Q1

In [1]:

```
import os
import numpy as np
import random
import matplotlib.pyplot as plt
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten
import cv2
```

In [2]:

```
def load_images_from_directory(directory, limit=None):
    images = []
    labels = []
    count = 0
    for filename in os.listdir(directory):
        if count == limit:
            break
        if filename.endswith(".jpg") or filename.endswith(".png"):
            img_path = os.path.join(directory, filename)
            img = cv2.imread(img_path)
            img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
            images.append(img)
            labels.append(1 if "female" in filename.lower() else 0)
            count += 1
    return np.array(images), np.array(labels)
```

In [3]:

```
X_train_male, Y_train_male = load_images_from_directory(r'C:\Users\ABC\Desktop
X_train_female, Y_train_female = load_images_from_directory(r'C:\Users\ABC\Desk

X_train = np.concatenate((X_train_male, X_train_female))
Y_train = np.concatenate((Y_train_male, Y_train_female))

X_test_male, Y_test_male = load_images_from_directory(r'C:\Users\ABC\Desktop\BA
X_test_female, Y_test_female = load_images_from_directory(r'C:\Users\ABC\Deskto

X_test = np.concatenate((X_test_male, X_test_female))
Y_test = np.concatenate((Y_test_male, Y_test_female))
```

In [4]:

```
face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_front
```

In [5]:

```
def detect_face_and_align(image):
    gray = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
    faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=

    if len(faces) == 0:
        return None, None

    (x, y, w, h) = faces[0]
    face = image[y:y + h, x:x + w]
    aligned_face = cv2.resize(face, (100, 100))

    return aligned_face, (x, y, w, h)
```

In [6]:

```
X_train_aligned = []
for i in range(len(X_train)):
    aligned_face, _ = detect_face_and_align(X_train[i])
    if aligned_face is not None:
        X_train_aligned.append(aligned_face)

X_train_aligned = np.array(X_train_aligned)
Y_train = Y_train[:len(X_train_aligned)]
```

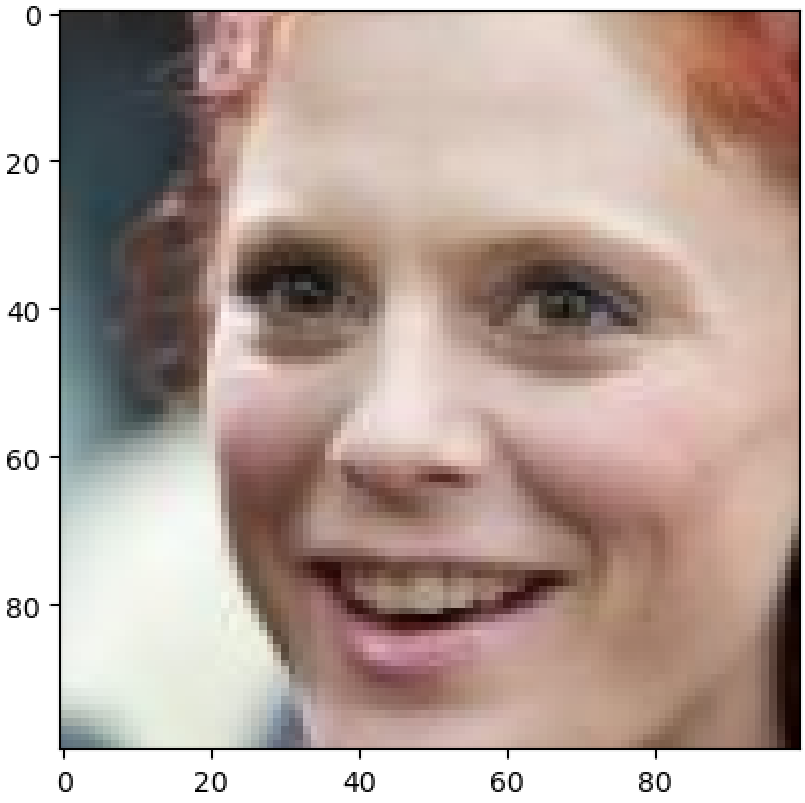
In [7]:

```
X_test_aligned = []
for i in range(len(X_test)):
    aligned_face, _ = detect_face_and_align(X_test[i])
    if aligned_face is not None:
        X_test_aligned.append(aligned_face)

X_test_aligned = np.array(X_test_aligned)
Y_test = Y_test[:len(X_test_aligned)]
```

In [8]:

```
idx = random.randint(0, len(X_train_aligned))
plt.imshow(X_train_aligned[idx, :])
plt.show()
```



In [9]:

```
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(100, 100, 3)),
    MaxPooling2D((2, 2)),
    Conv2D(32, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(1, activation='sigmoid')
])
```

In [10]:

```
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
```

In [11]:

```
model.fit(X_train_aligned, Y_train, epochs=10, batch_size=64)
```

```
Epoch 1/10
3/3 [==============================] - 3s 433ms/step - loss: 3.9231 - accurac
y: 0.7234
Epoch 2/10
3/3 [==============================] - 1s 445ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 3/10
3/3 [==============================] - 1s 457ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 4/10
3/3 [==============================] - 1s 461ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 5/10
3/3 [==============================] - 1s 457ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 6/10
3/3 [==============================] - 1s 449ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 7/10
3/3 [==============================] - 1s 464ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 8/10
3/3 [==============================] - 1s 466ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 9/10
3/3 [==============================] - 1s 450ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
Epoch 10/10
3/3 [==============================] - 1s 463ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
```

Out[11]:

```
<keras.src.callbacks.History at 0x292b7ab1b90>
```

In [12]:

```
model.evaluate(X_test_aligned, Y_test)
```

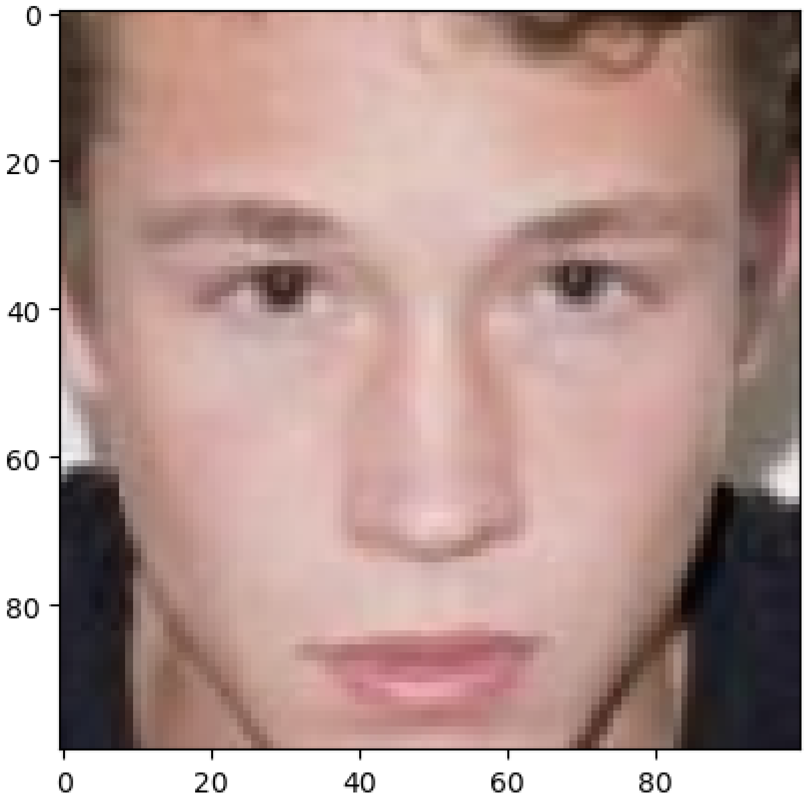
```
7/7 [==============================] - 1s 63ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
```

Out[12]:

```
[0.0, 1.0]
```

In [13]:

```
idx2 = random.randint(0, len(Y_test))
plt.imshow(X_test_aligned[idx2, :])
plt.show()
```



In [14]:

```
y_pred = model.predict(X_test_aligned[idx2, :].reshape(1, 100, 100, 3))
y_pred = y_pred > 0.5

if y_pred == 0:
    pred = 'male'
else:
    pred = 'female'

print("Our model says it is a:", pred)
```

```
1/1 [==============================] - 0s 141ms/step
Our model says it is a: male
```

Q2

In [75]:

```
import glob

def load_images_from_directory(directory, limit=None):
    images = []
    labels = []
    count = 0
    image_paths = glob.glob(os.path.join(directory, '*.jpg')) + glob.glob(os.pa

    for img_path in image_paths[:limit]:
        img = cv2.imread(img_path, cv2.IMREAD_GRAYSCALE)
        if img is None:
            print(f"Error loading image: {img_path}")
            continue
        img = cv2.resize(img, (100, 100))
        images.append(img)
        labels.append(os.path.basename(directory).lower())
        count += 1

    print("Loaded images:", len(images))
    print("Loaded labels:", len(labels))

    return np.array(images), np.array(labels)
```

In [76]:
```
X_train_angry, Y_train_angry = load_images_from_directory(r'C:\Users\ABC\Deskto
X_train_happy, Y_train_happy = load_images_from_directory(r'C:\Users\ABC\Deskto
X_train_other, Y_train_other = load_images_from_directory(r'C:\Users\ABC\Deskto
X_train_sad, Y_train_sad = load_images_from_directory(r'C:\Users\ABC\Desktop\BA

X_train = np.concatenate((X_train_angry, X_train_happy, X_train_other, X_train_
Y_train = np.concatenate((Y_train_angry, Y_train_happy, Y_train_other, Y_train_

X_test_angry, Y_test_angry = load_images_from_directory(r'C:\Users\ABC\Desktop\
X_test_happy, Y_test_happy = load_images_from_directory(r'C:\Users\ABC\Desktop\
X_test_other, Y_test_other = load_images_from_directory(r'C:\Users\ABC\Desktop\
X_test_sad, Y_test_sad = load_images_from_directory(r'C:\Users\ABC\Desktop\BAI\

X_test = np.concatenate((X_test_angry, X_test_happy, X_test_other, X_test_sad))
Y_test = np.concatenate((Y_test_angry, Y_test_happy, Y_test_other, Y_test_sad))
```

```
Loaded images: 50
Loaded labels: 50
Loaded images: 50
Loaded labels: 50
Loaded images: 47
Loaded labels: 47
Loaded images: 50
Loaded labels: 50
Loaded images: 75
Loaded labels: 75
Loaded images: 90
Loaded labels: 90
Loaded images: 47
Loaded labels: 47
Loaded images: 84
Loaded labels: 84
```

In [77]:
```
print("Number of images in X_train:", len(X_train))
print("Number of labels in Y_train:", len(Y_train))
```

```
Number of images in X_train: 197
Number of labels in Y_train: 197
```

In [78]:
```
face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_front
```

In [81]:

```
def detect_face_and_align(image):
    gray = image
    faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=

    if len(faces) == 0:
        return None, None

    (x, y, w, h) = faces[0]
    face = image[y:y + h, x:x + w]
    aligned_face = cv2.resize(face, (100, 100))

    return aligned_face, (x, y, w, h)
```

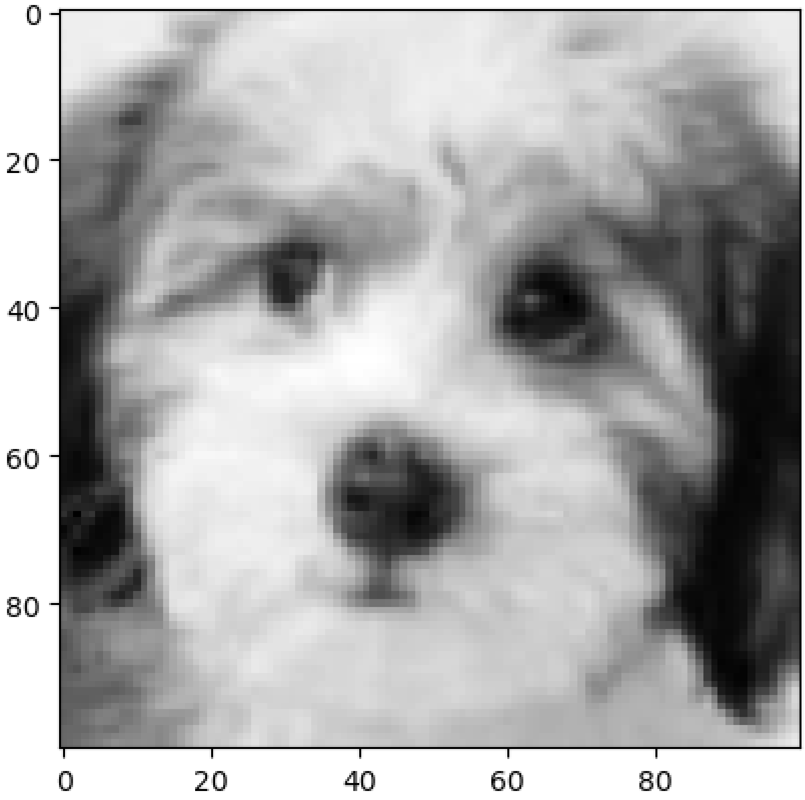
In [82]:

```
X_train_aligned = []
for i in range(len(X_train)):
    aligned_face, _ = detect_face_and_align(X_train[i])
    if aligned_face is not None:
        X_train_aligned.append(aligned_face)

X_train_aligned = np.array(X_train_aligned)
Y_train = Y_train[:len(X_train_aligned)]
```

In [83]:

```
idx = random.randint(0, len(X_train_aligned) - 1)
plt.imshow(X_train_aligned[idx], cmap='gray')
plt.show()
```



In [84]:

```
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(100, 100, 1)),
    MaxPooling2D((2, 2)),
    Conv2D(32, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(4, activation='softmax')
])
```

In [85]:

```
model.compile(loss='sparse_categorical_crossentropy', optimizer='adam', metrics
```

In [90]:

```
from sklearn.preprocessing import LabelEncoder

label_encoder = LabelEncoder()
Y_train_encoded = label_encoder.fit_transform(Y_train)

Y_test_filtered = [label for label in Y_test if label in label_encoder.classes_

Y_test_encoded = label_encoder.transform(Y_test_filtered)

model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(100, 100, 1)),
    MaxPooling2D((2, 2)),
    Conv2D(32, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(4, activation='softmax')
])

model.compile(loss='sparse_categorical_crossentropy', optimizer='adam', metrics

model.fit(X_train_aligned, Y_train_encoded, epochs=10, batch_size=64)
```

```
Epoch 1/10
1/1 [==============================] - 1s 1s/step - loss: 0.0000e+00 - accura
cy: 1.0000
Epoch 2/10
1/1 [==============================] - 0s 50ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 3/10
1/1 [==============================] - 0s 48ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 4/10
1/1 [==============================] - 0s 46ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 5/10
1/1 [==============================] - 0s 46ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 6/10
1/1 [==============================] - 0s 44ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 7/10
1/1 [==============================] - 0s 50ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 8/10
1/1 [==============================] - 0s 47ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 9/10
1/1 [==============================] - 0s 40ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
Epoch 10/10
1/1 [==============================] - 0s 50ms/step - loss: 0.0000e+00 - accu
racy: 1.0000
```

Out[90]:

```
<keras.src.callbacks.History at 0x292cb515090>
```

In [93]:

```
X_test_aligned = []
for i in range(len(X_test)):
    aligned_face, _ = detect_face_and_align(X_test[i])
    if aligned_face is not None:
        X_test_aligned.append(aligned_face)

X_test_aligned = np.array(X_test_aligned)

Y_test_encoded = label_encoder.transform(Y_test)

model.evaluate(X_test_aligned, Y_test_encoded)
```

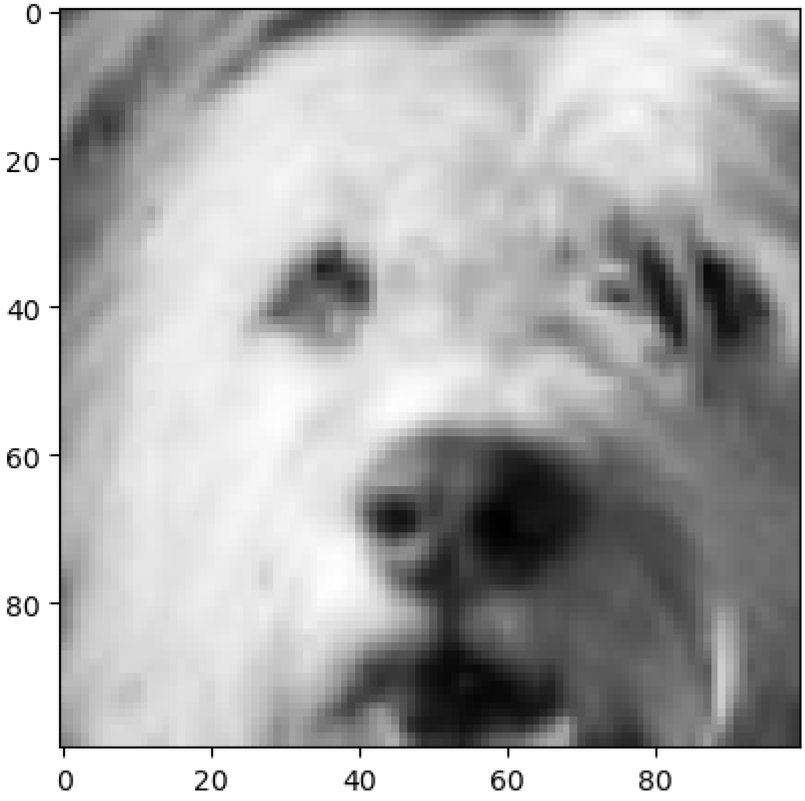
```
1/1 [==============================] - 0s 278ms/step - loss: 0.0000e+00 - acc
uracy: 1.0000
```

Out[93]:

```
[0.0, 1.0]
```

In [94]:

```
idx2 = random.randint(0, len(Y_test) - 1)
plt.imshow(X_test_aligned[idx2], cmap='gray')
plt.show()
```



In [95]:

```
y_pred_probs = model.predict(X_test_aligned[idx2].reshape(1, 100, 100, 1))
y_pred = np.argmax(y_pred_probs)

expression_mapping = {0: 'angry', 1: 'happy', 2: 'other', 3: 'sad'}
pred = expression_mapping[y_pred]

print("Our model predicts the expression as:", pred)
```

```
1/1 [==============================] - 0s 85ms/step
Our model predicts the expression as: angry
```

Q3

```
In [7]: import pandas as pd
        import numpy as np
        import cv2
        from sklearn.model_selection import train_test_split
        from sklearn.preprocessing import LabelEncoder
        from keras.models import Sequential
        from keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

        df = pd.read_csv(r"C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 08\Task 03\train

        def load_and_preprocess_images(file_paths):
            images = []
            for file_path in file_paths:
                img = cv2.imread(r"C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 08\Task 0
                img = cv2.resize(img, (224, 224))
                images.append(img)
            return np.array(images)

        X = load_and_preprocess_images(df['ID'].values)
        y = df['Class'].values

        label_encoder = LabelEncoder()
        y_encoded = label_encoder.fit_transform(y)

        X_train, X_val, y_train, y_val = train_test_split(X, y_encoded, test_size=0.2,

        model = Sequential()
        model.add(Conv2D(32, (3, 3), activation='relu', input_shape=(224, 224, 3)))
        model.add(MaxPooling2D((2, 2)))
        model.add(Conv2D(64, (3, 3), activation='relu'))
        model.add(MaxPooling2D((2, 2)))
        model.add(Conv2D(128, (3, 3), activation='relu'))
        model.add(MaxPooling2D((2, 2)))
        model.add(Flatten())
        model.add(Dense(128, activation='relu'))
        model.add(Dense(1, activation='linear'))

        model.compile(optimizer='adam', loss='mean_squared_error', metrics=['mae'])

        model.fit(X_train, y_train, epochs=10, batch_size=32, validation_data=(X_val, y

        val_loss, val_mae = model.evaluate(X_val, y_val)
        print(f"Validation Mean Absolute Error: {val_mae}")

        model.save("age_estimation_model.h5")
```

```
Epoch 1/10
498/498 [==============================] - 1199s 2s/step - loss: 10342.1006 -
mae: 6.4624 - val_loss: 0.8018 - val_mae: 0.7515
Epoch 2/10
498/498 [==============================] - 1485s 3s/step - loss: 1.1094 - ma
e: 0.7983 - val_loss: 0.8762 - val_mae: 0.8198
Epoch 3/10
498/498 [==============================] - 1405s 3s/step - loss: 0.8141 - ma
e: 0.8279 - val_loss: 0.8206 - val_mae: 0.8414
Epoch 4/10
498/498 [==============================] - 1071s 2s/step - loss: 0.7899 - ma
e: 0.8250 - val_loss: 0.8079 - val_mae: 0.8379
Epoch 5/10
498/498 [==============================] - 1092s 2s/step - loss: 0.7743 - ma
e: 0.8131 - val_loss: 0.8161 - val_mae: 0.8352
Epoch 6/10
498/498 [==============================] - 1071s 2s/step - loss: 0.7655 - ma
e: 0.8050 - val_loss: 0.8127 - val_mae: 0.8338
Epoch 7/10
498/498 [==============================] - 1071s 2s/step - loss: 0.7532 - ma
e: 0.7959 - val_loss: 0.8220 - val_mae: 0.8364
Epoch 8/10
498/498 [==============================] - 1050s 2s/step - loss: 0.7467 - ma
e: 0.7914 - val_loss: 0.8214 - val_mae: 0.8358
Epoch 9/10
498/498 [==============================] - 1127s 2s/step - loss: 0.7328 - ma
e: 0.7809 - val_loss: 0.8354 - val_mae: 0.8341
Epoch 10/10
498/498 [==============================] - 1078s 2s/step - loss: 0.7215 - ma
e: 0.7714 - val_loss: 0.8334 - val_mae: 0.8371
125/125 [==============================] - 66s 525ms/step - loss: 0.8334 - ma
e: 0.8371
Validation Mean Absolute Error: 0.8370787501335144
```

```
C:\Users\ABC\anaconda3\Lib\site-packages\keras\src\engine\training.py:3079: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. Thi
s file format is considered legacy. We recommend using instead the native Ker
as format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(
```

In [40]:

```
import cv2
import numpy as np
from keras.models import load_model
from sklearn.preprocessing import LabelEncoder

face_cascade_path = cv2.data.haarcascades + 'haarcascade_frontalface_alt.xml'
face_cascade = cv2.CascadeClassifier(face_cascade_path)

def classify_age(video_path, model_path, label_encoder):
    model = load_model(model_path)

    cap = cv2.VideoCapture(video_path)

    if not hasattr(label_encoder, 'classes_') or len(label_encoder.classes_) ==
        raise ValueError("LabelEncoder is not fitted. Fit the LabelEncoder befo

    while True:
        ret, frame = cap.read()
        if not ret:
            break

        gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
        faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbo

        for (x, y, w, h) in faces:
            face = frame[y:y + h, x:x + w]
            face = cv2.resize(face, (224, 224))

            face = face / 255.0
            face = np.expand_dims(face, axis=0)

            predicted_age = model.predict(face).squeeze()

            # Need to define threshold since the classification was done accord
            young_age_threshold = 25
            old_age_threshold = 60

            if predicted_age < young_age_threshold:
                age_label = "YOUNG"
            elif predicted_age >= old_age_threshold:
                age_label = "OLD"
            else:
                age_label = "MIDDLE"

            cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
            cv2.putText(frame, f"Age: {age_label}", (x, y - 10), cv2.FONT_HERSH

        cv2.imshow('Age Estimation', frame)

        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    cap.release()
    cv2.destroyAllWindows()

model_path = "age_estimation_model.h5"
```

```
label_encoder = LabelEncoder()
label_encoder.fit(y_train)

video_path = r"C:\Users\ABC\Videos\Captures\Baby's Day Out full movie - YouTube

classify_age(video_path, model_path, label_encoder)
```

```
1/1 [==============================] - 0s 151ms/step
1/1 [==============================] - 0s 43ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 50ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 49ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 38ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
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1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 41ms/step
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1/1 [==============================] - 0s 41ms/step
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1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 42ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
```

```
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 41ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 42ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 43ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 42ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 42ms/step
1/1 [==============================] - 0s 40ms/step
1/1 [==============================] - 0s 39ms/step
1/1 [==============================] - 0s 41ms/step
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Q5

In [1]:

```
import numpy as np
import os
from PIL import Image
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import keras
import tensorflow as tf
from random import randint
from keras.utils import to_categorical
from sklearn.model_selection import train_test_split
from keras import layers
from keras import models
```

In [2]:

```
reverselookup = dict()
lookup = dict()
count = 0

for i in os.listdir(r'C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 08\leapGestRe
    if not i.startswith('.'):
        gesture_name = i[3:]
        lookup[gesture_name] = count
        reverselookup[count] = gesture_name
        count = count + 1

lookup
```

Out[2]:

```
{'palm': 0,
 'l': 1,
 'fist': 2,
 'fist_moved': 3,
 'thumb': 4,
 'index': 5,
 'ok': 6,
 'palm_moved': 7,
 'c': 8,
 'down': 9}
```

In [3]:

```
x_data = []
y_data = []
datacount = 0

for i in range(0, 10):
    for j in os.listdir(r'C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 08\leapGes

        if not j.startswith('.'):
            count = 0
            for k in os.listdir(r'C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 08

                img = Image.open(r'C:\Users\ABC\Desktop\BAI\BAI-S7\CV Lab\Lab 0
                img = img.resize((320, 120))
                arr = np.array(img)
                x_data.append(arr)
                count = count + 1
            gesture_name = j[3:]
            y_values = np.full((count, 1), lookup[gesture_name])
            y_data.append(y_values)
            datacount = datacount + count

x_data = np.array(x_data, dtype = 'float32')
y_data = np.array(y_data)
y_data = y_data.reshape(datacount, 1)
```

In [4]:

```
for i in range(0, 10):
    plt.imshow(x_data[i*200 , :, :], cmap="gray")
    plt.title(reverselookup[y_data[i*200 ,0]])
    plt.axis('off')
    plt.show()
```

fist_moved

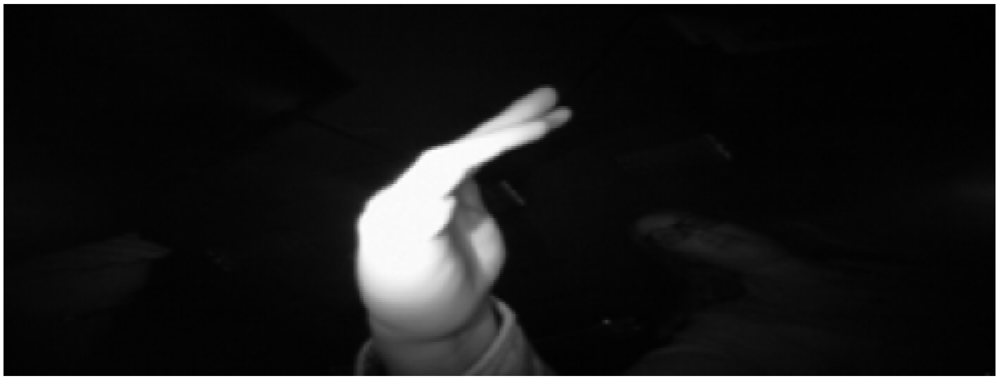
thumb

index

ok

palm_moved

c



down

```
In [5]: y_data = to_categorical(y_data)
```

```
In [6]: x_data = x_data.reshape((datacount, 120, 320, 1))
        x_data /= 255
```

```
In [7]: x_train, x_test_val, y_train, y_test_val = train_test_split(x_data, y_data, tes
        x_validate, x_test, y_validate, y_test = train_test_split(x_test_val, y_test_va
```

In [8]:

```
model = models.Sequential()
model.add(layers.Conv2D(32, (5, 5), strides = (2, 2), activation = 'relu', inpu
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation = 'relu'))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation = 'relu'))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Flatten())
model.add(layers.Dense(128, activation = 'relu'))
model.add(layers.Dense(10, activation = 'softmax'))
```

In [9]:

```
model.compile(optimizer = 'rmsprop', loss = 'categorical_crossentropy', metrics
model.fit(x_train, y_train, epochs = 10, batch_size = 32, verbose = 1, validati
```

```
Epoch 1/10
500/500 [==============================] - 219s 404ms/step - loss: 0.2158 - a
ccuracy: 0.9314 - val_loss: 0.0026 - val_accuracy: 1.0000
Epoch 2/10
500/500 [==============================] - 176s 351ms/step - loss: 0.0121 - a
ccuracy: 0.9976 - val_loss: 0.0065 - val_accuracy: 0.9990
Epoch 3/10
500/500 [==============================] - 172s 345ms/step - loss: 0.0056 - a
ccuracy: 0.9990 - val_loss: 0.0035 - val_accuracy: 0.9990
Epoch 4/10
500/500 [==============================] - 176s 353ms/step - loss: 0.0022 - a
ccuracy: 0.9993 - val_loss: 6.2701e-05 - val_accuracy: 1.0000
Epoch 5/10
500/500 [==============================] - 190s 380ms/step - loss: 2.4270e-06
- accuracy: 1.0000 - val_loss: 5.6018e-06 - val_accuracy: 1.0000
Epoch 6/10
500/500 [==============================] - 204s 408ms/step - loss: 5.2095e-07
- accuracy: 1.0000 - val_loss: 5.8764e-06 - val_accuracy: 1.0000
Epoch 7/10
500/500 [==============================] - 194s 388ms/step - loss: 3.7250e-07
- accuracy: 1.0000 - val_loss: 5.2844e-06 - val_accuracy: 1.0000
Epoch 8/10
500/500 [==============================] - 191s 382ms/step - loss: 2.9396e-07
- accuracy: 1.0000 - val_loss: 4.9739e-06 - val_accuracy: 1.0000
Epoch 9/10
500/500 [==============================] - 200s 401ms/step - loss: 2.4395e-07
- accuracy: 1.0000 - val_loss: 4.7480e-06 - val_accuracy: 1.0000
Epoch 10/10
500/500 [==============================] - 175s 350ms/step - loss: 2.0940e-07
- accuracy: 1.0000 - val_loss: 4.4782e-06 - val_accuracy: 1.0000
```

Out[9]:

```
<keras.src.callbacks.History at 0x25fff21e090>
```

In [10]:

```
[loss, acc] = model.evaluate(x_test,y_test,verbose = 1)
print("Accuracy:" + str(acc))
```

```
63/63 [==============================] - 6s 97ms/step - loss: 9.3993e-06 - ac
curacy: 1.0000
Accuracy:1.0
```

In [11]:
```
model.save_weights('hand_gesture_model_weights.h5')
model.save("hand_gesture_model.h5")
```

```
C:\Users\ABC\anaconda3\Lib\site-packages\keras\src\engine\training.py:3079: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. Thi
s file format is considered legacy. We recommend using instead the native Ker
as format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(
```

In [13]:

```
import cv2
import mediapipe as mp

image = cv2.imread('handgest.jpg', cv2.IMREAD_GRAYSCALE)
height, width = image.shape

mp_hands = mp.solutions.hands
hands = mp_hands.Hands()

image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

results = hands.process(image_rgb)

if results.multi_hand_landmarks:
    for landmarks in results.multi_hand_landmarks:
        for point in landmarks.landmark:
            x, y = int(point.x * width), int(point.y * height)
            cv2.circle(image, (x, y), 5, (0, 255, 0), -1)

img = cv2.resize(image, (320, 120))
arr = np.array(img)
arr = tf.reshape(arr, (-1, 120, 320, 1))

prediction = model.predict(arr)
print(prediction)

plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
plt.axis('off')
plt.show()
```

```
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