aplicacao

September 21, 2019

0.1 Imagens Coloridas

Como já vimos, as imagens manipuladas pelo `scikit-image` são simplesmente arrays do Numpy. Consequentemente, uma grande parte das operações sobre as imagens consistem do uso das funcionalidades do Numpy.

As imagens coloridas seguem este mesmo conceito: são arrays do Numpy, mas com uma dimensão adicional para os canais:

[2]:
```
%matplotlib inline
```

[81]:
```
from skimage import data
cat = data.chelsea()
type(cat)
```

[81]:
```
numpy.ndarray
```

[3]:
```
cat.shape
```

[3]:
```
(300, 451, 3)
```

Isto mostra que `cat` é um imagem com 300x451 pixels, com três canais (vermelho, verde e azul). Como antes, podemos acessar e definir os valores dos pixels:

[4]:
```
cat[10,20]
```

[4]:
```
array([151, 129, 115], dtype=uint8)
```

[5]:
```
# definindo o pixel na linha 50, coluna 60 como "black"
cat[50,60] = 0
```

[6]:
```
# definindo o pixel na linha 50, coluna 61 como verde
cat[50,61] = [0,255,0] # [red, green, blue]
```

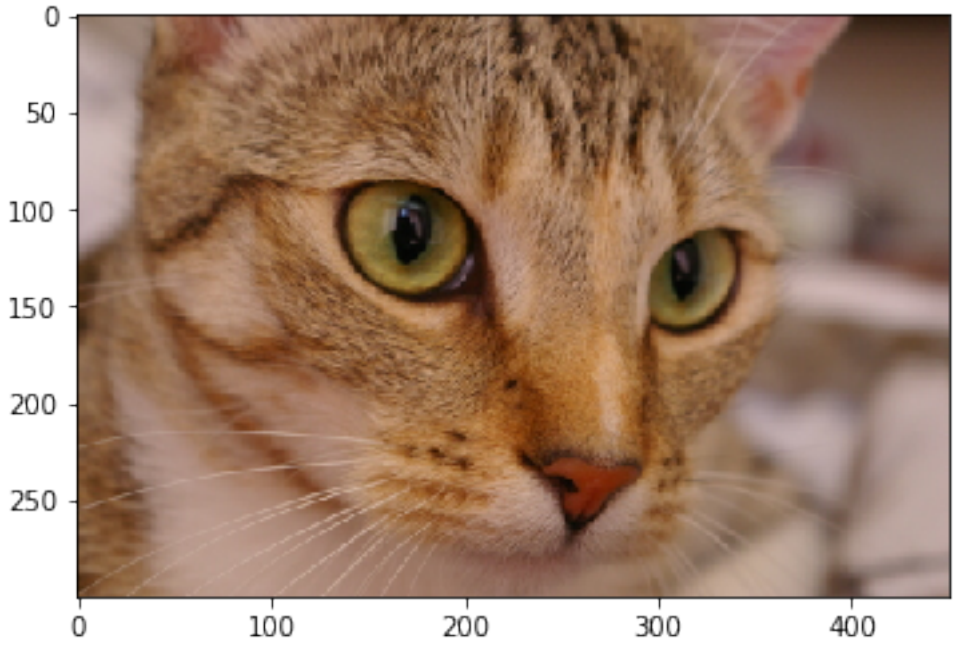
Nós também podemos utilizar máscaras booleanas 2D para uma imagem colorida 2D, como fizemos para imagens de nível de cinza:

Utilizando uma máscara 2D em uma imagem colorida 2D

[82]:
```
import matplotlib.pyplot as plt
import numpy as np
```

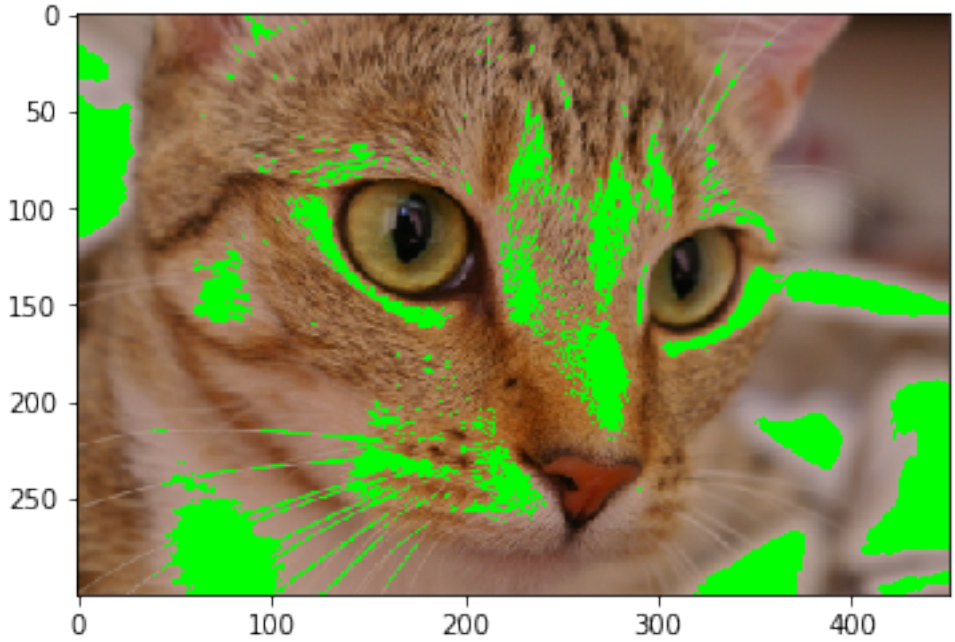
[8]:
```
cat = data.chelsea()
plt.imshow(cat)
```

[8]:
```
<matplotlib.image.AxesImage at 0x1f514b231d0>
```



[9]:
```
cat = data.chelsea()
reddish = cat[:,:,0] > 180
cat[reddish] = [0,255,0]
plt.imshow(cat)
```

[9]: <matplotlib.image.AxesImage at 0x1f514bce198>



[10]:
```
cat.shape
```

[10]:
```
(300, 451, 3)
```

[11]:
```
reddish.shape
```

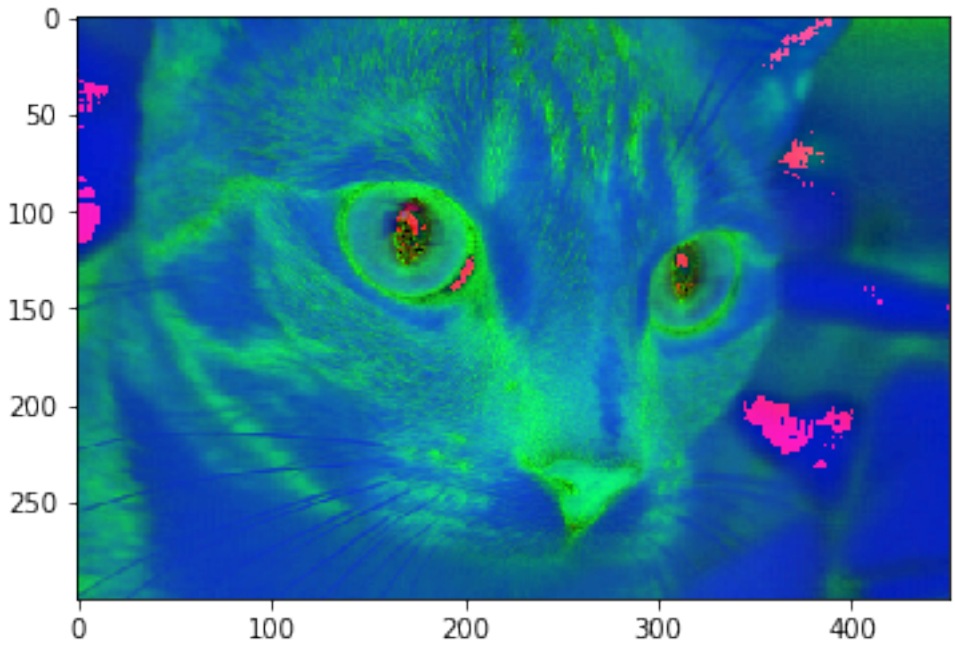
[11]:
```
(300, 451)
```

[4]:
```
import skimage.color
```

[13]:
```
cat_orig = data.chelsea()
cat_hsv = skimage.color.convert_colorspace(cat_orig,"RGB","HSV")
cat_g = skimage.color.rgb2gray(cat_orig)
```

[14]:
```
plt.imshow(cat_hsv, cmap = 'hsv')
```

[14]:
```
<matplotlib.image.AxesImage at 0x1f514c2ef28>
```



[15]:
```
cat_orig[50,60],cat_hsv[50,60],cat_g[50,60]
```

[15]:
```
(array([160, 118,  78], dtype=uint8),
 array([0.08130081, 0.5125    , 0.62745098]),
 0.48643529411764713)
```

[16]:
```
cat_orig[1:3,1:3,:]
```

[16]:
```
array([[[145, 122, 106],
        [143, 120, 104]],
```

```
        [[147, 125, 111],
         [146, 122, 109]]], dtype=uint8)
```

[17]:
```
cat_orig[1:3,1:3,:]/255
```

[17]:
```
array([[[0.56862745, 0.47843137, 0.41568627],
        [0.56078431, 0.47058824, 0.40784314]],

       [[0.57647059, 0.49019608, 0.43529412],
        [0.57254902, 0.47843137, 0.42745098]]])
```

0.2 Exercícios

1. Utilize duas imagens coloridas diferentes e refaça os processamentos que fizemos nos notebooks anteriores para explorar os conceitos de imagens coloridas. As imagens devem estar no espaço de cores RGB para estas operações.

    a. Transformações de Intensidade (equalização e normalização)

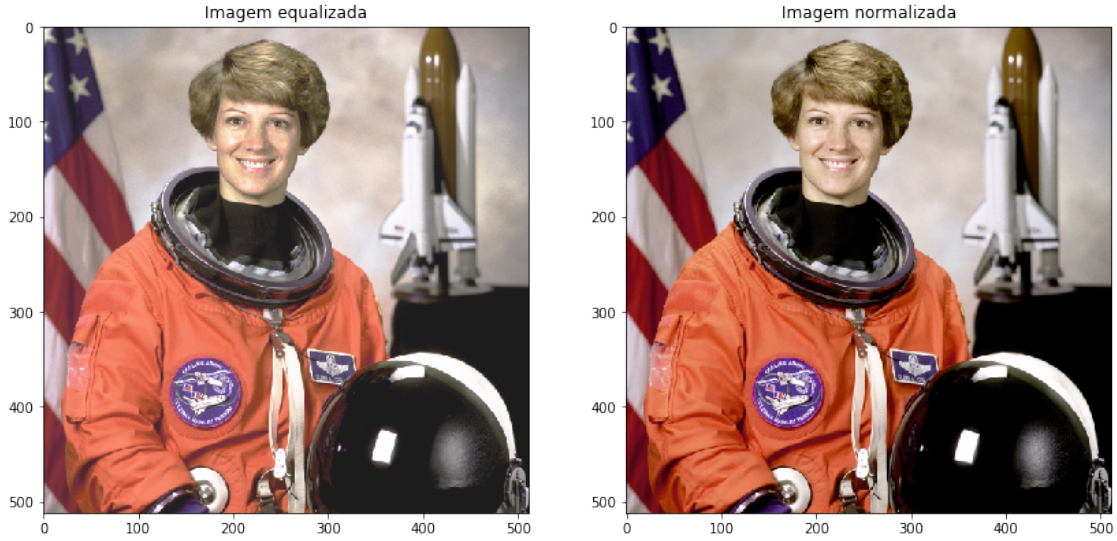
[83]:
```
from skimage import exposure
from skimage.filters import gaussian
from skimage.filters import unsharp_mask

img_ast = data.astronaut()
```

[21]:
```
fig = plt.figure(figsize=(14, 7))
plt.imshow(img_ast), plt.title("Imagem RGB original")
```

[21]:
```
(<matplotlib.image.AxesImage at 0x1c89715bf60>,
 Text(0.5, 1.0, 'Imagem RGB original'))
```

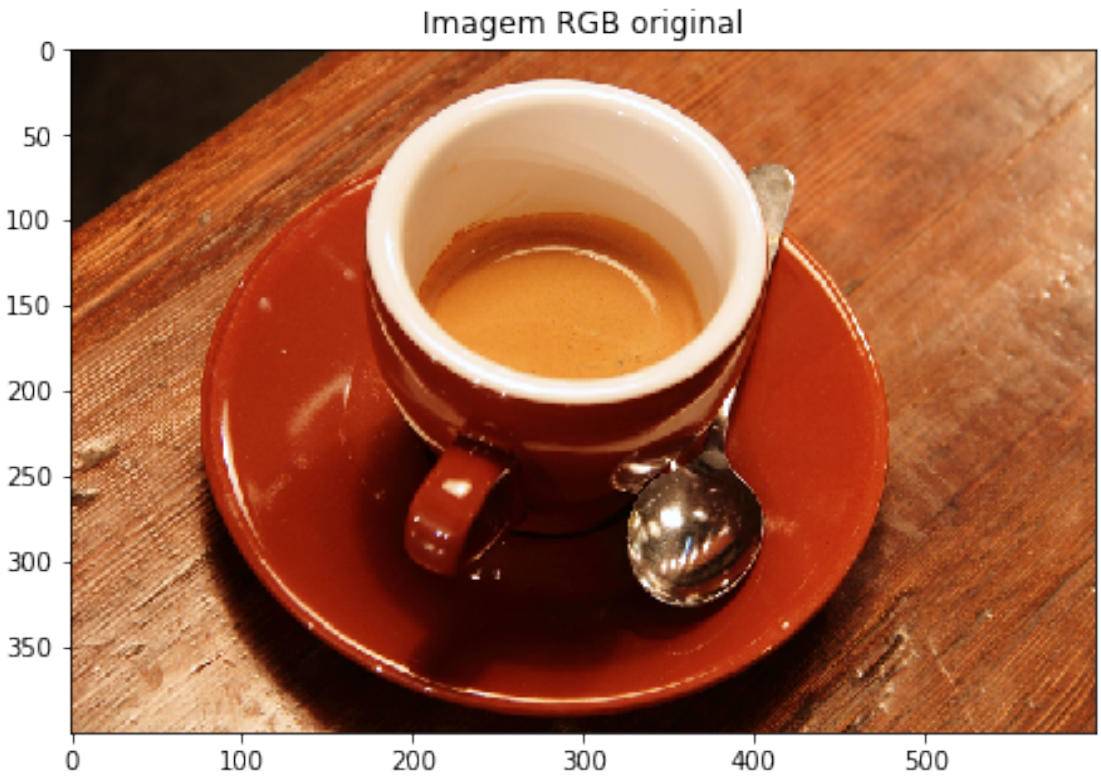
[42]:
```
img_ast_eq = exposure.equalize_hist(img_ast)

img_ast_norm = img_ast.copy()

img_ast_norm = img_ast_norm / 255

fig = plt.figure(figsize=(14, 7))

plt.subplot(121),plt.imshow(img_ast_eq), plt.title("Imagem equalizada")

plt.subplot(122),plt.imshow(img_ast_norm), plt.title("Imagem normalizada")
```

[42]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c00ef0c588>,
 <matplotlib.image.AxesImage at 0x1c00eed72b0>,
 Text(0.5, 1.0, 'Imagem normalizada'))
```



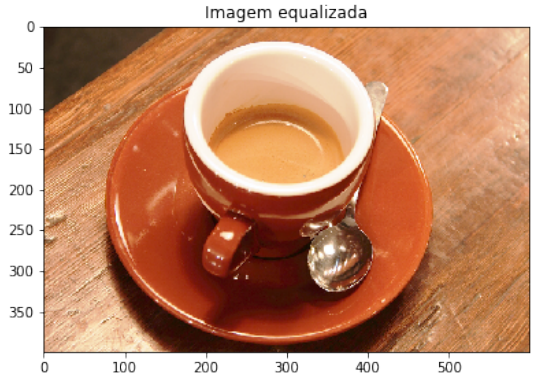
[84]:
```
img_cf = data.coffee()
fig = plt.figure(figsize=(14, 5))
plt.imshow(img_cf), plt.title("Imagem RGB original")
```

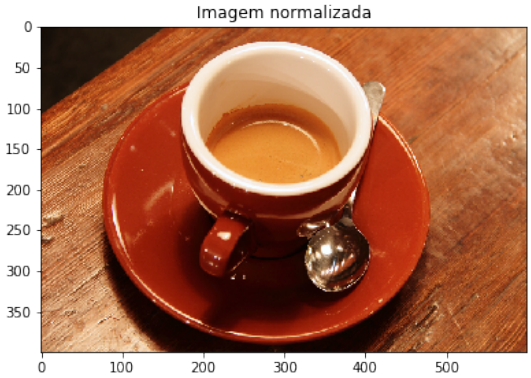
[84]:
```
(<matplotlib.image.AxesImage at 0x1c8990b0be0>,
 Text(0.5, 1.0, 'Imagem RGB original'))
```



[44]:
```
img_cf_eq = exposure.equalize_hist(img_cf)

img_cf_norm = img_cf.copy()

img_cf_norm = img_cf_norm / 255

fig = plt.figure(figsize=(14, 7))

plt.subplot(121),plt.imshow(img_cf_eq), plt.title("Imagem equalizada")

plt.subplot(122),plt.imshow(img_cf_norm), plt.title("Imagem normalizada")
```

[44]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c00f122978>,
 <matplotlib.image.AxesImage at 0x1c00efbb8d0>,
 Text(0.5, 1.0, 'Imagem normalizada'))
```

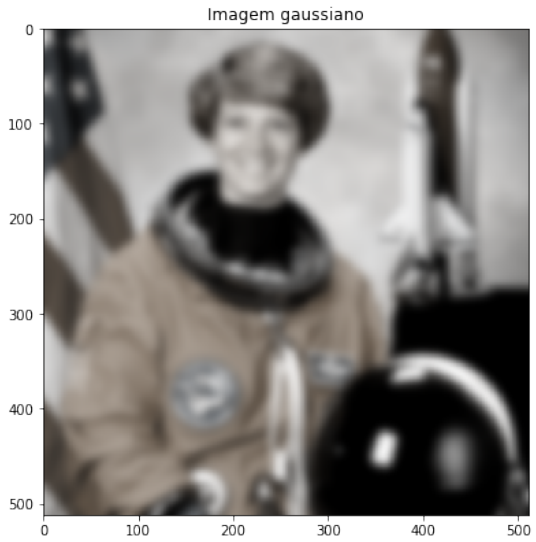


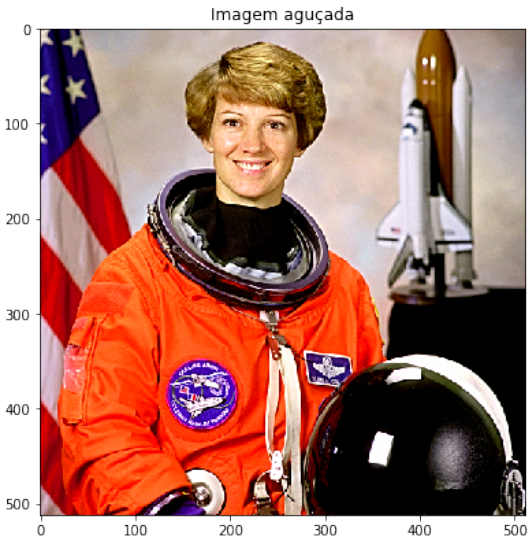


b. Filtros Espaciais (filtro de suavização e de aguçamento)

[60]:
```
ast_gaus = gaussian(img_ast,sigma=5,multichannel=False)

aust_sharp = unsharp_mask(img_ast, radius=2, amount=1)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(ast_gaus), plt.title("Imagem gaussiano")
plt.subplot(122),plt.imshow(aust_sharp), plt.title("Imagem aguçada")
```

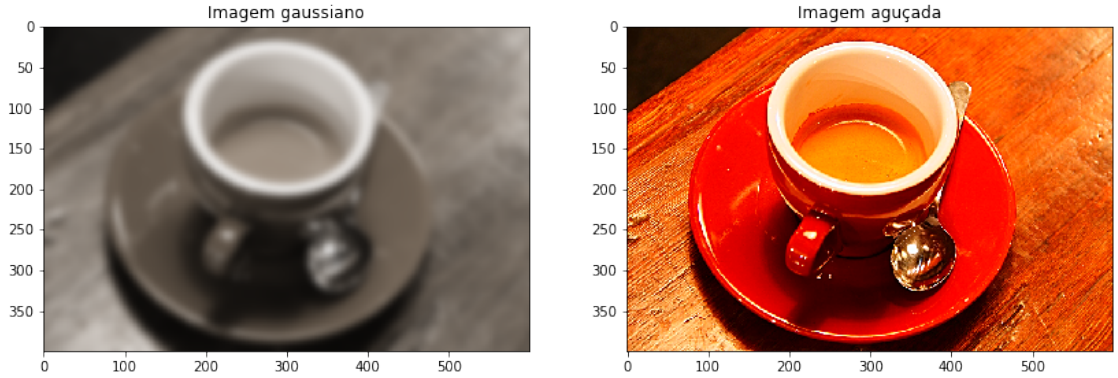
[60]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c0155966d8>,
 <matplotlib.image.AxesImage at 0x1c01956d5f8>,
 Text(0.5, 1.0, 'Imagem aguçada'))
```





[61]:
```
cf_gaus = gaussian(img_cf,sigma=5,multichannel=False)

cf_sharp = unsharp_mask(img_cf, radius=2, amount=1)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(cf_gaus), plt.title("Imagem gaussiano")
plt.subplot(122),plt.imshow(cf_sharp), plt.title("Imagem aguçada")
```

[61]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c01b3ab2b0>,
 <matplotlib.image.AxesImage at 0x1c01b3f61d0>,
 Text(0.5, 1.0, 'Imagem aguçada'))
```



c. Filtros de Frequência (filtro passa baixa Butterworth e filtro passa-alta Gaussiano)

Para cada processamento, documente os resultados obtidos, indicando se são coerentes ou não.

[62]:
```
import numpy as np
from skimage import exposure
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
from scipy import misc

def butter2d_lp(shape, f, n, pxd=1):
    pxd = float(pxd)
    rows, cols = shape
    x = np.linspace(-0.5, 0.5, cols)  * cols / pxd
    y = np.linspace(-0.5, 0.5, rows)  * rows / pxd
    radius = np.sqrt((x**2)[np.newaxis] + (y**2)[:, np.newaxis])
    filt = 1 / (1.0 + (radius / f)**(2*n))
    return filt

def butter2d_hp(shape, f, n, pxd=1):
    """Designs an n-th order highpass 2D Butterworth filter with cutin
```

```
    frequency f. pxd defines the number of pixels per unit of frequency (e.g.,
    degrees of visual angle)."""
    return 1. - butter2d_lp(shape, f, n, pxd)
```

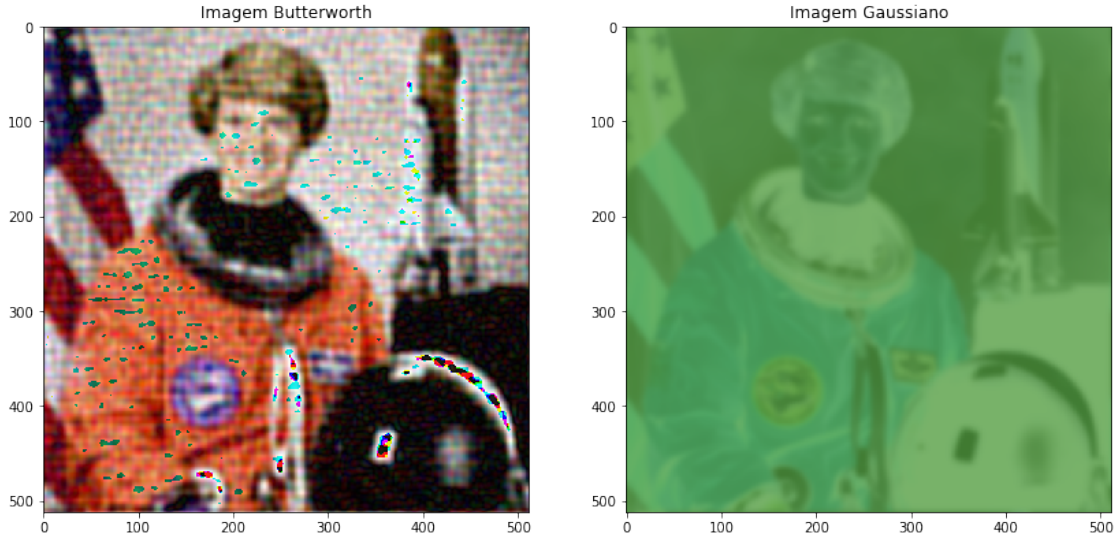
[223]:
```
def butter_lp_canal(canal, n):
    f = np.fft.fft2(canal)
    filtro_b = butter2d_lp(canal.shape, f, n)
    mult = f * filtro_b
    retorno = np.abs(np.fft.ifft2(mult))
    return retorno
```

[272]:
```
from scipy import signal

def gaus_hp_canal(canal, n):
    kernel = 1. - np.outer(signal.gaussian(canal.shape[0], n), signal.
 ↪gaussian(canal.shape[1], n))
    f = np.fft.fft2(canal)
    f_kernel = np.fft.fft2(np.fft.fftshift(kernel))
    mult = f*f_kernel
    retorno = np.abs(np.fft.ifft2(mult))

    print(retorno[0,0])
    return retorno
```

[210]:
```
from scipy import signal

r = img_ast[:,:,0].copy() / 255
g = img_ast[:,:,1].copy() / 255
b = img_ast[:,:,2].copy() / 255

img_ast_b = img_ast.copy()
img_ast_g = img_ast.copy()

#butterworth
img_ast_b[:,:,0] = butter_lp_canal(r, 5) * 255
img_ast_b[:,:,1] = butter_lp_canal(g, 5) * 255
img_ast_b[:,:,2] = butter_lp_canal(b, 5) * 255

#gaussiano
img_ast_g[:,:,0] = gaus_hp_canal(r, 3)
img_ast_g[:,:,1] = gaus_hp_canal(g, 3)
img_ast_g[:,:,2] = gaus_hp_canal(b, 3)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(img_ast_b), plt.title("Imagem Butterworth")
plt.subplot(122),plt.imshow(img_ast_g), plt.title("Imagem Gaussiano")
```

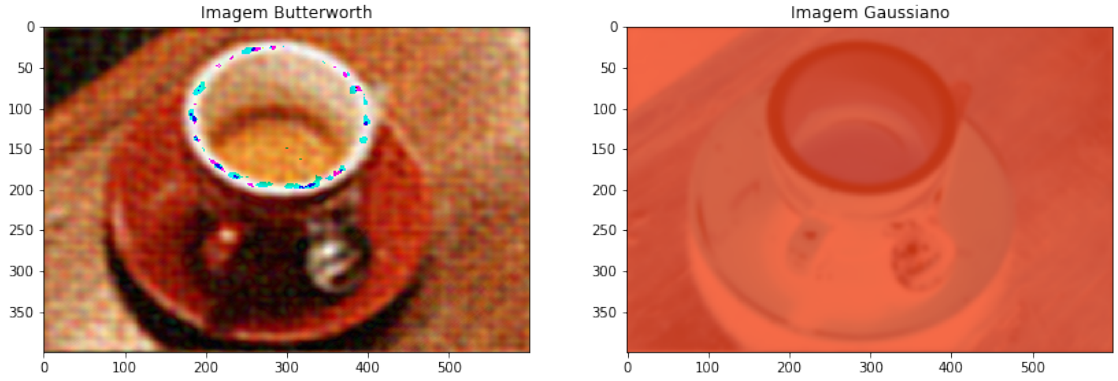
[210]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8b21ca048>,
 <matplotlib.image.AxesImage at 0x1c8b220df98>,
```

```
Text(0.5, 1.0, 'Imagem Gaussiano'))
```



[211]:
```
from scipy import signal

r = img_cf[:,:,0].copy() / 255
g = img_cf[:,:,1].copy() / 255
b = img_cf[:,:,2].copy() / 255

img_cf_b = img_cf.copy()
img_cf_g = img_cf.copy()

#butterworth
img_cf_b[:,:,0] = butter_lp_canal(r, 5) * 255
img_cf_b[:,:,1] = butter_lp_canal(g, 5) * 255
img_cf_b[:,:,2] = butter_lp_canal(b, 5) * 255

#gaussiano
img_cf_g[:,:,0] = gaus_hp_canal(r, 3)
img_cf_g[:,:,1] = gaus_hp_canal(g, 3)
img_cf_g[:,:,2] = gaus_hp_canal(b, 3)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(img_cf_b), plt.title("Imagem Butterworth")
plt.subplot(122),plt.imshow(img_cf_g), plt.title("Imagem Gaussiano")
```

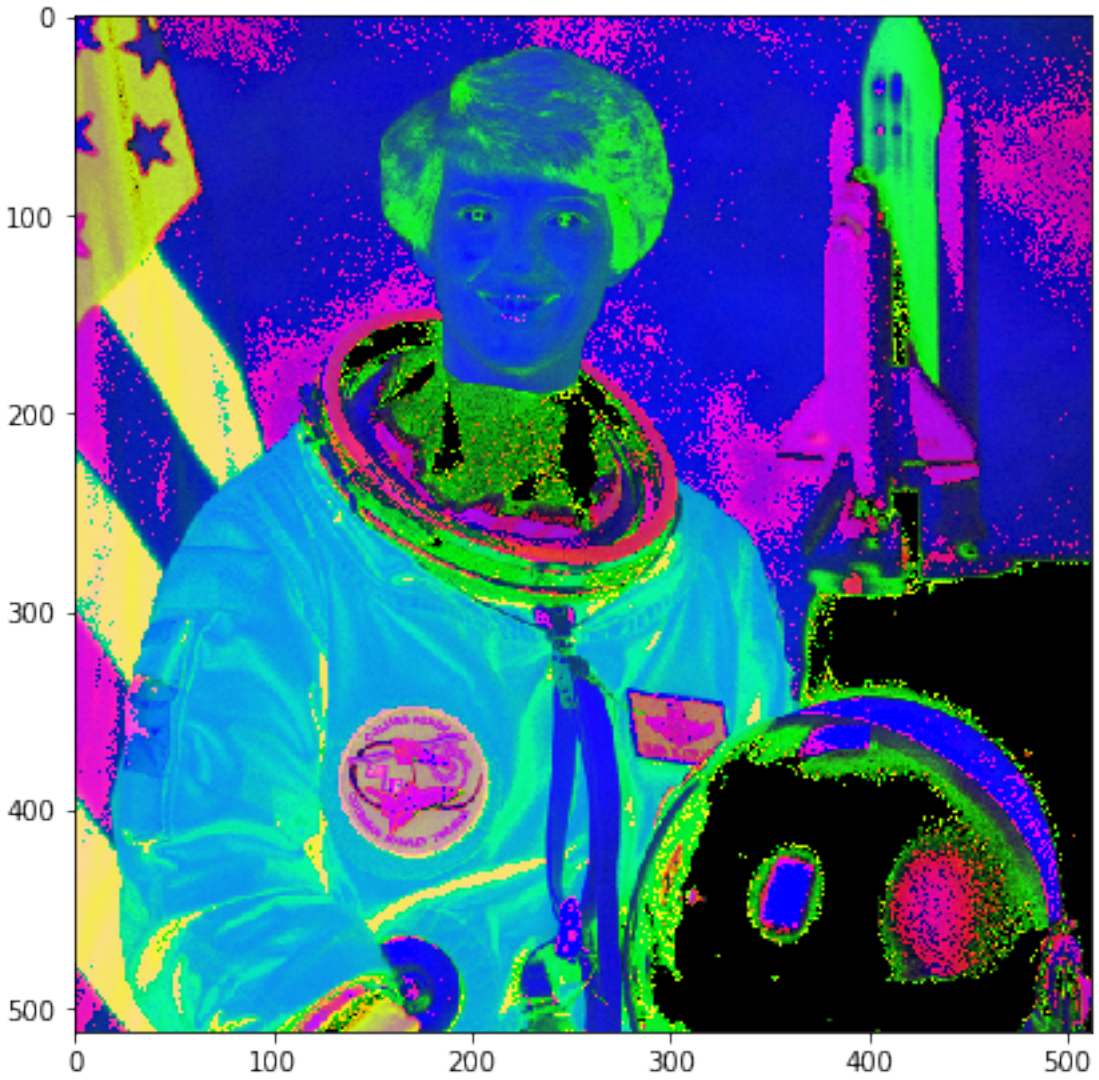
[211]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8b2410be0>,
 <matplotlib.image.AxesImage at 0x1c8b3a13b70>,
 Text(0.5, 1.0, 'Imagem Gaussiano'))
```



2. Utilize a função `skimage.color.convert_colorspace` e explore os processamentos nos espaços de cor "RGB" e "HSV". Repita os processamentos da questão 1.

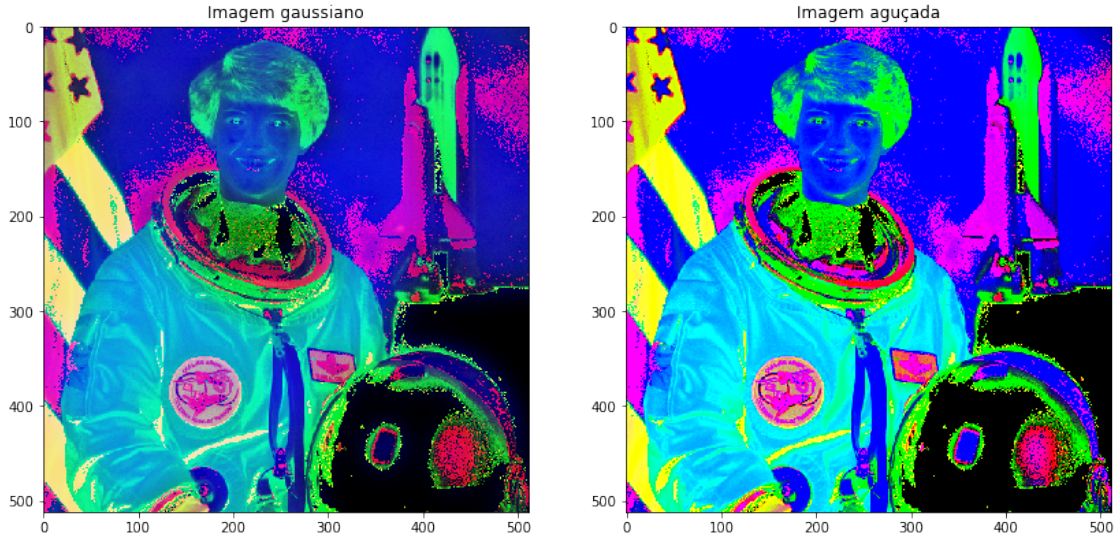
[215]:
```
fig = plt.figure(figsize=(14, 7))
ast_hsv = color.rgb2hsv(img_ast)
plt.imshow(ast_hsv, cmap="hsv")
```

[215]:
```
<matplotlib.image.AxesImage at 0x1c8b3a8a6d8>
```



[220]:
```
ast_gaus = ast_hsv.copy()
ast_gaus[:,:,2] = gaussian(ast_gaus[:,:,2],sigma=15,multichannel=False)

aust_sharp = unsharp_mask(ast_hsv, radius=2, amount=1)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(ast_gaus), plt.title("Imagem gaussiano")
plt.subplot(122),plt.imshow(aust_sharp), plt.title("Imagem aguçada")
```

[220]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8b6033ba8>,
 <matplotlib.image.AxesImage at 0x1c8b6089a58>,
 Text(0.5, 1.0, 'Imagem aguçada'))
```

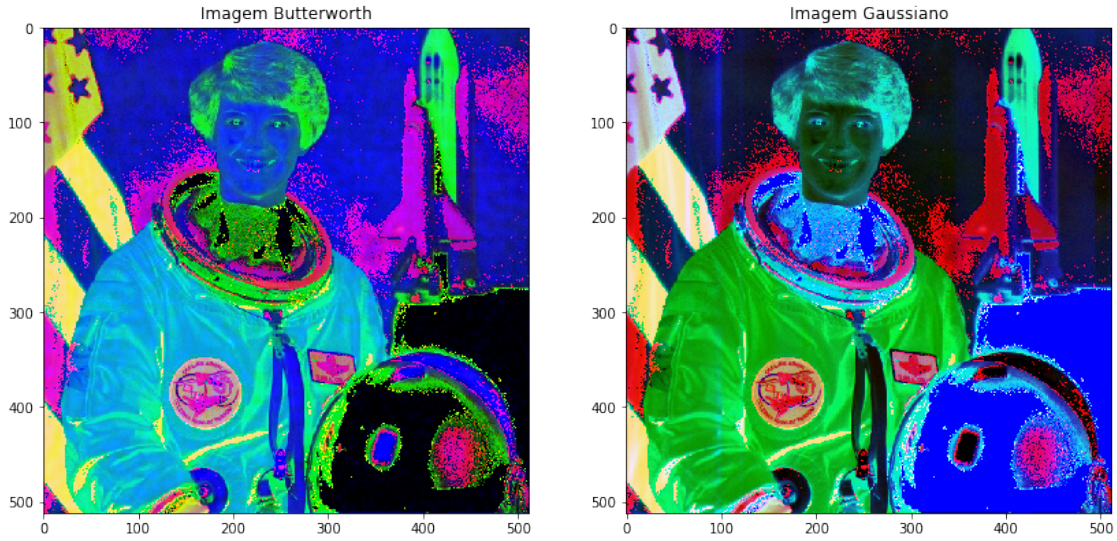


[283]:
```
##aplicando os filtros somente no canal do valor do hsv e transformando de␣
↪volta para rgb

v = ast_hsv[:,:,2].copy()

ast_hsv_b = ast_hsv.copy()
ast_hsv_g = ast_hsv.copy()

print(ast_hsv_g[0,0])

#butterworth
ast_hsv_b[:,:,2] = butter_lp_canal(v, 5)

#gaussiano normalizando o resultado entre 0 e 1
from sklearn import preprocessing
ast_hsv_g[:,:,2] = preprocessing.minmax_scale(gaus_hp_canal(ast_hsv_g[:,:,2],␣
↪1))


print(ast_hsv_g[0,0])

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(ast_hsv_b), plt.title("Imagem Butterworth")
plt.subplot(122),plt.imshow(ast_hsv_g), plt.title("Imagem Gaussiano")
```

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

[0.9047619  0.04545455 0.60392157]
```

```
146990.79026619485
[0.9047619  0.04545455 0.51840571]
```

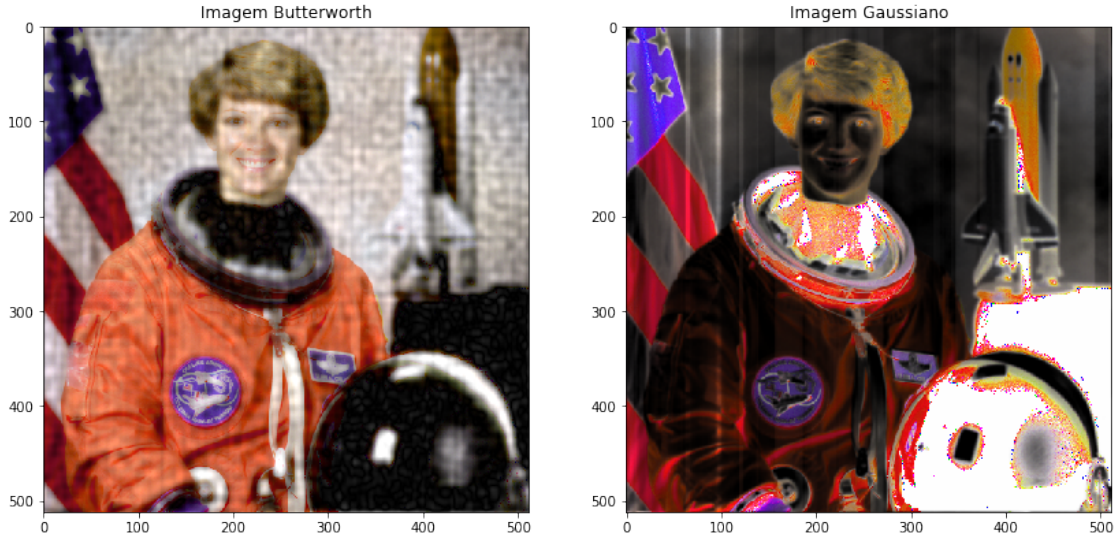
[283]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8d82fe0b8>,
 <matplotlib.image.AxesImage at 0x1c8d8346080>,
 Text(0.5, 1.0, 'Imagem Gaussiano'))
```



[282]:
```
fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(color.hsv2rgb(ast_hsv_b)), plt.title("Imagem␣
 ↪Butterworth")
plt.subplot(122),plt.imshow(color.hsv2rgb(ast_hsv_g)), plt.title("Imagem␣
 ↪Gaussiano")
```

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

[282]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8d84ba588>,
 <matplotlib.image.AxesImage at 0x1c8d8f7bf60>,
 Text(0.5, 1.0, 'Imagem Gaussiano'))
```

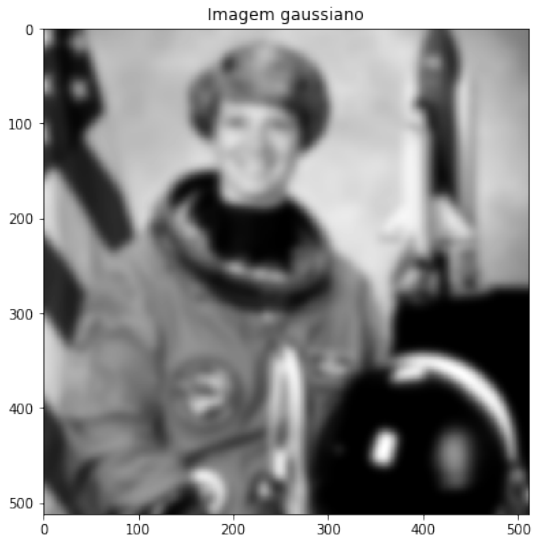


3. Compare os resultados dos processamentos feitos no espaço de cor 'RGB' e 'HSV' e com as imagens convertidas para *nível de cinza*. Explique os resultados obtidos.

[247]:
```
gray = rgb2gray(img_ast)
```

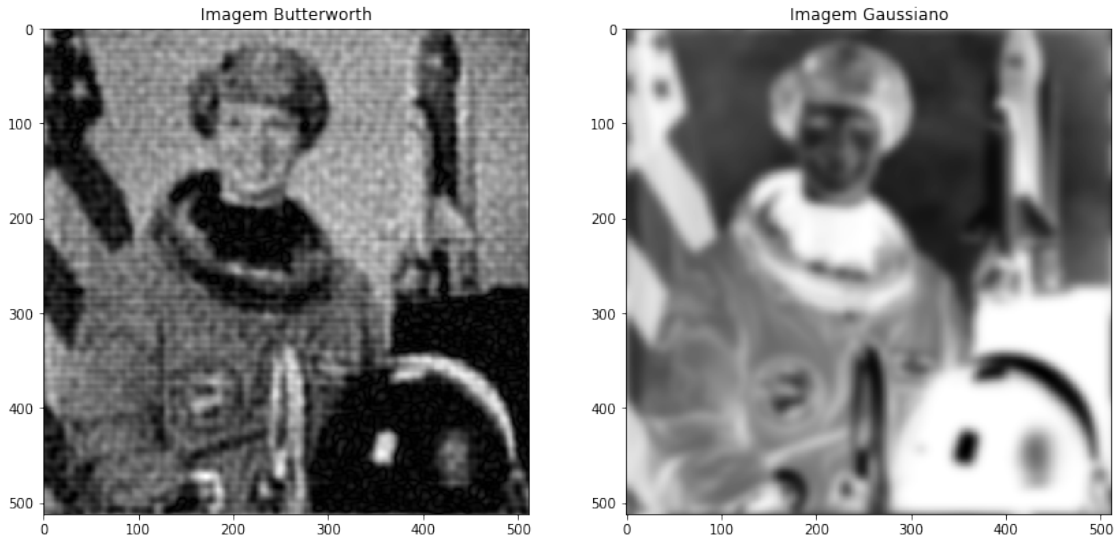
[260]:
```
gray_gaus = gaussian(gray,sigma=5,multichannel=False)

gray_sharp = unsharp_mask(gray, radius=2, amount=1)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(gray_gaus, cmap="gray"), plt.title("Imagem␣
 ↪gaussiano")
plt.subplot(122),plt.imshow(gray_sharp, cmap="gray"), plt.title("Imagem␣
 ↪aguçada")
```

[260]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8aad57f60>,
 <matplotlib.image.AxesImage at 0x1c8b6252860>,
 Text(0.5, 1.0, 'Imagem aguçada'))
```



[265]:
```
gray_b = gray.copy()
gray_g = gray.copy()

#butterworth
gray_b = butter_lp_canal(gray, 5)

gray_g = gaus_hp_canal(gray, 5)

fig = plt.figure(figsize=(14, 7))
plt.subplot(121),plt.imshow(gray_b, cmap="gray"), plt.title("Imagem␣
 ↪Butterworth")
plt.subplot(122),plt.imshow(gray_g, cmap="gray"), plt.title("Imagem Gaussiano")
```

[265]:
```
(<matplotlib.axes._subplots.AxesSubplot at 0x1c8cf1d8978>,
 <matplotlib.image.AxesImage at 0x1c8cf9cb908>,
 Text(0.5, 1.0, 'Imagem Gaussiano'))
```



i) Na imagem em RGB os filtros no campo espacial não tiveram muitos problemas de serem aplicados como o filtro gaussiano e o de realce. Porém no campo da frequência tiveram que ser aplicados separadamente em cada camada, com isso as cores foram alteradas já que o valor RGB de cada pixel foi modificado.

ii) Na imagem HSV, todos os filtros foram aplicados no valor V da imagem, alterando somente a itensidade do pixel.Dessa forma as mudanças mantiveram a as cores originais, sem muitos problemas apresentados na aplicação da imagem RGB.

iii) Na imagem em escala de cinza, como só tem 1 canal as aplicações são mais simples e funcionam perfeitamente, o único problema é a falta de informação de cor das outras imagens.

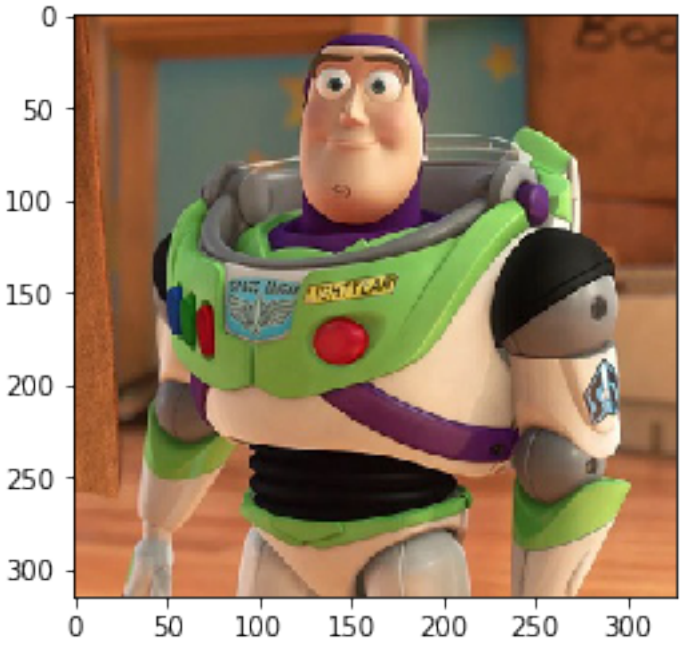
0.2.1 Exercício de implementação

Implemente uma função de conversão de espaço de cor RGB para HSV conforme apresentado no livro texto (Gonzalez & Woods, capítulo 6.) Compare (demonstre) o resultado da sua função com as funções da biblioteca `skimage.color.convert_colorspace`

[213]:
```
import numpy as np
from skimage import io
import math
from skimage import color
import matplotlib.pyplot as plt
```

[11]:
```
img = io.imread('buzz.jpg')

plt.imshow(img)
```

[11]:
```
<matplotlib.image.AxesImage at 0x2140825a9b0>
```



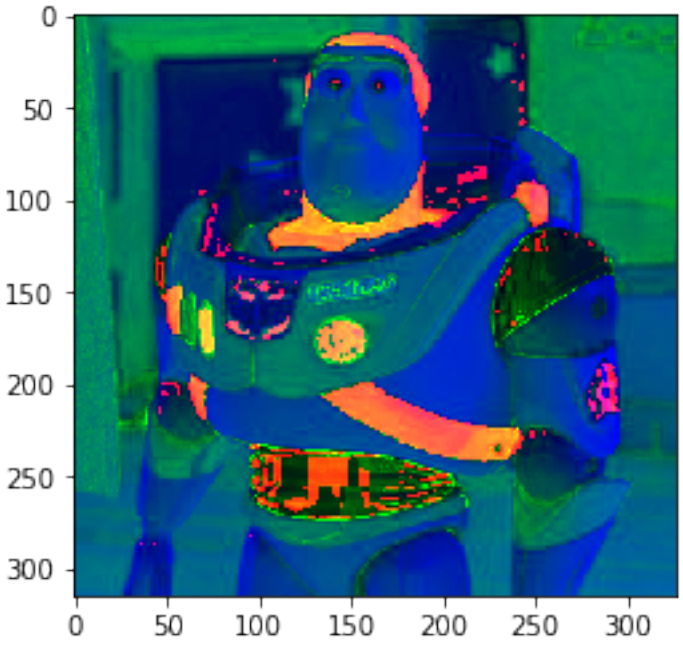
[83]:
```
def calcular_h(r, g, b):

    h = r.copy()

    for x in range (len(r)):
        for y in range (len(r[0])):
            numerador = (((r[x][y] - g[x][y]) + (r[x][y] - b[x][y])) * 0.5)
            denominador = (((r[x][y] - g[x][y]) ** 2) + ((r[x][y] - b[x][y]) *␣
↪(g[x][y] - b[x][y]))) ** 0.5

            h[x][y] = math.acos(numerador / (denominador + 0.0001))

            if b[x][y] > g[x][y]:
                h[x][y] = 360 - h[x][y]

            h[x][y] = h[x][y] / 360

    return h


def calcular_s(r, g, b):
    minimo = np.minimum(np.minimum(r, g), b)
    s = 1 - (3 / (r + g + b + 0.001)) * minimo
    return s

def calcular_i(r, g, b):
```

```
    return np.divide(b + g + r, 3)

def transformar_hsi(rgb):

    #normalizando os valores para entre 0 e 1
    rgb2 = np.float32(rgb)/255

    red = rgb2[:,:,0].copy()
    green = rgb2[:,:,1].copy()
    blue = rgb2[:,:,2].copy()

    hsi = rgb2.copy()
    hsi[:,:,0] = calcular_h(red, green, blue)
    hsi[:,:,1] = calcular_s(red, green, blue)
    hsi[:,:,2] = calcular_i(red, green, blue)



    return hsi
```

[84]:
```
hsv = transformar_hsi(img)
print(hsv[0,0])
plt.imshow(hsv,  cmap="hsv")
```

```
[0.00112183 0.62140954 0.2379085 ]
```

[84]: <matplotlib.image.AxesImage at 0x2140af97eb8>



[57]:
```
image_hsv = color.rgb2hsv(img)
print(image_hsv[0,0])
plt.imshow(image_hsv, cmap="hsv")
```

```
[0.06584362 0.77884615 0.40784314]
```

[57]: <matplotlib.image.AxesImage at 0x2140a777390>