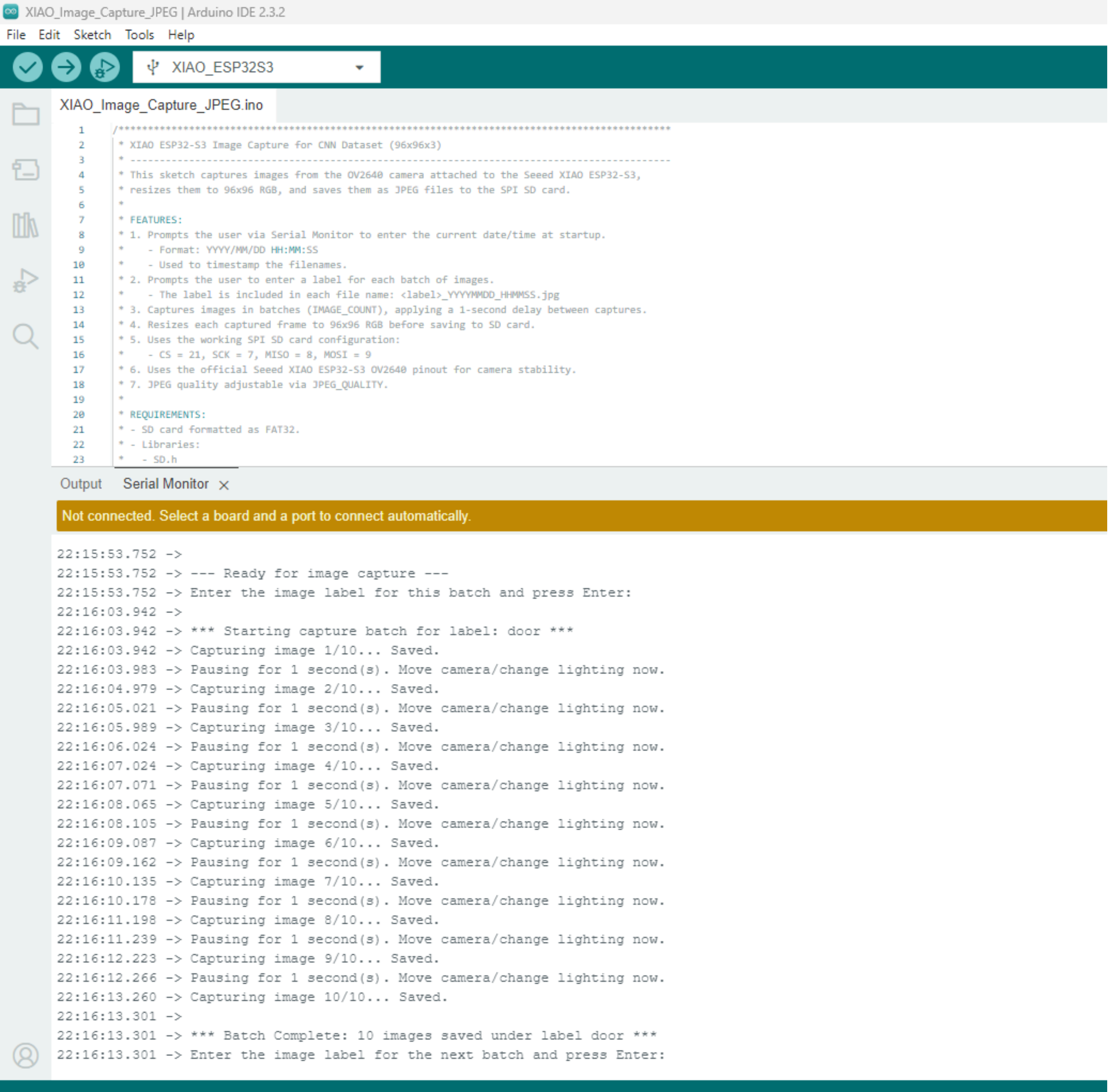
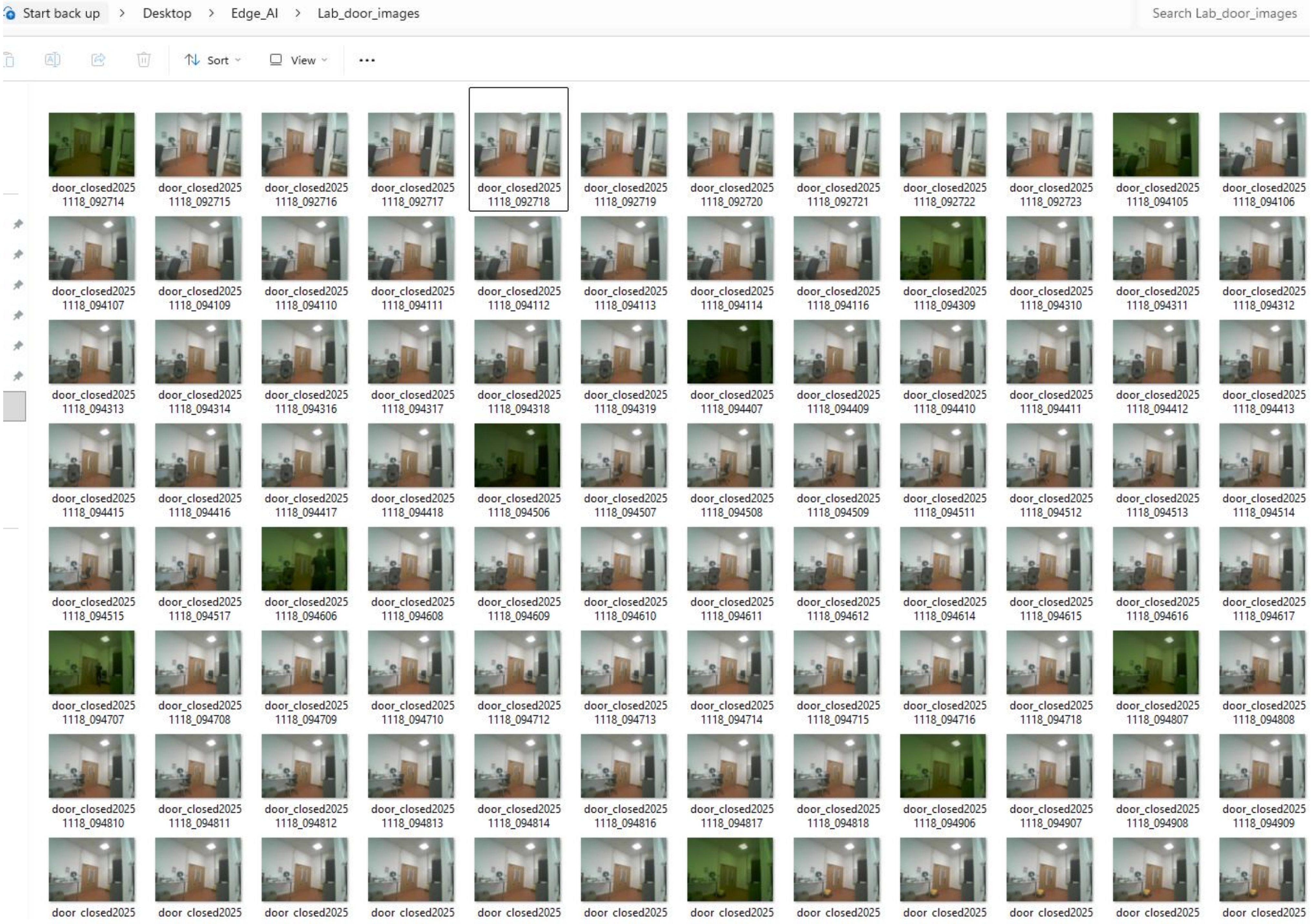

XIAO_Image_Capture_JPEG | Arduino IDE 2.3.2
File
Edit
Sketch
Tools
Help
XIAO_ESP32S3
XIAO_Image_Capture_JPEG.ino
Output
Serial Monitor

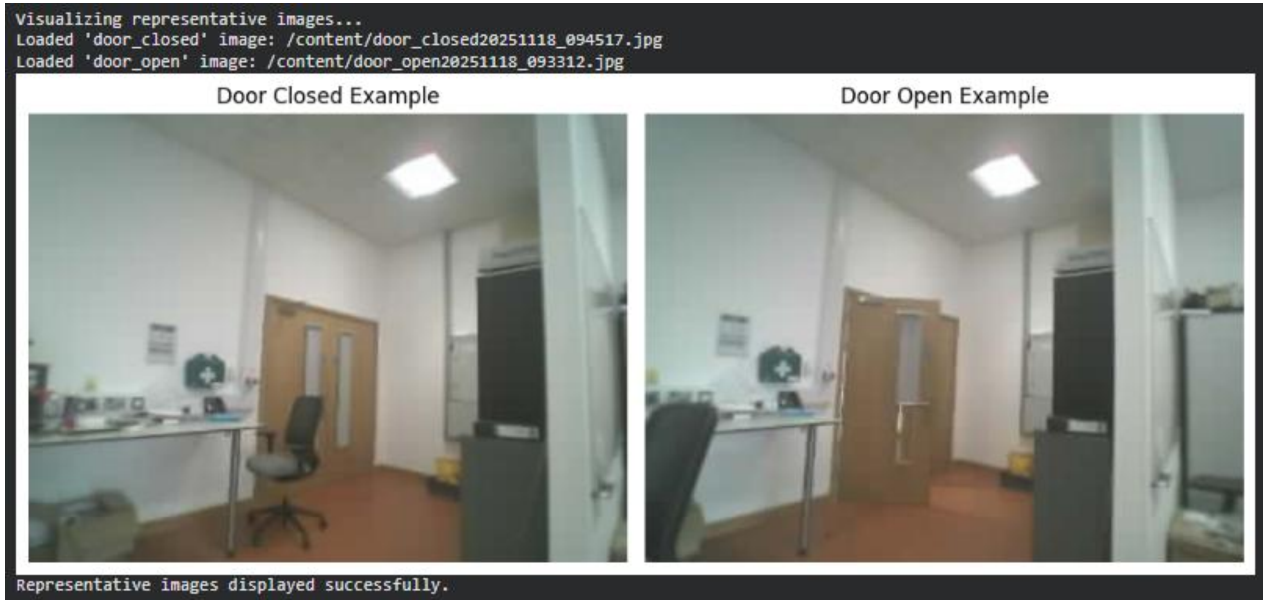
```
/*****************************************************************************************
* XIAO ESP32-S3 Image Capture for CNN Dataset (96x96x3)
* ---------------------------------------------------------------------------------------
* This sketch captures images from the OV2640 camera attached to the Seeed XIAO ESP32-S3,
* resizes them to 96x96 RGB, and saves them as JPEG files to the SPI SD card.
*
* FEATURES:
* 1. Prompts the user via Serial Monitor to enter the current date/time at startup.
*    - Format: YYYY/MM/DD HH:MM:SS
*    - Used to timestamp the filenames.
* 2. Prompts the user to enter a label for each batch of images.
*    - The label is included in each file name: <label>_YYYYMMDD_HHMMSS.jpg
* 3. Captures images in batches (IMAGE_COUNT), applying a 1-second delay between captures.
* 4. Resizes each captured frame to 96x96 RGB before saving to SD card.
* 5. Uses the working SPI SD card configuration:
*    - CS = 21, SCK = 7, MISO = 8, MOSI = 9
* 6. Uses the official Seeed XIAO ESP32-S3 OV2640 pinout for camera stability.
* 7. JPEG quality adjustable via JPEG_QUALITY.
*
* REQUIREMENTS:
* - SD card formatted as FAT32.
* - Libraries:
*   - SD.h
```

Not connected. Select a board and a port to connect automatically.

```
22:15:53.752 ->
22:15:53.752 -> --- Ready for image capture ---
22:15:53.752 -> Enter the image label for this batch and press Enter:
22:16:03.942 ->
22:16:03.942 -> *** Starting capture batch for label: door ***
22:16:03.942 -> Capturing image 1/10... Saved.
22:16:03.983 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:04.979 -> Capturing image 2/10... Saved.
22:16:05.021 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:05.989 -> Capturing image 3/10... Saved.
22:16:06.024 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:07.024 -> Capturing image 4/10... Saved.
22:16:07.071 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:08.065 -> Capturing image 5/10... Saved.
22:16:08.105 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:09.087 -> Capturing image 6/10... Saved.
22:16:09.162 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:10.135 -> Capturing image 7/10... Saved.
22:16:10.178 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:11.198 -> Capturing image 8/10... Saved.
22:16:11.239 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:12.223 -> Capturing image 9/10... Saved.
22:16:12.266 -> Pausing for 1 second(s). Move camera/change lighting now.
22:16:13.260 -> Capturing image 10/10... Saved.
22:16:13.301 ->
22:16:13.301 -> *** Batch Complete: 10 images saved under label door ***
22:16:13.301 -> Enter the image label for the next batch and press Enter:
```

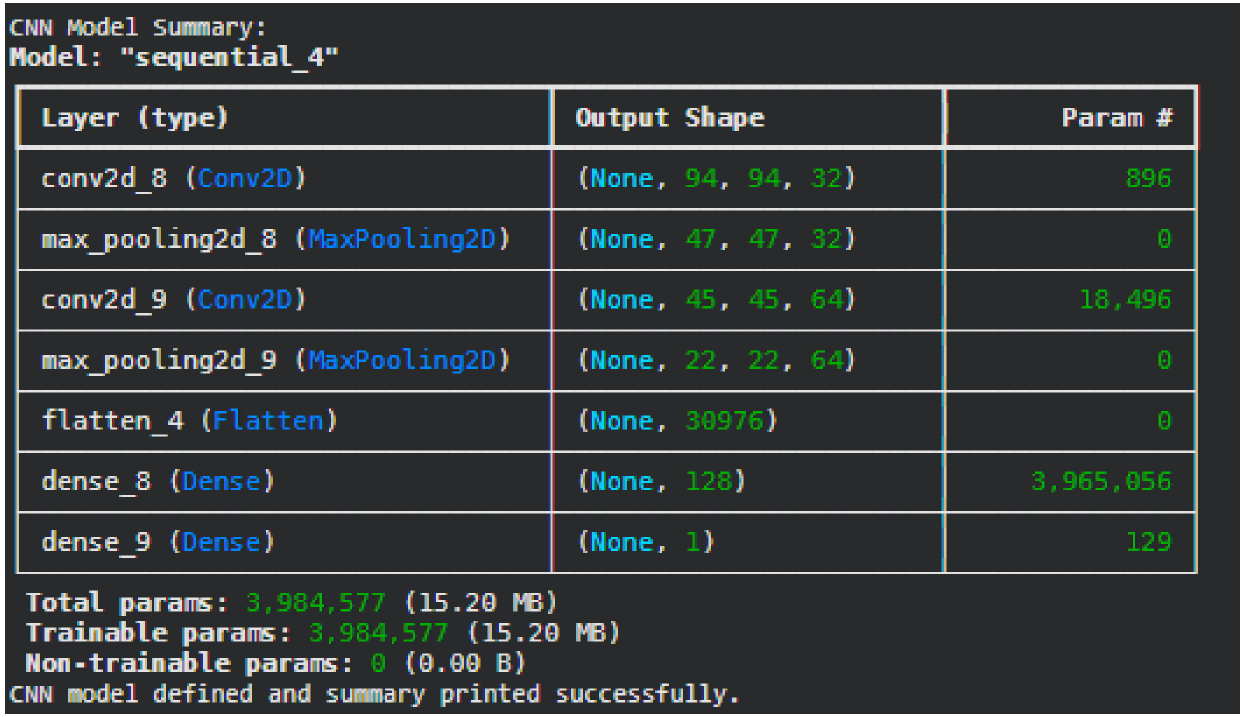


door_closed2025 1118_092714	door_closed2025 1118_092715	door_closed2025 1118_092716	door_closed2025 1118_092717	door_closed2025 1118_092718	door_closed2025 1118_092719	door_closed2025 1118_092720	door_closed2025 1118_092721	door_closed2025 1118_092722	door_closed2025 1118_092723	door_closed2025 1118_094105	door_closed2025 1118_094106
door_closed2025 1118_094107	door_closed2025 1118_094109	door_closed2025 1118_094110	door_closed2025 1118_094111	door_closed2025 1118_094112	door_closed2025 1118_094113	door_closed2025 1118_094114	door_closed2025 1118_094116	door_closed2025 1118_094309	door_closed2025 1118_094310	door_closed2025 1118_094311	door_closed2025 1118_094312
door_closed2025 1118_094313	door_closed2025 1118_094314	door_closed2025 1118_094316	door_closed2025 1118_094317	door_closed2025 1118_094318	door_closed2025 1118_094319	door_closed2025 1118_094407	door_closed2025 1118_094409	door_closed2025 1118_094410	door_closed2025 1118_094411	door_closed2025 1118_094412	door_closed2025 1118_094413
door_closed2025 1118_094415	door_closed2025 1118_094416	door_closed2025 1118_094417	door_closed2025 1118_094418	door_closed2025 1118_094506	door_closed2025 1118_094507	door_closed2025 1118_094508	door_closed2025 1118_094509	door_closed2025 1118_094511	door_closed2025 1118_094512	door_closed2025 1118_094513	door_closed2025 1118_094514
door_closed2025 1118_094515	door_closed2025 1118_094517	door_closed2025 1118_094606	door_closed2025 1118_094608	door_closed2025 1118_094609	door_closed2025 1118_094610	door_closed2025 1118_094611	door_closed2025 1118_094612	door_closed2025 1118_094614	door_closed2025 1118_094615	door_closed2025 1118_094616	door_closed2025 1118_094617
door_closed2025 1118_094707	door_closed2025 1118_094708	door_closed2025 1118_094709	door_closed2025 1118_094710	door_closed2025 1118_094712	door_closed2025 1118_094713	door_closed2025 1118_094714	door_closed2025 1118_094715	door_closed2025 1118_094716	door_closed2025 1118_094718	door_closed2025 1118_094807	door_closed2025 1118_094808
door_closed2025 1118_094810	door_closed2025 1118_094811	door_closed2025 1118_094812	door_closed2025 1118_094813	door_closed2025 1118_094814	door_closed2025 1118_094816	door_closed2025 1118_094817	door_closed2025 1118_094818	door_closed2025 1118_094906	door_closed2025 1118_094907	door_closed2025 1118_094908	door_closed2025 1118_094909
door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025	door closed2025

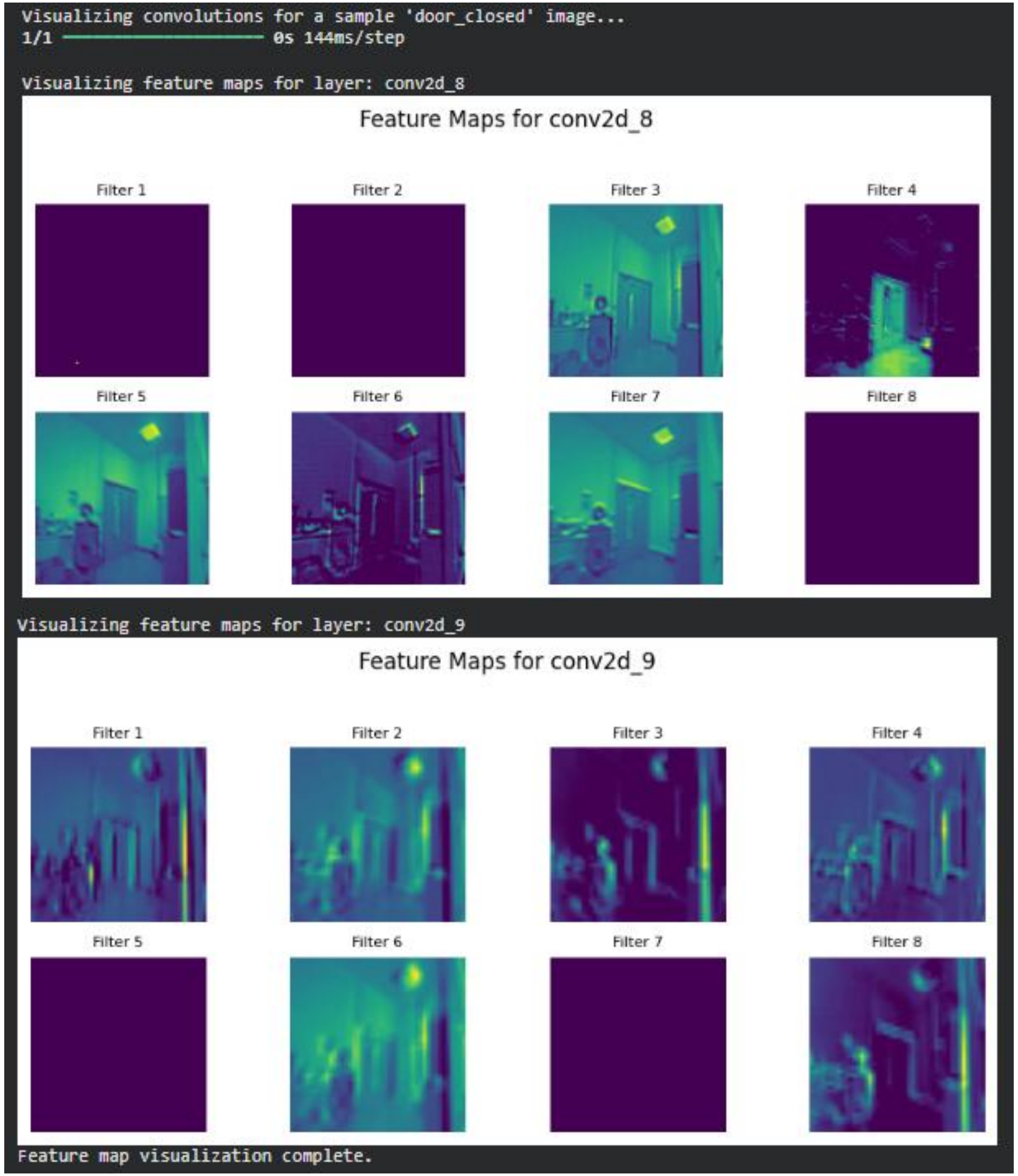


```
Visualizing representative images...
Loaded 'door_closed' image: /content/door_closed20251118_094517.jpg
Loaded 'door_open' image: /content/door_open20251118_093312.jpg
```

```
Representative images displayed successfully.
```



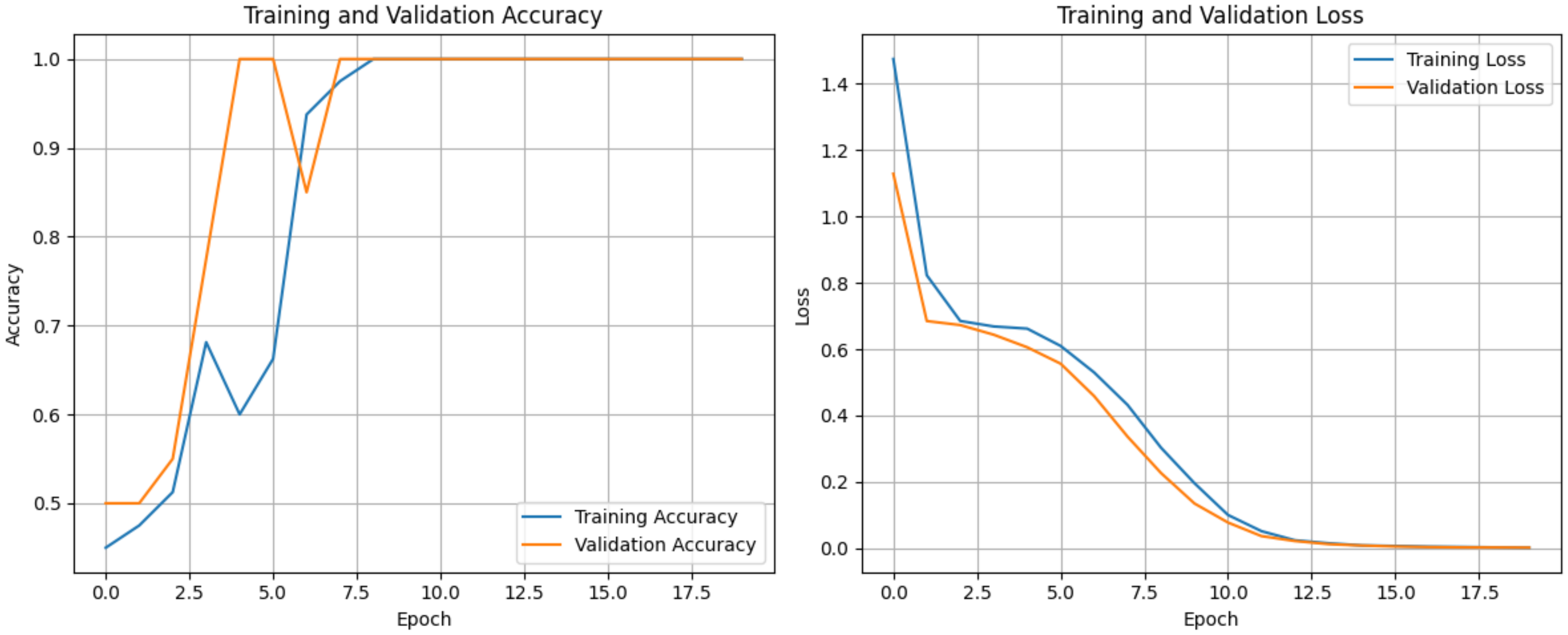
```
CNN Model Summary:
Model: "sequential_4"
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━┓
┃ Layer (type)                 ┃ Output Shape           ┃       Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━┩
│ conv2d_8 (Conv2D)            │ (None, 94, 94, 32)     │           896 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ max_pooling2d_8 (MaxPooling2D)│ (None, 47, 47, 32)    │             0 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ conv2d_9 (Conv2D)            │ (None, 45, 45, 64)     │        18,496 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ max_pooling2d_9 (MaxPooling2D)│ (None, 22, 22, 64)    │             0 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ flatten_4 (Flatten)          │ (None, 30976)          │             0 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ dense_8 (Dense)              │ (None, 128)            │     3,965,056 │
├──────────────────────────────┼────────────────────────┼───────────────┤
│ dense_9 (Dense)              │ (None, 1)              │           129 │
└──────────────────────────────┴────────────────────────┴───────────────┘
 Total params: 3,984,577 (15.20 MB)
 Trainable params: 3,984,577 (15.20 MB)
 Non-trainable params: 0 (0.00 B)
CNN model defined and summary printed successfully.
```

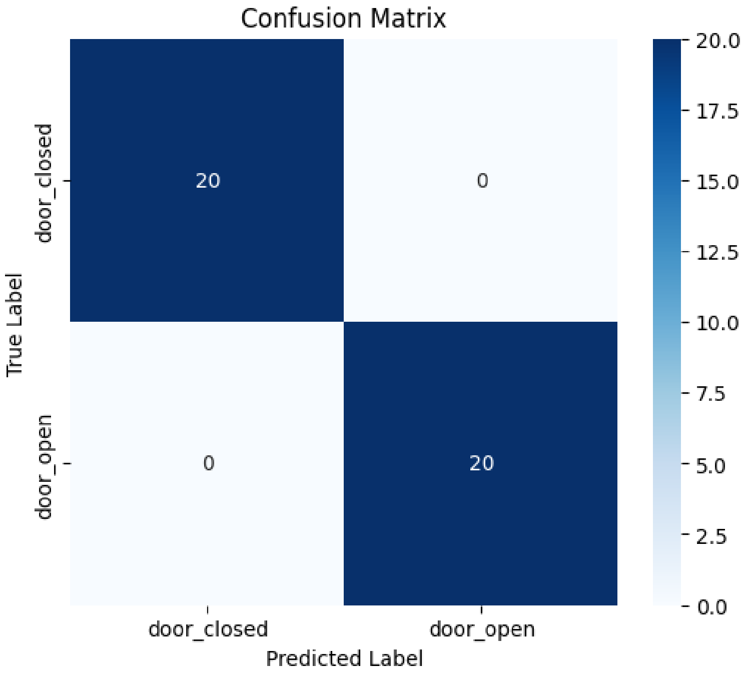


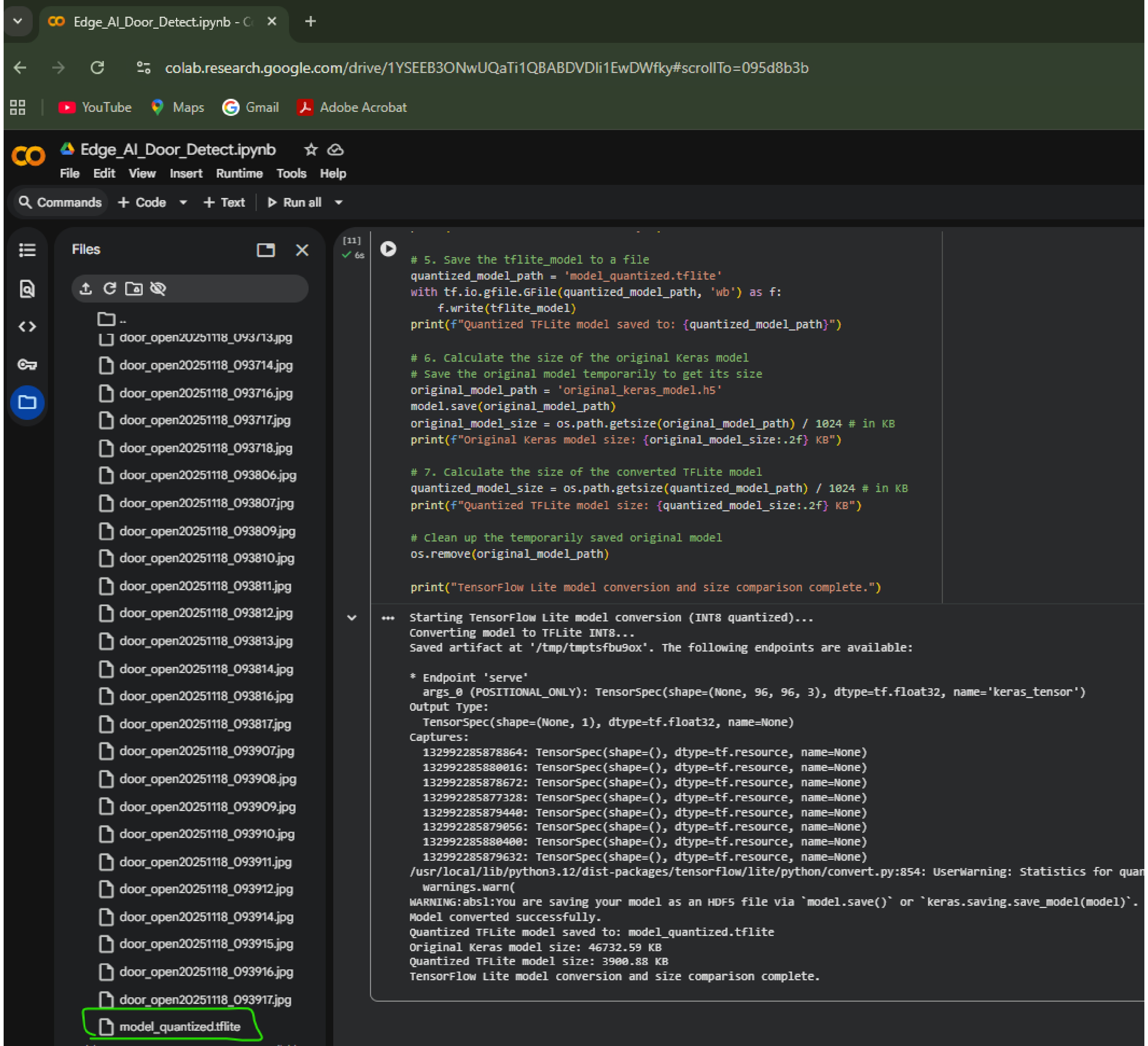
```
Visualizing convolutions for a sample 'door_closed' image...
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 144ms/step

Visualizing feature maps for layer: conv2d_8
```

```
Visualizing feature maps for layer: conv2d_9
```

```
Feature map visualization complete.
```


Training and Validation Accuracy
Accuracy
1.0
0.9
0.8
0.7
0.6
0.5
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epoch
Training Accuracy
Validation Accuracy
Training and Validation Loss
Loss
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epoch
Training Loss
Validation Loss

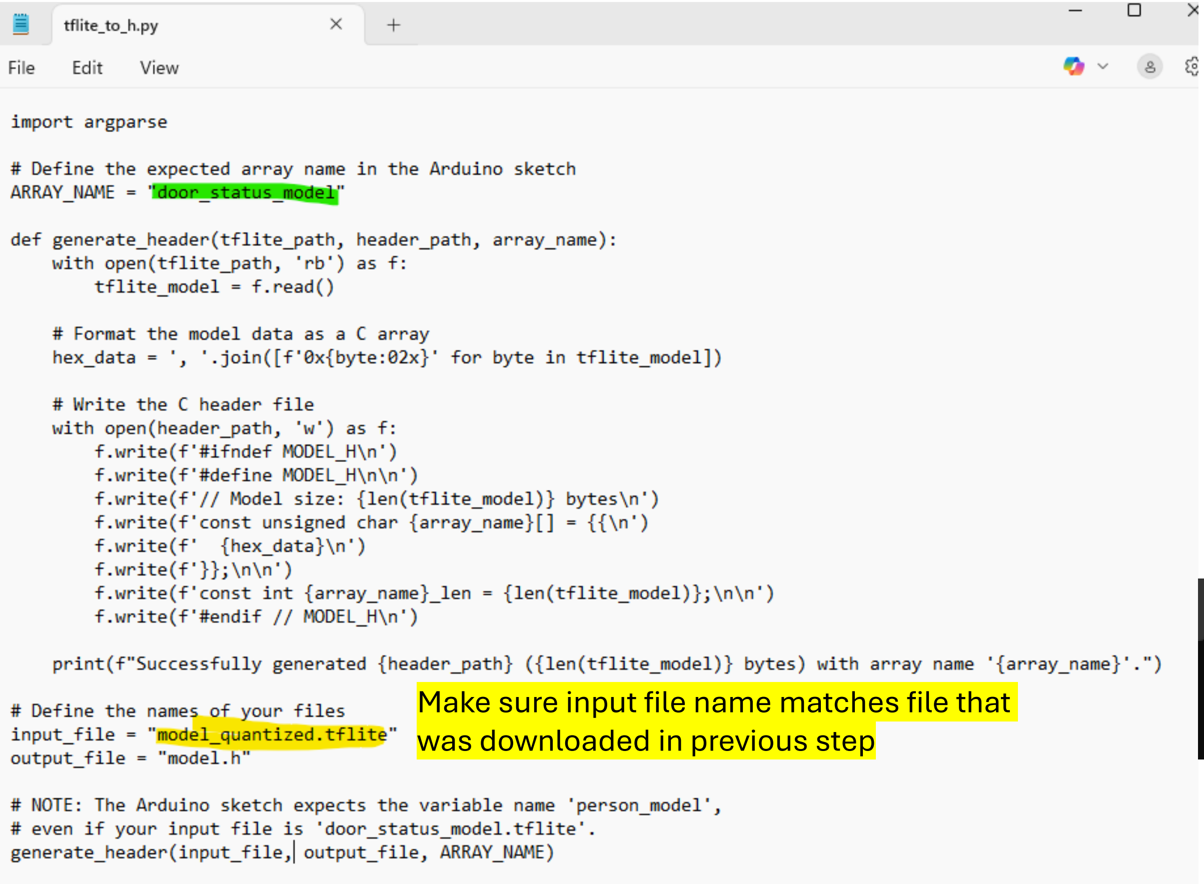

Confusion Matrix
True Label
door_closed
door_open
20
0
0
20
door_closed
door_open
Predicted Label
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0


Edge_AI_Door_Detect.ipynb - C
colab.research.google.com/drive/1YSEEB3ONwUQaTi1QBABDVDli1EwDWfky#scrollTo=095d8b3b
YouTube
Maps
Gmail
Adobe Acrobat
Edge_AI_Door_Detect.ipynb
File
Edit
View
Insert
Runtime
Tools
Help
Commands
+ Code
+ Text
Run all
Files
..
door_open20251118_093713.jpg
door_open20251118_093714.jpg
door_open20251118_093716.jpg
door_open20251118_093717.jpg
door_open20251118_093718.jpg
door_open20251118_093806.jpg
door_open20251118_093807.jpg
door_open20251118_093809.jpg
door_open20251118_093810.jpg
door_open20251118_093811.jpg
door_open20251118_093812.jpg
door_open20251118_093813.jpg
door_open20251118_093814.jpg
door_open20251118_093816.jpg
door_open20251118_093817.jpg
door_open20251118_093907.jpg
door_open20251118_093908.jpg
door_open20251118_093909.jpg
door_open20251118_093910.jpg
door_open20251118_093911.jpg
door_open20251118_093912.jpg
door_open20251118_093914.jpg
door_open20251118_093915.jpg
door_open20251118_093916.jpg
door_open20251118_093917.jpg
model_quantized.tflite
[11]
6s

```
# 5. Save the tflite_model to a file
quantized_model_path = 'model_quantized.tflite'
with tf.io.gfile.GFile(quantized_model_path, 'wb') as f:
    f.write(tflite_model)
print(f"Quantized TFLite model saved to: {quantized_model_path}")

# 6. Calculate the size of the original Keras model
# Save the original model temporarily to get its size
original_model_path = 'original_keras_model.h5'
model.save(original_model_path)
original_model_size = os.path.getsize(original_model_path) / 1024 # in KB
print(f"Original Keras model size: {original_model_size:.2f} KB")

# 7. Calculate the size of the converted TFLite model
quantized_model_size = os.path.getsize(quantized_model_path) / 1024 # in KB
print(f"Quantized TFLite model size: {quantized_model_size:.2f} KB")

# Clean up the temporarily saved original model
os.remove(original_model_path)

print("TensorFlow Lite model conversion and size comparison complete.")
```

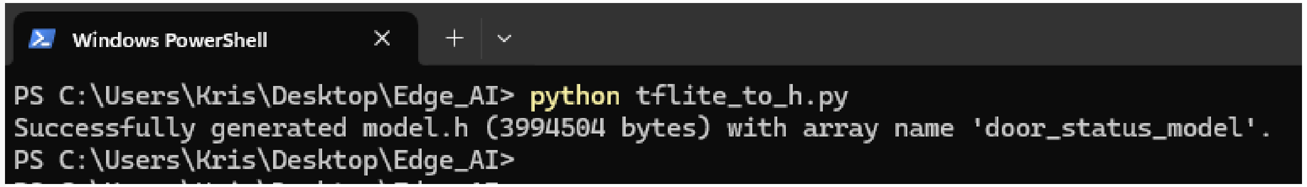
```
Starting TensorFlow Lite model conversion (INT8 quantized)...
Converting model to TFLite INT8...
Saved artifact at '/tmp/tmptsfbu9ox'. The following endpoints are available:

* Endpoint 'serve'
  args_0 (POSITIONAL_ONLY): TensorSpec(shape=(None, 96, 96, 3), dtype=tf.float32, name='keras_tensor')
Output Type:
  TensorSpec(shape=(None, 1), dtype=tf.float32, name=None)
Captures:
  132992285878864: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285880016: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285878672: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285877328: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285879440: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285879056: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285880400: TensorSpec(shape=(), dtype=tf.resource, name=None)
  132992285879632: TensorSpec(shape=(), dtype=tf.resource, name=None)
/usr/local/lib/python3.12/dist-packages/tensorflow/lite/python/convert.py:854: UserWarning: Statistics for quan
  warnings.warn(
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`.
Model converted successfully.
Quantized TFLite model saved to: model_quantized.tflite
Original Keras model size: 46732.59 KB
Quantized TFLite model size: 3900.88 KB
TensorFlow Lite model conversion and size comparison complete.
```

Left-click->download

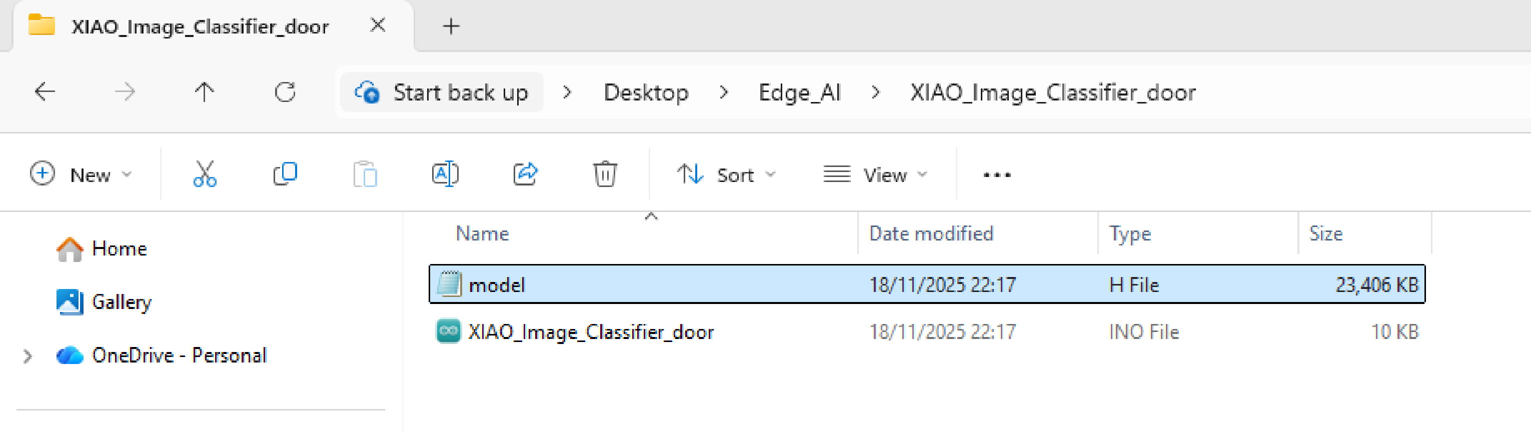


```
import argparse

# Define the expected array name in the Arduino sketch
ARRAY_NAME = "door_status_model"

def generate_header(tflite_path, header_path, array_name):
    with open(tflite_path, 'rb') as f:
        tflite_model = f.read()

    # Format the model data as a C array
    hex_data = ', '.join([f'0x{byte:02x}' for byte in tflite_model])

    # Write the C header file
    with open(header_path, 'w') as f:
        f.write(f'#ifndef MODEL_H\n')
        f.write(f'#define MODEL_H\n\n')
        f.write(f'// Model size: {len(tflite_model)} bytes\n')
        f.write(f'const unsigned char {array_name}[] = {{\n')
        f.write(f'  {hex_data}\n')
        f.write(f'}};\n\n')
        f.write(f'const int {array_name}_len = {len(tflite_model)};\n\n')
        f.write(f'#endif // MODEL_H\n')

    print(f"Successfully generated {header_path} ({len(tflite_model)} bytes) with array name '{array_name}'.")

# Define the names of your files
input_file = "model_quantized.tflite"
output_file = "model.h"

# NOTE: The Arduino sketch expects the variable name 'person_model',
# even if your input file is 'door_status_model.tflite'.
generate_header(input_file, output_file, ARRAY_NAME)
```

Make sure input file name matches file that was downloaded in previous step

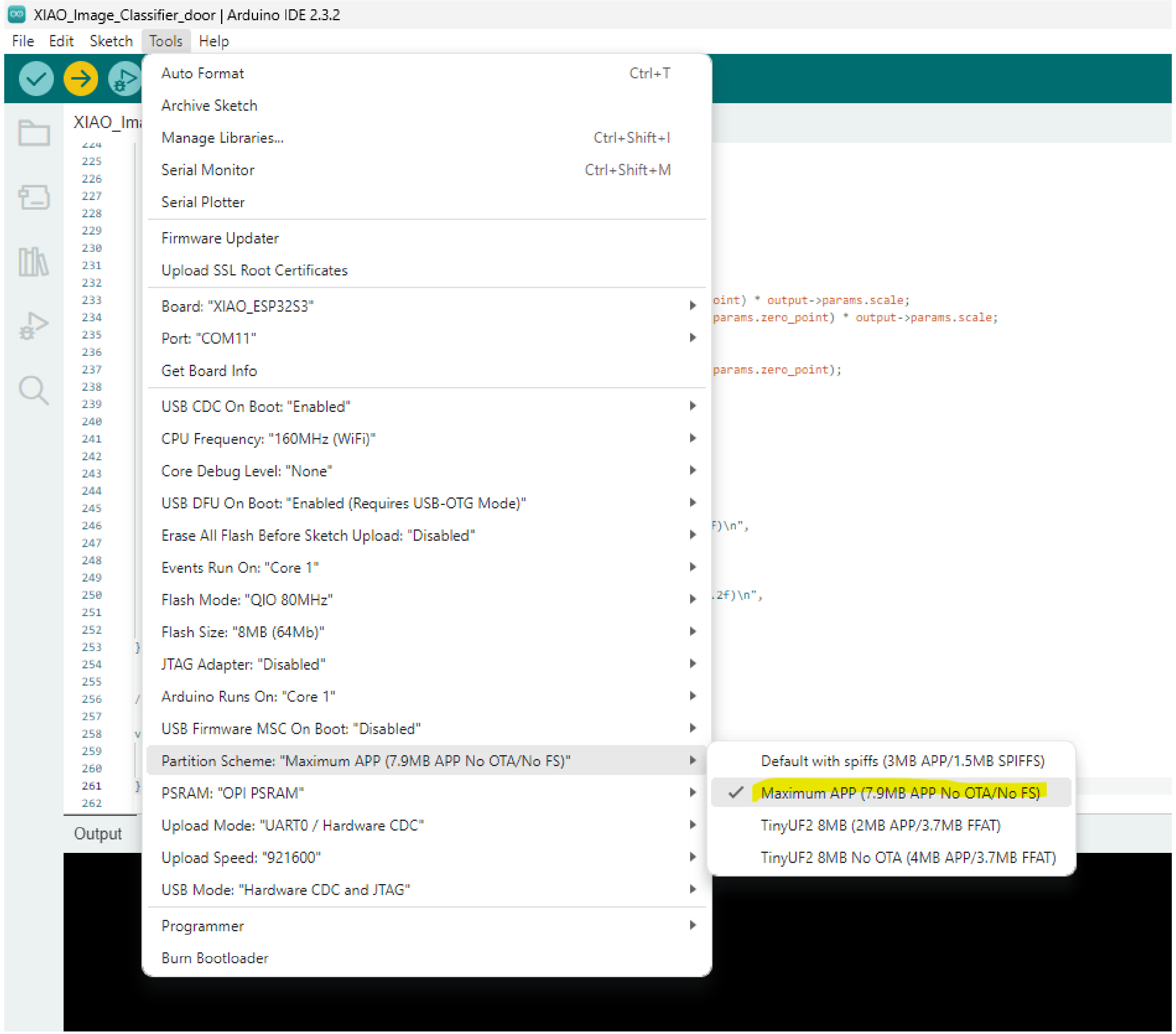


```
PS C:\Users\Kris\Desktop\Edge_AI> python tflite_to_h.py
Successfully generated model.h (3994504 bytes) with array name 'door_status_model'.
PS C:\Users\Kris\Desktop\Edge_AI>
```



Name	Date modified	Type	Size
model	18/11/2025 22:17	H File	23,406 KB
XIAO_Image_Classifier_door	18/11/2025 22:17	INO File	10 KB

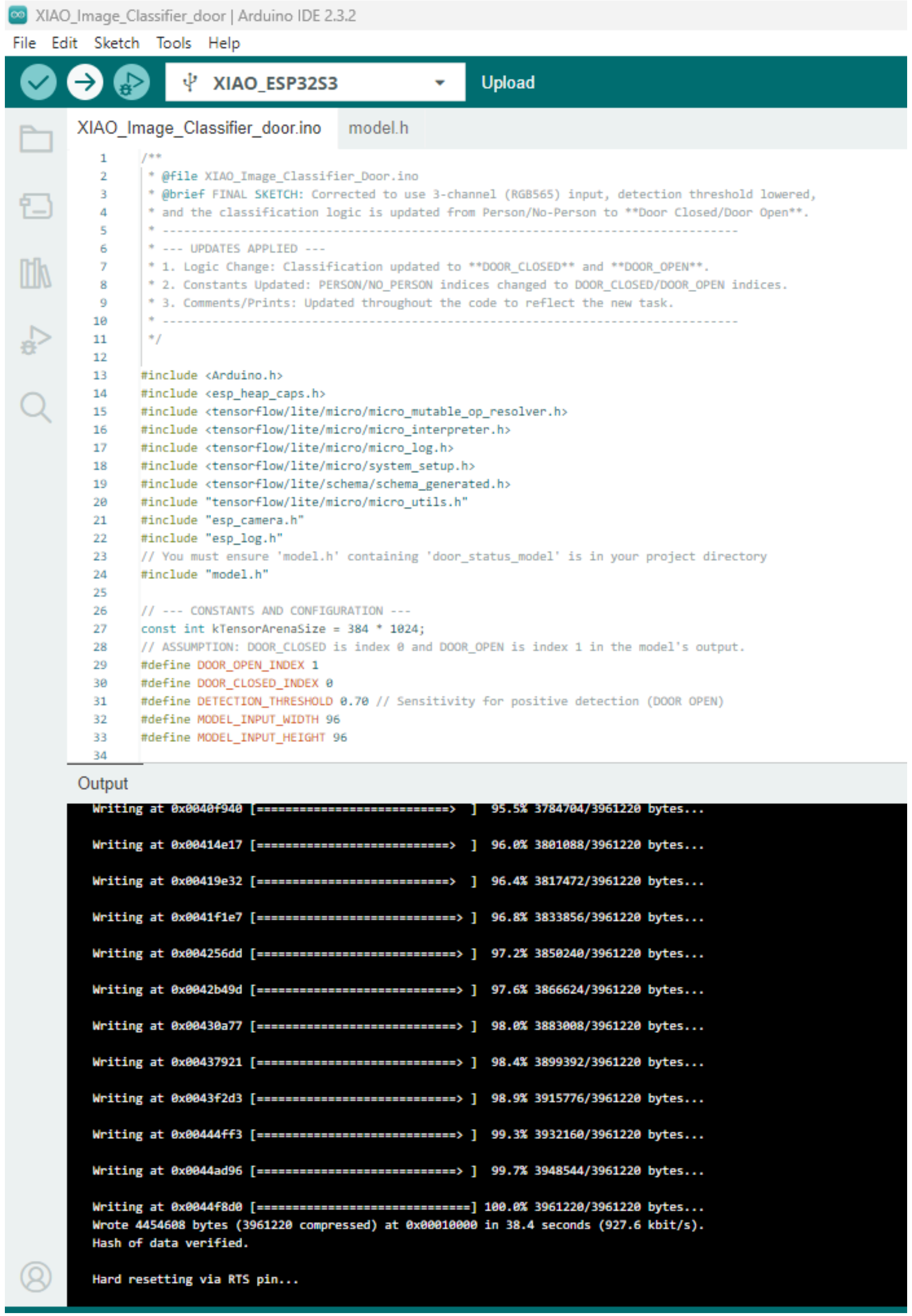
Note: The model is quantised int8 to ensure it is small enough for the Seeed XIAO!



Auto Format Ctrl+T
Archive Sketch
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter
Firmware Updater
Upload SSL Root Certificates
Board: "XIAO_ESP32S3"
Port: "COM11"
Get Board Info
USB CDC On Boot: "Enabled"
CPU Frequency: "160MHz (WiFi)"
Core Debug Level: "None"
USB DFU On Boot: "Enabled (Requires USB-OTG Mode)"
Erase All Flash Before Sketch Upload: "Disabled"
Events Run On: "Core 1"
Flash Mode: "QIO 80MHz"
Flash Size: "8MB (64Mb)"
JTAG Adapter: "Disabled"
Arduino Runs On: "Core 1"
USB Firmware MSC On Boot: "Disabled"
Partition Scheme: "Maximum APP (7.9MB APP No OTA/No FS)"
PSRAM: "OPI PSRAM"
Upload Mode: "UART0 / Hardware CDC"
Upload Speed: "921600"
USB Mode: "Hardware CDC and JTAG"
Programmer
Burn Bootloader

Default with spiffs (3MB APP/1.5MB SPIFFS)
✓ Maximum APP (7.9MB APP No OTA/No FS)
TinyUF2 8MB (2MB APP/3.7MB FFAT)
TinyUF2 8MB No OTA (4MB APP/3.7MB FFAT)

```
oint) * output->params.scale;
params.zero_point) * output->params.scale;

params.zero_point);

F)\n",

.2f)\n",
```


XIAO_Image_Classifier_door | Arduino IDE 2.3.2
File
Edit
Sketch
Tools
Help
XIAO_ESP32S3
Upload
XIAO_Image_Classifier_door.ino
model.h

```
/**
 * @file XIAO_Image_Classifier_Door.ino
 * @brief FINAL SKETCH: Corrected to use 3-channel (RGB565) input, detection threshold lowered,
 * and the classification logic is updated from Person/No-Person to **Door Closed/Door Open**.
 * ---------------------------------------------------------------------------------------
 * --- UPDATES APPLIED ---
 * 1. Logic Change: Classification updated to **DOOR_CLOSED** and **DOOR_OPEN**.
 * 2. Constants Updated: PERSON/NO_PERSON indices changed to DOOR_CLOSED/DOOR_OPEN indices.
 * 3. Comments/Prints: Updated throughout the code to reflect the new task.
 * ---------------------------------------------------------------------------------------
 */

#include <Arduino.h>
#include <esp_heap_caps.h>
#include <tensorflow/lite/micro/micro_mutable_op_resolver.h>
#include <tensorflow/lite/micro/micro_interpreter.h>
#include <tensorflow/lite/micro/micro_log.h>
#include <tensorflow/lite/micro/system_setup.h>
#include <tensorflow/lite/schema/schema_generated.h>
#include "tensorflow/lite/micro/micro_utils.h"
#include "esp_camera.h"
#include "esp_log.h"
// You must ensure 'model.h' containing 'door_status_model' is in your project directory
#include "model.h"

// --- CONSTANTS AND CONFIGURATION ---
const int kTensorArenaSize = 384 * 1024;
// ASSUMPTION: DOOR_CLOSED is index 0 and DOOR_OPEN is index 1 in the model's output.
#define DOOR_OPEN_INDEX 1
#define DOOR_CLOSED_INDEX 0
#define DETECTION_THRESHOLD 0.70 // Sensitivity for positive detection (DOOR OPEN)
#define MODEL_INPUT_WIDTH 96
#define MODEL_INPUT_HEIGHT 96

```

```
Writing at 0x0040f940 [==========================>  ]  95.5% 3784704/3961220 bytes...

Writing at 0x00414e17 [==========================>  ]  96.0% 3801088/3961220 bytes...

Writing at 0x00419e32 [==========================>  ]  96.4% 3817472/3961220 bytes...

Writing at 0x0041f1e7 [===========================> ]  96.8% 3833856/3961220 bytes...

Writing at 0x004256dd [===========================> ]  97.2% 3850240/3961220 bytes...

Writing at 0x0042b49d [===========================> ]  97.6% 3866624/3961220 bytes...

Writing at 0x00430a77 [===========================> ]  98.0% 3883008/3961220 bytes...

Writing at 0x00437921 [===========================> ]  98.4% 3899392/3961220 bytes...

Writing at 0x0043f2d3 [===========================> ]  98.9% 3915776/3961220 bytes...

Writing at 0x00444ff3 [===========================> ]  99.3% 3932160/3961220 bytes...

Writing at 0x0044ad96 [===========================> ]  99.7% 3948544/3961220 bytes...

Writing at 0x0044f8d0 [=============================] 100.0% 3961220/3961220 bytes...
Wrote 4454608 bytes (3961220 compressed) at 0x00010000 in 38.4 seconds (927.6 kbit/s).
Hash of data verified.

Hard resetting via RTS pin...
```