1. Importing Modules

In [1]:
```
# Importing tensorflow and File Management
import tensorflow as tf
import os

# Data Management and Display
import numpy as np
from matplotlib import pyplot as plt

# Image Processing
import cv2
import imghdr

# Model Training Modules
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten, Drop

# Metrics from Keras
from tensorflow.keras.metrics import Precision, Recall, BinaryAccuracy

# For Loading Model
from tensorflow.keras.models import load_model
```

2. Data Cleaning

data_dir = 'data'

image_exts = ['jpeg','jpg', 'bmp', 'png']

for image_class in os.listdir(data_dir): for image in os.listdir(os.path.join(data_dir, image_class)): image_path = os.path.join(data_dir, image_class, image) try: img = cv2.imread(image_path) tip = imghdr.what(image_path) if tip not in image_exts: print('Unsupported Extension: {}'.format(image_path)) os.remove(image_path) except Exception as e: print('Error with Image: {}'.format(image_path)) # os.remove(image_path)

3. Loading Data

In [2]:
```
#Import numpy library
import numpy as np
from matplotlib import pyplot as plt
```

In [3]:
```
#loading images from dataset
data = tf.keras.utils.image_dataset_from_directory('F:\\DataSets\\Train')
```

```
Found 2326 files belonging to 2 classes.
```

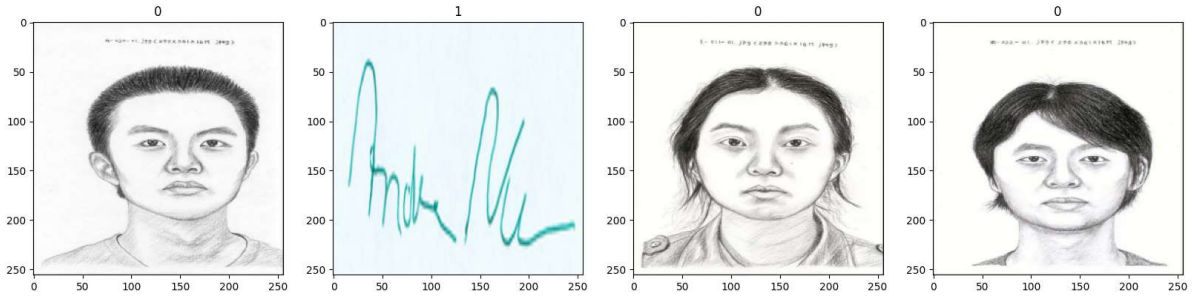
In [4]:
```
#Convert dataset to numpy iterator
data_iterator = data.as_numpy_iterator()
```

In [5]:
```
#get a batch of data
batch = data_iterator.next()

batch
```

```
          [255.      , 255.      , 252.78125 ],
          [194.53706 , 194.664   , 192.78706 ]],

         [[196.05821 , 197.05821 , 192.05821 ],
          [250.06526 , 251.06526 , 246.06526 ],
          [254.40825 , 254.95122 , 250.40825 ],
          ...,
          [253.46475 , 253.46475 , 253.46475 ],
          [253.73714 , 253.73714 , 253.73714 ],
          [195.8043  , 195.8043  , 195.8043  ]],

         [[180.5922  , 181.5922  , 176.5922  ],
          [227.45589 , 228.45589 , 223.45589 ],
          [231.91994 , 232.62894 , 227.91994 ],
          ...,
          [231.20312 , 231.20312 , 231.20312 ],
          [230.36137 , 230.36137 , 230.36137 ],
          [182.8211  , 182.8211  , 182.8211  ]]],
```

In [6]:
```
#displaying images from the block
fig, ax = plt.subplots(ncols=4, figsize=(20,20))
for idx, img in enumerate(batch[0][:4]):
    ax[idx].imshow(img.astype(int))
    ax[idx].title.set_text(batch[1][idx])

#maximum pixel value
batch[0].max()
```

Out[6]: 255.0



4. Data Scaling

In [7]:
```
data = data.map(lambda x,y: (x/255, y))
```

```
WARNING:tensorflow:From C:\Users\chana\AppData\Local\Programs\Python\Python39
\lib\site-packages\tensorflow\python\autograph\pyct\static_analysis\liveness.
py:83: Analyzer.lamba_check (from tensorflow.python.autograph.pyct.static_ana
lysis.liveness) is deprecated and will be removed after 2023-09-23.
Instructions for updating:
Lambda fuctions will be no more assumed to be used in the statement where the
y are used, or at least in the same block. https://github.com/tensorflow/tens
orflow/issues/56089 (https://github.com/tensorflow/tensorflow/issues/56089)
```

In [8]:
```
data.as_numpy_iterator().next()
```

Out[8]:
```
(array([[[[0.60750324, 0.6584836 , 0.7212287 ],
          [0.6139696 , 0.66102844, 0.72377354],
          [0.6086675 , 0.6557263 , 0.7184714 ],
          ...,
          [0.512927  , 0.52861327, 0.5752097 ],
          [0.4836981 , 0.49548292, 0.5594334 ],
          [0.4648562 , 0.4948807 , 0.56418216]],

         [[0.6128887 , 0.6599475 , 0.7226926 ],
          [0.6117044 , 0.65876323, 0.7215083 ],
          [0.6158825 , 0.6585957 , 0.72278935],
          ...,
          [0.47263998, 0.48875037, 0.54612535],
          [0.506429  , 0.5297746 , 0.592581  ],
          [0.46948242, 0.49946672, 0.5687883 ]],

         [[0.61583656, 0.66289544, 0.72564054],
          [0.60923046, 0.65194356, 0.71613723],
          [0.6183948 , 0.6536889 , 0.7203556 ],
```

5. Data Splitting

In [9]:
```
len(data)
```

Out[9]:
```
73
```

In [10]:
```
train_size = int(len(data)*.7)
val_size = int(len(data)*.2) + 1
test_size = int(len(data)*.1)
```

In [11]:
```
# Checking if len(data) = sum(test, train, val sizes)
train_size + val_size + test_size
```

Out[11]:
```
73
```

In [12]:
```
train = data.take(train_size)
val = data.skip(train_size).take(val_size)
test = data.skip(train_size+val_size).take(test_size)
```

Building DL Model

In [13]:
```
#Creating Empty Sequential Model

model = Sequential()
```

In [14]:
```
#defining a CNN in Keras using the Sequential model and several layers

model.add(Conv2D(16, (3,3), 1, activation='relu', input_shape=(256,256,3)))
model.add(MaxPooling2D())

model.add(Conv2D(32, (3,3), 1, activation='relu'))
model.add(MaxPooling2D())

model.add(Conv2D(16, (3,3), 1, activation='relu'))
model.add(MaxPooling2D())

model.add(Flatten())

model.add(Dense(256, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
```

In [15]:
```
#Compiling the defined Keras mode
model.compile('adam', loss=tf.losses.BinaryCrossentropy(), metrics=['accuracy'
```

In [16]:
```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 254, 254, 16)      448

 max_pooling2d (MaxPooling2D  (None, 127, 127, 16)     0
 )

 conv2d_1 (Conv2D)           (None, 125, 125, 32)      4640

 max_pooling2d_1 (MaxPooling  (None, 62, 62, 32)       0
 2D)

 conv2d_2 (Conv2D)           (None, 60, 60, 16)        4624

 max_pooling2d_2 (MaxPooling  (None, 30, 30, 16)       0
 2D)

 flatten (Flatten)           (None, 14400)             0

 dense (Dense)               (None, 256)               3686656

 dense_1 (Dense)             (None, 1)                 257

=================================================================
Total params: 3,696,625
Trainable params: 3,696,625
Non-trainable params: 0
_________________________________________________________________
```

7. Training the Model

In [17]:
```
logdir='logs'
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [18]:
```
hist = model.fit(train, epochs=25, validation_data=val, callbacks=[tensorboard
```

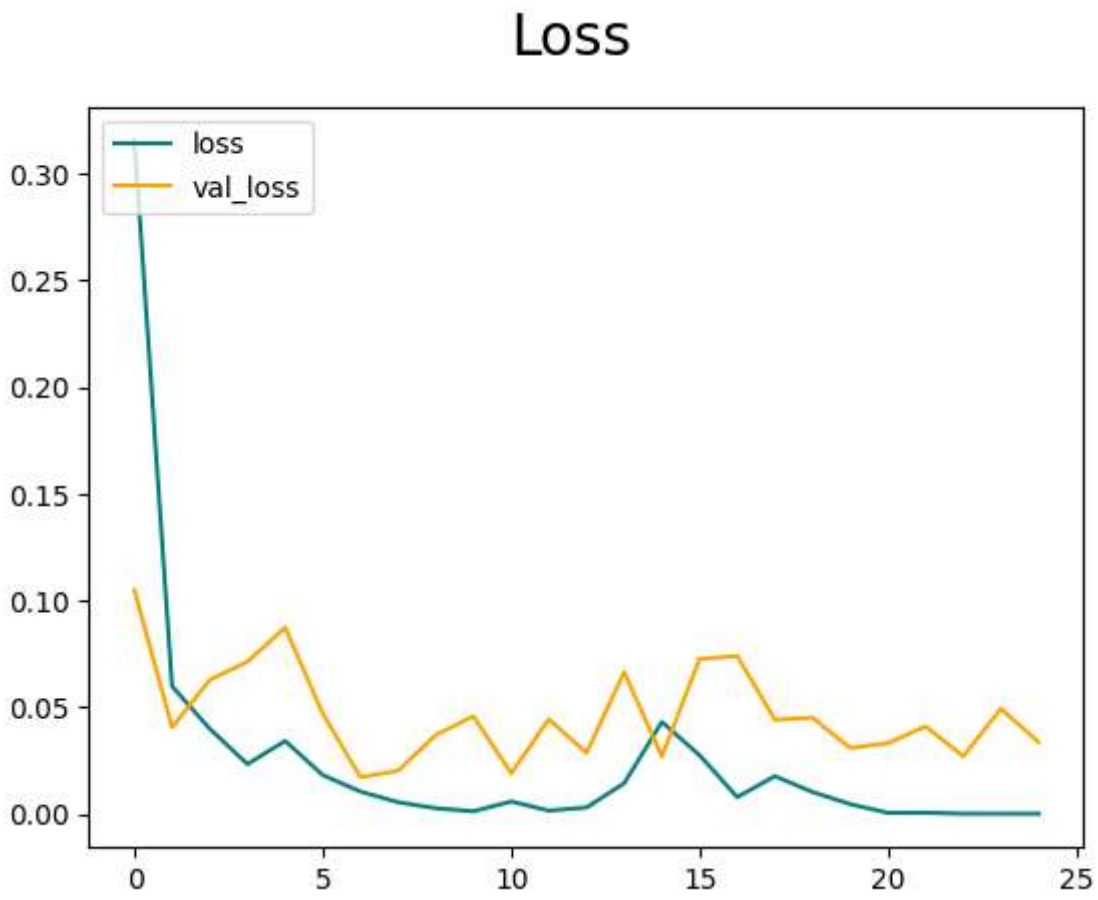
```
Epoch 1/25
51/51 [==============================] - 69s 1s/step - loss: 0.3156 - accurac
y: 0.8517 - val_loss: 0.1048 - val_accuracy: 0.9833
Epoch 2/25
51/51 [==============================] - 57s 1s/step - loss: 0.0598 - accurac
y: 0.9841 - val_loss: 0.0405 - val_accuracy: 0.9937
Epoch 3/25
51/51 [==============================] - 58s 1s/step - loss: 0.0399 - accurac
y: 0.9884 - val_loss: 0.0628 - val_accuracy: 0.9875
Epoch 4/25
51/51 [==============================] - 64s 1s/step - loss: 0.0233 - accurac
y: 0.9933 - val_loss: 0.0713 - val_accuracy: 0.9917
Epoch 5/25
51/51 [==============================] - 74s 1s/step - loss: 0.0342 - accurac
y: 0.9926 - val_loss: 0.0873 - val_accuracy: 0.9875
Epoch 6/25
51/51 [==============================] - 57s 1s/step - loss: 0.0182 - accurac
y: 0.9945 - val_loss: 0.0470 - val_accuracy: 0.9896
Epoch 7/25
51/51 [==============================] - 57s 1s/step - loss: 0.0104 - accurac
y: 0.9975 - val_loss: 0.0172 - val_accuracy: 0.9979
Epoch 8/25
51/51 [==============================] - 57s 1s/step - loss: 0.0054 - accurac
y: 0.9975 - val_loss: 0.0202 - val_accuracy: 0.9958
Epoch 9/25
51/51 [==============================] - 57s 1s/step - loss: 0.0027 - accurac
y: 0.9988 - val_loss: 0.0370 - val_accuracy: 0.9917
Epoch 10/25
51/51 [==============================] - 57s 1s/step - loss: 0.0012 - accurac
y: 1.0000 - val_loss: 0.0457 - val_accuracy: 0.9896
Epoch 11/25
51/51 [==============================] - 57s 1s/step - loss: 0.0058 - accurac
y: 0.9982 - val_loss: 0.0190 - val_accuracy: 0.9958
Epoch 12/25
51/51 [==============================] - 57s 1s/step - loss: 0.0015 - accurac
y: 1.0000 - val_loss: 0.0443 - val_accuracy: 0.9917
Epoch 13/25
51/51 [==============================] - 57s 1s/step - loss: 0.0030 - accurac
y: 0.9988 - val_loss: 0.0285 - val_accuracy: 0.9937
Epoch 14/25
51/51 [==============================] - 57s 1s/step - loss: 0.0143 - accurac
y: 0.9951 - val_loss: 0.0665 - val_accuracy: 0.9917
Epoch 15/25
51/51 [==============================] - 57s 1s/step - loss: 0.0431 - accurac
y: 0.9890 - val_loss: 0.0268 - val_accuracy: 0.9896
Epoch 16/25
51/51 [==============================] - 57s 1s/step - loss: 0.0275 - accurac
y: 0.9896 - val_loss: 0.0726 - val_accuracy: 0.9833
Epoch 17/25
51/51 [==============================] - 57s 1s/step - loss: 0.0078 - accurac
y: 0.9975 - val_loss: 0.0739 - val_accuracy: 0.9875
Epoch 18/25
51/51 [==============================] - 57s 1s/step - loss: 0.0177 - accurac
y: 0.9939 - val_loss: 0.0441 - val_accuracy: 0.9896
Epoch 19/25
51/51 [==============================] - 57s 1s/step - loss: 0.0102 - accurac
y: 0.9963 - val_loss: 0.0451 - val_accuracy: 0.9917
```

```
Epoch 20/25
51/51 [==============================] - 57s 1s/step - loss: 0.0045 - accurac
y: 0.9988 - val_loss: 0.0309 - val_accuracy: 0.9958
Epoch 21/25
51/51 [==============================] - 57s 1s/step - loss: 4.8169e-04 - acc
uracy: 1.0000 - val_loss: 0.0331 - val_accuracy: 0.9937
Epoch 22/25
51/51 [==============================] - 57s 1s/step - loss: 5.3487e-04 - acc
uracy: 1.0000 - val_loss: 0.0410 - val_accuracy: 0.9937
Epoch 23/25
51/51 [==============================] - 59s 1s/step - loss: 8.9725e-05 - acc
uracy: 1.0000 - val_loss: 0.0270 - val_accuracy: 0.9958
Epoch 24/25
51/51 [==============================] - 58s 1s/step - loss: 7.3278e-05 - acc
uracy: 1.0000 - val_loss: 0.0493 - val_accuracy: 0.9917
Epoch 25/25
51/51 [==============================] - 57s 1s/step - loss: 6.6464e-05 - acc
uracy: 1.0000 - val_loss: 0.0335 - val_accuracy: 0.9937
```

8. Performance Evaluation

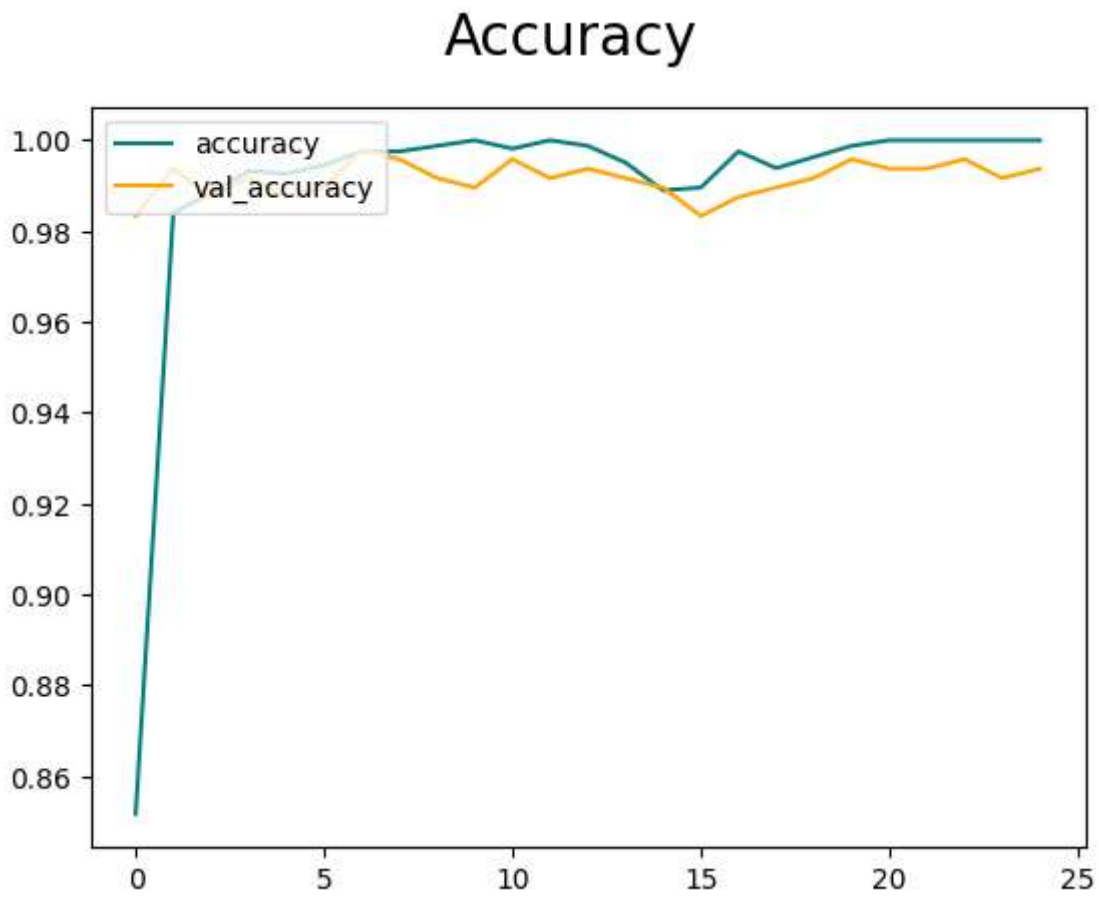
i. Loss

In [19]:
```
fig = plt.figure()
plt.plot(hist.history['loss'], color='teal', label='loss')
plt.plot(hist.history['val_loss'], color='orange', label='val_loss')
fig.suptitle('Loss', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



ii. Accuracy

In [20]:
```
fig = plt.figure()
plt.plot(hist.history['accuracy'], color='teal', label='accuracy')
plt.plot(hist.history['val_accuracy'], color='orange', label='val_accuracy')
fig.suptitle('Accuracy', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



iii. Evaluation Metrics

In [21]:
```
pre = Precision()
re = Recall()
acc = BinaryAccuracy()

for batch in test.as_numpy_iterator():
    X, y = batch
    yhat = model.predict(X)
    pre.update_state(y, yhat)
    re.update_state(y, yhat)
    acc.update_state(y, yhat)
```

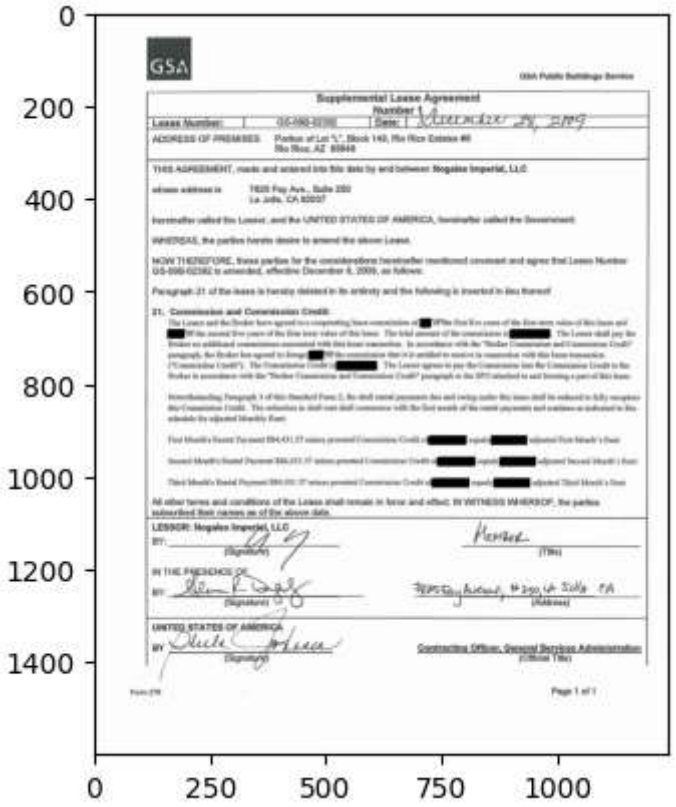
```
1/1 [==============================] - 0s 323ms/step
1/1 [==============================] - 0s 211ms/step
1/1 [==============================] - 0s 217ms/step
1/1 [==============================] - 0s 224ms/step
1/1 [==============================] - 0s 213ms/step
1/1 [==============================] - 0s 217ms/step
1/1 [==============================] - 0s 233ms/step
```

In [22]:
```
print(pre.result(), re.result(), acc.result())
```

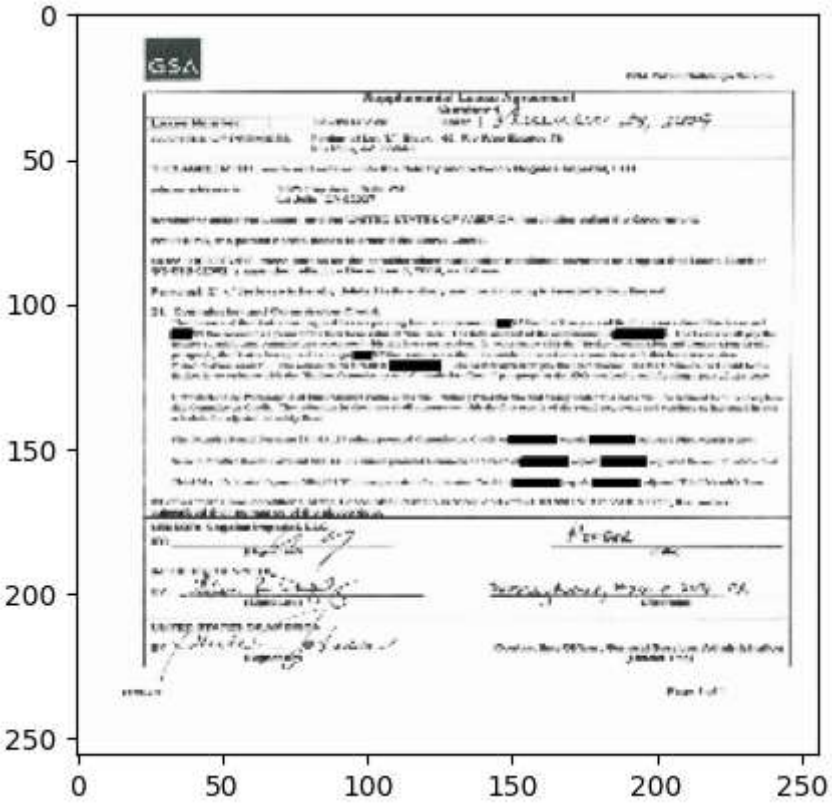
```
tf.Tensor(1.0, shape=(), dtype=float32) tf.Tensor(0.96363634, shape=(), dtype
=float32) tf.Tensor(0.99065423, shape=(), dtype=float32)
```

10. Testing

In [33]:
```
img = cv2.imread('test5.jfif')
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.show()
```



In [34]:
```
resize = tf.image.resize(cv2.cvtColor(img, cv2.COLOR_BGR2RGB), (256,256))
plt.imshow(resize.numpy().astype(int))
plt.show()
```



In [35]:
```
yhat = model.predict(np.expand_dims(resize/255, 0))
```

```
1/1 [==============================] - 0s 43ms/step
```

In [36]:
```
if yhat > 0.5:
    print(f'Predicted class is Signature')
    print(f"Certainty = {float(yhat)*100}")
else:
    print(f'Predicted class is Portrait')
    print(f"Certainty = {float(1-yhat)*100}")
```

```
Predicted class is Signature
Certainty = 84.3981683254242
```

11. Saving the Model

In [27]:
```
model.save(os.path.join('models','model1.h5'))
```

In [28]:
```
#new_model = load_model('C:\\Users\\chana\\Downloads\\models\\imageclassifiere
```

Created **Deepnote**(https://deepnote.com?utm_source=created-in-deepnote-cell&projectId=e5eb307f-57c9-4fe9-995d-1913de4a6e89) in