```
Epoch 1/100
99/99 [==============================] - 33s 175ms/step - loss: 1.5553 - sparse_categorical_accuracy: 0.4872
- val_loss: 5.3627 - val_sparse_categorical_accuracy: 0.1000
Epoch 2/100
99/99 [==============================] - 16s 157ms/step - loss: 1.1749 - sparse_categorical_accuracy: 0.5952
- val_loss: 2.8138 - val_sparse_categorical_accuracy: 0.1266
Epoch 3/100
99/99 [==============================] - 15s 150ms/step - loss: 1.0372 - sparse_categorical_accuracy: 0.6449
- val_loss: 2.8392 - val_sparse_categorical_accuracy: 0.1766
Epoch 4/100
99/99 [==============================] - 16s 159ms/step - loss: 0.9189 - sparse_categorical_accuracy: 0.6860
- val_loss: 2.7006 - val_sparse_categorical_accuracy: 0.2320
Epoch 5/100
99/99 [==============================] - 17s 172ms/step - loss: 0.8135 - sparse_categorical_accuracy: 0.7223
- val_loss: 1.9257 - val_sparse_categorical_accuracy: 0.3852
Epoch 6/100
99/99 [==============================] - 17s 167ms/step - loss: 0.7093 - sparse_categorical_accuracy: 0.7583
- val_loss: 1.8747 - val_sparse_categorical_accuracy: 0.4383
Epoch 7/100
99/99 [==============================] - 16s 162ms/step - loss: 0.6116 - sparse_categorical_accuracy: 0.7913
- val_loss: 2.4465 - val_sparse_categorical_accuracy: 0.4078
Epoch 8/100
99/99 [==============================] - 16s 159ms/step - loss: 0.5063 - sparse_categorical_accuracy: 0.8275
- val_loss: 3.7209 - val_sparse_categorical_accuracy: 0.2727
Epoch 9/100
99/99 [==============================] - 15s 153ms/step - loss: 0.4140 - sparse_categorical_accuracy: 0.8567
- val_loss: 2.8978 - val_sparse_categorical_accuracy: 0.4055
Epoch 10/100
99/99 [==============================] - 16s 163ms/step - loss: 0.3285 - sparse_categorical_accuracy: 0.8884
- val_loss: 1.6340 - val_sparse_categorical_accuracy: 0.5773
Epoch 11/100
99/99 [==============================] - 16s 164ms/step - loss: 0.2351 - sparse_categorical_accuracy: 0.9191
- val_loss: 1.6266 - val_sparse_categorical_accuracy: 0.6195
Epoch 12/100
99/99 [==============================] - 15s 156ms/step - loss: 0.1912 - sparse_categorical_accuracy: 0.9365
- val_loss: 1.9920 - val_sparse_categorical_accuracy: 0.5617
Epoch 13/100
99/99 [==============================] - 15s 156ms/step - loss: 0.1530 - sparse_categorical_accuracy: 0.9449
- val_loss: 2.1145 - val_sparse_categorical_accuracy: 0.6117
Epoch 14/100
99/99 [==============================] - 16s 159ms/step - loss: 0.1214 - sparse_categorical_accuracy: 0.9591
- val_loss: 1.7246 - val_sparse_categorical_accuracy: 0.6523
Epoch 15/100
```

99/99 [==============================] - 16s 158ms/step - loss: 0.1021 - sparse_categorical_accuracy: 0.9660 - val_loss: 2.7935 - val_sparse_categorical_accuracy: 0.5469

Epoch 16/100

99/99 [==============================] - 15s 156ms/step - loss: 0.0867 - sparse_categorical_accuracy: 0.9706 - val_loss: 1.9650 - val_sparse_categorical_accuracy: 0.6422

Epoch 17/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0653 - sparse_categorical_accuracy: 0.9779 - val_loss: 2.7184 - val_sparse_categorical_accuracy: 0.5586

Epoch 18/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0710 - sparse_categorical_accuracy: 0.9764 - val_loss: 2.2853 - val_sparse_categorical_accuracy: 0.6117

Epoch 19/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0562 - sparse_categorical_accuracy: 0.9813 - val_loss: 2.4115 - val_sparse_categorical_accuracy: 0.6000

Epoch 20/100

99/99 [==============================] - 16s 157ms/step - loss: 0.0376 - sparse_categorical_accuracy: 0.9871 - val_loss: 2.0436 - val_sparse_categorical_accuracy: 0.6562

Epoch 21/100

99/99 [==============================] - 16s 157ms/step - loss: 0.0703 - sparse_categorical_accuracy: 0.9767 - val_loss: 1.8746 - val_sparse_categorical_accuracy: 0.6625

Epoch 22/100

99/99 [==============================] - 16s 157ms/step - loss: 0.0597 - sparse_categorical_accuracy: 0.9807 - val_loss: 2.1459 - val_sparse_categorical_accuracy: 0.6344

Epoch 23/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0434 - sparse_categorical_accuracy: 0.9849 - val_loss: 2.1246 - val_sparse_categorical_accuracy: 0.6187

Epoch 24/100

99/99 [==============================] - 16s 157ms/step - loss: 0.0479 - sparse_categorical_accuracy: 0.9848 - val_loss: 2.9765 - val_sparse_categorical_accuracy: 0.5070

Epoch 25/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0529 - sparse_categorical_accuracy: 0.9825 - val_loss: 2.8074 - val_sparse_categorical_accuracy: 0.5844

Epoch 26/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0370 - sparse_categorical_accuracy: 0.9872 - val_loss: 2.3671 - val_sparse_categorical_accuracy: 0.6195

Epoch 27/100

99/99 [==============================] - 16s 161ms/step - loss: 0.0297 - sparse_categorical_accuracy: 0.9901 - val_loss: 1.7707 - val_sparse_categorical_accuracy: 0.6719

Epoch 28/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0164 - sparse_categorical_accuracy: 0.9953 - val_loss: 2.7510 - val_sparse_categorical_accuracy: 0.6023

Epoch 29/100

99/99 [==============================] - 16s 157ms/step - loss: 0.0596 - sparse_categorical_accuracy: 0.9801 - val_loss: 3.0712 - val_sparse_categorical_accuracy: 0.5484

```
Epoch 30/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0384 - sparse_categorical_accuracy: 0.9865
- val_loss: 2.0331 - val_sparse_categorical_accuracy: 0.6477
Epoch 31/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0321 - sparse_categorical_accuracy: 0.9895
- val_loss: 2.1254 - val_sparse_categorical_accuracy: 0.6383
Epoch 32/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0419 - sparse_categorical_accuracy: 0.9864
- val_loss: 1.9106 - val_sparse_categorical_accuracy: 0.6578
Epoch 33/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0269 - sparse_categorical_accuracy: 0.9913
- val_loss: 2.7091 - val_sparse_categorical_accuracy: 0.5797
Epoch 34/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0173 - sparse_categorical_accuracy: 0.9938
- val_loss: 1.8856 - val_sparse_categorical_accuracy: 0.6594
Epoch 35/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0321 - sparse_categorical_accuracy: 0.9896
- val_loss: 2.3702 - val_sparse_categorical_accuracy: 0.6297
Epoch 36/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0404 - sparse_categorical_accuracy: 0.9872
- val_loss: 2.1358 - val_sparse_categorical_accuracy: 0.6359
Epoch 37/100
99/99 [==============================] - 16s 161ms/step - loss: 0.0394 - sparse_categorical_accuracy: 0.9884
- val_loss: 2.5129 - val_sparse_categorical_accuracy: 0.6047
Epoch 38/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0286 - sparse_categorical_accuracy: 0.9903
- val_loss: 2.0256 - val_sparse_categorical_accuracy: 0.6609
Epoch 39/100
99/99 [==============================] - 16s 163ms/step - loss: 0.0422 - sparse_categorical_accuracy: 0.9860
- val_loss: 2.1724 - val_sparse_categorical_accuracy: 0.6797
Epoch 40/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0191 - sparse_categorical_accuracy: 0.9937
- val_loss: 2.0484 - val_sparse_categorical_accuracy: 0.6859
Epoch 41/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0354 - sparse_categorical_accuracy: 0.9888
- val_loss: 2.3992 - val_sparse_categorical_accuracy: 0.6195
Epoch 42/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0170 - sparse_categorical_accuracy: 0.9941
- val_loss: 2.8137 - val_sparse_categorical_accuracy: 0.5883
Epoch 43/100
99/99 [==============================] - 16s 157ms/step - loss: 0.0251 - sparse_categorical_accuracy: 0.9918
- val_loss: 1.8389 - val_sparse_categorical_accuracy: 0.6875
Epoch 44/100
```

99/99 [==============================] - 16s 159ms/step - loss: 0.0392 - sparse_categorical_accuracy: 0.9864 - val_loss: 3.0170 - val_sparse_categorical_accuracy: 0.5641

Epoch 45/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0426 - sparse_categorical_accuracy: 0.9855 - val_loss: 1.8965 - val_sparse_categorical_accuracy: 0.6617

Epoch 46/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0305 - sparse_categorical_accuracy: 0.9910 - val_loss: 2.6766 - val_sparse_categorical_accuracy: 0.6070

Epoch 47/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0140 - sparse_categorical_accuracy: 0.9948 - val_loss: 1.7529 - val_sparse_categorical_accuracy: 0.6836

Epoch 48/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0127 - sparse_categorical_accuracy: 0.9963 - val_loss: 2.3142 - val_sparse_categorical_accuracy: 0.6680

Epoch 49/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0176 - sparse_categorical_accuracy: 0.9936 - val_loss: 2.6736 - val_sparse_categorical_accuracy: 0.6273

Epoch 50/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0184 - sparse_categorical_accuracy: 0.9940 - val_loss: 2.0077 - val_sparse_categorical_accuracy: 0.6961

Epoch 51/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0287 - sparse_categorical_accuracy: 0.9907 - val_loss: 2.0887 - val_sparse_categorical_accuracy: 0.6750

Epoch 52/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0189 - sparse_categorical_accuracy: 0.9942 - val_loss: 1.7425 - val_sparse_categorical_accuracy: 0.6992

Epoch 53/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0139 - sparse_categorical_accuracy: 0.9962 - val_loss: 2.1745 - val_sparse_categorical_accuracy: 0.6539

Epoch 54/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0177 - sparse_categorical_accuracy: 0.9944 - val_loss: 1.9854 - val_sparse_categorical_accuracy: 0.6758

Epoch 55/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0156 - sparse_categorical_accuracy: 0.9944 - val_loss: 2.2714 - val_sparse_categorical_accuracy: 0.6398

Epoch 56/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0232 - sparse_categorical_accuracy: 0.9921 - val_loss: 3.0103 - val_sparse_categorical_accuracy: 0.5789

Epoch 57/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0369 - sparse_categorical_accuracy: 0.9871 - val_loss: 2.4049 - val_sparse_categorical_accuracy: 0.6602

Epoch 58/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0243 - sparse_categorical_accuracy: 0.9914 - val_loss: 3.0831 - val_sparse_categorical_accuracy: 0.5516

Epoch 59/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0226 - sparse_categorical_accuracy: 0.9923 - val_loss: 3.7255 - val_sparse_categorical_accuracy: 0.5180

Epoch 60/100

99/99 [==============================] - 16s 161ms/step - loss: 0.0425 - sparse_categorical_accuracy: 0.9868 - val_loss: 4.7495 - val_sparse_categorical_accuracy: 0.4313

Epoch 61/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0297 - sparse_categorical_accuracy: 0.9916 - val_loss: 2.5326 - val_sparse_categorical_accuracy: 0.6281

Epoch 62/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0140 - sparse_categorical_accuracy: 0.9953 - val_loss: 2.4811 - val_sparse_categorical_accuracy: 0.6258

Epoch 63/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0194 - sparse_categorical_accuracy: 0.9931 - val_loss: 2.6610 - val_sparse_categorical_accuracy: 0.6313

Epoch 64/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0142 - sparse_categorical_accuracy: 0.9950 - val_loss: 2.1837 - val_sparse_categorical_accuracy: 0.6750

Epoch 65/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0141 - sparse_categorical_accuracy: 0.9948 - val_loss: 2.5561 - val_sparse_categorical_accuracy: 0.6469

Epoch 66/100

99/99 [==============================] - 16s 160ms/step - loss: 0.0141 - sparse_categorical_accuracy: 0.9952 - val_loss: 2.3042 - val_sparse_categorical_accuracy: 0.6562

Epoch 67/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0153 - sparse_categorical_accuracy: 0.9952 - val_loss: 3.3460 - val_sparse_categorical_accuracy: 0.5781

Epoch 68/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0248 - sparse_categorical_accuracy: 0.9925 - val_loss: 2.3677 - val_sparse_categorical_accuracy: 0.6844

Epoch 69/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0680 - sparse_categorical_accuracy: 0.9798 - val_loss: 3.2784 - val_sparse_categorical_accuracy: 0.5602

Epoch 70/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0080 - sparse_categorical_accuracy: 0.9974 - val_loss: 1.7643 - val_sparse_categorical_accuracy: 0.6914

Epoch 71/100

99/99 [==============================] - 16s 158ms/step - loss: 0.0036 - sparse_categorical_accuracy: 0.9987 - val_loss: 1.6490 - val_sparse_categorical_accuracy: 0.7219

Epoch 72/100

99/99 [==============================] - 16s 159ms/step - loss: 0.0011 - sparse_categorical_accuracy: 0.9998 - val_loss: 1.6347 - val_sparse_categorical_accuracy: 0.7234

Epoch 73/100

```
99/99 [==============================] - 16s 159ms/step - loss: 2.7333e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6507 - val_sparse_categorical_accuracy: 0.7258
Epoch 74/100
99/99 [==============================] - 16s 160ms/step - loss: 1.5158e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6453 - val_sparse_categorical_accuracy: 0.7219
Epoch 75/100
99/99 [==============================] - 17s 168ms/step - loss: 1.2484e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6195 - val_sparse_categorical_accuracy: 0.7273
Epoch 76/100
99/99 [==============================] - 16s 159ms/step - loss: 9.1841e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6428 - val_sparse_categorical_accuracy: 0.7242
Epoch 77/100
99/99 [==============================] - 16s 160ms/step - loss: 6.0044e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6478 - val_sparse_categorical_accuracy: 0.7289
Epoch 78/100
99/99 [==============================] - 16s 160ms/step - loss: 5.6959e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6602 - val_sparse_categorical_accuracy: 0.7273
Epoch 79/100
99/99 [==============================] - 16s 160ms/step - loss: 4.7947e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6632 - val_sparse_categorical_accuracy: 0.7250
Epoch 80/100
99/99 [==============================] - 16s 161ms/step - loss: 7.3773e-04 - sparse_categorical_accuracy:
0.9998 - val_loss: 2.9611 - val_sparse_categorical_accuracy: 0.6125
Epoch 81/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0260 - sparse_categorical_accuracy: 0.9921
- val_loss: 3.7882 - val_sparse_categorical_accuracy: 0.4727
Epoch 82/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0967 - sparse_categorical_accuracy: 0.9702
- val_loss: 2.0236 - val_sparse_categorical_accuracy: 0.6250
Epoch 83/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0349 - sparse_categorical_accuracy: 0.9891
- val_loss: 22.8903 - val_sparse_categorical_accuracy: 0.2156
Epoch 84/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0304 - sparse_categorical_accuracy: 0.9902
- val_loss: 2.9127 - val_sparse_categorical_accuracy: 0.5523
Epoch 85/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0099 - sparse_categorical_accuracy: 0.9973
- val_loss: 1.7305 - val_sparse_categorical_accuracy: 0.7016
Epoch 86/100
99/99 [==============================] - 16s 161ms/step - loss: 0.0059 - sparse_categorical_accuracy: 0.9984
- val_loss: 1.8696 - val_sparse_categorical_accuracy: 0.6938
Epoch 87/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0056 - sparse_categorical_accuracy: 0.9986
- val_loss: 1.9814 - val_sparse_categorical_accuracy: 0.6859
```

```
Epoch 88/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0038 - sparse_categorical_accuracy: 0.9987
- val_loss: 2.2207 - val_sparse_categorical_accuracy: 0.6664
Epoch 89/100
99/99 [==============================] - 16s 158ms/step - loss: 0.1311 - sparse_categorical_accuracy: 0.9605
- val_loss: 1.9167 - val_sparse_categorical_accuracy: 0.6219
Epoch 90/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0299 - sparse_categorical_accuracy: 0.9913
- val_loss: 3.0279 - val_sparse_categorical_accuracy: 0.5297
Epoch 91/100
99/99 [==============================] - 16s 160ms/step - loss: 0.0060 - sparse_categorical_accuracy: 0.9983
- val_loss: 1.6456 - val_sparse_categorical_accuracy: 0.7180
Epoch 92/100
99/99 [==============================] - 16s 159ms/step - loss: 0.0017 - sparse_categorical_accuracy: 0.9996
- val_loss: 1.7037 - val_sparse_categorical_accuracy: 0.7063
Epoch 93/100
99/99 [==============================] - 16s 161ms/step - loss: 3.1730e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.6878 - val_sparse_categorical_accuracy: 0.7211
Epoch 94/100
99/99 [==============================] - 16s 159ms/step - loss: 1.6547e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7002 - val_sparse_categorical_accuracy: 0.7258
Epoch 95/100
99/99 [==============================] - 16s 158ms/step - loss: 0.0014 - sparse_categorical_accuracy: 0.9998
- val_loss: 1.8040 - val_sparse_categorical_accuracy: 0.7180
Epoch 96/100
99/99 [==============================] - 16s 160ms/step - loss: 1.6680e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7736 - val_sparse_categorical_accuracy: 0.7227
Epoch 97/100
99/99 [==============================] - 16s 160ms/step - loss: 1.3294e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7714 - val_sparse_categorical_accuracy: 0.7211
Epoch 98/100
99/99 [==============================] - 16s 160ms/step - loss: 1.4164e-04 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7853 - val_sparse_categorical_accuracy: 0.7242
Epoch 99/100
99/99 [==============================] - 16s 161ms/step - loss: 5.8940e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7838 - val_sparse_categorical_accuracy: 0.7281
Epoch 100/100
99/99 [==============================] - 16s 159ms/step - loss: 4.5718e-05 - sparse_categorical_accuracy:
1.0000 - val_loss: 1.7848 - val_sparse_categorical_accuracy: 0.7266
Model: "shallow_res_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_66 (Conv2D)          multiple                  9472
```

```
batch_normalization_66 (Bat  multiple                  256
chNormalization)

activation_54 (Activation)   multiple                  0

max_pooling2d_4 (MaxPooling  multiple                  0
2D)

sequential_4 (Sequential)    (None, 4, 4, 512)         18565504

global_average_pooling2d_4   multiple                  0
(GlobalAveragePooling2D)

dense_4 (Dense)              multiple                  5130

=================================================================
Total params: 18,580,362
Trainable params: 18,566,154
Non-trainable params: 14,208
_________________________________________________________________
```