

Exp No: 4

## HANDWRITTEN DIGITS RECOGNITION WITH MNIST

Aim:

To build a handwritten digit's recognition with MNIST dataset.

Procedure:

1. Download and load the MNIST dataset.
2. Perform analysis and preprocessing of the dataset.
3. Build a simple neural network model using Keras/TensorFlow.
4. Compile and fit the model.
5. Perform prediction with the test dataset.
6. Calculate performance metrics.

Program:

```
from tensorflow import keras
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Flatten
from tensorflow.keras.layers import Conv2D, MaxPooling2D
from tensorflow.keras import backend as K
```

```
(x_train, y_train), (x_test, y_test) = mnist.load_data()
print(x_train.shape, y_train.shape)
x_train = x_train.reshape(x_train.shape[0], 28, 28, 1)
x_test = x_test.reshape(x_test.shape[0], 28, 28, 1)
input_shape = (28, 28, 1)
y_train = keras.utils.to_categorical(y_train, 10)
y_test = keras.utils.to_categorical(y_test, 10)
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
```

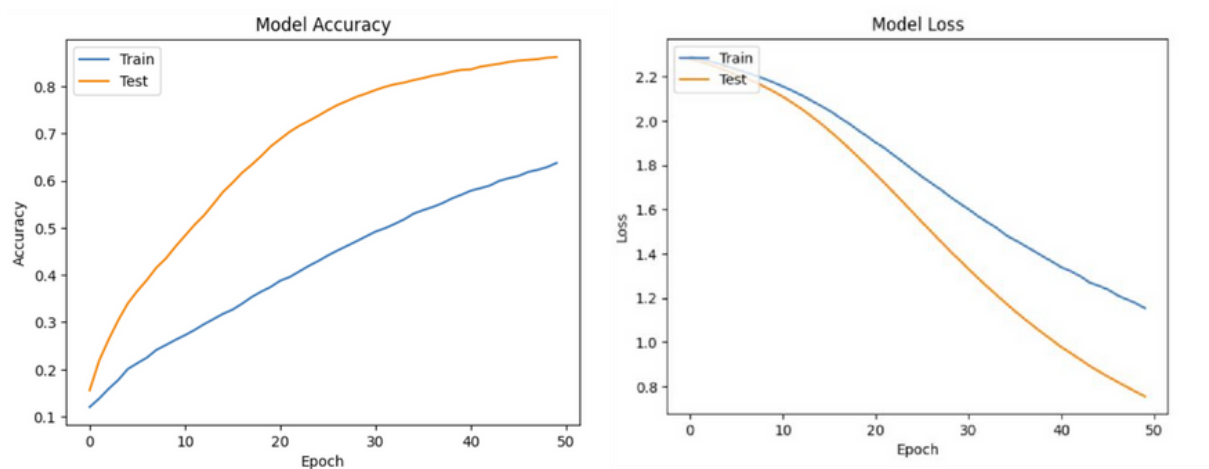
```
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')
batch_size = 128
num_classes = 10
epochs = 50
model = Sequential()
model.add(Conv2D(32, kernel_size=(5, 5), activation='relu', input_shape=input_shape))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.3))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
model.compile(loss=keras.losses.categorical_crossentropy, optimizer=keras.optimizers.Adadelta(), metrics=['accuracy'])
hist = model.fit(x_train,
y_train, batch_size=batch_size, epochs=epochs, verbose=1, validation_data=(x_test, y_test))
print("The model has successfully trained")
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
import matplotlib.pyplot as plt

plt.plot(hist.history['accuracy'])
plt.plot(hist.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
```

```
plt.xlabel('Epoch')  
plt.legend(['Train', 'Test'], loc='upper left')  
plt.show()
```

```
# Plot training & validation loss values  
plt.plot(hist.history['loss'])  
plt.plot(hist.history['val_loss'])  
plt.title('Model Loss')  
plt.ylabel('Loss')  
plt.xlabel('Epoch')  
plt.legend(['Train', 'Test'], loc='upper left')  
plt.show()
```

## Output



## Result

Handwritten digit recognition with MNIST has been successfully created.