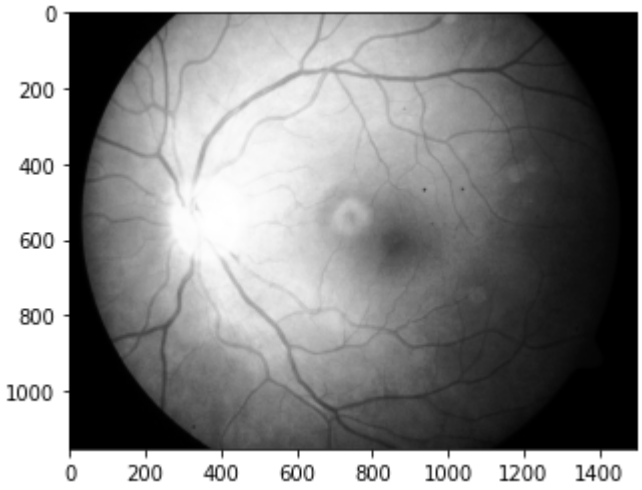
In [1]:
```
from scipy import misc
from PIL import Image
from skimage import exposure
from sklearn import svm

import scipy
from math import sqrt,pi
from numpy import exp
from matplotlib import pyplot as plt
import numpy as np
import glob
import matplotlib.pyplot as pltss
import cv2
from matplotlib import cm
import pandas as pd
from math import pi, sqrt
import pywt
```

In [2]:
```
#img_rows=img_cols=200
immatrix=[]
im_unpre = []
#image_path = Image.open('C:\Users\Rohan\Desktop\Diabetic_Retinopathy\diaretdb1_v_1
#image = misc.imread(image_path)

for i in range(1,90):
    img_pt = r'C:\Users\G Harsh Vardhan\Desktop\dataset\resources\images\ddb1_fundu
    if i < 10:
        img_pt = img_pt + "00" + str(i) + ".png"
    else:
        img_pt = img_pt + "0" + str(i)+ ".png"

    img = cv2.imread(img_pt)
    #im_unpre.append(np.array(img).flatten())
    img_gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    equ = cv2.equalizeHist(img_gray)
    immatrix.append(np.array(equ).flatten())
    #res = np.hstack((img_gray,equ))
```

In [3]:
```
np.shape(np.array(equ).flatten())
```

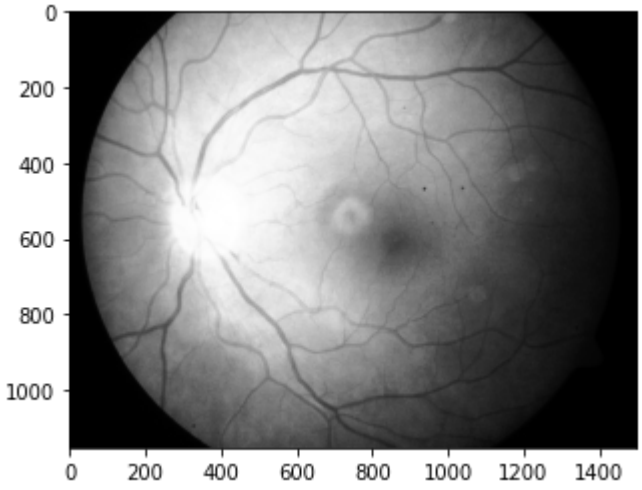
Out[3]:
```
(1728000,)
```

In [5]:
```
np.shape(immatrix)
np.shape(equ)
plt.imshow(immatrix[78].reshape((1152,1500)),cmap='gray')
plt.show()
```



In [6]:
```
imm_dwt = []
for equ in immatrix:
    equ = equ.reshape((1152,1500))
    coeffs = pywt.dwt2(equ, 'haar')
    equ2 = pywt.idwt2(coeffs, 'haar')
    imm_dwt.append(np.array(equ2).flatten())
```

In [7]:
```
np.shape(imm_dwt)
np.shape(equ2)
plt.imshow(imm_dwt[78].reshape((1152,1500)),cmap='gray')
plt.show()
```

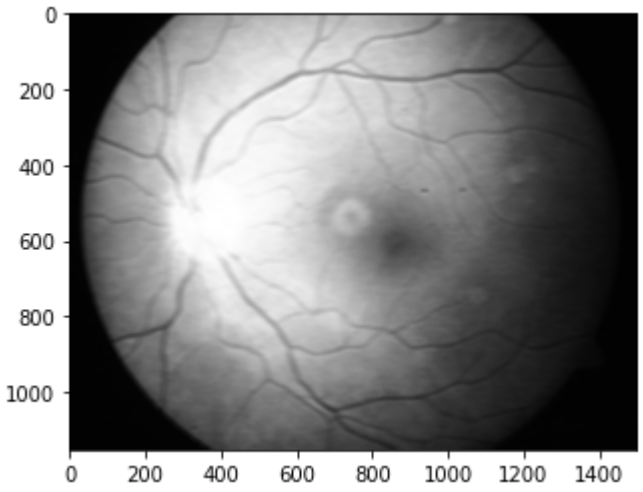


In [8]:
```
def _filter_kernel_mf_fdog(L, sigma, t = 3, mf = True):
    dim_y = int(L)
    dim_x = 2 * int(t * sigma)
    arr = np.zeros((dim_y, dim_x), 'f')

    ctr_x = dim_x / 2
    ctr_y = int(dim_y / 2.)

    # an un-natural way to set elements of the array
    # to their x coordinate.
    # x's are actually columns, so the first dimension of the iterator is used
    it = np.nditer(arr, flags=['multi_index'])
    while not it.finished:
        arr[it.multi_index] = it.multi_index[1] - ctr_x
        it.iternext()

    two_sigma_sq = 2 * sigma * sigma
```

```
    sqrt_w_pi_sigma = 1. / (sqrt(2 * pi) * sigma)
    if not mf:
        sqrt_w_pi_sigma = sqrt_w_pi_sigma / sigma ** 2

    #@vectorize(['float32(float32)'], target='cpu')
    def k_fun(x):
        return sqrt_w_pi_sigma * exp(-x * x / two_sigma_sq)

    #@vectorize(['float32(float32)'], target='cpu')
    def k_fun_derivative(x):
        return -x * sqrt_w_pi_sigma * exp(-x * x / two_sigma_sq)

    if mf:
        kernel = k_fun(arr)
        kernel = kernel - kernel.mean()
    else:
        kernel = k_fun_derivative(arr)

    # return the "convolution" kernel for filter2D
    return cv2.flip(kernel, -1)

def show_images(images,titles=None, scale=1.3):
    """Display a list of images"""
    n_ims = len(images)
    if titles is None: titles = ['(%d)' % i for i in range(1,n_ims + 1)]
    fig = plt.figure()
    n = 1
    for image,title in zip(images,titles):
        a = fig.add_subplot(1,n_ims,n) # Make subplot
        if image.ndim == 2: # Is image grayscale?
            plt.imshow(image, cmap = cm.Greys_r)
        else:
            plt.imshow(cv2.cvtColor(image, cv2.COLOR_RGB2BGR))
        a.set_title(title)
        plt.axis("off")
        n += 1
    fig.set_size_inches(np.array(fig.get_size_inches(), dtype=np.float) * n_ims / s
    plt.show()


def gaussian_matched_filter_kernel(L, sigma, t = 3):
    '''
    K =  1/(sqrt(2 * pi) * sigma ) * exp(-x^2/2sigma^2), |y| <= L/2, |x| < s * t
    '''
    return _filter_kernel_mf_fdog(L, sigma, t, True)

#Creating a matched filter bank using the kernel generated from the above functions
def createMatchedFilterBank(K, n = 12):
    rotate = 180 / n
    center = (K.shape[1] / 2, K.shape[0] / 2)
    cur_rot = 0
    kernels = [K]

    for i in range(1, n):
        cur_rot += rotate
        r_mat = cv2.getRotationMatrix2D(center, cur_rot, 1)
        k = cv2.warpAffine(K, r_mat, (K.shape[1], K.shape[0]))
        kernels.append(k)

    return kernels
```

```
#Given a filter bank, apply them and record maximum response

def applyFilters(im, kernels):

    images = np.array([cv2.filter2D(im, -1, k) for k in kernels])
    return np.max(images, 0)


gf = gaussian_matched_filter_kernel(20, 5)
bank_gf = createMatchedFilterBank(gf, 4)

imm_gauss = []
for equ2 in imm_dwt:
    equ2 = equ2.reshape((1152,1500))
    equ3 = applyFilters(equ2,bank_gf)
    imm_gauss.append(np.array(equ3).flatten())
```

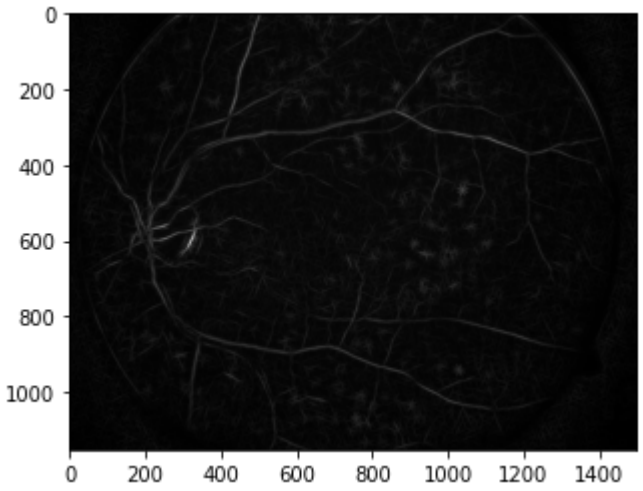
In [9]:
```
# the array ranges from 0 - 89
np.shape(imm_gauss)
plt.imshow(imm_gauss[78].reshape((1152,1500)),cmap='gray')
plt.show()
```



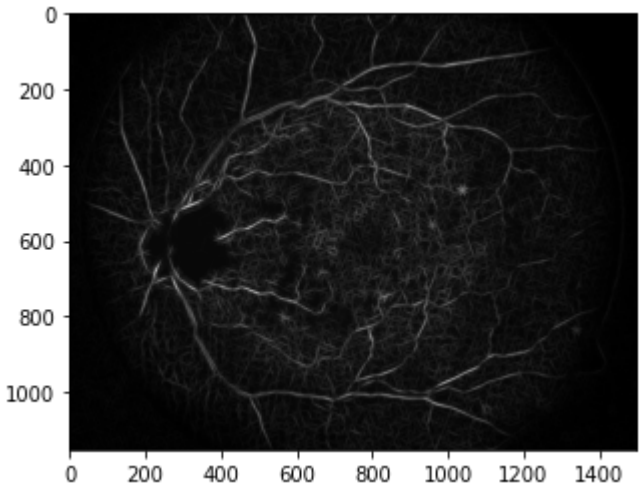
In [10]:
```
def createMatchedFilterBank():
    filters = []
    ksize = 31
    for theta in np.arange(0, np.pi, np.pi / 16):
        kern = cv2.getGaborKernel((ksize, ksize), 6, theta,12, 0.37, 0, ktype=cv2.C
        kern /= 1.5*kern.sum()
        filters.append(kern)
    return filters

def applyFilters(im, kernels):
    images = np.array([cv2.filter2D(im, -1, k) for k in kernels])
    return np.max(images, 0)

bank_gf = createMatchedFilterBank()
#equx=equ3
#equ3 = applyFilters(equ2,bank_gf)
imm_gauss2 = []
for equ2 in imm_dwt:
    equ2 = equ2.reshape((1152,1500))
    equ3 = applyFilters(equ2,bank_gf)
    imm_gauss2.append(np.array(equ3).flatten())
```

In [11]:
```
# the array ranges from 0 - 89
```

```
np.shape(imm_gauss2)
plt.imshow(imm_gauss2[20].reshape((1152,1500)),cmap='gray')
plt.show()
```



In [12]:
```
# the array ranges from 0 - 89
np.shape(imm_gauss2)
plt.imshow(imm_gauss2[1].reshape((1152,1500)),cmap='gray')
plt.show()
```



In [13]:
```
e_ = equ3
np.shape(e_)
e_=e_.reshape((-1,3))
np.shape(e_)
```

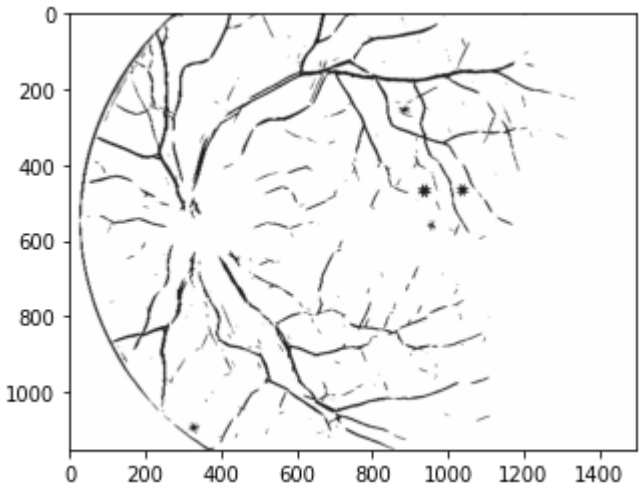
Out[13]:
```
(576000, 3)
```

In [14]:
```
img = equ3
Z = img.reshape((-1,3))

# convert to np.float32
Z = np.float32(Z)

k=cv2.KMEANS_PP_CENTERS


# define criteria, number of clusters(K) and apply kmeans()
criteria = (cv2.TERM_CRITERIA_EPS + cv2.TERM_CRITERIA_MAX_ITER, 10, 1.0)
K = 2
ret,label,center=cv2.kmeans(Z,K,None,criteria,10,k)
```

```
# Now convert back into uint8, and make original image
center = np.uint8(center)
res = center[label.flatten()]
res2 = res.reshape((img.shape))
```

In [15]:
```
imm_kmean = []
for equ3 in imm_gauss2:
    img = equ3.reshape((1152,1500))
    Z = img.reshape((-1,3))

    # convert to np.float32
    Z = np.float32(Z)

    k=cv2.KMEANS_PP_CENTERS


    # define criteria, number of clusters(K) and apply kmeans()
    criteria = (cv2.TERM_CRITERIA_EPS + cv2.TERM_CRITERIA_MAX_ITER, 10, 1.0)
    K = 2
    ret,label,center=cv2.kmeans(Z,K,None,criteria,10,k)

    # Now convert back into uint8, and make original image
    center = np.uint8(center)
    res = center[label.flatten()]
    res2 = res.reshape((img.shape))
    imm_kmean.append(np.array(res2).flatten())
```

In [16]:
```
# the array ranges from 0 - 89
np.shape(imm_kmean)
plt.imshow(imm_kmean[78].reshape((1152,1500)),cmap="gray")
plt.show()
```



In [17]:
```
from sklearn.svm import SVC
clf = SVC()
```

In [18]:
```
Y = np.ones(89)
```

In [19]:
```
Y[1]=Y[5]=Y[7]=Y[17]=Y[6]=0
```

In [20]:
```
clf.fit(imm_kmean, Y)
```

Out[20]:
```
SVC()
```

In [21]:
```
y_pred = clf.predict(imm_kmean)
```

In [22]:
```
k = [1,3,4,9,10,11,13,14,20,22,24,25,26,27,28,29,35,36,38,42,53,55,57,64,70,79,84,8
```

In [23]:
```
k = k-np.ones(len(k))
```

In [24]:
```
k
```

Out[24]:
```
array([ 0.,  2.,  3.,  8.,  9., 10., 12., 13., 19., 21., 23., 24., 25.,
       26., 27., 28., 34., 35., 37., 41., 52., 54., 56., 63., 69., 78.,
       83., 85.])
```

In [25]:
```
k =[int(x) for x in k]
```

In [27]:
```
k
```

Out[27]:
```
[0,
 2,
 3,
 8,
 9,
 10,
 12,
 13,
 19,
 21,
 23,
 24,
 25,
 26,
 27,
 28,
 34,
 35,
 37,
 41,
 52,
 54,
 56,
 63,
 69,
 78,
 83,
 85]
```

In [28]:
```
imm_train = []
y_train = []
k.append(5)
k.append(7)
for i in k:
    imm_train.append(imm_kmean[i])
    y_train.append(Y[i])
```

In [29]:
```
y_train
```

Out[29]:
```
[1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 1.0,
 0.0,
 0.0]
```

In [30]:
```
clf.fit(imm_train, y_train)
```

Out[30]:
```
SVC()
```

In [31]:
```
y_pred = clf.predict(imm_kmean)
```

In [35]:
```
import sklearn
```

In [36]:
```
sklearn.metrics.accuracy_score(Y,y_pred)
```

Out[36]:
```
0.9438202247191011
```