In [1]:
```
# Importing required libraries
import os
import xml.etree.ElementTree as ET
import numpy as np
import matplotlib.pyplot as plt
from skimage import io, color, exposure, filters
from sklearn.metrics.pairwise import euclidean_distances, manhattan_distances, cosine_distances
from skimage.feature import hog
from sklearn.decomposition import PCA
from skimage.transform import resize
from skimage import img_as_ubyte

import warnings
warnings.filterwarnings("ignore")
```

In [2]:
```
# Code Snippet 1: Function to get bounding boxes from Annotations
def get_bounding_boxes(annot):
    xml = annot
    tree = ET.parse(xml)
    root = tree.getroot()
    objects = root.findall('object')
    bbox = []
    for o in objects:
        bndbox = o.find('bndbox')
        xmin = int(bndbox.find('xmin').text)
        ymin = int(bndbox.find('ymin').text)
        xmax = int(bndbox.find('xmax').text)
        ymax = int(bndbox.find('ymax').text)
        bbox.append((xmin, ymin, xmax, ymax))
    return bbox
```

In [3]:
```
# Code Snippet 2: Cropping and Resizing Images
def process_images(dog_images, annotations):
    for i in range(len(dog_images)):
        bbox = get_bounding_boxes(annotations[i])
        dog = io.imread(dog_images[i])
        for j in range(len(bbox)):
            im2 = dog[bbox[j][1]:bbox[j][3], bbox[j][0]:bbox[j][2]]

            # Check if the cropped region is not empty before resizing
            if im2.size > 0:
                im2 = resize(im2, (128, 128), anti_aliasing=True)
                im2 = img_as_ubyte(im2)

                new_path = dog_images[i].replace('rajani images', 'Cropped').replace('.jpg', f'-{j}.jpg')

                # Create the directory if it doesn't exist
                os.makedirs(os.path.dirname(new_path), exist_ok=True)

                io.imsave(new_path, im2)
```

In [4]:
```
dog_images_folder = 'rajani images'
annotations_folder = 'rajani annotations'
dog_images = {}
annotations = {}

# Load images and annotations
for folder_name in os.listdir(dog_images_folder):
    folder_path = os.path.join(dog_images_folder, folder_name)
    images = [os.path.join(folder_path, img) for img in os.listdir(folder_path)]
    dog_images[folder_name] = images

for folder_name in os.listdir(annotations_folder):
    folder_path = os.path.join(annotations_folder, folder_name)
    annotations[folder_name] = [os.path.join(folder_path, annot) for annot in os.listdir(folder_path)]
```

In [7]:
```
dog_images.keys()
```

Out[7]:
```
dict_keys(['n02093991-Irish_terrier', 'n02098413-Lhasa', 'n02102480-Sussex_spaniel', 'n02105412-kelpie'])
```

In [8]:
```
process_images(dog_images['n02105412-kelpie'], annotations['n02105412-kelpie'])
```

In [9]:
```
process_images(dog_images['n02093991-Irish_terrier'], annotations['n02093991-Irish_terrier'])
process_images(dog_images['n02098413-Lhasa'], annotations[ 'n02098413-Lhasa'])
process_images(dog_images['n02102480-Sussex_spaniel'], annotations['n02102480-Sussex_spaniel'])
```

In [10]:
```
crop_folder='Cropped'
```

In [19]:
```
def edge_histogram(selected_images):
    ims=[]
    dogs=[]
    for idx, path in enumerate(selected_images):
        img_path = os.path.join(crop_folder,path)
        for im in os.listdir(img_path):
            src = os.path.join(img_path, im)
            img = io.imread(src)
            gray_img = color.rgb2gray(img)
            dx, dy = filters.sobel_h(gray_img), filters.sobel_v(gray_img)
            angle_sobel = np.mod(np.arctan2(dy, dx), np.pi)
            hist, bins = exposure.histogram(angle_sobel, nbins=36)
            ims.append(hist)
            dogs.append(idx)
    return ims,dogs
```

In [28]:
```
ims,dogs=edge_histogram(os.listdir(crop_folder))
```

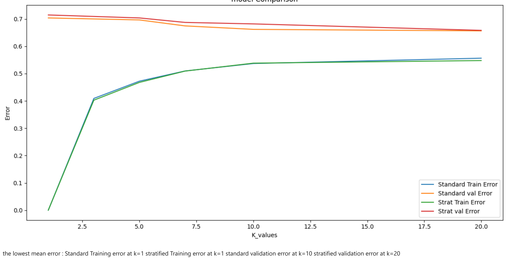
In [29]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

X_train, X_test, y_train, y_test = train_test_split(np.array(ims),np.array(dogs), test_size=0.2,stratify=dogs, random_state=42)
scaler = StandardScaler()
X_train= scaler.fit_transform(X_train)
X_test=scaler.transform(X_test)
```

In [30]:
```
import matplotlib.pyplot as plt
from sklearn.metrics import f1_score,accuracy_score,confusion_matrix,ConfusionMatrixDisplay
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import StratifiedKFold ,KFold
from sklearn.neural_network import MLPClassifier
from sklearn.svm import LinearSVC
from sklearn.ensemble import AdaBoostClassifier
```

In [32]:
```
k_values = [1,3,5,7,10,20]

def Model_Selection(fold):
    train_errors,val_errors =[],[]
    for k in [1,3,5,7,10,20]:
        KNN = KNeighborsClassifier(k)
        train,val = [],[]
        for train_index, test_index in fold.split(X_train, y_train):
            xtrain, xval = X_train[train_index], X_train[test_index]
            ytrain, yval = y_train[train_index], y_train[test_index]
            KNN.fit(xtrain, ytrain)
            train_pred = KNN.predict(xtrain)
            val_pred = KNN.predict(xval)
            train_acc = accuracy_score(ytrain, train_pred)
            val_acc = accuracy_score(yval, val_pred)
            train.append(1-train_acc)
            val.append(1-val_acc)
        train_errors.append(np.mean(train))
        val_errors.append(np.mean(val))
    return train_errors,val_errors
def plot_KNN():
    plt.figure(figsize=(12, 6))
    plt.plot(k_values, standardtrain, label='Standard Train Error')
    plt.plot(k_values, standardval, label='Standard val Error')
    plt.plot(k_values, stratrtrain, label='Strat Train Error')
    plt.plot(k_values, stratval, label='Strat val Error')
    plt.xlabel('K_values')
    plt.ylabel('Error')
    plt.title('model Comparison')
    plt.legend()
    plt.tight_layout()
    plt.show()
standardtrain,standardval = Model_Selection(KFold(n_splits=5))
stratrtrain,stratval= Model_Selection(StratifiedKFold(n_splits=5))
plot_KNN()
```



the lowest mean error : Standard Training error at k=1 stratified Training error at k=1 standard validation error at k=10 stratified validation error at k=20

the model complexity : Less at k = 1 Intermidiate at k = 3,5,7,10 high at k = 20

model : overfits at k = 1 training error is less validation is more. underfits at k =20 Great number of neighbours

In [33]:
```
#Test error
KNN =KNeighborsClassifier(20)
KNN.fit(X_train,y_train)
err=1-accuracy_score(y_test,KNN.predict(X_test))
print(err)
```

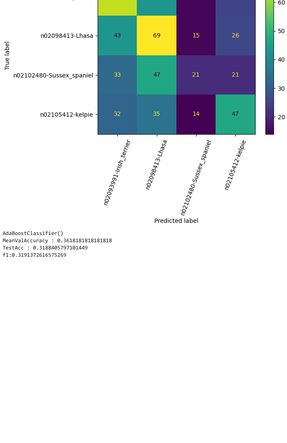
```
0.7181449275362319
```

In [38]:
```
#https://stackoverflow.com/questions/67636948/confusionmatrixdisplay-scikit-learn-plot-labels-out-of-range
def performance_comparision(assigned_classifiers):
    for classifier in assigned_classifiers:
        print(classifier)
        Actual,predicted,validation,confu_matrix=[],[],[],[]
        for train_index, test_index in StratifiedKFold(n_splits=5).split(X_train, y_train):
            xtrain, xval = X_train[train_index], X_train[test_index]
            ytrain, yval = y_train[train_index], y_train[test_index]

            classifier.fit(xtrain, ytrain)
            pred= classifier.predict(xval)
            Actual.extend(yval)
            predicted.extend(pred)
            vala = accuracy_score(yval, pred)
            validation.append(vala)
        print("MeanValAccuracy : "+str(np.mean(validation)))
        sub= classifier.predict(X_test)
        test_accuracy = accuracy_score(y_test,sub)
        print("TestAcc : "+str(test_accuracy))
        f1 = f1_score(y_test, sub, average='weighted')
        print("f1:"+str(f1))
        confu_matrix.append(confusion_matrix(Actual, predicted))
        cm_display = ConfusionMatrixDisplay(confusion_matrix = sum(confu_matrix)/len(confu_matrix), display_labels = os.listdir(crop_folder))
        cm_display.plot(xticks_rotation=70)
        plt.show()
```

In [39]:
```
assigned_classifiers=[MLPClassifier(hidden_layer_sizes=(10,10,10)),LinearSVC(),AdaBoostClassifier()]
performance_comparision(assigned_classifiers)
```

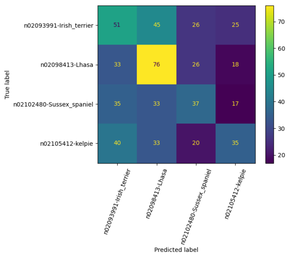
```
MLPClassifier(hidden_layer_sizes=(10, 10, 10))
MeanValAccuracy : 0.3254545454545455
TestAcc : 0.3478260869565217
f1:0.3316154118062919
```




```
LinearSVC()
MeanValAccuracy : 0.3654545454545455
TestAcc : 0.3260869565217391
f1:0.3232606318487596
```



```
AdaBoostClassifier()
MeanValAccuracy : 0.3618181818181818
TestAcc : 0.3188405797101449
f1:0.3191372616575269
```



Based on Confusion matrix display Linear SVC performs best with large nubers in diagonal. Mean validation of linear SVC is more. while test accuracy and f1 are good for MLP classifier.

In [ ]: