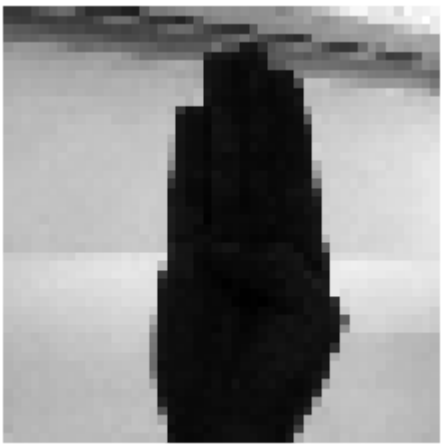
In [1]:
```
#preparation of the model

import numpy as np
import seaborn as sns
from keras.preprocessing.image import load_img, img_to_array
import matplotlib.pyplot as plt
import os

# size of the image
pic_size = 48

# input path for the images
base_path = 'images/'

from keras.preprocessing.image import ImageDataGenerator

# number of images to feed into the NN for every batch
batch_size = 1

datagen_train = ImageDataGenerator()

total_data = datagen_train.flow_from_directory(base_path + "train/train",
                                               target_size=(pic_size,pic_s
                                               color_mode="grayscale",
                                               batch_size=batch_size,
                                               class_mode='categorical',
                                               shuffle=True)
```

```
Using TensorFlow backend.

Found 87000 images belonging to 29 classes.
```

In [2]:
```
import numpy as np
d = np.random.permutation(87000)
# out of 10700 datasets I will be using 80:20 (10000 datasets) for training:val
x_train = np.empty((10000, 48, 48, 1), dtype=np.float32)
y_train = np.empty((10000, 29), dtype=np.float32)
x_test = np.empty((700, 48, 48, 1), dtype=np.float32)
y_test = np.empty((700, 29), dtype=np.float32)
for i in range(0,10000):
    x_train[i] = total_data[d[i]][0][0]
    y_train[i] = total_data[d[i]][1][0]
for i in range(10000,10700):
    x_test[i-10000] = total_data[d[i]][0][0]
    y_test[i-10000] = total_data[d[i]][1][0]
```

In [3]:
```
# Defining Image Computations
def plot_image(i):
    image = x_test[i]
    plt.imshow(image, cmap="gray", interpolation="nearest")
    plt.axis("off")

def plot_color_image(image):
    plt.imshow(image.astype(np.uint8),interpolation="nearest")
    plt.axis("off")
x_test.resize((700,48,48))
## Printing the shape of the hands
print(x_test.shape)

## Plotting 1 image
plot_image(13)
```

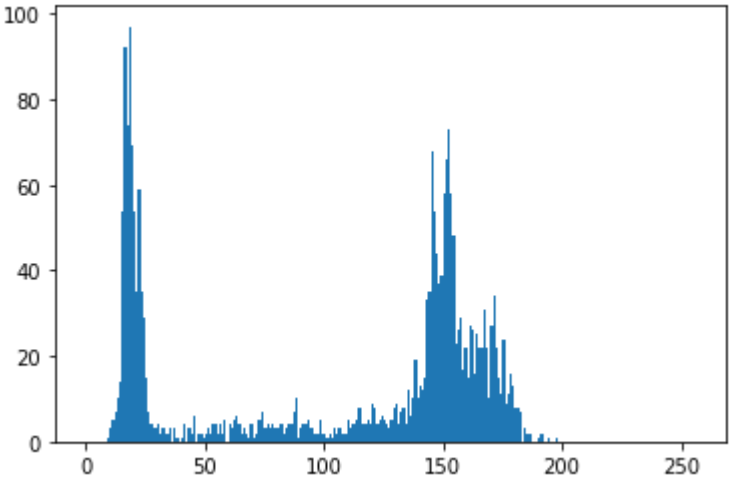
```
(700, 48, 48)
```



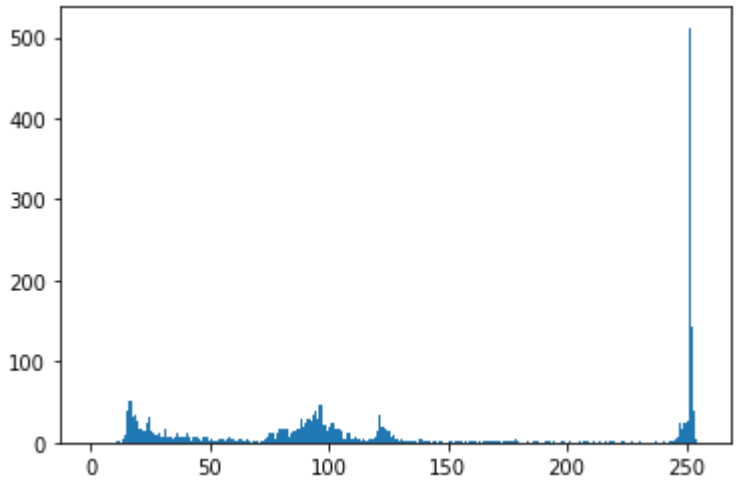
plot_image(16)

In [4]:
```
## Plotting second image
plot_image(16)
```

In [5]:
```
# Let's plot histogram for 2 images to see the sharp differences between the im
import cv2
def plot_histogram(i):
    img = x_test[i]
    plt.hist(img.ravel(),256,[0,256])
    plt.show()
plot_histogram(13)
```



In [6]:
```
plot_histogram(16)
```

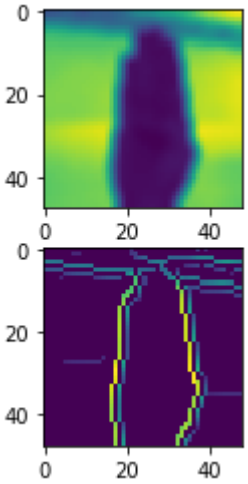


In [7]:

```
import numpy as np
import os
import cv2
import matplotlib.pyplot as plt


# defining the canny detector function

# here weak_th and strong_th are thresholds for
# double thresholding step
def Canny_detector(i, weak_th = None, strong_th = None):
    img = x_test[i]
    # conversion of image to grayscale
#     img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

    # Noise reduction step
    img = cv2.GaussianBlur(img, (5, 5), 1.4)

    # Calculating the gradients
    gx = cv2.Sobel(np.float32(img), cv2.CV_64F, 1, 0, 3)
    gy = cv2.Sobel(np.float32(img), cv2.CV_64F, 0, 1, 3)

    # Conversion of Cartesian coordinates to polar
    mag, ang = cv2.cartToPolar(gx, gy, angleInDegrees = True)

    # setting the minimum and maximum thresholds
    # for double thresholding
    mag_max = np.max(mag)
    if not weak_th:weak_th = mag_max * 0.1
    if not strong_th:strong_th = mag_max * 0.5

    # getting the dimensions of the input image
    height, width = img.shape

    # Looping through every pixel of the grayscale
    # image
    for i_x in range(width):
        for i_y in range(height):

            grad_ang = ang[i_y, i_x]
            grad_ang = abs(grad_ang-180) if abs(grad_ang)>180 else abs(grad_ang

            # selecting the neighbours of the target pixel
            # according to the gradient direction
            # In the x axis direction
            if grad_ang<= 22.5:
                neighb_1_x, neighb_1_y = i_x-1, i_y
                neighb_2_x, neighb_2_y = i_x + 1, i_y

            # top right (diagnol-1) direction
            elif grad_ang>22.5 and grad_ang<=(22.5 + 45):
                neighb_1_x, neighb_1_y = i_x-1, i_y-1
                neighb_2_x, neighb_2_y = i_x + 1, i_y + 1

            # In y-axis direction
            elif grad_ang>(22.5 + 45) and grad_ang<=(22.5 + 90):
```

```
                    neighb_1_x, neighb_1_y = i_x, i_y-1
                    neighb_2_x, neighb_2_y = i_x, i_y + 1

                # top left (diagnol-2) direction
                elif grad_ang>(22.5 + 90) and grad_ang<=(22.5 + 135):
                    neighb_1_x, neighb_1_y = i_x-1, i_y + 1
                    neighb_2_x, neighb_2_y = i_x + 1, i_y-1

                # Now it restarts the cycle
                elif grad_ang>(22.5 + 135) and grad_ang<=(22.5 + 180):
                    neighb_1_x, neighb_1_y = i_x-1, i_y
                    neighb_2_x, neighb_2_y = i_x + 1, i_y

                # Non-maximum suppression step
                if width>neighb_1_x>= 0 and height>neighb_1_y>= 0:
                    if mag[i_y, i_x]<mag[neighb_1_y, neighb_1_x]:
                        mag[i_y, i_x]= 0
                        continue

                if width>neighb_2_x>= 0 and height>neighb_2_y>= 0:
                    if mag[i_y, i_x]<mag[neighb_2_y, neighb_2_x]:
                        mag[i_y, i_x]= 0

        weak_ids = np.zeros_like(img)
        strong_ids = np.zeros_like(img)
        ids = np.zeros_like(img)

        # double thresholding step
        for i_x in range(width):
            for i_y in range(height):

                grad_mag = mag[i_y, i_x]

                if grad_mag<weak_th:
                    mag[i_y, i_x]= 0
                elif strong_th>grad_mag>= weak_th:
                    ids[i_y, i_x]= 1
                else:
                    ids[i_y, i_x]= 2

        plt.figure()
        f, plots = plt.subplots(2, 1)
        plots[0].imshow(img)
        plots[1].imshow(mag)

    Canny_detector(13)

    # # Displaying the input and output image
    # plt.figure()
    # f, plots = plt.subplots(2, 1)
    # plots[0].imshow(frame)
    # plots[1].imshow(canny_img)
```

```
<Figure size 432x288 with 0 Axes>
```

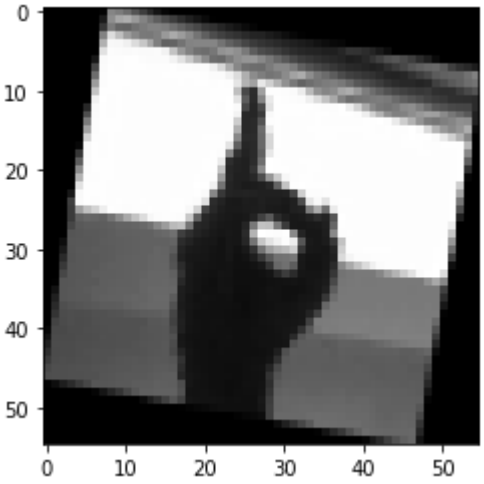


In [8]:

```
# After This we will train the model & augment the data
def rotate_bound(image, angle):
    # grab the dimensions of the image and then determine the
    # center
    (h, w) = image.shape[:2]
    (cX, cY) = (w // 2, h // 2)
    # grab the rotation matrix (applying the negative of the
    # angle to rotate clockwise), then grab the sine and cosine
    # (i.e., the rotation components of the matrix)
    M = cv2.getRotationMatrix2D((cX, cY), -angle, 1.0)
    cos = np.abs(M[0, 0])
    sin = np.abs(M[0, 1])
    # compute the new bounding dimensions of the image
    nW = int((h * sin) + (w * cos))
    nH = int((h * cos) + (w * sin))
    # adjust the rotation matrix to take into account translation
    M[0, 2] += (nW / 2) - cX
    M[1, 2] += (nH / 2) - cY
    # perform the actual rotation and return the image
    return cv2.warpAffine(image, M, (nW, nH))
```

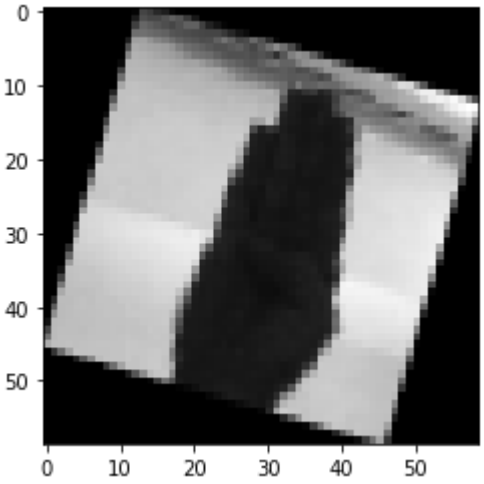
In [14]:
```
img_rotated = rotate_bound(x_test[16],10)
plt.imshow(img_rotated, cmap="gray", interpolation="nearest")
```

Out[14]: <matplotlib.image.AxesImage at 0x7efc18f3dc88>



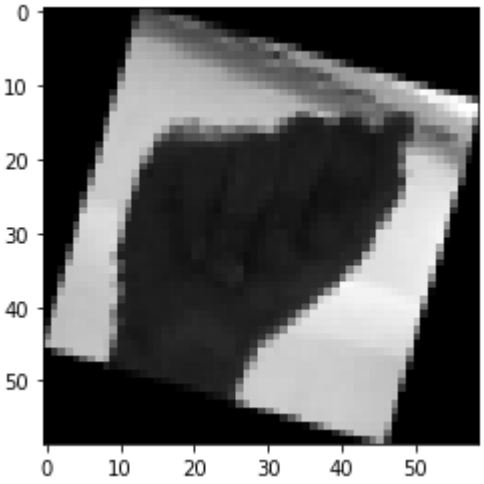
In [16]:
```
img_rotated = rotate_bound(x_test[13],16)
plt.imshow(img_rotated, cmap="gray", interpolation="nearest")
```

Out[16]: <matplotlib.image.AxesImage at 0x7efc18f64eb8>



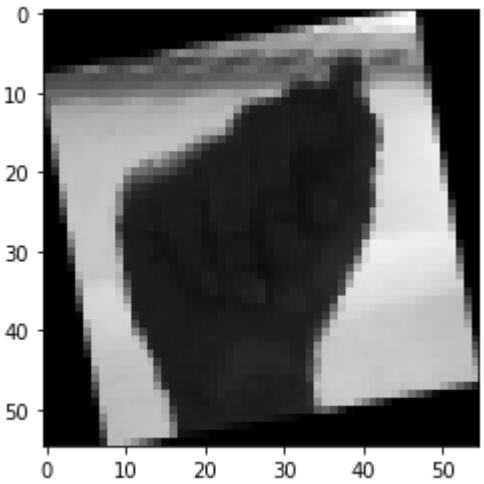
In [17]:
```
img_rotated = rotate_bound(x_test[14],16)
plt.imshow(img_rotated, cmap="gray", interpolation="nearest")
```

Out[17]: <matplotlib.image.AxesImage at 0x7efc1900bfd0>



In [18]:
```
img_rotated = rotate_bound(x_test[14],-10)
plt.imshow(img_rotated, cmap="gray", interpolation="nearest")
```

Out[18]: <matplotlib.image.AxesImage at 0x7efc19028160>



In [ ]: