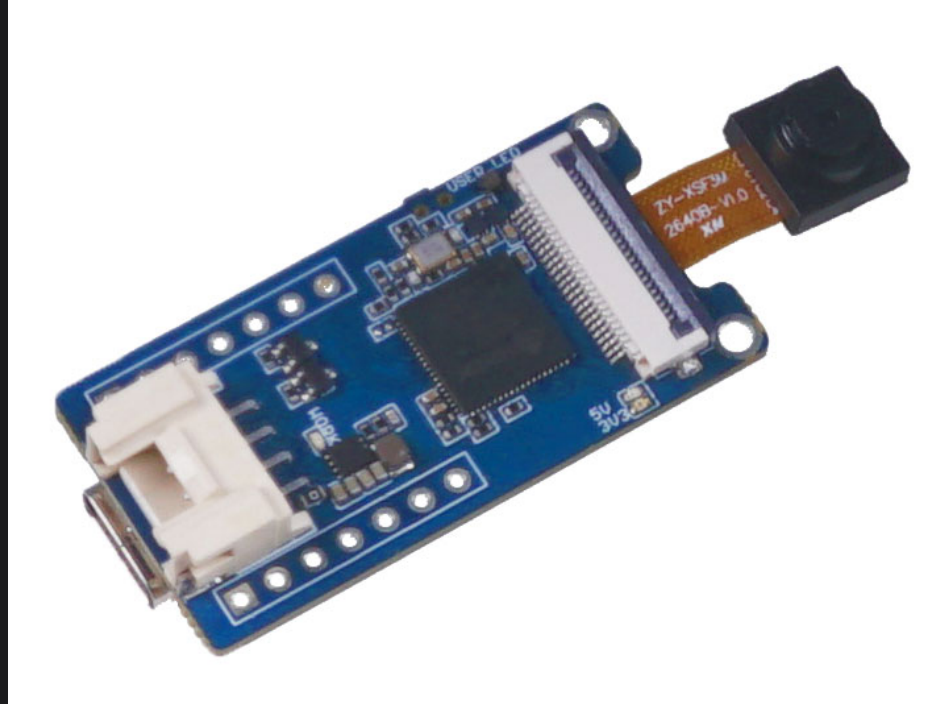# Grove Vision AI Module

Get One Now 🖱

Introduction

Grove Vision AI Module Sensor represents a thumb-sized AI camera, customized sensor which has been already installed ML algorithm for people detection, and other customized models. Being easily deployed and displayed within minutes, it works under ultra-low power model, and provides two ways of singal transmission and multiple onboard modules, all of which make it perfect for getting started with AI-powered camera.

In this wiki, we will show you how to utilize the Grove Vision AI module Sensor connecting seeed studio XIAO Series and Arduino, to detect people, panda, and then display it on the website.

Specification

Parameters	Description	Note
Connector	Grove (Grove base for Arduino)	5V Charge and Data Transmission
	Double row 7pin socket (seeed duino XIAO)	5V Charge and Data Transmission
	USB Type-C	5V Charge and Firmware burn
Communication Mode	IIC	

Parameters	Description	Note
Processor	Himax HX6537-A	400Mhz DSP (ultra low power consumption)
Camera Sensor	OV2640 chip	Resolution Ratio 1600*1200
Microphone	MSM261D3526H1CPM chip	-26dBFs sensitivity
Accelerometer Sensor	STLSM6DS3TR-C Sensor	3D accelerometer and 3D gyroscope

Feature

- Easy-to-use AI Camera: Apply Edge Machine Learning algorithm in the camera sensor perfectly for detecting obejcts
- Plug and Play: Make toilless effort to perform full function and display within minutes
- Ultra-low Power consumption: Activate while detected objects moving for power saving
- Compact AI-powered Camera Sensor: The device itself is thumb-sized, vision-based, and suitable for Edge Intelligence
- Customized Sensor Design: Support custom ML models by users define

- Two Signal Transmission Supported: Refer to seeed studio XIAO elegant connecting and Grove base for Arduino simple connection

- Onboard Camera Sensor: Corporate OV2640 chip with 1600*1200 resolution ratio

- Onboard Microphone: Corporate MSM261D3526H1CPM chip with -26dBFs sensitivity

- Onboard Accelerometer Sensor: Corporate STLSM6DS3TR-C sensor for 3D accelerometer and 3D gyroscope detected

- Onboard 32 MB SPI Ultra Low Power Flash

- One wire for all data output: Represent Grove family simplified connection for only one Grove cable required between the sensor and the single board
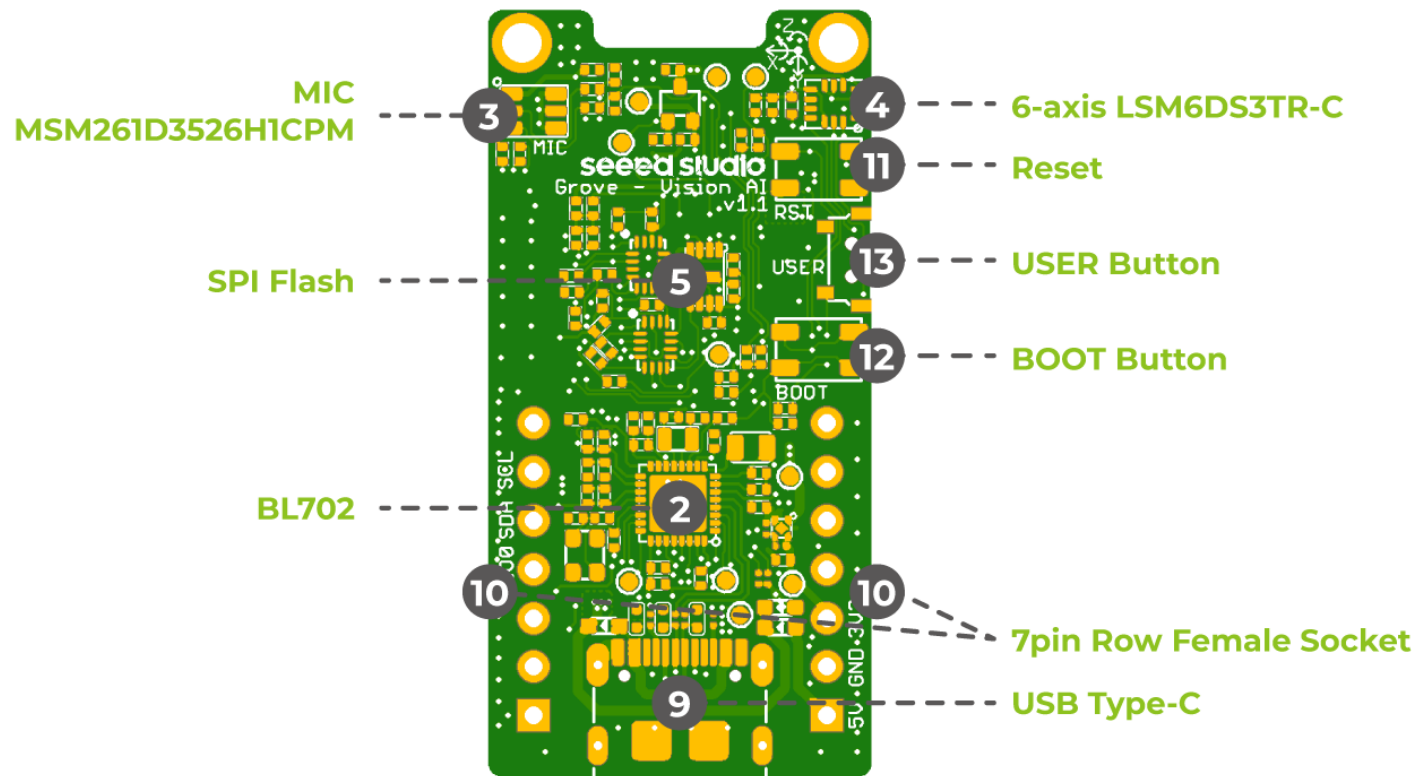
Hardware Overview

We assume you might want to be aware of some basic parameters of the product. The following tables present information about the characteristics and pinout of Grove Vision AI Module Sensor.

| Characteristic	Value	Unit
Operating Voltage	5	V
Rate	115200	

Characteristic	Value	Unit
I2C Interface	seeed studio XIAO & Arduino	-
Power Supply	dual 7-pin connector & Type-C	-
Downloading & Firmware Burn Interface	Type-C	-
Dimensions	402013	mm

Pinout Overview

MIC
MSM261D3526H1CPM

6-axis LSM6DS3TR-C

Reset

SPI Flash

USER Button

BOOT Button

BL702

7pin Row Female Socket

USB Type-C

- 2 —— BL702

- 3 —— MIC MSM261D3526H1CPM

- 4 —— 6-axis LSM6DS3TR-C
- 5 —— SPI Flash
- 9 —— USB type C
- 10 —— Dual 7-pin female socket
- 11 —— **Reset button**
- 12 —— **BOOT button**
- 13 —— **USER button**
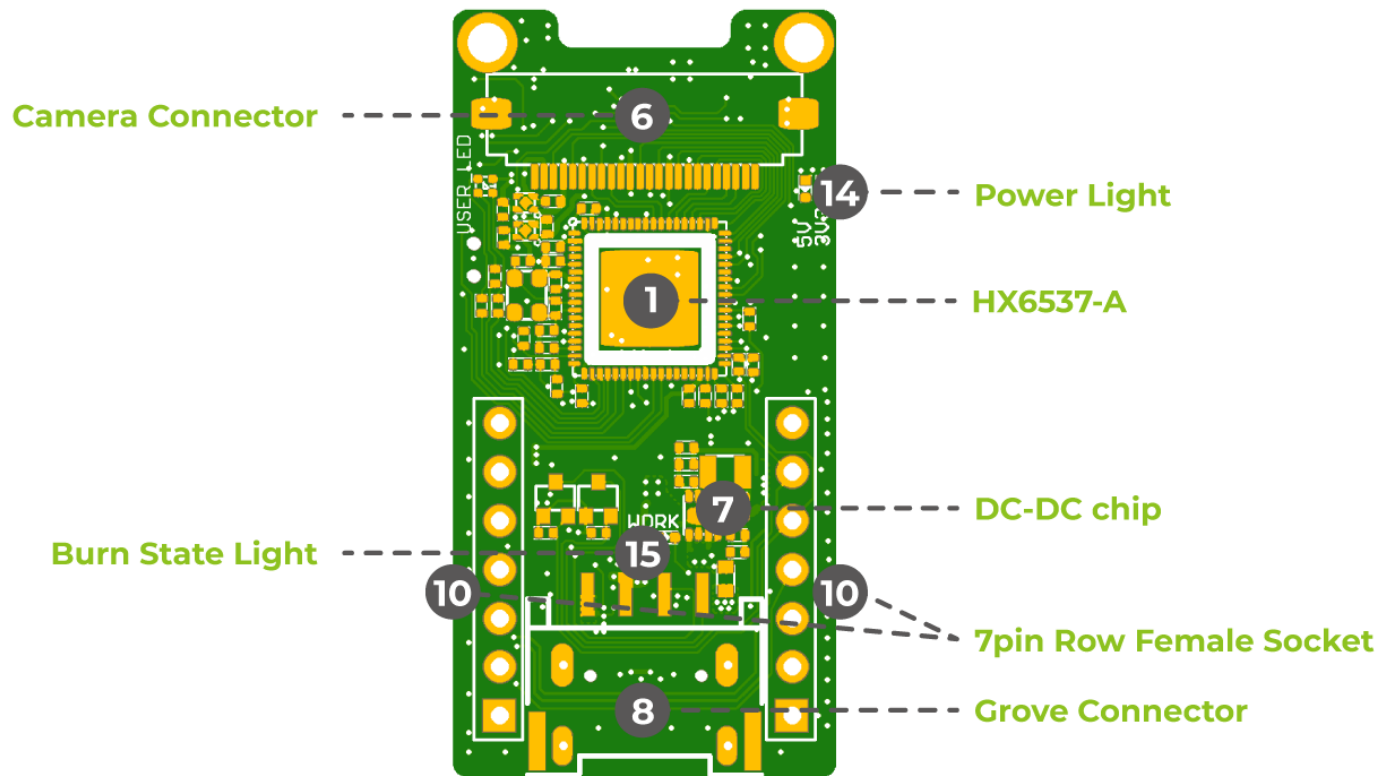
- 1 —— HX6537-A

- 6 —— Camera Connector

- 7 —— DC-DC Chip

- 8 —— Grove Connector

- 14 —— Power Light
- 15 —— Burning indicator light

Getting Started

We will show you the basic function about the module, and then introduce you the customized way that you can build the ML model of your own. But before we fully apply the module to our projects, it will take us serval steps to get the module ready.

Preparation

Hardware

- Grove Vision AI Module Sensor
- **Windows host** PC (Win10 tested)
- Type-C cable

Arduino Library Overview

> 💡 **TIP**
>
> If this is your first time using Arduino, we highly recommend you to refer to Getting Started with Arduino.

The code we use here provides serval methods of classification and selectable models, including customized models. The default we select here is object detection method and pre-trained model.

Seeed Studio will develop more methods and models for the foreseeable future, stay tuned with us.

Download the Libraries :octocat:

Function

Before we get started developing a sketch, let's look at the available functions of the library.

1. `if (ai.begin(ALGO_OBJECT_DETECTION, MODEL_EXT_INDEX_1))` - This is where we can select our methods of classification and the models.

   You can change `ALGO_OBJECT_DETECTION` to `ALGO_OBJECT_COUNT` or `ALGO_IMAGE_CLASSIFICATION`.

   Meanwhile, if you also burn your customized model(firmware) into the module, you can change `MODEL_EXT_INDEX_1` to `MODEL_EXT_INDEX_2` or 3, 4, as you named it.

2. `object_detection_t data` - This is the struct dataset where the result output.

   If you change the classification method, you need to change `object_detection_t` correspondingly to `image_classification_t` or `object_count_t`.

3. `uint8_t len = ai.get_result_len()` - The "len" here means how many human face it detects.

4. `object_detection_t data` - The data here represent a **struct** format and the tpye is "object_detection_t" that is pre-defined.

   Meanwhile, if you choose other methods of classification, you need to change it to `image_classification_t data` or `object_count_t data`.

5. `Serial.print(data.confidence)` - The **struct** format can not be directly used to print, it should point to the specific type which is defined in the head file.

```
typedef struct
{
    uint16_t x;
    uint16_t y;
    uint16_t w;
    uint16_t h;
    uint8_t confidence;
    uint8_t target;
} object_detection_t;
```

> 💡 **TIP**
>
> The "confidence" we want to print here shows how much "confidence" the camera has to detect the object.
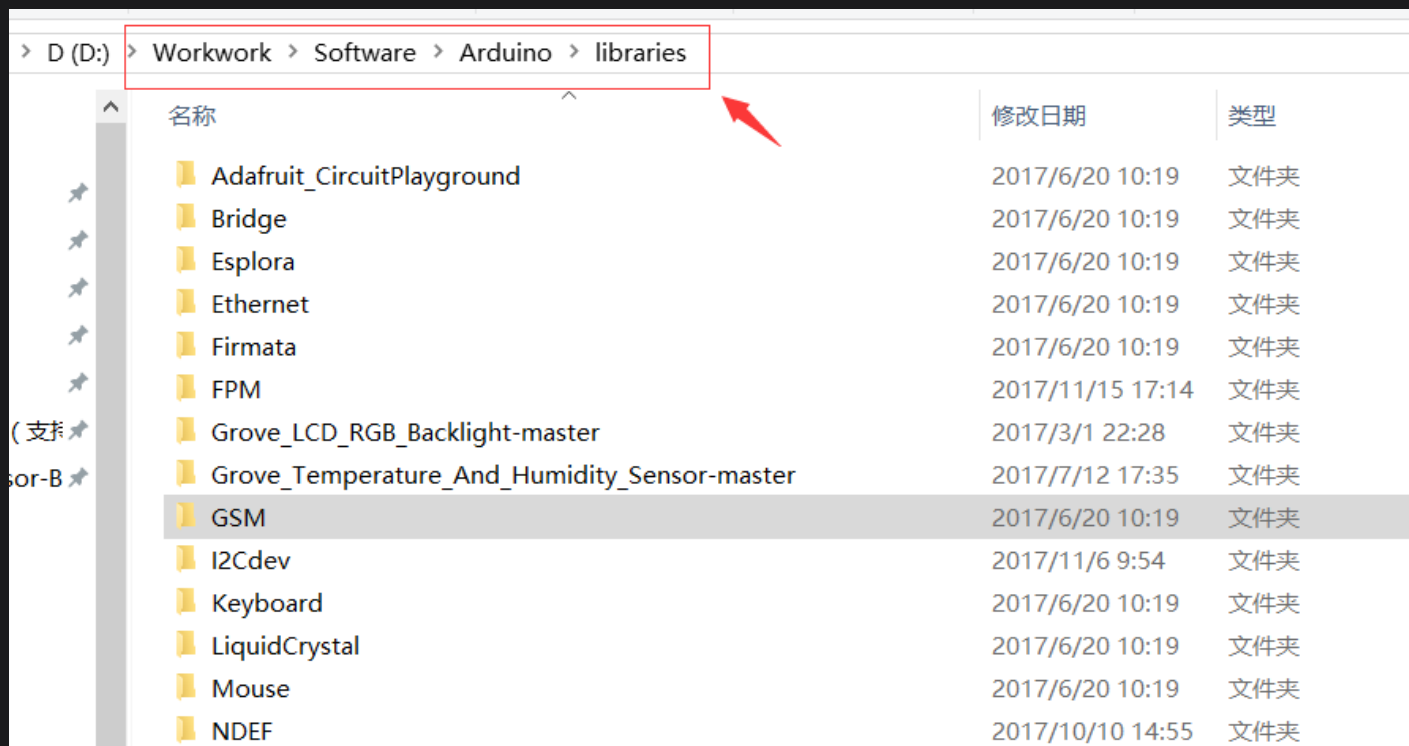
Library Installation

Since we have downloaded the zip Library, open your Arduino IDE, click on **Sketch > Include Library > Add .ZIP Library**. Choose the zip file you just downloaded， and if the library install correct, you will see **Library added to your libraries** in the notice window. Which means the library is installed successfully.
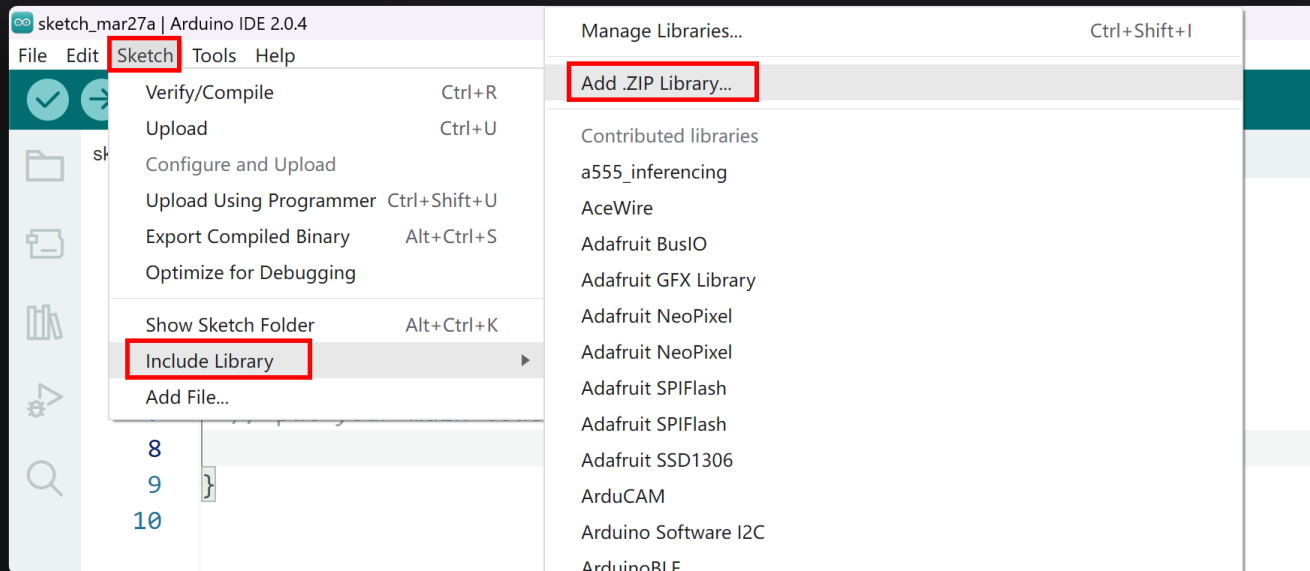
Library Upgrading

In the foreseeable future, we will optimize and upgrade the product library for more interesting function. According to the library installation methods provided above, we here introduce you the way to upgrade.

We will update the link when the library is optimized. You can **delete the original library folder** in your computer's folder, then download the latest version, unzip it and put it in the Arduino IDE library directory. (**...\Arduino\libraries. ....** is the path you setup Arduino)

Seeed Studio XIAO / Seeeduino / Arduino Example

Now that we have our library installed and the firmware burned. we can now run some examples with Grove AI module sensor on Seeed Studio XIAO nRF52840 and Seeeduino V4.2 to see how it behaves.

Step 1. Launch the Arduino application.

Step 2. Select your development board model and add it to the Arduino IDE.

- If you want to use **Seeeduino** for the later routines, please refer to this tutorial to finish adding.

- If you want to use **Seeed Studio XIAO SAMD21** for the later routines, please refer to this tutorial to finish adding.

- If you want to use **Seeed Studio XIAO RP2040** for the later routines, please refer to this tutorial to finish adding.

- If you want to use **Seeed Studio XIAO nRF52840** for the later routines, please refer to this tutorial to finish adding.

Demo 1 Human Detection with Seeed Studio XIAO nRF52840 / Seeeduino / Arduino

In this demo, we will detect human face and count how many people the module detects on both Seeed Studio XIAO nRF52840 Sense and Seeeduino V4.2 (Arduino UNO). Meanwhile, Seeed Studio provves a website to display what the module sees.

Materials Required

- **For seeed studio XIAO BLE Sense**
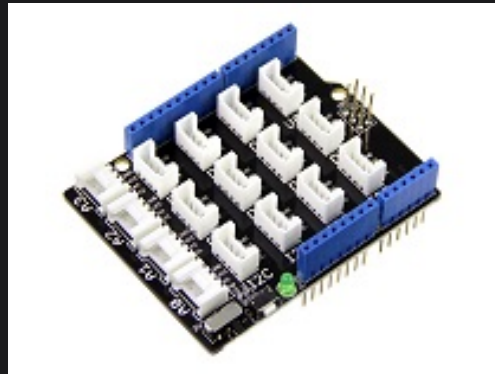
Seeed Studio XIAO nRF52840 Sense	Grove AI Camera
Get One Now 🖱	**Get One Now** 🖱
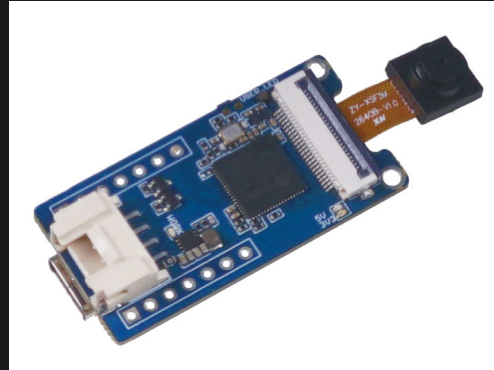
- **For Seeeduino V4.2**

| Seeeduino V4.2	Base Shield	Grove AI Camera
Get One Now 🖱	Get One Now 🖱	Get One Now 🖱
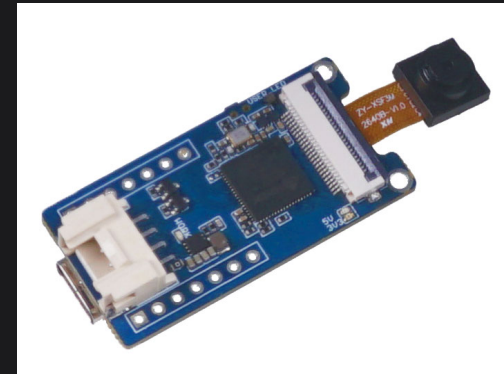
Operation Steps

- **Step 3 (Seeed Studio XIAO).** Parpare a Type-C cable and connect it to one seeed studio XIAO Series board. Plug it pin by pin into the Grove AI Module and use another Type-C cable to connect the module.

  Both Type-C cable should be connected with the PC. In the end, the direction of the Type-C connector on the module should be the same as Type-C connector on the seeed studio XIAO samd21. For instance:
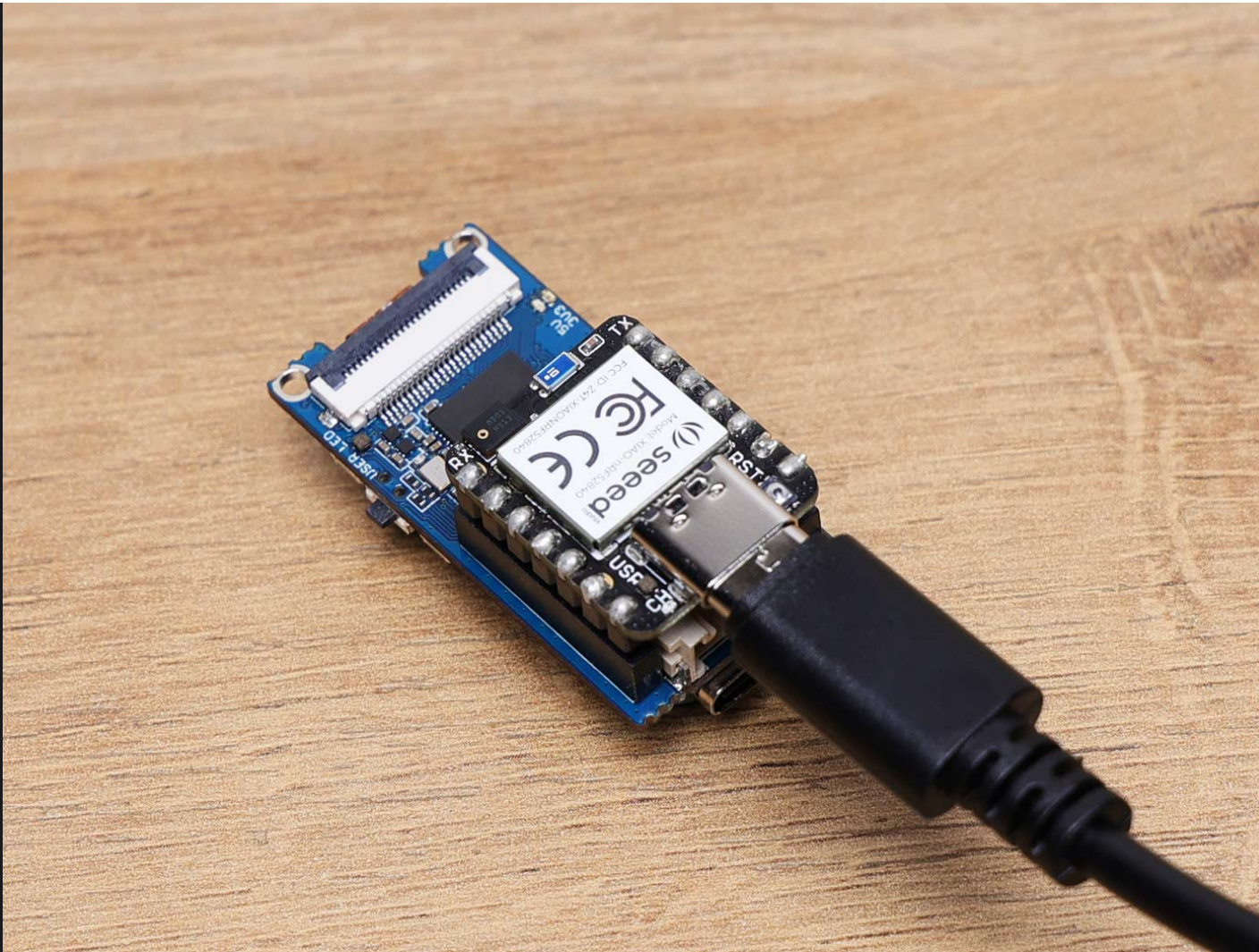
- **Step 3 (Arduino).** Parpare a Grove cable and connect it to one Arduino board. Use another Type-C cable to connect the module.
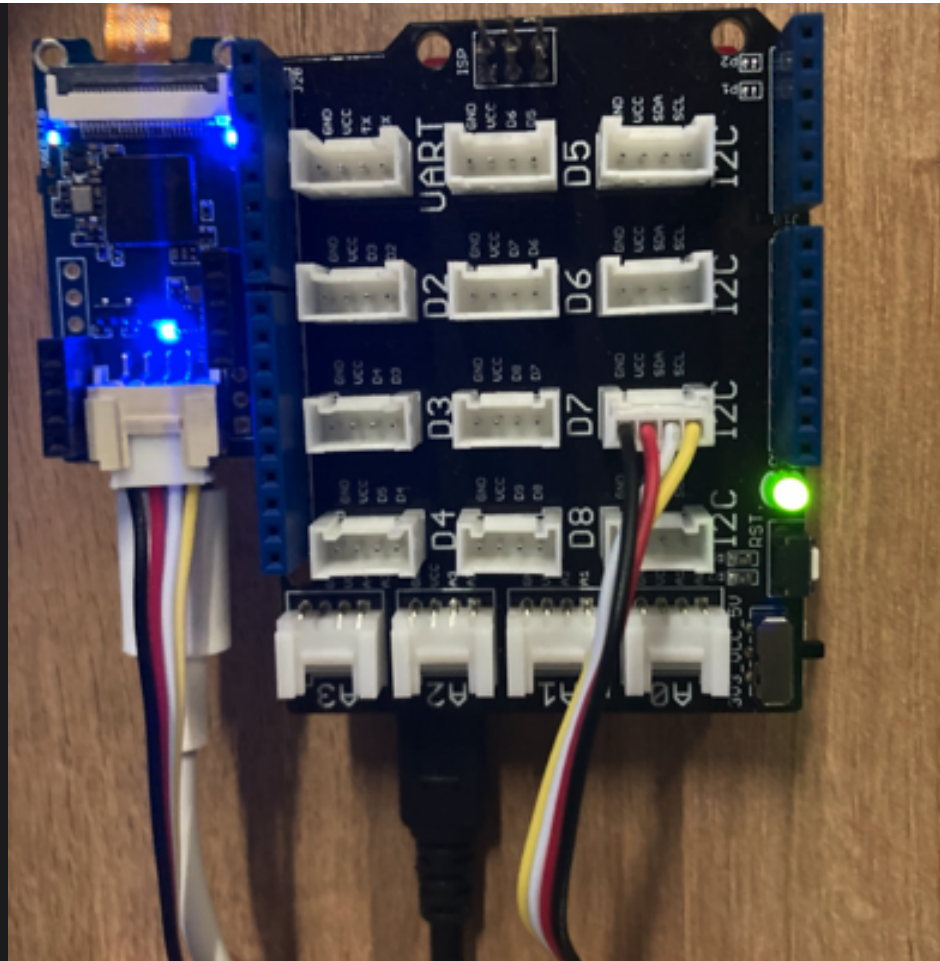
- **Step 4.** Upload the program.

```
#include "Seeed_Arduino_GroveAI.h"
#include <Wire.h>

GroveAI ai(Wire);
uint8_t state = 0;
void setup()
```

```cpp
{
  Wire.begin();
  Serial.begin(115200);

   Serial.println("begin");
  if (ai.begin(ALGO_OBJECT_DETECTION, (MODEL_INDEX_T)0x11)) // Object detection and pre-
trained model 1
  {
    Serial.print("Version: ");
    Serial.println(ai.version());
    Serial.print("ID: ");
    Serial.println( ai.id());
    Serial.print("Algo: ");
    Serial.println( ai.algo());
    Serial.print("Model: ");
    Serial.println(ai.model());
    Serial.print("Confidence: ");
    Serial.println(ai.confidence());
    state = 1;
  }
  else
  {
    Serial.println("Algo begin failed.");
  }
}

void loop()
{
```

```cpp
if (state == 1)
{
  uint32_t tick = millis();
  if (ai.invoke()) // begin invoke
  {
    while (1) // wait for invoking finished
    {
      CMD_STATE_T ret = ai.state();
      if (ret == CMD_STATE_IDLE)
      {
        break;
      }
      delay(20);
    }

    uint8_t len = ai.get_result_len(); // receive how many people detect
    if(len)
    {
      int time1 = millis() - tick;
      Serial.print("Time consuming: ");
      Serial.println(time1);
      Serial.print("Number of people: ");
      Serial.println(len);
      object_detection_t data;       //get data

      for (int i = 0; i < len; i++)
      {
        Serial.println("result:detected");
```

```cpp
        Serial.print("Detecting and calculating: ");
        Serial.println(i+1);
        ai.get_result(i, (uint8_t*)&data, sizeof(object_detection_t)); //get result

        Serial.print("confidence:");
        Serial.print(data.confidence);
        Serial.println();
      }
    }
    else
    {
      Serial.println("No identification");
    }
  }
  else
  {
    delay(1000);
    Serial.println("Invoke Failed.");
  }
  }
  else
  {
    state == 0;
  }
}
```

Open the serial monitor and set baud rate as 115200 and the result of people detection should be showed continuously. Meanwhile, the image that is captured by the module also will display on the website. The successful ongong output should be like:

On the display website, you can see that two faces are framed with dual number. Number 0 means the human face that module detected, and the other number means the confidence.

About Models

The Seeed Studio has provided pre-trained people detected model and will provide more models in the foreseeable future. You can directly use them to quickly get to know AI camera.

You can find our firmware and models for Grove Vision AI at the following locations.

Download the Model

Default Firmware: People Detected Model

More Models

Release v2.0.0 (Latest)

New Features:

- Introducing AT Server Support: Now you can take advantage of AT Server, which offers a comprehensive set of commands with functionality on par with I2C Server.
- Enhanced Algorithm Capabilities: Added support for pointer-based tables and numerical table calculations to further enhance your workflow.

Bug Fixes:

- Resolved Error Code Mishap: Fixed an issue where incorrect error codes were displayed when retrieving storage models, ensuring accurate error identification.
- Centered Grove Vision AI Display: Addressed the problem of the Grove Vision AI screen not being properly centered, resulting in a more visually appealing user experience.

▼ Assets 9

⬡ erase_model.uf2	37.5 KB	last month
⬡ grove_ai_v02-00.uf2	1.47 MB	last month
⬡ meter_seg7_pre_6.uf2	1.61 MB	last month
⬡ meter_water_pre_6.uf2	1.61 MB	Aug 2
⬡ person_detection_pre_17.uf2	1.43 MB	Aug 2
⬡ pfld_meter_pre_5.uf2	470 KB	Aug 2
⬡ sensecap_ai_v02-00.uf2	1.48 MB	last month
🗎 Source code (zip)		Apr 28

Source code (tar.gz)   Apr 28

😊

We are continuously maintaining and updating more useful models, so you can keep an eye on this repository.

> 💡 **TIP**
>
> Typically, model files are in **UF2** format and have a suffix in the format **pre_num**.

Custom Models

If you want to customize your own model, you can refer to here which is powered by YOLOV5.

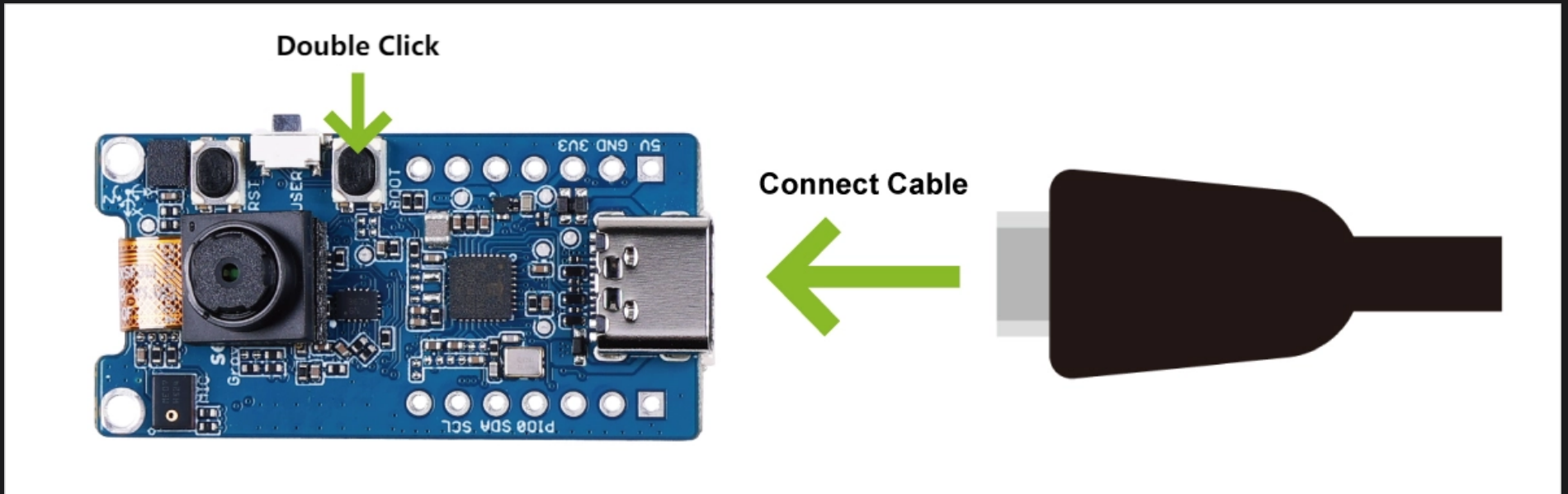Or refer to the tutorial here and train your own model to suit your needs.

Replacement of new models

The training models are all represented as ".uf2" file, which is what we need.
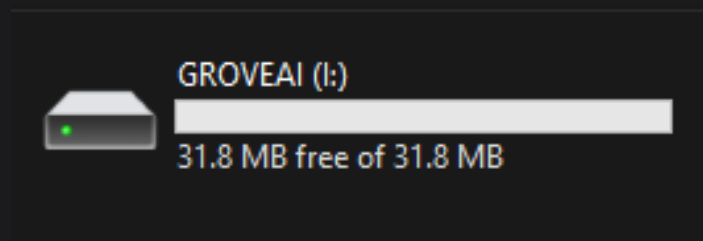
- **Step 1**. Connect module to the host PC with a Type-C cable and **double click** BOOT button on the module.
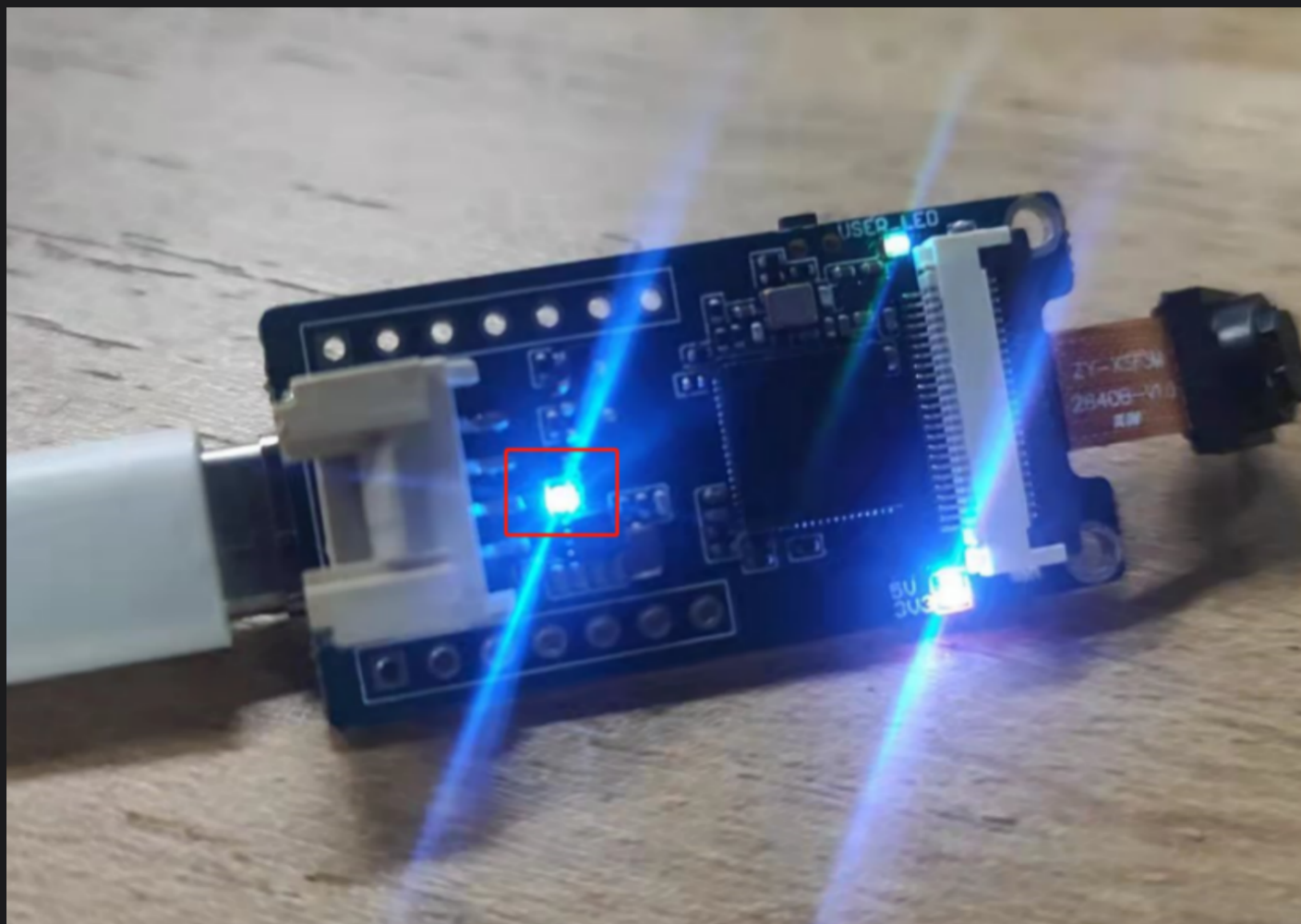

There will be a "GROVEAI" disk pop up.

- **Step 2**. Please copy the Model `.uf2` file to the GROVEAI disk to complete the firmware flash.

We can see that Work LED on the module flash in speed, that means the process is ongoing. After the disk disapper, the process of burnning firmware is finished.

- **Step 3**. Please modify the program according to the model you are using.

In the demo we provided, inside the `setup()` function is initializing the model by calling `ai.begin()`.

```
if (ai.begin(ALGO_OBJECT_DETECTION, (MODEL_INDEX_T)0x11))
```

`ai.begin()` has two arguments, the type of model and the model number. The numbering is generally different for different models. That is to say, the model number of the sample program only applies to the **People Detected Model**, if you use other models, then the number is no longer `0x11`.

> ⚠️ **CAUTION**
>
> If you encounter the error message "Algo begin failed." when using the demo, you should first check if the model number is wrong.

So how do you determine the model number? Our R&D engineers have provided a detailed introductory document for developers to read.

- Protocol

But if you don't want to read such a long article, a simple way to determine this is to keep an eye out for the last number of the model in Release, which is the number we need.

For example, for the model **pfld_meter_pre_5.uf2**, the last digit is **5**, which means the model number is **5**. You can use

```
ai.begin(ALGO_OBJECT_DETECTION, (MODEL_INDEX_T)5)
```

directly, or rewrite it as hexadecimal

```
ai.begin(ALGO_ OBJECT_DETECTION, (MODEL_INDEX_T)0x05)
```

Exception Processing

If you have encountered an unforeseen situation in actual use, or if you have used it incorrectly and have experienced an outcome other than medical treatment. Please refer to the following steps to troubleshoot and attempt to repair the module.

Part 1. Check BootLoader Version

You may need to detect if the BootLoader version needs to be updated to decide if the update should be done. The method to check the version number is as follows.

Connect the Grove Vision AI to your computer via the USB-C port. Then double-click the Boot button until the computer comes up with a USB flash drive named GROVEAI.

Open this disk drive and open the **INFO_UF2.TXT** file.
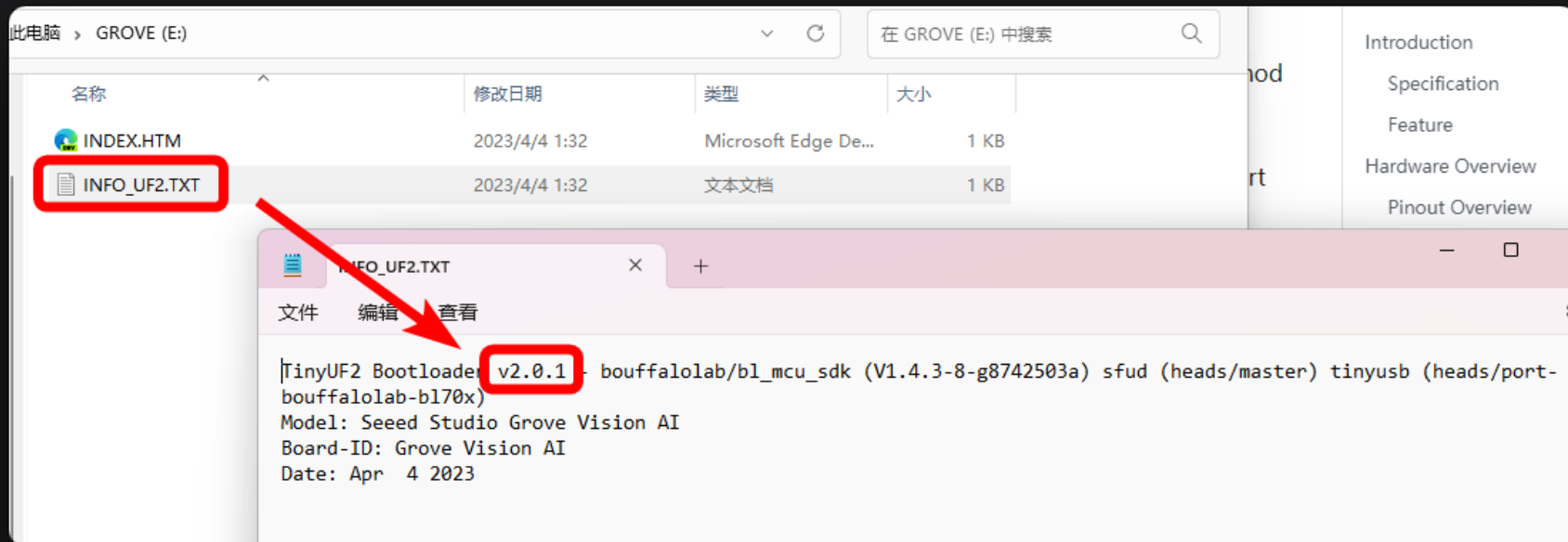
As shown in the figure, you can see the Bootloader version number on the first line. As of September 2023, the latest BootLoader version number should be **v2.0.1**. If you also check the same version number, then in principle you don't need to do the next second step.

Part 2. Update BootLoader

If your Grove Vision AI is not recognized by your computer and behaves as no port number, then you may need to update the BootLoader.

- **Step 1**. Download the BootLoader `.bin` file on the windows PC.

Please download the latest version of the BootLoader file in the link below. The name of the BootLoader is usually `tinyuf2-grove_vision_ai_vx.x.x.bin`.

Download BootLoader :octocat:

This is the firmware that controls the BL702 chip that builds the connection between the computer and the Himax chip. The latest version of the BootLoader has now fixed the problem of Vision AI not being able to be recognised by Mac and Linux.

- **Step 2**. Download and open **BLDevCube.exe** software, select **BL702/704/706**, and then click **Finish**.
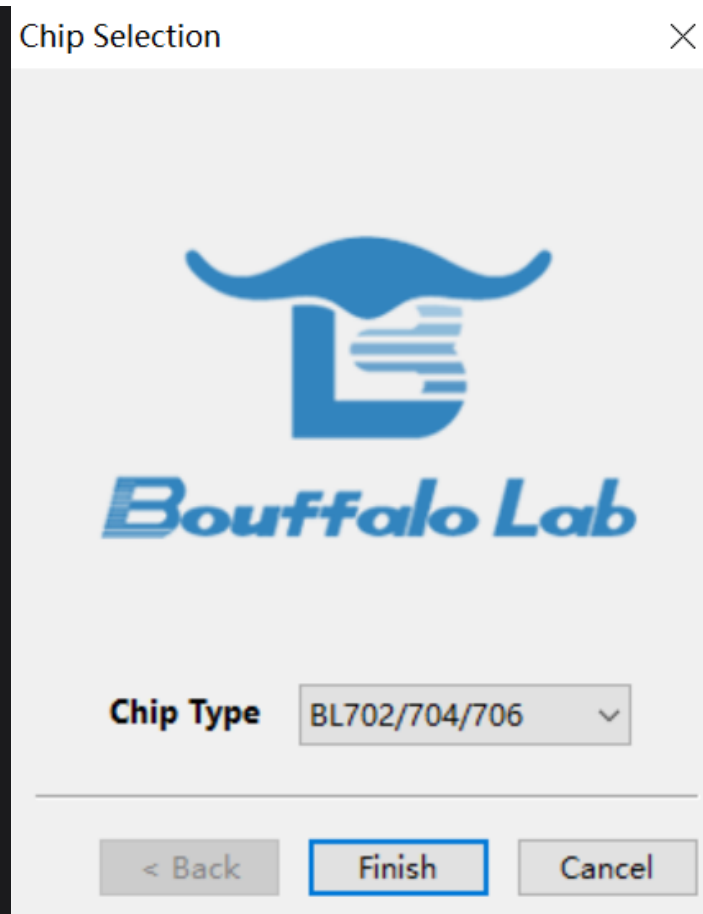
- **Step 3**. Click **View**, choose **MCU** first. Move to **Image file**, click **Browse** and select the firmware you just downloaded.

- **Step 4**. Make sure there are no other devices connect to the PC. Then hold the Boot button on the module, connect it to the PC.
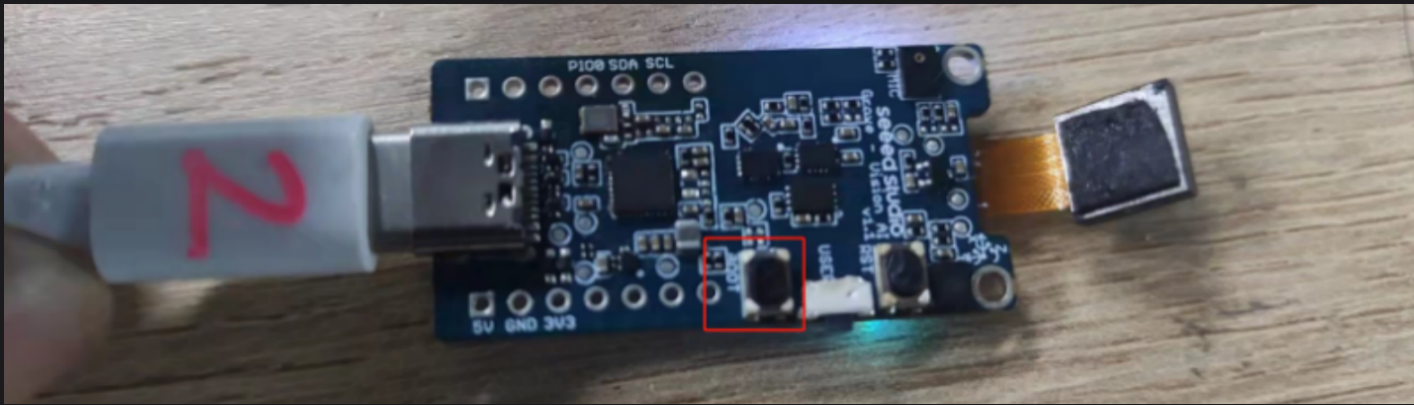
We can see 5V light and 3.3V LED light are lighting on the back of the module, then loose the Boot button.
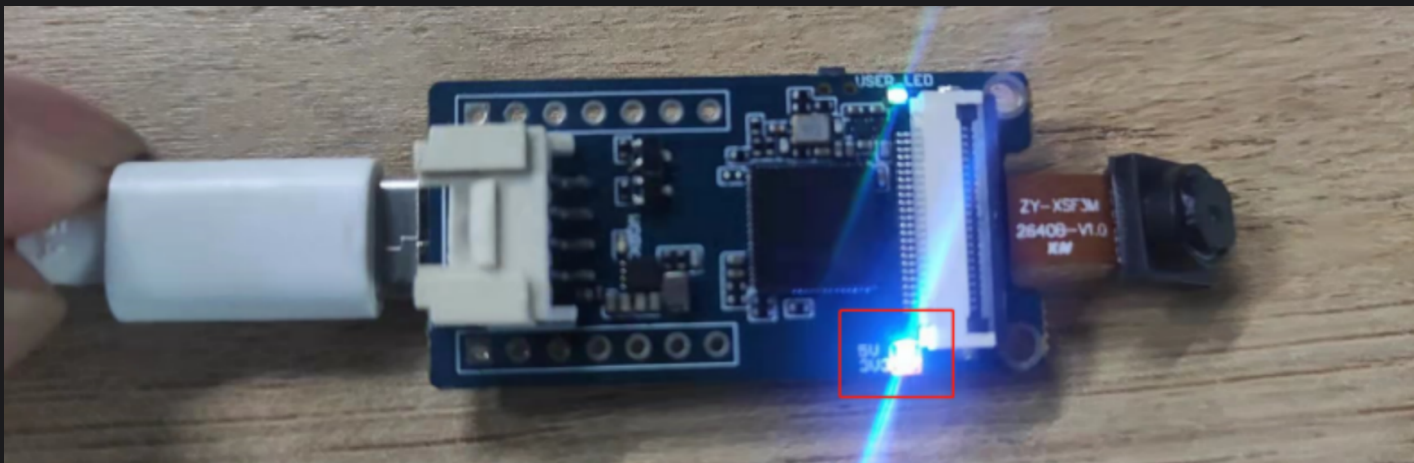
- **Step 5**. Back to the BLDevCube software on the PC, click **Refresh** and choose a proper port. Then click **Open UART** and set **Chip Erase** to **True**, then click **Creat&Program**, wait for the process done.

Bouffalo Lab Dev Cube 1.6.6 - BL702/704/706

File   View   Help

Image | Partition | Security | Efuse Key | Flash Utils | IAP

General Options

Interface   Uart

COM Port   COM23

Uart Speed   2000000

JLink Speed   1000

Chip Erase   True

Xtal   32M

Boot Source   Flash   BootInfo Addr   0x0   Bind

Image Type   SingleCPU   Image Addr   0x2000   Save Image

Image File   G:\1-Project\9-Grove AI Camera\grove_ai_camera_i2c_test\grove_ai_camera_i2c   Browse

Device Tree   Browse

click here to show advanced options >>

Refresh   1

Clear

5

Success   Log   Create & Program   Open UART
                           4   3

LOG

search

[10:07:56.631] - write check
[10:07:56.632] - Flash load time cost(ms): 429.7392578125
[10:07:56.632] - Finished
[10:07:56.634] - Sha caled by host: 0a54fd55149929b4dc6877bae80b82e34deee9885eb0dd5e9d6d493f18fffd43
[10:07:56.635] - xip mode Verify
[10:07:56.655] - Read Sha256/85776
[10:07:56.656] - Flash xip readsha time cost(ms): 19.98828125
[10:07:56.656] - Finished
[10:07:56.657] - Sha caled by dev: 0a54fd55149929b4dc6877bae80b82e34deee9885eb0dd5e9d6d493f18fffd43
[10:07:56.657] - Verify success
[10:07:56.658] - Program Finished
[10:07:56.659] - All time cost(ms): 3359.08056640625
[10:07:56.774] - [All Success]

- **Step 6**. It is recommended to check the Vision AI version number again to ensure that the latest BootLoader is being used.
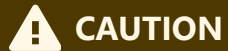
Part 3. Restore Factory Firmware

> 💡 **TIP**
>
> If ever uploading firmware on the latest version of Windows 11 has rendered the device unusable, you may need to refer to the section on Update BootLoader.

- **Step 1**. Erase firmware

> ⚠️ **CAUTION**
>
> You can try to skip this step and copy the firmware directly to the Vision AI, if it works, then you don't have to erase the original firmware. If it fails, you may need to erase the firmware.

Please use the Arduino motherboard you have, the Seeed Studio XIAO series, Wio Terminal or Seeeduino are recommended. Connect the Grove Vision AI to the motherboard via the IIC interface.

Open the Arduino IDE and upload the program to erase the firmware.

```
#include "Seeed_Arduino_GroveAI.h"
#include <Wire.h>
```

```cpp
WEI wei(Wire);

void setup()
{
    Wire.begin();
    Serial.begin(115200);
    while (!Serial)
    {
        /* code */
    }
    delay(1000);
    Serial.println("Press any key to start erase");
}

void loop()
{
    if (Serial.available())
    {
        while (Serial.available())
        {
            Serial.read();
        }
        uint32_t id = wei.ID();
        Serial.print("ID: 0x");
        Serial.println(id, HEX);
        wei.enter_bootloader();
        Serial.println("Erase");
        wei.erase();
```
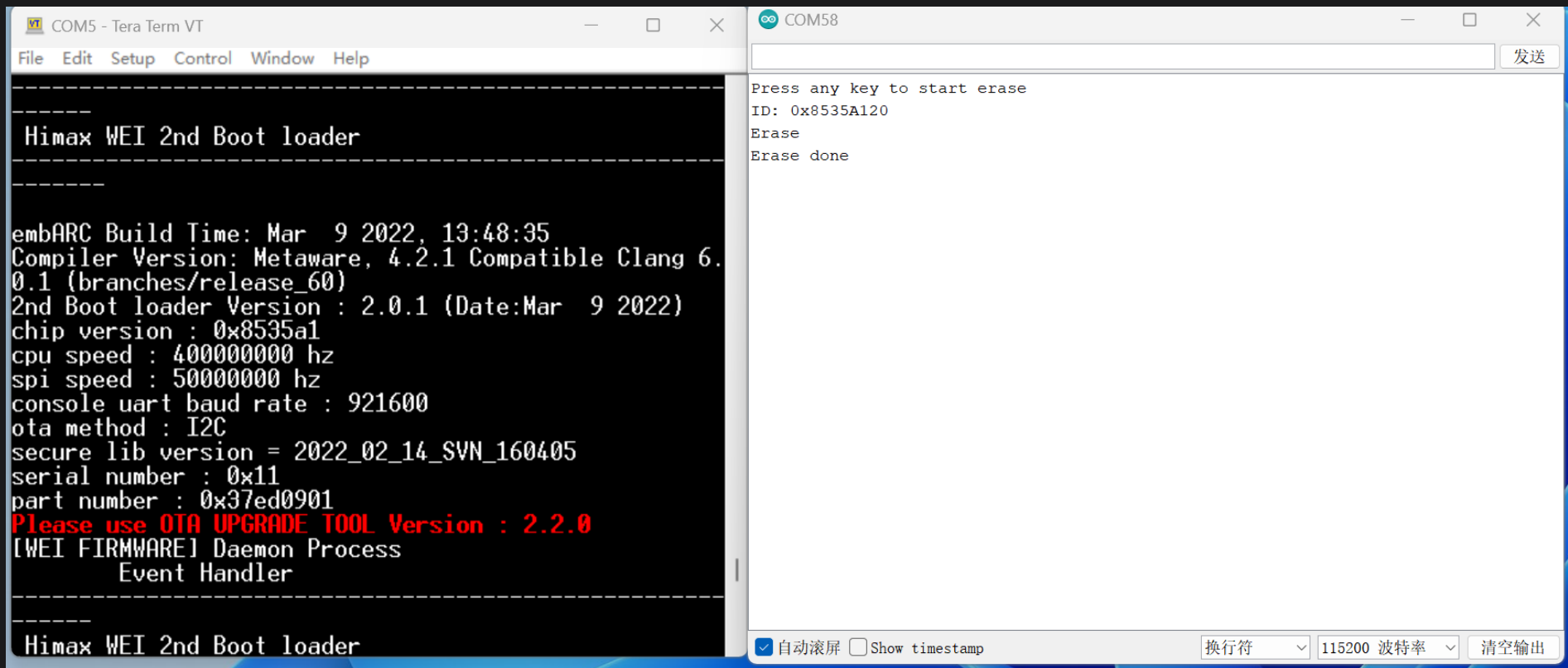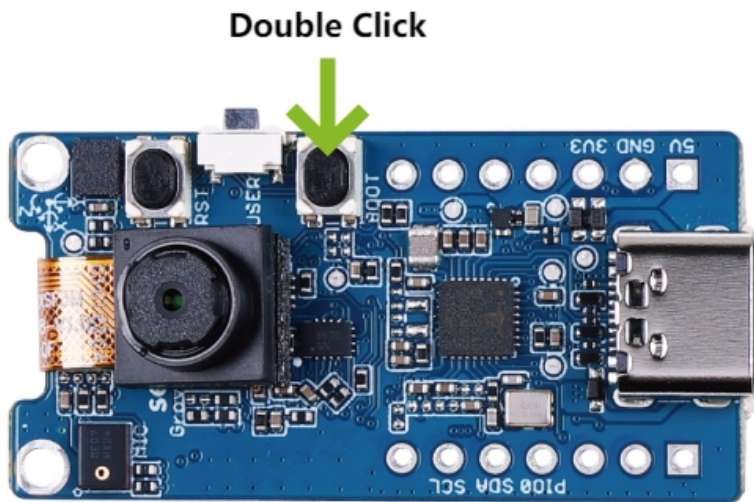
```
        Serial.println("Erase done");
    }
}
```
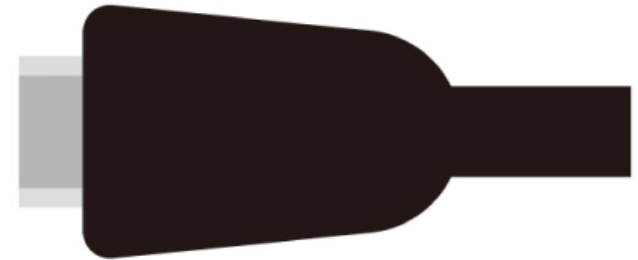
Open the serial monitor, enter some random characters, such as "a", click send, then the erase operation will start to execute. If you see the following message, then it proves that the firmware erase was successful. We can go to the next step.

- **Step 2**. Connect module to the host PC with a Type-C cable and **double click** BOOT button on the module.

There will be a "GROVEAI" disk pop up.

GROVEAI (I:)
31.8 MB free of 31.8 MB

- **Step 3**. Download the factory firmware.

Please download the latest version of the factory firmware in the link below. The name of the factory firmware is usually `grove_ai_without_crc_vxx.uf2` or `grove_ai_vxx.uf2`.

Download the Firware

- **Step 4**. Flash the factory firmware.

Copy the `grove_ai_without_crc_vxx.uf2` or `grove_ai_vxx.uf2` file to the GROVEAI disk to complete the firmware flash.

The above three parts need to be judged and executed in turn, when the above steps are executed, you can do your operation again, if there are still problems, please contact our technical support team.

Trouble Shooting

Q1: What is the main method of connection?

- a. Link the microcontroller and the module first.
- b. Connect the microcontroller with host PC second.
- c. Connect the module with host PC at last.

Q2: Why can't I see the image display on the website? Nor the detecting?

- a. Is the module heated? Connect the module only will cost heat problem and let the module not functioning for a moment.

- b. Is connecting after the correct method?

Q3: Why does Grove Vision AI suddenly get an "Algo begin failed." error one day while in use?

In the demo we provided, inside the `setup()` function is initializing the model by calling `ai.begin()`.

```
if (ai.begin(ALGO_OBJECT_DETECTION, (MODEL_INDEX_T)0x11))
```

`ai.begin()` has two arguments, the type of model and the model number. The numbering is generally different for different models. That is to say, the model number of the sample program only applies to the **People Detected Model**, if you use other models, then the number is no longer `0x11`.

> ⚠️ **CAUTION**
>
> If you encounter the error message "Algo begin failed." when using the demo, you should first check if the model number is wrong.

So how do you determine the model number? Our R&D engineers have provided a detailed introductory document for developers to read.

- Protocol

But if you don't want to read such a long article, a simple way to determine this is to keep an eye out for the last number of the model in Release, which is the number we need.

For example, for the model **pfld_meter_pre_5.uf2**, the last digit is **5**, which means the model number is **5**. You can use

```
ai.begin(ALGO_OBJECT_DETECTION, (MODEL_INDEX_T)5)
```

directly, or rewrite it as hexadecimal

```
ai.begin(ALGO_ OBJECT_DETECTION, (MODEL_INDEX_T)0x05)
```

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