Image Process and Feature Matching

Dataset in use: https://susanqq.github.io/UTKFace/ (https://susanqq.github.io/UTKFace/)

In-the-wild Faces is used and part-2 is selected for train, part-3 is selected for test set.

In [1]:
```
import os
import cv2
import glob
import logging
import numpy as np
import pandas as pd
from tqdm import tqdm
from sklearn import metrics
from skimage import feature
import matplotlib.pyplot as plt
```

In [2]:
```
import warnings
warnings.filterwarnings("ignore")
```

In [3]:
```
def mkdir(path):
    try:
        if not os.path.exists(path):
            os.makedirs(path)
            logging.debug(f"Folder '{path}' created successfully.")
        else:
            raise RuntimeError(f"Folder '{path}' already exists.")
    except Exception as e:
        logging.error(f"Error creating folder '{path}': {e} You are going to modify an existing fil
        raise
```

In [4]:
```
'''
Raporda belirtildigi gibi, girdi olarak net cekilen 1 adet yuz goruntusu verilir ve cikti olarak da

SIFT, SURF, distance vb. için tabi ki hazır fonksiyonları kullanacaksınız ama göz bulma, yüz bulma
hazır kütüphane kullanamazsınız.

ibaresi proje ile alakali degildir. Projemiz yuz tespiti degil, girdi olarak verilen yuz goruntusun
Girdi hatasi olmasi durumunda kodun yine de calismasi amaciyla hazir kutuphane kullanilmaktadir.
'''

def face_extractor(source_dir, dest_dir, ext='jpg'):
    mkdir(dest_dir)
    haar_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_frontalface_default.x

    pimgs = glob.glob(f"{source_dir}/*.{ext}")

    for pimg in tqdm(pimgs, desc="Cropping faces from wild images"):
        img=cv2.imread(pimg)
        gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
        faces_rect = haar_cascade.detectMultiScale(gray_img, 1.2, 5)

        if faces_rect is ():
            logging.debug('No face detected')
            continue

        for (x, y, w, h) in faces_rect:
            cv2.rectangle(img, (x, y), (x+w, y+h), (0, 255, 0), 2)
            cropped_face = gray_img[y:y+h, x:x+w]
            img_name = os.path.splitext(os.path.basename(pimg))[0]
            cv2.imwrite(f'{dest_dir}/{img_name}_cropped.jpg', cropped_face)
```

In [5]:
```
def metric_report(actual, predicted):
    acc = metrics.accuracy_score(actual, predicted)
    precision = metrics.precision_score(actual, predicted)
    recall = metrics.recall_score(actual, predicted)
    f1 = metrics.f1_score(actual, predicted)
    return (acc, precision, recall, f1)
```

In [6]:
```
source_dir='./utk_train'
dest_dir='./utk_train_cropped'
ext='jpg'
```

In [7]:
```
test_source_dir='./utk_test'
test_dest_dir='./utk_test_cropped'
```

In [8]:
```
test_dir = './test_images'
```

Local Binary Patterns

In [9]:
```
class LocalBinaryPatterns:
    def __init__(self, numPoints, radius):
        self.numPoints = numPoints
        self.radius = radius

    def describe(self, image, eps=1e-7):
        lbp = feature.local_binary_pattern(image, self.numPoints, self.radius, method="uniform")
        (hist, _) = np.histogram(lbp.ravel(),
                                 bins=np.arange(0, self.numPoints + 3),
                                 range=(0, self.numPoints + 2))

        hist = hist.astype("float")
        hist /= (hist.sum() + eps)
        return hist
```

In [10]:
```
def single_image_pipeline(img, desc, male_hist_path, female_hist_path):
    fimg = cv2.imread(img, cv2.COLOR_BGR2GRAY)

    lbp_hist = desc.describe(fimg)
    lbp_hist = lbp_hist.astype(np.float32)

    male_lbp_hist = np.load(male_hist_path).astype(np.float32)
    female_lbp_hist = np.load(female_hist_path).astype(np.float32)

    male_distance = cv2.compareHist(lbp_hist, male_lbp_hist, cv2.HISTCMP_INTERSECT)
    female_distance = cv2.compareHist(lbp_hist, female_lbp_hist, cv2.HISTCMP_INTERSECT)
    # HISTCMP_INTERSECT, HISTCMP_CORREL, HISTCMP_BHATTACHARYYA, HISTCMP_HELLINGER, HISTCMP_CHISQR

    return 0 if male_distance >= female_distance else 1
```

In [11]:
```
'''
UTK Train setindeki goruntulerden yuzler elde edilir ve dest_dir uzerine kaydedilir.
'''
#face_extractor(source_dir, dest_dir)
```

Out[11]:
```
'\nUTK Train setindeki goruntulerden yuzler elde edilir ve dest_dir uzerine kaydedilir.\n'
```

In [12]:
```
'''
Elde edilen yuz goruntuleri cinsiyete gore ayristirilir.
'''
'''
male_images=[]
female_images=[]
for pimg in tqdm(glob.glob(f"{dest_dir}/*.{ext}"), desc="Creating Male and Female Arrays"):
    img = cv2.imread(pimg, cv2.COLOR_BGR2GRAY)
    female_images.append(img) if int(os.path.basename(pimg).split('_')[1]) else male_images.append(
'''
```

Out[12]:
```
'\nmale_images=[]\nfemale_images=[]\nfor pimg in tqdm(glob.glob(f"{dest_dir}/*.{ext}"), desc="Crea
ting Male and Female Arrays"):\n    img = cv2.imread(pimg, cv2.COLOR_BGR2GRAY)\n    female_images.
append(img) if int(os.path.basename(pimg).split(\'_\')[1]) else male_images.append(img)\n'
```

In [13]:
```
#print(f'Number of male images in trainset: {len(male_images)}\nNumber of female images in trainset
```

In [14]:
```
desc=LocalBinaryPatterns(24, 8) # define descriptor instance
```

In [15]:
```
'''
Male-Female LBP histogramlari elde edilir ve kaydedilir.
'''
'''
male_histograms = [desc.describe(img) for img in tqdm(male_images, desc="Computing LBP histogram - M
female_histograms = [desc.describe(img) for img in tqdm(female_images, desc="Computing LBP histogra

np.save('male_lbp_histograms.npy', male_histograms)
np.save('female_lbp_histograms.npy', female_histograms)

male_lbp_hist = np.mean(male_histograms, axis=0)
female_lbp_hist = np.mean(female_histograms, axis=0)

np.save('male_lbp_hist.npy', male_lbp_hist)
np.save('female_lbp_hist.npy', female_lbp_hist)
'''
```

Out[15]:
```
'\nmale_histograms = [desc.describe(img) for img in tqdm(male_images, desc="Computing LBP histogra
m - Male")]\nfemale_histograms = [desc.describe(img) for img in tqdm(female_images, desc="Computin
g LBP histogram - Female")]\n\nnp.save(\'male_lbp_histograms.npy\', male_histograms)\nnp.save(\'fe
male_lbp_histograms.npy\', female_histograms)\n\nmale_lbp_hist = np.mean(male_histograms, axis=0)
\nfemale_lbp_hist = np.mean(female_histograms, axis=0)\n\nnp.save(\'male_lbp_hist.npy\', male_lbp_
hist)\nnp.save(\'female_lbp_hist.npy\', female_lbp_hist)\n'
```

In [16]:
```
#face_extractor(source_dir, dest_dir)
```

In [17]:
```
'''
Test veri setinden rastgele goruntu secilerek cinsiyet tahmini yapilir.
'''

random_image_pick = np.random.choice(glob.glob(test_dest_dir + f'/*.{ext}'))
pred = single_image_pipeline(random_image_pick, desc, 'male_lbp_hist.npy', 'female_lbp_hist.npy')
```

In [18]:
```
'''
Tum test verisi uzerinde tahminler gerceklestirilir.
'''

timgs = glob.glob(f"{test_dest_dir}/*.{ext}") #test images

actual, predicted = [], []
for timg in tqdm(timgs, desc="Inference in progress"):
    gender = single_image_pipeline(timg, desc, 'male_lbp_hist.npy', 'female_lbp_hist.npy')
    label = int(os.path.basename(timg).split('_')[1])

    actual.append(label)
    predicted.append(gender)
```

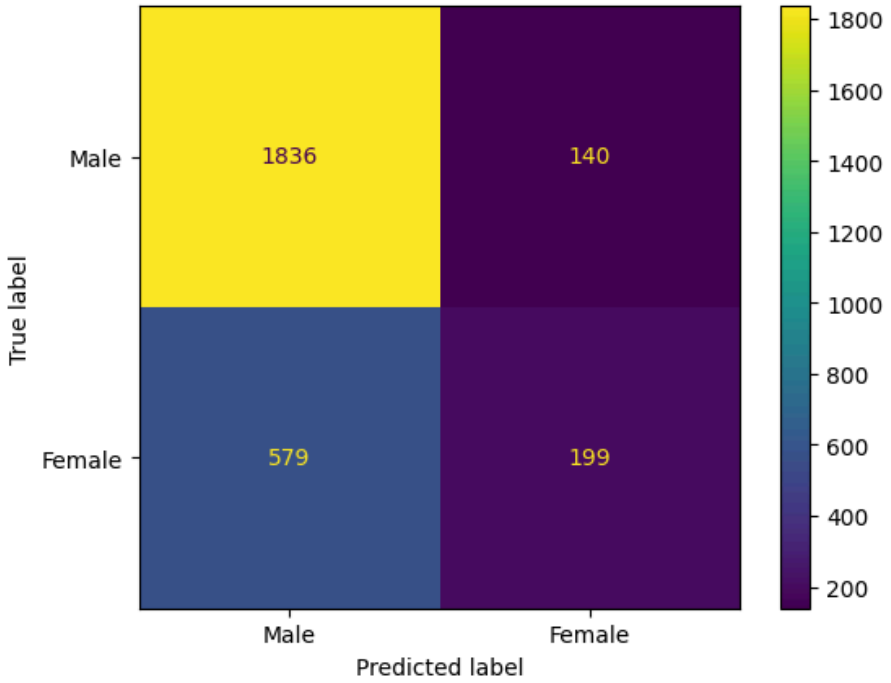
```
Inference in progress: 100%|████████████████████████████████████████| 2754/2754 [00:55<00:00,
49.79it/s]
```

In [19]:
```
metric_report(actual, predicted)
```

Out[19]:
```
(0.7389251997095134,
 0.5870206489675516,
 0.25578406169665807,
 0.35631154879140553)
```

In [20]:
```
confusion_matrix = metrics.confusion_matrix(actual, predicted)
```

In [21]:
```
cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_labels = [
cm_display.plot()
plt.show()
```



In [22]:
```
female_data = np.sum(actual); male_data = len(actual) - female_data
female_data, male_data
```

Out[22]: (778, 1976)

In [23]:
```
# Asagidaki img_path degiskenine istenen goruntulerin pathi verilir ve lbp ile gender detect edilir
```

In [24]:
```
img_path = 'test_images/22_0_0_20170119151204830_cropped.jpg'
actual = int(os.path.basename(img_path).split('_')[1])
```

In [25]:
```
pred = single_image_pipeline(img_path, desc, 'male_lbp_hist.npy', 'female_lbp_hist.npy')
```

In [26]:
```
if actual == pred:
    print('Gender Detected!')
```

```
Gender Detected!
```

Scale Invariant Feature Transform (SIFT)

In [27]:
```
sift = cv2.SIFT_create()
```

In [28]:
```
def flann_match(query_descriptors, train_descriptors):
    FLANN_INDEX_KDTREE = 1
    index_params = dict(algorithm=FLANN_INDEX_KDTREE, trees=5)
    search_params = dict(checks=50)

    flann = cv2.FlannBasedMatcher(index_params, search_params)
    matches = flann.knnMatch(query_descriptors, np.vstack(train_descriptors), k=2)

    # Ratio test as per Lowe's paper
    good_matches = []
    for m, n in matches:
        if m.distance < 0.7 * n.distance:
            good_matches.append(m)
    return len(good_matches)
```

In [29]:
```
def extract_descriptors(image, extractor):
    gray = cv2.imread(image, 0)
    keypoints, descriptors = extractor.detectAndCompute(gray, None)
    return descriptors
```

In [30]:
```
def single_image_pipeline_sift(img, male_desc_path, female_desc_path):
    descriptor = extract_descriptors(img, sift)

    male_desc = np.load(male_desc_path).astype(np.float32)
    female_desc = np.load(female_desc_path).astype(np.float32)

    male_distance = flann_match(descriptor, male_desc)
    female_distance = flann_match(descriptor, female_desc)

    return 0 if male_distance >= female_distance else 1
```

In [31]:
```
'''
Male-Female SIFT descriptor elde edilir.
'''

'''
male_descriptors = []
female_descriptors = []

for img in tqdm(male_images, desc= 'Extracting descriptors - Male'):
    desc = extract_descriptors(img)
    if desc is not None:
        male_descriptors.extend(desc)

for img in tqdm(female_images, desc='Extracting descriptors - Female'):
    desc = extract_descriptors(img)
    if desc is not None:
        female_descriptors.extend(desc)
'''
```

Out[31]:
```
"\nmale_descriptors = []\nfemale_descriptors = []\n\nfor img in tqdm(male_images, desc= 'Extractin
g descriptors - Male'):\n    desc = extract_descriptors(img)\n    if desc is not None:\n        ma
le_descriptors.extend(desc)\n\nfor img in tqdm(female_images, desc='Extracting descriptors - Femal
e'):\n    desc = extract_descriptors(img)\n    if desc is not None:\n        female_descriptors.ex
tend(desc)\n"
```

In [32]:
```
'''
Cikartilan descriptorlar kaydedilir.
'''

'''
male_descriptors = np.array(male_descriptors, dtype=np.float32)
female_descriptors = np.array(female_descriptors, dtype=np.float32)

np.save('male_descriptors.npy', male_descriptors)
np.save('female_descriptors.npy', female_descriptors)
'''
```

Out[32]:
```
"\nmale_descriptors = np.array(male_descriptors, dtype=np.float32)\nfemale_descriptors = np.array
(female_descriptors, dtype=np.float32)\n\nnp.save('male_descriptors.npy', male_descriptors)\nnp.sa
ve('female_descriptors.npy', female_descriptors)\n"
```

In [33]:
```
male_descriptors = np.load('male_descriptors.npy')
female_descriptors = np.load('female_descriptors.npy')
```

In [34]:
```
'./utk_test_cropped/'
```

Out[34]:
```
'./utk_test_cropped/'
```

In [35]:
```
results=[]
for _ in tqdm(range(10), desc='SIFT Inference'):
    random_image_picked = np.random.choice(glob.glob(test_dir + f'/*.{ext}'), replace=False)
    img = cv2.imread(random_image_picked, 0)
    keypoints, descriptors = sift.detectAndCompute(img, None)

    male_matches = flann_match(descriptors, male_descriptors)
    female_matches = flann_match(descriptors, female_descriptors)

    predicted_gender = 0 if male_matches > female_matches else 1
    actual_gender = int(os.path.basename(random_image_picked).split('_')[1])  # Assumes filename fo

    results.append((predicted_gender, actual_gender))

for result in results:
    print(f"Predicted Gender: {'Male' if result[0] == 0 else 'Female'}, Actual Gender: {'Male' if r
```

```
SIFT Inference: 100%|██████████████████████████████████████████████████| 10/10 [02:21<00:00,
14.17s/it]

Predicted Gender: Female, Actual Gender: Female
Predicted Gender: Male, Actual Gender: Male
Predicted Gender: Female, Actual Gender: Female
Predicted Gender: Female, Actual Gender: Female
Predicted Gender: Female, Actual Gender: Male
Predicted Gender: Female, Actual Gender: Female
Predicted Gender: Male, Actual Gender: Male
Predicted Gender: Male, Actual Gender: Male
Predicted Gender: Female, Actual Gender: Female
Predicted Gender: Female, Actual Gender: Male
```

Compared to LBP-H algorithm implemented above, SIFT also performed same accuracy on the benchmark tests. Because of computational problems in FLANN, metrics cannot be obtained directly but sampling is used.

SIFT has approximately %70 (Accuracy) on the UTK Test Set

In [36]:
```
# Asagidaki img_path degiskenine istenen goruntulerin pathi verilir ve sift ile gender detect edili
```

In [37]:
```
img_path = 'test_images/16_0_0_20170120133327900_cropped.jpg'
actual = int(os.path.basename(img_path).split('_')[1])
```

In [38]:
```
pred = single_image_pipeline_sift(img_path, 'male_descriptors.npy', 'female_descriptors.npy')
```

In [39]:
```
if actual == pred:
    print('Gender Detected!')
```

```
Gender Detected!
```

Flann yerine baska bir algoritma ile daha hizli sonuclar dondurulecektir. Akabinde metrikler de gosterilecektir. Kullanilacak bazi algoritmalar 21 Mart dersinde islenmistir ve hizla koda eklenecektir.