

```
In [157]: import os
import matplotlib.pyplot as plt
import tensorflow as tf

In [158]: dataset_dir = os.path.join(os.getcwd(), 'I.A')

dataset_train_dir = os.path.join(dataset_dir, 'Train')

dataset_train_Terraria_len = len(os.listdir(os.path.join(dataset_train_dir, 'Terraria')))

dataset_train_Fort_len = len(os.listdir(os.path.join(dataset_train_dir, 'Fort')))

dataset_validation_dir = os.path.join(dataset_dir, 'Validation')

dataset_validation_Terraria_len = len(os.listdir(os.path.join(dataset_validation_dir, 'Terraria')))

dataset_validation_Fort_len = len(os.listdir(os.path.join(dataset_validation_dir, 'Fort')))

print('Train Terraria: %s' % dataset_train_Terraria_len)
print('Validation Terraria: %s' % dataset_validation_Terraria_len)

print('Train Fort: %s' % dataset_train_Fort_len)
print('Validation Fort: %s' % dataset_validation_Fort_len)
```

Train Terraria: 500
 Validation Terraria: 500
 Train Fort: 500
 Validation Fort: 500

```
In [159]: image_width = 160
image_height = 160
image_color_channel = 3
image_color_channel_size = 255
image_size = (image_width, image_height)
image_shape = image_size + (image_color_channel,)

batch_size = 32
epochs = 100
learning_rate = 0.0001

class_names = ['Fortnite', 'Terraria']
```

```
In [160]: dataset_train = tf.keras.preprocessing.image_dataset_from_directory(
    dataset_train_dir,
    image_size = image_size,
    batch_size = batch_size,
    shuffle = True
)
```

Found 1000 files belonging to 2 classes.

```
In [161]: dataset_validation = tf.keras.preprocessing.image_dataset_from_directory(
    dataset_validation_dir,
```

```
    image_size = image_size,
    batch_size = batch_size,
    shuffle = True
)
```

Found 1000 files belonging to 2 classes.

```
In [162]: dataset_validation_cardinality = tf.data.experimental.cardinality(dataset_validation)
dataset_validation_batches = dataset_validation_cardinality // 5

dataset_test = dataset_validation.take(dataset_validation_batches)
dataset_validation = dataset_validation.skip(dataset_validation_batches)

print('Validation Dataset Cardinality: %d' % tf.data.experimental.cardinality(dataset_validation))
print('Test Dataset Cardinality: %d' % tf.data.experimental.cardinality(dataset_test))

Validation Dataset Cardinality: 26
Test Dataset Cardinality: 6
```

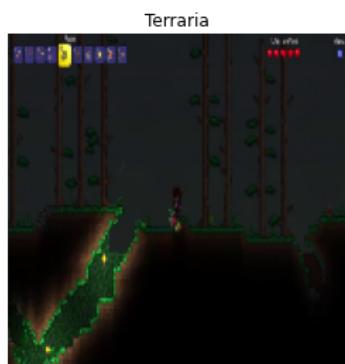
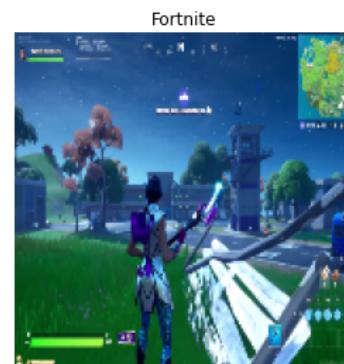
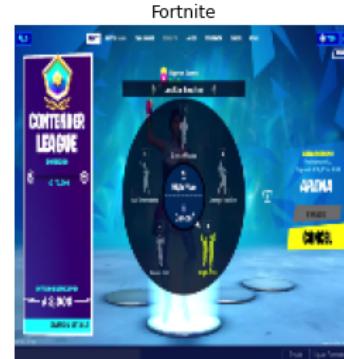
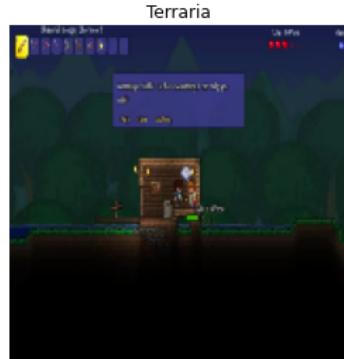
```
In [163]: def plot_dataset(dataset):

    plt.gcf().clear()
    plt.figure(figsize = (15, 15))
    for features, labels in dataset.take(1):

        for i in range(9):
            plt.subplot(3, 3, i + 1)
            plt.axis('off')
            plt.imshow(features[i].numpy().astype('uint8'))
            plt.title(class_names[labels[i]])
```

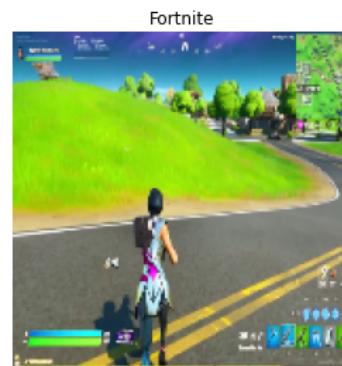
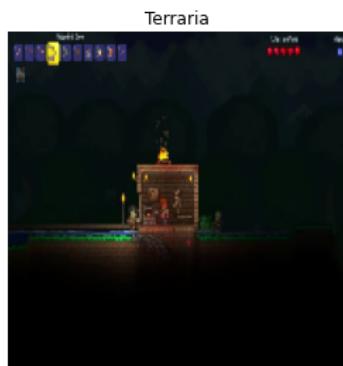
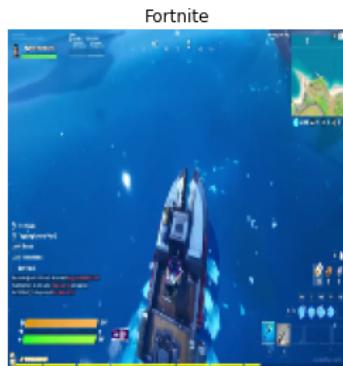
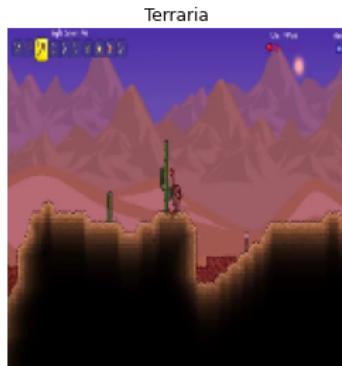
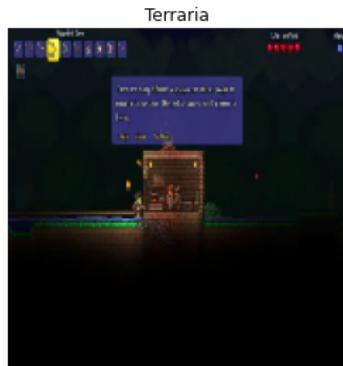
```
In [164]: plot_dataset(dataset_train)

<Figure size 432x288 with 0 Axes>
```



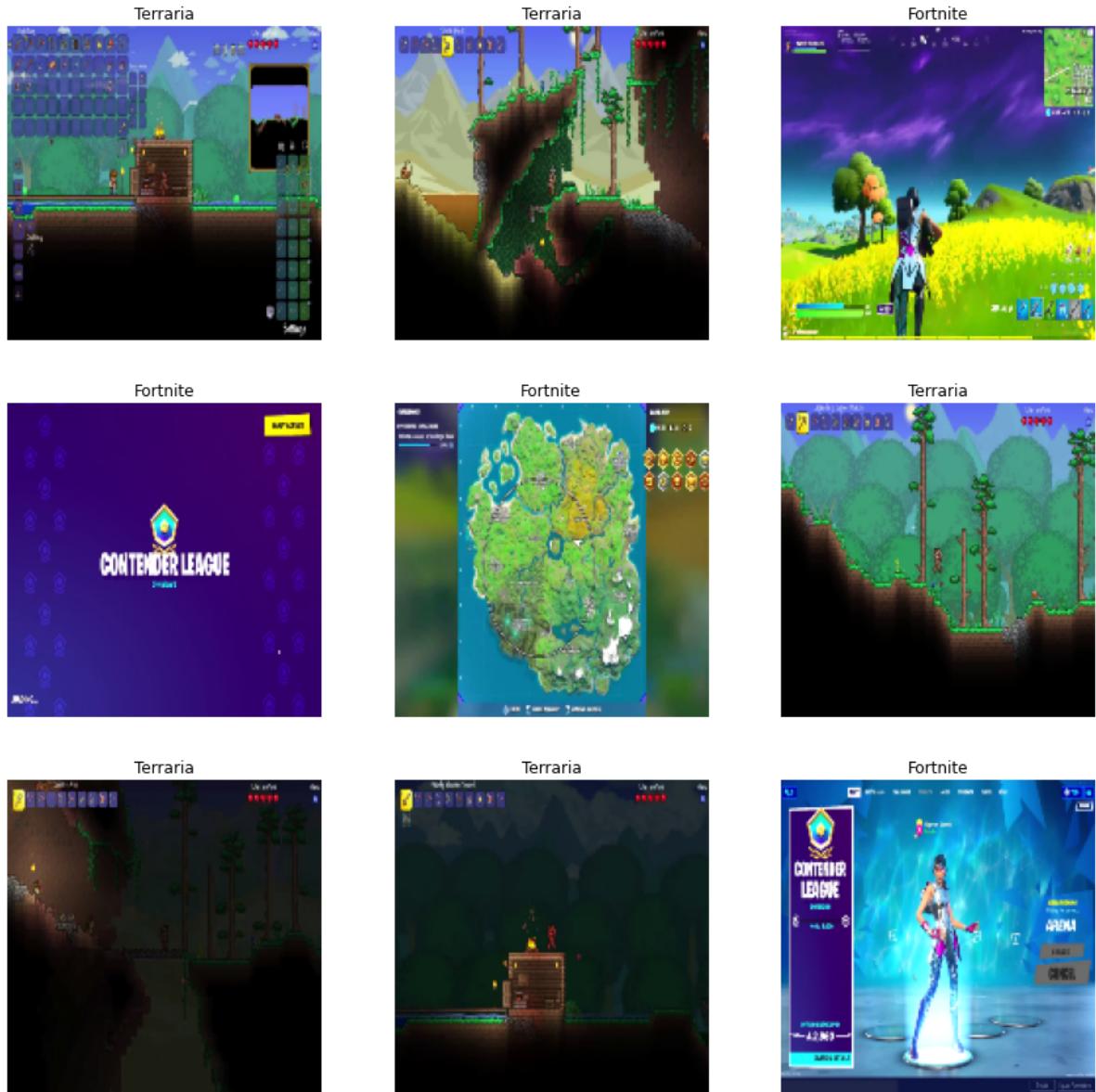
```
In [165]: plot_dataset(dataset_validation)
```

```
<Figure size 432x288 with 0 Axes>
```



```
In [166]: plot_dataset(dataset_test)
```

```
<Figure size 432x288 with 0 Axes>
```



```
In [167]: data_augmentation = tf.keras.models.Sequential([
    tf.keras.layers.experimental.preprocessing.RandomFlip('horizontal'),
    tf.keras.layers.experimental.preprocessing.RandomRotation(0.2),
    tf.keras.layers.experimental.preprocessing.RandomZoom(0.2)
])
```

```
In [168]: def plot_dataset_data_augmentation(dataset):

    plt.gcf().clear()
    plt.figure(figsize = (15, 15))

    for features, _ in dataset.take(1):

        feature = features[0]

        for i in range(9):

            feature_data_augmentation = data_augmentation(tf.expand_dims(feature, 0))

            plt.subplot(3, 3, i + 1)
            plt.axis('off')

            plt.imshow(feature_data_augmentation[0] / image_color_channel_size)
```

```
In [169]: plot_dataset_data_augmentation(dataset_train)
```

<Figure size 432x288 with 0 Axes>



```
In [170]: model_transfer_learning = tf.keras.applications.MobileNetV2(  
    input_shape = image_shape,  
    include_top = False,  
    weights = 'imagenet'  
)  
  
model_transfer_learning.trainable = False  
  
model_transfer_learning.summary()
```

Model: "mobilenetv2_1.00_160"

Layer (type)	Output Shape	Param #	Connected to
<hr/>			
input_5 (InputLayer)	[None, 160, 160, 3]	0	[]
Conv1 (Conv2D)	(None, 80, 80, 32)	864	['input_5[0][0]']
bn_Conv1 (BatchNormalization)	(None, 80, 80, 32)	128	['Conv1[0][0]']
Conv1_relu (ReLU)	(None, 80, 80, 32)	0	['bn_Conv1[0][0]']
expanded_conv_depthwise (DepthwiseConv2D)	(None, 80, 80, 32)	288	['Conv1_relu[0]']
expanded_conv_depthwise_BN (BatchNormalization)	(None, 80, 80, 32)	128	['expanded_conv_depthwise[0][0]']
expanded_conv_depthwise_relu (ReLU)	(None, 80, 80, 32)	0	['expanded_conv_depthwise_BN[0][0]']
expanded_conv_project (Conv2D)	(None, 80, 80, 16)	512	['expanded_conv_depthwise_relu[0]']
expanded_conv_project_BN (BatchNormalization)	(None, 80, 80, 16)	64	['expanded_conv_project[0][0]']
block_1_expand (Conv2D)	(None, 80, 80, 96)	1536	['expanded_conv_project_BN[0][0]']
block_1_expand_BN (BatchNormalization)	(None, 80, 80, 96)	384	['block_1_expand[0]']
block_1_expand_relu (ReLU)	(None, 80, 80, 96)	0	['block_1_expand_BN[0][0]']
block_1_pad (ZeroPadding2D)	(None, 81, 81, 96)	0	['block_1_expand_relu[0][0]']
block_1_depthwise (DepthwiseConv2D)	(None, 40, 40, 96)	864	['block_1_pad[0]']
block_1_depthwise_BN (BatchNormalization)	(None, 40, 40, 96)	384	['block_1_depthwise[0][0]']
block_1_depthwise_relu (ReLU)	(None, 40, 40, 96)	0	['block_1_depthwise_BN[0][0]']
block_1_project (Conv2D)	(None, 40, 40, 24)	2304	['block_1_depthwise_relu[0][0]']
block_1_project_BN (BatchNormalization)	(None, 40, 40, 24)	96	['block_1_project[0]']

[0][0]'] lization)			
block_2_expand (Conv2D) N[0][0]']	(None, 40, 40, 144) 3456		['block_1_project_B
block_2_expand_BN (BatchNormal [0]'] ization)	(None, 40, 40, 144) 576		['block_2_expand[0]
block_2_expand_relu (ReLU) [0][0]']	(None, 40, 40, 144) 0		['block_2_expand_BN
block_2_depthwise (DepthwiseCo lu[0][0]'] nv2D)	(None, 40, 40, 144) 1296		['block_2_expand_re
block_2_depthwise_BN (BatchNor [0][0]'] malization)	(None, 40, 40, 144) 576		['block_2_depthwise
block_2_depthwise_relu (ReLU) _BN[0][0]']	(None, 40, 40, 144) 0		['block_2_depthwise
block_2_project (Conv2D) _relu[0][0]']	(None, 40, 40, 24) 3456		['block_2_depthwise
block_2_project_BN (BatchNorma [0][0]'] lization)	(None, 40, 40, 24) 96		['block_2_project
block_2_add (Add) N[0][0]', N[0][0]']	(None, 40, 40, 24) 0		['block_1_project_B 'block_2_project_B
block_3_expand (Conv2D) [0]']	(None, 40, 40, 144) 3456		['block_2_add[0]
block_3_expand_BN (BatchNormal [0]'] ization)	(None, 40, 40, 144) 576		['block_3_expand[0]
block_3_expand_relu (ReLU) [0][0]']	(None, 40, 40, 144) 0		['block_3_expand_BN
block_3_pad (ZeroPadding2D) lu[0][0]']	(None, 41, 41, 144) 0		['block_3_expand_re
block_3_depthwise (DepthwiseCo [0]'] nv2D)	(None, 20, 20, 144) 1296		['block_3_pad[0]
block_3_depthwise_BN (BatchNor [0][0]'] malization)	(None, 20, 20, 144) 576		['block_3_depthwise
block_3_depthwise_relu (ReLU) _BN[0][0]']	(None, 20, 20, 144) 0		['block_3_depthwise
block_3_project (Conv2D) _relu[0][0]']	(None, 20, 20, 32) 4608		['block_3_depthwise
block_3_project_BN (BatchNorma [0]']	(None, 20, 20, 32) 128		['block_3_project

[0][0]'] lization)			
block_4_expand (Conv2D) N[0][0]']	(None, 20, 20, 192) 6144		['block_3_project_B
block_4_expand_BN (BatchNormal [0]'] ization)	(None, 20, 20, 192) 768		['block_4_expand[0]
block_4_expand_relu (ReLU) [0][0]']	(None, 20, 20, 192) 0		['block_4_expand_BN
block_4_depthwise (DepthwiseCo lu[0][0]'] nv2D)	(None, 20, 20, 192) 1728		['block_4_expand_re
block_4_depthwise_BN (BatchNor [0][0]'] malization)	(None, 20, 20, 192) 768		['block_4_depthwise
block_4_depthwise_relu (ReLU) _BN[0][0]']	(None, 20, 20, 192) 0		['block_4_depthwise
block_4_project (Conv2D) _relu[0][0]']	(None, 20, 20, 32) 6144		['block_4_depthwise
block_4_project_BN (BatchNorma [0][0]'] lization)	(None, 20, 20, 32) 128		['block_4_project
block_4_add (Add) N[0][0]', N[0][0]']	(None, 20, 20, 32) 0		['block_3_project_B 'block_4_project_B
block_5_expand (Conv2D) [0]']	(None, 20, 20, 192) 6144		['block_4_add[0]
block_5_expand_BN (BatchNormal [0]'] ization)	(None, 20, 20, 192) 768		['block_5_expand[0]
block_5_expand_relu (ReLU) [0][0]']	(None, 20, 20, 192) 0		['block_5_expand_BN
block_5_depthwise (DepthwiseCo lu[0][0]'] nv2D)	(None, 20, 20, 192) 1728		['block_5_expand_re
block_5_depthwise_BN (BatchNor [0][0]'] malization)	(None, 20, 20, 192) 768		['block_5_depthwise
block_5_depthwise_relu (ReLU) _BN[0][0]']	(None, 20, 20, 192) 0		['block_5_depthwise
block_5_project (Conv2D) _relu[0][0]']	(None, 20, 20, 32) 6144		['block_5_depthwise
block_5_project_BN (BatchNorma [0][0]'] lization)	(None, 20, 20, 32) 128		['block_5_project

CNN Fortnite e Terraria			
block_5_add (Add) [0]', N[0][0]']	(None, 20, 20, 32) 0	0	['block_4_add[0] 'block_5_project_B
block_6_expand (Conv2D) [0]']	(None, 20, 20, 192) 6144	6144	['block_5_add[0]
block_6_expand_BN (BatchNormal [0]' ization)	(None, 20, 20, 192) 768	768	['block_6_expand[0]
block_6_expand_relu (ReLU) [0][0]']	(None, 20, 20, 192) 0	0	['block_6_expand_BN
block_6_pad (ZeroPadding2D) lu[0][0]']	(None, 21, 21, 192) 0	0	['block_6_expand_re
block_6_depthwise (DepthwiseCo [0]' nv2D)	(None, 10, 10, 192) 1728	1728	['block_6_pad[0]
block_6_depthwise_BN (BatchNor [0][0]' malization)	(None, 10, 10, 192) 768	768	['block_6_depthwise
block_6_depthwise_relu (ReLU) _BN[0][0]']	(None, 10, 10, 192) 0	0	['block_6_depthwise
block_6_project (Conv2D) _relu[0][0]']	(None, 10, 10, 64) 12288	12288	['block_6_depthwise
block_6_project_BN (BatchNorma [0][0]' lization)	(None, 10, 10, 64) 256	256	['block_6_project
block_7_expand (Conv2D) N[0][0]']	(None, 10, 10, 384) 24576	24576	['block_6_project_B
block_7_expand_BN (BatchNormal [0]' ization)	(None, 10, 10, 384) 1536	1536	['block_7_expand[0]
block_7_expand_relu (ReLU) [0][0]']	(None, 10, 10, 384) 0	0	['block_7_expand_BN
block_7_depthwise (DepthwiseCo lu[0][0]' nv2D)	(None, 10, 10, 384) 3456	3456	['block_7_expand_re
block_7_depthwise_BN (BatchNor [0][0]' malization)	(None, 10, 10, 384) 1536	1536	['block_7_depthwise
block_7_depthwise_relu (ReLU) _BN[0][0]']	(None, 10, 10, 384) 0	0	['block_7_depthwise
block_7_project (Conv2D) _relu[0][0]']	(None, 10, 10, 64) 24576	24576	['block_7_depthwise
block_7_project_BN (BatchNorma [0][0]' lization)	(None, 10, 10, 64) 256	256	['block_7_project

CNN Fortnite e Terraria			
block_7_add (Add)	(None, 10, 10, 64)	0	['block_6_project_B', 'block_7_project_B']
N[0][0]', N[0][0]'			
block_8_expand (Conv2D)	(None, 10, 10, 384)	24576	['block_7_add[0]
[0]']			
block_8_expand_BN (BatchNormal	(None, 10, 10, 384)	1536	['block_8_expand[0]
[0]']			
ization)			
block_8_expand_relu (ReLU)	(None, 10, 10, 384)	0	['block_8_expand_BN
[0][0]']			
block_8_depthwise (DepthwiseCo	(None, 10, 10, 384)	3456	['block_8_expand_re
lu[0][0]']			
nv2D)			
block_8_depthwise_BN (BatchNor	(None, 10, 10, 384)	1536	['block_8_depthwise
[0][0]']			
malization)			
block_8_depthwise_relu (ReLU)	(None, 10, 10, 384)	0	['block_8_depthwise
_BN[0][0]']			
block_8_project (Conv2D)	(None, 10, 10, 64)	24576	['block_8_depthwise
_relu[0][0]']			
block_8_project_BN (BatchNorma	(None, 10, 10, 64)	256	['block_8_project
[0][0]']			
lization)			
block_8_add (Add)	(None, 10, 10, 64)	0	['block_7_add[0]
[0]',			
N[0][0]']			'block_8_project_B']
block_9_expand (Conv2D)	(None, 10, 10, 384)	24576	['block_8_add[0]
[0]']			
block_9_expand_BN (BatchNormal	(None, 10, 10, 384)	1536	['block_9_expand[0]
[0]']			
ization)			
block_9_expand_relu (ReLU)	(None, 10, 10, 384)	0	['block_9_expand_BN
[0][0]']			
block_9_depthwise (DepthwiseCo	(None, 10, 10, 384)	3456	['block_9_expand_re
lu[0][0]']			
nv2D)			
block_9_depthwise_BN (BatchNor	(None, 10, 10, 384)	1536	['block_9_depthwise
[0][0]']			
malization)			
block_9_depthwise_relu (ReLU)	(None, 10, 10, 384)	0	['block_9_depthwise
_BN[0][0]']			
block_9_project (Conv2D)	(None, 10, 10, 64)	24576	['block_9_depthwise
_relu[0][0]']			
block_9_project_BN (BatchNorma	(None, 10, 10, 64)	256	['block_9_project
[0][0]']			

lization)			
block_9_add (Add) [0]', N[0][0]']	(None, 10, 10, 64) 0		['block_8_add[0] 'block_9_project_B
block_10_expand (Conv2D) [0]']	(None, 10, 10, 384) 24576		['block_9_add[0]
block_10_expand_BN (BatchNorma [0][0]' lization)	(None, 10, 10, 384) 1536		['block_10_expand
block_10_expand_relu (ReLU) N[0][0]']	(None, 10, 10, 384) 0		['block_10_expand_B
block_10_depthwise (DepthwiseC elu[0][0]' onv2D)	(None, 10, 10, 384) 3456		['block_10_expand_r
block_10_depthwise_BN (BatchNo e[0][0]' rmalization)	(None, 10, 10, 384) 1536		['block_10_depthwis
block_10_depthwise_relu (ReLU) e_BN[0][0]']	(None, 10, 10, 384) 0		['block_10_depthwis
block_10_project (Conv2D) e_relu[0][0]']	(None, 10, 10, 96) 36864		['block_10_depthwis
block_10_project_BN (BatchNorm [0][0]' alization)	(None, 10, 10, 96) 384		['block_10_project
block_11_expand (Conv2D) BN[0][0]']	(None, 10, 10, 576) 55296		['block_10_project_
block_11_expand_BN (BatchNorma [0][0]' lization)	(None, 10, 10, 576) 2304		['block_11_expand
block_11_expand_relu (ReLU) N[0][0]']	(None, 10, 10, 576) 0		['block_11_expand_B
block_11_depthwise (DepthwiseC elu[0][0]' onv2D)	(None, 10, 10, 576) 5184		['block_11_expand_r
block_11_depthwise_BN (BatchNo e[0][0]' rmalization)	(None, 10, 10, 576) 2304		['block_11_depthwis
block_11_depthwise_relu (ReLU) e_BN[0][0]']	(None, 10, 10, 576) 0		['block_11_depthwis
block_11_project (Conv2D) e_relu[0][0]']	(None, 10, 10, 96) 55296		['block_11_depthwis
block_11_project_BN (BatchNorm [0][0]' alization)	(None, 10, 10, 96) 384		['block_11_project
block_11_add (Add)	(None, 10, 10, 96) 0		['block_10_project_

BN[0][0]',		'block_11_project_
BN[0][0]']		
block_12_expand (Conv2D) (None, 10, 10, 576) 55296	['block_11_add[0]	
[0]']		
block_12_expand_BN (BatchNorma (None, 10, 10, 576) 2304	['block_12_expand	
[0][0]']		
lization)		
block_12_expand_relu (ReLU) (None, 10, 10, 576) 0	['block_12_expand_B	
N[0][0]']		
block_12_depthwise (DepthwiseC (None, 10, 10, 576) 5184	['block_12_expand_r	
elu[0][0]']		
onv2D)		
block_12_depthwise_BN (BatchNo (None, 10, 10, 576) 2304	['block_12_depthwis	
e[0][0]']		
rmalization)		
block_12_depthwise_relu (ReLU) (None, 10, 10, 576) 0	['block_12_depthwis	
e_BN[0][0]']		
block_12_project (Conv2D) (None, 10, 10, 96) 55296	['block_12_depthwis	
e_relu[0][0]']		
block_12_project_BN (BatchNorm (None, 10, 10, 96) 384	['block_12_project	
[0][0]']		
alization)		
block_12_add (Add) (None, 10, 10, 96) 0	['block_11_add[0]	
[0]',		
BN[0][0]']		'block_12_project_
block_13_expand (Conv2D) (None, 10, 10, 576) 55296	['block_12_add[0]	
[0]']		
block_13_expand_BN (BatchNorma (None, 10, 10, 576) 2304	['block_13_expand	
[0][0]']		
lization)		
block_13_expand_relu (ReLU) (None, 10, 10, 576) 0	['block_13_expand_B	
N[0][0]']		
block_13_pad (ZeroPadding2D) (None, 11, 11, 576) 0	['block_13_expand_r	
elu[0][0]']		
block_13_depthwise (DepthwiseC (None, 5, 5, 576) 5184	['block_13_pad[0]	
[0]']		
onv2D)		
block_13_depthwise_BN (BatchNo (None, 5, 5, 576) 2304	['block_13_depthwis	
e[0][0]']		
rmalization)		
block_13_depthwise_relu (ReLU) (None, 5, 5, 576) 0	['block_13_depthwis	
e_BN[0][0]']		
block_13_project (Conv2D) (None, 5, 5, 160) 92160	['block_13_depthwis	
e_relu[0][0]']		

CNN Fortnite e Terraria				
block_13_project_BN (BatchNorm [0][0])	(None, 5, 5, 160)	640		['block_13_project']
block_14_expand (Conv2D BN[0][0])	(None, 5, 5, 960)	153600		['block_13_project']
block_14_expand_BN (BatchNorm [0][0])	(None, 5, 5, 960)	3840		['block_14_expand']
block_14_expand_relu (ReLU N[0][0])	(None, 5, 5, 960)	0		['block_14_expand_B']
block_14_depthwise (DepthwiseConv2D elu[0][0])	(None, 5, 5, 960)	8640		['block_14_expand_r']
block_14_depthwise_BN (BatchNormal [0][0])	(None, 5, 5, 960)	3840		['block_14_depthwis']
block_14_depthwise_relu (ReLU e_BN[0][0])	(None, 5, 5, 960)	0		['block_14_depthwis']
block_14_project (Conv2D e_relu[0][0])	(None, 5, 5, 160)	153600		['block_14_depthwis']
block_14_project_BN (BatchNorm [0][0])	(None, 5, 5, 160)	640		['block_14_project']
block_14_add (Add BN[0][0])	(None, 5, 5, 160)	0		['block_13_project']
BN[0][0]				'block_14_project'
BN[0][0]				
block_15_expand (Conv2D [0])	(None, 5, 5, 960)	153600		['block_14_add[0]']
block_15_expand_BN (BatchNorm [0][0])	(None, 5, 5, 960)	3840		['block_15_expand']
block_15_expand_relu (ReLU N[0][0])	(None, 5, 5, 960)	0		['block_15_expand_B']
block_15_depthwise (DepthwiseConv2D elu[0][0])	(None, 5, 5, 960)	8640		['block_15_expand_r']
block_15_depthwise_BN (BatchNormal [0][0])	(None, 5, 5, 960)	3840		['block_15_depthwis']
block_15_depthwise_relu (ReLU e_BN[0][0])	(None, 5, 5, 960)	0		['block_15_depthwis']
block_15_project (Conv2D e_relu[0][0])	(None, 5, 5, 160)	153600		['block_15_depthwis']
block_15_project_BN (BatchNorm [0][0])	(None, 5, 5, 160)	640		['block_15_project']

block_15_add (Add) [0]',	(None, 5, 5, 160)	0	['block_14_add[0] 'block_15_project_
block_16_expand (Conv2D) [0]'	(None, 5, 5, 960)	153600	['block_15_add[0]
block_16_expand_BN (BatchNorma [0][0]' lization)	(None, 5, 5, 960)	3840	['block_16_expand
block_16_expand_relu (ReLU) N[0][0]'	(None, 5, 5, 960)	0	['block_16_expand_B
block_16_depthwise (DepthwiseC elu[0][0]' onv2D)	(None, 5, 5, 960)	8640	['block_16_expand_r
block_16_depthwise_BN (BatchNo e[0][0]' rmalization)	(None, 5, 5, 960)	3840	['block_16_depthwis
block_16_depthwise_relu (ReLU) e_BN[0][0]'	(None, 5, 5, 960)	0	['block_16_depthwis
block_16_project (Conv2D) e_relu[0][0]'	(None, 5, 5, 320)	307200	['block_16_depthwis
block_16_project_BN (BatchNorm [0][0]' alization)	(None, 5, 5, 320)	1280	['block_16_project
Conv_1 (Conv2D) BN[0][0]'	(None, 5, 5, 1280)	409600	['block_16_project_
Conv_1_bn (BatchNormalizatio n)	(None, 5, 5, 1280)	5120	['Conv_1[0][0]']
out_relu (ReLU)	(None, 5, 5, 1280)	0	['Conv_1_bn[0][0]']
<hr/>			
<hr/>			
Total params: 2,257,984			
Trainable params: 0			
Non-trainable params: 2,257,984			

In [171]:

```
model = tf.keras.models.Sequential([
    tf.keras.layers.experimental.preprocessing.Rescaling(
        1. / image_color_channel_size,
        input_shape = image_shape
    ),
    data_augmentation,
    model_transfer_learning,
    tf.keras.layers.GlobalAveragePooling2D(),
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(1, activation = 'sigmoid')
])

model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate = learning_rate),
```

```
        loss = tf.keras.losses.BinaryCrossentropy(),
        metrics = ['accuracy']
    )

model.summary()
```

Model: "sequential_9"

Layer (type)	Output Shape	Param #
<hr/>		
rescaling_4 (Rescaling)	(None, 160, 160, 3)	0
sequential_8 (Sequential)	(None, 160, 160, 3)	0
mobilenetv2_1.00_160 (Functional)	(None, 5, 5, 1280)	2257984
global_average_pooling2d_4 (GlobalAveragePooling2D)	(None, 1280)	0
dropout_4 (Dropout)	(None, 1280)	0
dense_4 (Dense)	(None, 1)	1281
<hr/>		
Total params: 2,259,265		
Trainable params: 1,281		
Non-trainable params: 2,257,984		

In [172]: history = model.fit(
 dataset_train,
 validation_data = dataset_validation,
 epochs = epochs
)

Epoch 1/100
32/32 [=====] - 43s 1s/step - loss: 0.8424 - accuracy: 0.46
50 - val_loss: 0.6722 - val_accuracy: 0.6126
Epoch 2/100
32/32 [=====] - 39s 1s/step - loss: 0.7061 - accuracy: 0.59
20 - val_loss: 0.5913 - val_accuracy: 0.6943
Epoch 3/100
32/32 [=====] - 40s 1s/step - loss: 0.5779 - accuracy: 0.71
40 - val_loss: 0.5326 - val_accuracy: 0.7376
Epoch 4/100
32/32 [=====] - 43s 1s/step - loss: 0.4845 - accuracy: 0.78
20 - val_loss: 0.4734 - val_accuracy: 0.7983
Epoch 5/100
32/32 [=====] - 40s 1s/step - loss: 0.4205 - accuracy: 0.81
60 - val_loss: 0.4339 - val_accuracy: 0.8230
Epoch 6/100
32/32 [=====] - 40s 1s/step - loss: 0.3675 - accuracy: 0.86
20 - val_loss: 0.4072 - val_accuracy: 0.8342
Epoch 7/100
32/32 [=====] - 41s 1s/step - loss: 0.3368 - accuracy: 0.87
50 - val_loss: 0.3775 - val_accuracy: 0.8552
Epoch 8/100
32/32 [=====] - 48s 1s/step - loss: 0.2895 - accuracy: 0.91
40 - val_loss: 0.3651 - val_accuracy: 0.8515
Epoch 9/100
32/32 [=====] - 48s 1s/step - loss: 0.2571 - accuracy: 0.92
70 - val_loss: 0.3383 - val_accuracy: 0.8725
Epoch 10/100
32/32 [=====] - 42s 1s/step - loss: 0.2378 - accuracy: 0.93
50 - val_loss: 0.3186 - val_accuracy: 0.8837
Epoch 11/100
32/32 [=====] - 43s 1s/step - loss: 0.2275 - accuracy: 0.93
40 - val_loss: 0.3161 - val_accuracy: 0.8837
Epoch 12/100
32/32 [=====] - 43s 1s/step - loss: 0.1903 - accuracy: 0.95
30 - val_loss: 0.3002 - val_accuracy: 0.8923
Epoch 13/100
32/32 [=====] - 47s 1s/step - loss: 0.1830 - accuracy: 0.95
20 - val_loss: 0.2882 - val_accuracy: 0.9035
Epoch 14/100
32/32 [=====] - 48s 1s/step - loss: 0.1775 - accuracy: 0.95
40 - val_loss: 0.2737 - val_accuracy: 0.9084
Epoch 15/100
32/32 [=====] - 44s 1s/step - loss: 0.1675 - accuracy: 0.96
30 - val_loss: 0.2725 - val_accuracy: 0.9035
Epoch 16/100
32/32 [=====] - 45s 1s/step - loss: 0.1539 - accuracy: 0.96
20 - val_loss: 0.2750 - val_accuracy: 0.9010
Epoch 17/100
32/32 [=====] - 46s 1s/step - loss: 0.1398 - accuracy: 0.96
00 - val_loss: 0.2627 - val_accuracy: 0.9035
Epoch 18/100
32/32 [=====] - 45s 1s/step - loss: 0.1285 - accuracy: 0.97
50 - val_loss: 0.2509 - val_accuracy: 0.9121
Epoch 19/100
32/32 [=====] - 45s 1s/step - loss: 0.1334 - accuracy: 0.96
90 - val_loss: 0.2457 - val_accuracy: 0.9084
Epoch 20/100
32/32 [=====] - 44s 1s/step - loss: 0.1210 - accuracy: 0.97
30 - val_loss: 0.2460 - val_accuracy: 0.9097
Epoch 21/100
32/32 [=====] - 47s 1s/step - loss: 0.1122 - accuracy: 0.98
00 - val_loss: 0.2424 - val_accuracy: 0.9084
Epoch 22/100

```
32/32 [=====] - 44s 1s/step - loss: 0.1077 - accuracy: 0.98
30 - val_loss: 0.2316 - val_accuracy: 0.9134
Epoch 23/100
32/32 [=====] - 45s 1s/step - loss: 0.1074 - accuracy: 0.97
60 - val_loss: 0.2309 - val_accuracy: 0.9146
Epoch 24/100
32/32 [=====] - 44s 1s/step - loss: 0.0960 - accuracy: 0.98
10 - val_loss: 0.2358 - val_accuracy: 0.9097
Epoch 25/100
32/32 [=====] - 45s 1s/step - loss: 0.1017 - accuracy: 0.97
80 - val_loss: 0.2221 - val_accuracy: 0.9158
Epoch 26/100
32/32 [=====] - 45s 1s/step - loss: 0.0954 - accuracy: 0.98
10 - val_loss: 0.2312 - val_accuracy: 0.9097
Epoch 27/100
32/32 [=====] - 44s 1s/step - loss: 0.0856 - accuracy: 0.98
90 - val_loss: 0.2181 - val_accuracy: 0.9146
Epoch 28/100
32/32 [=====] - 45s 1s/step - loss: 0.0790 - accuracy: 0.98
50 - val_loss: 0.2090 - val_accuracy: 0.9171
Epoch 29/100
32/32 [=====] - 43s 1s/step - loss: 0.0842 - accuracy: 0.98
40 - val_loss: 0.2138 - val_accuracy: 0.9183
Epoch 30/100
32/32 [=====] - 45s 1s/step - loss: 0.0741 - accuracy: 0.98
80 - val_loss: 0.2070 - val_accuracy: 0.9245
Epoch 31/100
32/32 [=====] - 43s 1s/step - loss: 0.0842 - accuracy: 0.98
40 - val_loss: 0.2112 - val_accuracy: 0.9183
Epoch 32/100
32/32 [=====] - 44s 1s/step - loss: 0.0705 - accuracy: 0.98
60 - val_loss: 0.2174 - val_accuracy: 0.9171
Epoch 33/100
32/32 [=====] - 47s 1s/step - loss: 0.0673 - accuracy: 0.99
10 - val_loss: 0.2094 - val_accuracy: 0.9208
Epoch 34/100
32/32 [=====] - 46s 1s/step - loss: 0.0630 - accuracy: 0.98
90 - val_loss: 0.2147 - val_accuracy: 0.9171
Epoch 35/100
32/32 [=====] - 45s 1s/step - loss: 0.0636 - accuracy: 0.99
00 - val_loss: 0.2120 - val_accuracy: 0.9233
Epoch 36/100
32/32 [=====] - 44s 1s/step - loss: 0.0613 - accuracy: 0.98
90 - val_loss: 0.2115 - val_accuracy: 0.9171
Epoch 37/100
32/32 [=====] - 43s 1s/step - loss: 0.0693 - accuracy: 0.98
50 - val_loss: 0.1994 - val_accuracy: 0.9245
Epoch 38/100
32/32 [=====] - 43s 1s/step - loss: 0.0561 - accuracy: 0.99
10 - val_loss: 0.2147 - val_accuracy: 0.9171
Epoch 39/100
32/32 [=====] - 44s 1s/step - loss: 0.0620 - accuracy: 0.98
60 - val_loss: 0.2069 - val_accuracy: 0.9220
Epoch 40/100
32/32 [=====] - 42s 1s/step - loss: 0.0518 - accuracy: 0.99
30 - val_loss: 0.2059 - val_accuracy: 0.9196
Epoch 41/100
32/32 [=====] - 42s 1s/step - loss: 0.0526 - accuracy: 0.99
30 - val_loss: 0.2115 - val_accuracy: 0.9158
Epoch 42/100
32/32 [=====] - 42s 1s/step - loss: 0.0529 - accuracy: 0.99
40 - val_loss: 0.1965 - val_accuracy: 0.9245
Epoch 43/100
32/32 [=====] - 52s 2s/step - loss: 0.0544 - accuracy: 0.99
```

```
20 - val_loss: 0.1995 - val_accuracy: 0.9233
Epoch 44/100
32/32 [=====] - 52s 2s/step - loss: 0.0502 - accuracy: 0.99
50 - val_loss: 0.2002 - val_accuracy: 0.9220
Epoch 45/100
32/32 [=====] - 52s 2s/step - loss: 0.0497 - accuracy: 0.98
70 - val_loss: 0.2039 - val_accuracy: 0.9183
Epoch 46/100
32/32 [=====] - 50s 2s/step - loss: 0.0495 - accuracy: 0.99
40 - val_loss: 0.2010 - val_accuracy: 0.9171
Epoch 47/100
32/32 [=====] - 60s 2s/step - loss: 0.0513 - accuracy: 0.99
30 - val_loss: 0.1968 - val_accuracy: 0.9220
Epoch 48/100
32/32 [=====] - 57s 2s/step - loss: 0.0451 - accuracy: 0.99
50 - val_loss: 0.1991 - val_accuracy: 0.9171
Epoch 49/100
32/32 [=====] - 45s 1s/step - loss: 0.0458 - accuracy: 0.98
90 - val_loss: 0.2095 - val_accuracy: 0.9146
Epoch 50/100
32/32 [=====] - 45s 1s/step - loss: 0.0411 - accuracy: 0.99
30 - val_loss: 0.1838 - val_accuracy: 0.9233
Epoch 51/100
32/32 [=====] - 46s 1s/step - loss: 0.0471 - accuracy: 0.99
10 - val_loss: 0.2038 - val_accuracy: 0.9134
Epoch 52/100
32/32 [=====] - 45s 1s/step - loss: 0.0367 - accuracy: 0.99
60 - val_loss: 0.1910 - val_accuracy: 0.9220
Epoch 53/100
32/32 [=====] - 44s 1s/step - loss: 0.0403 - accuracy: 0.99
10 - val_loss: 0.1888 - val_accuracy: 0.9208
Epoch 54/100
32/32 [=====] - 44s 1s/step - loss: 0.0395 - accuracy: 0.99
40 - val_loss: 0.1894 - val_accuracy: 0.9220
Epoch 55/100
32/32 [=====] - 45s 1s/step - loss: 0.0380 - accuracy: 0.99
30 - val_loss: 0.2030 - val_accuracy: 0.9134
Epoch 56/100
32/32 [=====] - 44s 1s/step - loss: 0.0387 - accuracy: 0.99
50 - val_loss: 0.1979 - val_accuracy: 0.9171
Epoch 57/100
32/32 [=====] - 45s 1s/step - loss: 0.0414 - accuracy: 0.99
40 - val_loss: 0.2002 - val_accuracy: 0.9146
Epoch 58/100
32/32 [=====] - 47s 1s/step - loss: 0.0389 - accuracy: 0.99
30 - val_loss: 0.1946 - val_accuracy: 0.9134
Epoch 59/100
32/32 [=====] - 48s 1s/step - loss: 0.0350 - accuracy: 0.99
60 - val_loss: 0.1904 - val_accuracy: 0.9171
Epoch 60/100
32/32 [=====] - 44s 1s/step - loss: 0.0376 - accuracy: 0.99
40 - val_loss: 0.1890 - val_accuracy: 0.9196
Epoch 61/100
32/32 [=====] - 47s 1s/step - loss: 0.0319 - accuracy: 0.99
80 - val_loss: 0.2005 - val_accuracy: 0.9146
Epoch 62/100
32/32 [=====] - 45s 1s/step - loss: 0.0372 - accuracy: 0.99
30 - val_loss: 0.1924 - val_accuracy: 0.9171
Epoch 63/100
32/32 [=====] - 47s 1s/step - loss: 0.0261 - accuracy: 0.99
90 - val_loss: 0.1948 - val_accuracy: 0.9158
Epoch 64/100
32/32 [=====] - 50s 2s/step - loss: 0.0300 - accuracy: 0.99
50 - val_loss: 0.1918 - val_accuracy: 0.9183
```

```
Epoch 65/100
32/32 [=====] - 49s 2s/step - loss: 0.0303 - accuracy: 0.99
60 - val_loss: 0.1708 - val_accuracy: 0.9295
Epoch 66/100
32/32 [=====] - 49s 2s/step - loss: 0.0362 - accuracy: 0.99
20 - val_loss: 0.1836 - val_accuracy: 0.9208
Epoch 67/100
32/32 [=====] - 40s 1s/step - loss: 0.0278 - accuracy: 0.99
60 - val_loss: 0.1793 - val_accuracy: 0.9220
Epoch 68/100
32/32 [=====] - 44s 1s/step - loss: 0.0306 - accuracy: 0.99
40 - val_loss: 0.1892 - val_accuracy: 0.9196
Epoch 69/100
32/32 [=====] - 47s 1s/step - loss: 0.0267 - accuracy: 0.99
80 - val_loss: 0.1893 - val_accuracy: 0.9196
Epoch 70/100
32/32 [=====] - 46s 1s/step - loss: 0.0345 - accuracy: 0.99
30 - val_loss: 0.1957 - val_accuracy: 0.9134
Epoch 71/100
32/32 [=====] - 46s 1s/step - loss: 0.0316 - accuracy: 0.99
20 - val_loss: 0.1850 - val_accuracy: 0.9208
Epoch 72/100
32/32 [=====] - 47s 1s/step - loss: 0.0289 - accuracy: 0.99
70 - val_loss: 0.1853 - val_accuracy: 0.9196
Epoch 73/100
32/32 [=====] - 48s 1s/step - loss: 0.0272 - accuracy: 0.99
80 - val_loss: 0.1850 - val_accuracy: 0.9171
Epoch 74/100
32/32 [=====] - 48s 1s/step - loss: 0.0290 - accuracy: 0.99
60 - val_loss: 0.1766 - val_accuracy: 0.9233
Epoch 75/100
32/32 [=====] - 41s 1s/step - loss: 0.0233 - accuracy: 0.99
90 - val_loss: 0.1951 - val_accuracy: 0.9146
Epoch 76/100
32/32 [=====] - 42s 1s/step - loss: 0.0253 - accuracy: 0.99
50 - val_loss: 0.1787 - val_accuracy: 0.9208
Epoch 77/100
32/32 [=====] - 40s 1s/step - loss: 0.0252 - accuracy: 0.99
70 - val_loss: 0.1932 - val_accuracy: 0.9109
Epoch 78/100
32/32 [=====] - 51s 2s/step - loss: 0.0235 - accuracy: 0.99
70 - val_loss: 0.1876 - val_accuracy: 0.9196
Epoch 79/100
32/32 [=====] - 53s 2s/step - loss: 0.0270 - accuracy: 0.99
40 - val_loss: 0.1965 - val_accuracy: 0.9146
Epoch 80/100
32/32 [=====] - 48s 1s/step - loss: 0.0240 - accuracy: 0.99
50 - val_loss: 0.1730 - val_accuracy: 0.9208
Epoch 81/100
32/32 [=====] - 45s 1s/step - loss: 0.0227 - accuracy: 0.99
70 - val_loss: 0.1882 - val_accuracy: 0.9158
Epoch 82/100
32/32 [=====] - 47s 1s/step - loss: 0.0253 - accuracy: 0.99
70 - val_loss: 0.1922 - val_accuracy: 0.9109
Epoch 83/100
32/32 [=====] - 43s 1s/step - loss: 0.0220 - accuracy: 0.99
80 - val_loss: 0.1873 - val_accuracy: 0.9121
Epoch 84/100
32/32 [=====] - 44s 1s/step - loss: 0.0238 - accuracy: 0.99
60 - val_loss: 0.1689 - val_accuracy: 0.9233
Epoch 85/100
32/32 [=====] - 45s 1s/step - loss: 0.0250 - accuracy: 0.99
60 - val_loss: 0.1749 - val_accuracy: 0.9257
Epoch 86/100
```

```
32/32 [=====] - 47s 1s/step - loss: 0.0231 - accuracy: 0.99
50 - val_loss: 0.1738 - val_accuracy: 0.9257
Epoch 87/100
32/32 [=====] - 46s 1s/step - loss: 0.0288 - accuracy: 0.99
30 - val_loss: 0.1891 - val_accuracy: 0.9134
Epoch 88/100
32/32 [=====] - 41s 1s/step - loss: 0.0195 - accuracy: 0.99
90 - val_loss: 0.1716 - val_accuracy: 0.9196
Epoch 89/100
32/32 [=====] - 44s 1s/step - loss: 0.0219 - accuracy: 0.99
70 - val_loss: 0.1644 - val_accuracy: 0.9220
Epoch 90/100
32/32 [=====] - 46s 1s/step - loss: 0.0210 - accuracy: 0.99
70 - val_loss: 0.1681 - val_accuracy: 0.9196
Epoch 91/100
32/32 [=====] - 46s 1s/step - loss: 0.0182 - accuracy: 0.99
80 - val_loss: 0.1841 - val_accuracy: 0.9158
Epoch 92/100
32/32 [=====] - 50s 2s/step - loss: 0.0232 - accuracy: 0.99
50 - val_loss: 0.1771 - val_accuracy: 0.9196
Epoch 93/100
32/32 [=====] - 46s 1s/step - loss: 0.0202 - accuracy: 0.99
70 - val_loss: 0.1778 - val_accuracy: 0.9158
Epoch 94/100
32/32 [=====] - 41s 1s/step - loss: 0.0196 - accuracy: 0.99
80 - val_loss: 0.1782 - val_accuracy: 0.9183
Epoch 95/100
32/32 [=====] - 38s 1s/step - loss: 0.0171 - accuracy: 0.99
80 - val_loss: 0.1753 - val_accuracy: 0.9196
Epoch 96/100
32/32 [=====] - 36s 1s/step - loss: 0.0164 - accuracy: 0.99
90 - val_loss: 0.1738 - val_accuracy: 0.9196
Epoch 97/100
32/32 [=====] - 39s 1s/step - loss: 0.0179 - accuracy: 0.99
80 - val_loss: 0.1956 - val_accuracy: 0.9097
Epoch 98/100
32/32 [=====] - 41s 1s/step - loss: 0.0211 - accuracy: 0.99
50 - val_loss: 0.1832 - val_accuracy: 0.9146
Epoch 99/100
32/32 [=====] - 41s 1s/step - loss: 0.0185 - accuracy: 0.99
70 - val_loss: 0.1780 - val_accuracy: 0.9183
Epoch 100/100
32/32 [=====] - 41s 1s/step - loss: 0.0206 - accuracy: 0.99
70 - val_loss: 0.1873 - val_accuracy: 0.9134
```

In [173]:

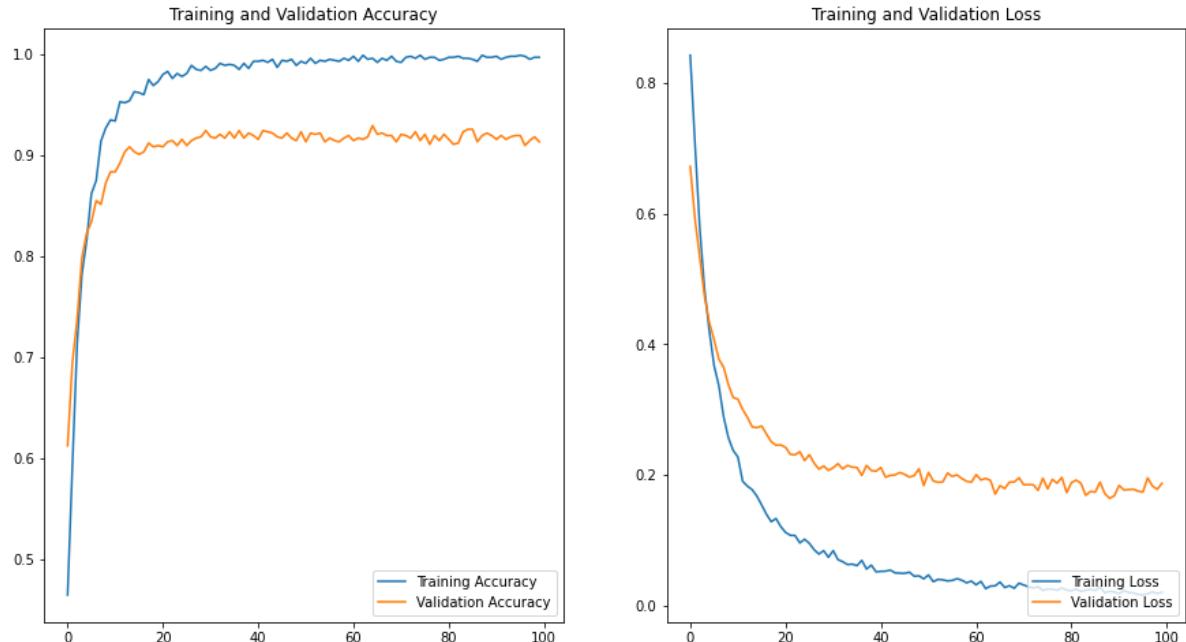
```
def plot_model():

    accuracy = history.history['accuracy']
    val_accuracy = history.history['val_accuracy']
    loss = history.history['loss']
    val_loss = history.history['val_loss']
    epochs_range = range(epochs)
    plt.gcf().clear()
    plt.figure(figsize = (15, 8))
    plt.subplot(1, 2, 1)
    plt.title('Training and Validation Accuracy')
    plt.plot(epochs_range, accuracy, label = 'Training Accuracy')
    plt.plot(epochs_range, val_accuracy, label = 'Validation Accuracy')
    plt.legend(loc = 'lower right')
    plt.subplot(1, 2, 2)
    plt.title('Training and Validation Loss')
    plt.plot(epochs_range, loss, label = 'Training Loss')
    plt.plot(epochs_range, val_loss, label = 'Validation Loss')
```

```
plt.legend(loc = 'lower right')
plt.show()
```

In [174]: `plot_model()`

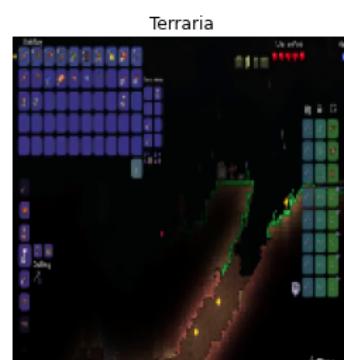
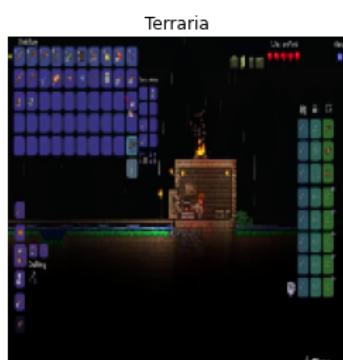
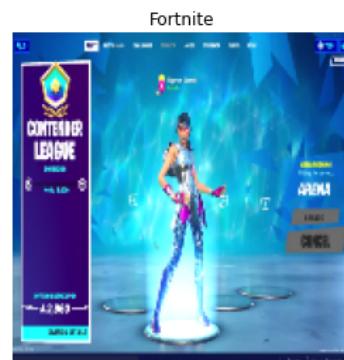
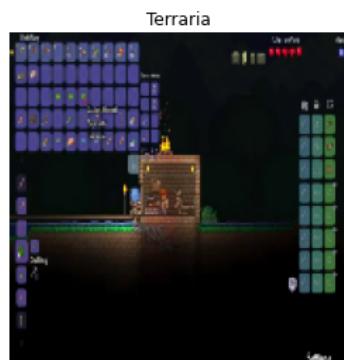
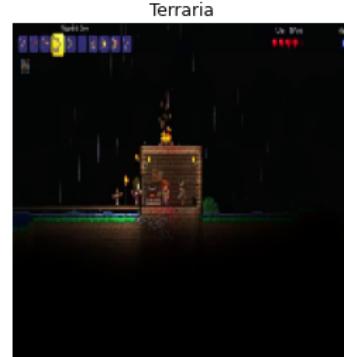
<Figure size 432x288 with 0 Axes>



In [175]: `def plot_dataset_predictions(dataset):`
 `features, labels = dataset.as_numpy_iterator().next()`
 `predictions = model.predict_on_batch(features).flatten()`
 `predictions = tf.where(predictions < 0.5, 0, 1)`
 `print('Labels: %s' % labels)`
 `print('Predictions: %s' % predictions.numpy())`
 `plt.gcf().clear()`
 `plt.figure(figsize = (15, 15))`
 `for i in range(9):`
 `plt.subplot(3, 3, i + 1)`
 `plt.axis('off')`
 `plt.imshow(features[i].astype('uint8'))`
 `plt.title(class_names[predictions[i]])`

In [177]: `plot_dataset_predictions(dataset_test)`

Labels: [0 0 1 0 1 0 1 0 1 0 0 1 0 1 1 1 0 0 0 1 0 0 0 1 1 1 1 1 1 0 1]
Predictions: [0 0 1 0 1 0 1 0 1 0 0 1 0 1 1 1 0 0 0 1 0 0 0 1 1 1 1 1 1 0 1]
<Figure size 432x288 with 0 Axes>



In []:

In [164]: `model.save('path/to/model')`

```
WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_com
piled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op, _j
it_compiled_convolution_op while saving (showing 5 of 52). These functions will not
be directly callable after loading.
INFO:tensorflow:Assets written to: path/to/model\assets
INFO:tensorflow:Assets written to: path/to/model\assets
```