```
Epoch 1/100
121/121 [==============================] - 39s 175ms/step - loss: 1.9675 - sparse_categorical_accuracy:
0.3914 - val_loss: 4.0867 - val_sparse_categorical_accuracy: 0.0677
Epoch 2/100
121/121 [==============================] - 19s 152ms/step - loss: 1.4491 - sparse_categorical_accuracy:
0.5363 - val_loss: 3.6467 - val_sparse_categorical_accuracy: 0.1161
Epoch 3/100
121/121 [==============================] - 17s 141ms/step - loss: 1.2767 - sparse_categorical_accuracy:
0.5906 - val_loss: 4.2821 - val_sparse_categorical_accuracy: 0.1281
Epoch 4/100
121/121 [==============================] - 19s 156ms/step - loss: 1.1219 - sparse_categorical_accuracy:
0.6346 - val_loss: 2.5595 - val_sparse_categorical_accuracy: 0.2937
Epoch 5/100
121/121 [==============================] - 19s 154ms/step - loss: 0.9758 - sparse_categorical_accuracy:
0.6844 - val_loss: 1.9065 - val_sparse_categorical_accuracy: 0.4333
Epoch 6/100
121/121 [==============================] - 19s 156ms/step - loss: 0.8637 - sparse_categorical_accuracy:
0.7165 - val_loss: 1.4760 - val_sparse_categorical_accuracy: 0.5453
Epoch 7/100
121/121 [==============================] - 18s 147ms/step - loss: 0.7598 - sparse_categorical_accuracy:
0.7553 - val_loss: 3.1541 - val_sparse_categorical_accuracy: 0.3073
Epoch 8/100
121/121 [==============================] - 19s 157ms/step - loss: 0.6332 - sparse_categorical_accuracy:
0.7930 - val_loss: 1.3269 - val_sparse_categorical_accuracy: 0.6021
Epoch 9/100
121/121 [==============================] - 18s 145ms/step - loss: 0.4955 - sparse_categorical_accuracy:
0.8362 - val_loss: 1.7319 - val_sparse_categorical_accuracy: 0.5448
Epoch 10/100
121/121 [==============================] - 18s 146ms/step - loss: 0.3769 - sparse_categorical_accuracy:
0.8746 - val_loss: 2.1885 - val_sparse_categorical_accuracy: 0.5036
Epoch 11/100
121/121 [==============================] - 18s 146ms/step - loss: 0.2685 - sparse_categorical_accuracy:
0.9111 - val_loss: 2.9072 - val_sparse_categorical_accuracy: 0.4490
Epoch 12/100
121/121 [==============================] - 18s 151ms/step - loss: 0.2093 - sparse_categorical_accuracy:
0.9306 - val_loss: 2.4073 - val_sparse_categorical_accuracy: 0.5130
Epoch 13/100
121/121 [==============================] - 18s 146ms/step - loss: 0.1715 - sparse_categorical_accuracy:
0.9429 - val_loss: 2.4231 - val_sparse_categorical_accuracy: 0.5229
Epoch 14/100
121/121 [==============================] - 18s 151ms/step - loss: 0.1429 - sparse_categorical_accuracy:
0.9530 - val_loss: 3.8668 - val_sparse_categorical_accuracy: 0.4250
Epoch 15/100
```

121/121 [==============================] - 18s 146ms/step - loss: 0.0981 - sparse_categorical_accuracy: 0.9676 - val_loss: 2.2104 - val_sparse_categorical_accuracy: 0.6010

Epoch 16/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0694 - sparse_categorical_accuracy: 0.9758 - val_loss: 2.7857 - val_sparse_categorical_accuracy: 0.4854

Epoch 17/100

121/121 [==============================] - 18s 146ms/step - loss: 0.1036 - sparse_categorical_accuracy: 0.9660 - val_loss: 2.6221 - val_sparse_categorical_accuracy: 0.5625

Epoch 18/100

121/121 [==============================] - 18s 150ms/step - loss: 0.0789 - sparse_categorical_accuracy: 0.9733 - val_loss: 2.6184 - val_sparse_categorical_accuracy: 0.5521

Epoch 19/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0752 - sparse_categorical_accuracy: 0.9747 - val_loss: 2.4435 - val_sparse_categorical_accuracy: 0.6010

Epoch 20/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0768 - sparse_categorical_accuracy: 0.9761 - val_loss: 2.3900 - val_sparse_categorical_accuracy: 0.5792

Epoch 21/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0485 - sparse_categorical_accuracy: 0.9851 - val_loss: 2.1563 - val_sparse_categorical_accuracy: 0.6344

Epoch 22/100

121/121 [==============================] - 18s 145ms/step - loss: 0.0461 - sparse_categorical_accuracy: 0.9859 - val_loss: 4.6055 - val_sparse_categorical_accuracy: 0.4313

Epoch 23/100

121/121 [==============================] - 18s 145ms/step - loss: 0.0874 - sparse_categorical_accuracy: 0.9720 - val_loss: 3.3198 - val_sparse_categorical_accuracy: 0.5089

Epoch 24/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0326 - sparse_categorical_accuracy: 0.9893 - val_loss: 2.4150 - val_sparse_categorical_accuracy: 0.6115

Epoch 25/100

121/121 [==============================] - 18s 152ms/step - loss: 0.0469 - sparse_categorical_accuracy: 0.9842 - val_loss: 2.3335 - val_sparse_categorical_accuracy: 0.5995

Epoch 26/100

121/121 [==============================] - 18s 150ms/step - loss: 0.0554 - sparse_categorical_accuracy: 0.9835 - val_loss: 2.4636 - val_sparse_categorical_accuracy: 0.5823

Epoch 27/100

121/121 [==============================] - 18s 150ms/step - loss: 0.0441 - sparse_categorical_accuracy: 0.9849 - val_loss: 2.4117 - val_sparse_categorical_accuracy: 0.6458

Epoch 28/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0487 - sparse_categorical_accuracy: 0.9838 - val_loss: 2.5765 - val_sparse_categorical_accuracy: 0.5776

Epoch 29/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0382 - sparse_categorical_accuracy: 0.9889 - val_loss: 2.2187 - val_sparse_categorical_accuracy: 0.6125

```
Epoch 30/100
121/121 [==============================] - 18s 150ms/step - loss: 0.0408 - sparse_categorical_accuracy:
0.9871 - val_loss: 2.2073 - val_sparse_categorical_accuracy: 0.6464
Epoch 31/100
121/121 [==============================] - 18s 150ms/step - loss: 0.0403 - sparse_categorical_accuracy:
0.9879 - val_loss: 2.3579 - val_sparse_categorical_accuracy: 0.6292
Epoch 32/100
121/121 [==============================] - 18s 147ms/step - loss: 0.0289 - sparse_categorical_accuracy:
0.9912 - val_loss: 2.7360 - val_sparse_categorical_accuracy: 0.6026
Epoch 33/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0387 - sparse_categorical_accuracy:
0.9886 - val_loss: 2.6016 - val_sparse_categorical_accuracy: 0.5839
Epoch 34/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0476 - sparse_categorical_accuracy:
0.9859 - val_loss: 2.2079 - val_sparse_categorical_accuracy: 0.6292
Epoch 35/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0386 - sparse_categorical_accuracy:
0.9868 - val_loss: 2.6029 - val_sparse_categorical_accuracy: 0.5880
Epoch 36/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0237 - sparse_categorical_accuracy:
0.9908 - val_loss: 2.2433 - val_sparse_categorical_accuracy: 0.6292
Epoch 37/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0174 - sparse_categorical_accuracy:
0.9948 - val_loss: 2.6580 - val_sparse_categorical_accuracy: 0.6115
Epoch 38/100
121/121 [==============================] - 18s 147ms/step - loss: 0.0209 - sparse_categorical_accuracy:
0.9938 - val_loss: 2.1613 - val_sparse_categorical_accuracy: 0.6531
Epoch 39/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0410 - sparse_categorical_accuracy:
0.9872 - val_loss: 2.4818 - val_sparse_categorical_accuracy: 0.5797
Epoch 40/100
121/121 [==============================] - 18s 150ms/step - loss: 0.0433 - sparse_categorical_accuracy:
0.9866 - val_loss: 2.8811 - val_sparse_categorical_accuracy: 0.5828
Epoch 41/100
121/121 [==============================] - 18s 145ms/step - loss: 0.0522 - sparse_categorical_accuracy:
0.9849 - val_loss: 2.9468 - val_sparse_categorical_accuracy: 0.5854
Epoch 42/100
121/121 [==============================] - 18s 150ms/step - loss: 0.0298 - sparse_categorical_accuracy:
0.9901 - val_loss: 2.2724 - val_sparse_categorical_accuracy: 0.6266
Epoch 43/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0128 - sparse_categorical_accuracy:
0.9958 - val_loss: 2.4511 - val_sparse_categorical_accuracy: 0.6427
Epoch 44/100
```

121/121 [==============================] - 18s 146ms/step - loss: 0.0321 - sparse_categorical_accuracy: 0.9895 - val_loss: 2.8041 - val_sparse_categorical_accuracy: 0.5901

Epoch 45/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0221 - sparse_categorical_accuracy: 0.9932 - val_loss: 2.3869 - val_sparse_categorical_accuracy: 0.6365

Epoch 46/100

121/121 [==============================] - 18s 150ms/step - loss: 0.0918 - sparse_categorical_accuracy: 0.9709 - val_loss: 3.2798 - val_sparse_categorical_accuracy: 0.5385

Epoch 47/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0376 - sparse_categorical_accuracy: 0.9884 - val_loss: 2.1847 - val_sparse_categorical_accuracy: 0.6385

Epoch 48/100

121/121 [==============================] - 18s 145ms/step - loss: 0.0125 - sparse_categorical_accuracy: 0.9958 - val_loss: 1.8683 - val_sparse_categorical_accuracy: 0.6828

Epoch 49/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0034 - sparse_categorical_accuracy: 0.9990 - val_loss: 2.0739 - val_sparse_categorical_accuracy: 0.6620

Epoch 50/100

121/121 [==============================] - 18s 150ms/step - loss: 0.0012 - sparse_categorical_accuracy: 0.9999 - val_loss: 1.9145 - val_sparse_categorical_accuracy: 0.6875

Epoch 51/100

121/121 [==============================] - 18s 147ms/step - loss: 6.8879e-04 - sparse_categorical_accuracy: 0.9999 - val_loss: 1.8552 - val_sparse_categorical_accuracy: 0.7042

Epoch 52/100

121/121 [==============================] - 18s 146ms/step - loss: 2.2119e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.8201 - val_sparse_categorical_accuracy: 0.7104

Epoch 53/100

121/121 [==============================] - 18s 146ms/step - loss: 1.3987e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.8134 - val_sparse_categorical_accuracy: 0.7188

Epoch 54/100

121/121 [==============================] - 18s 151ms/step - loss: 1.2336e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.8159 - val_sparse_categorical_accuracy: 0.7177

Epoch 55/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0024 - sparse_categorical_accuracy: 0.9995 - val_loss: 5.2794 - val_sparse_categorical_accuracy: 0.3812

Epoch 56/100

121/121 [==============================] - 18s 146ms/step - loss: 0.1772 - sparse_categorical_accuracy: 0.9478 - val_loss: 2.5419 - val_sparse_categorical_accuracy: 0.5536

Epoch 57/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0658 - sparse_categorical_accuracy: 0.9802 - val_loss: 2.1640 - val_sparse_categorical_accuracy: 0.6500

Epoch 58/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0150 - sparse_categorical_accuracy: 0.9952 - val_loss: 2.1409 - val_sparse_categorical_accuracy: 0.6531

Epoch 59/100
121/121 [==============================] - 18s 145ms/step - loss: 0.0142 - sparse_categorical_accuracy: 0.9972 - val_loss: 2.6857 - val_sparse_categorical_accuracy: 0.5604
Epoch 60/100
121/121 [==============================] - 18s 150ms/step - loss: 0.0135 - sparse_categorical_accuracy: 0.9959 - val_loss: 2.4611 - val_sparse_categorical_accuracy: 0.6318
Epoch 61/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0126 - sparse_categorical_accuracy: 0.9955 - val_loss: 2.3319 - val_sparse_categorical_accuracy: 0.6651
Epoch 62/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0210 - sparse_categorical_accuracy: 0.9940 - val_loss: 2.3940 - val_sparse_categorical_accuracy: 0.6516
Epoch 63/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0571 - sparse_categorical_accuracy: 0.9812 - val_loss: 4.4348 - val_sparse_categorical_accuracy: 0.4490
Epoch 64/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0614 - sparse_categorical_accuracy: 0.9792 - val_loss: 2.3817 - val_sparse_categorical_accuracy: 0.5995
Epoch 65/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0188 - sparse_categorical_accuracy: 0.9939 - val_loss: 2.4476 - val_sparse_categorical_accuracy: 0.6161
Epoch 66/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0049 - sparse_categorical_accuracy: 0.9988 - val_loss: 1.9165 - val_sparse_categorical_accuracy: 0.6880
Epoch 67/100
121/121 [==============================] - 18s 146ms/step - loss: 9.3363e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.9867 - val_sparse_categorical_accuracy: 0.6802
Epoch 68/100
121/121 [==============================] - 18s 151ms/step - loss: 3.3471e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.9280 - val_sparse_categorical_accuracy: 0.6906
Epoch 69/100
121/121 [==============================] - 18s 146ms/step - loss: 2.1347e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.8963 - val_sparse_categorical_accuracy: 0.7010
Epoch 70/100
121/121 [==============================] - 18s 151ms/step - loss: 1.8373e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.9149 - val_sparse_categorical_accuracy: 0.6995
Epoch 71/100
121/121 [==============================] - 18s 147ms/step - loss: 1.1541e-04 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.8973 - val_sparse_categorical_accuracy: 0.7021
Epoch 72/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0014 - sparse_categorical_accuracy: 0.9997 - val_loss: 1.9715 - val_sparse_categorical_accuracy: 0.7005
Epoch 73/100

121/121 [==============================] - 18s 151ms/step - loss: 8.9133e-05 - sparse_categorical_accuracy: 1.0000 - val_loss: 1.9626 - val_sparse_categorical_accuracy: 0.6974

Epoch 74/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0087 - sparse_categorical_accuracy: 0.9977 - val_loss: 3.7578 - val_sparse_categorical_accuracy: 0.5589

Epoch 75/100

121/121 [==============================] - 18s 151ms/step - loss: 0.1157 - sparse_categorical_accuracy: 0.9634 - val_loss: 4.1625 - val_sparse_categorical_accuracy: 0.4526

Epoch 76/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0574 - sparse_categorical_accuracy: 0.9811 - val_loss: 2.0848 - val_sparse_categorical_accuracy: 0.6344

Epoch 77/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0256 - sparse_categorical_accuracy: 0.9929 - val_loss: 2.0379 - val_sparse_categorical_accuracy: 0.6521

Epoch 78/100

121/121 [==============================] - 18s 151ms/step - loss: 0.0031 - sparse_categorical_accuracy: 0.9994 - val_loss: 1.7934 - val_sparse_categorical_accuracy: 0.6943

Epoch 79/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0012 - sparse_categorical_accuracy: 0.9998 - val_loss: 1.8403 - val_sparse_categorical_accuracy: 0.6922

Epoch 80/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0011 - sparse_categorical_accuracy: 0.9999 - val_loss: 1.8689 - val_sparse_categorical_accuracy: 0.6911

Epoch 81/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0018 - sparse_categorical_accuracy: 0.9995 - val_loss: 2.1210 - val_sparse_categorical_accuracy: 0.6505

Epoch 82/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0057 - sparse_categorical_accuracy: 0.9986 - val_loss: 4.1350 - val_sparse_categorical_accuracy: 0.5016

Epoch 83/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0110 - sparse_categorical_accuracy: 0.9966 - val_loss: 2.8470 - val_sparse_categorical_accuracy: 0.5854

Epoch 84/100

121/121 [==============================] - 18s 152ms/step - loss: 0.0452 - sparse_categorical_accuracy: 0.9846 - val_loss: 3.3127 - val_sparse_categorical_accuracy: 0.5490

Epoch 85/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0610 - sparse_categorical_accuracy: 0.9802 - val_loss: 2.2984 - val_sparse_categorical_accuracy: 0.6323

Epoch 86/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0117 - sparse_categorical_accuracy: 0.9966 - val_loss: 1.9040 - val_sparse_categorical_accuracy: 0.6766

Epoch 87/100

121/121 [==============================] - 18s 146ms/step - loss: 0.0018 - sparse_categorical_accuracy: 0.9995 - val_loss: 2.0294 - val_sparse_categorical_accuracy: 0.6786

```
Epoch 88/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0016 - sparse_categorical_accuracy:
0.9995 - val_loss: 1.9606 - val_sparse_categorical_accuracy: 0.6807
Epoch 89/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0017 - sparse_categorical_accuracy:
0.9995 - val_loss: 2.2813 - val_sparse_categorical_accuracy: 0.6240
Epoch 90/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0037 - sparse_categorical_accuracy:
0.9989 - val_loss: 2.0002 - val_sparse_categorical_accuracy: 0.6807
Epoch 91/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0119 - sparse_categorical_accuracy:
0.9970 - val_loss: 3.1827 - val_sparse_categorical_accuracy: 0.5370
Epoch 92/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0484 - sparse_categorical_accuracy:
0.9857 - val_loss: 3.3660 - val_sparse_categorical_accuracy: 0.5406
Epoch 93/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0581 - sparse_categorical_accuracy:
0.9828 - val_loss: 2.7375 - val_sparse_categorical_accuracy: 0.6036
Epoch 94/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0329 - sparse_categorical_accuracy:
0.9906 - val_loss: 2.5475 - val_sparse_categorical_accuracy: 0.6057
Epoch 95/100
121/121 [==============================] - 18s 146ms/step - loss: 0.0134 - sparse_categorical_accuracy:
0.9957 - val_loss: 2.3966 - val_sparse_categorical_accuracy: 0.6292
Epoch 96/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0071 - sparse_categorical_accuracy:
0.9979 - val_loss: 3.1616 - val_sparse_categorical_accuracy: 0.6021
Epoch 97/100
121/121 [==============================] - 18s 152ms/step - loss: 0.0069 - sparse_categorical_accuracy:
0.9983 - val_loss: 3.9610 - val_sparse_categorical_accuracy: 0.5141
Epoch 98/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0056 - sparse_categorical_accuracy:
0.9984 - val_loss: 2.5067 - val_sparse_categorical_accuracy: 0.6531
Epoch 99/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0020 - sparse_categorical_accuracy:
0.9995 - val_loss: 2.1679 - val_sparse_categorical_accuracy: 0.6948
Epoch 100/100
121/121 [==============================] - 18s 151ms/step - loss: 0.0215 - sparse_categorical_accuracy:
0.9934 - val_loss: 4.1574 - val_sparse_categorical_accuracy: 0.4766
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)         17087104

global_average_pooling2d_4   multiple                  0
(GlobalAveragePooling2D)

dense_4 (Dense)              multiple                  7695

=================================================================
Total params: 17,104,527
Trainable params: 17,091,855
Non-trainable params: 12,672
_________________________________________________________________
```