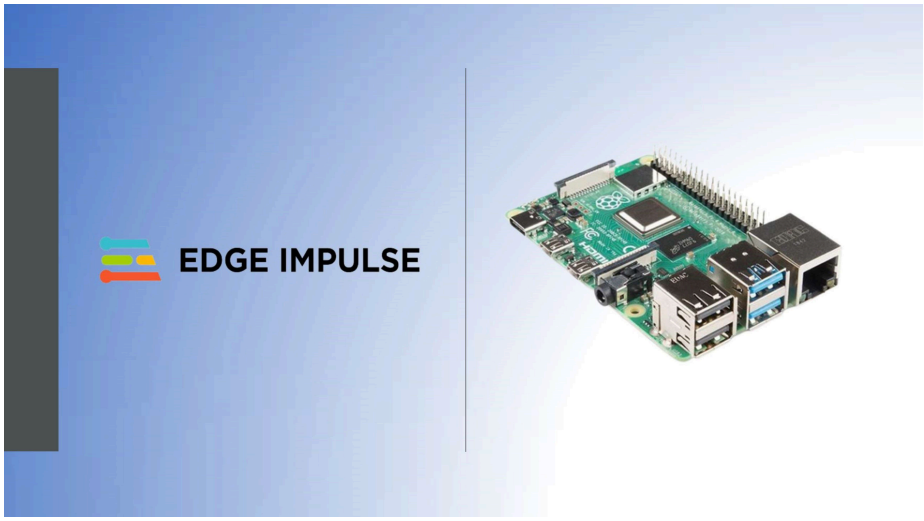


Tags

Edgeimpulse

Machine learning

Raspberry Pi

Camera

Object classification

Raspberry Pi

Object Classification with Edge Impulse Using Raspberry Pi 4 and Camera Module

Khor Jia Yong 02 Jan 2024 7

Project Intermediate 1889

Introduction

The primary emphasis of this project lies in object classification or recognition. This involves identifying various objects during the capturing process. To construct this, Edge Impulse functions as a machine learning platform, training Raspberry Pi 4 to recognise different object types when connected to a camera.

Hardware Components

- Raspberry Pi 4 Model B

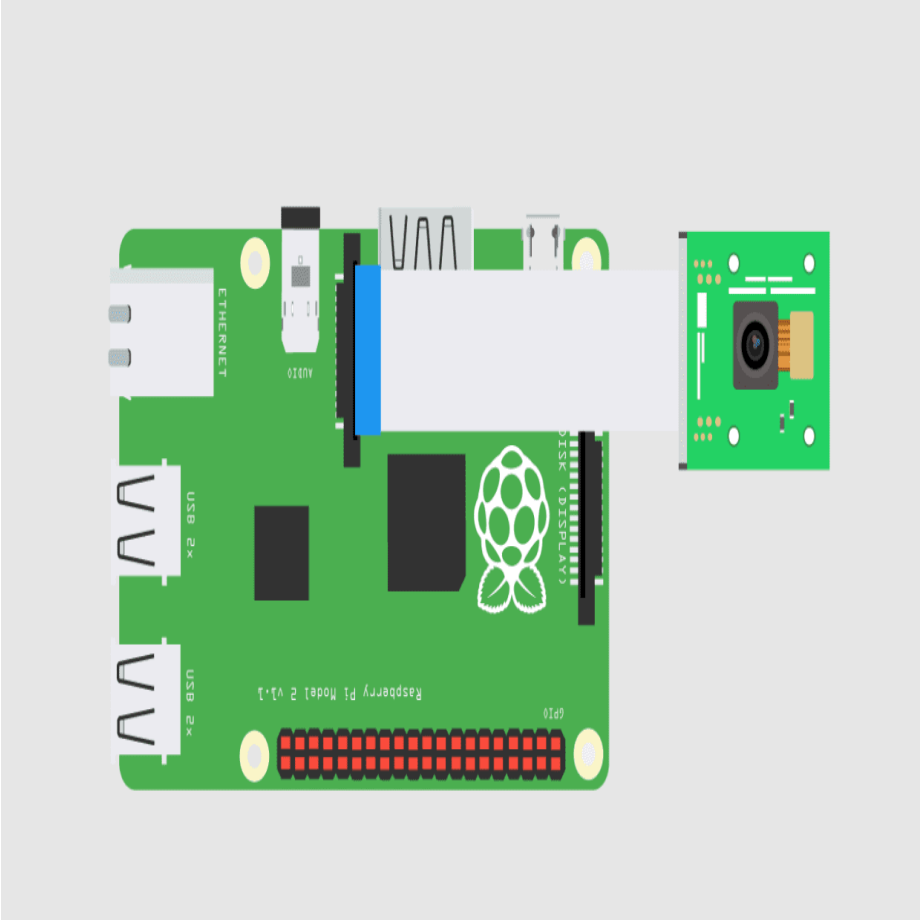
Software Requirement

- Raspberry Pi Imager

Project Development

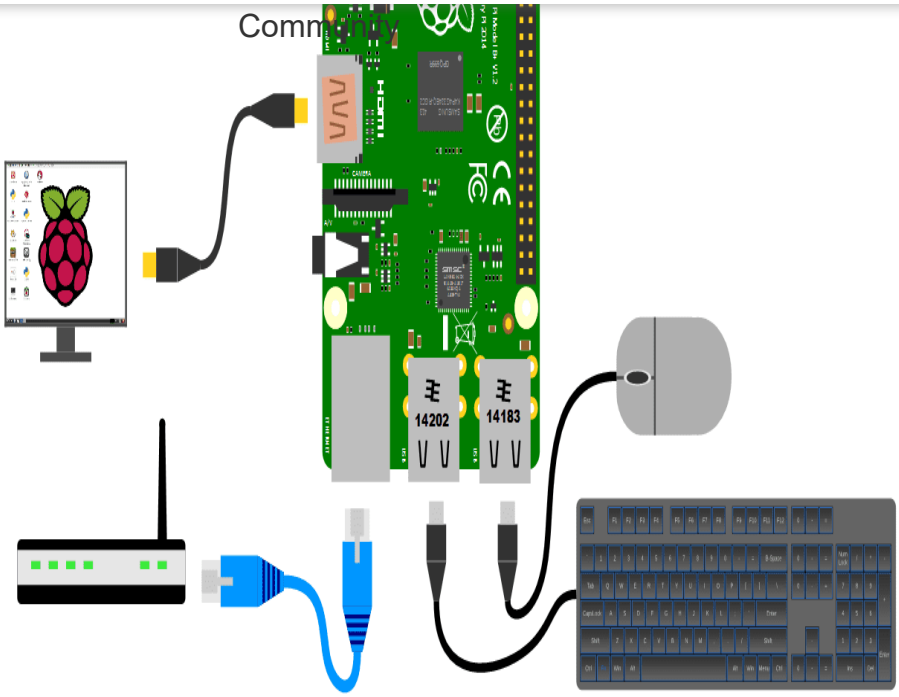
Hardware Part

i. Connect the Raspberry Pi camera module to the camera port available on the Raspberry Pi 4 with a ribbon cable.



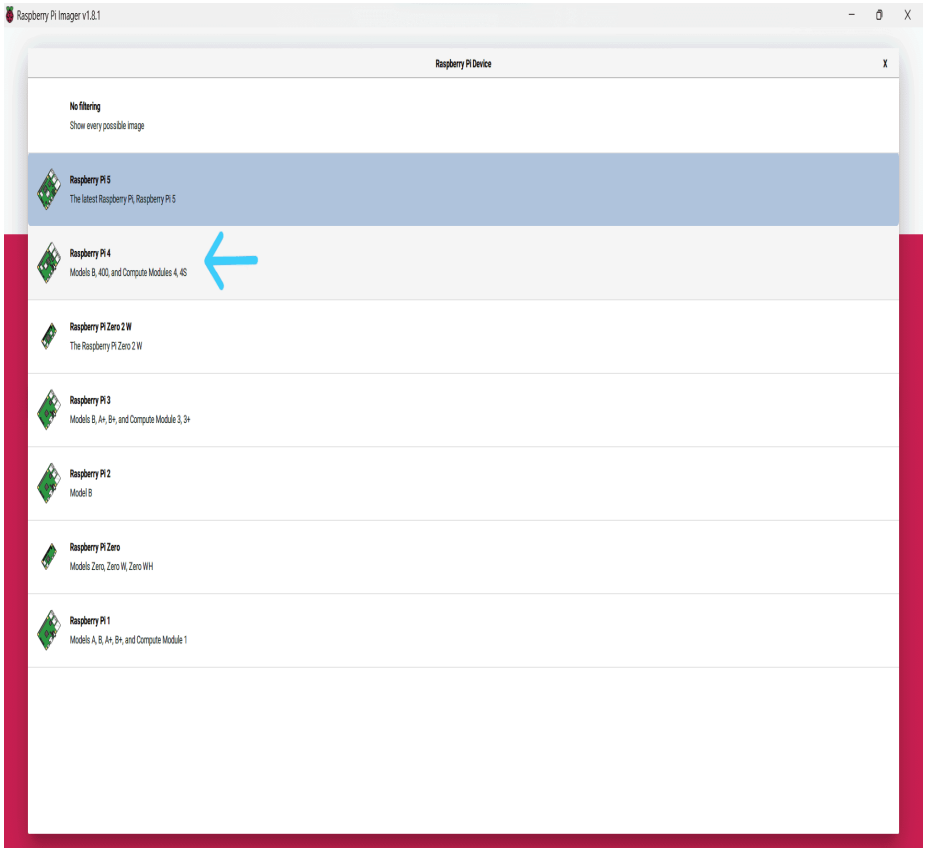
ii. For additional information regarding the connection, refer to this documentation.

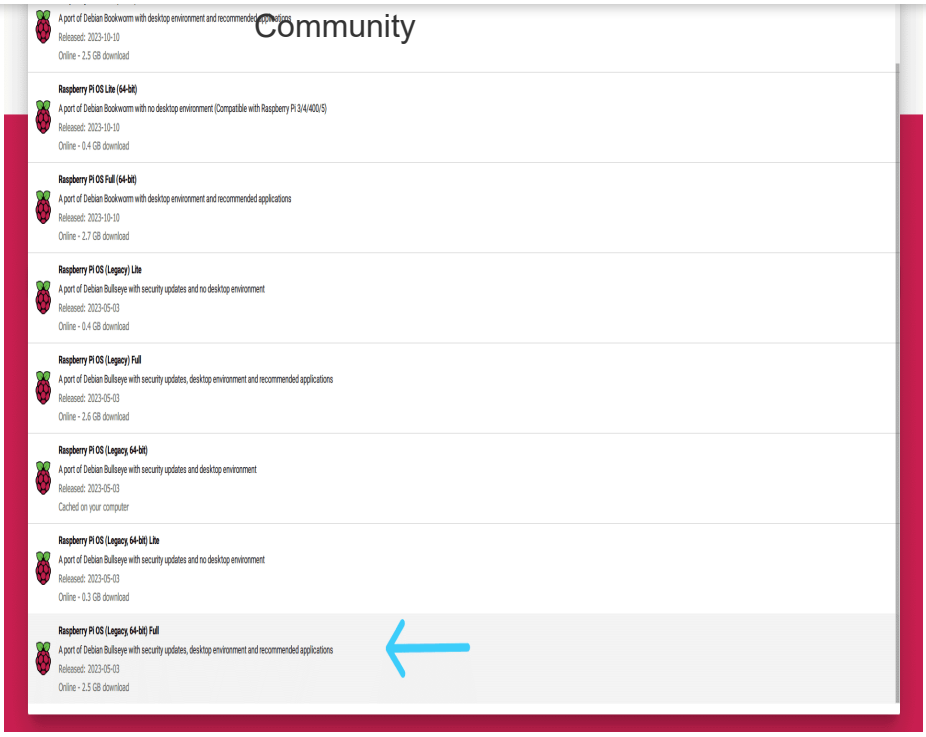
iii. Set up your Raspberry Pi 4 device by connecting the mouse, keyboard as well as monitor to the Raspberry Pi 4.



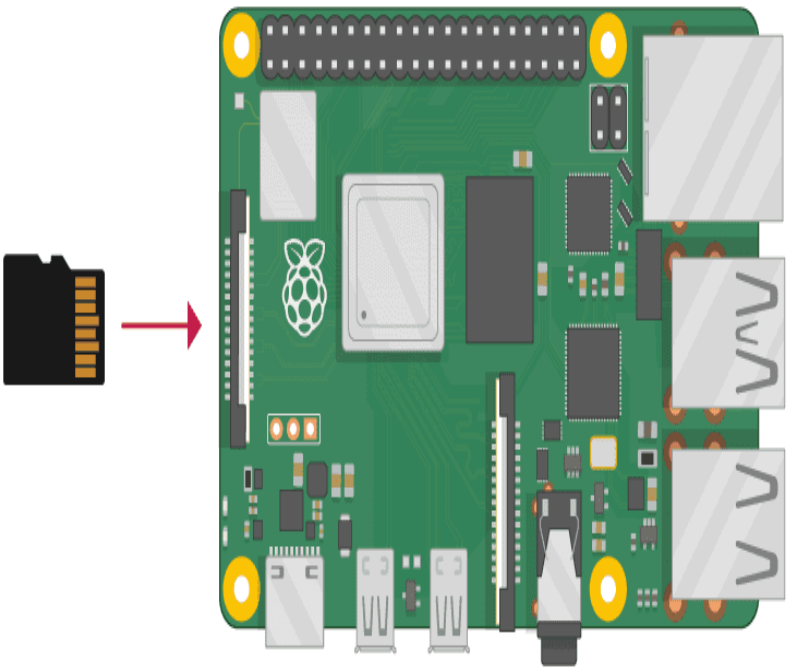
Software Part

i. Flash the Raspberry Pi OS into the microSD card by choosing the Raspberry Pi 4 device and Raspberry Pi OS with Full Legacy 64-bits.





ii. After successfully flashing the Raspberry Pi OS into the microSD card, insert the SD card into the Raspberry Pi 4.



iii. Initialise your new Raspberry Pi OS by filling in several details on the setup page.

iv. If you haven't linked the Raspberry Pi 4 using a LAN cable, connect it to your WiFi network and click the

the sequence provided in the table below.

No.	Command
1	sudo apt update
2	curl -sL https://deb.nodesource.com/setup_12.x | sudo bash -
3	sudo apt install -y gcc g++ make build-essential nodejs sox gstreamer1.0-tools gstreamer1.0-plugins-good gstreamer1.0-plugins-base gstreamer1.0-plugins-base-apps
4	npm config set user root && sudo npm install edge-impulse-linux -g --unsafe-perm

vi. Refer to the datasheet of the camera module and determine the model sensor type of the camera module you are using in the project.

Net price	$25	$25	$25	$35	$50
Size	Around 25 x 24 x 9 mm	Around 25 x 24 x 9 mm	Around 25 x 24 x 11.5 mm	Around 25 x 24 x 12.4 mm	38 x 38 x 18.4mm (excluding lens)
Weight	3g	3g	4g	4g	
Still resolution	5 Megapixels	8 Megapixels	11.9 Megapixels	11.9 Megapixels	12.3 Megapixels
Video modes	1080p30, 720p60 and 640 x 480p60/90	1080p47, 1640 x 1232p41 and 640 x 480p206	1080p50 / 720p100 / 640 x 480p120	1080p50 / 720p100 / 640 x 480p120	2028 x 1080p50, 2028 x 1520p40 and 1332 x 990p120
Sensor	OmniVision OV5647	Sony IMX219	Sony IMX708	Sony IMX708	Sony IMX477]
Sensor resolution	2592 x 1944 pixels	3280 x 2464 pixels	4608 x 2592 pixels	4608 x 2592 pixels	4056 x 3040 pixels
Sensor image area	3.76 x 2.74 mm	3.68 x 2.76 mm (4.6 mm diagonal)	6.45 x 3.63mm (7.4mm diagonal)	6.45 x 3.63mm (7.4mm diagonal)	6.287mm x 4.712 mm (7.9mm diagonal)
Pixel size	1.4 µm x 1.4 µm	1.12 µm x 1.12 µm	1.4 µm x 1.4 µm	1.4 µm x 1.4 µm	1.55 µm x 1.55 µm
Optical size	1/4"	1/4"	1/2.43"	1/2.43"	1/2.3"
Focus	Fixed	Adjustable	Motorized	Motorized	Adjustable
Depth of field	Approx 1 m to ∞	Approx 10 cm to ∞	Approx 10 cm to ∞	Approx 5 cm to ∞	N/A
Focal length	3.60 mm +/- 0.01	3.04 mm	4.74 mm	2.75 mmm	Depends on lens
Horizontal Field of View (FoV)	53.50 +/- 0.13 degrees	62.2 degrees	66 degrees	102 degrees	Depends on lens
Vertical Field of View (FoV)	41.41 +/- 0.11 degrees	48.8 degrees	41 degrees	67 degrees	Depends on lens
Focal ratio (F-Stop)	F2.9	F2.0	F1.8	F2.2	Depends on lens
Maximum exposure times (seconds)	6	11.76	112	112	670.74
Lens Mount	N/A	N/A	N/A	N/A	CS- or M12-mount

vii. To interface your camera module into the Raspberry Pi, command this in the terminal:

sudo nano /boot/config.txt

viii. Add the command to the configuration text file depending on your model sensor type.

dtoverlay=imx708

File Edit Tabs Help

GNU nano 5.4

```
# no display
#config_hdmi_boost=4

# uncomment for composite PAL
#sdtv_mode=2

#uncomment to overclock the arm. 700 MHz is the default.
#arm_freq=800

# Uncomment some or all of these to enable the optional hardware interfaces
#dtparam=i2c_arm=on
#dtparam=i2s=on
#dtparam=spi=on

# Uncomment this to enable infrared communication.
#dtoverlay=gpio-ir,gpio_pin=17
#dtoverlay=gpio-ir-tx,gpio_pin=18

# Additional overlays and parameters are documented /boot/overlays/README

# Enable audio (loads snd_bcm2835)
dtparam=audio=on

# Automatically load overlays for detected cameras
start_x=1

# Automatically load overlays for detected DSI displays
display_auto_detect=1

# Enable DRM VC4 V3D driver
#dtoverlay=vc4-kms-v3d
max_framebuffers=2

# Run in 64-bit mode
arm_64bit=1

# Disable compensation for displays with overscan
disable_overscan=1

[cm4]
# Enable host mode on the 2711 built-in XHCI USB controller.
# This line should be removed if the legacy DWC2 controller is required
# (e.g. for USB device mode) or if USB support is not required.
otg_mode=1

[all]
```

Tutorials

(Because the sensor type is the Raspberry Pi camera module 3, specifically imx708, it is designated to the variable "dtoverlay.")

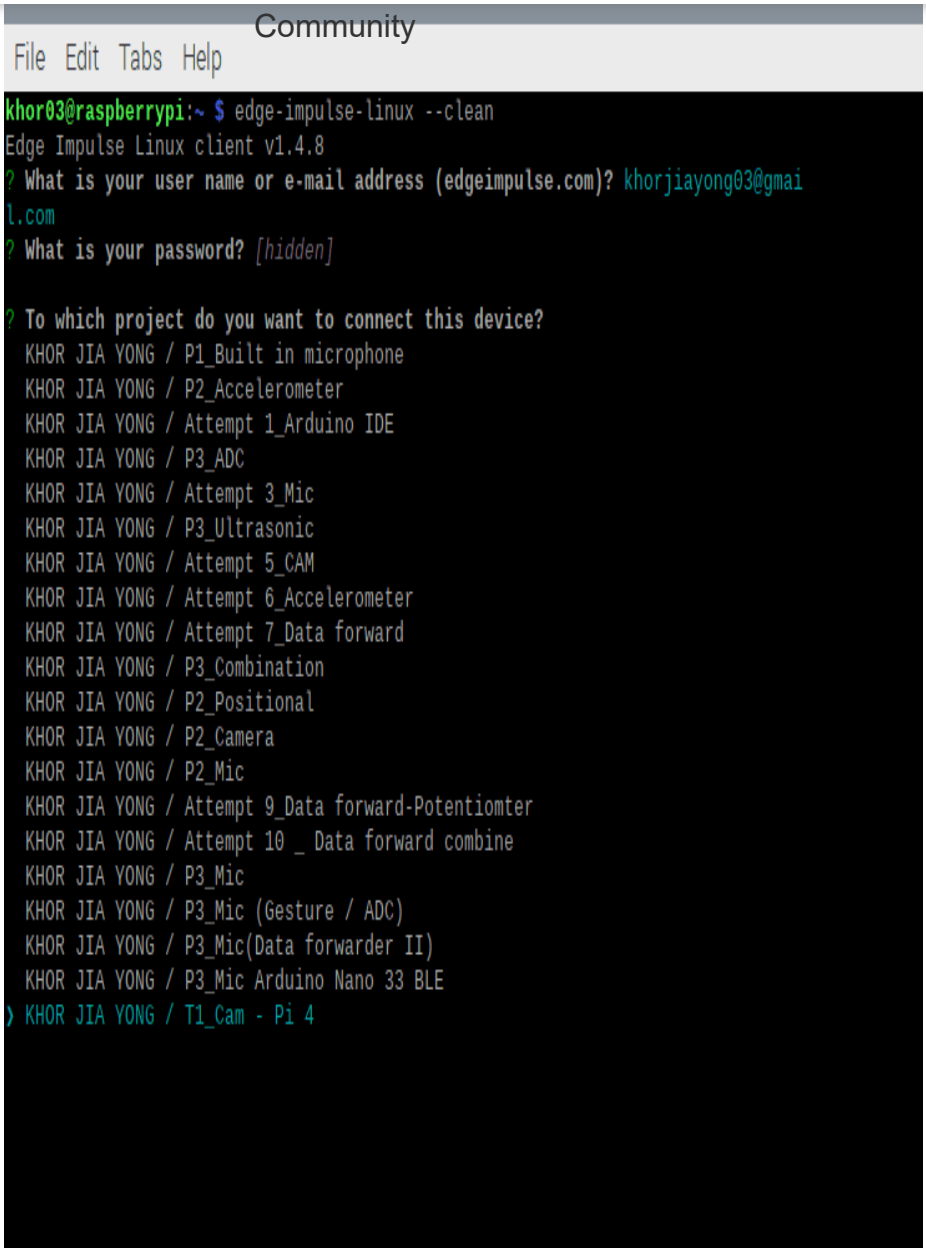
ix. Press “Ctrl + X” -> “Ctrl + Y” -> “ ENTER” to save the edit.
x. Reboot your Raspberry Pi device.

Edge Impulse Part

i. Create a new project on your Edge Impulse.
ii. Open the terminal and enter the command below to enable the connection between Edge Impulse and Raspberry Pi.

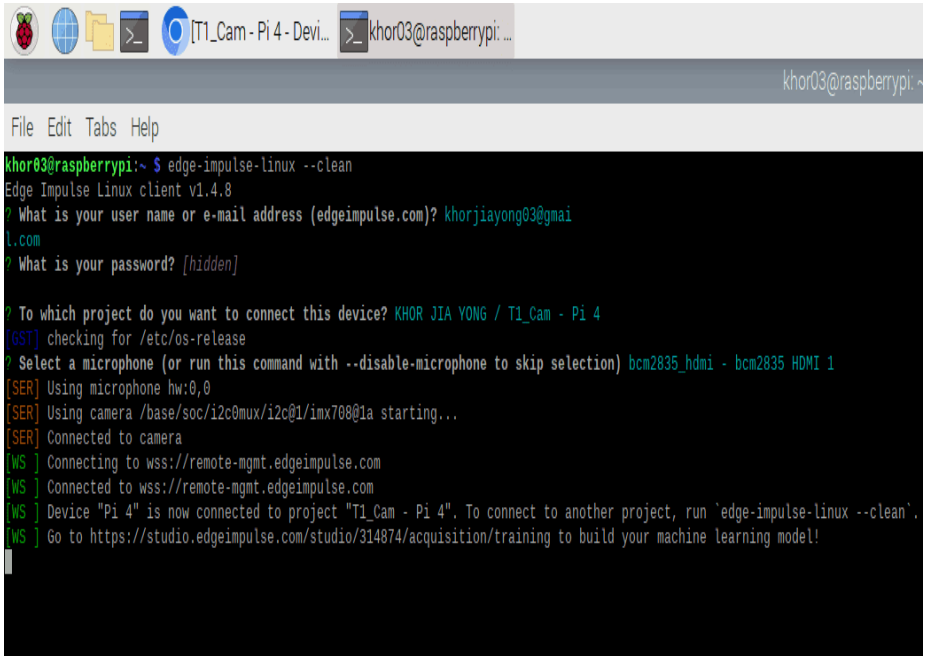
edge-impulse-linux --clean

iii. Fill in the details and select the project you created on the Edge Impulse.



iv. Select your sensor type where the HDMI type is chosen.

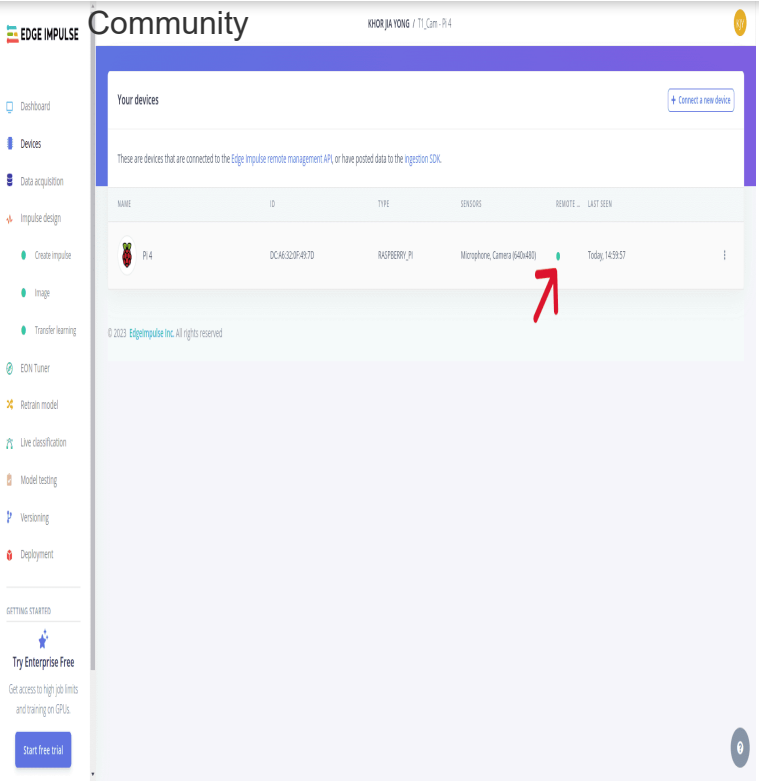
v. The figure below shows the successful connection between the Raspberry Pi and Edge Impulse.



vi. Within Edge Impulse, there are five stages to be taken into account:

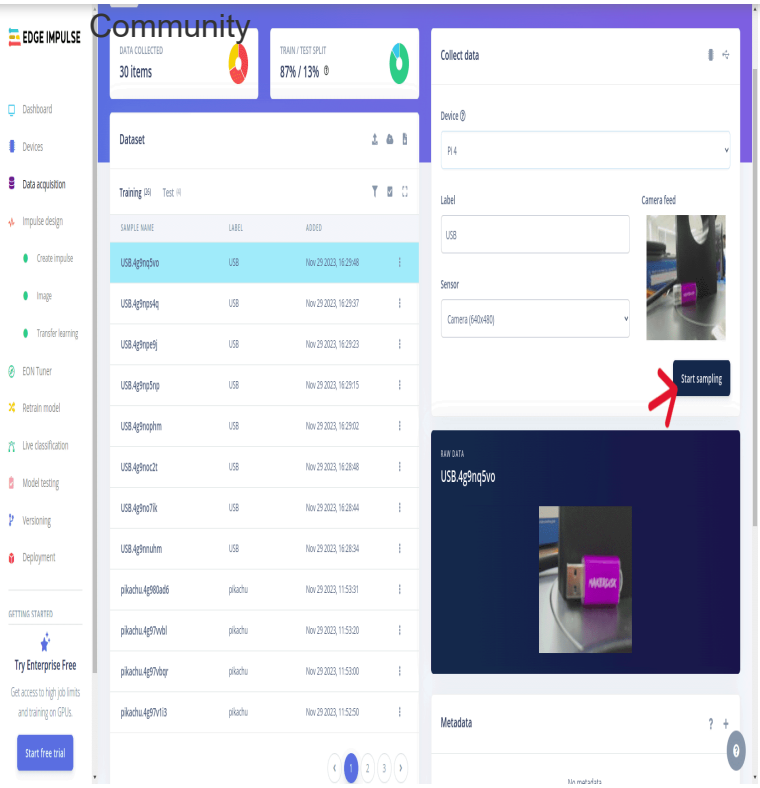
a. Device

- When the icon of Raspberry Pi turns from red colour to green colour, this indicates that the Raspberry Pi 4 device is successfully linked to the Edge Impulse.



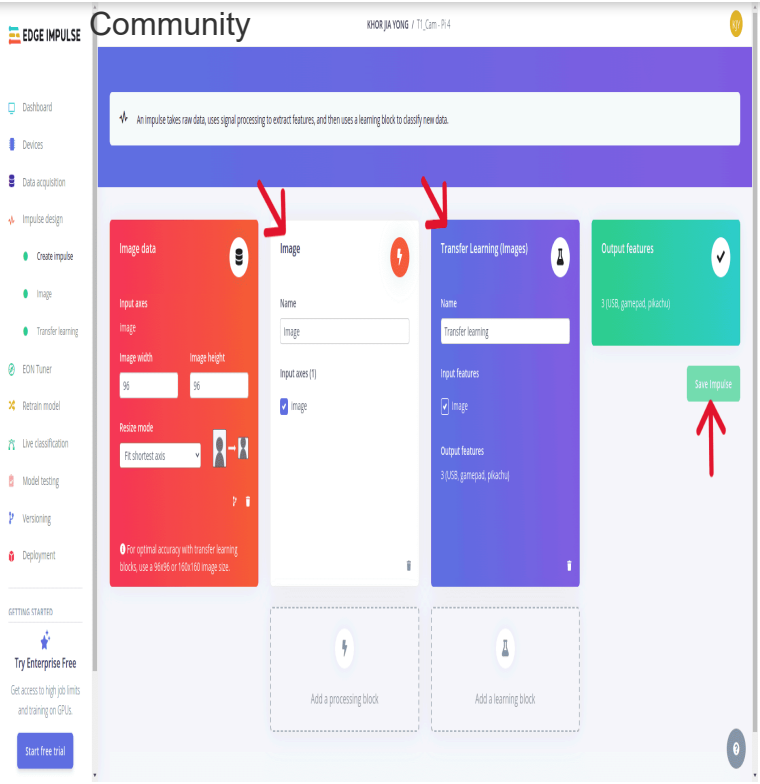
b. Data Acquisition

- The sensor type of camera is chosen from the list and the sample length can be adjusted on the same page.
- When the “Start sampling” is clicked, the data for capturing objects from the camera module is recorded. For example, the data collection included “pikachu”, “USB” and “gamepad” in this case.
- By changing the "label" of the data, the data type can be modified.
- Then, the data collected is uploaded and saved to the same data acquisition page.

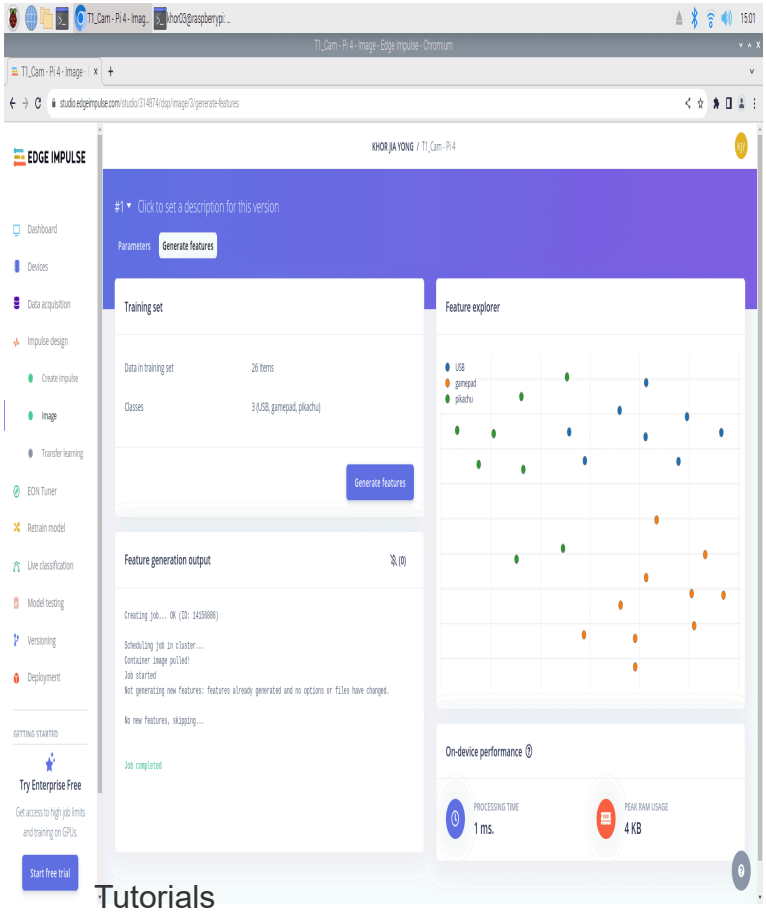


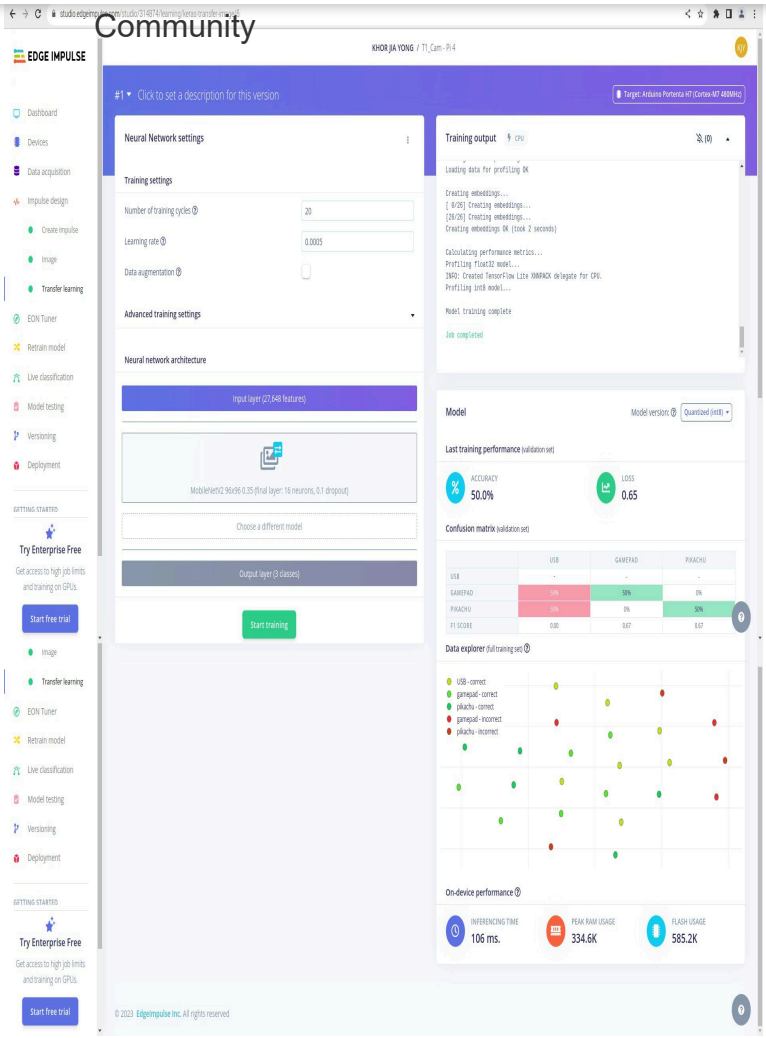
c. Impulse Design

- Graphical representation, be it in a chart or table, requires setting up the impulse or feature first by selecting from the recommended list. For instance, create two block models: a processing block and a learning block, with one block allowed for each category. Remember to save the created impulse.



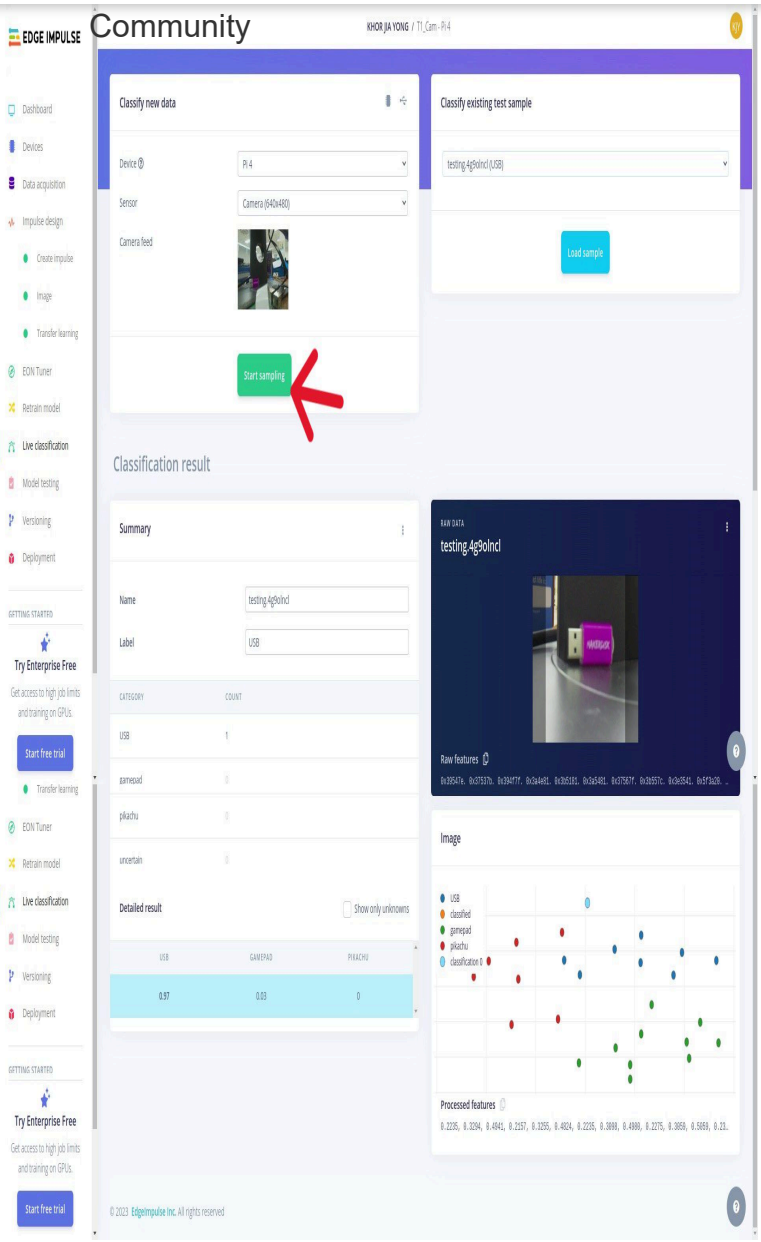
- Each created impulse must be accessed and trained independently.





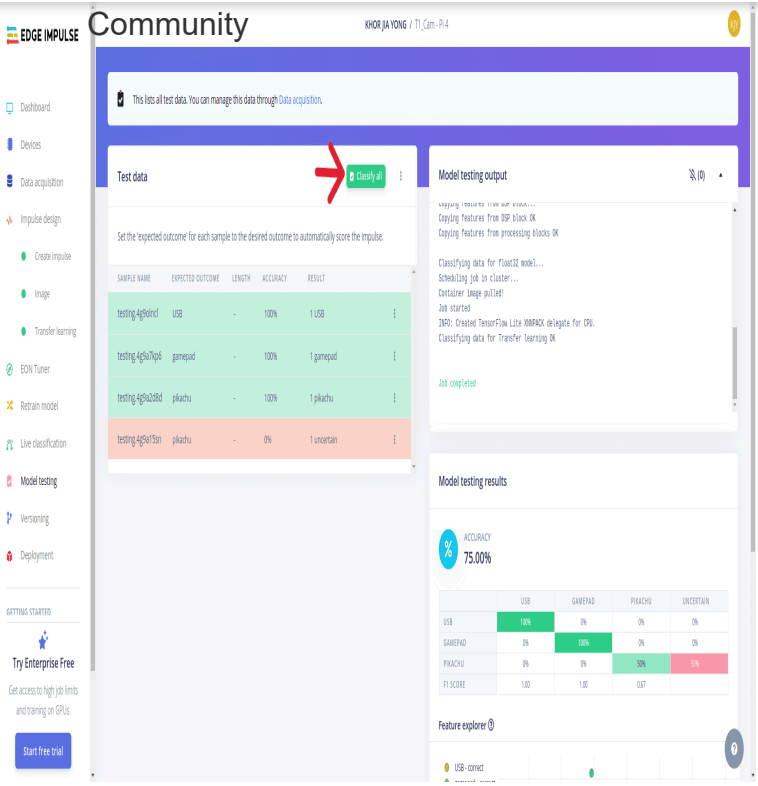
d. Live Classification

- In the live classification category, users can verify data collected using the camera module to gather and classify test data by clicking "Start sampling". Be sure to label each test data with its expected outcome.



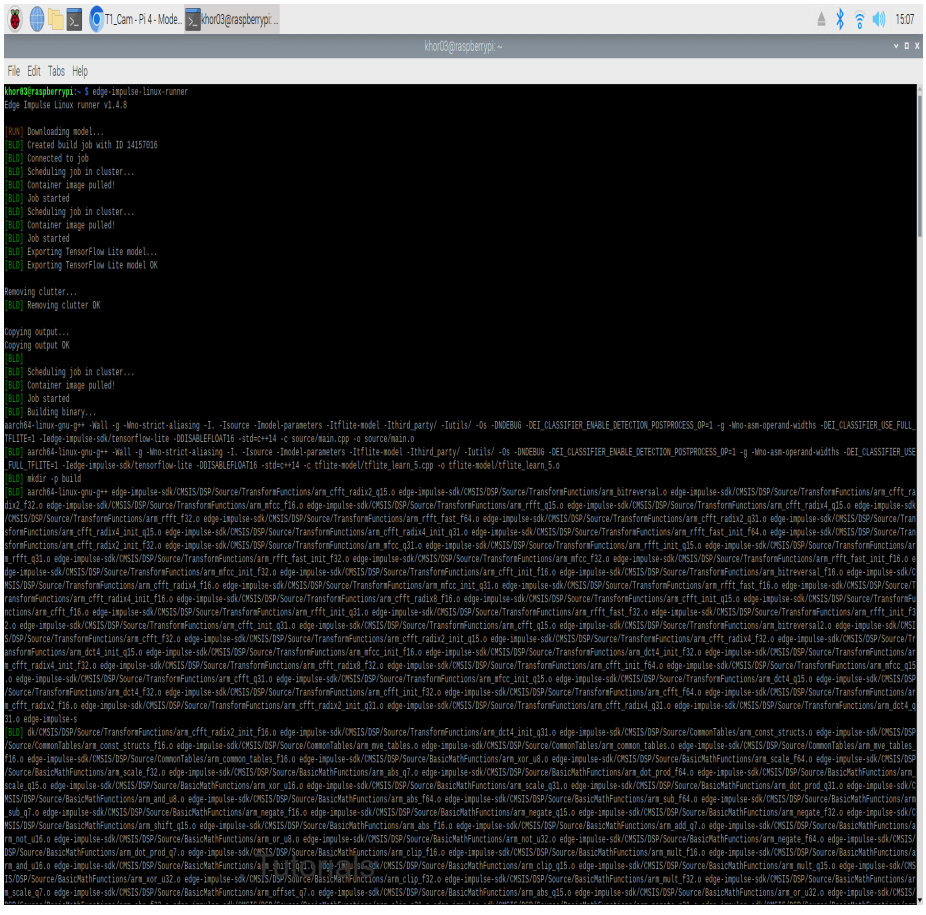
e. Model Testing

- By clicking "Classify all", model testing characterises test data using graphical charts. After testing, observe the output through the provided chart.

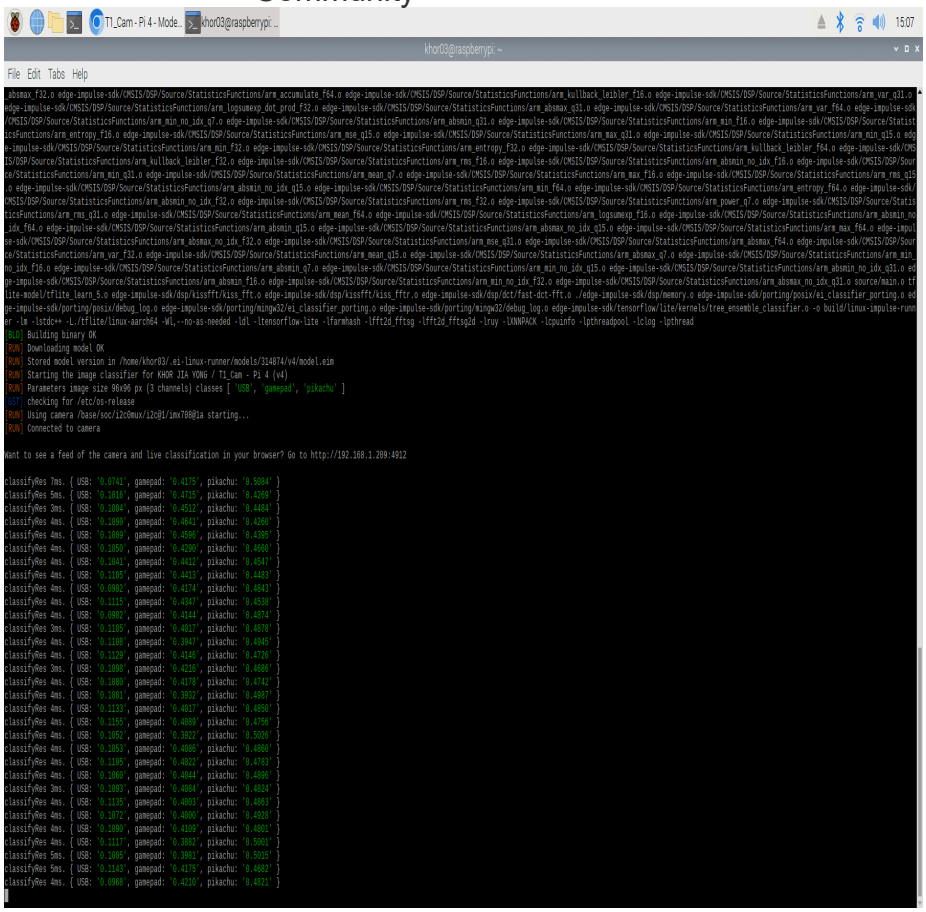


vii. To run the building machine model locally, consider the command below.

edge-impulse-linux-runner

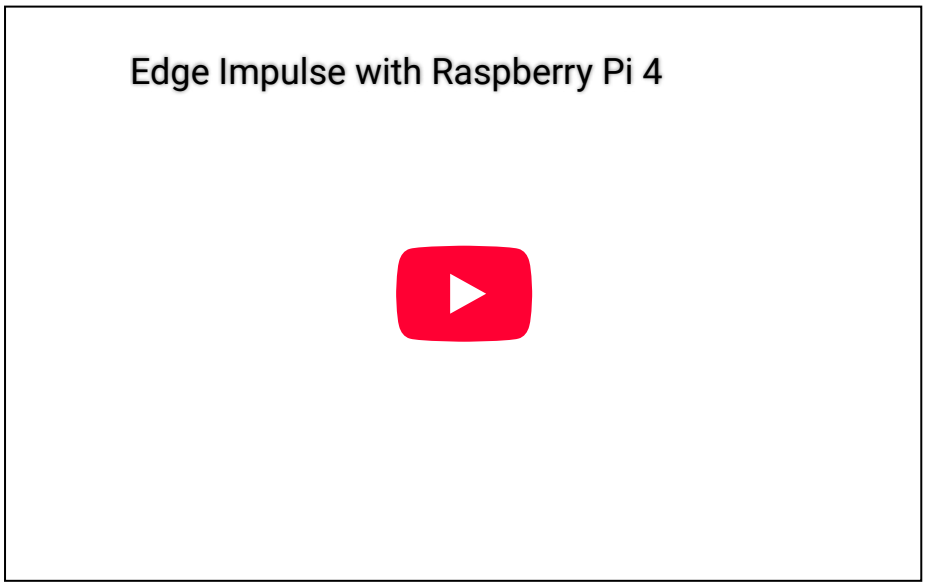


entering the command mentioned above.



Tutorial Video

This tutorial video provides a clear illustration of the entire project development, showcasing an object recognition project that identifies various objects and delivers results in terms of the accuracy of object capturing.



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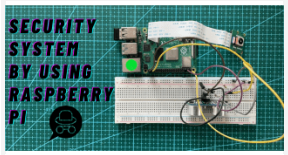

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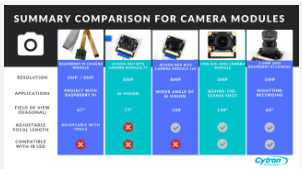

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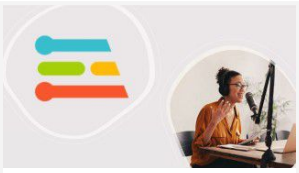

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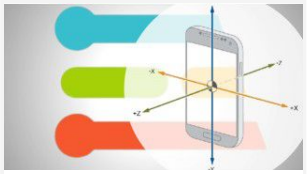

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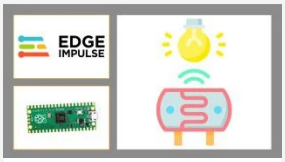

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