



Installation Guide

12 Feb 2024

The sensorCAM is an advanced concept foreign to most model railroaders and consequently deals with many unfamiliar issues. It also calls on multiple software applications to address them. The initial software setup for an inexperienced tinkerer is consequently involved and needing perseverance. The Arduino IDE, the ESP32 libraries, the Processing 4 App, the EX-Command Station and EX-rail (if used) combine to create a unique system supporting the sensorCAM's own software. Any prior knowledge of these will vastly expedite the installation.

Outline:

This installation process is divided into 12 steps outlined below. It is recommended that it be treated as a learning exercise and that testing of progress occur after each major step. For example, familiarization with Arduino IDE should be developed before moving to the ESP32 example, and then familiarize with the ESP32- CAM before moving on to the sensorCAM loading.

As the sensorCAM is not for Conductors, and perhaps only advanced Tinkerers, it is anticipated that users will already be familiar with the Arduino IDE and maybe already have toyed with the ESP32-CAM. We have not therefore included much detail on the first few steps but rather referred to existing documentation elsewhere (e.g. Arduino & youtube). Most detail is provided in steps 4 to 8 at this stage.

The chapters of the full manual may be referred to where additional detail is sought. The 12 steps are:

1. Check youtube video then acquire ESP32-CAM and MB/FTDI
2. install Arduino IDE with the ESP32 libraries (includes a WiFi CAM example)
3. Load the CAM with the WiFi example and test.
4. Install the sensorCAM.ino software and configure.
5. Test the basic sensorCAM functions to confirm functional install
6. Load Processing 4 app. and sensorCAM.pde code
7. Use the Processing 4 app to replace the Arduino Monitor. Further familiarise and test.
8. With a fixed camera, create test sensors and test detection with moving targets.
9. Setup the CAM viewing the model railroad and test a virtual sensor with moving rolling stock.
10. Optimise parameters for best performance.
11. Connect CAM to an i2c interface (e.g. PCA9515A or better)
12. Depending on system, integrate sensorCAM into Command Station using appropriate code.

Step 1. ESP-32 CAM

To understand the animal, watch the video at [ESP32 CAM - 10 Dollar Camera for IoT Projects - YouTube](#)

Be aware that you need a USB adapter and the ESP32-CAM-MB is preferred as it avoids hazards associated with a “wired” FTDI power where errors can easily result in CAM destruction. Programming is also easier. Acquire a CAM from your favourite source. Also be prepared for defective product so a spare CAM may be worthwhile. I have had 2 faulty ov2640 modules.

Step 2. Install the Arduino IDE

If you are not already familiar with this IDE (Integrated Development Environment), rather than go into details that are already covered in great detail on the Arduino web page, just follow the instructions in the following link and then return here.

[Arduino IDE Guide](#)

Step 2A. Install the IDE ESP32 libraries (including for ESP32-CAM).

If you are new to ESP32, the board manager for ESP32 must be loaded. This is explained in the video at the 10minute mark.

[Introduction to ESP32 - Getting Started - YouTube](#)

To get an introduction to the ESP32-CAM review this

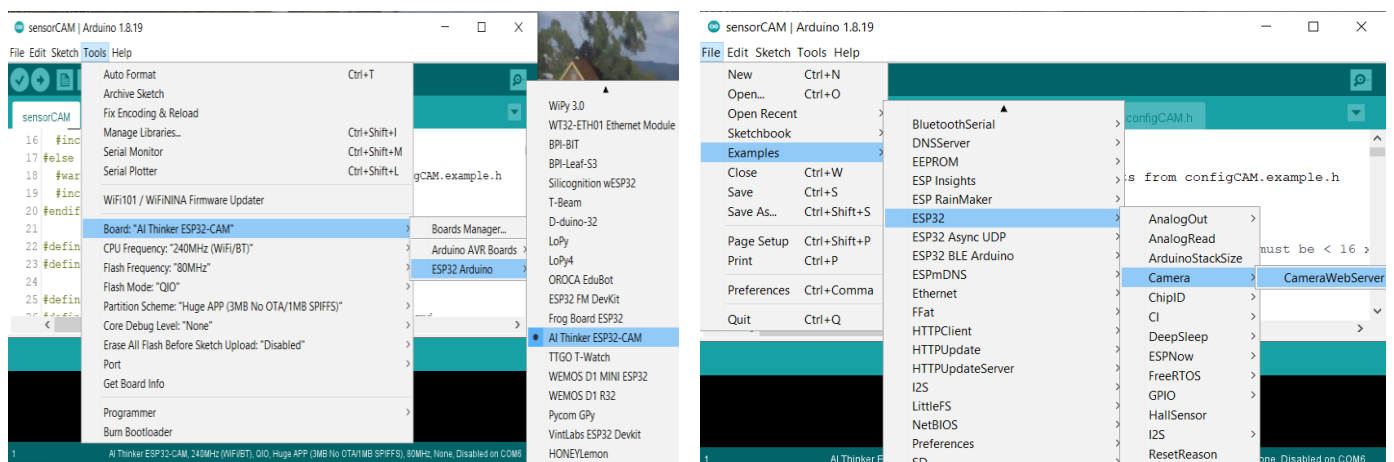
[ESP32 CAM - 10 Dollar Camera for IoT Projects - YouTube](#)

Step 3. Load and test the ESP32-CAM example

Select the tools - board manager and the AI thinker ESP32 CAM . Then run the example as per youtube at 9:30 minutes in. Run the ESP32 - camera - webserver example

[ESP32 CAM - 10 Dollar Camera for IoT Projects - YouTube](#)

Note: With the MB board there is a push button that replaces the FTDI programming link. Hold the button in when powering up the CAM to initiate programming mode.

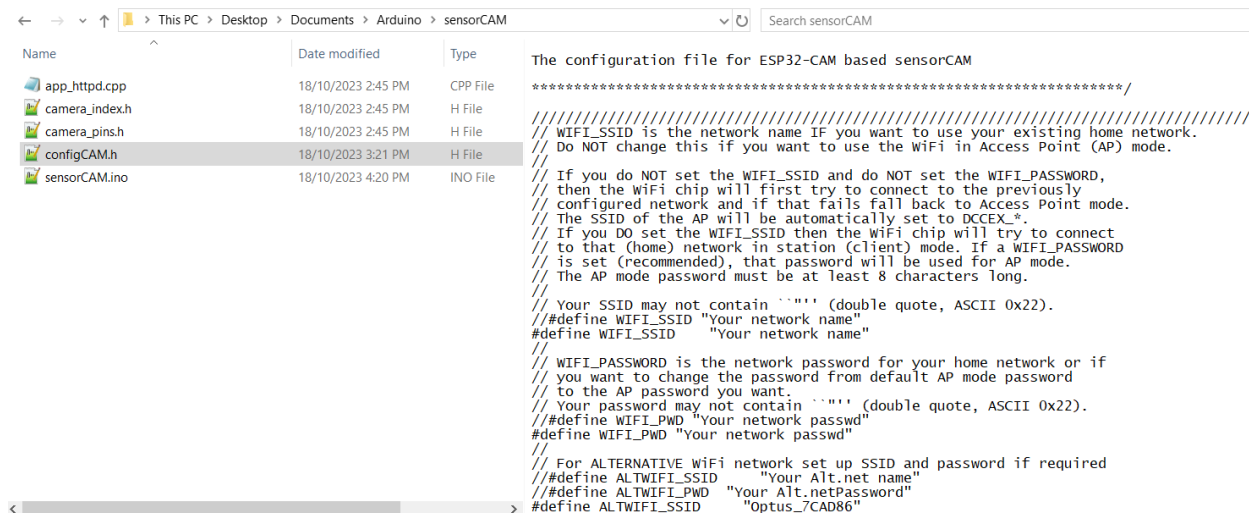


Step4. Install the sensor CAM

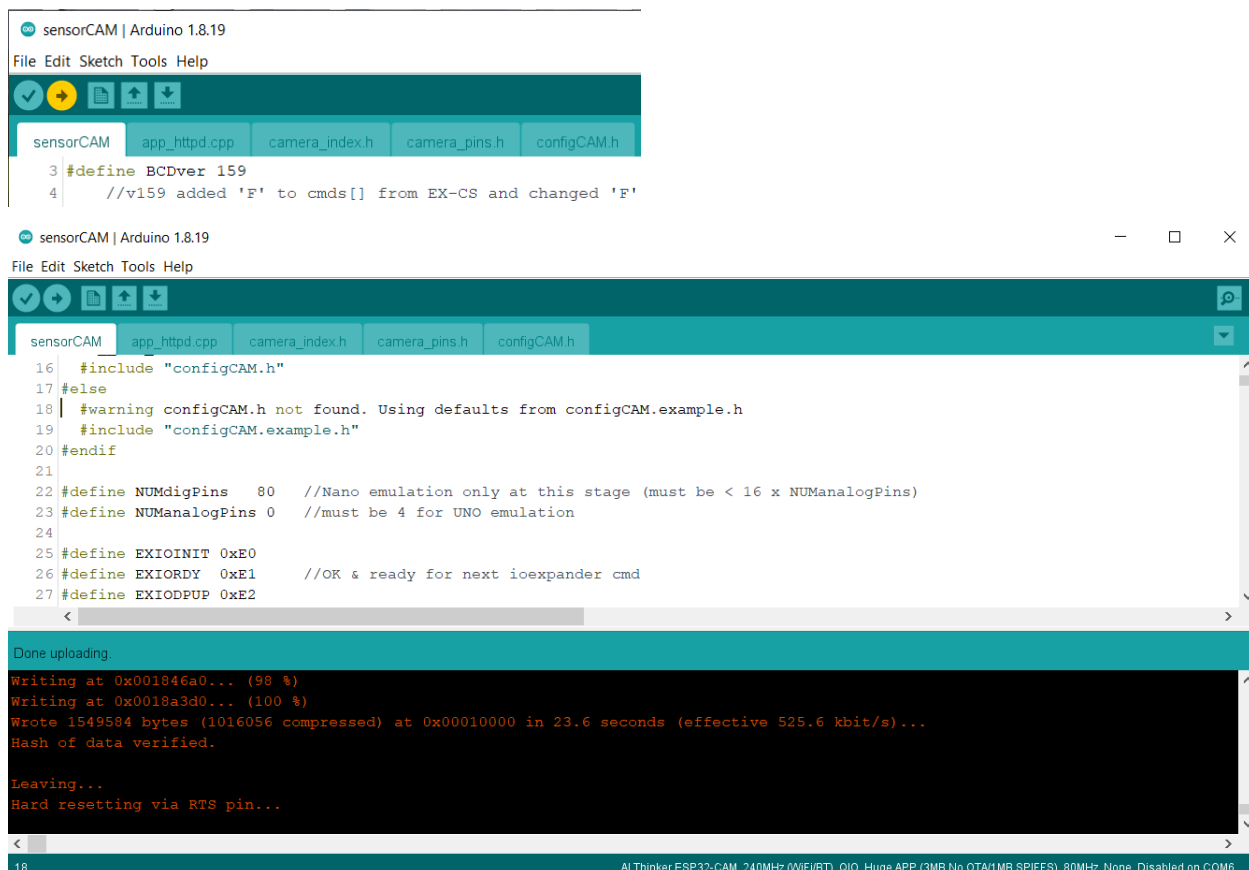
Copy (or Clone) the Github software into your sketch directory Arduino/sensorCAM

<https://github.com/DCC-EX/EX-SensorCAM>

The essential files for now are shown below. Other files may be used in later install steps.

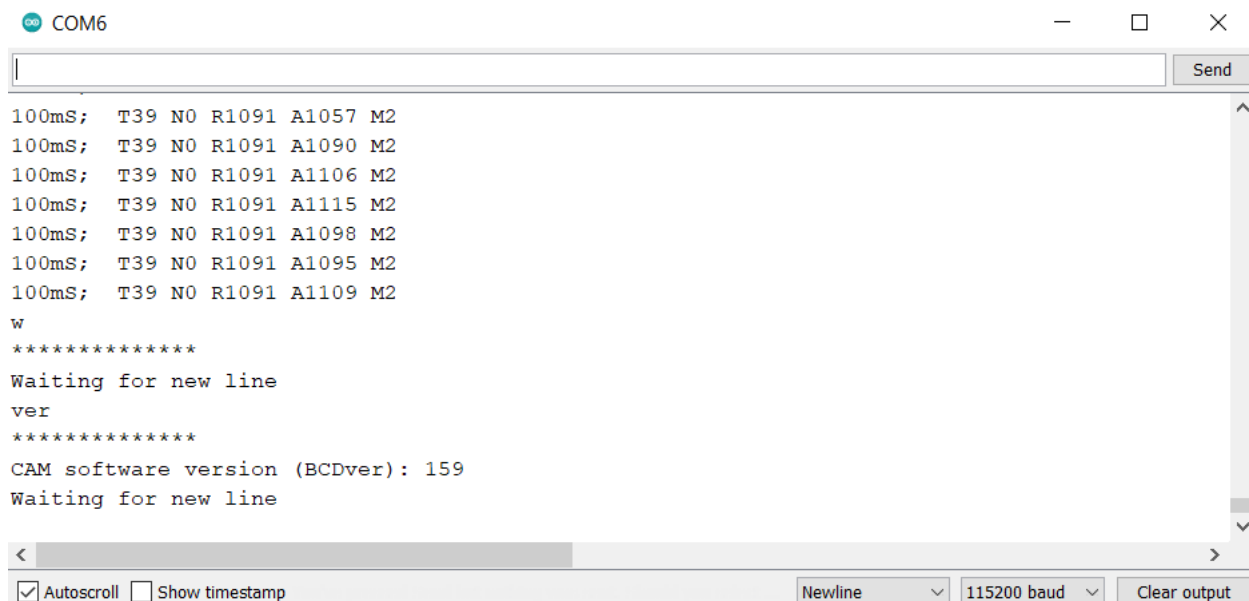


Using the configCAM.example.h as a guide, create and edit a configCAM.h to reflect your WiFi network name and password. Then with the correct com port and board selected, compile the sensorCAM.ino sketch. If all is well, load it into the CAM (replacing the ESP32 WiFi example)



Step 5. Test the basic sensorCAM functions

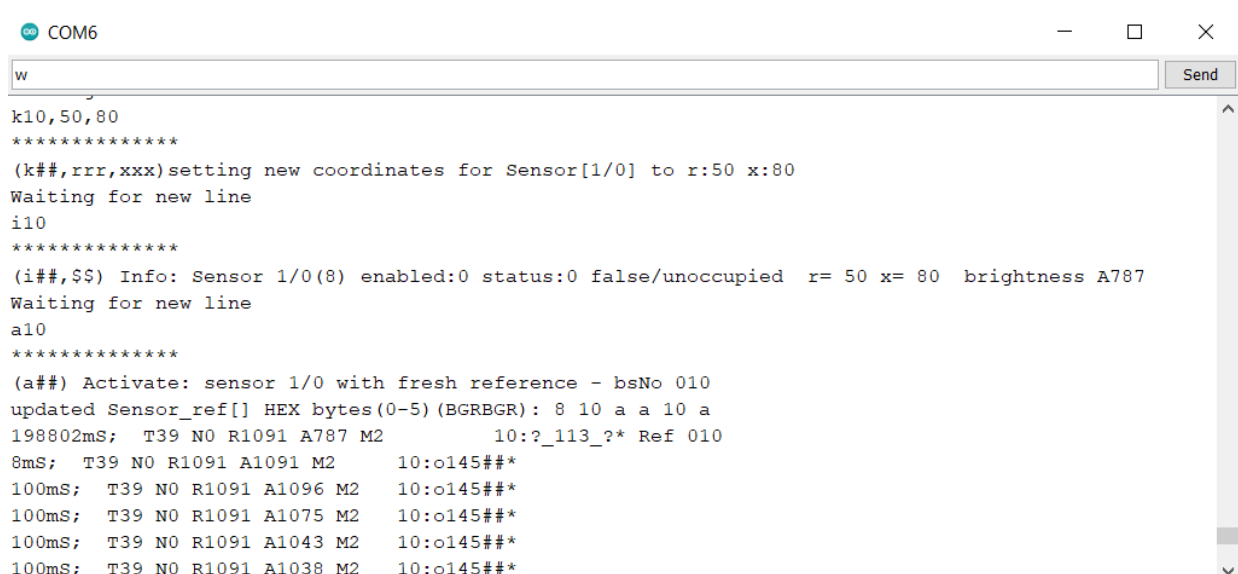
The sensorCAM has a suite of command codes with which you will need familiarity. Refer to the manual summary Appendix A or [Chapter 5](#) (Configuration) for more detailed description. For now, open the Arduino monitor and the initialization procedure should scroll out. After about 15 seconds you can enter the '**w**' (wait) command into the monitor and the scrolling should pause. Another command such as '**ver**' will give relevant command response, or **Enter** alone will resume scrolling tabular output. The sensors still need configuring before they can work.



```
COM6
100mS; T39 N0 R1091 A1057 M2
100mS; T39 N0 R1091 A1090 M2
100mS; T39 N0 R1091 A1106 M2
100mS; T39 N0 R1091 A1115 M2
100mS; T39 N0 R1091 A1098 M2
100mS; T39 N0 R1091 A1095 M2
100mS; T39 N0 R1091 A1109 M2
w
*****
Waiting for new line
ver
*****
CAM software version (BCDver): 159
Waiting for new line
```

Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

At this time a NEW CAM will have NO sensors set and is a clean slate needing meaningful configuration data. If all is well, this would be a good time to familiarize oneself with some commands starting with **k10,50,80** to DEFINE your first sensor, followed by **i10** to read back the new sensor S10 coordinates (50,80). Try **a10** to enable sensor 10, quickly followed by **w** to stop scrolling of new sensor values.



```
COM6
w
k10,50,80
*****
(k##,rrr,xxx)setting new coordinates for Sensor[1/0] to r:50 x:80
Waiting for new line
i10
*****
(i##,$$) Info: Sensor 1/0(8) enabled:0 status:0 false/unoccupied r= 50 x= 80 brightness A787
Waiting for new line
a10
*****
(a##) Activate: sensor 1/0 with fresh reference - bsNo 010
updated Sensor_ref[] HEX bytes(0-5) (BGRBGR): 8 10 a a 10 a
198802mS; T39 N0 R1091 A787 M2 10:?_113_?* Ref 010
8mS; T39 N0 R1091 A1091 M2 10:0145##*
100mS; T39 N0 R1091 A1096 M2 10:0145##*
100mS; T39 N0 R1091 A1075 M2 10:0145##*
100mS; T39 N0 R1091 A1043 M2 10:0145##*
100mS; T39 N0 R1091 A1038 M2 10:0145##*
```

```
all,60,90
*****
(a##,rrr,xxx)setting new coordinates for Sensor[1/1] to r:60 x:90
Waiting for new line
(a##) Activate: sensor 1/1 with fresh reference - bsNo 011
updated Sensor_ref[] HEX bytes(0-5) (BGRBGR): e e e e e e
p1
*****
(p##) Position Pointers: TL corners for DEFINED Sensors to block 1
Block 0;
Block 1; s[0]: r= 50 x= 80 s[1]: r= 60 x= 90
Waiting for new line
```

```

w
r00
*****
(r##) refresh Reference for sensor[##]. (default r00 for all) (MUST BE UNOCCUPIED!)
No action as Sensor(bsNo) undefined
476723mS; T39 N0 R1091 A873 M2 10:0145### 11:0065### Ref 011
7mS; T39 N0 R1091 A1022 M2 10:0145### 11:0119###
100mS; T39 N0 R1091 A1020 M2 10:0145### 11:0119###
(r##) refresh Reference for sensor[##]. (default r00 for all) (MUST BE UNOCCUPIED!)
References: enable new Sensor_ref[1/1]; HEX bytes[0-6]: 3E 3F 3E 3E 3F 3E
full new ref[bsNo] from current frame only - average ref still to be calculated
114mS; SUS T39 N0 R1091 A2992 M2 10:0145### 11:?_32### Ref 011
76mS; T39 N0 R1091 A1047 M2 10:0145### 11:?_32###
100mS; T39 N0 R1091 A1044 M2 10:0145### 11:--32--*
100mS; T39 N0 R1091 A1032 M2 10:0145### 11:--32--*
100mS; T39 N0 R1091 A1039 M2 10:0145### 11:--32--*
w
*****
Waiting for new line

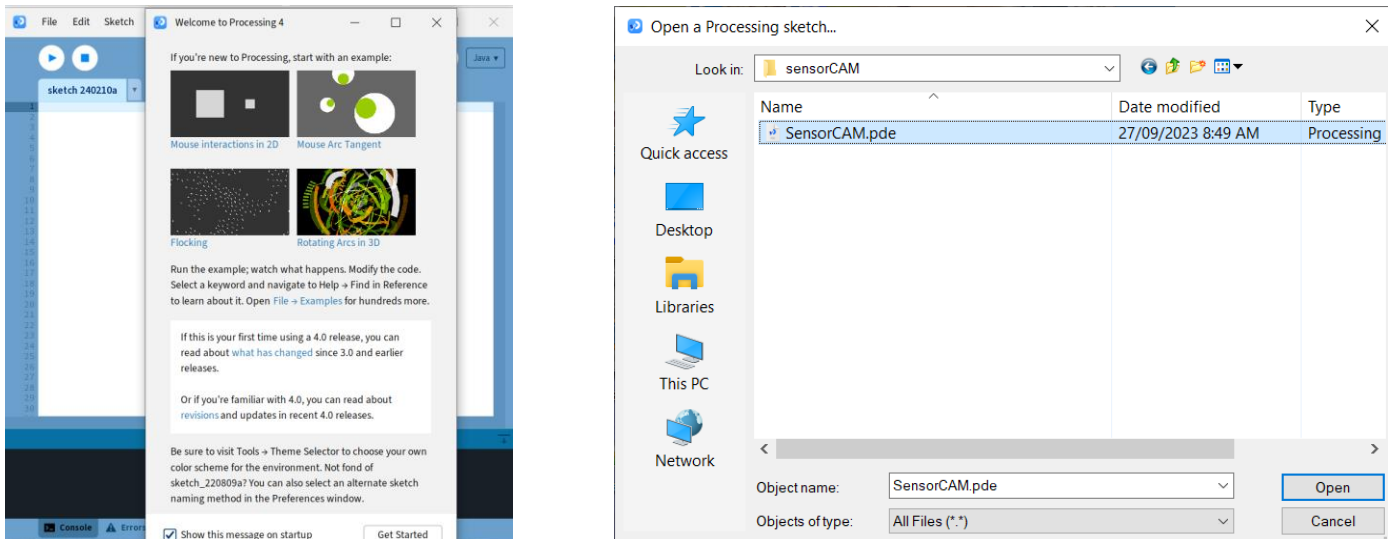
```

Note: There are other (easier) ways to position new sensors. The coordinate method is best for “tweaking” positions by small amounts. Step 6 below leads to the preferable visual setting method.

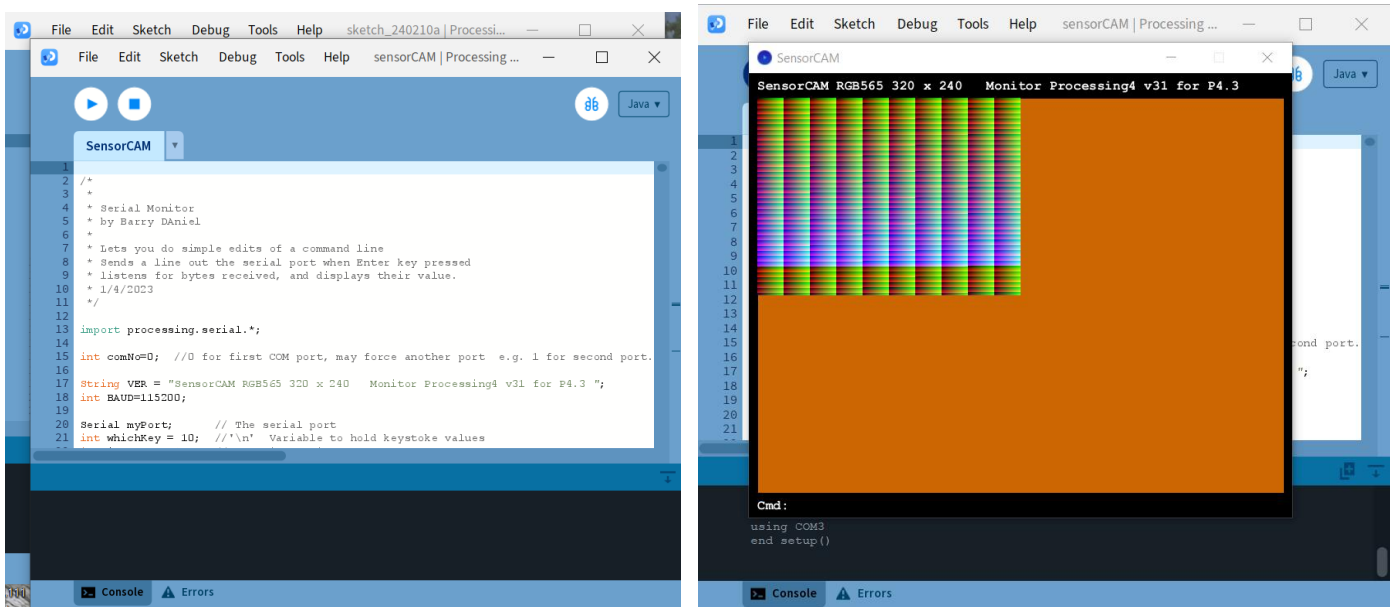
The Arduino monitor is not “visual”. The Processing 4 software enables one to see what the CAM sees and permits one to place sensors visually. Close down the Arduino IDE to free up the sesorCAM USB com port.

Click the GetStarted box on the Welcome window

Click file-open, select sensorCAM.pde and open.



Click the (left) circular run button to produce the test pattern shown below



Reposition and resize the Console window and test pattern to look like that below, wide enough to avoid line wrap-around. The Cmd: line space will be the text entry line to be used for the CAM commands previously used with Arduino monitor. The broad black Console space replaces the sensorCAM monitor display and the test pattern window is for image display and sensor positioning.

Note the first lines of monitor output. Choosing the first [0] COM port is the default. Should you have two (or more) COM ports listed, you may have to edit the **int comNo=0;** line to reflect the port the sensorCAM is attached to in the list (e.g. [1] as in image below). (this needs to be automated in a future revision)

If the sensorCAM reboots and runs, enter cmd: **w Enter** or **ver Enter** which will suspend any scrolling and print the sensorCAM version. Use the scroll bar to view the top/bottom of the monitor window.

Note the dark blue round icon on the taskbar will bring the image to the front should it vanish behind the Console window. The white round button to the right of "Run" will "Stop" the **sensorCAM.pde** program.

Step 8. Create test sensors and test detection with moving targets

Create some test sensors using Processing 4 by typing Cmd: **a31** (no Enter!) and following with a click on the image previously obtained as above. The command line will be completed with the cursor coordinates. Follow up with an **Enter** to define a new sensor S31. Verify the new sensor with a '**p3**' command and SEE the new sensor with a '**Y**' command.

The sensor squares on the image are colour coded with the b/s number using the standard resistor colour codes (refer manual Appendix E).

Place a coloured object at the sensor position and observe the change in the scrolling tabulation for the sensor. Without the obstruction, after a reference command ('**r00**'), the difference score should be below 40 and with the obstruction the diff score should rise substantially. If the threshold is set ('**t45**' say) the sensor will "trip" and indicate occupied confirming successful installation. A moving hand test is an easy quick test to do.

It is advisable to define a "reference" sensor S00 that will NOT be obstructed. Any trips of this sensor will indicate an unwanted change to the environment (e.g. lighting). To define such a sensor use **a00** and a Processing 4 image "click" on a quiet location away from tracks but with "good" mid-range illumination (see Manual section 8.4). S00 is reserved and displayed separately at the left of the scrolling status table.

Step 9. Setup the CAM viewing a railroad and test a virtual sensor with moving rolling stock.

The CAM must be rigidly mounted, in a "convenient" location for testing at this stage. It may be limited by your cabling reach with USB control. Later, with buffered I2C and power the CAMERA may be able to be located more optimally.

The manual Chapter 5 covers many points of relevance to getting satisfactory detection. Review this chapter and test topics for clarification. Good familiarity leads to success. Initial tests should be with good contrast between track and rolling stock. Refine parameters later to handle more difficult targets.

10. Optimise parameters for best performance.

Initially by trial & error you will learn the significance of parameters. This is an Alpha release and consequently the default settings may not be best. Refer manual Appendix B.

11. Connect CAM to an i2c interface (e.g. PCA9515A or better)

The quickest and simplest method is to fit a PCA9515A to the ESP32-CAM-MB. Refer to the manual Chapter 3, the pictures in the manual (Figure 7 and Appendix F). Level shifting (3.3V to 5V) is the primary function of the PCA9515A. If distance becomes an issue, as the PCA9515 is limited to about 3metres, a buffered i2c solution will be needed. The manual Chapter 7 describes the prototype solution used. Other methods can be devised.

12. Depending on system, integrate sensorCAM into Command Station using appropriate code.

The sensorCAM can be connected to an EX-Command Station and interrogated with EX-Rail commands. Refer to the DCC-EX website for details. The CAM can also be connected to other “Control Stations” via i2c using appropriate host code (typically C++).

The sensorCAM comes with a driver for a Command Station, but the driver can be adapted to different systems. The driver is described in the manual Appendix G & H with a EX-Command Station flavor. For other systems, the interfacing skills of an “Engineer” may be needed at this Alpha stage . It has been successfully interfaced to another test platform (Arduino Mega).