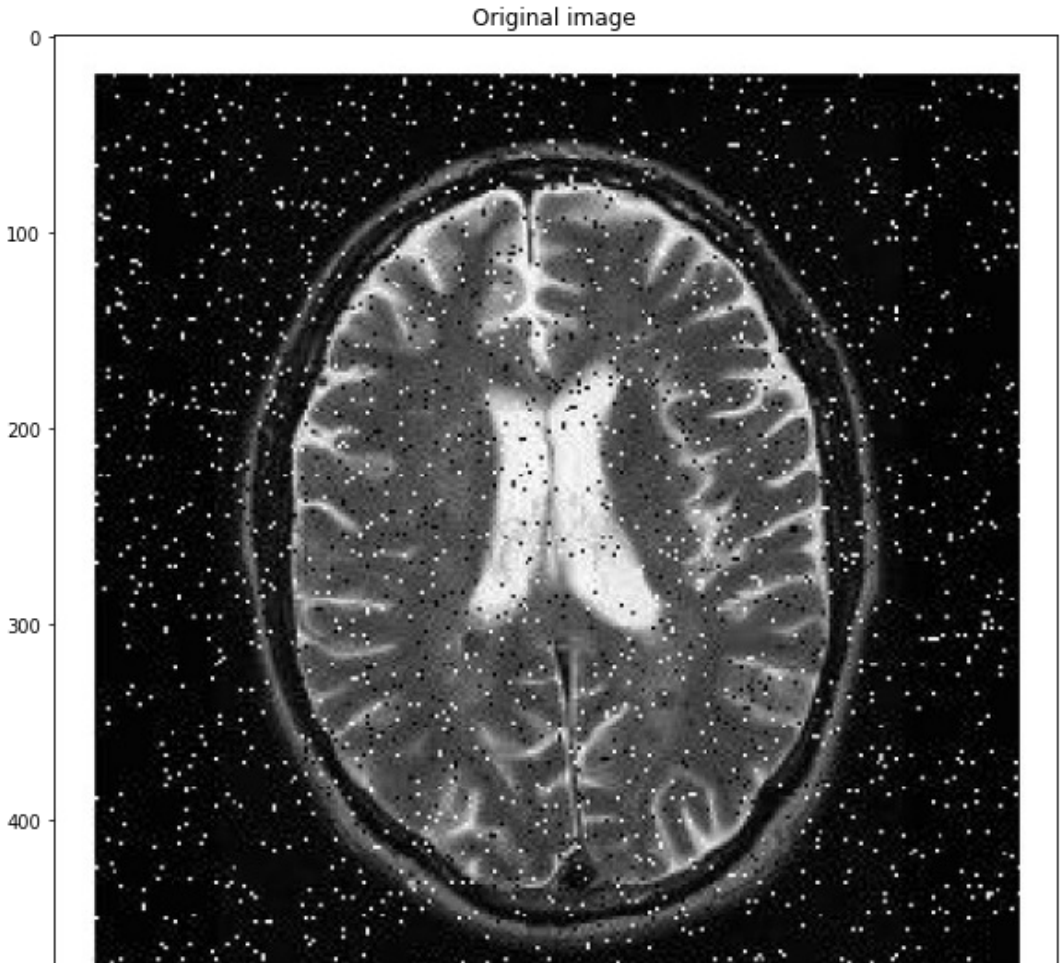
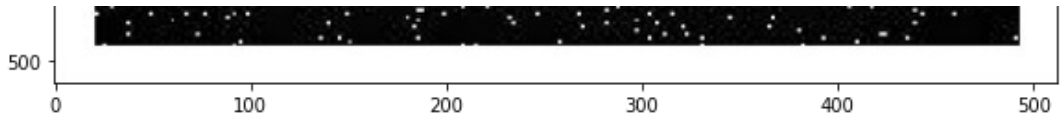
In [66]:

```
%matplotlib inline
from IPython.display import display, Math, Latex
import cv2
import random
import numpy as np
import matplotlib.pyplot as plt
import requests
from PIL import Image
from io import BytesIO
import math
import scipy.ndimage as nd
import pylab as pl
from collections import defaultdict

#url = 'https://www.researchgate.net/profile/Zhiwu-Liao/publication/44850068/figure/fig2/AS:305428874448947@1449831326678/Noisy-Lena-a-and-denoised-Lena-using-Wieners-filter-with-77-mask-b.png'
url = 'https://miro.medium.com/max/1074/1*2I9jCD3ZuQd-SUhC21ra8Q.jpeg'
response = requests.get(url)
img = Image.open(BytesIO(response.content)).convert('L')
img.thumbnail((512, 512), Image.ANTIALIAS)

# display the image
figsize = (10,10)
plt.figure(figsize=figsize)

plt.imshow(img, cmap='gray', vmin=0, vmax=255)
plt.title("Original image")
```

Out[66]:

```
Text(0.5, 1.0, 'Original image')
```





In [67]:

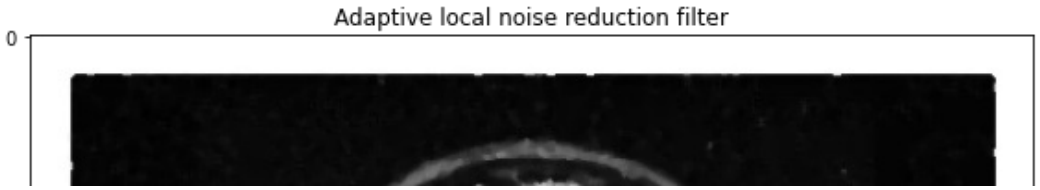
```
def adaptive_local_noise_reduction_filter(img, var_g, s=3):
 x, y = img.shape
 # Initialize result image
 result = np.zeros_like(img)

 filter_edge = int(s/2)

 # Traverse through image
 for i in range(0,x):
  for j in range(0,y):
    # Create new filter list
    filtr = []

    # Traverse through filter
    for u in range(s):
     for v in range(s):
      # Get current position
      cur_x = (i + u - filter_edge)
      cur_y = (j + v - filter_edge)

      # Stay inside image boundaries
      if((cur_x >= 0) and (cur_y >= 0) and (cur_x < x) and (cur_y < y)):
       # Append value to filter list
       filtr.append(img[cur_x, cur_y])

    # Convert filter list to numpy array
    filtr = np.array(filtr)
    # Get local mean from filter
    mean_l = np.mean(filtr)
    # Get local variance from filter
    var_l = np.var(filtr)

    # If local variance is smaller than global variance, set ratio to 1
    if var_g <= var_l:
     r = var_g/var_l
    else:
     r = 1
    # Get the output value and round off to nearest integer
    result[i, j] = img[i, j] - (r * (img[i, j] - mean_l))
 return cv2.medianBlur(img, 5)
```

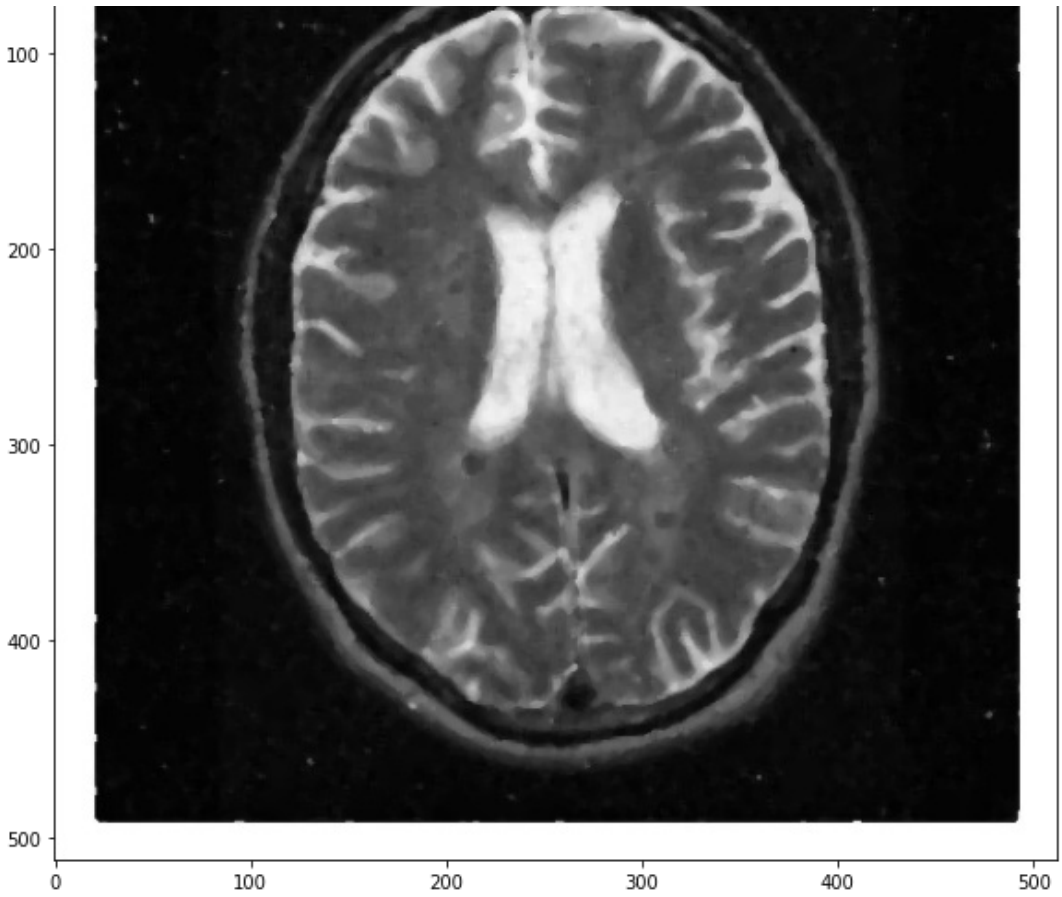
In [70]:

```
img = np.asarray(img)
enhance_img = adaptive_local_noise_reduction_filter(img, 0.1)
# display the image
figsize = (10,10)
plt.figure(figsize=figsize)

plt.imshow(enhance_img, cmap='gray', vmin=0, vmax=255)
plt.title("Adaptive local noise reduction filter")
```

Out[70]:

```
Text(0.5, 1.0, 'Adaptive local noise reduction filter')
```




100
200
300
400
500
0
100
200
300
400
500