Ex.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. Split the dataset into training data and test data.
3. Build a convolutional neural network model using Keras/TensorFlow.
4. Compile and fit the model on the training data.
5. Perform prediction with the test data.
6. Calculate performance metrics.

PROGRAM:

```
import tensorflow as tf

from tensorflow.keras.datasets import mnist

from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Dense, Flatten

from tensorflow.keras.utils import to_categorical

import matplotlib.pyplot as plt


(x_train, y_train), (x_test, y_test) = mnist.load_data()


x_train = x_train / 255.0
x_test = x_test / 255.0
```

```python
y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)


model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3), activation='relu', input_shape=(28, 28, 1)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dense(10, activation='softmax'))


model.compile(optimizer='adam',
loss='categorical_crossentropy',
metrics=['accuracy'])
model.fit(x_train, y_train, epochs=5, validation_split=0.2)


predictions = model.predict(x_test)


test_loss, test_acc = model.evaluate(x_test, y_test)
print(f'Test accuracy: {test_acc:.4f}')


# Display a few predictions
plt.figure(figsize=(10, 5))
for i in range(5):
    plt.subplot(1, 5, i+1)
```

```
    plt.imshow(x_test[i], cmap='gray')

    plt.title(f'Pred: {predictions[i].argmax()}')

    plt.axis('off')

plt.show()
```

OUTPUT:

```
Epoch 1/5
1500/1500 ———————————————— 15s 9ms/step - accuracy: 0.9024 - loss: 0.3330 - val_accuracy: 0.9820 - val_loss: 0.0591
Epoch 2/5
1500/1500 ———————————————— 14s 9ms/step - accuracy: 0.9852 - loss: 0.0459 - val_accuracy: 0.9818 - val_loss: 0.0560
Epoch 3/5
1500/1500 ———————————————— 13s 9ms/step - accuracy: 0.9911 - loss: 0.0287 - val_accuracy: 0.9888 - val_loss: 0.0420
Epoch 4/5
1500/1500 ———————————————— 14s 9ms/step - accuracy: 0.9933 - loss: 0.0211 - val_accuracy: 0.9886 - val_loss: 0.0431
Epoch 5/5
1500/1500 ———————————————— 13s 9ms/step - accuracy: 0.9958 - loss: 0.0135 - val_accuracy: 0.9897 - val_loss: 0.0390
313/313 ——————————— 1s 4ms/step
313/313 ——————————— 1s 4ms/step - accuracy: 0.9886 - loss: 0.0392
Test accuracy: 0.9911
```
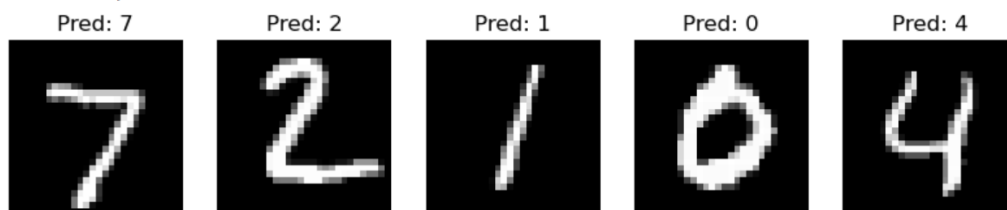

RESULT:

Thus, the handwritten digit's recognition with MNIST dataset was successfully implemented.