Step 2. Removing Noise

- Purpose: to remove background noise while maintaining the structure of the flagellum.

In [1]:
```
from __future__ import print_function
import SimpleITK as sitk
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
def DisplayImageAsArray(image, title):
    array = sitk.GetArrayFromImage(image)
    plt.imshow(array, cmap='gray')
    plt.title(title)
    plt.show()
    return
```

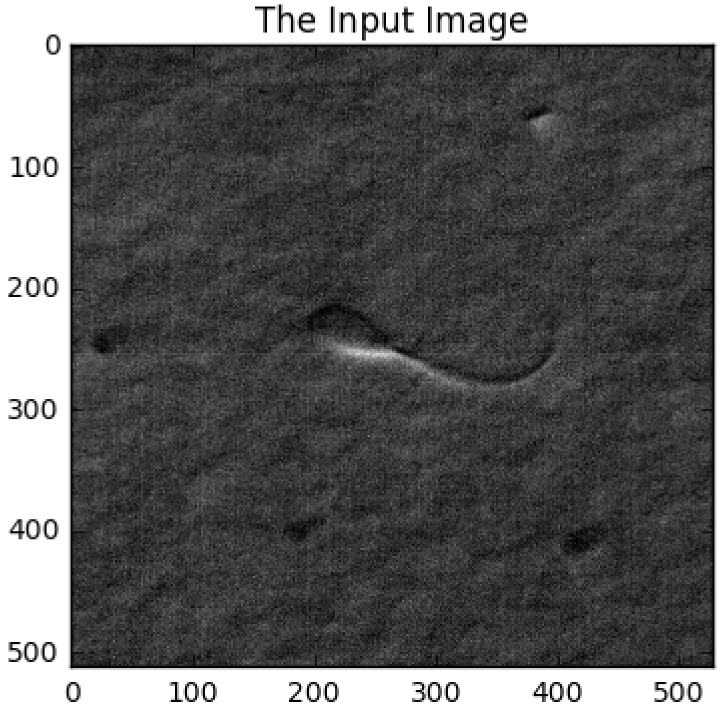
2.1 Read the movie.

In [3]:
```
imread = sitk.ImageFileReader()
imread.SetFileName( '../Movie/movieCorrectedIllunimation.mha' )
movie = imread.Execute();
```

In [4]:
```
# Get the size of the movie.
(n1,n2,n3) = movie.GetSize()
```

In [5]:

```
# Disply a frame as an example.
I = movie[:,:,10]
DisplayImageAsArray(I, "The Input Image")
```

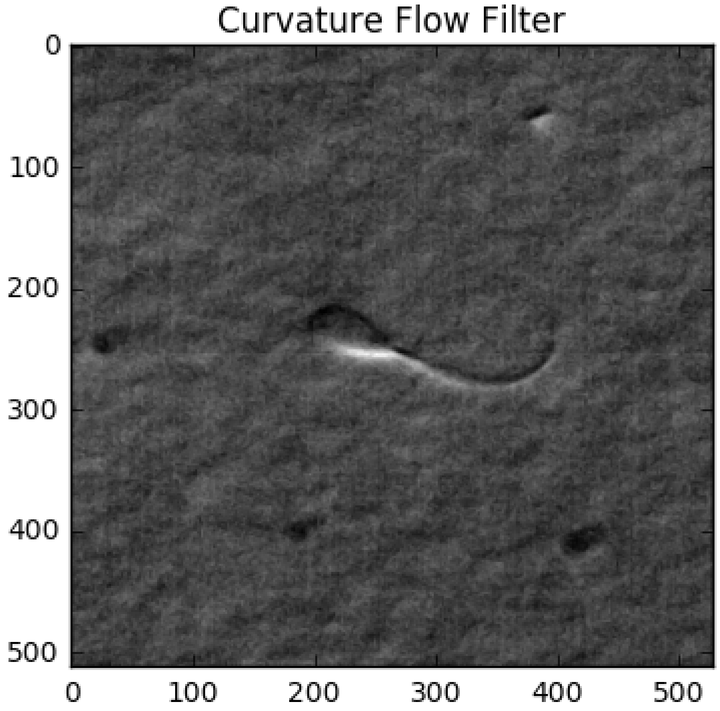


2.3a Apply curvature flow filter to a frame.

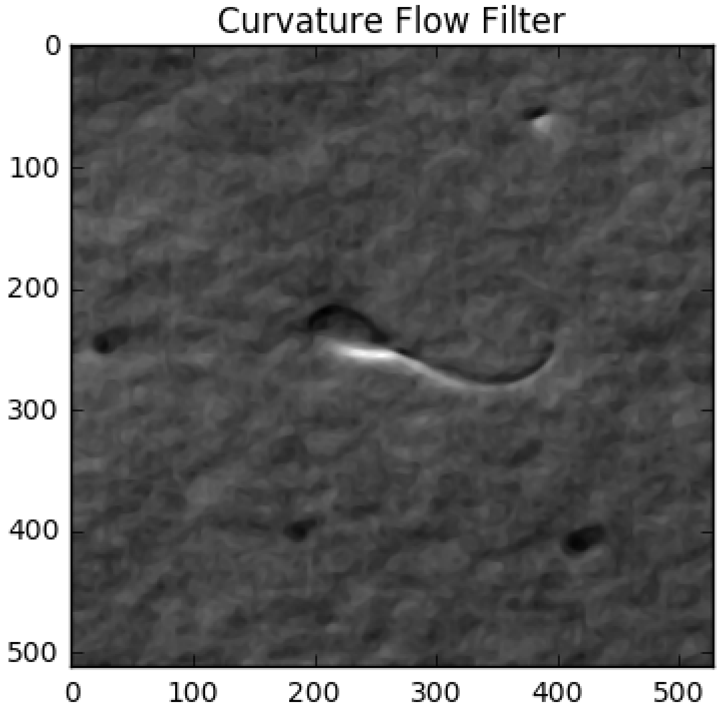
In [6]:

```
def CurvatureFlow( image, iterations, timestep ):
    imcurvaflow = sitk.CurvatureFlowImageFilter()
    imcurvaflow.SetNumberOfIterations( iterations )
    imcurvaflow.SetTimeStep( timestep )
    return imcurvaflow.Execute( image )
```

In [7]:
```
# Apply the filter to one frame.
img = CurvatureFlow( I, 10, 0.1 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```

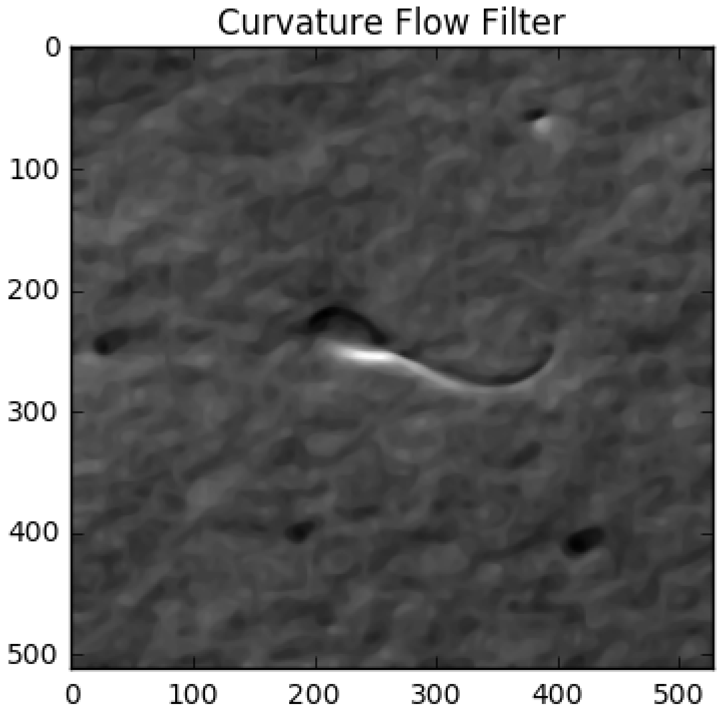

Curvature Flow Filter

In [8]:
```
# Apply the filter to one frame.
img = CurvatureFlow( I, 50, 0.1 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```


Curvature Flow Filter

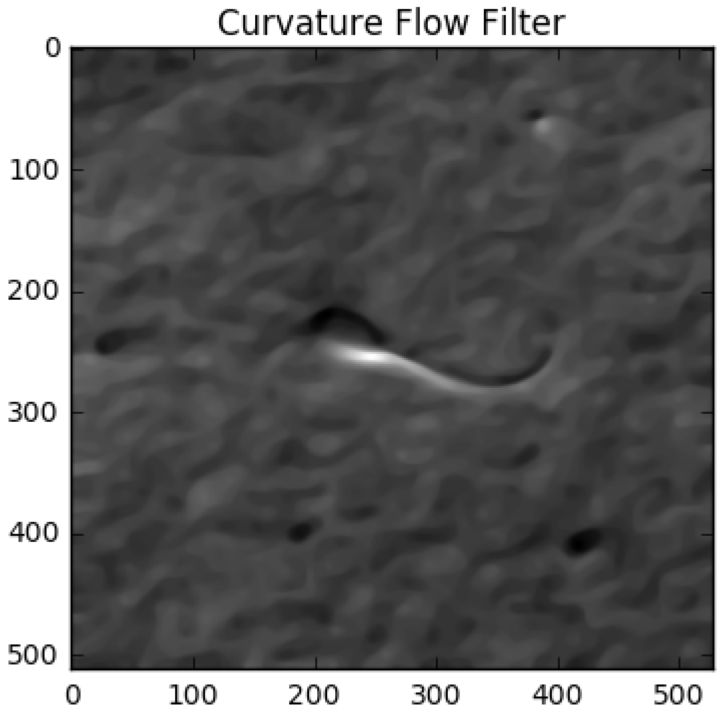
In [9]:

```
# Apply the filter to one frame.
img = CurvatureFlow( I, 50, 0.2 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```



In [10]:

```
# Apply the filter to one frame.
img = CurvatureFlow( I, 50, 0.4 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```



2.3b Apply curvature flow filter to the movie frame by

frame.

In [11]:

```
newMovie = sitk.Image(n1,n2,n3, sitk.sitkFloat64)
iteration = 50
timestep = 0.2
for ii in range(n3):
    newImage = CurvatureFlow( movie[:,:,ii], iteration, timestep )
    volume = sitk.JoinSeries(newImage)
    newMovie = sitk.Paste(newMovie, volume, volume.GetSize(), destinationInc
```

2.4 Write out the result.

In [12]:

```
imwrite = sitk.ImageFileWriter()
imwrite.SetFileName("movieBlurredCurvatureFlow.mha")
imwrite.Execute(newMovie)
```

Out[12]:

```
<SimpleITK.SimpleITK.ImageFileWriter; proxy of <Swig Object of type 'it
k::simple::ImageFileWriter *' at 0x11a68f3c0> >
```

Choosing a blurring filter.

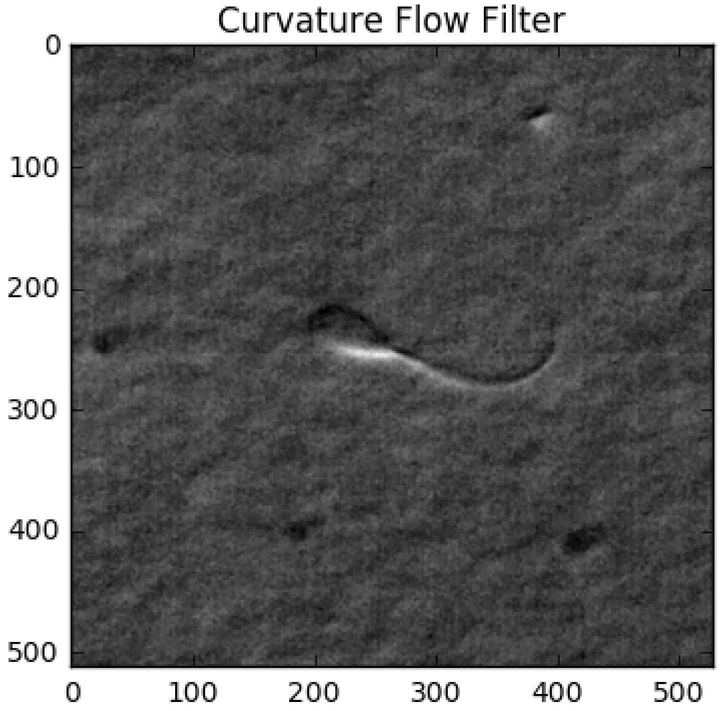
Apply median filter to the input movie to determine which blurring filter is better

2.3a Apply median filter to a frame.

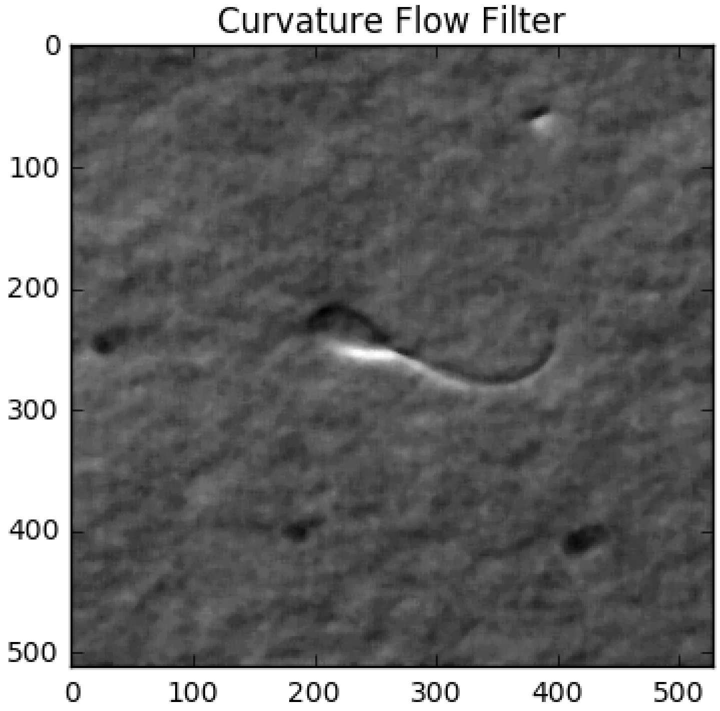
In [13]:

```
def Median2D( image, radius ):
    medfilt2 = sitk.MedianImageFilter()
    medfilt2.SetRadius( radius )
    return medfilt2.Execute( image )
```

```
In [14]: # Apply the filter to one frame.
         img = Median2D( I, 1 )
         DisplayImageAsArray(img, "Curvature Flow Filter")
```

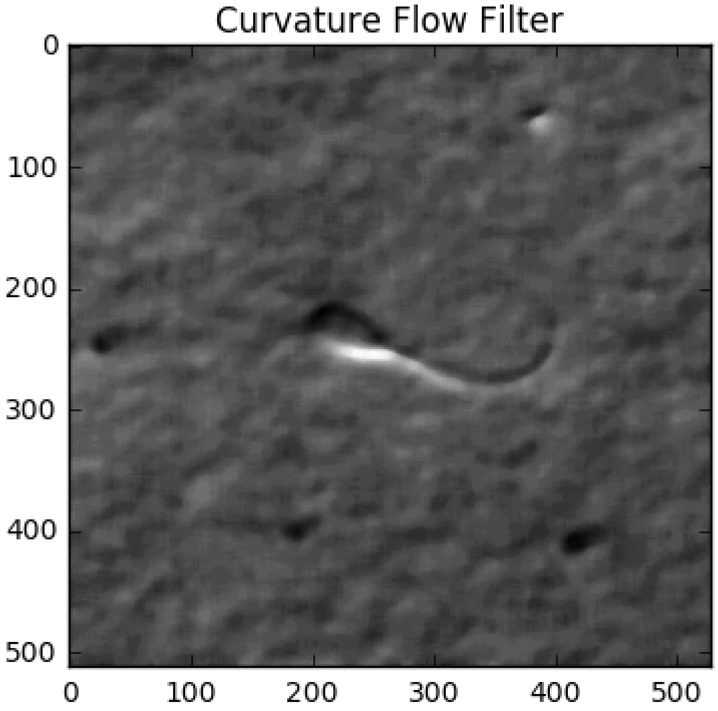


```
In [15]: # Apply the filter to one frame.
         img = Median2D( I, 3 )
         DisplayImageAsArray(img, "Curvature Flow Filter")
```



In [16]:

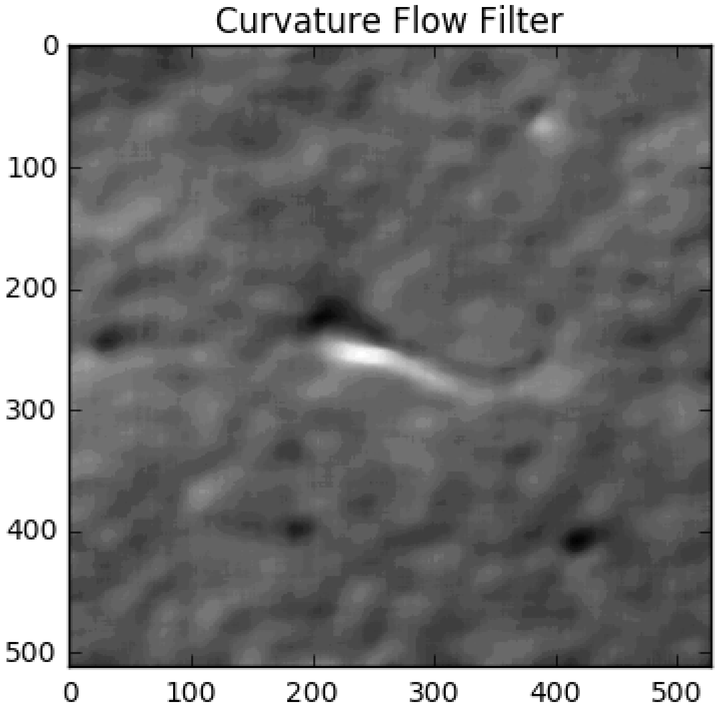
```
# Apply the filter to one frame.
img = Median2D( I, 5 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```



Curvature Flow Filter

In [17]:

```
# Apply the filter to one frame.
img = Median2D( I, 10 )
DisplayImageAsArray(img, "Curvature Flow Filter")
```



Curvature Flow Filter

2.3b Apply median filter to the movie frame by frame.

In [18]:

```
newMovie = sitk.Image(n1,n2,n3, sitk.sitkUInt16)
radius = 3
for ii in range(n3):
    newImage = Median2D( movie[:,:,ii], radius )
    volume = sitk.JoinSeries(newImage)
    newMovie = sitk.Paste(newMovie, volume, volume.GetSize(), destinationInc
```

2.4 Write out the result.

In [19]:

```
imwrite = sitk.ImageFileWriter()
imwrite.SetFileName("movieBlurredMedian.mha")
imwrite.Execute(newMovie)
```

Out[19]:

```
<SimpleITK.SimpleITK.ImageFileWriter; proxy of <Swig Object of type 'it
k::simple::ImageFileWriter *' at 0x11a68f3f0> >
```

2.5 Conclusion.

- So far, it is not clear which blurring filter is better.
- Since the background noise is strong, we need to set the parameters big for either filter to remove as much noise as possible.
- On the other hand, the flagellum is very thin, the parameters for either filter cannot be set to big in order to keep the feature of the sperm.
- Solution: is there a "local" blurring method, which is analogous to block thresholding?

In [ ]:

```
```