XIAO_Image_Capture_JPEG | Arduino IDE 2.3.2

File Edit Sketch Tools Help

XIAO_ESP32S3

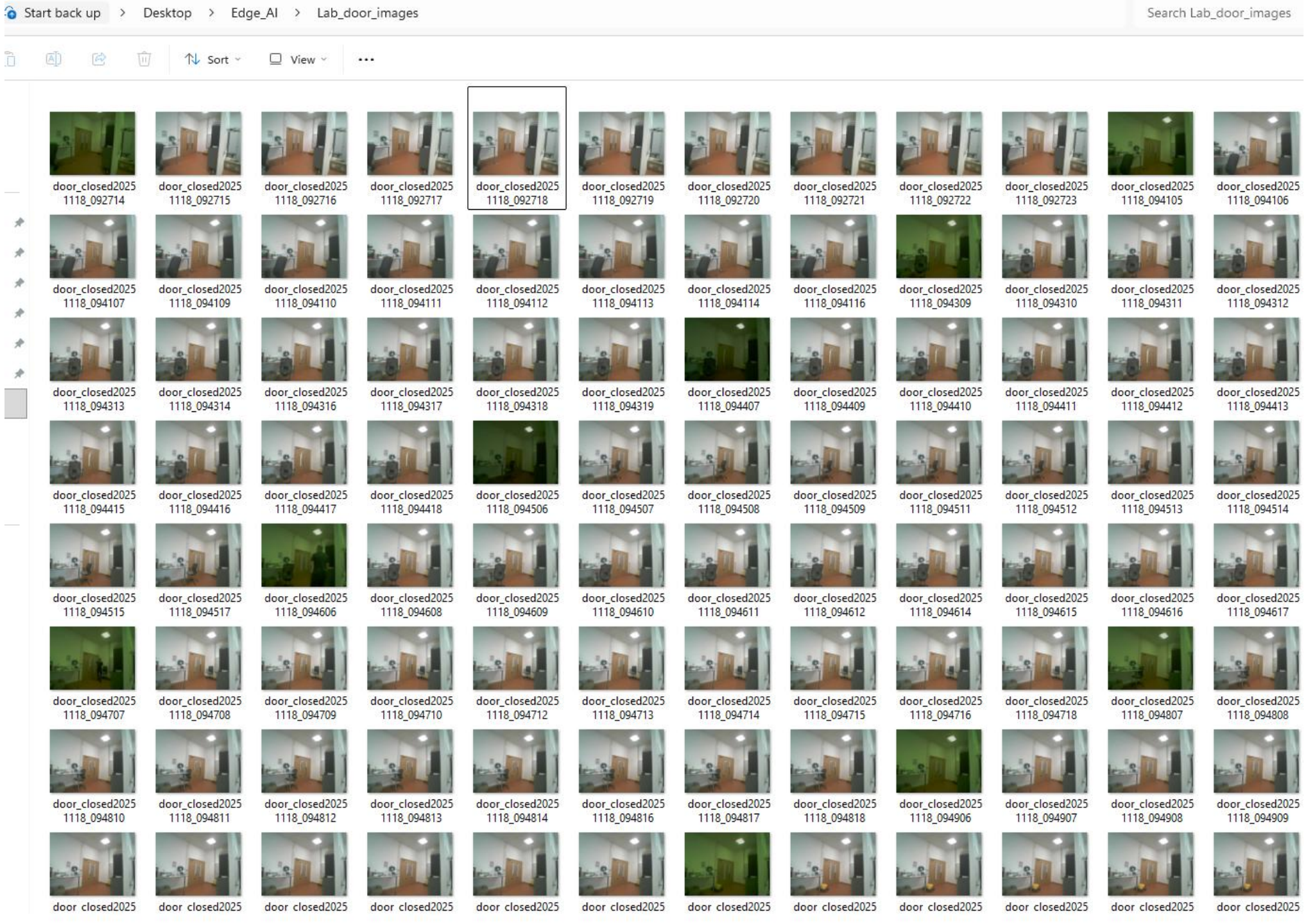
XIAO_Image_Capture_JPEG.ino

```
/*****************************************************************************************
 * 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
```

Output Serial Monitor ×

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:
```


Start back up
Desktop
Edge_AI
Lab_door_images
Search Lab_door_images
Sort
View
door_closed20251118_092714
door_closed20251118_092715
door_closed20251118_092716
door_closed20251118_092717
door_closed20251118_092718
door_closed20251118_092719
door_closed20251118_092720
door_closed20251118_092721
door_closed20251118_092722
door_closed20251118_092723
door_closed20251118_094105
door_closed20251118_094106
door_closed20251118_094107
door_closed20251118_094109
door_closed20251118_094110
door_closed20251118_094111
door_closed20251118_094112
door_closed20251118_094113
door_closed20251118_094114
door_closed20251118_094116
door_closed20251118_094309
door_closed20251118_094310
door_closed20251118_094311
door_closed20251118_094312
door_closed20251118_094313
door_closed20251118_094314
door_closed20251118_094316
door_closed20251118_094317
door_closed20251118_094318
door_closed20251118_094319
door_closed20251118_094407
door_closed20251118_094409
door_closed20251118_094410
door_closed20251118_094411
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door_closed20251118_094417
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door_closed20251118_094515
door_closed20251118_094517
door_closed20251118_094606
door_closed20251118_094608
door_closed20251118_094609
door_closed20251118_094610
door_closed20251118_094611
door_closed20251118_094612
door_closed20251118_094614
door_closed20251118_094615
door_closed20251118_094616
door_closed20251118_094617
door_closed20251118_094707
door_closed20251118_094708
door_closed20251118_094709
door_closed20251118_094710
door_closed20251118_094712
door_closed20251118_094713
door_closed20251118_094714
door_closed20251118_094715
door_closed20251118_094716
door_closed20251118_094718
door_closed20251118_094807
door_closed20251118_094808
door_closed20251118_094810
door_closed20251118_094811
door_closed20251118_094812
door_closed20251118_094813
door_closed20251118_094814
door_closed20251118_094816
door_closed20251118_094817
door_closed20251118_094818
door_closed20251118_094906
door_closed20251118_094907
door_closed20251118_094908
door_closed20251118_094909
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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"

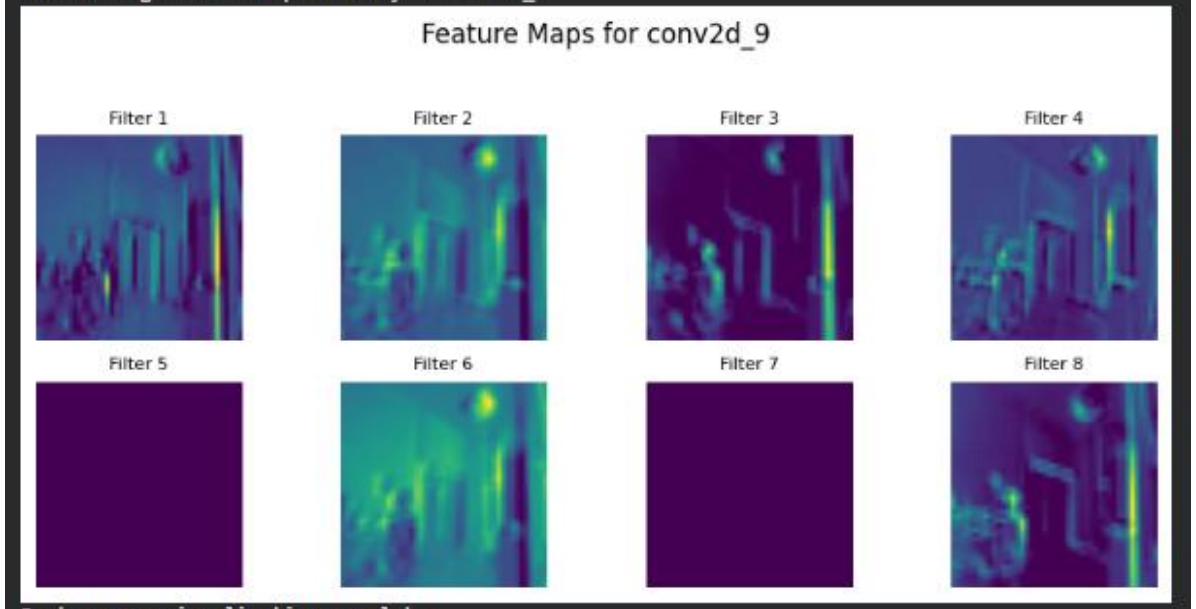
Layer (type)	Output Shape	Param #
conv2d_8 (Conv2D)	(None, 94, 94, 32)	896
max_pooling2d_8 (MaxPooling2D)	(None, 47, 47, 32)	0
conv2d_9 (Conv2D)	(None, 45, 45, 64)	18,496
max_pooling2d_9 (MaxPooling2D)	(None, 22, 22, 64)	0
flatten_4 (Flatten)	(None, 30976)	0
dense_8 (Dense)	(None, 128)	3,965,056
dense_9 (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)

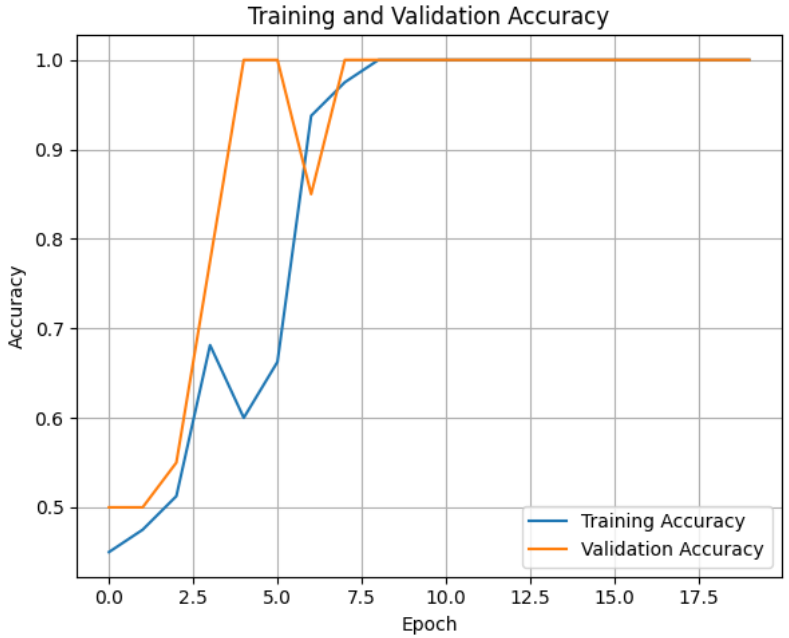
CNN model defined and summary printed successfully.

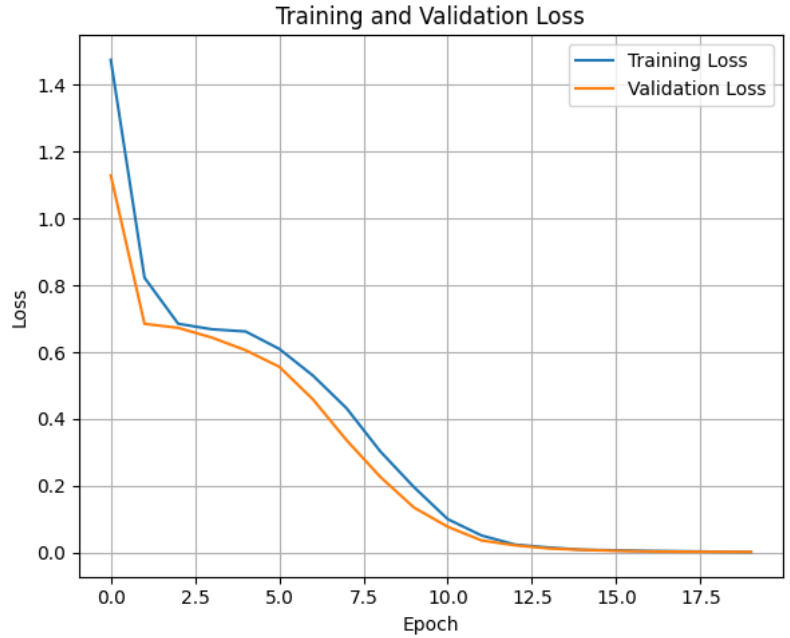
```
Visualizing convolutions for a sample 'door_closed' image...
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 144ms/step
Visualizing feature maps for layer: conv2d_8
```

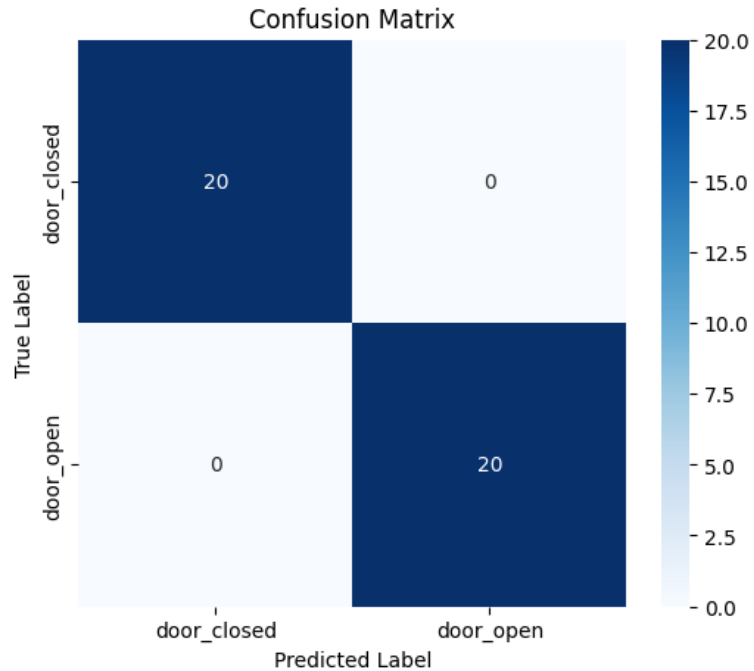

```
Visualizing feature maps for layer: conv2d_9
```

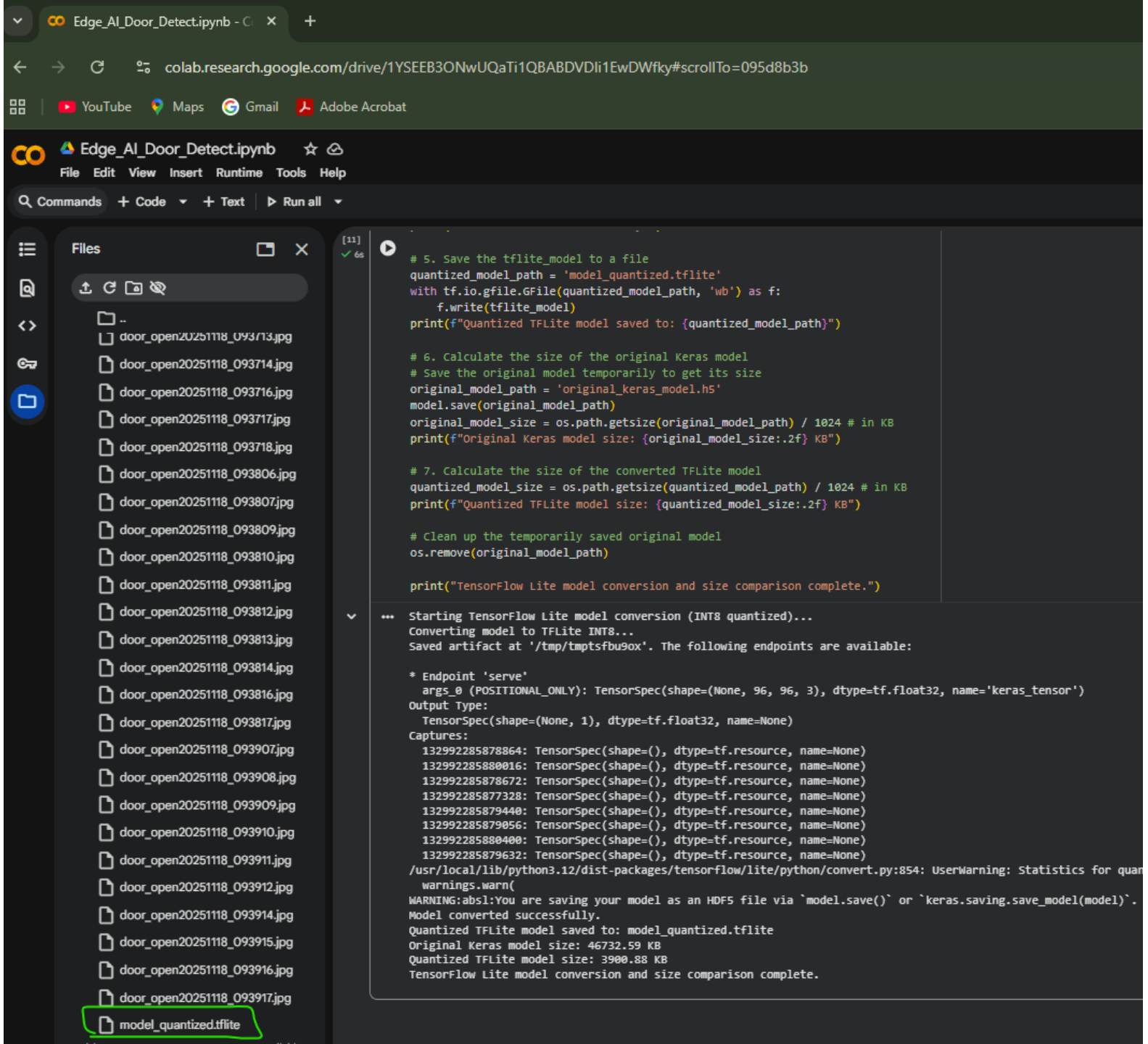



```
Feature map visualization complete.
```


Training and Validation Accuracy
Accuracy
Epoch
Training Accuracy
Validation Accuracy


Training and Validation Loss
Loss
Epoch
Training Loss
Validation Loss


Confusion Matrix
True Label
Predicted Label
door_closed
door_open
20
0
0
20



Left-click->download

tflite_to_h.py

File Edit View

```python
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

Windows PowerShell

```
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>
```

XIAO_Image_Classifier_door

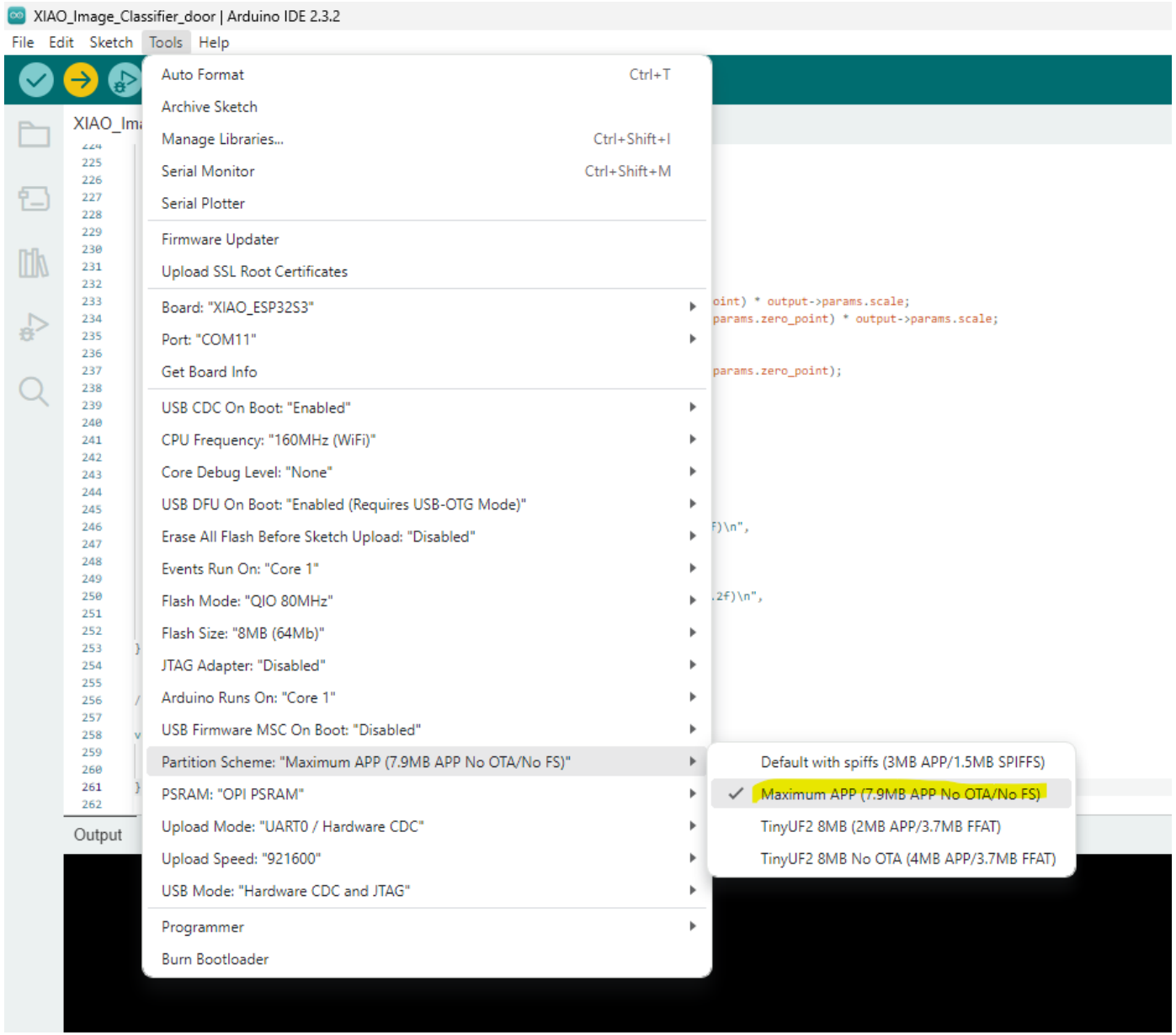
Start back up > Desktop > Edge_AI > XIAO_Image_Classifier_door

New Sort View

Home
Gallery
OneDrive - Personal

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!


XIAO_Image_Classifier_door | Arduino IDE 2.3.2
File Edit Sketch Tools Help
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)
Output


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
Output
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...

camera_usb_viewer | Arduino IDE 2.3.2

ile Edit Sketch Tools Help

XIAO_ESP32S3

camera_usb_viewer.ino

```
/**
 * @file Camera_USB_Viewer.ino
 * @brief Standalone sketch to stream 96x96 grayscale image data over USB serial.
 * This is used to diagnose image brightness/quality issues (like the door-open scene being too dark).
 */

#include <Arduino.h>
#include "esp_camera.h"
#include "esp_log.h"

#define IMAGE_WI
#define IMAGE_HE
#define FRAME_DE

// Camera config
static camera_co
    .pin_pwdn =
    .pin_reset =

    // --- CORRE
    .pin_xclk =
    .pin_sccb_sd
    .pin_sccb_sc

    // Data Pins (D7-D0)
    .pin_d7 = 48, .pin_d6 = 11, .pin_d5 = 12, .pin_d4 = 14,
    .pin_d3 = 16, .pin_d2 = 18, .pin_d1 = 17, .pin_d0 = 15,

    // Sync Pins
    .pin_vsync = 38, .pin_href = 47, .pin_pclk = 13,
    .xclk_freq_hz = 20000000,

    .ledc_timer = LEDC_TIMER_0,
    .ledc_channel = LEDC_CHANNEL_0,
    .pixel_format = PIXFORMAT_RGB565,
    .frame_size = FRAMESIZE_96X96,
    .jpeg_quality = 12,
    .fb_count = 1,
    .fb_location = CAMERA_FB_IN_PSRAM,
```

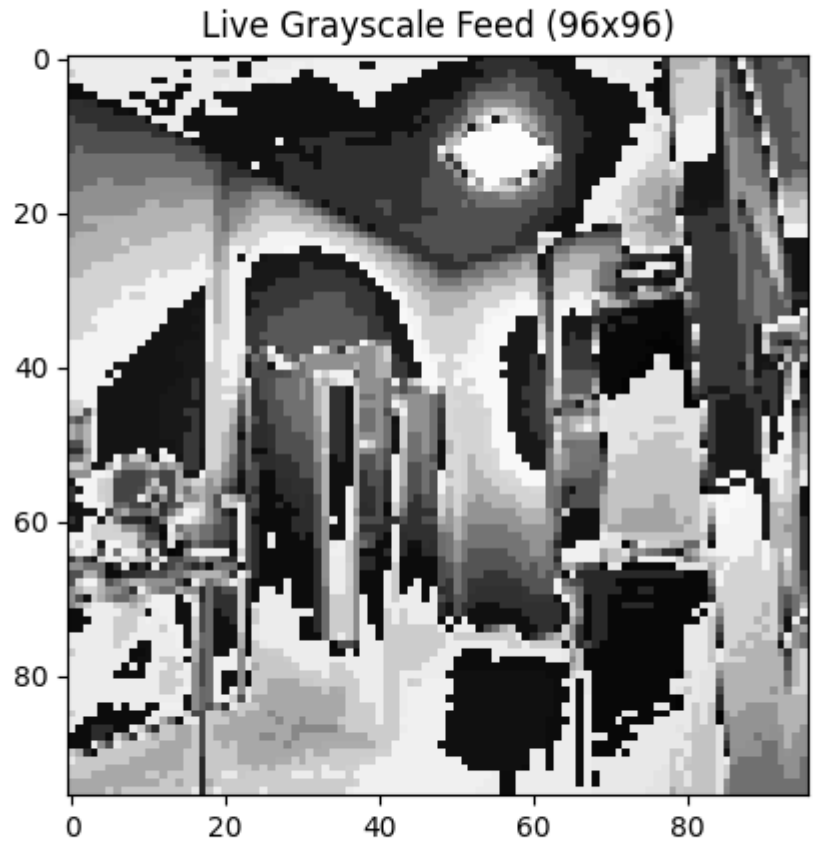
Output

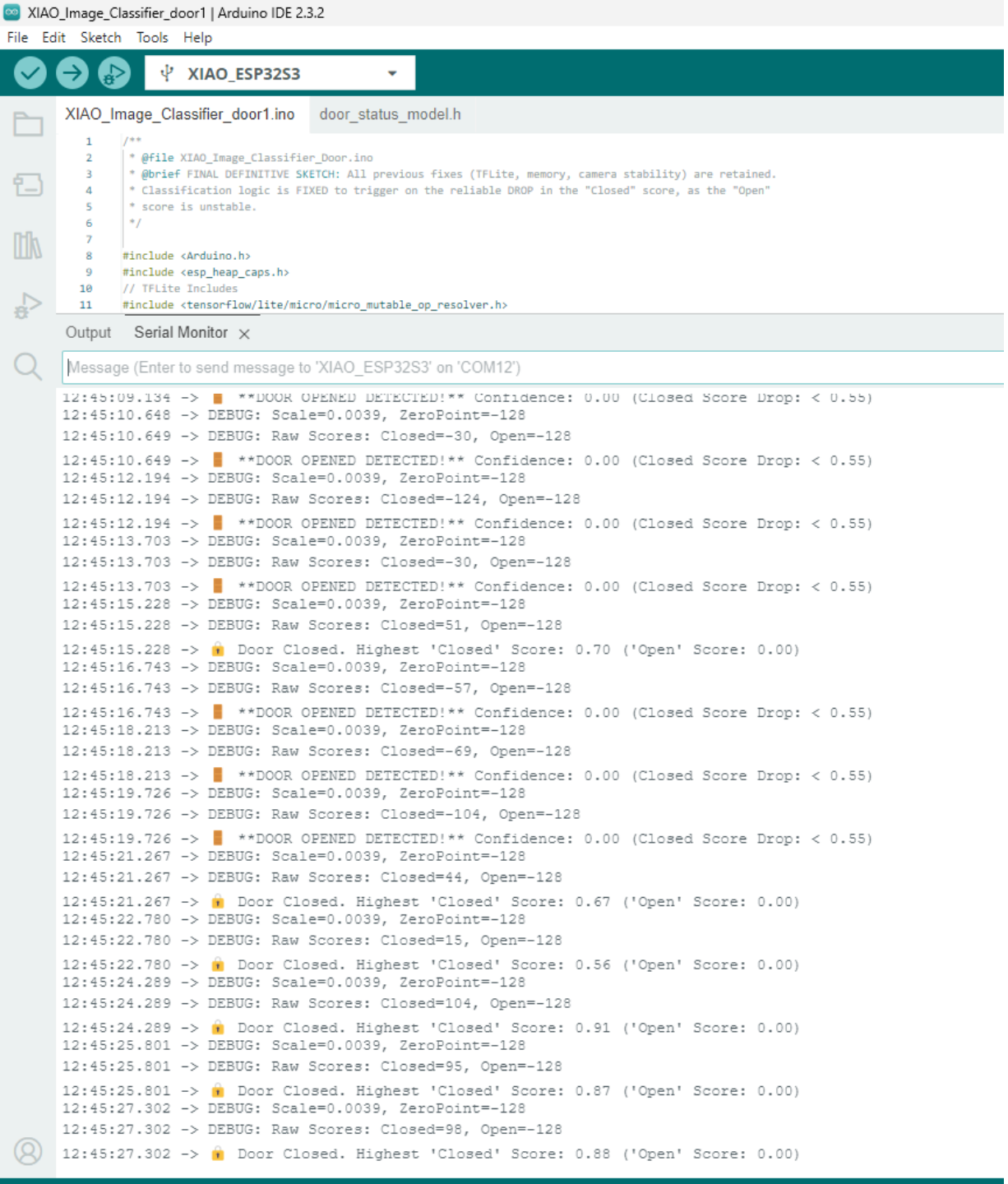
```
Writing at 0x0003a8b3 [==========>                ]  41.0% 81920/199599 bytes...

Writing at 0x00040177 [===========>               ]  49.3% 98304/199599 bytes...

Writing at 0x0004662f [================>          ]  57.5% 114688/199599 bytes...

Writing at 0x0004c9e7 [=================>         ]  65.7% 131072/199599 bytes...

Writing at 0x00053017 [====================>      ]  73.9% 147456/199599 bytes...

Writing at 0x0005b431 [=====================>     ]  82.1% 163840/199599 bytes...

Writing at 0x00060ed8 [========================>  ]  90.3% 180224/199599 bytes...

Writing at 0x00066e24 [=========================> ]  98.5% 196608/199599 bytes...

Writing at 0x000683f0 [==============================] 100.0% 199599/199599 bytes...
Wrote 361456 bytes (199599 compressed) at 0x00010000 in 2.7 seconds (1075.9 kbit/s).
Hash of data verified.

Hard resetting via RTS pin...
```

Windows PowerShell

```
PS C:\Users\Kris\Desktop\Edge_AI> python serial_viewer.py
Connected to COM12 at 500000 baud. Starting viewer...

Exiting viewer.
PS C:\Users\Kris\Desktop\Edge_AI>
```

Figure 1





Door Status Condition Threshold **OPEN** ClosedScore < 0.55
CLOSED_DOOR_THRESHOLD **CLOSED** ClosedScore ≥ 0.55

The logic-reversal strategy is fully legitimate and widely used in ML systems—especially in TinyML and embedded vision.