Traffic sign Classification with LE-NET

In [19]:
```
# Importing packages
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import pickle
```

In [2]:
```
# Import Data
with open("./traffic-signs-data/train.p", mode = 'rb') as training_data:
        train = pickle.load(training_data)
with open("./traffic-signs-data/valid.p", mode = 'rb') as validation_data:
        valid = pickle.load(validation_data)
with open("./traffic-signs-data/test.p", mode = 'rb') as testing_data:
        test = pickle.load(testing_data)
```

In [3]:
```
x_train, y_train = train['features'], train['labels']
x_validation, y_validation =  valid['features'], valid['labels']
x_test, y_test = test['features'], test['labels']
```

In [4]:
```
x_train.shape
```

Out[4]: (34799, 32, 32, 3)

In [5]:
```
y_train.shape
```

Out[5]: (34799,)

In [6]:
```
x_validation.shape
```

Out[6]: (4410, 32, 32, 3)

In [7]:
```
y_validation.shape
```

Out[7]: (4410,)

In [8]:
```
x_test.shape
```

Out[8]: (12630, 32, 32, 3)

In [9]:
```
y_test.shape
```

Out[9]: (12630,)

In [15]:
```
# Quick Check with the images
i = 500
plt.imshow(x_train[i])
y_train[i]
```

Out[15]: 31

In [17]:
```
# Shuffle
from sklearn.utils import shuffle
x_train, y_train = shuffle(x_train, y_train)
```

In [22]:
```
x_train_gray = np.sum(x_train/3, axis = 3, keepdims = True)
x_test_gray = np.sum(x_test/3, axis = 3, keepdims = True)
x_validation_gray = np.sum(x_validation/3, axis = 3, keepdims = True)
```

In [21]:
```
x_train_gray.shape
```

Out[21]: (34799, 32, 32, 1)

In [23]:
```
x_test_gray.shape
```

Out[23]: (12630, 32, 32, 1)

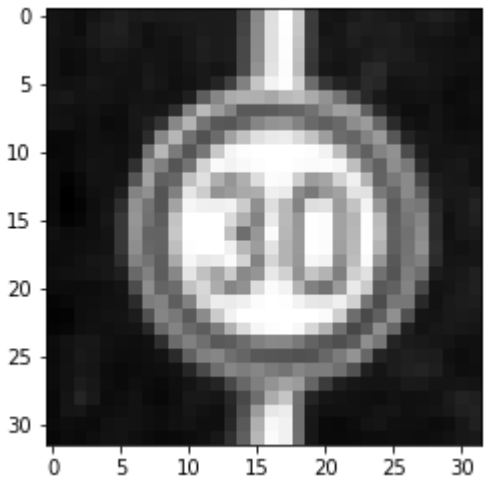
In [24]:
```
x_validation_gray.shape
```

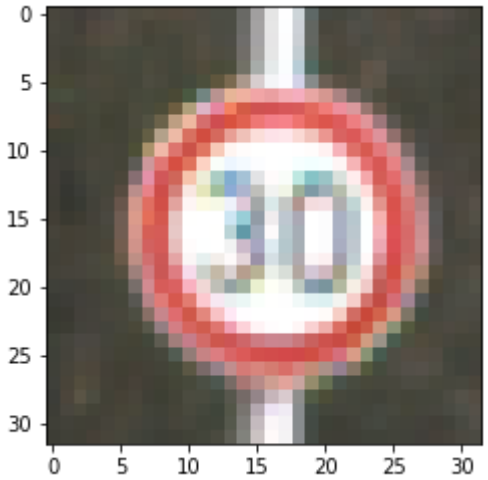
Out[24]: (4410, 32, 32, 1)

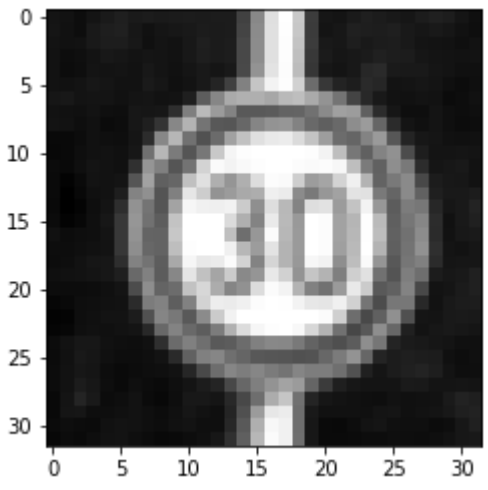
In [25]:
```
# Data Normalization
x_train_gray_norm = (x_train_gray - 128)/128
x_test_gray_norm = (x_test_gray - 128)/128
x_validation_gray_norm = (x_validation_gray - 128)/128
```

In [31]:
```
# Checking the image again
i = 610
plt.imshow(x_train_gray[i].squeeze(), cmap='gray')
plt.figure()
plt.imshow(x_train[i])
plt.figure()
plt.imshow(x_train_gray_norm[i].squeeze(), cmap='gray')
```

Out[31]: <matplotlib.image.AxesImage at 0x11cf2d47f40>







Model Training:

In [33]:
```
from keras.models import Sequential
from keras.layers import Conv2D, MaxPooling2D, AveragePooling2D, Dense, Flatten, Dropout
from keras.optimizers import Adam
from keras.callbacks import TensorBoard
```

In [38]:
```
cnn_model = Sequential()

cnn_model.add(Conv2D(filters = 6, kernel_size = (5,5), activation = 'relu', input_shape = (32,32,1)))
cnn_model.add(AveragePooling2D())
```

```
cnn_model.add(Conv2D(filters = 16, kernel_size = (5,5), activation = 'relu'))
cnn_model.add(AveragePooling2D())

cnn_model.add(Flatten())
cnn_model.add(Dense(units = 120, activation = 'relu'))
cnn_model.add(Dense(units = 84, activation = 'relu'))
cnn_model.add(Dense(units = 43, activation = 'softmax'))
```

In [39]:
```
cnn_model.compile(loss = 'sparse_categorical_crossentropy', optimizer = Adam(lr = 0.001), metrics = ['accuracy'])
```

In [49]:
```
history =  cnn_model.fit(x_train_gray_norm,
             y_train,
             batch_size=500,
             epochs = 500,
             verbose = 1,
             validation_data=(x_validation_gray_norm, y_validation))
```

```
Epoch 1/500
70/70 [==============================] - 3s 39ms/step - loss: 1.6208e-05 - accuracy: 1.0000 - val_loss: 0.8496 - val_accuracy: 0.9059
Epoch 2/500
70/70 [==============================] - 3s 39ms/step - loss: 1.5514e-05 - accuracy: 1.0000 - val_loss: 0.8542 - val_accuracy: 0.9070
Epoch 3/500
70/70 [==============================] - 3s 40ms/step - loss: 1.5022e-05 - accuracy: 1.0000 - val_loss: 0.8559 - val_accuracy: 0.9063
Epoch 4/500
70/70 [==============================] - 3s 39ms/step - loss: 1.4462e-05 - accuracy: 1.0000 - val_loss: 0.8569 - val_accuracy: 0.9068
Epoch 5/500
70/70 [==============================] - 3s 39ms/step - loss: 1.3833e-05 - accuracy: 1.0000 - val_loss: 0.8607 - val_accuracy: 0.9063
Epoch 6/500
70/70 [==============================] - 3s 40ms/step - loss: 1.3247e-05 - accuracy: 1.0000 - val_loss: 0.8588 - val_accuracy: 0.9066
Epoch 7/500
70/70 [==============================] - 3s 39ms/step - loss: 1.2786e-05 - accuracy: 1.0000 - val_loss: 0.8607 - val_accuracy: 0.9070
Epoch 8/500
70/70 [==============================] - 3s 39ms/step - loss: 1.2304e-05 - accuracy: 1.0000 - val_loss: 0.8652 - val_accuracy: 0.9066
Epoch 9/500
70/70 [==============================] - 3s 40ms/step - loss: 1.1813e-05 - accuracy: 1.0000 - val_loss: 0.8679 - val_accuracy: 0.9066
Epoch 10/500
70/70 [==============================] - 3s 40ms/step - loss: 1.1357e-05 - accuracy: 1.0000 - val_loss: 0.8699 - val_accuracy: 0.9066
Epoch 11/500
70/70 [==============================] - 3s 39ms/step - loss: 1.0975e-05 - accuracy: 1.0000 - val_loss: 0.8750 - val_accuracy: 0.9070
Epoch 12/500
70/70 [==============================] - 3s 40ms/step - loss: 1.0554e-05 - accuracy: 1.0000 - val_loss: 0.8736 - val_accuracy: 0.9066
Epoch 13/500
70/70 [==============================] - 3s 40ms/step - loss: 1.0204e-05 - accuracy: 1.0000 - val_loss: 0.8799 - val_accuracy: 0.9059
Epoch 14/500
70/70 [==============================] - 3s 40ms/step - loss: 9.8867e-06 - accuracy: 1.0000 - val_loss: 0.8810 - val_accuracy: 0.9061
Epoch 15/500
70/70 [==============================] - 3s 40ms/step - loss: 9.4609e-06 - accuracy: 1.0000 - val_loss: 0.8785 - val_accuracy: 0.9059
Epoch 16/500
70/70 [==============================] - 3s 39ms/step - loss: 9.1395e-06 - accuracy: 1.0000 - val_loss: 0.8852 - val_accuracy: 0.9061
Epoch 17/500
70/70 [==============================] - 3s 40ms/step - loss: 8.8224e-06 - accuracy: 1.0000 - val_loss: 0.8852 - val_accuracy: 0.9057
Epoch 18/500
70/70 [==============================] - 3s 39ms/step - loss: 8.4465e-06 - accuracy: 1.0000 - val_loss: 0.8887 - val_accuracy: 0.9057
Epoch 19/500
70/70 [==============================] - 3s 39ms/step - loss: 8.1577e-06 - accuracy: 1.0000 - val_loss: 0.8933 - val_accuracy: 0.9057
Epoch 20/500
70/70 [==============================] - 3s 40ms/step - loss: 7.9058e-06 - accuracy: 1.0000 - val_loss: 0.8923 - val_accuracy: 0.9061
Epoch 21/500
70/70 [==============================] - 3s 40ms/step - loss: 7.6345e-06 - accuracy: 1.0000 - val_loss: 0.8979 - val_accuracy: 0.9059
Epoch 22/500
70/70 [==============================] - 3s 39ms/step - loss: 7.3613e-06 - accuracy: 1.0000 - val_loss: 0.8994 - val_accuracy: 0.9061
Epoch 23/500
70/70 [==============================] - 3s 40ms/step - loss: 7.0882e-06 - accuracy: 1.0000 - val_loss: 0.9000 - val_accuracy: 0.9061
Epoch 24/500
70/70 [==============================] - 3s 40ms/step - loss: 6.8289e-06 - accuracy: 1.0000 - val_loss: 0.9002 - val_accuracy: 0.9061
Epoch 25/500
70/70 [==============================] - 3s 40ms/step - loss: 6.6361e-06 - accuracy: 1.0000 - val_loss: 0.9034 - val_accuracy: 0.9063
Epoch 26/500
70/70 [==============================] - 3s 42ms/step - loss: 6.4020e-06 - accuracy: 1.0000 - val_loss: 0.9026 - val_accuracy: 0.9066
Epoch 27/500
70/70 [==============================] - 3s 42ms/step - loss: 6.2084e-06 - accuracy: 1.0000 - val_loss: 0.9075 - val_accuracy: 0.9066
Epoch 28/500
70/70 [==============================] - 3s 42ms/step - loss: 5.9610e-06 - accuracy: 1.0000 - val_loss: 0.9091 - val_accuracy: 0.9066
Epoch 29/500
70/70 [==============================] - 3s 41ms/step - loss: 5.7283e-06 - accuracy: 1.0000 - val_loss: 0.9136 - val_accuracy: 0.9068
Epoch 30/500
70/70 [==============================] - 3s 42ms/step - loss: 5.5509e-06 - accuracy: 1.0000 - val_loss: 0.9169 - val_accuracy: 0.9073
Epoch 31/500
70/70 [==============================] - 3s 42ms/step - loss: 5.3876e-06 - accuracy: 1.0000 - val_loss: 0.9180 - val_accuracy: 0.9075
Epoch 32/500
70/70 [==============================] - 3s 42ms/step - loss: 5.2238e-06 - accuracy: 1.0000 - val_loss: 0.9170 - val_accuracy: 0.9070
Epoch 33/500
70/70 [==============================] - 3s 43ms/step - loss: 5.0518e-06 - accuracy: 1.0000 - val_loss: 0.9184 - val_accuracy: 0.9077
Epoch 34/500
70/70 [==============================] - 3s 42ms/step - loss: 4.8551e-06 - accuracy: 1.0000 - val_loss: 0.9276 - val_accuracy: 0.9075
Epoch 35/500
70/70 [==============================] - 3s 42ms/step - loss: 4.7230e-06 - accuracy: 1.0000 - val_loss: 0.9238 - val_accuracy: 0.9068
Epoch 36/500
70/70 [==============================] - 3s 42ms/step - loss: 4.5150e-06 - accuracy: 1.0000 - val_loss: 0.9246 - val_accuracy: 0.9075
Epoch 37/500
70/70 [==============================] - 3s 42ms/step - loss: 4.4126e-06 - accuracy: 1.0000 - val_loss: 0.9236 - val_accuracy: 0.9077
Epoch 38/500
70/70 [==============================] - 3s 42ms/step - loss: 4.2827e-06 - accuracy: 1.0000 - val_loss: 0.9325 - val_accuracy: 0.9079
Epoch 39/500
70/70 [==============================] - 3s 42ms/step - loss: 4.1414e-06 - accuracy: 1.0000 - val_loss: 0.9313 - val_accuracy: 0.9079
Epoch 40/500
70/70 [==============================] - 3s 41ms/step - loss: 4.0568e-06 - accuracy: 1.0000 - val_loss: 0.9337 - val_accuracy: 0.9079
Epoch 41/500
```

```
70/70 [==============================] - 3s 41ms/step - loss: 3.8738e-06 - accuracy: 1.0000 - val_loss: 0.9357 - val_accuracy: 0.9086
Epoch 42/500
70/70 [==============================] - 3s 41ms/step - loss: 3.7692e-06 - accuracy: 1.0000 - val_loss: 0.9358 - val_accuracy: 0.9079
Epoch 43/500
70/70 [==============================] - 3s 42ms/step - loss: 3.6064e-06 - accuracy: 1.0000 - val_loss: 0.9376 - val_accuracy: 0.9082
Epoch 44/500
70/70 [==============================] - 3s 43ms/step - loss: 3.4675e-06 - accuracy: 1.0000 - val_loss: 0.9440 - val_accuracy: 0.9077
Epoch 45/500
70/70 [==============================] - 3s 43ms/step - loss: 3.3752e-06 - accuracy: 1.0000 - val_loss: 0.9417 - val_accuracy: 0.9082
Epoch 46/500
70/70 [==============================] - 3s 42ms/step - loss: 3.3020e-06 - accuracy: 1.0000 - val_loss: 0.9455 - val_accuracy: 0.9082
Epoch 47/500
70/70 [==============================] - 3s 42ms/step - loss: 3.1718e-06 - accuracy: 1.0000 - val_loss: 0.9465 - val_accuracy: 0.9082
Epoch 48/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0522e-06 - accuracy: 1.0000 - val_loss: 0.9517 - val_accuracy: 0.9086
Epoch 49/500
70/70 [==============================] - 3s 42ms/step - loss: 2.9617e-06 - accuracy: 1.0000 - val_loss: 0.9480 - val_accuracy: 0.9082
Epoch 50/500
70/70 [==============================] - 3s 42ms/step - loss: 2.8504e-06 - accuracy: 1.0000 - val_loss: 0.9583 - val_accuracy: 0.9082
Epoch 51/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7781e-06 - accuracy: 1.0000 - val_loss: 0.9652 - val_accuracy: 0.9088
Epoch 52/500
70/70 [==============================] - 3s 42ms/step - loss: 2.7118e-06 - accuracy: 1.0000 - val_loss: 0.9647 - val_accuracy: 0.9091
Epoch 53/500
70/70 [==============================] - 3s 42ms/step - loss: 2.6404e-06 - accuracy: 1.0000 - val_loss: 0.9588 - val_accuracy: 0.9093
Epoch 54/500
70/70 [==============================] - 3s 42ms/step - loss: 2.5575e-06 - accuracy: 1.0000 - val_loss: 0.9592 - val_accuracy: 0.9093
Epoch 55/500
70/70 [==============================] - 3s 43ms/step - loss: 2.4193e-06 - accuracy: 1.0000 - val_loss: 0.9689 - val_accuracy: 0.9091
Epoch 56/500
70/70 [==============================] - 3s 42ms/step - loss: 2.3844e-06 - accuracy: 1.0000 - val_loss: 0.9700 - val_accuracy: 0.9091
Epoch 57/500
70/70 [==============================] - 3s 42ms/step - loss: 2.2758e-06 - accuracy: 1.0000 - val_loss: 0.9692 - val_accuracy: 0.9091
Epoch 58/500
70/70 [==============================] - 3s 43ms/step - loss: 2.1791e-06 - accuracy: 1.0000 - val_loss: 0.9709 - val_accuracy: 0.9088
Epoch 59/500
70/70 [==============================] - 3s 47ms/step - loss: 2.1428e-06 - accuracy: 1.0000 - val_loss: 0.9788 - val_accuracy: 0.9098
Epoch 60/500
70/70 [==============================] - 3s 45ms/step - loss: 2.0544e-06 - accuracy: 1.0000 - val_loss: 0.9718 - val_accuracy: 0.9100
Epoch 61/500
70/70 [==============================] - 3s 43ms/step - loss: 1.9938e-06 - accuracy: 1.0000 - val_loss: 0.9723 - val_accuracy: 0.9091
Epoch 62/500
70/70 [==============================] - 3s 42ms/step - loss: 1.9173e-06 - accuracy: 1.0000 - val_loss: 0.9791 - val_accuracy: 0.9095
Epoch 63/500
70/70 [==============================] - 3s 42ms/step - loss: 1.8919e-06 - accuracy: 1.0000 - val_loss: 0.9795 - val_accuracy: 0.9100
Epoch 64/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7867e-06 - accuracy: 1.0000 - val_loss: 0.9864 - val_accuracy: 0.9095
Epoch 65/500
70/70 [==============================] - 3s 43ms/step - loss: 1.7268e-06 - accuracy: 1.0000 - val_loss: 0.9939 - val_accuracy: 0.9098
Epoch 66/500
70/70 [==============================] - 3s 43ms/step - loss: 1.7112e-06 - accuracy: 1.0000 - val_loss: 0.9858 - val_accuracy: 0.9098
Epoch 67/500
70/70 [==============================] - 3s 45ms/step - loss: 1.6552e-06 - accuracy: 1.0000 - val_loss: 0.9883 - val_accuracy: 0.9088
Epoch 68/500
70/70 [==============================] - 3s 45ms/step - loss: 1.5928e-06 - accuracy: 1.0000 - val_loss: 0.9901 - val_accuracy: 0.9098
Epoch 69/500
70/70 [==============================] - 3s 44ms/step - loss: 1.5575e-06 - accuracy: 1.0000 - val_loss: 0.9951 - val_accuracy: 0.9091
Epoch 70/500
70/70 [==============================] - 3s 46ms/step - loss: 1.4788e-06 - accuracy: 1.0000 - val_loss: 0.9946 - val_accuracy: 0.9102
Epoch 71/500
70/70 [==============================] - 3s 44ms/step - loss: 1.4390e-06 - accuracy: 1.0000 - val_loss: 1.0014 - val_accuracy: 0.9102
Epoch 72/500
70/70 [==============================] - 3s 43ms/step - loss: 1.3798e-06 - accuracy: 1.0000 - val_loss: 1.0025 - val_accuracy: 0.9100
Epoch 73/500
70/70 [==============================] - 3s 45ms/step - loss: 1.4144e-06 - accuracy: 1.0000 - val_loss: 1.0058 - val_accuracy: 0.9100
Epoch 74/500
70/70 [==============================] - 3s 43ms/step - loss: 1.3004e-06 - accuracy: 1.0000 - val_loss: 1.0043 - val_accuracy: 0.9109
Epoch 75/500
70/70 [==============================] - 3s 44ms/step - loss: 1.2454e-06 - accuracy: 1.0000 - val_loss: 1.0078 - val_accuracy: 0.9102
Epoch 76/500
70/70 [==============================] - 3s 45ms/step - loss: 1.2487e-06 - accuracy: 1.0000 - val_loss: 1.0134 - val_accuracy: 0.9109
Epoch 77/500
70/70 [==============================] - 3s 45ms/step - loss: 1.1628e-06 - accuracy: 1.0000 - val_loss: 1.0101 - val_accuracy: 0.9098
Epoch 78/500
70/70 [==============================] - 3s 44ms/step - loss: 1.1984e-06 - accuracy: 1.0000 - val_loss: 1.0242 - val_accuracy: 0.9107
Epoch 79/500
70/70 [==============================] - 3s 45ms/step - loss: 1.1176e-06 - accuracy: 1.0000 - val_loss: 1.0153 - val_accuracy: 0.9107
Epoch 80/500
70/70 [==============================] - 3s 43ms/step - loss: 1.1256e-06 - accuracy: 1.0000 - val_loss: 1.0198 - val_accuracy: 0.9100
Epoch 81/500
70/70 [==============================] - 3s 42ms/step - loss: 1.0278e-06 - accuracy: 1.0000 - val_loss: 1.0183 - val_accuracy: 0.9104
Epoch 82/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0186e-06 - accuracy: 1.0000 - val_loss: 1.0198 - val_accuracy: 0.9104
Epoch 83/500
70/70 [==============================] - 3s 42ms/step - loss: 9.7506e-07 - accuracy: 1.0000 - val_loss: 1.0216 - val_accuracy: 0.9104
Epoch 84/500
70/70 [==============================] - 3s 42ms/step - loss: 9.9555e-07 - accuracy: 1.0000 - val_loss: 1.0260 - val_accuracy: 0.9098
Epoch 85/500
70/70 [==============================] - 3s 44ms/step - loss: 0.0595 - accuracy: 0.9871 - val_loss: 0.6547 - val_accuracy: 0.8730
Epoch 86/500
70/70 [==============================] - 3s 44ms/step - loss: 0.0300 - accuracy: 0.9909 - val_loss: 0.4991 - val_accuracy: 0.9095
Epoch 87/500
70/70 [==============================] - 3s 46ms/step - loss: 0.0044 - accuracy: 0.9989 - val_loss: 0.6014 - val_accuracy: 0.9070
Epoch 88/500
70/70 [==============================] - 3s 45ms/step - loss: 9.6236e-04 - accuracy: 0.9999 - val_loss: 0.5820 - val_accuracy: 0.9111
Epoch 89/500
70/70 [==============================] - 3s 44ms/step - loss: 3.6287e-04 - accuracy: 1.0000 - val_loss: 0.5921 - val_accuracy: 0.9129
Epoch 90/500
70/70 [==============================] - 3s 42ms/step - loss: 2.3095e-04 - accuracy: 1.0000 - val_loss: 0.6003 - val_accuracy: 0.9122
Epoch 91/500
70/70 [==============================] - 3s 42ms/step - loss: 1.7628e-04 - accuracy: 1.0000 - val_loss: 0.6030 - val_accuracy: 0.9127
Epoch 92/500
70/70 [==============================] - 3s 42ms/step - loss: 1.4670e-04 - accuracy: 1.0000 - val_loss: 0.6138 - val_accuracy: 0.9125
```

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Epoch 93/500
70/70 [==============================] - 3s 42ms/step - loss: 1.2610e-04 - accuracy: 1.0000 - val_loss: 0.6193 - val_accuracy: 0.9141
Epoch 94/500
70/70 [==============================] - 3s 42ms/step - loss: 1.0992e-04 - accuracy: 1.0000 - val_loss: 0.6200 - val_accuracy: 0.9141
Epoch 95/500
70/70 [==============================] - 3s 42ms/step - loss: 9.7164e-05 - accuracy: 1.0000 - val_loss: 0.6232 - val_accuracy: 0.9147
Epoch 96/500
70/70 [==============================] - 3s 41ms/step - loss: 8.7217e-05 - accuracy: 1.0000 - val_loss: 0.6271 - val_accuracy: 0.9143
Epoch 97/500
70/70 [==============================] - 3s 43ms/step - loss: 7.8616e-05 - accuracy: 1.0000 - val_loss: 0.6280 - val_accuracy: 0.9156
Epoch 98/500
70/70 [==============================] - 3s 45ms/step - loss: 7.0916e-05 - accuracy: 1.0000 - val_loss: 0.6338 - val_accuracy: 0.9154
Epoch 99/500
70/70 [==============================] - 3s 45ms/step - loss: 6.5697e-05 - accuracy: 1.0000 - val_loss: 0.6363 - val_accuracy: 0.9156
Epoch 100/500
70/70 [==============================] - 3s 45ms/step - loss: 5.9892e-05 - accuracy: 1.0000 - val_loss: 0.6402 - val_accuracy: 0.9154
Epoch 101/500
70/70 [==============================] - 3s 45ms/step - loss: 5.5040e-05 - accuracy: 1.0000 - val_loss: 0.6438 - val_accuracy: 0.9156
Epoch 102/500
70/70 [==============================] - 3s 45ms/step - loss: 5.0777e-05 - accuracy: 1.0000 - val_loss: 0.6489 - val_accuracy: 0.9161
Epoch 103/500
70/70 [==============================] - 3s 44ms/step - loss: 4.6866e-05 - accuracy: 1.0000 - val_loss: 0.6522 - val_accuracy: 0.9159
Epoch 104/500
70/70 [==============================] - 3s 44ms/step - loss: 4.3402e-05 - accuracy: 1.0000 - val_loss: 0.6572 - val_accuracy: 0.9159
Epoch 105/500
70/70 [==============================] - 3s 44ms/step - loss: 4.0817e-05 - accuracy: 1.0000 - val_loss: 0.6599 - val_accuracy: 0.9161
Epoch 106/500
70/70 [==============================] - 3s 45ms/step - loss: 3.7704e-05 - accuracy: 1.0000 - val_loss: 0.6631 - val_accuracy: 0.9159
Epoch 107/500
70/70 [==============================] - 3s 45ms/step - loss: 3.5329e-05 - accuracy: 1.0000 - val_loss: 0.6684 - val_accuracy: 0.9168
Epoch 108/500
70/70 [==============================] - 3s 44ms/step - loss: 3.3208e-05 - accuracy: 1.0000 - val_loss: 0.6712 - val_accuracy: 0.9152
Epoch 109/500
70/70 [==============================] - 3s 43ms/step - loss: 3.1370e-05 - accuracy: 1.0000 - val_loss: 0.6760 - val_accuracy: 0.9161
Epoch 110/500
70/70 [==============================] - 3s 42ms/step - loss: 2.9357e-05 - accuracy: 1.0000 - val_loss: 0.6783 - val_accuracy: 0.9161
Epoch 111/500
70/70 [==============================] - 3s 42ms/step - loss: 2.7847e-05 - accuracy: 1.0000 - val_loss: 0.6764 - val_accuracy: 0.9168
Epoch 112/500
70/70 [==============================] - 3s 43ms/step - loss: 2.6397e-05 - accuracy: 1.0000 - val_loss: 0.6809 - val_accuracy: 0.9168
Epoch 113/500
70/70 [==============================] - 3s 45ms/step - loss: 2.4930e-05 - accuracy: 1.0000 - val_loss: 0.6849 - val_accuracy: 0.9166
Epoch 114/500
70/70 [==============================] - 3s 45ms/step - loss: 2.3559e-05 - accuracy: 1.0000 - val_loss: 0.6910 - val_accuracy: 0.9159
Epoch 115/500
70/70 [==============================] - 3s 44ms/step - loss: 2.2396e-05 - accuracy: 1.0000 - val_loss: 0.6920 - val_accuracy: 0.9161
Epoch 116/500
70/70 [==============================] - 3s 46ms/step - loss: 2.1324e-05 - accuracy: 1.0000 - val_loss: 0.6934 - val_accuracy: 0.9166
Epoch 117/500
70/70 [==============================] - 3s 45ms/step - loss: 2.0123e-05 - accuracy: 1.0000 - val_loss: 0.6965 - val_accuracy: 0.9163
Epoch 118/500
70/70 [==============================] - 3s 45ms/step - loss: 1.9297e-05 - accuracy: 1.0000 - val_loss: 0.6995 - val_accuracy: 0.9163
Epoch 119/500
70/70 [==============================] - 3s 47ms/step - loss: 1.8311e-05 - accuracy: 1.0000 - val_loss: 0.6992 - val_accuracy: 0.9159
Epoch 120/500
70/70 [==============================] - 3s 46ms/step - loss: 1.7382e-05 - accuracy: 1.0000 - val_loss: 0.7042 - val_accuracy: 0.9163
Epoch 121/500
70/70 [==============================] - 3s 45ms/step - loss: 1.6600e-05 - accuracy: 1.0000 - val_loss: 0.7017 - val_accuracy: 0.9159
Epoch 122/500
70/70 [==============================] - 3s 45ms/step - loss: 1.5785e-05 - accuracy: 1.0000 - val_loss: 0.7067 - val_accuracy: 0.9161
Epoch 123/500
70/70 [==============================] - 3s 44ms/step - loss: 1.5060e-05 - accuracy: 1.0000 - val_loss: 0.7107 - val_accuracy: 0.9159
Epoch 124/500
70/70 [==============================] - 3s 44ms/step - loss: 1.4272e-05 - accuracy: 1.0000 - val_loss: 0.7145 - val_accuracy: 0.9159
Epoch 125/500
70/70 [==============================] - 3s 45ms/step - loss: 1.3737e-05 - accuracy: 1.0000 - val_loss: 0.7164 - val_accuracy: 0.9156
Epoch 126/500
70/70 [==============================] - 3s 45ms/step - loss: 1.3137e-05 - accuracy: 1.0000 - val_loss: 0.7193 - val_accuracy: 0.9161
Epoch 127/500
70/70 [==============================] - 3s 44ms/step - loss: 1.2557e-05 - accuracy: 1.0000 - val_loss: 0.7201 - val_accuracy: 0.9154
Epoch 128/500
70/70 [==============================] - 3s 44ms/step - loss: 1.1997e-05 - accuracy: 1.0000 - val_loss: 0.7224 - val_accuracy: 0.9163
Epoch 129/500
70/70 [==============================] - 3s 44ms/step - loss: 1.1550e-05 - accuracy: 1.0000 - val_loss: 0.7281 - val_accuracy: 0.9159
Epoch 130/500
70/70 [==============================] - 3s 44ms/step - loss: 1.1015e-05 - accuracy: 1.0000 - val_loss: 0.7286 - val_accuracy: 0.9161
Epoch 131/500
70/70 [==============================] - 3s 43ms/step - loss: 1.0637e-05 - accuracy: 1.0000 - val_loss: 0.7256 - val_accuracy: 0.9163
Epoch 132/500
70/70 [==============================] - 3s 45ms/step - loss: 1.0120e-05 - accuracy: 1.0000 - val_loss: 0.7327 - val_accuracy: 0.9163
Epoch 133/500
70/70 [==============================] - 3s 46ms/step - loss: 9.6928e-06 - accuracy: 1.0000 - val_loss: 0.7328 - val_accuracy: 0.9166
Epoch 134/500
70/70 [==============================] - 3s 45ms/step - loss: 9.2932e-06 - accuracy: 1.0000 - val_loss: 0.7385 - val_accuracy: 0.9159
Epoch 135/500
70/70 [==============================] - 3s 43ms/step - loss: 9.0171e-06 - accuracy: 1.0000 - val_loss: 0.7417 - val_accuracy: 0.9159
Epoch 136/500
70/70 [==============================] - 3s 42ms/step - loss: 8.6246e-06 - accuracy: 1.0000 - val_loss: 0.7416 - val_accuracy: 0.9161
Epoch 137/500
70/70 [==============================] - 3s 45ms/step - loss: 8.2628e-06 - accuracy: 1.0000 - val_loss: 0.7427 - val_accuracy: 0.9168
Epoch 138/500
70/70 [==============================] - 3s 47ms/step - loss: 7.9432e-06 - accuracy: 1.0000 - val_loss: 0.7461 - val_accuracy: 0.9166
Epoch 139/500
70/70 [==============================] - 3s 46ms/step - loss: 7.6164e-06 - accuracy: 1.0000 - val_loss: 0.7491 - val_accuracy: 0.9168
Epoch 140/500
70/70 [==============================] - 3s 44ms/step - loss: 7.3530e-06 - accuracy: 1.0000 - val_loss: 0.7507 - val_accuracy: 0.9170
Epoch 141/500
70/70 [==============================] - 3s 41ms/step - loss: 7.0607e-06 - accuracy: 1.0000 - val_loss: 0.7563 - val_accuracy: 0.9168
Epoch 142/500
70/70 [==============================] - 3s 43ms/step - loss: 6.8019e-06 - accuracy: 1.0000 - val_loss: 0.7505 - val_accuracy: 0.9168
Epoch 143/500
70/70 [==============================] - 3s 44ms/step - loss: 6.5714e-06 - accuracy: 1.0000 - val_loss: 0.7602 - val_accuracy: 0.9168
Epoch 144/500
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70/70 [==============================] - 3s 43ms/step - loss: 6.3536e-06 - accuracy: 1.0000 - val_loss: 0.7549 - val_accuracy: 0.9170
Epoch 145/500
70/70 [==============================] - 3s 44ms/step - loss: 6.1026e-06 - accuracy: 1.0000 - val_loss: 0.7610 - val_accuracy: 0.9170
Epoch 146/500
70/70 [==============================] - 3s 41ms/step - loss: 5.8359e-06 - accuracy: 1.0000 - val_loss: 0.7644 - val_accuracy: 0.9168
Epoch 147/500
70/70 [==============================] - 3s 43ms/step - loss: 5.6262e-06 - accuracy: 1.0000 - val_loss: 0.7707 - val_accuracy: 0.9166
Epoch 148/500
70/70 [==============================] - 3s 45ms/step - loss: 5.4993e-06 - accuracy: 1.0000 - val_loss: 0.7660 - val_accuracy: 0.9163
Epoch 149/500
70/70 [==============================] - 3s 41ms/step - loss: 5.2781e-06 - accuracy: 1.0000 - val_loss: 0.7727 - val_accuracy: 0.9166
Epoch 150/500
70/70 [==============================] - 3s 42ms/step - loss: 5.1179e-06 - accuracy: 1.0000 - val_loss: 0.7762 - val_accuracy: 0.9166
Epoch 151/500
70/70 [==============================] - 3s 44ms/step - loss: 4.8348e-06 - accuracy: 1.0000 - val_loss: 0.7765 - val_accuracy: 0.9170
Epoch 152/500
70/70 [==============================] - 3s 45ms/step - loss: 4.7084e-06 - accuracy: 1.0000 - val_loss: 0.7780 - val_accuracy: 0.9172
Epoch 153/500
70/70 [==============================] - 3s 46ms/step - loss: 4.5047e-06 - accuracy: 1.0000 - val_loss: 0.7780 - val_accuracy: 0.9172
Epoch 154/500
70/70 [==============================] - 3s 44ms/step - loss: 4.3571e-06 - accuracy: 1.0000 - val_loss: 0.7831 - val_accuracy: 0.9163
Epoch 155/500
70/70 [==============================] - 3s 43ms/step - loss: 4.1678e-06 - accuracy: 1.0000 - val_loss: 0.7822 - val_accuracy: 0.9166
Epoch 156/500
70/70 [==============================] - 3s 44ms/step - loss: 4.0105e-06 - accuracy: 1.0000 - val_loss: 0.7861 - val_accuracy: 0.9166
Epoch 157/500
70/70 [==============================] - 3s 44ms/step - loss: 3.8880e-06 - accuracy: 1.0000 - val_loss: 0.7889 - val_accuracy: 0.9163
Epoch 158/500
70/70 [==============================] - 3s 45ms/step - loss: 3.7370e-06 - accuracy: 1.0000 - val_loss: 0.7944 - val_accuracy: 0.9166
Epoch 159/500
70/70 [==============================] - 3s 43ms/step - loss: 3.5771e-06 - accuracy: 1.0000 - val_loss: 0.7918 - val_accuracy: 0.9166
Epoch 160/500
70/70 [==============================] - 3s 43ms/step - loss: 3.4833e-06 - accuracy: 1.0000 - val_loss: 0.7938 - val_accuracy: 0.9170
Epoch 161/500
70/70 [==============================] - 3s 45ms/step - loss: 3.3333e-06 - accuracy: 1.0000 - val_loss: 0.7995 - val_accuracy: 0.9166
Epoch 162/500
70/70 [==============================] - 3s 41ms/step - loss: 3.2167e-06 - accuracy: 1.0000 - val_loss: 0.8029 - val_accuracy: 0.9163
Epoch 163/500
70/70 [==============================] - 3s 43ms/step - loss: 3.0845e-06 - accuracy: 1.0000 - val_loss: 0.8045 - val_accuracy: 0.9166
Epoch 164/500
70/70 [==============================] - 3s 44ms/step - loss: 2.9743e-06 - accuracy: 1.0000 - val_loss: 0.8059 - val_accuracy: 0.9163
Epoch 165/500
70/70 [==============================] - 3s 42ms/step - loss: 2.8743e-06 - accuracy: 1.0000 - val_loss: 0.8081 - val_accuracy: 0.9168
Epoch 166/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7831e-06 - accuracy: 1.0000 - val_loss: 0.8093 - val_accuracy: 0.9168
Epoch 167/500
70/70 [==============================] - 3s 42ms/step - loss: 2.7983e-06 - accuracy: 1.0000 - val_loss: 0.8135 - val_accuracy: 0.9163
Epoch 168/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5856e-06 - accuracy: 1.0000 - val_loss: 0.8151 - val_accuracy: 0.9168
Epoch 169/500
70/70 [==============================] - 3s 41ms/step - loss: 2.4727e-06 - accuracy: 1.0000 - val_loss: 0.8192 - val_accuracy: 0.9168
Epoch 170/500
70/70 [==============================] - 3s 41ms/step - loss: 2.4138e-06 - accuracy: 1.0000 - val_loss: 0.8181 - val_accuracy: 0.9172
Epoch 171/500
70/70 [==============================] - 3s 44ms/step - loss: 2.3350e-06 - accuracy: 1.0000 - val_loss: 0.8244 - val_accuracy: 0.9166
Epoch 172/500
70/70 [==============================] - 3s 41ms/step - loss: 2.2503e-06 - accuracy: 1.0000 - val_loss: 0.8254 - val_accuracy: 0.9168
Epoch 173/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1650e-06 - accuracy: 1.0000 - val_loss: 0.8305 - val_accuracy: 0.9170
Epoch 174/500
70/70 [==============================] - 3s 43ms/step - loss: 2.0813e-06 - accuracy: 1.0000 - val_loss: 0.8346 - val_accuracy: 0.9166
Epoch 175/500
70/70 [==============================] - 3s 41ms/step - loss: 2.0147e-06 - accuracy: 1.0000 - val_loss: 0.8340 - val_accuracy: 0.9163
Epoch 176/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9378e-06 - accuracy: 1.0000 - val_loss: 0.8344 - val_accuracy: 0.9168
Epoch 177/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8888e-06 - accuracy: 1.0000 - val_loss: 0.8455 - val_accuracy: 0.9168
Epoch 178/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8190e-06 - accuracy: 1.0000 - val_loss: 0.8457 - val_accuracy: 0.9168
Epoch 179/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7354e-06 - accuracy: 1.0000 - val_loss: 0.8433 - val_accuracy: 0.9168
Epoch 180/500
70/70 [==============================] - 3s 42ms/step - loss: 1.6837e-06 - accuracy: 1.0000 - val_loss: 0.8456 - val_accuracy: 0.9163
Epoch 181/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6287e-06 - accuracy: 1.0000 - val_loss: 0.8466 - val_accuracy: 0.9166
Epoch 182/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6067e-06 - accuracy: 1.0000 - val_loss: 0.8553 - val_accuracy: 0.9163
Epoch 183/500
70/70 [==============================] - 3s 42ms/step - loss: 1.5405e-06 - accuracy: 1.0000 - val_loss: 0.8570 - val_accuracy: 0.9170
Epoch 184/500
70/70 [==============================] - 3s 41ms/step - loss: 1.5031e-06 - accuracy: 1.0000 - val_loss: 0.8618 - val_accuracy: 0.9166
Epoch 185/500
70/70 [==============================] - 3s 42ms/step - loss: 1.4255e-06 - accuracy: 1.0000 - val_loss: 0.8604 - val_accuracy: 0.9166
Epoch 186/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4028e-06 - accuracy: 1.0000 - val_loss: 0.8594 - val_accuracy: 0.9163
Epoch 187/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3491e-06 - accuracy: 1.0000 - val_loss: 0.8669 - val_accuracy: 0.9168
Epoch 188/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3085e-06 - accuracy: 1.0000 - val_loss: 0.8659 - val_accuracy: 0.9163
Epoch 189/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2550e-06 - accuracy: 1.0000 - val_loss: 0.8689 - val_accuracy: 0.9170
Epoch 190/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2186e-06 - accuracy: 1.0000 - val_loss: 0.8759 - val_accuracy: 0.9172
Epoch 191/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1792e-06 - accuracy: 1.0000 - val_loss: 0.8724 - val_accuracy: 0.9170
Epoch 192/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1521e-06 - accuracy: 1.0000 - val_loss: 0.8797 - val_accuracy: 0.9168
Epoch 193/500
70/70 [==============================] - 3s 40ms/step - loss: 1.0836e-06 - accuracy: 1.0000 - val_loss: 0.8860 - val_accuracy: 0.9159
Epoch 194/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1122e-06 - accuracy: 1.0000 - val_loss: 0.8846 - val_accuracy: 0.9166
Epoch 195/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0239e-06 - accuracy: 1.0000 - val_loss: 0.8871 - val_accuracy: 0.9163
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Epoch 196/500
70/70 [==============================] - 3s 42ms/step - loss: 9.8129e-07 - accuracy: 1.0000 - val_loss: 0.8891 - val_accuracy: 0.9166
Epoch 197/500
70/70 [==============================] - 3s 41ms/step - loss: 9.7712e-07 - accuracy: 1.0000 - val_loss: 0.8878 - val_accuracy: 0.9161
Epoch 198/500
70/70 [==============================] - 3s 41ms/step - loss: 9.4607e-07 - accuracy: 1.0000 - val_loss: 0.8918 - val_accuracy: 0.9161
Epoch 199/500
70/70 [==============================] - 3s 41ms/step - loss: 8.8245e-07 - accuracy: 1.0000 - val_loss: 0.8971 - val_accuracy: 0.9163
Epoch 200/500
70/70 [==============================] - 3s 41ms/step - loss: 8.7267e-07 - accuracy: 1.0000 - val_loss: 0.8981 - val_accuracy: 0.9163
Epoch 201/500
70/70 [==============================] - 3s 41ms/step - loss: 8.3370e-07 - accuracy: 1.0000 - val_loss: 0.8994 - val_accuracy: 0.9163
Epoch 202/500
70/70 [==============================] - 3s 41ms/step - loss: 8.1655e-07 - accuracy: 1.0000 - val_loss: 0.9070 - val_accuracy: 0.9159
Epoch 203/500
70/70 [==============================] - 3s 41ms/step - loss: 8.0706e-07 - accuracy: 1.0000 - val_loss: 0.9049 - val_accuracy: 0.9161
Epoch 204/500
70/70 [==============================] - 3s 42ms/step - loss: 7.5667e-07 - accuracy: 1.0000 - val_loss: 0.9099 - val_accuracy: 0.9154
Epoch 205/500
70/70 [==============================] - 3s 41ms/step - loss: 7.3183e-07 - accuracy: 1.0000 - val_loss: 0.9108 - val_accuracy: 0.9161
Epoch 206/500
70/70 [==============================] - 3s 41ms/step - loss: 7.0909e-07 - accuracy: 1.0000 - val_loss: 0.9137 - val_accuracy: 0.9161
Epoch 207/500
70/70 [==============================] - 3s 41ms/step - loss: 6.9554e-07 - accuracy: 1.0000 - val_loss: 0.9151 - val_accuracy: 0.9154
Epoch 208/500
70/70 [==============================] - 3s 41ms/step - loss: 6.5344e-07 - accuracy: 1.0000 - val_loss: 0.9175 - val_accuracy: 0.9152
Epoch 209/500
70/70 [==============================] - 3s 41ms/step - loss: 6.4882e-07 - accuracy: 1.0000 - val_loss: 0.9188 - val_accuracy: 0.9152
Epoch 210/500
70/70 [==============================] - 3s 41ms/step - loss: 6.2952e-07 - accuracy: 1.0000 - val_loss: 0.9249 - val_accuracy: 0.9152
Epoch 211/500
70/70 [==============================] - 3s 41ms/step - loss: 6.1331e-07 - accuracy: 1.0000 - val_loss: 0.9298 - val_accuracy: 0.9152
Epoch 212/500
70/70 [==============================] - 3s 41ms/step - loss: 6.1192e-07 - accuracy: 1.0000 - val_loss: 0.9255 - val_accuracy: 0.9152
Epoch 213/500
70/70 [==============================] - 3s 41ms/step - loss: 5.8556e-07 - accuracy: 1.0000 - val_loss: 0.9310 - val_accuracy: 0.9152
Epoch 214/500
70/70 [==============================] - 3s 41ms/step - loss: 5.6914e-07 - accuracy: 1.0000 - val_loss: 0.9366 - val_accuracy: 0.9147
Epoch 215/500
70/70 [==============================] - 3s 41ms/step - loss: 5.5191e-07 - accuracy: 1.0000 - val_loss: 0.9303 - val_accuracy: 0.9154
Epoch 216/500
70/70 [==============================] - 3s 41ms/step - loss: 5.3318e-07 - accuracy: 1.0000 - val_loss: 0.9372 - val_accuracy: 0.9154
Epoch 217/500
70/70 [==============================] - 3s 40ms/step - loss: 4.9008e-07 - accuracy: 1.0000 - val_loss: 0.9375 - val_accuracy: 0.9152
Epoch 218/500
70/70 [==============================] - 3s 41ms/step - loss: 4.8593e-07 - accuracy: 1.0000 - val_loss: 0.9341 - val_accuracy: 0.9154
Epoch 219/500
70/70 [==============================] - 3s 40ms/step - loss: 4.7301e-07 - accuracy: 1.0000 - val_loss: 0.9432 - val_accuracy: 0.9145
Epoch 220/500
70/70 [==============================] - 3s 41ms/step - loss: 4.6429e-07 - accuracy: 1.0000 - val_loss: 0.9369 - val_accuracy: 0.9156
Epoch 221/500
70/70 [==============================] - 3s 41ms/step - loss: 4.7078e-07 - accuracy: 1.0000 - val_loss: 0.9502 - val_accuracy: 0.9145
Epoch 222/500
70/70 [==============================] - 3s 42ms/step - loss: 4.3969e-07 - accuracy: 1.0000 - val_loss: 0.9475 - val_accuracy: 0.9154
Epoch 223/500
70/70 [==============================] - 3s 43ms/step - loss: 4.2962e-07 - accuracy: 1.0000 - val_loss: 0.9541 - val_accuracy: 0.9147
Epoch 224/500
70/70 [==============================] - 3s 42ms/step - loss: 4.1237e-07 - accuracy: 1.0000 - val_loss: 0.9531 - val_accuracy: 0.9145
Epoch 225/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8356e-07 - accuracy: 1.0000 - val_loss: 0.9602 - val_accuracy: 0.9152
Epoch 226/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8161e-07 - accuracy: 1.0000 - val_loss: 0.9584 - val_accuracy: 0.9143
Epoch 227/500
70/70 [==============================] - 3s 41ms/step - loss: 3.6313e-07 - accuracy: 1.0000 - val_loss: 0.9554 - val_accuracy: 0.9152
Epoch 228/500
70/70 [==============================] - 3s 41ms/step - loss: 3.7720e-07 - accuracy: 1.0000 - val_loss: 0.9628 - val_accuracy: 0.9147
Epoch 229/500
70/70 [==============================] - 3s 41ms/step - loss: 3.6467e-07 - accuracy: 1.0000 - val_loss: 0.9639 - val_accuracy: 0.9141
Epoch 230/500
70/70 [==============================] - 3s 42ms/step - loss: 3.2503e-07 - accuracy: 1.0000 - val_loss: 0.9663 - val_accuracy: 0.9136
Epoch 231/500
70/70 [==============================] - 3s 41ms/step - loss: 3.5726e-07 - accuracy: 1.0000 - val_loss: 0.9809 - val_accuracy: 0.9145
Epoch 232/500
70/70 [==============================] - 3s 42ms/step - loss: 3.3159e-07 - accuracy: 1.0000 - val_loss: 0.9765 - val_accuracy: 0.9152
Epoch 233/500
70/70 [==============================] - 3s 41ms/step - loss: 3.1081e-07 - accuracy: 1.0000 - val_loss: 0.9756 - val_accuracy: 0.9147
Epoch 234/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0759e-07 - accuracy: 1.0000 - val_loss: 0.9789 - val_accuracy: 0.9143
Epoch 235/500
70/70 [==============================] - 3s 41ms/step - loss: 3.3499e-07 - accuracy: 1.0000 - val_loss: 0.9866 - val_accuracy: 0.9141
Epoch 236/500
70/70 [==============================] - 3s 41ms/step - loss: 2.8040e-07 - accuracy: 1.0000 - val_loss: 0.9814 - val_accuracy: 0.9143
Epoch 237/500
70/70 [==============================] - 3s 41ms/step - loss: 2.6023e-07 - accuracy: 1.0000 - val_loss: 0.9820 - val_accuracy: 0.9143
Epoch 238/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7017e-07 - accuracy: 1.0000 - val_loss: 0.9847 - val_accuracy: 0.9136
Epoch 239/500
70/70 [==============================] - 3s 40ms/step - loss: 2.3916e-07 - accuracy: 1.0000 - val_loss: 0.9889 - val_accuracy: 0.9143
Epoch 240/500
70/70 [==============================] - 3s 42ms/step - loss: 2.3660e-07 - accuracy: 1.0000 - val_loss: 0.9915 - val_accuracy: 0.9147
Epoch 241/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7040e-07 - accuracy: 1.0000 - val_loss: 0.9890 - val_accuracy: 0.9132
Epoch 242/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1780e-07 - accuracy: 1.0000 - val_loss: 0.9998 - val_accuracy: 0.9134
Epoch 243/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1331e-07 - accuracy: 1.0000 - val_loss: 0.9976 - val_accuracy: 0.9143
Epoch 244/500
70/70 [==============================] - 3s 40ms/step - loss: 2.1174e-07 - accuracy: 1.0000 - val_loss: 1.0044 - val_accuracy: 0.9145
Epoch 245/500
70/70 [==============================] - 3s 42ms/step - loss: 2.0295e-07 - accuracy: 1.0000 - val_loss: 0.9933 - val_accuracy: 0.9141
Epoch 246/500
70/70 [==============================] - 3s 42ms/step - loss: 0.0453 - accuracy: 0.9907 - val_loss: 0.8777 - val_accuracy: 0.8667
Epoch 247/500
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70/70 [==============================] - 3s 41ms/step - loss: 0.0279 - accuracy: 0.9913 - val_loss: 0.6370 - val_accuracy: 0.9023
Epoch 248/500
70/70 [==============================] - 3s 41ms/step - loss: 0.0048 - accuracy: 0.9984 - val_loss: 0.7279 - val_accuracy: 0.8986
Epoch 249/500
70/70 [==============================] - 3s 42ms/step - loss: 0.0018 - accuracy: 0.9996 - val_loss: 0.7564 - val_accuracy: 0.9075
Epoch 250/500
70/70 [==============================] - 3s 41ms/step - loss: 8.2381e-04 - accuracy: 0.9999 - val_loss: 0.7465 - val_accuracy: 0.9079
Epoch 251/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8728e-04 - accuracy: 1.0000 - val_loss: 0.7289 - val_accuracy: 0.9104
Epoch 252/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0875e-04 - accuracy: 1.0000 - val_loss: 0.7468 - val_accuracy: 0.9113
Epoch 253/500
70/70 [==============================] - 3s 41ms/step - loss: 8.5367e-05 - accuracy: 1.0000 - val_loss: 0.7626 - val_accuracy: 0.9111
Epoch 254/500
70/70 [==============================] - 3s 41ms/step - loss: 7.2024e-05 - accuracy: 1.0000 - val_loss: 0.7713 - val_accuracy: 0.9113
Epoch 255/500
70/70 [==============================] - 3s 41ms/step - loss: 6.3630e-05 - accuracy: 1.0000 - val_loss: 0.7777 - val_accuracy: 0.9116
Epoch 256/500
70/70 [==============================] - 3s 42ms/step - loss: 5.6506e-05 - accuracy: 1.0000 - val_loss: 0.7877 - val_accuracy: 0.9118
Epoch 257/500
70/70 [==============================] - 3s 41ms/step - loss: 5.0764e-05 - accuracy: 1.0000 - val_loss: 0.7949 - val_accuracy: 0.9111
Epoch 258/500
70/70 [==============================] - 3s 41ms/step - loss: 4.6124e-05 - accuracy: 1.0000 - val_loss: 0.8018 - val_accuracy: 0.9111
Epoch 259/500
70/70 [==============================] - 3s 42ms/step - loss: 4.2399e-05 - accuracy: 1.0000 - val_loss: 0.8063 - val_accuracy: 0.9107
Epoch 260/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8979e-05 - accuracy: 1.0000 - val_loss: 0.8101 - val_accuracy: 0.9104
Epoch 261/500
70/70 [==============================] - 3s 41ms/step - loss: 3.6150e-05 - accuracy: 1.0000 - val_loss: 0.8151 - val_accuracy: 0.9104
Epoch 262/500
70/70 [==============================] - 3s 42ms/step - loss: 3.3793e-05 - accuracy: 1.0000 - val_loss: 0.8212 - val_accuracy: 0.9109
Epoch 263/500
70/70 [==============================] - 3s 41ms/step - loss: 3.1497e-05 - accuracy: 1.0000 - val_loss: 0.8222 - val_accuracy: 0.9107
Epoch 264/500
70/70 [==============================] - 3s 41ms/step - loss: 2.9544e-05 - accuracy: 1.0000 - val_loss: 0.8269 - val_accuracy: 0.9109
Epoch 265/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7547e-05 - accuracy: 1.0000 - val_loss: 0.8289 - val_accuracy: 0.9109
Epoch 266/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5922e-05 - accuracy: 1.0000 - val_loss: 0.8309 - val_accuracy: 0.9107
Epoch 267/500
70/70 [==============================] - 3s 42ms/step - loss: 2.4449e-05 - accuracy: 1.0000 - val_loss: 0.8350 - val_accuracy: 0.9107
Epoch 268/500
70/70 [==============================] - 3s 41ms/step - loss: 2.3108e-05 - accuracy: 1.0000 - val_loss: 0.8360 - val_accuracy: 0.9104
Epoch 269/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1712e-05 - accuracy: 1.0000 - val_loss: 0.8403 - val_accuracy: 0.9107
Epoch 270/500
70/70 [==============================] - 3s 40ms/step - loss: 2.0354e-05 - accuracy: 1.0000 - val_loss: 0.8434 - val_accuracy: 0.9102
Epoch 271/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9271e-05 - accuracy: 1.0000 - val_loss: 0.8476 - val_accuracy: 0.9102
Epoch 272/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8281e-05 - accuracy: 1.0000 - val_loss: 0.8504 - val_accuracy: 0.9100
Epoch 273/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7220e-05 - accuracy: 1.0000 - val_loss: 0.8521 - val_accuracy: 0.9102
Epoch 274/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6419e-05 - accuracy: 1.0000 - val_loss: 0.8556 - val_accuracy: 0.9095
Epoch 275/500
70/70 [==============================] - 3s 41ms/step - loss: 1.5606e-05 - accuracy: 1.0000 - val_loss: 0.8580 - val_accuracy: 0.9093
Epoch 276/500
70/70 [==============================] - 3s 42ms/step - loss: 1.4802e-05 - accuracy: 1.0000 - val_loss: 0.8618 - val_accuracy: 0.9098
Epoch 277/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4135e-05 - accuracy: 1.0000 - val_loss: 0.8637 - val_accuracy: 0.9095
Epoch 278/500
70/70 [==============================] - 3s 42ms/step - loss: 1.3438e-05 - accuracy: 1.0000 - val_loss: 0.8663 - val_accuracy: 0.9095
Epoch 279/500
70/70 [==============================] - 3s 42ms/step - loss: 1.2840e-05 - accuracy: 1.0000 - val_loss: 0.8688 - val_accuracy: 0.9095
Epoch 280/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2281e-05 - accuracy: 1.0000 - val_loss: 0.8717 - val_accuracy: 0.9095
Epoch 281/500
70/70 [==============================] - 3s 40ms/step - loss: 1.1725e-05 - accuracy: 1.0000 - val_loss: 0.8745 - val_accuracy: 0.9095
Epoch 282/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1216e-05 - accuracy: 1.0000 - val_loss: 0.8760 - val_accuracy: 0.9098
Epoch 283/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0733e-05 - accuracy: 1.0000 - val_loss: 0.8796 - val_accuracy: 0.9098
Epoch 284/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0276e-05 - accuracy: 1.0000 - val_loss: 0.8818 - val_accuracy: 0.9098
Epoch 285/500
70/70 [==============================] - 3s 41ms/step - loss: 9.8942e-06 - accuracy: 1.0000 - val_loss: 0.8839 - val_accuracy: 0.9100
Epoch 286/500
70/70 [==============================] - 3s 42ms/step - loss: 9.4466e-06 - accuracy: 1.0000 - val_loss: 0.8861 - val_accuracy: 0.9104
Epoch 287/500
70/70 [==============================] - 3s 41ms/step - loss: 9.0728e-06 - accuracy: 1.0000 - val_loss: 0.8867 - val_accuracy: 0.9104
Epoch 288/500
70/70 [==============================] - 3s 40ms/step - loss: 8.6901e-06 - accuracy: 1.0000 - val_loss: 0.8910 - val_accuracy: 0.9102
Epoch 289/500
70/70 [==============================] - 3s 41ms/step - loss: 8.3615e-06 - accuracy: 1.0000 - val_loss: 0.8926 - val_accuracy: 0.9104
Epoch 290/500
70/70 [==============================] - 3s 41ms/step - loss: 8.0246e-06 - accuracy: 1.0000 - val_loss: 0.8947 - val_accuracy: 0.9102
Epoch 291/500
70/70 [==============================] - 3s 41ms/step - loss: 7.7271e-06 - accuracy: 1.0000 - val_loss: 0.8964 - val_accuracy: 0.9107
Epoch 292/500
70/70 [==============================] - 3s 41ms/step - loss: 7.4175e-06 - accuracy: 1.0000 - val_loss: 0.8995 - val_accuracy: 0.9107
Epoch 293/500
70/70 [==============================] - 3s 41ms/step - loss: 7.1184e-06 - accuracy: 1.0000 - val_loss: 0.9006 - val_accuracy: 0.9107
Epoch 294/500
70/70 [==============================] - 3s 41ms/step - loss: 6.8434e-06 - accuracy: 1.0000 - val_loss: 0.9043 - val_accuracy: 0.9104
Epoch 295/500
70/70 [==============================] - 3s 42ms/step - loss: 6.5948e-06 - accuracy: 1.0000 - val_loss: 0.9059 - val_accuracy: 0.9107
Epoch 296/500
70/70 [==============================] - 3s 41ms/step - loss: 6.3200e-06 - accuracy: 1.0000 - val_loss: 0.9079 - val_accuracy: 0.9109
Epoch 297/500
70/70 [==============================] - 3s 41ms/step - loss: 6.0780e-06 - accuracy: 1.0000 - val_loss: 0.9103 - val_accuracy: 0.9107
Epoch 298/500
70/70 [==============================] - 3s 41ms/step - loss: 5.8727e-06 - accuracy: 1.0000 - val_loss: 0.9121 - val_accuracy: 0.9116
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Epoch 299/500
70/70 [==============================] - 3s 41ms/step - loss: 5.6791e-06 - accuracy: 1.0000 - val_loss: 0.9147 - val_accuracy: 0.9113
Epoch 300/500
70/70 [==============================] - 3s 41ms/step - loss: 5.4384e-06 - accuracy: 1.0000 - val_loss: 0.9166 - val_accuracy: 0.9109
Epoch 301/500
70/70 [==============================] - 3s 40ms/step - loss: 5.2240e-06 - accuracy: 1.0000 - val_loss: 0.9187 - val_accuracy: 0.9113
Epoch 302/500
70/70 [==============================] - 3s 41ms/step - loss: 5.0407e-06 - accuracy: 1.0000 - val_loss: 0.9223 - val_accuracy: 0.9111
Epoch 303/500
70/70 [==============================] - 3s 41ms/step - loss: 4.8687e-06 - accuracy: 1.0000 - val_loss: 0.9229 - val_accuracy: 0.9113
Epoch 304/500
70/70 [==============================] - 3s 40ms/step - loss: 4.6742e-06 - accuracy: 1.0000 - val_loss: 0.9259 - val_accuracy: 0.9111
Epoch 305/500
70/70 [==============================] - 3s 41ms/step - loss: 4.5213e-06 - accuracy: 1.0000 - val_loss: 0.9282 - val_accuracy: 0.9113
Epoch 306/500
70/70 [==============================] - 3s 41ms/step - loss: 4.3501e-06 - accuracy: 1.0000 - val_loss: 0.9294 - val_accuracy: 0.9111
Epoch 307/500
70/70 [==============================] - 3s 41ms/step - loss: 4.1871e-06 - accuracy: 1.0000 - val_loss: 0.9325 - val_accuracy: 0.9111
Epoch 308/500
70/70 [==============================] - 3s 41ms/step - loss: 4.0479e-06 - accuracy: 1.0000 - val_loss: 0.9342 - val_accuracy: 0.9116
Epoch 309/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8957e-06 - accuracy: 1.0000 - val_loss: 0.9361 - val_accuracy: 0.9109
Epoch 310/500
70/70 [==============================] - 3s 41ms/step - loss: 3.7564e-06 - accuracy: 1.0000 - val_loss: 0.9364 - val_accuracy: 0.9111
Epoch 311/500
70/70 [==============================] - 3s 41ms/step - loss: 3.6165e-06 - accuracy: 1.0000 - val_loss: 0.9398 - val_accuracy: 0.9116
Epoch 312/500
70/70 [==============================] - 3s 41ms/step - loss: 3.5025e-06 - accuracy: 1.0000 - val_loss: 0.9417 - val_accuracy: 0.9111
Epoch 313/500
70/70 [==============================] - 3s 41ms/step - loss: 3.3762e-06 - accuracy: 1.0000 - val_loss: 0.9441 - val_accuracy: 0.9113
Epoch 314/500
70/70 [==============================] - 3s 41ms/step - loss: 3.2485e-06 - accuracy: 1.0000 - val_loss: 0.9455 - val_accuracy: 0.9113
Epoch 315/500
70/70 [==============================] - 3s 41ms/step - loss: 3.1359e-06 - accuracy: 1.0000 - val_loss: 0.9474 - val_accuracy: 0.9113
Epoch 316/500
70/70 [==============================] - 3s 40ms/step - loss: 3.0333e-06 - accuracy: 1.0000 - val_loss: 0.9489 - val_accuracy: 0.9113
Epoch 317/500
70/70 [==============================] - 3s 42ms/step - loss: 2.9243e-06 - accuracy: 1.0000 - val_loss: 0.9510 - val_accuracy: 0.9116
Epoch 318/500
70/70 [==============================] - 3s 41ms/step - loss: 2.8248e-06 - accuracy: 1.0000 - val_loss: 0.9527 - val_accuracy: 0.9113
Epoch 319/500
70/70 [==============================] - 3s 40ms/step - loss: 2.7253e-06 - accuracy: 1.0000 - val_loss: 0.9578 - val_accuracy: 0.9116
Epoch 320/500
70/70 [==============================] - 3s 40ms/step - loss: 2.6302e-06 - accuracy: 1.0000 - val_loss: 0.9573 - val_accuracy: 0.9116
Epoch 321/500
70/70 [==============================] - 3s 40ms/step - loss: 2.5600e-06 - accuracy: 1.0000 - val_loss: 0.9605 - val_accuracy: 0.9116
Epoch 322/500
70/70 [==============================] - 3s 41ms/step - loss: 2.4613e-06 - accuracy: 1.0000 - val_loss: 0.9631 - val_accuracy: 0.9116
Epoch 323/500
70/70 [==============================] - 3s 41ms/step - loss: 2.3715e-06 - accuracy: 1.0000 - val_loss: 0.9632 - val_accuracy: 0.9116
Epoch 324/500
70/70 [==============================] - 3s 41ms/step - loss: 2.2881e-06 - accuracy: 1.0000 - val_loss: 0.9650 - val_accuracy: 0.9118
Epoch 325/500
70/70 [==============================] - 3s 40ms/step - loss: 2.2105e-06 - accuracy: 1.0000 - val_loss: 0.9686 - val_accuracy: 0.9113
Epoch 326/500
70/70 [==============================] - 3s 42ms/step - loss: 2.1275e-06 - accuracy: 1.0000 - val_loss: 0.9707 - val_accuracy: 0.9116
Epoch 327/500
70/70 [==============================] - 3s 41ms/step - loss: 2.0669e-06 - accuracy: 1.0000 - val_loss: 0.9743 - val_accuracy: 0.9116
Epoch 328/500
70/70 [==============================] - 3s 43ms/step - loss: 1.9917e-06 - accuracy: 1.0000 - val_loss: 0.9755 - val_accuracy: 0.9113
Epoch 329/500
70/70 [==============================] - 3s 40ms/step - loss: 1.9308e-06 - accuracy: 1.0000 - val_loss: 0.9762 - val_accuracy: 0.9111
Epoch 330/500
70/70 [==============================] - 3s 40ms/step - loss: 1.8466e-06 - accuracy: 1.0000 - val_loss: 0.9805 - val_accuracy: 0.9111
Epoch 331/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7855e-06 - accuracy: 1.0000 - val_loss: 0.9795 - val_accuracy: 0.9113
Epoch 332/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7303e-06 - accuracy: 1.0000 - val_loss: 0.9805 - val_accuracy: 0.9109
Epoch 333/500
70/70 [==============================] - 3s 43ms/step - loss: 1.6712e-06 - accuracy: 1.0000 - val_loss: 0.9848 - val_accuracy: 0.9109
Epoch 334/500
70/70 [==============================] - 3s 43ms/step - loss: 1.6157e-06 - accuracy: 1.0000 - val_loss: 0.9871 - val_accuracy: 0.9109
Epoch 335/500
70/70 [==============================] - 3s 42ms/step - loss: 1.5564e-06 - accuracy: 1.0000 - val_loss: 0.9903 - val_accuracy: 0.9111
Epoch 336/500
70/70 [==============================] - 3s 42ms/step - loss: 1.4974e-06 - accuracy: 1.0000 - val_loss: 0.9912 - val_accuracy: 0.9111
Epoch 337/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4544e-06 - accuracy: 1.0000 - val_loss: 0.9922 - val_accuracy: 0.9111
Epoch 338/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4015e-06 - accuracy: 1.0000 - val_loss: 0.9947 - val_accuracy: 0.9107
Epoch 339/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3563e-06 - accuracy: 1.0000 - val_loss: 0.9987 - val_accuracy: 0.9107
Epoch 340/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3084e-06 - accuracy: 1.0000 - val_loss: 0.9986 - val_accuracy: 0.9111
Epoch 341/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2572e-06 - accuracy: 1.0000 - val_loss: 1.0022 - val_accuracy: 0.9109
Epoch 342/500
70/70 [==============================] - 3s 40ms/step - loss: 1.2136e-06 - accuracy: 1.0000 - val_loss: 1.0045 - val_accuracy: 0.9109
Epoch 343/500
70/70 [==============================] - 3s 40ms/step - loss: 1.1749e-06 - accuracy: 1.0000 - val_loss: 1.0070 - val_accuracy: 0.9109
Epoch 344/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1363e-06 - accuracy: 1.0000 - val_loss: 1.0074 - val_accuracy: 0.9113
Epoch 345/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1015e-06 - accuracy: 1.0000 - val_loss: 1.0113 - val_accuracy: 0.9107
Epoch 346/500
70/70 [==============================] - 3s 40ms/step - loss: 1.0667e-06 - accuracy: 1.0000 - val_loss: 1.0112 - val_accuracy: 0.9111
Epoch 347/500
70/70 [==============================] - 3s 40ms/step - loss: 1.0273e-06 - accuracy: 1.0000 - val_loss: 1.0128 - val_accuracy: 0.9107
Epoch 348/500
70/70 [==============================] - 3s 41ms/step - loss: 9.8974e-07 - accuracy: 1.0000 - val_loss: 1.0162 - val_accuracy: 0.9107
Epoch 349/500
70/70 [==============================] - 3s 41ms/step - loss: 9.5560e-07 - accuracy: 1.0000 - val_loss: 1.0174 - val_accuracy: 0.9111
Epoch 350/500
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70/70 [==============================] - 3s 41ms/step - loss: 9.2327e-07 - accuracy: 1.0000 - val_loss: 1.0221 - val_accuracy: 0.9107
Epoch 351/500
70/70 [==============================] - 3s 40ms/step - loss: 8.9896e-07 - accuracy: 1.0000 - val_loss: 1.0205 - val_accuracy: 0.9109
Epoch 352/500
70/70 [==============================] - 3s 41ms/step - loss: 8.6119e-07 - accuracy: 1.0000 - val_loss: 1.0230 - val_accuracy: 0.9111
Epoch 353/500
70/70 [==============================] - 3s 41ms/step - loss: 8.3299e-07 - accuracy: 1.0000 - val_loss: 1.0280 - val_accuracy: 0.9111
Epoch 354/500
70/70 [==============================] - 3s 41ms/step - loss: 8.1256e-07 - accuracy: 1.0000 - val_loss: 1.0267 - val_accuracy: 0.9113
Epoch 355/500
70/70 [==============================] - 3s 41ms/step - loss: 7.8315e-07 - accuracy: 1.0000 - val_loss: 1.0308 - val_accuracy: 0.9107
Epoch 356/500
70/70 [==============================] - 3s 41ms/step - loss: 7.4933e-07 - accuracy: 1.0000 - val_loss: 1.0339 - val_accuracy: 0.9111
Epoch 357/500
70/70 [==============================] - 3s 41ms/step - loss: 7.3139e-07 - accuracy: 1.0000 - val_loss: 1.0354 - val_accuracy: 0.9111
Epoch 358/500
70/70 [==============================] - 3s 42ms/step - loss: 7.0391e-07 - accuracy: 1.0000 - val_loss: 1.0367 - val_accuracy: 0.9109
Epoch 359/500
70/70 [==============================] - 3s 41ms/step - loss: 6.8095e-07 - accuracy: 1.0000 - val_loss: 1.0390 - val_accuracy: 0.9111
Epoch 360/500
70/70 [==============================] - 3s 42ms/step - loss: 6.5740e-07 - accuracy: 1.0000 - val_loss: 1.0407 - val_accuracy: 0.9116
Epoch 361/500
70/70 [==============================] - 3s 42ms/step - loss: 6.4286e-07 - accuracy: 1.0000 - val_loss: 1.0448 - val_accuracy: 0.9113
Epoch 362/500
70/70 [==============================] - 3s 41ms/step - loss: 6.1583e-07 - accuracy: 1.0000 - val_loss: 1.0451 - val_accuracy: 0.9111
Epoch 363/500
70/70 [==============================] - 3s 41ms/step - loss: 5.9334e-07 - accuracy: 1.0000 - val_loss: 1.0475 - val_accuracy: 0.9113
Epoch 364/500
70/70 [==============================] - 3s 41ms/step - loss: 5.6974e-07 - accuracy: 1.0000 - val_loss: 1.0518 - val_accuracy: 0.9111
Epoch 365/500
70/70 [==============================] - 3s 41ms/step - loss: 5.5739e-07 - accuracy: 1.0000 - val_loss: 1.0502 - val_accuracy: 0.9111
Epoch 366/500
70/70 [==============================] - 3s 42ms/step - loss: 5.3124e-07 - accuracy: 1.0000 - val_loss: 1.0552 - val_accuracy: 0.9107
Epoch 367/500
70/70 [==============================] - 3s 41ms/step - loss: 5.1480e-07 - accuracy: 1.0000 - val_loss: 1.0578 - val_accuracy: 0.9104
Epoch 368/500
70/70 [==============================] - 3s 41ms/step - loss: 4.9934e-07 - accuracy: 1.0000 - val_loss: 1.0574 - val_accuracy: 0.9113
Epoch 369/500
70/70 [==============================] - 3s 42ms/step - loss: 4.8046e-07 - accuracy: 1.0000 - val_loss: 1.0640 - val_accuracy: 0.9107
Epoch 370/500
70/70 [==============================] - 3s 41ms/step - loss: 4.6675e-07 - accuracy: 1.0000 - val_loss: 1.0631 - val_accuracy: 0.9113
Epoch 371/500
70/70 [==============================] - 3s 41ms/step - loss: 4.5451e-07 - accuracy: 1.0000 - val_loss: 1.0642 - val_accuracy: 0.9109
Epoch 372/500
70/70 [==============================] - 3s 42ms/step - loss: 4.3866e-07 - accuracy: 1.0000 - val_loss: 1.0668 - val_accuracy: 0.9109
Epoch 373/500
70/70 [==============================] - 3s 41ms/step - loss: 4.2544e-07 - accuracy: 1.0000 - val_loss: 1.0680 - val_accuracy: 0.9109
Epoch 374/500
70/70 [==============================] - 3s 41ms/step - loss: 4.0889e-07 - accuracy: 1.0000 - val_loss: 1.0690 - val_accuracy: 0.9109
Epoch 375/500
70/70 [==============================] - 3s 41ms/step - loss: 3.9688e-07 - accuracy: 1.0000 - val_loss: 1.0715 - val_accuracy: 0.9111
Epoch 376/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8178e-07 - accuracy: 1.0000 - val_loss: 1.0738 - val_accuracy: 0.9109
Epoch 377/500
70/70 [==============================] - 3s 42ms/step - loss: 3.6950e-07 - accuracy: 1.0000 - val_loss: 1.0754 - val_accuracy: 0.9109
Epoch 378/500
70/70 [==============================] - 3s 41ms/step - loss: 3.5707e-07 - accuracy: 1.0000 - val_loss: 1.0760 - val_accuracy: 0.9113
Epoch 379/500
70/70 [==============================] - 3s 41ms/step - loss: 3.4522e-07 - accuracy: 1.0000 - val_loss: 1.0830 - val_accuracy: 0.9109
Epoch 380/500
70/70 [==============================] - 3s 41ms/step - loss: 3.3381e-07 - accuracy: 1.0000 - val_loss: 1.0815 - val_accuracy: 0.9113
Epoch 381/500
70/70 [==============================] - 3s 41ms/step - loss: 3.2400e-07 - accuracy: 1.0000 - val_loss: 1.0854 - val_accuracy: 0.9107
Epoch 382/500
70/70 [==============================] - 3s 40ms/step - loss: 3.1251e-07 - accuracy: 1.0000 - val_loss: 1.0864 - val_accuracy: 0.9104
Epoch 383/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0044e-07 - accuracy: 1.0000 - val_loss: 1.0903 - val_accuracy: 0.9102
Epoch 384/500
70/70 [==============================] - 3s 41ms/step - loss: 2.9533e-07 - accuracy: 1.0000 - val_loss: 1.0915 - val_accuracy: 0.9111
Epoch 385/500
70/70 [==============================] - 3s 40ms/step - loss: 2.8236e-07 - accuracy: 1.0000 - val_loss: 1.0952 - val_accuracy: 0.9111
Epoch 386/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7251e-07 - accuracy: 1.0000 - val_loss: 1.0944 - val_accuracy: 0.9116
Epoch 387/500
70/70 [==============================] - 3s 41ms/step - loss: 2.6434e-07 - accuracy: 1.0000 - val_loss: 1.0965 - val_accuracy: 0.9111
Epoch 388/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5818e-07 - accuracy: 1.0000 - val_loss: 1.0996 - val_accuracy: 0.9116
Epoch 389/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5696e-07 - accuracy: 1.0000 - val_loss: 1.0980 - val_accuracy: 0.9104
Epoch 390/500
70/70 [==============================] - 3s 41ms/step - loss: 2.4056e-07 - accuracy: 1.0000 - val_loss: 1.1026 - val_accuracy: 0.9111
Epoch 391/500
70/70 [==============================] - 3s 41ms/step - loss: 2.3306e-07 - accuracy: 1.0000 - val_loss: 1.1012 - val_accuracy: 0.9102
Epoch 392/500
70/70 [==============================] - 3s 41ms/step - loss: 2.2538e-07 - accuracy: 1.0000 - val_loss: 1.1090 - val_accuracy: 0.9104
Epoch 393/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1879e-07 - accuracy: 1.0000 - val_loss: 1.1113 - val_accuracy: 0.9102
Epoch 394/500
70/70 [==============================] - 3s 42ms/step - loss: 2.1275e-07 - accuracy: 1.0000 - val_loss: 1.1126 - val_accuracy: 0.9109
Epoch 395/500
70/70 [==============================] - 3s 41ms/step - loss: 2.0272e-07 - accuracy: 1.0000 - val_loss: 1.1119 - val_accuracy: 0.9111
Epoch 396/500
70/70 [==============================] - 3s 42ms/step - loss: 1.9862e-07 - accuracy: 1.0000 - val_loss: 1.1171 - val_accuracy: 0.9095
Epoch 397/500
70/70 [==============================] - 3s 42ms/step - loss: 1.9232e-07 - accuracy: 1.0000 - val_loss: 1.1170 - val_accuracy: 0.9093
Epoch 398/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8495e-07 - accuracy: 1.0000 - val_loss: 1.1206 - val_accuracy: 0.9104
Epoch 399/500
70/70 [==============================] - 3s 42ms/step - loss: 1.7819e-07 - accuracy: 1.0000 - val_loss: 1.1220 - val_accuracy: 0.9104
Epoch 400/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7330e-07 - accuracy: 1.0000 - val_loss: 1.1257 - val_accuracy: 0.9095
Epoch 401/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6839e-07 - accuracy: 1.0000 - val_loss: 1.1263 - val_accuracy: 0.9107
```

```
Epoch 402/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6610e-07 - accuracy: 1.0000 - val_loss: 1.1350 - val_accuracy: 0.9109
Epoch 403/500
70/70 [==============================] - 3s 41ms/step - loss: 1.5812e-07 - accuracy: 1.0000 - val_loss: 1.1302 - val_accuracy: 0.9104
Epoch 404/500
70/70 [==============================] - 3s 42ms/step - loss: 1.5259e-07 - accuracy: 1.0000 - val_loss: 1.1370 - val_accuracy: 0.9107
Epoch 405/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4892e-07 - accuracy: 1.0000 - val_loss: 1.1317 - val_accuracy: 0.9098
Epoch 406/500
70/70 [==============================] - 3s 40ms/step - loss: 1.4124e-07 - accuracy: 1.0000 - val_loss: 1.1384 - val_accuracy: 0.9102
Epoch 407/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4058e-07 - accuracy: 1.0000 - val_loss: 1.1419 - val_accuracy: 0.9100
Epoch 408/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3301e-07 - accuracy: 1.0000 - val_loss: 1.1400 - val_accuracy: 0.9102
Epoch 409/500
70/70 [==============================] - 3s 41ms/step - loss: 1.3073e-07 - accuracy: 1.0000 - val_loss: 1.1426 - val_accuracy: 0.9095
Epoch 410/500
70/70 [==============================] - 3s 43ms/step - loss: 1.2631e-07 - accuracy: 1.0000 - val_loss: 1.1441 - val_accuracy: 0.9100
Epoch 411/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2248e-07 - accuracy: 1.0000 - val_loss: 1.1461 - val_accuracy: 0.9088
Epoch 412/500
70/70 [==============================] - 3s 41ms/step - loss: 1.2040e-07 - accuracy: 1.0000 - val_loss: 1.1492 - val_accuracy: 0.9100
Epoch 413/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1436e-07 - accuracy: 1.0000 - val_loss: 1.1526 - val_accuracy: 0.9102
Epoch 414/500
70/70 [==============================] - 3s 41ms/step - loss: 1.1362e-07 - accuracy: 1.0000 - val_loss: 1.1496 - val_accuracy: 0.9102
Epoch 415/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0764e-07 - accuracy: 1.0000 - val_loss: 1.1542 - val_accuracy: 0.9102
Epoch 416/500
70/70 [==============================] - 3s 41ms/step - loss: 1.0281e-07 - accuracy: 1.0000 - val_loss: 1.1630 - val_accuracy: 0.9100
Epoch 417/500
70/70 [==============================] - 3s 41ms/step - loss: 9.8117e-08 - accuracy: 1.0000 - val_loss: 1.1603 - val_accuracy: 0.9095
Epoch 418/500
70/70 [==============================] - 3s 41ms/step - loss: 9.7833e-08 - accuracy: 1.0000 - val_loss: 1.1614 - val_accuracy: 0.9100
Epoch 419/500
70/70 [==============================] - 3s 40ms/step - loss: 9.2982e-08 - accuracy: 1.0000 - val_loss: 1.1608 - val_accuracy: 0.9098
Epoch 420/500
70/70 [==============================] - 3s 40ms/step - loss: 8.9913e-08 - accuracy: 1.0000 - val_loss: 1.1646 - val_accuracy: 0.9100
Epoch 421/500
70/70 [==============================] - 3s 41ms/step - loss: 8.8638e-08 - accuracy: 1.0000 - val_loss: 1.1661 - val_accuracy: 0.9102
Epoch 422/500
70/70 [==============================] - 3s 41ms/step - loss: 8.5970e-08 - accuracy: 1.0000 - val_loss: 1.1686 - val_accuracy: 0.9107
Epoch 423/500
70/70 [==============================] - 3s 40ms/step - loss: 8.2931e-08 - accuracy: 1.0000 - val_loss: 1.1785 - val_accuracy: 0.9100
Epoch 424/500
70/70 [==============================] - 3s 41ms/step - loss: 7.9783e-08 - accuracy: 1.0000 - val_loss: 1.1744 - val_accuracy: 0.9102
Epoch 425/500
70/70 [==============================] - 3s 42ms/step - loss: 7.8012e-08 - accuracy: 1.0000 - val_loss: 1.1705 - val_accuracy: 0.9109
Epoch 426/500
70/70 [==============================] - 3s 42ms/step - loss: 7.5587e-08 - accuracy: 1.0000 - val_loss: 1.1761 - val_accuracy: 0.9100
Epoch 427/500
70/70 [==============================] - 3s 42ms/step - loss: 7.4124e-08 - accuracy: 1.0000 - val_loss: 1.1780 - val_accuracy: 0.9102
Epoch 428/500
70/70 [==============================] - 3s 43ms/step - loss: 7.1336e-08 - accuracy: 1.0000 - val_loss: 1.1754 - val_accuracy: 0.9109
Epoch 429/500
70/70 [==============================] - 3s 42ms/step - loss: 7.0894e-08 - accuracy: 1.0000 - val_loss: 1.1797 - val_accuracy: 0.9104
Epoch 430/500
70/70 [==============================] - 3s 41ms/step - loss: 6.8222e-08 - accuracy: 1.0000 - val_loss: 1.1839 - val_accuracy: 0.9100
Epoch 431/500
70/70 [==============================] - 3s 41ms/step - loss: 6.5933e-08 - accuracy: 1.0000 - val_loss: 1.1901 - val_accuracy: 0.9102
Epoch 432/500
70/70 [==============================] - 3s 42ms/step - loss: 6.0898e-08 - accuracy: 1.0000 - val_loss: 1.1890 - val_accuracy: 0.9102
Epoch 433/500
70/70 [==============================] - 3s 41ms/step - loss: 5.8911e-08 - accuracy: 1.0000 - val_loss: 1.1999 - val_accuracy: 0.9098
Epoch 434/500
70/70 [==============================] - 3s 41ms/step - loss: 5.7140e-08 - accuracy: 1.0000 - val_loss: 1.1944 - val_accuracy: 0.9102
Epoch 435/500
70/70 [==============================] - 3s 40ms/step - loss: 5.6133e-08 - accuracy: 1.0000 - val_loss: 1.2010 - val_accuracy: 0.9098
Epoch 436/500
70/70 [==============================] - 3s 40ms/step - loss: 5.3646e-08 - accuracy: 1.0000 - val_loss: 1.1988 - val_accuracy: 0.9100
Epoch 437/500
70/70 [==============================] - 3s 41ms/step - loss: 5.2717e-08 - accuracy: 1.0000 - val_loss: 1.1987 - val_accuracy: 0.9100
Epoch 438/500
70/70 [==============================] - 3s 41ms/step - loss: 5.0470e-08 - accuracy: 1.0000 - val_loss: 1.2053 - val_accuracy: 0.9100
Epoch 439/500
70/70 [==============================] - 3s 41ms/step - loss: 4.8730e-08 - accuracy: 1.0000 - val_loss: 1.2103 - val_accuracy: 0.9100
Epoch 440/500
70/70 [==============================] - 3s 41ms/step - loss: 4.7723e-08 - accuracy: 1.0000 - val_loss: 1.2136 - val_accuracy: 0.9100
Epoch 441/500
70/70 [==============================] - 3s 41ms/step - loss: 4.6325e-08 - accuracy: 1.0000 - val_loss: 1.2139 - val_accuracy: 0.9098
Epoch 442/500
70/70 [==============================] - 3s 41ms/step - loss: 4.3711e-08 - accuracy: 1.0000 - val_loss: 1.2087 - val_accuracy: 0.9095
Epoch 443/500
70/70 [==============================] - 3s 42ms/step - loss: 4.2964e-08 - accuracy: 1.0000 - val_loss: 1.2176 - val_accuracy: 0.9095
Epoch 444/500
70/70 [==============================] - 3s 41ms/step - loss: 4.2529e-08 - accuracy: 1.0000 - val_loss: 1.2145 - val_accuracy: 0.9102
Epoch 445/500
70/70 [==============================] - 3s 41ms/step - loss: 4.0512e-08 - accuracy: 1.0000 - val_loss: 1.2219 - val_accuracy: 0.9098
Epoch 446/500
70/70 [==============================] - 3s 42ms/step - loss: 4.3674e-08 - accuracy: 1.0000 - val_loss: 1.2229 - val_accuracy: 0.9104
Epoch 447/500
70/70 [==============================] - 3s 42ms/step - loss: 3.7483e-08 - accuracy: 1.0000 - val_loss: 1.2237 - val_accuracy: 0.9098
Epoch 448/500
70/70 [==============================] - 3s 42ms/step - loss: 3.7415e-08 - accuracy: 1.0000 - val_loss: 1.2265 - val_accuracy: 0.9100
Epoch 449/500
70/70 [==============================] - 3s 41ms/step - loss: 3.5966e-08 - accuracy: 1.0000 - val_loss: 1.2240 - val_accuracy: 0.9104
Epoch 450/500
70/70 [==============================] - 3s 41ms/step - loss: 3.4171e-08 - accuracy: 1.0000 - val_loss: 1.2331 - val_accuracy: 0.9098
Epoch 451/500
70/70 [==============================] - 3s 43ms/step - loss: 3.3904e-08 - accuracy: 1.0000 - val_loss: 1.2364 - val_accuracy: 0.9098
Epoch 452/500
70/70 [==============================] - 3s 42ms/step - loss: 3.3088e-08 - accuracy: 1.0000 - val_loss: 1.2334 - val_accuracy: 0.9098
Epoch 453/500
```

```
70/70 [==============================] - 3s 41ms/step - loss: 3.1584e-08 - accuracy: 1.0000 - val_loss: 1.2412 - val_accuracy: 0.9102
Epoch 454/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0831e-08 - accuracy: 1.0000 - val_loss: 1.2402 - val_accuracy: 0.9098
Epoch 455/500
70/70 [==============================] - 3s 41ms/step - loss: 2.9416e-08 - accuracy: 1.0000 - val_loss: 1.2395 - val_accuracy: 0.9093
Epoch 456/500
70/70 [==============================] - 3s 42ms/step - loss: 2.9419e-08 - accuracy: 1.0000 - val_loss: 1.2438 - val_accuracy: 0.9098
Epoch 457/500
70/70 [==============================] - 3s 41ms/step - loss: 2.8145e-08 - accuracy: 1.0000 - val_loss: 1.2433 - val_accuracy: 0.9102
Epoch 458/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7361e-08 - accuracy: 1.0000 - val_loss: 1.2433 - val_accuracy: 0.9102
Epoch 459/500
70/70 [==============================] - 3s 42ms/step - loss: 2.6929e-08 - accuracy: 1.0000 - val_loss: 1.2591 - val_accuracy: 0.9088
Epoch 460/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5627e-08 - accuracy: 1.0000 - val_loss: 1.2515 - val_accuracy: 0.9098
Epoch 461/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5569e-08 - accuracy: 1.0000 - val_loss: 1.2594 - val_accuracy: 0.9088
Epoch 462/500
70/70 [==============================] - 3s 41ms/step - loss: 2.4130e-08 - accuracy: 1.0000 - val_loss: 1.2614 - val_accuracy: 0.9095
Epoch 463/500
70/70 [==============================] - 3s 41ms/step - loss: 2.3705e-08 - accuracy: 1.0000 - val_loss: 1.2680 - val_accuracy: 0.9100
Epoch 464/500
70/70 [==============================] - 3s 41ms/step - loss: 2.2876e-08 - accuracy: 1.0000 - val_loss: 1.2646 - val_accuracy: 0.9098
Epoch 465/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1612e-08 - accuracy: 1.0000 - val_loss: 1.2646 - val_accuracy: 0.9093
Epoch 466/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1859e-08 - accuracy: 1.0000 - val_loss: 1.2781 - val_accuracy: 0.9098
Epoch 467/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1181e-08 - accuracy: 1.0000 - val_loss: 1.2687 - val_accuracy: 0.9093
Epoch 468/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9965e-08 - accuracy: 1.0000 - val_loss: 1.2737 - val_accuracy: 0.9095
Epoch 469/500
70/70 [==============================] - 3s 41ms/step - loss: 2.0338e-08 - accuracy: 1.0000 - val_loss: 1.2669 - val_accuracy: 0.9100
Epoch 470/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8324e-08 - accuracy: 1.0000 - val_loss: 1.2665 - val_accuracy: 0.9093
Epoch 471/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9567e-08 - accuracy: 1.0000 - val_loss: 1.2803 - val_accuracy: 0.9091
Epoch 472/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9420e-08 - accuracy: 1.0000 - val_loss: 1.2836 - val_accuracy: 0.9093
Epoch 473/500
70/70 [==============================] - 3s 41ms/step - loss: 2.1215e-08 - accuracy: 1.0000 - val_loss: 1.2853 - val_accuracy: 0.9088
Epoch 474/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9009e-08 - accuracy: 1.0000 - val_loss: 1.2840 - val_accuracy: 0.9091
Epoch 475/500
70/70 [==============================] - 3s 40ms/step - loss: 1.6313e-08 - accuracy: 1.0000 - val_loss: 1.2885 - val_accuracy: 0.9093
Epoch 476/500
70/70 [==============================] - 3s 42ms/step - loss: 1.5309e-08 - accuracy: 1.0000 - val_loss: 1.2954 - val_accuracy: 0.9095
Epoch 477/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6775e-08 - accuracy: 1.0000 - val_loss: 1.3012 - val_accuracy: 0.9095
Epoch 478/500
70/70 [==============================] - 3s 41ms/step - loss: 3.2224e-08 - accuracy: 1.0000 - val_loss: 1.3214 - val_accuracy: 0.9100
Epoch 479/500
70/70 [==============================] - 3s 41ms/step - loss: 0.0570 - accuracy: 0.9865 - val_loss: 0.9117 - val_accuracy: 0.8834
Epoch 480/500
70/70 [==============================] - 3s 41ms/step - loss: 0.0080 - accuracy: 0.9974 - val_loss: 0.8075 - val_accuracy: 0.8966
Epoch 481/500
70/70 [==============================] - 3s 41ms/step - loss: 0.0061 - accuracy: 0.9983 - val_loss: 0.7303 - val_accuracy: 0.8968
Epoch 482/500
70/70 [==============================] - 3s 41ms/step - loss: 8.9812e-04 - accuracy: 0.9998 - val_loss: 0.7835 - val_accuracy: 0.9025
Epoch 483/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0518e-04 - accuracy: 0.9999 - val_loss: 0.8481 - val_accuracy: 0.9016
Epoch 484/500
70/70 [==============================] - 3s 40ms/step - loss: 8.1116e-05 - accuracy: 1.0000 - val_loss: 0.8100 - val_accuracy: 0.9061
Epoch 485/500
70/70 [==============================] - 3s 41ms/step - loss: 4.7181e-05 - accuracy: 1.0000 - val_loss: 0.8068 - val_accuracy: 0.9070
Epoch 486/500
70/70 [==============================] - 3s 41ms/step - loss: 3.8555e-05 - accuracy: 1.0000 - val_loss: 0.8131 - val_accuracy: 0.9070
Epoch 487/500
70/70 [==============================] - 3s 41ms/step - loss: 3.3847e-05 - accuracy: 1.0000 - val_loss: 0.8146 - val_accuracy: 0.9075
Epoch 488/500
70/70 [==============================] - 3s 41ms/step - loss: 3.0103e-05 - accuracy: 1.0000 - val_loss: 0.8195 - val_accuracy: 0.9070
Epoch 489/500
70/70 [==============================] - 3s 41ms/step - loss: 2.7311e-05 - accuracy: 1.0000 - val_loss: 0.8221 - val_accuracy: 0.9068
Epoch 490/500
70/70 [==============================] - 3s 41ms/step - loss: 2.5001e-05 - accuracy: 1.0000 - val_loss: 0.8258 - val_accuracy: 0.9066
Epoch 491/500
70/70 [==============================] - 3s 42ms/step - loss: 2.3010e-05 - accuracy: 1.0000 - val_loss: 0.8274 - val_accuracy: 0.9068
Epoch 492/500
70/70 [==============================] - 3s 43ms/step - loss: 2.1383e-05 - accuracy: 1.0000 - val_loss: 0.8302 - val_accuracy: 0.9066
Epoch 493/500
70/70 [==============================] - 3s 41ms/step - loss: 1.9843e-05 - accuracy: 1.0000 - val_loss: 0.8336 - val_accuracy: 0.9068
Epoch 494/500
70/70 [==============================] - 3s 41ms/step - loss: 1.8516e-05 - accuracy: 1.0000 - val_loss: 0.8377 - val_accuracy: 0.9068
Epoch 495/500
70/70 [==============================] - 3s 41ms/step - loss: 1.7354e-05 - accuracy: 1.0000 - val_loss: 0.8409 - val_accuracy: 0.9063
Epoch 496/500
70/70 [==============================] - 3s 41ms/step - loss: 1.6321e-05 - accuracy: 1.0000 - val_loss: 0.8437 - val_accuracy: 0.9066
Epoch 497/500
70/70 [==============================] - 3s 43ms/step - loss: 1.5344e-05 - accuracy: 1.0000 - val_loss: 0.8464 - val_accuracy: 0.9068
Epoch 498/500
70/70 [==============================] - 3s 41ms/step - loss: 1.4456e-05 - accuracy: 1.0000 - val_loss: 0.8502 - val_accuracy: 0.9066
Epoch 499/500
70/70 [==============================] - 3s 39ms/step - loss: 1.3680e-05 - accuracy: 1.0000 - val_loss: 0.8532 - val_accuracy: 0.9063
Epoch 500/500
70/70 [==============================] - 3s 40ms/step - loss: 1.2955e-05 - accuracy: 1.0000 - val_loss: 0.8555 - val_accuracy: 0.9066
```

Model Evaluation:

In [48]:

```
score =  cnn_model.evaluate(x_test_gray_norm, y_test)
print('Test Accuracy: {}'.format(score[1]))
```

```
395/395 [==============================] - 1s 2ms/step - loss: 1.4642 - accuracy: 0.8994
Test Accuracy: 0.8994457721710205
```

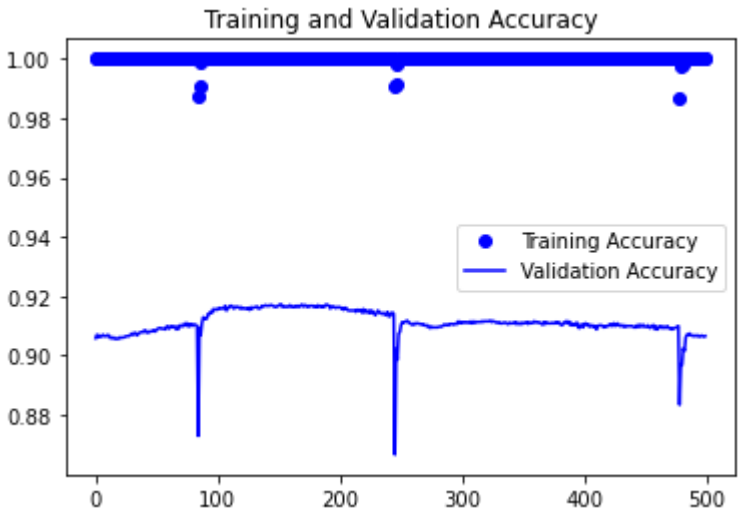
In [50]:
```
history.history.keys()
```

Out[50]:
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

In [51]:
```
accuracy = history.history['accuracy']
val_accuracy = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
```

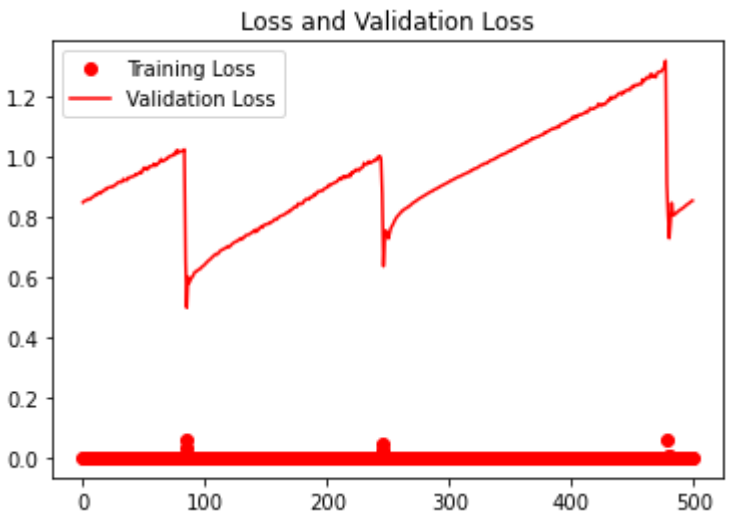
In [55]:
```
# Trained the model twice
epochs = range(len(accuracy))
plt.plot(epochs, accuracy, 'bo', label = 'Training Accuracy')
plt.plot(epochs, val_accuracy, 'b', label = 'Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.legend()
```

Out[55]:
```
<matplotlib.legend.Legend at 0x11c982a5b50>
```



In [57]:
```
epochs = range(len(accuracy))
plt.plot(epochs, loss, 'ro', label = 'Training Loss')
plt.plot(epochs, val_loss, 'r', label = 'Validation Loss')
plt.title('Loss and Validation Loss')
plt.legend()
```

Out[57]:
```
<matplotlib.legend.Legend at 0x11c98516940>
```



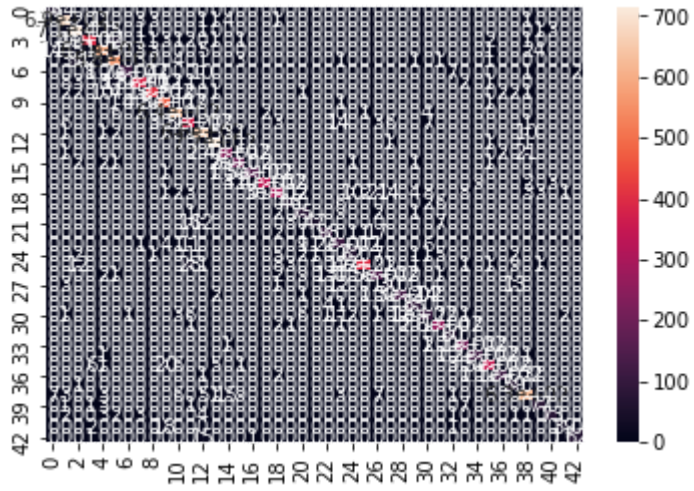
In [58]:
```
predicted_classes = cnn_model.predict_classes(x_test_gray_norm)
y_true = y_test
```

```
WARNING:tensorflow:From <ipython-input-58-e83eb0902b90>:1: Sequential.predict_classes (from tensorflow.python.keras.engine.sequential) is deprecated and will be removed after 2021-01-01.
Instructions for updating:
Please use instead:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g. if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if your model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
```

In [59]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_true, predicted_classes)
```

In [60]:
```
sns.heatmap(cm, annot = True)
```

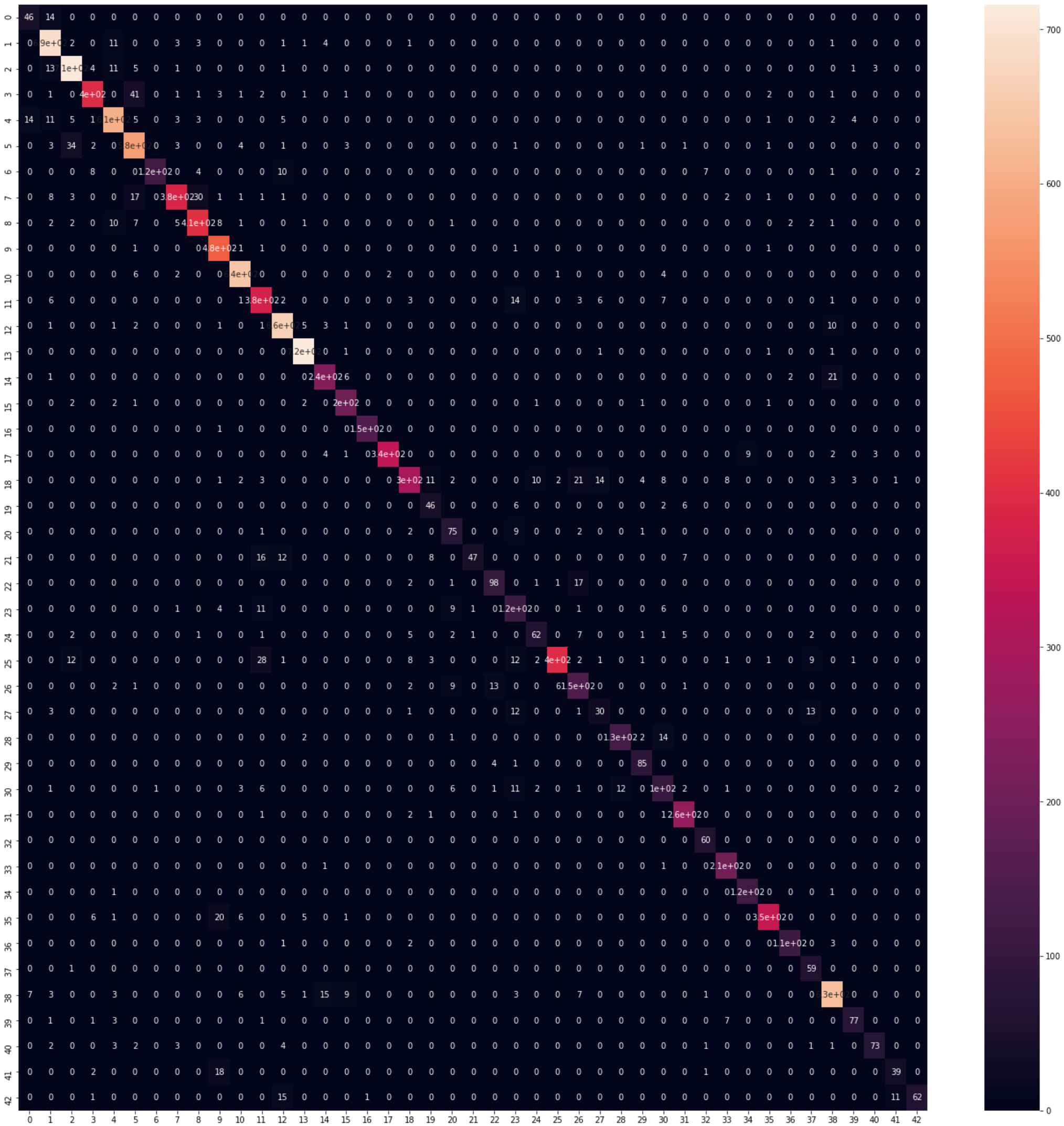
Out[60]:
```
<AxesSubplot:>
```



In [61]:

```
plt.figure(figsize=(25,25))
sns.heatmap(cm, annot = True)
```

Out[61]: <AxesSubplot:>



In [66]:

```
L = 7
W = 7

fig, axes = plt.subplots(L, W, figsize=(12,12))
```

```
axes = axes.ravel()

for i in np.arange(0, L*W):
    axes[i].imshow(x_test[i])
    axes[i].set_title('Prediction = {} \n True = {}'.format(predicted_classes[i], y_true[i]))
    axes[i].axis('off')

plt.subplots_adjust(wspace=1)
```