Load dữ liệu train và validation

In [ ]:

```
import tensorflow as tf
import matplotlib.pyplot as plt
import os
import numpy as np

# --- Cấu hình ---
IMG_SIZE = (64, 64)
BATCH_SIZE = 64
DATA_DIR = "cropped_and_augment"
EPOCHS = 10
SEED = 123

print("Đang tải toàn bộ dữ liệu từ thư mục:", DATA_DIR)

# --- Tải toàn bộ dữ liệu một lần ---
full_ds = tf.keras.utils.image_dataset_from_directory(
    DATA_DIR,
    labels='inferred',
    label_mode='int',
    image_size=IMG_SIZE,
    shuffle=True,
    seed=SEED,
    batch_size=BATCH_SIZE  # batch ở đây chỉ để load nhanh hơn
)

class_names = full_ds.class_names
num_classes = len(class_names)
print(f"Các lớp tìm thấy: {class_names}")
print(f"Tổng số lớp: {num_classes}")

# --- Ghép toàn bộ ảnh và nhãn ---
image_list = []
label_list = []

for images, labels in full_ds:
    image_list.append(images)
    label_list.append(labels)

all_images = tf.concat(image_list, axis=0)
all_labels = tf.concat(label_list, axis=0)

# --- Shuffle toàn bộ dữ liệu ---
num_samples = all_images.shape[0]
indices = tf.random.shuffle(tf.range(num_samples), seed=SEED)
all_images = tf.gather(all_images, indices)
all_labels = tf.gather(all_labels, indices)

# --- Chia theo tỷ lệ 60-20-20 ---
train_size = int(0.6 * num_samples)
val_size = int(0.2 * num_samples)
```

```
test_size = num_samples - train_size - val_size

train_images, train_labels = all_images[:train_size], all_labels[:train_size]
val_images, val_labels = all_images[train_size:train_size+val_size], all_labels[tra
test_images, test_labels = all_images[train_size+val_size:], all_labels[train_size+

# --- Tạo tf.data.Dataset ---
train_ds = tf.data.Dataset.from_tensor_slices((train_images, train_labels)).batch(B
val_ds = tf.data.Dataset.from_tensor_slices((val_images, val_labels)).batch(BATCH_S
test_ds = tf.data.Dataset.from_tensor_slices((test_images, test_labels)).batch(BATC

# --- Thông tin kiểm tra ---
print("\n--- Thông tin các tập dữ liệu đã chia ---")
print(f"Số ảnh trong Train: {train_size}")
print(f"Số ảnh trong Validation: {val_size}")
print(f"Số ảnh trong Test: {test_size}")
```

```
Đang tải toàn bộ dữ liệu từ thư mục: cropped_and_augment
Found 43118 files belonging to 52 classes.
Các lớp tìm thấy: ['0', '1', '10', '11', '12', '13', '14', '15', '16', '17', '18',
'19', '2', '20', '21', '22', '23', '24', '25', '26', '27', '28', '29', '3', '30', '3
1', '32', '33', '34', '35', '36', '37', '38', '39', '4', '40', '41', '42', '43', '4
4', '45', '46', '47', '48', '49', '5', '50', '51', '6', '7', '8', '9']
Tổng số lớp: 52

--- Thông tin các tập dữ liệu đã chia ---
Số ảnh trong Train: 25870
Số ảnh trong Validation: 8623
Số ảnh trong Test: 8625
```

In [9]:
```
for images, labels in train_ds.take(1):
    plt.figure(figsize=(10, 10))
    for i in range(9):
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(class_names[labels[i]])
        plt.axis("off")
    plt.show()
```

Mô hình

In [10]:
```
model = tf.keras.Sequential([
    tf.keras.layers.Rescaling(1./255, input_shape=IMG_SIZE + (3,)),

    tf.keras.layers.Conv2D(64, 5, activation='relu', padding='same'),
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Conv2D(64, 5, activation='relu', padding='same'),
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.MaxPooling2D(),
    tf.keras.layers.Dropout(0.25),

    tf.keras.layers.Conv2D(96, 3, activation='relu', padding='same'),
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Conv2D(96, 3, activation='relu', padding='same'),
    tf.keras.layers.BatchNormalization(),
```

```
    tf.keras.layers.MaxPooling2D(),
    tf.keras.layers.Dropout(0.25),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dropout(0.5),
    tf.keras.layers.Dense(256, activation='relu'),
    tf.keras.layers.Dense(num_classes, activation='softmax')
])

#compile mô hình
model.compile(
    optimizer='adam',
    loss=tf.keras.losses.SparseCategoricalCrossentropy(),  # <- Không dùng from_log
    metrics=['accuracy']
)
model.summary()
```

```
c:\Users\84335\anaconda3\envs\tf_traffic_sign\lib\site-packages\keras\src\layers\preprocessing\tf_data_layer.py:19: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(**kwargs)
```

Model: "sequential"

Layer (type)	Output Shape	Param #
rescaling (Rescaling)	(None, 64, 64, 3)	0
conv2d (Conv2D)	(None, 64, 64, 64)	4,864
batch_normalization (BatchNormalization)	(None, 64, 64, 64)	256
conv2d_1 (Conv2D)	(None, 64, 64, 64)	102,464
batch_normalization_1 (BatchNormalization)	(None, 64, 64, 64)	256
max_pooling2d (MaxPooling2D)	(None, 32, 32, 64)	0
dropout (Dropout)	(None, 32, 32, 64)	0
conv2d_2 (Conv2D)	(None, 32, 32, 96)	55,392
batch_normalization_2 (BatchNormalization)	(None, 32, 32, 96)	384
conv2d_3 (Conv2D)	(None, 32, 32, 96)	83,040
batch_normalization_3 (BatchNormalization)	(None, 32, 32, 96)	384
max_pooling2d_1 (MaxPooling2D)	(None, 16, 16, 96)	0
dropout_1 (Dropout)	(None, 16, 16, 96)	0
flatten (Flatten)	(None, 24576)	0
dropout_2 (Dropout)	(None, 24576)	0
dense (Dense)	(None, 256)	6,291,712
dense_1 (Dense)	(None, 52)	13,364

Total params: 6,552,116 (24.99 MB)

Trainable params: 6,551,476 (24.99 MB)

Non-trainable params: 640 (2.50 KB)

Huấn luyện

In [11]:
```
from sklearn.utils import class_weight
import numpy as np

EPOCHS = 10
```

```python
# --- B1: Thu thập nhãn từ train_ds ---
y_train = []
for batch_images, batch_labels in train_ds:
    y_train.extend(batch_labels.numpy())

y_train = np.array(y_train)

# --- B2: Tính class_weight ---
class_weights = class_weight.compute_class_weight(
    class_weight='balanced',
    classes=np.unique(y_train),
    y=y_train
)
class_weights = dict(enumerate(class_weights))

# In ra để kiểm tra
print("Class weights:", class_weights)

# --- B3: Huấn luyện mô hình ---
history = model.fit(
    train_ds,
    validation_data=val_ds,
    epochs=EPOCHS,
    class_weight=class_weights
)
model.evaluate(test_ds)
```

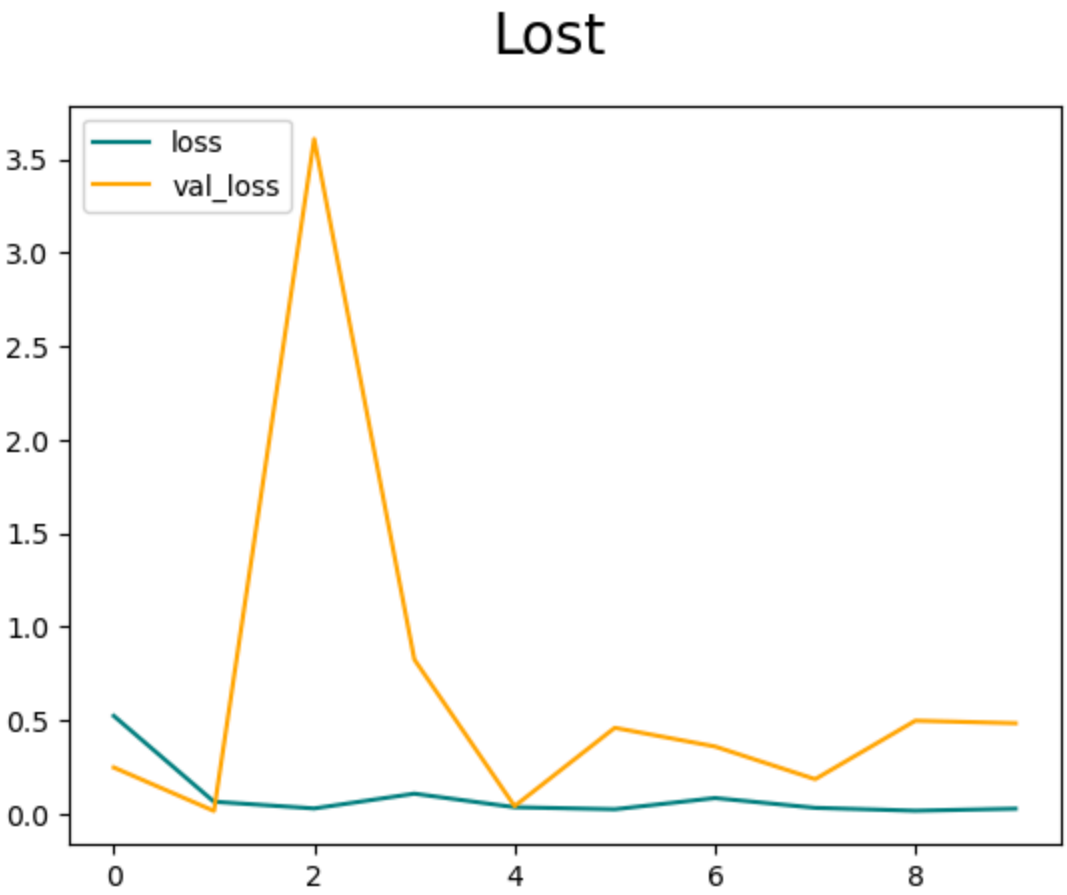
```
Class weights: {0: 1.060767590618337, 1: 1.3373655913978495, 2: 0.756079027355623,
3: 1.1817102137767221, 4: 0.9930139720558883, 5: 1.1255656108597285, 6: 0.8291666666
666667, 7: 1.0386221294363256, 8: 0.7810047095761381, 9: 0.8011272141706924, 10: 0.8
947841726618705, 11: 1.063034188034188, 12: 1.3667582417582418, 13: 0.80371567043618
74, 14: 2.794943820224719, 15: 0.8667247386759582, 16: 1.2855297157622738, 17: 0.827
7870216306157, 18: 1.2691326530612246, 19: 0.8169129720853858, 20: 0.803715670436187
4, 21: 1.040794979079498, 22: 0.7985553772070626, 23: 1.2756410256410255, 24: 0.8562
822719449226, 25: 0.7934609250398724, 26: 0.9111721611721612, 27: 1.526073619631901
8, 28: 0.7896825396825397, 29: 0.820957095709571, 30: 0.756079027355623, 31: 0.79727
56410256411, 32: 0.916206261510129, 33: 1.2626903553299493, 34: 0.8789752650176679,
35: 0.9422348484848485, 36: 1.0585106382978724, 37: 1.4420289855072463, 38: 1.086244
5414847162, 39: 8.883928571428571, 40: 0.9111721611721612, 41: 1.240648379052369, 4
2: 1.9586614173228347, 43: 0.7871835443037974, 44: 0.9299065420560748, 45: 0.9512428
298279159, 46: 0.8277870216306157, 47: 5.993975903614458, 48: 0.8758802816901409, 4
9: 0.9404536862003781, 50: 0.9264432029795159, 51: 0.7713178294573644}
Epoch 1/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 667s 2s/step - accuracy: 0.7444 - loss: 1.4909 - val_ac
curacy: 0.9377 - val_loss: 0.2475
Epoch 2/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 654s 2s/step - accuracy: 0.9794 - loss: 0.0818 - val_ac
curacy: 0.9963 - val_loss: 0.0148
Epoch 3/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 632s 2s/step - accuracy: 0.9933 - loss: 0.0267 - val_ac
curacy: 0.6434 - val_loss: 3.6087
Epoch 4/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 631s 2s/step - accuracy: 0.9779 - loss: 0.1008 - val_ac
curacy: 0.9027 - val_loss: 0.8247
Epoch 5/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 627s 2s/step - accuracy: 0.9894 - loss: 0.0543 - val_ac
curacy: 0.9922 - val_loss: 0.0404
Epoch 6/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 633s 2s/step - accuracy: 0.9963 - loss: 0.0182 - val_ac
curacy: 0.9560 - val_loss: 0.4595
Epoch 7/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 647s 2s/step - accuracy: 0.9948 - loss: 0.0342 - val_ac
curacy: 0.9665 - val_loss: 0.3595
Epoch 8/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 630s 2s/step - accuracy: 0.9935 - loss: 0.0370 - val_ac
curacy: 0.9768 - val_loss: 0.1847
Epoch 9/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 640s 2s/step - accuracy: 0.9977 - loss: 0.0150 - val_ac
curacy: 0.9443 - val_loss: 0.4975
Epoch 10/10
405/405 ━━━━━━━━━━━━━━━━━━━━ 639s 2s/step - accuracy: 0.9964 - loss: 0.0269 - val_ac
curacy: 0.9537 - val_loss: 0.4839
135/135 ━━━━━━━━━━━━━━━━━━━━ 51s 372ms/step - accuracy: 0.9585 - loss: 0.3628
```

Out[11]: [0.4450702965259552, 0.9536231756210327]

In [13]:
```python
#Đồ thị loss của train và loss của val
print(model.evaluate(test_ds))
fig = plt.figure()
plt.plot(history.history['loss'], color='teal', label='loss')
plt.plot(history.history['val_loss'], color='orange', label='val_loss')
fig.suptitle('Lost', fontsize=20)
```

```
plt.legend(loc="upper left")
plt.show()
```

```
135/135 ━━━━━━━━━━━━━━━━━━━━ 37s 271ms/step - accuracy: 0.9585 - loss: 0.3628
[0.4450702965259552, 0.9536231756210327]
```



In [14]:
```
from sklearn.metrics import classification_report
import numpy as np

# Dự đoán trên validation
y_true = []
y_pred = []

for images, labels in val_ds:
    preds = model.predict(images, verbose=0)
    preds_classes = tf.argmax(preds, axis=1)

    y_true.extend(labels.numpy())
    y_pred.extend(preds_classes.numpy())

# Ép kiểu numpy cho an toàn
y_true = np.array(y_true)
y_pred = np.array(y_pred)

# Lấy các class thực sự xuất hiện
used_labels = sorted(set(y_true) | set(y_pred))
used_class_names = [class_names[i] for i in used_labels]

# In báo cáo phân loại
```

```
print(classification_report(
    y_true,
    y_pred,
    labels=used_labels,
    target_names=used_class_names,
    zero_division=0
))
```

	precision	recall	f1-score	support
0	0.91	0.93	0.92	151
1	0.99	0.98	0.98	125
10	0.97	0.99	0.98	211
11	0.98	1.00	0.99	134
12	0.99	1.00	1.00	166
13	0.79	1.00	0.88	150
14	0.95	0.95	0.95	220
15	0.99	0.95	0.97	153
16	0.97	0.97	0.97	203
17	1.00	0.92	0.96	180
18	0.99	0.95	0.97	172
19	0.95	1.00	0.97	163
2	0.77	0.92	0.84	129
20	0.87	0.98	0.92	225
21	0.98	1.00	0.99	57
22	0.92	0.85	0.88	202
23	0.85	1.00	0.92	141
24	1.00	0.93	0.97	252
25	0.99	1.00	1.00	163
26	1.00	0.58	0.74	223
27	0.93	0.99	0.96	206
28	1.00	1.00	1.00	127
29	0.99	0.99	0.99	221
3	0.96	0.97	0.96	138
30	1.00	0.97	0.98	194
31	0.96	1.00	0.98	219
32	0.92	0.96	0.94	202
33	1.00	1.00	1.00	103
34	1.00	0.97	0.98	209
35	0.98	1.00	0.99	194
36	0.98	0.99	0.99	179
37	0.94	1.00	0.97	222
38	1.00	0.95	0.97	182
39	1.00	1.00	1.00	126
4	0.99	0.94	0.96	173
40	1.00	0.99	0.99	174
41	0.96	0.82	0.88	163
42	1.00	1.00	1.00	116
43	0.94	1.00	0.97	153
44	1.00	1.00	1.00	22
45	0.99	1.00	1.00	189
46	1.00	0.85	0.92	118
47	1.00	0.73	0.85	97
48	1.00	0.92	0.96	219
49	0.93	0.99	0.96	159
5	0.90	0.99	0.94	141
50	0.85	0.93	0.89	201
51	0.94	1.00	0.97	34
6	0.87	1.00	0.93	167
7	0.96	0.93	0.94	170
8	0.98	0.98	0.98	182
9	1.00	1.00	1.00	203
accuracy			0.95	8623

```
   macro avg       0.96      0.96      0.95      8623
weighted avg       0.96      0.95      0.95      8623
```

Lưu mô hình

In [15]:
```
model.save("traffic_sign_classifier.h5")
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```