BAB VI
PENUTUP

A. Kesimpulan

Berdasarkan hasil analisis, pembahasan, dan pengujian, dapat disimpulkan bahwa sistem yang dibangun berhasil mengimplementasikan pembelajaran mesin dengan menggunakan metode *Convolutional Neural Network* (CNN) untuk mengklasifikasi jenis-jenis motif batik. Dapat disimpulkan juga bahwa dengan menggunakan arsitektur *ResNet*, hasil dari pembelajaran mesin dapat mencapai akurasi yang lebih baik dari model CNN biasa. Dengan *dataset* berukuran 1394 citra dan pembagian jumlah citra sejumlah 1112 citra untuk training dan 282 untuk validasi (80%:20%), model *Transfer Learning ResNet* dapat menghasilkan akurasi training sebesar 95.52% dan akurasi validasi sebesar 78.723%. Selain itu, sistem juga berhasil dibangun dalam bentuk aplikasi web yang dapat digunakan sebagai alat untuk melakukan klasifikasi gambar batik.

B. Saran

Beberapa saran yang dapat diberikan oleh penulis untuk penelitian dan penggunaan pembelajaran mesin selanjutnya:

1. Fitur penilaian pengguna dapat diimplementasikan pada web agar dapat membantu menunjukkan di motif mana yang memiliki jumlah kesalahan banyak sehingga peneliti dapat memanfaatkan informasi ini untuk melakukan *tuning* terhadap *dataset* maupun model.

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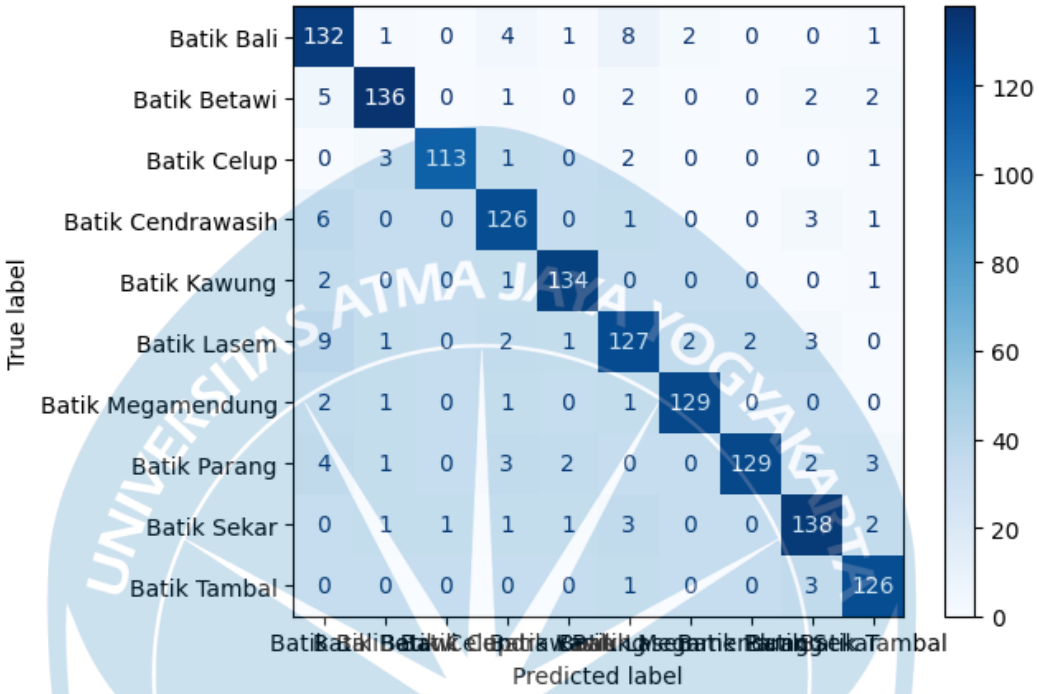
LAMPIRAN



Gambar 25 Confusion matrix model Transfer Learning

Classification Report

	precision	recall	f1-score	support
Batik Bali	0.82	0.89	0.85	149
Batik Betawi	0.94	0.92	0.93	148
Batik Celup	0.99	0.94	0.97	120
Batik Cendrawasih	0.90	0.92	0.91	137
Batik Kawung	0.96	0.97	0.97	138
Batik Lasem	0.88	0.86	0.87	147
Batik Megamendung	0.97	0.96	0.97	134
Batik Parang	0.98	0.90	0.94	144
Batik Sekar	0.91	0.94	0.93	147
Batik Tambal	0.92	0.97	0.94	130
accuracy			0.93	1394
macro avg	0.93	0.93	0.93	1394
weighted avg	0.93	0.93	0.93	1394

Tugas Akhir 190710193

Klasifikasi 10 Kelas Batik

Didesain untuk dijalankan di Google Colab

Setup Library

Install dependensi yang diperlukan seperti:

- tensorflow
- tensorflow-hub
- pillow
- split-folders

```
from google.colab import drive
drive.mount('/content/drive')
```

```
#!pip install tensorflow pillow split-folders tensorflow-hub
```

```
!pip install split-folders
```

Setup Dataset

Sumber dataset: Kaggle 1: https://www.kaggle.com/datasets/dionisiusdh/indonesian-batik-motifs

Kaggle 2: https://www.kaggle.com/datasets/alfanme/indonesian-batik-motifs-corak-app

Google

Download dataset yang telah diproses: Google Drive

```
import zipfile

# COLAB only
!cp '/content/drive/MyDrive/Dataset Tugas Akhir/dataset.zip' '/content/'

dataset_zip_path = 'dataset.zip'

zip_ref = zipfile.ZipFile(dataset_zip_path, 'r')
zip_ref.extractall('dataset')

zip_ref.close()


# # Download Dataset
# # Perlu install kaggle melalui pip untuk melakukan ini
# # Peneliti telah menggabungkan dataset dan disimpan di google drive

# !kaggle datasets download -d dionisiusdh/indonesian-batik-motifs
# !kaggle datasets download -d alfanme/indonesian-batik-motifs-corak-app

# # Extract Dataset

# import zipfile

# # Unzip
# local_zip = '/content/indonesian-batik-motifs-corak-app.zip'
# zip_ref = zipfile.ZipFile(local_zip, 'r')
# zip_ref.extractall('./Batik 1/')

# zip_ref.close()

# local_zip = '/content/indonesian-batik-motifs.zip'
# zip_ref = zipfile.ZipFile(local_zip, 'r')
# zip_ref.extractall('./Batik 2/')

# zip_ref.close()
```

Load model

```
import tensorflow as tf
import tensorflow_hub as hub
```

Pilih model

```
#@title Pilih model
model_type = "Transfer Learning" #@param ["Dense", "CNN", "Transfer Learning"]
color_dimension = 3 #@param ["1", "3"] {type:"raw"}

num_classes = 10

if model_type == "Dense":
  model = tf.keras.models.Sequential([
      # Lapisan input
      tf.keras.layers.Input(shape=(224, 224, color_dimension)),

      # 512 neuron dense layer
      tf.keras.layers.Dense(512, activation='relu'),

      tf.keras.layers.Dropout(0.2),

      tf.keras.layers.Flatten(),

      # 10 Neuron untuk 10 output kelas klasifikasi
      tf.keras.layers.Dense(num_classes, activation='softmax')
  ], name="Model_Dense_Layer")

elif model_type == "CNN":
  model = tf.keras.models.Sequential([
      # Lapisan input
      tf.keras.layers.Input(shape=(224, 224, color_dimension)),

      # Lapisan Convolution
      tf.keras.layers.Conv2D(16, (3,3), activation='relu'),
      tf.keras.layers.MaxPooling2D(2,2),

      # Lapisan Convolution
      tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
      tf.keras.layers.MaxPooling2D(2,2),

      # Lapisan Convolution
      tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
      tf.keras.layers.MaxPooling2D(2,2),

      # Lapisan Convolution
      tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
      tf.keras.layers.MaxPooling2D(2,2),

      tf.keras.layers.Dropout(0.2),

      # Lapisan flatten
      tf.keras.layers.Flatten(),

      # 512 neuron hidden layer
      tf.keras.layers.Dense(512, activation='relu'),

      # 10 Neuron untuk 10 output kelas klasifikasi
      tf.keras.layers.Dense(num_classes, activation='softmax')
  ], name="Model_CNN_Layer")

elif model_type == "Transfer Learning":
  model = tf.keras.Sequential([
      hub.KerasLayer("https://tfhub.dev/google/imagenet/resnet_v2_50/feature_vector/5",
                     trainable=False,
                    #  arguments=dict(batch_norm_momentum=0.97),
                     input_shape=(224, 224, 3), ),
      tf.keras.layers.Dense(num_classes, activation='softmax')
  ], name="Model_Transfer_Learning")
  model.build([None, 224, 224, color_dimension])  # Batch input shape.

model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics = ['accuracy'])

model.summary()
```

Load image

```
# Setup folders
# !cp -a '/content/drive/MyDrive/Dataset Tugas Akhir/Dataset Processed' '/content/'
# !rm '/content/Dataset Processed/190710193_BAB 0.docx'

import splitfolders
import os

dataset_path = 'dataset'
split_path = 'dataset_split'

import shutil
try:
    shutil.rmtree(split_path)
except FileNotFoundError:
    pass

# Split with a ratio.
splitfolders.ratio(dataset_path, output="dataset_split",
    seed=193, ratio=(.8, .2), group_prefix=None, move=False)


from tensorflow.keras.preprocessing.image import ImageDataGenerator

train_dir = os.path.join(split_path, 'train')
validation_dir = os.path.join(split_path, 'val')

# Preprocessing
train_datagen = ImageDataGenerator(
                    rescale = 1.0/255.0,
                    shear_range=0.2,
                    zoom_range=0.2,
                    horizontal_flip=True,
                    fill_mode='nearest'
                )

test_datagen  = ImageDataGenerator(rescale = 1.0/255.0)


# Create dataset
if color_dimension == 3:
  color_mode = 'rgb'
else:
  color_mode = 'grayscale'

train_generator = train_datagen.flow_from_directory(
                        train_dir,
                        class_mode = 'categorical',
                        target_size = (224, 224),
                        color_mode = color_mode
                      )

validation_generator =  test_datagen.flow_from_directory(
                          validation_dir,
                          class_mode = 'categorical',
                          target_size = (224, 224),
                          color_mode = color_mode
                        )
```

Train model

```
# !rm -rf '/content/0-19 April 2023-04'


import datetime

ts = int(round(datetime.datetime.now().timestamp()))

checkpoint_filepath = 'tmp/' + 'TL-' + str(ts) +'/model-{epoch:02d}'
model_checkpoint_callback = tf.keras.callbacks.ModelCheckpoint(
    filepath=checkpoint_filepath,
    monitor='val_accuracy',
    mode='max',
    save_best_only=True,
    verbose=1
  )

history = model.fit(
            train_generator,
            epochs=45,
```

```
              validation_data=validation_generator,
              verbose=1,
              callbacks=[model_checkpoint_callback]
             )
```

```
# !cp -r '/content/tmp/CNN1683598098/model-36' '/content/drive/MyDrive/Dataset Tugas Akhir/CNN Final/'
```

Evaluating Accuracy and Loss for the Model

You will plot the training/validation accuracy and loss as collected during training:

```
import matplotlib.pyplot as plt

#-----------------------------------------------------------
# Retrieve a list of list results on training and test data
# sets for each training epoch
#-----------------------------------------------------------
acc      = history.history[     'accuracy' ]
val_acc  = history.history[ 'val_accuracy' ]
loss     = history.history[    'loss' ]
val_loss = history.history['val_loss' ]

epochs   = range(len(acc)) # Get number of epochs

#------------------------------------------------
# Plot training and validation accuracy per epoch
#------------------------------------------------
plt.plot  ( epochs,     acc )
plt.plot  ( epochs, val_acc )
plt.title ('Training and validation accuracy')
plt.figure()

#------------------------------------------------
# Plot training and validation loss per epoch
#------------------------------------------------
plt.plot  ( epochs,     loss )
plt.plot  ( epochs, val_loss )
plt.title('Training and validation loss')


# import numpy as np

# import tensorflow as tf

# from google.colab import files
# from tensorflow.keras.utils import load_img, img_to_array

# # model = tf.keras.models.load_model('/content/drive/MyDrive/model-sakitkulit/model-sakitkulit')

# uploaded=files.upload()

# for fn in uploaded.keys():
#   # predicting images
#   path='/content/' + fn
#   img=load_img(path, target_size=(150, 150), color_mode = 'grayscale')

#   x=img_to_array(img)
#   x /= 255
#   x=np.expand_dims(x, axis=0)
#   images = np.vstack([x])

#   classes = model.predict(images, batch_size=10)

#   print(classes)

#   max_val = max(classes[0])
#   index = list(classes[0]).index(max_val)

#   print(index)
```

Confusion Matrix

```
from google.colab import drive
try:
  drive.mount('/content/drive')
```

```
except:
  pass


import os

folder_images = "dataset"
images = []
i=0
for root, dirs, image_filenames in os.walk(folder_images):
  # print(root)
    if i==0:
      i+=1
      continue
    images.extend(
      list(
          map(lambda x: str(root) + '/' + x, image_filenames)
          )
      )


images.sort()
print(images)


from keras.models import Sequential, load_model
from keras.preprocessing.image import ImageDataGenerator
from sklearn.metrics import confusion_matrix, classification_report, ConfusionMatrixDisplay
import matplotlib.pyplot as plt
import numpy as np
from keras.utils import load_img, img_to_array
from tqdm import tqdm
%matplotlib inline

model_path = '/content/drive/MyDrive/Dataset Tugas Akhir/Transfer Learning Final'
test_data_path = 'dataset'
color_mode = 'rgb'

model: Sequential = load_model(model_path)
img_size = 150

test_datagen = ImageDataGenerator(rescale=1.0/255.0)
test_dataset = test_datagen.flow_from_directory(
    test_data_path,
    class_mode='categorical',
    target_size=(img_size, img_size),
    color_mode=color_mode
)

class_names = ['Batik Bali', 'Batik Celup', 'Batik Kawung', 'Batik Megamendung', 'Batik Sekar',
               'Batik Betawi', 'Batik Cendrawasih', 'Batik Lasem', 'Batik Parang', 'Batik Tambal']
class_names.sort()


class estimator:
    _estimator_type = ''
    classes_ = []

    def __init__(self, model, classes):
        self.model = model
        self._estimator_type = 'classifier'
        self.classes_ = classes

    def predict(self, X):
        y_prob = self.model.predict(X)
        y_pred = y_prob.argmax(axis=1)
        return y_pred

test_dataset.reset()
classifier = estimator(model, class_names)

y_pred = []
for image in tqdm(images):
  img=load_img(image, target_size=(224, 224))

  # resizedImage = tf.image.resize(img, (150, 150))
  x=img_to_array(img)
  x /= 255
  x=np.expand_dims(x, axis=0)
  gambars = np.vstack([x])

  classes = model.predict(gambars, batch_size=10,verbose=0)

  max_val = max(classes[0])
```

```
    max_val = max(classes[0])
    index = list(classes[0]).index(max_val)
    y_pred.append(index)

cm = confusion_matrix(test_dataset.classes, y_pred)
print(test_dataset.classes)
print(y_pred)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=class_names)
disp.plot(cmap=plt.cm.Blues)
plt.show()

print(classification_report(test_dataset.classes,
      y_pred, target_names=class_names))
```