetectionSobel(image, thresh = 0.7):
  Gx = np.array([[1.0, 0.0, -1.0], [2.0, 0.0, -2.0], [1.0, 0.0, -1.0]])
  Gy = np.array([[1.0, 2.0, 1.0], [0.0, 0.0, 0.0], [-1.0, -2.0, -1.0]])
  mag = np.zeros(image.shape)
  [rows,columns] = np.shape(image)
  output_image = np.zeros(shape=(rows, columns))

  for i in range(rows-2):
    for j in range(columns-2):
      S1 = np.sum(np.multiply(Gx, image[i:i + 3, j:j + 3]))
      S2 = np.sum(np.multiply(Gy, image[i:i + 3, j:j + 3]))
      mag[i+1,j+1] = np.sqrt(S1**2+S2**2)

  max = np.max(mag)
  thresh = thresh*max
  for i in range(1,rows):
    for j in range(1,columns):
      if mag[i,j] < thresh:
        output_image[i,j] = min(255, mag[i,j])

  output_image = output_image.astype(np.uint8)
```

```
    return output_image
```

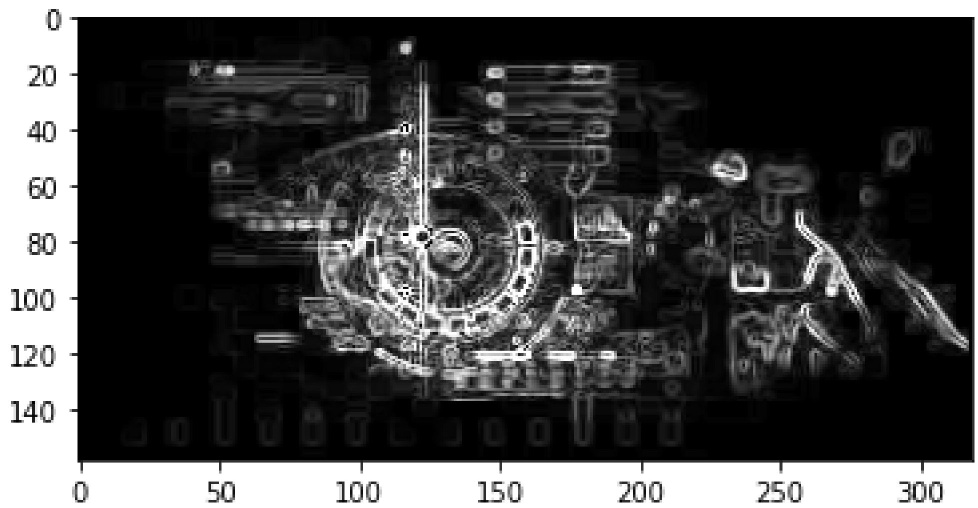
[202]:
```
img = cv2.cvtColor(cv2.imread('/content/drive/My Drive/computer vision/
 ↪assignments/assignment4/input/pic1.png'), cv2.COLOR_BGR2GRAY)
img = edgeDetectionSobel(img)
# img = img.astype(np.float32)
img = cv2.cvtColor(img, cv2.COLOR_GRAY2RGB)
plt.imshow(img)
# plt.savefig('pic1 output sobel.png')
# files.download("pic1 output sobel.png")
```

[202]: <matplotlib.image.AxesImage at 0x7f6b1b82b110>



[195]:
```
img = cv2.cvtColor(cv2.imread('/content/drive/My Drive/computer vision/
 ↪assignments/assignment4/input/pic2.png'), cv2.COLOR_BGR2GRAY)
img = edgeDetectionSobel(img)
img = cv2.cvtColor(img, cv2.COLOR_GRAY2RGB)
plt.imshow(img)
# plt.savefig('pic2 output sobel.png')
# files.download("pic2 output sobel.png")
```

[195]: <matplotlib.image.AxesImage at 0x7f6b1bb22710>




```
[ ]: # I used geeksforgeeks to help me write this code

def edgeDetectionCanny(image,thrs_1,thrs_2):

  height, width = image.shape

  # step 1 - smooth with gaussian
  image = cv2.GaussianBlur(image, (5, 5), 1.4)

  # step 2 - compute partial derivatives
  lx = cv2.Sobel(np.float32(image), cv2.CV_64F, 1, 0, 3)
  ly = cv2.Sobel(np.float32(image), cv2.CV_64F, 0, 1, 3)

  # step 3 - compute magnitude and direction
  magnitude, direction = cv2.cartToPolar(lx, ly, angleInDegrees = True)


  for x in range(width):
    for y in range(height):

      #  step 4 - quantize the gradient directions to 4 sections
      gradient_directions = direction[y, x]
      gradient_directions = abs(gradient_directions - 180) if␣
↪abs(gradient_directions) > 180 else abs(gradient_directions)

      # 0:[0,22.5)U(157.5,180]
      if gradient_directions < 22.5 or 157.5 < gradient_directions <= 180:
        first_neighbor_x, first_neighbor_y = x - 1, y
        second_neighbor_x, second_neighbor_y = x + 1, y
```

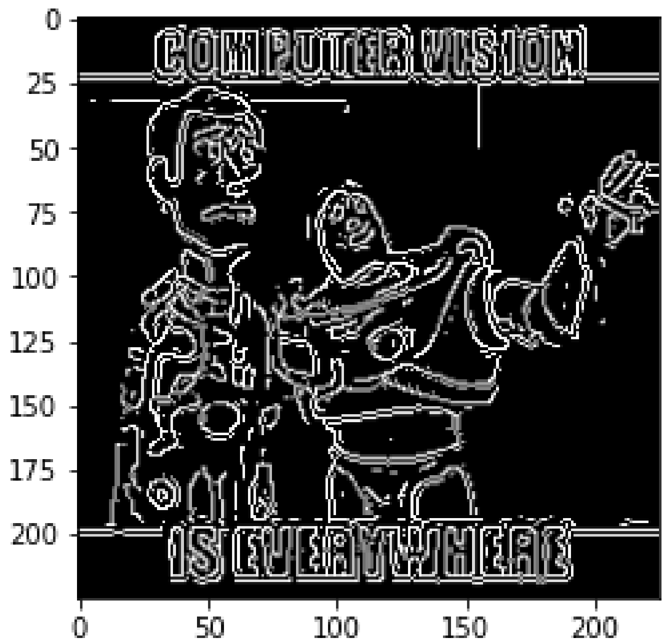
```
    # 45:[22.5,67.5)
    elif 22.5 <= gradient_directions < 67.5:
      first_neighbor_x, first_neighbor_y = x - 1, y - 1
      second_neighbor_x, second_neighbor_y = x + 1, y + 1

    # 90:[67.5,112.5)
    elif 67.5 <= gradient_directions < 112.5:
      first_neighbor_x, first_neighbor_y = x, y - 1
      second_neighbor_x, second_neighbor_y = x, y + 1

    # 135:[112.5,157.5)
    elif 112.5 <= gradient_directions < 157.5:
      first_neighbor_x, first_neighbor_y = x - 1, y + 1
      second_neighbor_x, second_neighbor_y = x + 1, y - 1


    # step 5 - preform NMS
    if width > first_neighbor_x >= 0 and height > first_neighbor_y >= 0:
      if magnitude[y, x] < magnitude[first_neighbor_y, first_neighbor_x]:
        magnitude[y, x]= 0
        continue

    if width > second_neighbor_x >= 0 and height > second_neighbor_y >= 0:
      if magnitude[y, x] < magnitude[second_neighbor_y, second_neighbor_x]:
        magnitude[y, x]= 0


# step 6.1 - define two threshholds
mag_max = np.max(magnitude)
T2 = mag_max * thrs_2
T1 = mag_max * thrs_1

# step 6.2
for x in range(width):
  for y in range(height):

    gradient_magnitude = magnitude[y, x]

    # if its smaller than borh than its not edge
    if gradient_magnitude < T2:
      magnitude[y, x]= 0

    # if its greater than T2 than it is presumed to be an edge
    elif T1 > gradient_magnitude >= T2:
      magnitude[y, x]= 1
```

```
      # and if its greater than T1 than its an edge
      elif gradient_magnitude > T1:
        magnitude[y, x]= 2

  return magnitude
```

[ ]:
```
img = cv2.cvtColor(cv2.imread('/content/drive/My Drive/computer vision/
 ↪assignments/assignment4/input/pic1.png'), cv2.COLOR_BGR2GRAY)
img = edgeDetectionCanny(img,0.2,0.09)
img = img.astype(np.float32)
img = cv2.cvtColor(img, cv2.COLOR_GRAY2RGB)
plt.imshow(img)
# plt.savefig('pic1 output canny.png')
# files.download("pic1 output canny.png")
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

[ ]:
```
<matplotlib.image.AxesImage at 0x7efee4061390>
```



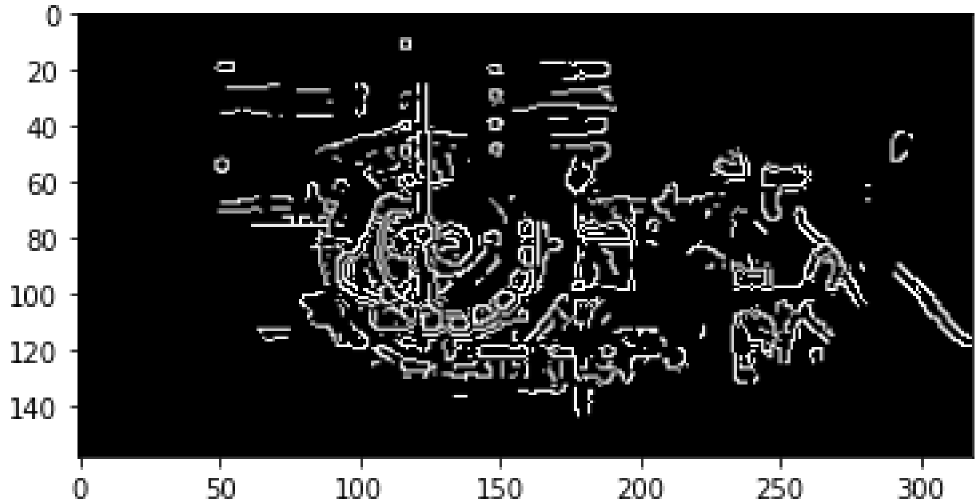
[ ]:
```
img = cv2.cvtColor(cv2.imread('/content/drive/My Drive/computer vision/
 ↪assignments/assignment4/input/pic2.png'), cv2.COLOR_BGR2GRAY)
img = edgeDetectionCanny(img,0.2,0.09)
img = img.astype(np.float32)
img = cv2.cvtColor(img, cv2.COLOR_GRAY2RGB)
plt.imshow(img)
```

```
# plt.savefig('pic2 output canny.png')
# files.download("pic2 output canny.png")
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

[ ]:

```
<matplotlib.image.AxesImage at 0x7efee43987d0>
```



#It seems that canny is more detailed, and find more edges than sobel, and it takes only the important edges.