Getting data

In [2]:

```
!wget --header="Host: ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com" --header="User-
Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_14_5) AppleWebKit/537.36 (KHTML, like Gecko) Chro
me/85.0.4183.121 Safari/537.36" --header="Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,ap
ation/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en,en-US;q=0.9,fr;q=0.8" --header="Re
ferer: https://www.dropbox.com/"
"https://ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com/cd/0/get/BB3rdcqDKuYB_1WV9QJ2Toi_1
ltT88t88i4nYJOZdWFVGqIktjQ4uZLzYg0a7r4ZRNThQBjTAcdg34HLEFK2w3mp1LBL9Ixl98xH3RkRw/file?
_download_id=902886681401278462577580158858967971025829340696561826066030709&_notify_domain=www.dro
.com&dl=1" -c -O 'phase-01-training.tar.gz'
```

```
--2020-10-23 20:21:50--
https://ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com/cd/0/get/BB3rdcqDKuYB_1WV9QJ2Toi_1lC
tT88t88i4nYJOZdWFVGqIktjQ4uZLzYg0a7r4ZRNThQBjTAcdg34HLEFK2w3mp1LBL9Ixl98xH3RkRw/file?
_download_id=902886681401278462577580158858967971025829340696561826066030709&_notify_domain=www.drc
.com&dl=1
Resolving ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com
(ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com)... 162.125.65.15,
2620:100:6021:15::a27d:410f
Connecting to ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com
(ucc5cb060f36bc71a23742b3a0d2.dl.dropboxusercontent.com)|162.125.65.15|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2749754446 (2.6G) [application/binary]
Saving to: 'phase-01-training.tar.gz'

phase-01-training.t 100%[===================>]   2.56G  22.0MB/s    in 1m 49s

2020-10-23 20:23:40 (24.0 MB/s) - 'phase-01-training.tar.gz' saved [2749754446/2749754446]
```

In [25]:

```
import os
os.environ['KAGGLE_CONFIG_DIR'] = "/content"
%cd /content
```

```
/content
```

In [26]:

```
!kaggle datasets download -d sophatvathana/casia-dataset
```

```
Warning: Your Kaggle API key is readable by other users on this system! To fix this, you can run '
chmod 600 /content/kaggle.json'
Downloading casia-dataset.zip to /content
100% 5.21G/5.22G [01:33<00:00, 58.7MB/s]
100% 5.22G/5.22G [01:33<00:00, 59.6MB/s]
```

Extracting Data

In [3]:

```
!tar -xf  '/content/phase-01-training.tar.gz' -C '/content/'
```

In [27]:

```
!unzip -qq '/content/casia-dataset.zip'
```

Importing libraries

In [ ]:

```
!pip install -q pyyaml h5py
```

In [1]:

```
!pip install segmentation-models
```

```
Collecting segmentation-models
  Downloading
https://files.pythonhosted.org/packages/da/b9/4a183518c21689a56b834eaaa45cad242d9ec09a4360b5b10139f
3f4/segmentation_models-1.0.1-py3-none-any.whl
Collecting keras-applications<=1.0.8,>=1.0.7
  Downloading
https://files.pythonhosted.org/packages/71/e3/19762fdfc62877ae9102edf6342d71b28fbfd9dea3d2f96a882ce
03f/Keras_Applications-1.0.8-py3-none-any.whl (50kB)
     |████████████████████████████████| 51kB 2.8MB/s
Collecting efficientnet==1.0.0
  Downloading
https://files.pythonhosted.org/packages/97/82/f3ae07316f0461417dc54affab6e86ab188a5a22f33176d352716
6e0/efficientnet-1.0.0-py3-none-any.whl
Collecting image-classifiers==1.0.0
  Downloading
https://files.pythonhosted.org/packages/81/98/6f84720e299a4942ab80df5f76ab97b7828b24d1de5e9b2cbbe60
8b7/image_classifiers-1.0.0-py3-none-any.whl
Requirement already satisfied: h5py in /usr/local/lib/python3.6/dist-packages (from keras-
applications<=1.0.8,>=1.0.7->segmentation-models) (2.10.0)
Requirement already satisfied: numpy>=1.9.1 in /usr/local/lib/python3.6/dist-packages (from keras-
applications<=1.0.8,>=1.0.7->segmentation-models) (1.18.5)
Requirement already satisfied: scikit-image in /usr/local/lib/python3.6/dist-packages (from
efficientnet==1.0.0->segmentation-models) (0.16.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from h5py->keras-
applications<=1.0.8,>=1.0.7->segmentation-models) (1.15.0)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from
scikit-image->efficientnet==1.0.0->segmentation-models) (7.0.0)
Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in /usr/local/lib/python3.6/dist-packages
(from scikit-image->efficientnet==1.0.0->segmentation-models) (3.2.2)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from
scikit-image->efficientnet==1.0.0->segmentation-models) (2.4.1)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from
scikit-image->efficientnet==1.0.0->segmentation-models) (1.1.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from
scikit-image->efficientnet==1.0.0->segmentation-models) (2.5)
Requirement already satisfied: scipy>=0.19.0 in /usr/local/lib/python3.6/dist-packages (from
scikit-image->efficientnet==1.0.0->segmentation-models) (1.4.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from
matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from
matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (1.2.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image-
>efficientnet==1.0.0->segmentation-models) (2.4.7)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages
(from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (2.8.1)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from
networkx>=2.0->scikit-image->efficientnet==1.0.0->segmentation-models) (4.4.2)
Installing collected packages: keras-applications, efficientnet, image-classifiers, segmentation-m
odels
Successfully installed efficientnet-1.0.0 image-classifiers-1.0.0 keras-applications-1.0.8
segmentation-models-1.0.1
```

In [2]:

```
import numpy as np
from prettytable import PrettyTable
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
from keras.utils.np_utils import to_categorical
from keras.models import Sequential
from keras.layers import Dense, Flatten, Conv2D, MaxPool2D, Dropout
from keras.optimizers import Adam
from keras.preprocessing.image import ImageDataGenerator
from keras.callbacks import EarlyStopping,ReduceLROnPlateau
from PIL import Image, ImageChops, ImageEnhance
```

```
import os
import itertools
import seaborn as sns
import shutil
from imageio import imread
import imageio
import pandas as pd
import tqdm
import matplotlib.pyplot as plt
import seaborn as sns
from keras.applications.resnet import ResNet50, ResNet101, ResNet152
import datetime
from keras.callbacks import TensorBoard
import cv2
from skimage.transform import resize
import PIL
from numpy import save,load
from keras.optimizers import Adam,SGD
%env SM_FRAMEWORK=tf.keras
# from tensorflow import keras
import tensorflow as tf
import segmentation_models as sm
from keras import backend as K
import tensorflow_addons as tfa
from segmentation_models import Unet
from tensorflow.keras.layers import Input, Add, Dropout,Dense, Activation, ZeroPadding2D, BatchNorm
alization, Flatten, Conv2D, AveragePooling2D, MaxPooling2D, GlobalMaxPooling2D, concatenate,Conv2DT
ranspose,GlobalMaxPool2D,GlobalAveragePooling2D,UpSampling2D
from tensorflow.keras.models import Model, load_model
from tensorflow.keras.initializers import glorot_uniform
from segmentation_models.metrics import iou_score
import gc
from sklearn.utils import shuffle
from albumentations import (
PadIfNeeded,
HorizontalFlip,
VerticalFlip,
Transpose,
HueSaturationValue,
ElasticTransform,
GridDistortion,
OpticalDistortion,
RandomBrightnessContrast,
RandomGamma,Resize
)
from tensorflow.keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, l
oad_img
```

```
env: SM_FRAMEWORK=tf.keras
Segmentation Models: using `tf.keras` framework.
```

In [6]:

```
 # Dice_Coeff or F1 score
def metric(y_true, y_pred):
    y_true_f = K.flatten(y_true)
    y_pred_f = K.flatten(y_pred)
    intersection = K.sum(y_true_f * y_pred_f)
    return (2. * intersection + 1) / (K.sum(y_true_f) + K.sum(y_pred_f) + 1)
```

In [7]:

```
def plot_predicted_images(index):

    pred = np.squeeze(predicted[index])
    plt.imsave('pred_mask.png',pred)
    im_gray = cv2.imread('pred_mask.png', cv2.IMREAD_GRAYSCALE)
    (thresh, im_bw) = cv2.threshold(im_gray, 220, 255, cv2.THRESH_BINARY | cv2.THRESH_OTSU)
    fig = plt.figure(figsize=(20,10))
    ax1 = fig.add_subplot(331)
    ax2 = fig.add_subplot(332)
    ax3 = fig.add_subplot(333)

    ax1.set_title("pristine image")
```

```
    ax2.set_title("original mask")
    ax3.set_title("predicted binary mask")
    ax1.imshow(X_val1[index])
    ax2.imshow(np.squeeze(Y_val[index]))
    ax3.imshow(im_bw)
```

Building Classification model

In [28]:

```
#Method to generate ELA of images
def generate_ela(path,quality):
  temp_file = 'temp_file.jpg'
  # ela_filename = 'temp_ela.png'

  image = Image.open(path).convert('RGB')
  image.save(temp_file, 'JPEG', quality = quality)
  temp_image = Image.open(temp_file)

  ela_img = ImageChops.difference(image, temp_image)

  extrema = ela_img.getextrema()
  max_diff = max([ex[1] for ex in extrema])
  if max_diff == 0:
      max_diff = 1
  scale = 255.0 / max_diff

  ela_img = ImageEnhance.Brightness(ela_img).enhance(scale)

  return ela_img
```

In [7]:

```
#Generating ela from normal images and resizing them
def get_image(path):
    return np.array(generate_ela(path, 90).resize((128,128))).flatten()/255
```

In [8]:

```
#Method to plot colored confusion matrix
def plot_confusion_matrix(cm, classes,normalize=False,title='Confusion matrix',cmap=plt.cm.Blues):
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)


    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

In [70]:

```
X = []
Y = []
```

In [30]:

```
#Adding image paths from pristine images with label 1 as they are ground truth
path = '/content/dataset-dist/phase-01/training/pristine'
for dir, paths, files in os.walk(path):
    for filename in files:
      if ('.DS_Store' not in filename):
        # if filename.endswith('jpg') or filename.endswith('png'):
```

```
        # if filename.endswith('jpg') or filename.endswith('png'):
            full_path = os.path.join(dir, filename)
            X.append(get_image(full_path))
            Y.append(1)

print(len(X), len(Y))
```

```
1050 1050
```

In [71]:

```
#Adding image paths from pristine images with label 1 as they are ground truth
path = '/content/casia/CASIA2/Au'
for dir, paths, files in os.walk(path):
    for filename in files:
        if filename.endswith('jpg') or filename.endswith('png'):
            full_path = os.path.join(dir, filename)
            X.append(get_image(full_path))
            Y.append(1)

print(len(X), len(Y))
```

```
/usr/local/lib/python3.6/dist-packages/PIL/TiffImagePlugin.py:770: UserWarning: Possibly corrupt E
XIF data.  Expecting to read 8 bytes but only got 2. Skipping tag 41487
  " Skipping tag %s" % (size, len(data), tag)
/usr/local/lib/python3.6/dist-packages/PIL/TiffImagePlugin.py:770: UserWarning: Possibly corrupt E
XIF data.  Expecting to read 8 bytes but only got 0. Skipping tag 41988
  " Skipping tag %s" % (size, len(data), tag)
```

```
7354 7354
```

In [72]:

```
#Adding image paths from pristine images with label 1 as they are ground truth
path = '/content/dataset-dist/phase-01/training/fake'
for dir, paths, files in os.walk(path):
    for filename in files:
      if (('.DS_Store' not in filename) and ('.mask.png' not in filename)):
        # if filename.endswith('jpg') or filename.endswith('png'):
            full_path = os.path.join(dir, filename)
            X.append(get_image(full_path))
            Y.append(0)

print(len(X), len(Y))
```

```
7804 7804
```

In [73]:

```
#Adding image paths from tampered images with label 0
path = '/content/casia/CASIA2/Tp'
for dir, paths, files in os.walk(path):
    for filename in files:
        if ((filename.endswith('jpg') or filename.endswith('png')) and '.mask.png' not in filename)
:
            full_path = os.path.join(dir, filename)
            X.append(get_image(full_path))
            Y.append(0)
print(len(X), len(Y))
```

```
9868 9868
```

In [74]:

```
X = np.array(X)
print(X.shape)
```

```
(9868, 49152)
```

In [75]:

```
Y = to_categorical(Y, 2)
X = X.reshape(-1, 128, 128, 3)
```

In [76]:

```
#Splitting the data
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.2, random_state=20)
```

In [77]:

```
print(X_train.shape,Y_train.shape)
print(X_test.shape,Y_test.shape)
```

```
(7894, 128, 128, 3) (7894, 2)
(1974, 128, 128, 3) (1974, 2)
```

In [78]:

```
model2 = Sequential()
model2.add(ResNet50(include_top = False, pooling = 'avg', weights = 'imagenet'))
model2.add(Dense(256, activation = 'relu'))
model2.add(Dropout(0.1))
model2.add(Dense(128, activation='relu'))
model2.add(Dense(64, activation='relu'))
model2.add(Dropout(0.2))
model2.add(Dense(32, activation='relu'))
model2.add(Dropout(0.3))
model2.add(Dense(2, activation = 'softmax'))
```

In [ ]:

```
model2.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
resnet50 (Functional)        (None, 2048)              23587712
_________________________________________________________________
dense_15 (Dense)             (None, 256)               524544
_________________________________________________________________
dropout_9 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_16 (Dense)             (None, 128)               32896
_________________________________________________________________
dense_17 (Dense)             (None, 64)                8256
_________________________________________________________________
dropout_10 (Dropout)         (None, 64)                0
_________________________________________________________________
dense_18 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_11 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_19 (Dense)             (None, 2)                 66
=================================================================
Total params: 24,155,554
Trainable params: 24,102,434
Non-trainable params: 53,120
_________________________________________________________________
```

In [43]:

```
!rm -rf 'logs2/fit/'
```

In [79]:

```
epochs = 7
batch_size = 32
```

```
init_lr = 1e-4
optimizer = Adam(lr = init_lr, decay = init_lr/epochs)
model2.compile(optimizer = optimizer, loss = 'binary_crossentropy', metrics = ['accuracy'])
early_stopping = EarlyStopping(monitor = 'val_accuracy',min_delta = 0,patience = 4,mode = 'auto')
log_dir = "logs2/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = TensorBoard(log_dir=log_dir, histogram_freq=1)
```

In [80]:

```
model2.fit(X_train,Y_train,batch_size = batch_size,epochs = epochs,validation_data = (X_test, Y_tes
t),callbacks = [tensorboard_callback])
```

```
Epoch 1/7
  2/247 [..............................] - ETA: 1:31 - loss: 0.6785 - accuracy:
0.5781WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time
(batch time: 0.0465s vs `on_train_batch_end` time: 0.6983s). Check your callbacks.
247/247 [==============================] - 16s 66ms/step - loss: 0.2572 - accuracy: 0.8832 - val_l
oss: 1.7946 - val_accuracy: 0.2573
Epoch 2/7
247/247 [==============================] - 14s 58ms/step - loss: 0.1416 - accuracy: 0.9419 - val_l
oss: 7.9553 - val_accuracy: 0.2573
Epoch 3/7
247/247 [==============================] - 14s 58ms/step - loss: 0.0945 - accuracy: 0.9650 - val_l
oss: 0.7141 - val_accuracy: 0.6160
Epoch 4/7
247/247 [==============================] - 14s 58ms/step - loss: 0.0822 - accuracy: 0.9710 - val_l
oss: 8.6171 - val_accuracy: 0.2898
Epoch 5/7
247/247 [==============================] - 14s 58ms/step - loss: 0.0518 - accuracy: 0.9838 - val_l
oss: 1.9954 - val_accuracy: 0.6322
Epoch 6/7
247/247 [==============================] - 14s 58ms/step - loss: 0.0353 - accuracy: 0.9867 - val_l
oss: 0.2077 - val_accuracy: 0.9448
Epoch 7/7
247/247 [==============================] - 14s 57ms/step - loss: 0.0320 - accuracy: 0.9887 - val_l
oss: 0.2299 - val_accuracy: 0.9417
```

Out[80]:

```
<tensorflow.python.keras.callbacks.History at 0x7fa1a1767f28>
```

In [ ]:

```
%load_ext tensorboard
%tensorboard --logdir logs2/fit
```

In [83]:

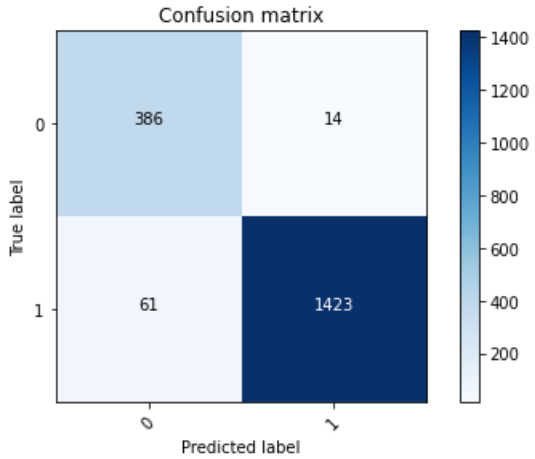
```
!mkdir -p saved_classification_model
model2.save('saved_classification_model/my_model')
# model2.save('saved_classification_model/my_model.h5')
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/training/tracking/tracking.py:111: Model.state_updates (from
tensorflow.python.keras.engine.training) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/training/tracking/tracking.py:111: Layer.updates (from
tensorflow.python.keras.engine.base_layer) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
INFO:tensorflow:Assets written to: saved_classification_model/my_model/assets
```

In [ ]:

```
# Predict the values from the validation dataset and computing the confusion matrix
Y_pred = model2.predict(X_test)
Y_pred_classes = np.argmax(Y_pred,axis = 1)
Y_true = np.argmax(Y_test,axis = 1)
```

```
confusion_mtx = confusion_matrix(Y_true, Y_pred_classes)
plot_confusion_matrix(confusion_mtx, classes = range(2))
```



In [84]:

```
!zip -r /content/classification.zip /content/saved_classification_model
```

```
  adding: content/saved_classification_model/ (stored 0%)
  adding: content/saved_classification_model/my_model/ (stored 0%)
  adding: content/saved_classification_model/my_model/saved_model.pb (deflated 92%)
  adding: content/saved_classification_model/my_model/variables/ (stored 0%)
  adding: content/saved_classification_model/my_model/variables/variables.data-00000-of-00001
(deflated 8%)
  adding: content/saved_classification_model/my_model/variables/variables.index (deflated 80%)
  adding: content/saved_classification_model/my_model/assets/ (stored 0%)
```

In [81]:

```
X_test = []

full_path = os.path.join('/content/dataset-dist/phase-
01/training/fake/022354380a1a17ff49226c9eae21a11f.png')
X_test.append(get_image(full_path))
```

In [82]:

```
X_test = np.array(X_test)
X_test = X_test.reshape(-1, 128, 128, 3)
Y_pred_test = model2.predict(X_test)
Y_pred_classes_test = np.argmax(Y_pred_test,axis = 1)
print(Y_pred_classes_test)
```

```
[0]
```

Preprocessing data

In [8]:

```
pristine_path = 'dataset-dist/phase-01/training/pristine'
fake_path = 'dataset-dist/phase-01/training/fake'
base_path = 'dataset-dist/phase-01/training/'
os.mkdir(base_path+'ela')
ela_path = 'dataset-dist/phase-01/training/ela'
# paths=[pristine_path,fake_path]
paths=[fake_path]
```

In [9]:

```
#method to convert to ela
def ELA(img_path):
    TEMP = 'ela_' + 'temp.jpg'
    SCALE = 10
```

```
    original = Image.open(img_path)
    try:
        original.save(TEMP, quality=90)
        temporary = Image.open(TEMP)
        diff = ImageChops.difference(original, temporary)

    except:

        original.convert('RGB').save(TEMP, quality=92)
        temporary = Image.open(TEMP)
        diff = ImageChops.difference(original.convert('RGB'), temporary)


    d = diff.load()

    WIDTH, HEIGHT = diff.size
    for x in range(WIDTH):
        for y in range(HEIGHT):
            d[x, y] = tuple(k * SCALE for k in d[x, y])
    return diff
```

In [10]:

```
fake_images = []
temp = os.listdir(base_path+'fake')
for idx,img in enumerate(temp):
  if(('.mask.png' not in img) and ('.DS_Store' not in img)):
    fake_images.append(img)

for img in tqdm.tqdm(fake_images, position=0, leave=True):
    ELA(fake_path+'/'+img).save(base_path + 'ela/'+img)
```

```
100%|██████████| 450/450 [22:40<00:00,  3.02s/it]
```

In [11]:

```
#Creating dataframes
mask_dict = {'name':[],'height':[], 'width':[], 'channels':[],'label':[]}
rest_dict = {'name':[],'height':[], 'width':[], 'channels':[],'label':[]}
for path in paths:
    for image in tqdm.tqdm(os.listdir(path),position=0, leave=True):
      if ('.DS_Store' not in image):
        if image.split('.')[-2]=='mask':
            img = imread(path+'/'+image)
            if len(img.shape)==2:
                height, width = img.shape
                channels = 1
            else:
                height, width, channels = img.shape
            mask_dict['name'].append(image)
            mask_dict['height'].append(height)
            mask_dict['width'].append(width)
            mask_dict['channels'].append(channels)
            mask_dict['label'].append('mask')
        else:
            try:
                img = imread(path+'/'+image)
                if len(img.shape)==2:
                    height, width = img.shape
                    channels = 1
                else:
                    height, width, channels = img.shape
            except:
                pass
            rest_dict['name'].append(image)
            rest_dict['height'].append(height)
            rest_dict['width'].append(width)
            rest_dict['channels'].append(channels)
            rest_dict['label'].append(path.split('/')[3])



for image in tqdm.tqdm(os.listdir(base_path+'ela/'),position=0, leave=True):
```

```
        if ('.DS_Store' not in image):
            img = imread(base_path+'ela/'+image)
            if len(img.shape)==2:
                height, width = img.shape
                channels = 1
            else:
                height, width, channels = img.shape
            rest_dict['name'].append(image)
            rest_dict['height'].append(height)
            rest_dict['width'].append(width)
            rest_dict['channels'].append(channels)
            rest_dict['label'].append('fake_ela')

df_images = pd.DataFrame.from_dict(rest_dict)
df_masks = pd.DataFrame.from_dict(mask_dict)
```

```
 26%|██▌       | 231/901 [00:10<00:26, 25.30it/s]/usr/local/lib/python3.6/dist-
packages/PIL/Image.py:932: UserWarning: Palette images with Transparency expressed in bytes should
be converted to RGBA images
  "Palette images with Transparency expressed in bytes should be "
100%|██████████| 901/901 [00:40<00:00, 22.45it/s]
100%|██████████| 450/450 [00:25<00:00, 17.39it/s]
```

In [12]:

```
print(df_images.shape)
print(df_masks.shape)
```

```
(900, 5)
(450, 5)
```

In [13]:

```
df_images = df_images.sort_values('name')
df_masks = df_masks.sort_values('name')
```

In [14]:

```
df_images.head()
```

Out[14]:

	name	height	width	channels	label
254	010543abfbd0db1e9aa1b24604336e0c.png	1536	2048	4	fake
704	010543abfbd0db1e9aa1b24604336e0c.png	1536	2048	3	fake_ela
599	022354380a1a17ff49226c9eae21a11f.png	768	1024	3	fake_ela
149	022354380a1a17ff49226c9eae21a11f.png	768	1024	3	fake
341	0294345b3b2324b195cb3b30e91d7678.png	600	800	4	fake

In [15]:

```
df_masks.head()
```

Out[15]:

	name	height	width	channels	label
423	010543abfbd0db1e9aa1b24604336e0c.mask.png	1536	2048	4	mask
80	022354380a1a17ff49226c9eae21a11f.mask.png	768	1024	1	mask
160	0294345b3b2324b195cb3b30e91d7678.mask.png	600	800	4	mask
394	0363353570f16ff0a73aa0a03a7795b8.mask.png	765	1024	1	mask
107	0830004e471e511458600f0763ce19f3.mask.png	768	1024	1	mask

In [16]:

```
fake_names_intersection = list(set([i.split('.')[0] for i in list(df_masks['name'])]) & set([i.spli
t('.')[0] for i in list(df_images[df_images.label=='fake']['name'])]))
print(len(fake_names_intersection))
```

```
450
```

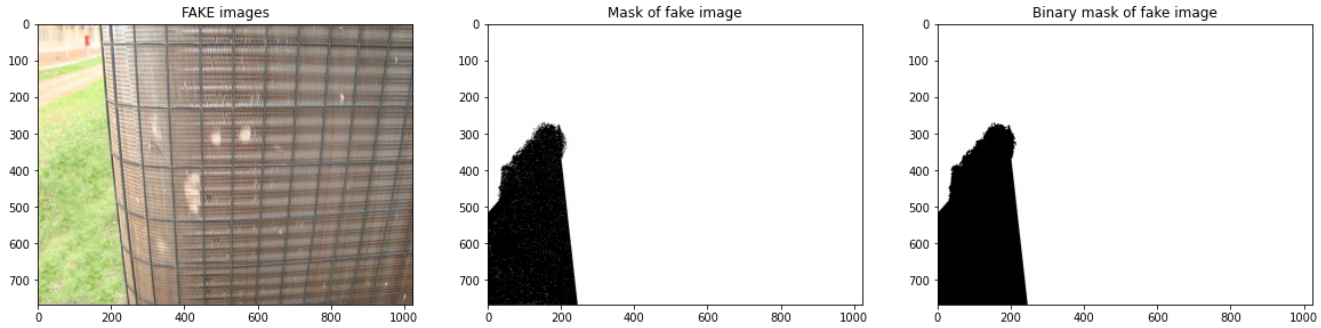
In [17]:

```
#Adding gaussian blur to masks to reduce noise and converting to single channel
os.mkdir(base_path+'binary_masks')
bin_masks =[]
for mask in tqdm.tqdm(fake_names_intersection,position=0, leave=True):
    mask_img = cv2.imread(base_path+'fake'+'/'+mask+'.mask.png')[:,:,:1]
    blur = cv2.GaussianBlur(mask_img,(5,5),0) #Adding gaussian blur
    ret,bin_mask = cv2.threshold(blur,0,255,cv2.THRESH_BINARY+cv2.THRESH_OTSU) #modifing the values
to either 0 or 255
    cv2.imwrite(base_path+'binary_masks/'+mask+'.mask.png',bin_mask)
    bin_masks.append(bin_mask)
```

```
100%|██████████| 450/450 [00:13<00:00, 34.40it/s]
```

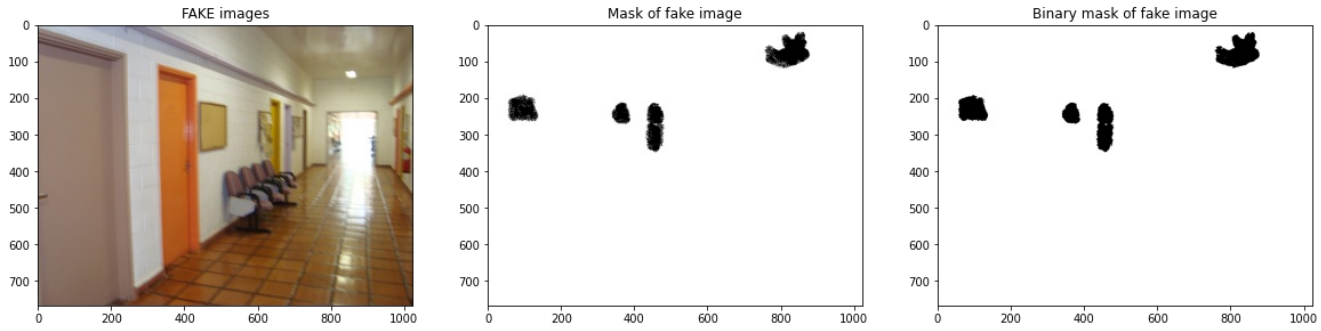
In [ ]:

```
index = 22
fig, ax = plt.subplots(1,3,figsize=(20,20))
image = imread(base_path+'/fake'+'/'+(df_images[df_images.label=='fake']['name']).iloc[index])
mask_image = imread(base_path+'/fake'+'/'+(df_images[df_images.label=='fake']['name']).iloc[index].
split('.')[0]+'.mask.png')
bin_mask = imread(base_path+'/binary_masks/'+(df_images[df_images.label=='fake']
['name']).iloc[index].split('.')[0]+'.mask.png')
ax[0].imshow(image)
ax[1].imshow(mask_image,cmap='gray')
ax[2].imshow(bin_mask,cmap='gray')
ax[0].set_title('FAKE images')
ax[1].set_title('Mask of fake image')
ax[2].set_title('Binary mask of fake image')
plt.show()
```



In [ ]:

```
index = 333
fig, ax = plt.subplots(1,3,figsize=(20,20))
image = imread(base_path+'/fake'+'/'+(df_images[df_images.label=='fake']['name']).iloc[index])
mask_image = imread(base_path+'/fake'+'/'+(df_images[df_images.label=='fake']['name']).iloc[index].
split('.')[0]+'.mask.png')
bin_mask = imread(base_path+'/binary_masks/'+(df_images[df_images.label=='fake']
['name']).iloc[index].split('.')[0]+'.mask.png')
ax[0].imshow(image)
ax[1].imshow(mask_image,cmap='gray')
ax[2].imshow(bin_mask,cmap='gray')
ax[0].set_title('FAKE images')
ax[1].set_title('Mask of fake image')
ax[2].set_title('Binary mask of fake image')
plt.show()
```



In [18]:

```
fake_images_df = pd.DataFrame([i+'.png' for i in fake_names_intersection],columns=['name'])
real_df = df_images[df_images.label == 'pristine']
fake_df = df_images[df_images.label == 'fake']
ela_df = df_images[df_images.label == 'fake_ela']
```

In [19]:

```
print(fake_images_df.shape)
print(fake_df.shape)
print(ela_df.shape)
```

```
(450, 1)
(450, 5)
(450, 5)
```

In [20]:

```
fake_df = fake_df.join(fake_images_df.set_index('name'), on='name',how='right')
ela_df = ela_df.join(fake_images_df.set_index('name'), on='name',how='right')
print(fake_df.shape)
print(ela_df.shape)
df_final = pd.concat([real_df, fake_df,ela_df], ignore_index=True)
print(df_final.shape)
```

```
(450, 5)
(450, 5)
(900, 5)
```

In [21]:

```
#Splitting the data
X_train, X_test, y_train, y_test = train_test_split(df_final[['channels', 'height', 'name', 'width'
,'label']],df_final['label'], test_size=0.2, stratify=df_final['label'],random_state=42)
# X_train, X_val, y_train, y_val = train_test_split(X_train[['channels', 'height', 'name', 'width'
,'label']],y_train, test_size=0.2, stratify=y_train,random_state=42)
```

In [22]:

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(576, 5)
(180, 5)
(576,)
(180,)
```

Adding Augmentation

In [24]:

```
#Resizing and augmenting images
def augment(aug_image_mask_ela):
```

```
def agument(aug,image,mask,ela):
    augmented = aug(image=image, mask=mask,ela=ela)
    return augmented['image'],augmented['mask'],augmented['ela']


def resize(image,mask,ela):
    aug = Resize(height=256,width=256,p=1)
    return agument(aug,image,mask,ela)

def horizontalFlip(image,mask,ela):
    aug = HorizontalFlip(p=1)
    return agument(aug,image,mask,ela)

def verticalFlip(image,mask,ela):
    aug = VerticalFlip(p=1)
    return agument(aug,image,mask,ela)

def transpose(image,mask,ela):
    aug = Transpose(p=1)
    return agument(aug,image,mask,ela)

def hueSaturationValue(image,mask,ela):
    aug = HueSaturationValue(p=1,hue_shift_limit=100, sat_shift_limit=100, val_shift_limit=50)
    return agument(aug,image,mask,ela)

def elasticTransform(image,mask,ela):
    aug = ElasticTransform(p=1)
    return agument(aug,image,mask,ela)

def opticalDistortion(image,mask,ela):
    aug = OpticalDistortion(p=1, distort_limit=3, shift_limit=0.4)
    return agument(aug,image,mask,ela)

def randomBrightnessContrast(image,mask,ela):
    aug =RandomBrightnessContrast(p=1,brightness_limit=0.5, contrast_limit=0.4)
    return agument(aug,image,mask,ela)
```

In [ ]:

```
!rm -rf 'augmentaions'
```

In [25]:

```
#Making directories for fake and pristine augmented data
train_path_fake_aug = 'augmentaions/train/fake_images/'
test_path_fake_aug = 'augmentaions/test/fake_images/'

train_path_fake_aug_ela = 'augmentaions/train/fake_ela/'
test_path_fake_aug_ela = 'augmentaions/test/fake_ela/'

train_path_fake_aug_mask = 'augmentaions/train/fake_mask/'
test_path_fake_aug_mask = 'augmentaions/test/fake_mask/'
# val_path_fake_aug = 'augmentaions/val/fake/'
os.makedirs(train_path_fake_aug)
os.makedirs(test_path_fake_aug)

os.makedirs(train_path_fake_aug_ela)
os.makedirs(test_path_fake_aug_ela)

os.makedirs(train_path_fake_aug_mask)
os.makedirs(test_path_fake_aug_mask)
# os.makedirs(val_path_fake_aug)

# train_path_pr_aug = 'augmentaions/train/pristine/'
# test_path_pr_aug = 'augmentaions/test/pristine/'
# val_path_pr_aug = 'augmentaions/val/pristine/'
# os.makedirs(train_path_pr_aug)
# os.makedirs(test_path_pr_aug)
# os.makedirs(val_path_pr_aug)
```

In [26]:

```
#Defining augmentation function
def Augment_data_fake(split_type,Type):
```

```
    for name in tqdm.tqdm(split_type[split_type['label']=='fake']['name'],position=0, leave=True):
        name_path = base_path+'fake/'+str(name)
        image_raw= imread(name_path)
        mask_raw = imread(base_path+'binary_masks/'+name.split('.')[0]+'.mask.png')
        ela_raw = imread(base_path+'ela/'+str(name))

        image_0,mask_0,ela_0= resize(image=image_raw,mask=mask_raw,ela=ela_raw)
        image_1,mask_1,ela_1= horizontalFlip(image=image_0,mask=mask_0,ela=ela_0)
        image_2,mask_2,ela_2= verticalFlip(image=image_0,mask=mask_0,ela=ela_0)
        image_3,mask_3,ela_3= transpose(image=image_0,mask=mask_0,ela=ela_0)
        image_4,mask_4,ela_4= hueSaturationValue(image=image_0,mask=mask_0,ela=ela_0)
        image_5,mask_5,ela_5= elasticTransform(image=image_0,mask=mask_0,ela=ela_0)
        image_6,mask_6,ela_6= opticalDistortion(image=image_0,mask=mask_0,ela=ela_0)
        image_7,mask_7,ela_7= randomBrightnessContrast(image=image_0,mask=mask_0,ela=ela_0)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(0)+'.png',image
_0)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(0)+'.mask.png',ma
sk_0)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(0)+'.png',ela_0)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(1)+'.png',image
_1)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(1)+'.mask.png',ma
sk_1)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(1)+'.png',ela_1)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(2)+'.png',image
_2)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(2)+'.mask.png',ma
sk_2)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(2)+'.png',ela_2)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(3)+'.png',image
_3)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(3)+'.mask.png',ma
sk_3)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(3)+'.png',ela_3)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(4)+'.png',image
_4)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(4)+'.mask.png',ma
sk_4)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(4)+'.png',ela_4)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(5)+'.png',image
_5)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(5)+'.mask.png',ma
sk_5)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(5)+'.png',ela_5)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(6)+'.png',image
_6)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(6)+'.mask.png',ma
sk_6)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(6)+'.png',ela_6)

        cv2.imwrite('augmentaions/'+Type+'/fake_images/'+name.split('.')[0]+'_'+str(7)+'.png',image
_7)
        cv2.imwrite('augmentaions/'+Type+'/fake_mask/'+name.split('.')[0]+'_'+str(7)+'.mask.png',ma
sk_7)
        cv2.imwrite('augmentaions/'+Type+'/fake_ela/'+name.split('.')[0]+'_'+str(7)+'.png',ela_7)

# def Augment_data_pristine(split_type,Type):
#     for name in tqdm.tqdm(split_type[split_type['label']=='pristine']['name'],position=0,
leave=True):
#         name_path = base_path+'pristine/'+str(name)
#         image_raw= imread(name_path)
#         mask_raw= imread('default.mask.png')
#         image_0,mask_0= resize(image=image_raw,mask=mask_raw)
#         image_1,mask_1= verticalFlip(image=image_0,mask=mask_raw)
#         image_2,mask_2= opticalDistortion(image=image_0,mask=mask_raw)
#         cv2.imwrite('augmentaions/'+Type+'/pristine/'+name.split('.')
[0]+'_'+str(0)+'.png',image_0)
#         cv2.imwrite('augmentaions/'+Type+'/pristine/'+name.split('.')
[0]+'_'+str(1)+'.png',image_1)
#         cv2.imwrite('augmentaions/'+Type+'/pristine/'+name.split('.')
```

```
[0]+'_'+str(3)+'.png',image_2)
```

In [27]:

```
Augment_data_fake(X_train,'train')
Augment_data_fake(X_test,'test')
# Augment_data_fake(X_val,'val')
```

```
100%|██████████| 288/288 [05:07<00:00,  1.07s/it]
100%|██████████| 90/90 [01:19<00:00,  1.13it/s]
```

In [28]:

```
print('Fake train image data after augmentation = ',len(os.listdir(train_path_fake_aug)))
print('Fake train ela data after augmentation = ',len(os.listdir(train_path_fake_aug_ela)))
print('Fake train mask data after augmentation = ',len(os.listdir(train_path_fake_aug_mask)))

print('Fake test image data after augmentation = ',len(os.listdir(test_path_fake_aug)))
print('Fake test ela data after augmentation = ',len(os.listdir(test_path_fake_aug_ela)))
print('Fake test mask data after augmentation = ',len(os.listdir(test_path_fake_aug_mask)))

# print('Fake test data after augmentation = ',len(os.listdir(test_path_fake_aug))/2)
# print('Fake validation data after augmentation = ',len(os.listdir(val_path_fake_aug))/2)
```

```
Fake train image data after augmentation =  2304
Fake train ela data after augmentation =  2304
Fake train mask data after augmentation =  2304
Fake test image data after augmentation =  720
Fake test ela data after augmentation =  720
Fake test mask data after augmentation =  720
```

In [ ]:

```
#Since there is no mask for pristine images so we will define a default mask
cv2.imwrite("default.mask.png",np.zeros((512,512))+255)
Augment_data_pristine(X_train,'train')
Augment_data_pristine(X_test,'test')
Augment_data_pristine(X_val,'val')
```

In [ ]:

```
print('Pristine train data after augmentation = ',len(os.listdir(train_path_pr_aug)))
print('Pristine test data after augmentation = ',len(os.listdir(test_path_pr_aug)))
print('Pristine validation data after augmentation = ',len(os.listdir(val_path_pr_aug)))
```

```
Pristine train data after augmentation =  2016
Pristine test data after augmentation =  630
Pristine validation data after augmentation =  504
```

In [29]:

```
def MakeData():
  train_df = pd.DataFrame()
  test_df = pd.DataFrame()
  # val_df = pd.DataFrame()
  #Train data
  X1 = []
  X2 = []
  y = []
  #Fake images and mask
  for i in (list({i.split('.')[0] for i in os.listdir(train_path_fake_aug)})):
      i = i.split('.')[0]
      X1.append(train_path_fake_aug+i+'.png')
      X2.append(train_path_fake_aug_ela+i+'.png')
      y.append(train_path_fake_aug_mask+i+'.mask.png')


  #Pristne images and mask
  # for i in (list({i.split('.')[0] for i in os.listdir(train_path_pr_aug)})):
  #     i = i.split('.')[0]
  #     X1.append(train_path_pr_aug+i+'.png')
```

```
#     X1.append(train_path_pr_aug+i+'.png')
#     y.append('default.mask.png')

# print(X2)
# print(y)
train_df['X1']  =  X1
train_df['X2']  =  X2
train_df['y']  =  y
train_df = shuffle(train_df)
train_df.reset_index(inplace=True, drop=True)

#Test Data
X1 = []
X2 = []
y = []
for i in (list({i.split('.')[0] for i in os.listdir(test_path_fake_aug)})):
    i = i.split('.')[0]
    X1.append(test_path_fake_aug+i+'.png')
    X2.append(test_path_fake_aug_ela+i+'.png')
    y.append(test_path_fake_aug_mask+i+'.mask.png')

# for i in (list({i.split('.')[0] for i in os.listdir(test_path_fake_aug)})):
#   if('_ela_' not in i):
#     X1.append(test_path_fake_aug+i+'.png')
#     y.append(test_path_fake_aug+i+'.mask.png')
#   else:
#     X2.append('augmentaions/'+'test'+'/fake/'+i+'.png')

# for i in (list({i.split('.')[0] for i in os.listdir(test_path_pr_aug)})):
#     X.append(test_path_pr_aug+i+'.png')
#     y.append('default.mask.png')

test_df['X1']  =  X1
test_df['X2']  =  X2
test_df['y']  =  y
test_df = shuffle(test_df)
test_df.reset_index(inplace=True, drop=True)


#Validation Data
# X1 = []
# X2 = []
# y = []
# for i in (list({i.split('.')[0] for i in os.listdir(val_path_fake_aug)})):
#   if('_ela_' not in i):
#     X1.append(val_path_fake_aug+i+'.png')
#     y.append(val_path_fake_aug+i+'.mask.png')
#   else:
#     X2.append('augmentaions/'+'val'+'/fake/'+i+'.png')

# for i in (list({i.split('.')[0] for i in os.listdir(val_path_pr_aug)})):
#     X.append(val_path_pr_aug+i+'.png')
#     y.append('default.mask.png')

# val_df['X1']  =  X1
# val_df['X2']  =  X2
# val_df['y']  =  y
# val_df = shuffle(val_df)
# val_df.reset_index(inplace=True, drop=True)

# return train_df,test_df,val_df
return train_df,test_df
```

In [30]:

```
#Creating final dataframes
train_df = pd.DataFrame()
test_df = pd.DataFrame()
# val_df = pd.DataFrame()
# train_df,test_df,val_df = MakeData()
train_df,test_df = MakeData()
print(train_df.shape)
print(test_df.shape)
# print(val_df.shape)
```

```
(2304, 3)
```

```
(720, 3)
```

In [31]:

```
train_df.head()
```

Out[31]:

	X1	X2	
0	augmentaions/train/fake_images/588da262d375acd...	augmentaions/train/fake_ela/588da262d375acd1ee...	augmentaions/train/f
1	augmentaions/train/fake_images/daa767cd9cc041a...	augmentaions/train/fake_ela/daa767cd9cc041a3b7...	augmentaions/train/f
2	augmentaions/train/fake_images/1990a2ed067b8c5...	augmentaions/train/fake_ela/1990a2ed067b8c537d...	augmentaions/train/f
3	augmentaions/train/fake_images/b9db78fd385d12b...	augmentaions/train/fake_ela/b9db78fd385d12b4ff...	augmentaions/train/f
4	augmentaions/train/fake_images/b46af5d99d6fd9a...	augmentaions/train/fake_ela/b46af5d99d6fd9a7f8...	augmentaions/train/f

In [32]:

```
test_df.head()
```

Out[32]:

	X1	X2	
0	augmentaions/test/fake_images/bb7ed6b43f565a1f...	augmentaions/test/fake_ela/bb7ed6b43f565a1fe2e...	augmentaions/test/fal
1	augmentaions/test/fake_images/b1fb2e2690c484ef...	augmentaions/test/fake_ela/b1fb2e2690c484ef7b0...	augmentaions/test/fal
2	augmentaions/test/fake_images/b3c8de573cfb53d7...	augmentaions/test/fake_ela/b3c8de573cfb53d7c52...	augmentaions/test/fal
3	augmentaions/test/fake_images/c3cd547094fa52e6...	augmentaions/test/fake_ela/c3cd547094fa52e65a2...	augmentaions/test/fal
4	augmentaions/test/fake_images/cabf04859faf2895...	augmentaions/test/fake_ela/cabf04859faf2895703...	augmentaions/test/fal

Training model

In [35]:

```
X_train1 = []
for filename in tqdm.tqdm(train_df['X1'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,3))
  X_train1.append(temp)
gc.collect()
X_train1 = np.array(X_train1)

X_train2 = []
for filename in tqdm.tqdm(train_df['X2'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,3))
  X_train2.append(temp)
gc.collect()
X_train2 = np.array(X_train2)

Y_train = []
for filename in tqdm.tqdm(train_df['y'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,1))
  Y_train.append(temp)
gc.collect()
Y_train = np.array(Y_train)

X_val1 = []
for filename in tqdm.tqdm(test_df['X1'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,3))
  X_val1.append(temp)
gc.collect()
X_val1 = np.array(X_val1)

X_val2 = []
for filename in tqdm.tqdm(test_df['X2'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,3))
```

```
  X_val2.append(temp)
gc.collect()
X_val2 = np.array(X_val2)

Y_val = []
for filename in tqdm.tqdm(test_df['y'].values, position=0, leave=True):
  temp = resize(imread(filename),(256,256,1))
  Y_val.append(temp)
gc.collect()
Y_val = np.array(Y_val)
```

```
100%|██████████| 2304/2304 [00:40<00:00, 57.35it/s]
100%|██████████| 2304/2304 [17:19<00:00,  2.22it/s]
100%|██████████| 2304/2304 [00:11<00:00, 199.31it/s]
100%|██████████| 720/720 [00:11<00:00, 60.96it/s]
100%|██████████| 720/720 [03:48<00:00,  3.15it/s]
100%|██████████| 720/720 [00:03<00:00, 213.42it/s]
```

In [36]:

```
save('/content/X_train1.npy',X_train1)
save('/content/X_train2.npy',X_train2)
save('/content/X_val1.npy',X_val1)
save('/content/X_val2.npy',X_val2)
save('/content/Y_train.npy',Y_train)
save('/content/Y_val.npy',Y_val)
```

In [ ]:

```
X_train1 = load('/content/X_train1.npy')
X_train2 = load('/content/X_train2.npy')
X_val1 = load('/content/X_val1.npy')
X_val2 = load('/content/X_val2.npy')
Y_train = load('/content/Y_train.npy')
Y_val = load('/content/Y_val.npy')
```

Model with Resnet101 + Upsampe2D(Bilinear interpolation) with images and ELA filter with augmentation

In [ ]:

```
path_img = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_img._name = 'path_1'
out1 = Conv2D(3,(1,1), activation='sigmoid')(path_img.output)
layer1 = UpSampling2D(interpolation="bilinear")(out1)

path_filter = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_filter._name = 'path_2'
out2 = Conv2D(3,(1,1), activation='sigmoid')(path_filter.output)
layer3 = UpSampling2D(interpolation="bilinear")(out2)
```

In [ ]:

```
for layer in path_img.layers:
    layer._name = layer.name + str("_img")
```

In [ ]:

```
combined = concatenate([layer1, layer3])
layer5 = Conv2D(3,(1,1),strides=(2, 2), activation='sigmoid')(combined)
final = Conv2D(1,(1,1),activation='sigmoid')(layer5)
model1 = Model(inputs=[path_img.input,path_filter.input], outputs=[final])
```

In [ ]:

```
metrics = [metric]
log_dir = "logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = TensorBoard(log_dir=log_dir, histogram_freq=1)
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=3)
```

```
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=5)
reduce_lr = ReduceLROnPlateau(monitor = 'val_loss', factor = 0.3, patience = 1, verbose = 1, min_de
lta = 0.0001)
model1.compile(tf.keras.optimizers.Adam(0.0001), 'binary_crossentropy',metrics)
```

In [ ]:

```
model1.fit([X_train1,X_train2], [Y_train],validation_data=([X_val1,X_val2], [Y_val]),epochs=18, bat
ch_size=1,callbacks=[reduce_lr,early_stop,tensorboard_callback],verbose=1)
```

```
Epoch 1/18
   2/2304 [..............................] - ETA: 44:43 - loss: 0.6866 - metric:
0.6508WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time
(batch time: 0.1203s vs `on_train_batch_end` time: 2.2113s). Check your callbacks.
2304/2304 [==============================] - 244s 106ms/step - loss: 0.4825 - metric: 0.7590 - val
_loss: 0.3557 - val_metric: 0.8309
Epoch 2/18
2304/2304 [==============================] - 237s 103ms/step - loss: 0.3276 - metric: 0.8527 - val
_loss: 0.2679 - val_metric: 0.8868
Epoch 3/18
2304/2304 [==============================] - 238s 103ms/step - loss: 0.2803 - metric: 0.8900 - val
_loss: 0.2355 - val_metric: 0.9119
Epoch 4/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2643 - metric: 0.9079 - val
_loss: 0.2229 - val_metric: 0.9243
Epoch 5/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2596 - metric: 0.9165 - val
_loss: 0.2187 - val_metric: 0.9295
Epoch 6/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2582 - metric: 0.9198 - val
_loss: 0.2166 - val_metric: 0.9323
Epoch 7/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2574 - metric: 0.9219 - val
_loss: 0.2158 - val_metric: 0.9332
Epoch 8/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2565 - metric: 0.9226 - val
_loss: 0.2155 - val_metric: 0.9335
Epoch 9/18
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2554 - metric: 0.9232 - val
_loss: 0.2153 - val_metric: 0.9334
Epoch 10/18
2304/2304 [==============================] - ETA: 0s - loss: 0.2542 - metric: 0.9234
Epoch 00010: ReduceLROnPlateau reducing learning rate to 2.9999999242136255e-05.
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2542 - metric: 0.9234 - val
_loss: 0.2161 - val_metric: 0.9339
Epoch 11/18
2304/2304 [==============================] - ETA: 0s - loss: 0.2524 - metric: 0.9237
Epoch 00011: ReduceLROnPlateau reducing learning rate to 8.999999772640877e-06.
2304/2304 [==============================] - 238s 103ms/step - loss: 0.2524 - metric: 0.9237 - val
_loss: 0.2153 - val_metric: 0.9345
Epoch 12/18
2304/2304 [==============================] - 237s 103ms/step - loss: 0.2515 - metric: 0.9238 - val
_loss: 0.2150 - val_metric: 0.9349
Epoch 13/18
2304/2304 [==============================] - ETA: 0s - loss: 0.2511 - metric: 0.9238
Epoch 00013: ReduceLROnPlateau reducing learning rate to 2.6999998226528985e-06.
2304/2304 [==============================] - 238s 103ms/step - loss: 0.2511 - metric: 0.9238 - val
_loss: 0.2151 - val_metric: 0.9347
Epoch 14/18
2304/2304 [==============================] - ETA: 0s - loss: 0.2508 - metric: 0.9239
Epoch 00014: ReduceLROnPlateau reducing learning rate to 8.099999604382901e-07.
2304/2304 [==============================] - 238s 103ms/step - loss: 0.2508 - metric: 0.9239 - val
_loss: 0.2150 - val_metric: 0.9349
Epoch 15/18
2304/2304 [==============================] - ETA: 0s - loss: 0.2507 - metric: 0.9239
Epoch 00015: ReduceLROnPlateau reducing learning rate to 2.4299998813148704e-07.
2304/2304 [==============================] - 239s 104ms/step - loss: 0.2507 - metric: 0.9239 - val
_loss: 0.2150 - val_metric: 0.9349
```

Out[ ]:

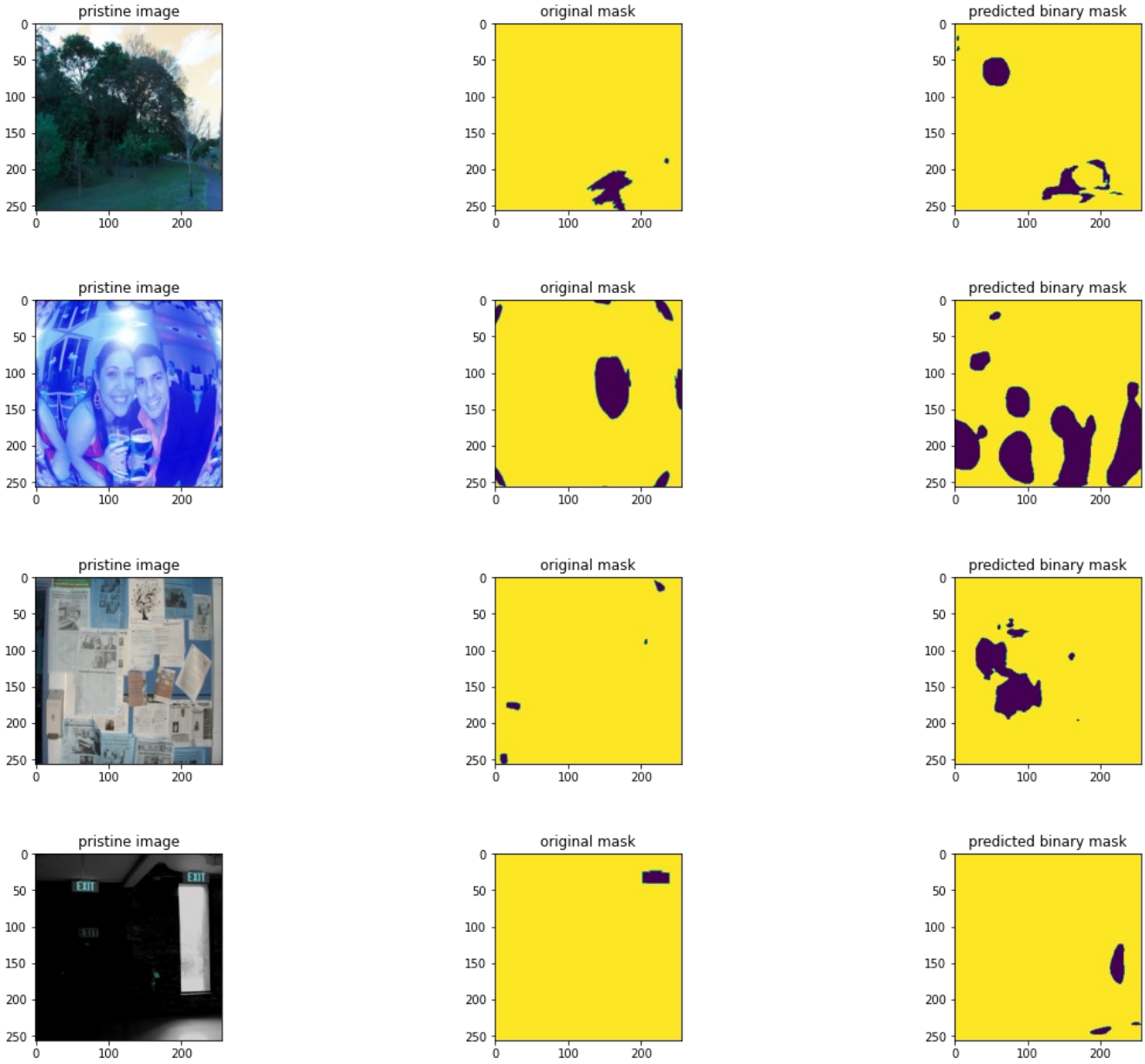
```
<tensorflow.python.keras.callbacks.History at 0x7fb3d6694748>
```

In [ ]:

```
predicted = model2.predict([X_val1,X_val2])
```

In [ ]:

```
plot_predicted_images(67)
plot_predicted_images(18)
plot_predicted_images(164)
plot_predicted_images(298)
```



Conclusion

- The model performs well in terms of reducing noise but for accurate mask prediction it needs a little improvement

Using Add layer instead of concat with Resnet101 with ELA and Augmentation

In [ ]:

```
path_img = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_img._name = 'path_1'
out1 = Conv2D(3,(1,1), activation='sigmoid')(path_img.output)
layer1 = Dropout(0.2)(out1)

path_filter = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_filter._name = 'path_2'
out2 = Conv2D(3,(1,1), activation='sigmoid')(path_filter.output)
```

```
layer2 = Dropout(0.2)(out2)
```

```
Downloading data from
https://github.com/qubvel/classification_models/releases/download/0.0.1/resnet101_imagenet_1000_no_
h5
171171840/171164896 [==============================] - 5s 0us/step
```

In [ ]:

```
for layer in path_img.layers:
    layer._name = layer.name + str("_img2")
```

In [ ]:

```
combined = Add()([layer1, layer2])
# layer3 = Dropout(0.3)(combined)
final = Conv2D(1,(1,1),activation='sigmoid')(combined)
model2 = Model(inputs=[path_img.input,path_filter.input], outputs=[final])
```

In [ ]:

```
!rm -rf 'logs_mask2/fit/'
```

In [ ]:

```
metrics = [metric]
log_dir = "logs_mask2/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = TensorBoard(log_dir=log_dir, histogram_freq=1)
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=3)
reduce_lr = ReduceLROnPlateau(monitor = 'val_loss', factor = 0.3, patience = 1, verbose = 1, min_de
lta = 0.0001)
model2.compile(tf.keras.optimizers.Adam(0.0001), 'binary_crossentropy',metrics)
```

In [ ]:

```
model2.fit([X_train1,X_train2], [Y_train],validation_data=([X_val1,X_val2], [Y_val]),epochs=15, bat
ch_size=1,callbacks=[reduce_lr,early_stop,tensorboard_callback],verbose=1)
```

```
Epoch 1/15
   1/2880 [..............................] - ETA: 0s - loss: 1.0607 - metric:
0.4735WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/ops/summary_ops_v2.py:1277: stop (from
tensorflow.python.eager.profiler) is deprecated and will be removed after 2020-07-01.
Instructions for updating:
use `tf.profiler.experimental.stop` instead.
   2/2880 [..............................] - ETA: 21:14 - loss: 1.1141 - metric:
0.4828WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time
(batch time: 0.1853s vs `on_train_batch_end` time: 0.6991s). Check your callbacks.
2880/2880 [==============================] - 492s 171ms/step - loss: 0.6437 - metric: 0.6910 - val
_loss: 0.3978 - val_metric: 0.8074
Epoch 2/15
2880/2880 [==============================] - 488s 169ms/step - loss: 0.3536 - metric: 0.8479 - val
_loss: 0.2774 - val_metric: 0.8914
Epoch 3/15
2877/2880 [==============================>.] - ETA: 0s - loss: 0.2896 - metric: 0.8966
```

In [ ]:

```
!rm -rf 'saved_mask2_model'
```

In [ ]:

```
!mkdir -p saved_mask2_model
model2.save('saved_mask2_model/my_model2')
# model2.save('my_model2.h5')
```

```
INFO:tensorflow:Assets written to: saved_mask2_model/my_model2/assets
```

In [ ]:

```
!zip -r /content/mask2.zip /content/saved_mask2_model
```

```
  adding: content/saved_mask2_model/ (stored 0%)
  adding: content/saved_mask2_model/my_model2/ (stored 0%)
  adding: content/saved_mask2_model/my_model2/saved_model.pb (deflated 93%)
  adding: content/saved_mask2_model/my_model2/variables/ (stored 0%)
  adding: content/saved_mask2_model/my_model2/variables/variables.data-00000-of-00001 (deflated
14%)
  adding: content/saved_mask2_model/my_model2/variables/variables.index (deflated 83%)
  adding: content/saved_mask2_model/my_model2/assets/ (stored 0%)
```

In [ ]:

```
model2 = tf.keras.models.load_model('saved_model/my_model2')
```

In [ ]:

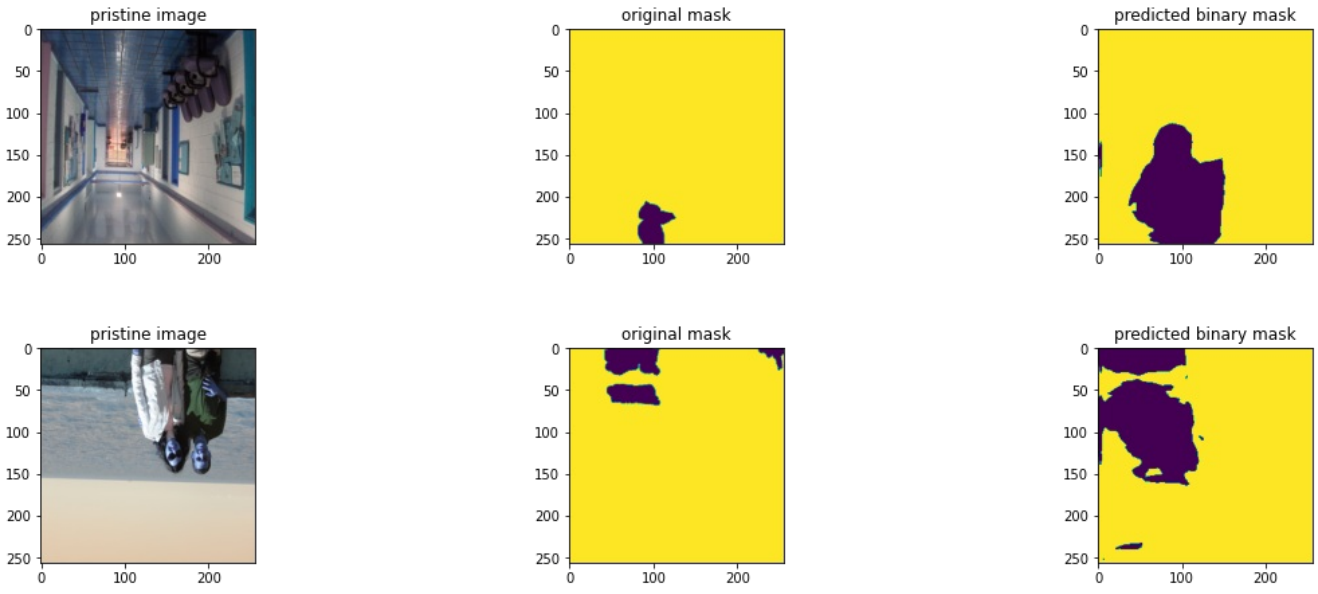
```
# del predicted
predicted2 = model2.predict([X_val1,X_val2])
```

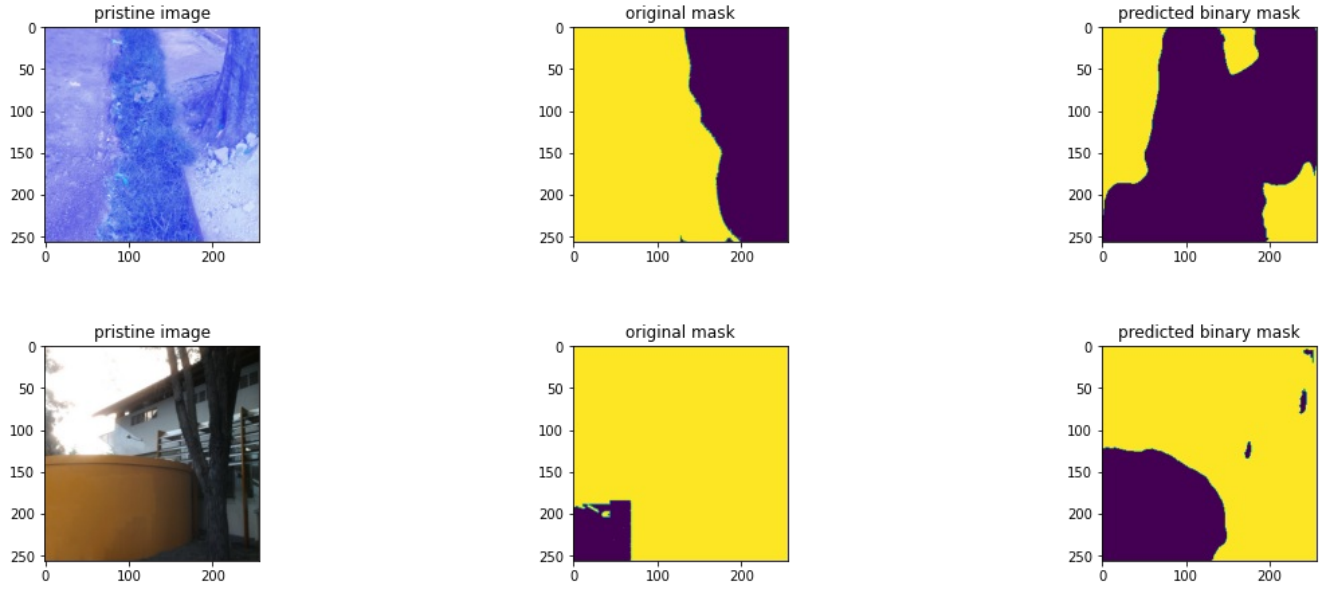
In [ ]:

```
def plot_predicted_images(index):

    pred = np.squeeze(predicted2[index])
    plt.imsave('pred_mask.png',pred)
    im_gray = cv2.imread('pred_mask.png', cv2.IMREAD_GRAYSCALE)
    (thresh, im_bw) = cv2.threshold(im_gray, 220, 255, cv2.THRESH_BINARY | cv2.THRESH_OTSU)
    fig = plt.figure(figsize=(20,10))
    ax1 = fig.add_subplot(331)
    ax2 = fig.add_subplot(332)
    ax3 = fig.add_subplot(333)

    ax1.set_title("pristine image")
    ax2.set_title("original mask")
    ax3.set_title("predicted binary mask")
    ax1.imshow(X_val1[index])
    ax2.imshow(np.squeeze(Y_val[index]))
    ax3.imshow(im_bw)
```

In [ ]:

```
plot_predicted_images(39)
plot_predicted_images(140)
plot_predicted_images(210)
plot_predicted_images(423)
```





Resnet101 with fake images and ELA with Augmentation

In [37]:

```
path_img = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_img._name = 'path_1'
out1 = Conv2D(3,(1,1), activation='sigmoid')(path_img.output)

path_filter = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',classes=3,input_shape=(256,256,3),decoder_use_batchnorm=True)
path_filter._name = 'path_2'
out2 = Conv2D(3,(1,1), activation='sigmoid')(path_filter.output)
```

```
Downloading data from
https://github.com/qubvel/classification_models/releases/download/0.0.1/resnet50_imagenet_1000_no_t
5
94593024/94592056 [==============================] - 1s 0us/step
```

In [38]:

```
for layer in path_img.layers:
    layer._name = layer.name + str("_img")
```

In [39]:

```
combined = concatenate([out1, out2])
# layer5 = Dropout(0.2)(combined)

final = Conv2D(1,(1,1),activation='sigmoid')(combined)
model3 = Model(inputs=[path_img.input,path_filter.input], outputs=[final])
```

In [49]:

```
!rm -rf 'logs_mask3/fit/'
```

In [ ]:

```
!rm -rf '/content/saved_mask_model' '/content/mask.zip'
```

In [40]:

```
metrics = [metric]
log_dir = "logs_mask3/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = TensorBoard(log_dir=log_dir, histogram_freq=1)
```

```
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=3)
reduce_lr = ReduceLROnPlateau(monitor = 'val_loss', factor = 0.22, patience = 1, verbose = 1, min_d
elta = 0.0001)
model3.compile(tf.keras.optimizers.Adam(0.0001), 'binary_crossentropy',metrics)
```

In [41]:

```
model3.fit([X_train1,X_train2], [Y_train],validation_data=([X_val1,X_val2], [Y_val]),epochs=10, bat
ch_size=1,callbacks=[reduce_lr,early_stop,tensorboard_callback],verbose=1)
```

```
Epoch 1/10
   1/2304 [..............................] - ETA: 0s - loss: 0.4506 - metric:
0.8126WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/ops/summary_ops_v2.py:1277: stop (from
tensorflow.python.eager.profiler) is deprecated and will be removed after 2020-07-01.
Instructions for updating:
use `tf.profiler.experimental.stop` instead.
   2/2304 [..............................] - ETA: 8:48 - loss: 0.4420 - metric:
0.8160WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time
(batch time: 0.0780s vs `on_train_batch_end` time: 0.3799s). Check your callbacks.
2304/2304 [==============================] - ETA: 0s - loss: 0.2507 - metric:
0.9230WARNING:tensorflow:Callbacks method `on_test_batch_end` is slow compared to the batch time (
batch time: 0.0113s vs `on_test_batch_end` time: 0.0184s). Check your callbacks.
2304/2304 [==============================] - 234s 102ms/step - loss: 0.2507 - metric: 0.9230 - val
_loss: 0.2400 - val_metric: 0.9311
Epoch 2/10
2304/2304 [==============================] - ETA: 0s - loss: 0.2472 - metric: 0.9290
Epoch 00002: ReduceLROnPlateau reducing learning rate to 0.00022000001044943928.
2304/2304 [==============================] - 231s 100ms/step - loss: 0.2472 - metric: 0.9290 - val
_loss: 0.2403 - val_metric: 0.9294
Epoch 3/10
2304/2304 [==============================] - 231s 100ms/step - loss: 0.2464 - metric: 0.9279 - val
_loss: 0.2398 - val_metric: 0.9312
Epoch 4/10
2304/2304 [==============================] - 231s 100ms/step - loss: 0.2458 - metric: 0.9290 - val
_loss: 0.2391 - val_metric: 0.9303
Epoch 5/10
2304/2304 [==============================] - ETA: 0s - loss: 0.2452 - metric: 0.9292
Epoch 00005: ReduceLROnPlateau reducing learning rate to 4.840000357944518e-05.
2304/2304 [==============================] - 231s 100ms/step - loss: 0.2452 - metric: 0.9292 - val
_loss: 0.2396 - val_metric: 0.9309
Epoch 6/10
2304/2304 [==============================] - ETA: 0s - loss: 0.2441 - metric: 0.9284
Epoch 00006: ReduceLROnPlateau reducing learning rate to 1.064800104359165e-05.
2304/2304 [==============================] - 230s 100ms/step - loss: 0.2441 - metric: 0.9284 - val
_loss: 0.2392 - val_metric: 0.9303
Epoch 7/10
2304/2304 [==============================] - ETA: 0s - loss: 0.2432 - metric: 0.9293
Epoch 00007: ReduceLROnPlateau reducing learning rate to 2.342560237593716e-06.
2304/2304 [==============================] - 230s 100ms/step - loss: 0.2432 - metric: 0.9293 - val
_loss: 0.2395 - val_metric: 0.9299
```

Out[41]:

```
<tensorflow.python.keras.callbacks.History at 0x7fb7bcbfca20>
```

In [ ]:

```
!rm -rf 'saved_mask3_model'
```

In [42]:

```
!mkdir -p saved_mask3_model_res50
model3.save('saved_mask3_model_res50/my_model3_res50')
# model3.save('my_model3.h5')
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/training/tracking/tracking.py:111: Model.state_updates (from
tensorflow.python.keras.engine.training) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/training/tracking/tracking.py:111: Layer.updates (from
```

```
tensorflow.python.keras.engine.base_layer) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
INFO:tensorflow:Assets written to: saved_mask3_model_res50/my_model3_res50/assets
```

In [ ]:

```
!zip -r /content/mask3.zip /content/saved_mask3_model
```

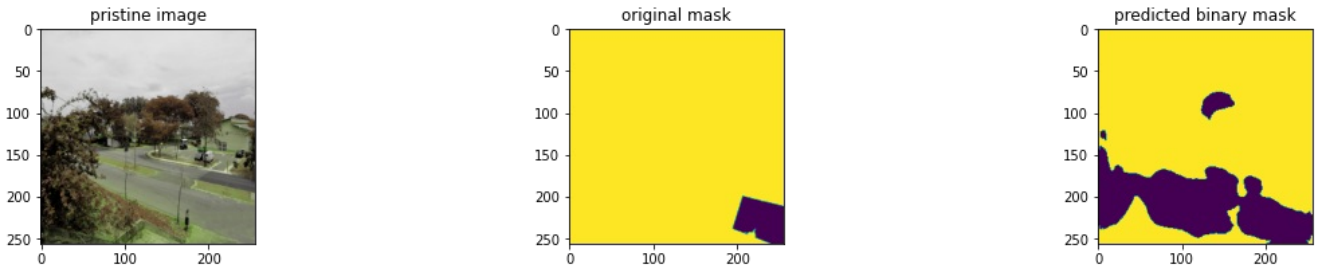
```
  adding: content/saved_mask3_model/ (stored 0%)
  adding: content/saved_mask3_model/my_model3/ (stored 0%)
  adding: content/saved_mask3_model/my_model3/saved_model.pb (deflated 93%)
  adding: content/saved_mask3_model/my_model3/variables/ (stored 0%)
  adding: content/saved_mask3_model/my_model3/variables/variables.data-00000-of-00001 (deflated
16%)
  adding: content/saved_mask3_model/my_model3/variables/variables.index (deflated 83%)
  adding: content/saved_mask3_model/my_model3/assets/ (stored 0%)
```

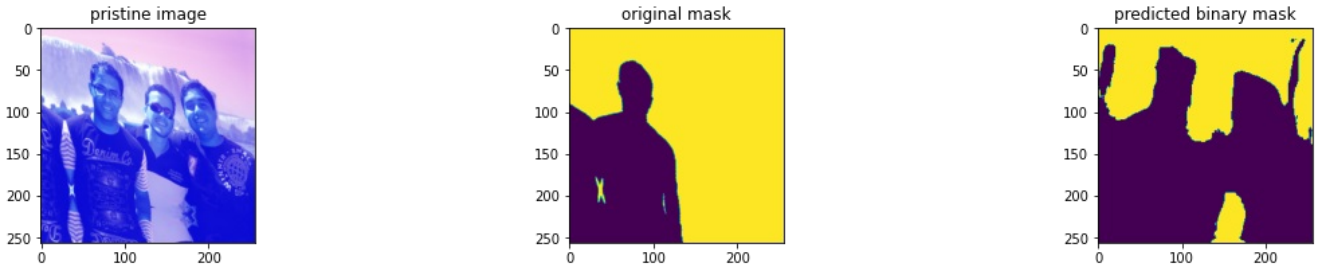
In [43]:

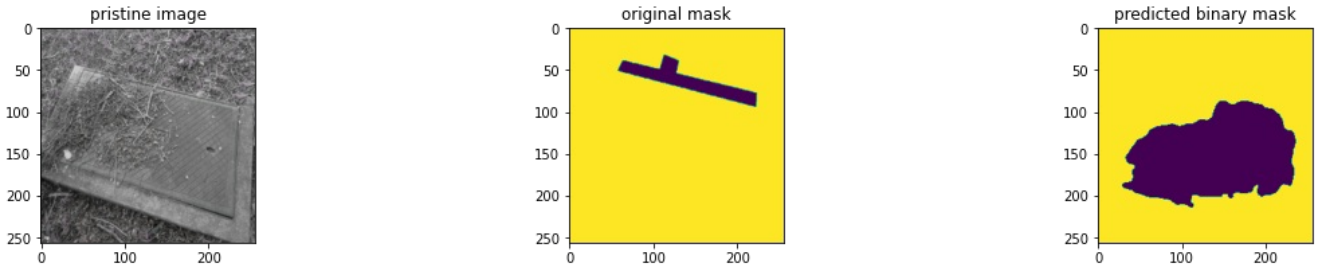
```
# del predicted
predicted = model3.predict([X_val1,X_val2])
```

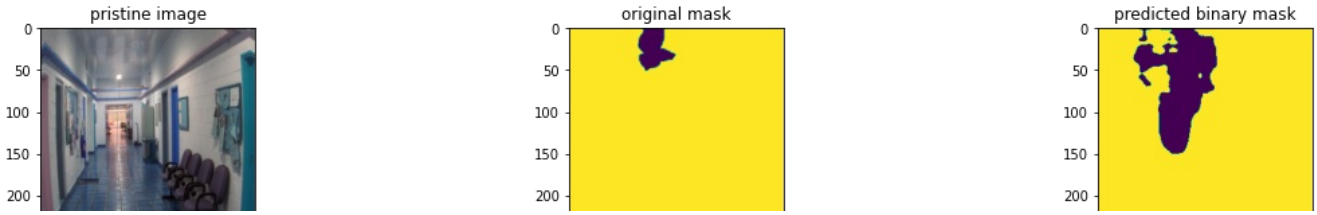
In [ ]:

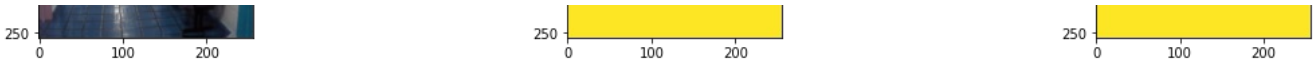
```
plot_predicted_images(30)
plot_predicted_images(24)
plot_predicted_images(178)
plot_predicted_images(262)
```











ResNet101 Model trained with fake images and their ELA with regularisation and Augmentation

In [ ]:

```
path_img = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',input_shape=(256,256,3))
path_img._name = 'path_1'
out1 = Conv2D(3,(1,1), activation='sigmoid')(path_img.output)
# layer1 = MaxPool2D(pool_size=(2,2))(out1)
layer2 = Dropout(0.2)(out1)

path_filter = Unet(backbone_name='resnet101', encoder_weights='imagenet',
activation='sigmoid',input_shape=(256,256,3))
path_filter._name = 'path_2'
out2 = Conv2D(3,(1,1), activation='sigmoid')(path_filter.output)
# layer3 = MaxPool2D(pool_size=(2,2))(out2)
layer4 = Dropout(0.2)(out2)
```

In [ ]:

```
for layer in path_img.layers:
    layer._name = layer.name + str("_img")
```

In [ ]:

```
combined = concatenate([layer2, layer4])
layer5 = Dropout(0.4)(combined)
# layer6 = UpSampling2D()(layer5)
final = Conv2D(1,(1,1),activation='sigmoid')(layer5)
model2 = Model(inputs=[path_img.input,path_filter.input], outputs=[final])
```

In [ ]:

```
!rm -rf 'logs_mask2/fit'
```

In [ ]:

```
metrics = [metric]
log_dir = "logs_mask2/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = TensorBoard(log_dir=log_dir, histogram_freq=1)
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=3)
reduce_lr = ReduceLROnPlateau(monitor = 'val_loss', factor = 0.3, patience = 1, verbose = 1, min_de
lta = 0.0001)
model2.compile(tf.keras.optimizers.Adam(0.0001), 'binary_crossentropy',metrics)
```

In [ ]:

```
model2.fit([X_train1,X_train2], [Y_train],validation_data=([X_val1,X_val2], [Y_val]),epochs=15, bat
ch_size=1,callbacks=[reduce_lr,early_stop,tensorboard_callback],verbose=1)
```

```
Epoch 1/15
   2/2304 [..............................] - ETA: 42:01 - loss: 1.5062 - metric:
0.4188WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time
(batch time: 0.1437s vs `on_train_batch_end` time: 2.0469s). Check your callbacks.
2304/2304 [==============================] - ETA: 0s - loss: 1.0694 - metric:
0.5346WARNING:tensorflow:Callbacks method `on_test_batch_end` is slow compared to the batch time (
batch time: 0.0185s vs `on_test_batch_end` time: 0.0328s). Check your callbacks.
2304/2304 [==============================] - 378s 164ms/step - loss: 1.0694 - metric: 0.5346 - val
_loss: 0.7095 - val_metric: 0.6453
Epoch 2/15
2304/2304 [==============================] - 372s 162ms/step - loss: 0.6182 - metric: 0.7171 - val
_loss: 0.4086 - val_metric: 0.8004
Epoch 3/15
2304/2304 [==============================] - 372s 161ms/step - loss: 0.4250 - metric: 0.8178 - val
_loss: 0.2806 - val_metric: 0.8784
Epoch 4/15
```

```
2304/2304 [==============================] - 372s 161ms/step - loss: 0.3469 - metric: 0.8654 - val
_loss: 0.2394 - val_metric: 0.9097
Epoch 5/15
2304/2304 [==============================] - 372s 161ms/step - loss: 0.3124 - metric: 0.8895 - val
_loss: 0.2259 - val_metric: 0.9229
Epoch 6/15
2304/2304 [==============================] - 372s 161ms/step - loss: 0.2936 - metric: 0.9030 - val
_loss: 0.2202 - val_metric: 0.9302
Epoch 7/15
2304/2304 [==============================] - 372s 161ms/step - loss: 0.2818 - metric: 0.9104 - val
_loss: 0.2186 - val_metric: 0.9328
Epoch 8/15
2304/2304 [==============================] - 372s 161ms/step - loss: 0.2744 - metric: 0.9163 - val
_loss: 0.2179 - val_metric: 0.9347
Epoch 9/15
2304/2304 [==============================] - 372s 162ms/step - loss: 0.2690 - metric: 0.9197 - val
_loss: 0.2169 - val_metric: 0.9366
Epoch 10/15
2304/2304 [==============================] - 372s 162ms/step - loss: 0.2647 - metric: 0.9215 - val
_loss: 0.2167 - val_metric: 0.9365
Epoch 11/15
2304/2304 [==============================] - ETA: 0s - loss: 0.2608 - metric: 0.9228
Epoch 00011: ReduceLROnPlateau reducing learning rate to 2.9999999242136255e-05.
2304/2304 [==============================] - 372s 161ms/step - loss: 0.2608 - metric: 0.9228 - val
_loss: 0.2166 - val_metric: 0.9376
Epoch 12/15
2304/2304 [==============================] - ETA: 0s - loss: 0.2576 - metric: 0.9237
Epoch 00012: ReduceLROnPlateau reducing learning rate to 8.999999772640877e-06.
2304/2304 [==============================] - 372s 162ms/step - loss: 0.2576 - metric: 0.9237 - val
_loss: 0.2170 - val_metric: 0.9378
Epoch 13/15
2304/2304 [==============================] - ETA: 0s - loss: 0.2561 - metric: 0.9241
Epoch 00013: ReduceLROnPlateau reducing learning rate to 2.6999998226528985e-06.
2304/2304 [==============================] - 372s 162ms/step - loss: 0.2561 - metric: 0.9241 - val
_loss: 0.2167 - val_metric: 0.9384
Epoch 14/15
2304/2304 [==============================] - ETA: 0s - loss: 0.2557 - metric: 0.9242
Epoch 00014: ReduceLROnPlateau reducing learning rate to 8.099999604382901e-07.
2304/2304 [==============================] - 373s 162ms/step - loss: 0.2557 - metric: 0.9242 - val
_loss: 0.2166 - val_metric: 0.9384
Epoch 15/15
2304/2304 [==============================] - ETA: 0s - loss: 0.2556 - metric: 0.9243
Epoch 00015: ReduceLROnPlateau reducing learning rate to 2.4299998813148704e-07.
2304/2304 [==============================] - 373s 162ms/step - loss: 0.2556 - metric: 0.9243 - val
_loss: 0.2167 - val_metric: 0.9381
```

Out[ ]:

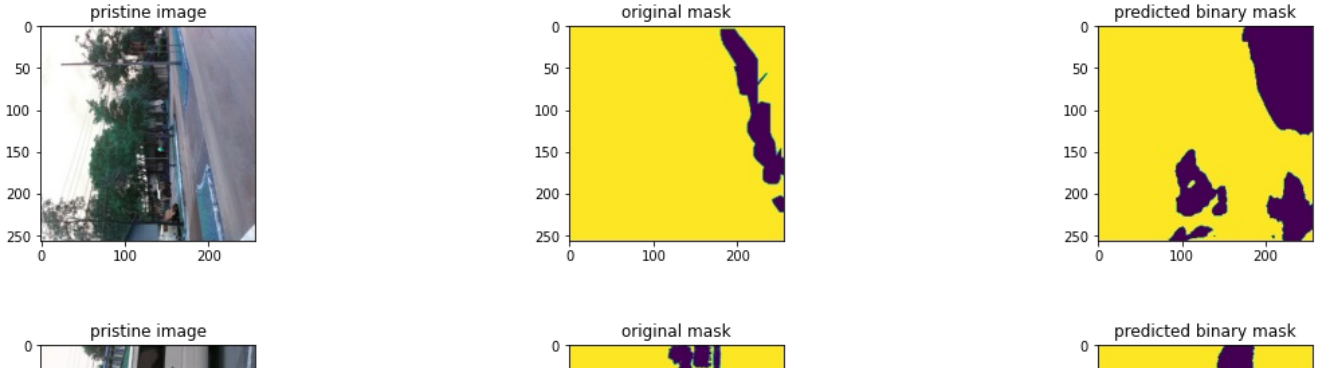
```
<tensorflow.python.keras.callbacks.History at 0x7f571ca8be80>
```

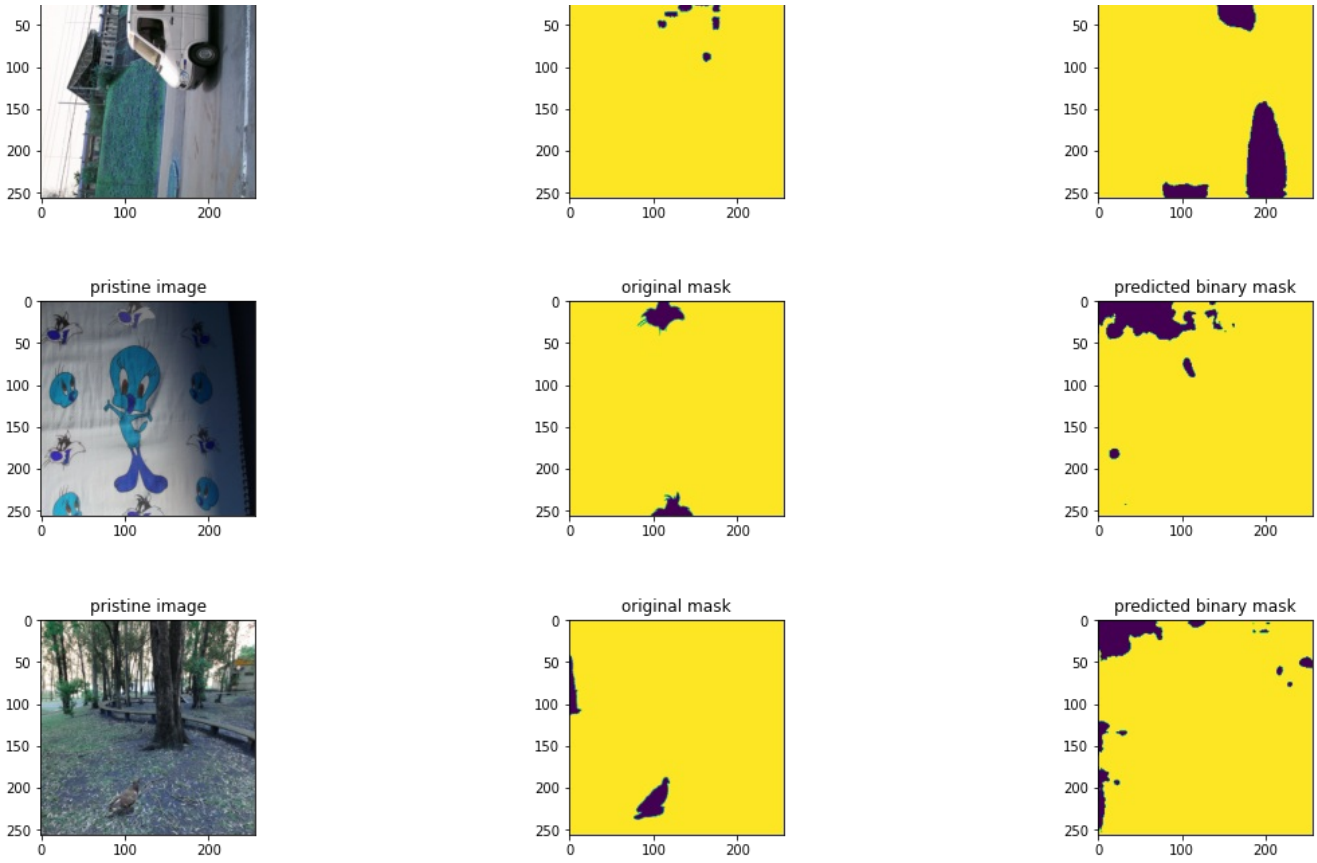
In [ ]:

```
predicted = model2.predict([X_val1,X_val2])
```

In [ ]:

```
plot_predicted_images(27)
plot_predicted_images(110)
plot_predicted_images(200)
plot_predicted_images(274)
```





Results without ELA, Only with single image input with Augmentation

In [ ]:

```
inputs = Input(shape=(512,512,3))
outputs = Unet(backbone_name='resnet34', encoder_weights='imagenet',classes=1,
activation='sigmoid',input_shape=(512,512,3),encoder_freeze = True)(inputs)
model = Model(inputs,outputs)
```

In [ ]:

```
metrics = [tfa.metrics.F1Score(num_classes=1,average="micro",threshold=0.5)]
model.compile(tf.keras.optimizers.Adam(0.0001), 'binary_crossentropy',metrics)
```

In [ ]:

```
model.fit(train_data_generated,steps_per_epoch=64,epochs=5,validation_data=val_data_generated,valid
ation_steps=64)
```

```
Epoch 1/5
64/64 [==============================] - 25s 396ms/step - loss: 0.4049 - f1_score: 0.9449 - val_lo
ss: 0.3960 - val_f1_score: 0.9646
Epoch 2/5
64/64 [==============================] - 24s 382ms/step - loss: 0.2825 - f1_score: 0.9704 - val_lo
ss: 0.3905 - val_f1_score: 0.9653
Epoch 3/5
64/64 [==============================] - 24s 379ms/step - loss: 0.2746 - f1_score: 0.9615 - val_lo
ss: 0.3315 - val_f1_score: 0.9653
Epoch 4/5
64/64 [==============================] - 24s 379ms/step - loss: 0.2535 - f1_score: 0.9630 - val_lo
ss: 0.3042 - val_f1_score: 0.9653
Epoch 5/5
64/64 [==============================] - 25s 383ms/step - loss: 0.2325 - f1_score: 0.9646 - val_lo
ss: 0.2773 - val_f1_score: 0.9653
```

Out[ ]:

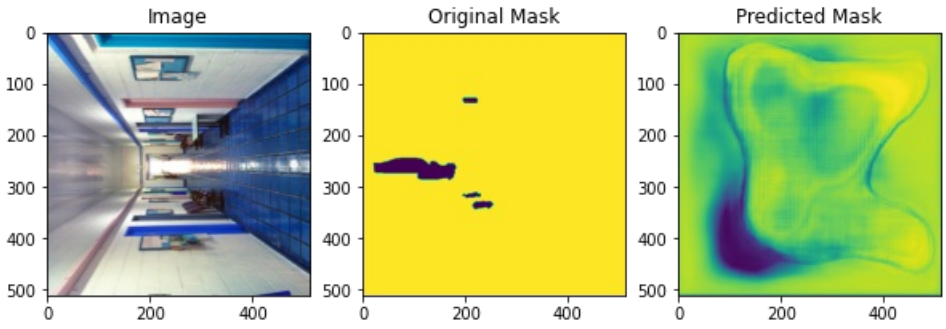
```
<tensorflow.python.keras.callbacks.History at 0x7f8d0462e128>
```

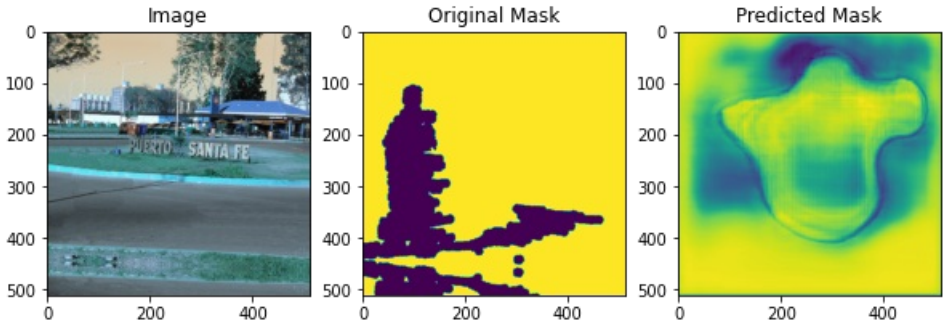
In [ ]:

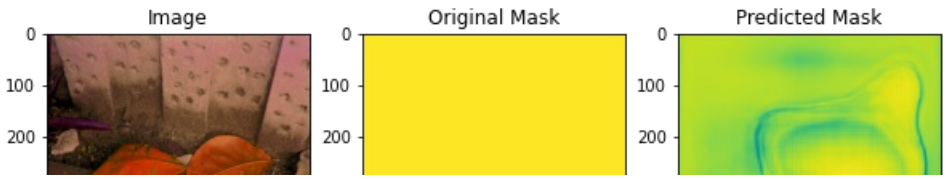
```
def print_results(split_data_df,show_images):

    samples = split_data_df.sample(n=show_images)
    input_img = []
    input_img_array = []
    mask_array = []
    GT_mask = []
    Predicted_mask = []
    for index,row in samples.iterrows():
        image = load_img(row['X'])
        image_arr = img_to_array(image)
        image_arr=np.array(image_arr).reshape(-1, 512, 512, 3)/255
        #tf_image = tf.data.Dataset.from_tensor_slices(image_arr)
        input_img_array.append(image_arr)
        mask = imread(row['y'])
        mask_arr= img_to_array(mask,dtype=np.uint8)
        mask_array.append(mask_arr/255)
        # output = model.predict(image_arr).reshape(512,512)
        pred = np.squeeze(model.predict(image_arr).reshape(512,512))
        plt.imsave('pred_mask.png',pred)
        im_gray = cv2.imread('pred_mask.png', cv2.IMREAD_GRAYSCALE)
        (thresh, im_bw) = cv2.threshold(im_gray, 220, 255, cv2.THRESH_BINARY | cv2.THRESH_OTSU)
        input_img.append(image)
        GT_mask.append(mask)
        Predicted_mask.append(pred)

    for i in range(show_images):
        fig, ax = plt.subplots(1,3,figsize=(10, 10))
        ax[0].imshow(input_img[i])
        ax[0].set_title("Image")
        ax[1].imshow(GT_mask[i])
        ax[1].set_title("Original Mask")
        ax[2].imshow(Predicted_mask[i])
        ax[2].set_title("Predicted Mask")
```

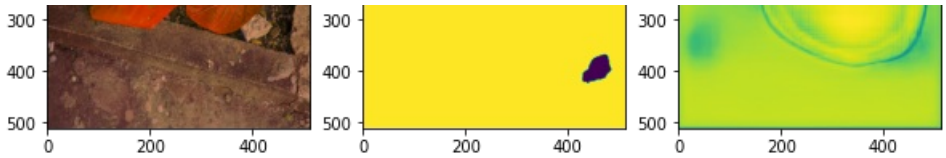
In [ ]:

```
print_results(test_df[test_df['y']!='default.mask.png'],8)
```









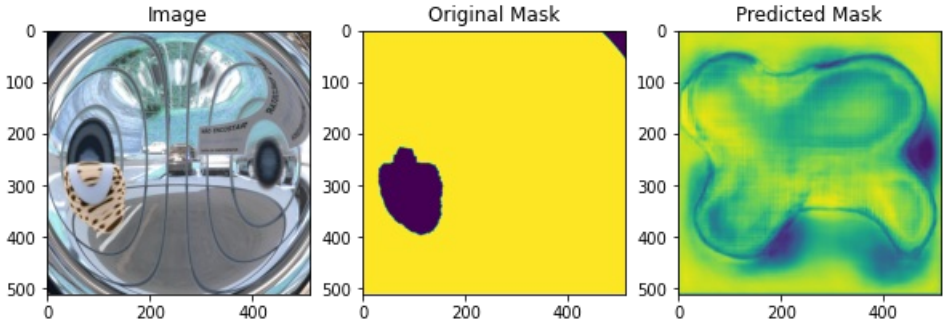


Image
Original Mask
Predicted Mask

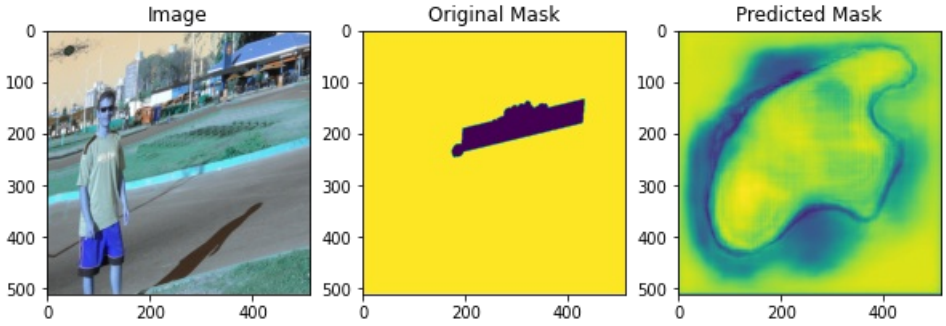


Image
Original Mask
Predicted Mask

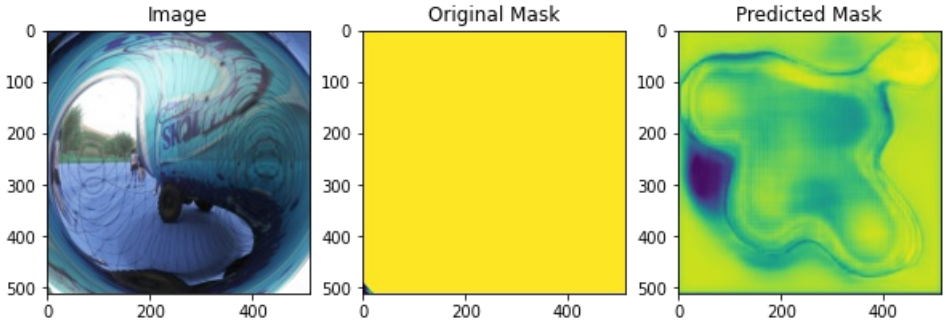


Image
Original Mask
Predicted Mask

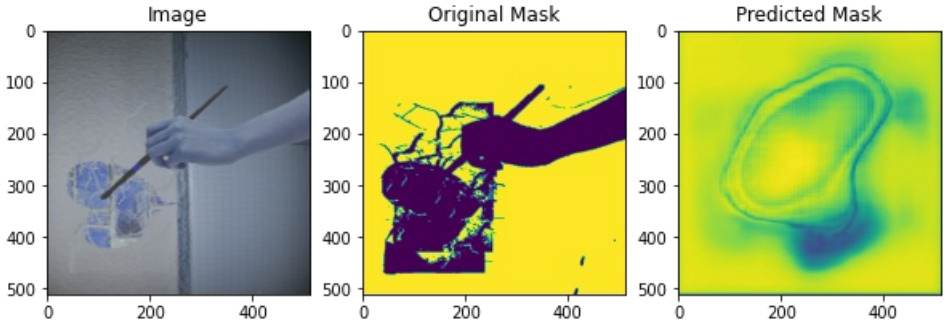


Image
Original Mask
Predicted Mask

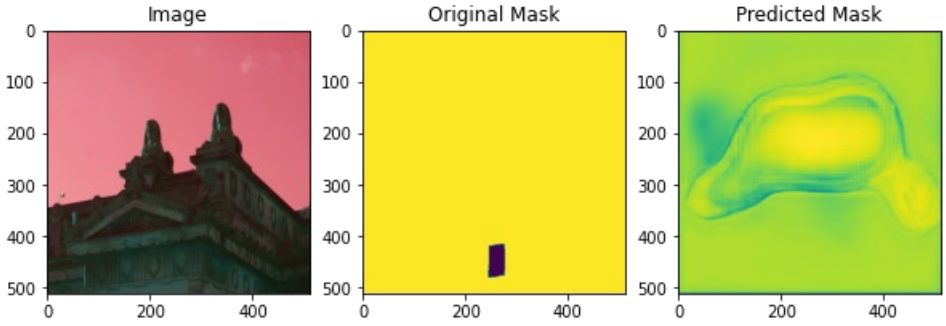


Image
Original Mask
Predicted Mask

Summary of all the models in the notebook

Classification model

In [3]:

```
x = PrettyTable()
x.field_names = ["Model and architecture used", "Result"]
x.add_row(["Sequential model with ResNet50 and imagenet weights and custom architecture, trained o
n CASIA2 and IEEE IFS-TC dataset", "Correct predictions = 1809, Incorrect predictions = 75"])
print(x)
```

```
+-------------------------------------------------------------------------------------------------
-----------------+-----------------------------------------------------------+
|                                                Model and architecture used
|                          Result                           |
+-------------------------------------------------------------------------------------------------
-----------------+-----------------------------------------------------------+
| Sequential model with ResNet50 and imagenet weights and custom architecture, trained on CASIA2 a
nd IEEE IFS-TC dataset | Correct predictions = 1809, Incorrect predictions = 75 |
+-------------------------------------------------------------------------------------------------
-----------------+-----------------------------------------------------------+
```

Mask prediction models

In [3]:

```
x = PrettyTable()
x.field_names = ["Model and architecture used", "Result"]
x.add_row(["Resnet101 with imagenet weights +Upsampling with bilinear interpolation + Gaussian Blu
r + Concat output from two streams + ELA filter + With Augmentation", "Less noise but not accurate
predictions"])
x.add_row(["Resnet101 with imagenet weights + Gaussian Blur + Add output from two streams + ELA fi
lter + With Augmentation", "Some improvement in mask prediction"])
x.add_row(["Resnet101 with imagenet weights + Gaussian Blur + Concat output from two streams + ELA
filter + With Augmentation", "Less noise and good prediction"])
x.add_row(["Resnet101 with imagenet weights + Regularisation + Gaussian Blur + Add output from two
streams + ELA filter + With Augmentation", "Similar to without regularisation but with some noise"
])
x.add_row(["Resnet34 with imagenet weights + Gaussian Blur + Single input of fake image without EL
A + With Augmentation", "A lot of noise"])
print(x)
```

```
+-------------------------------------------------------------------------------------------------
-----------------------------------------------------+-----------------------------------------
------+
|                                                                                  Model and architecture used
|                          Result                           |
+-------------------------------------------------------------------------------------------------
-----------------------------------------------------+-----------------------------------------
------+
| Resnet101 with imagenet weights +Upsampling with bilinear interpolation + Gaussian Blur + Concat
output from two streams + ELA filter + With Augmentation |        Less noise but not accurate
predictions        |
|                       Resnet101 with imagenet weights + Gaussian Blur + Add output from two strea
ms + ELA filter + With Augmentation                       |          Some improvement in mask
prediction          |
|                      Resnet101 with imagenet weights + Gaussian Blur + Concat output from two stre
ams + ELA filter + With Augmentation                      |             Less noise and good predicti
n            |
|               Resnet101 with imagenet weights + Regularisation + Gaussian Blur + Add output from t
wo streams + ELA filter + With Augmentation               | Similar to without regularisation but wi
th some noise |
|                        Resnet34 with imagenet weights + Gaussian Blur + Single input of fake imag
e without ELA + With Augmentation                         |                      A lot of noise
|
+-------------------------------------------------------------------------------------------------
-----------------------------------------------------+-----------------------------------------
------+
```