

Research Internship

IOT based with Arduino | Portenta | Nicla boards

Under Prof Rohin Daruwala Sir

From 6th June 2023 - 28th July 2023

ESP8266 CONNECT TO THINK SPEAK SERVER

ESP8266 Wireless Module sends data in the form of random value, monitored from anywhere by free IOT service provider -ThingSpeak.

I2C & SPI & UART

Communication between microcontrollers and various integrated circuits on the same PCB

Small Tasks

LED CONTROLLED BY ARDUINO

Led Blink with breadboard & Bluetooth connection , with M4 AND M7 Core

PULSE WIDTH MODULATION

Arduino PWM modulates digital signals, controlling LED brightness or motor speed. Utilizes duty cycles to vary output, offering versatile applications.

ACTUATORS & SENSORS

Servo Motors ,Light sensor,Motion sensor,Vibrationsensor ,Sound sensorPosition sensor

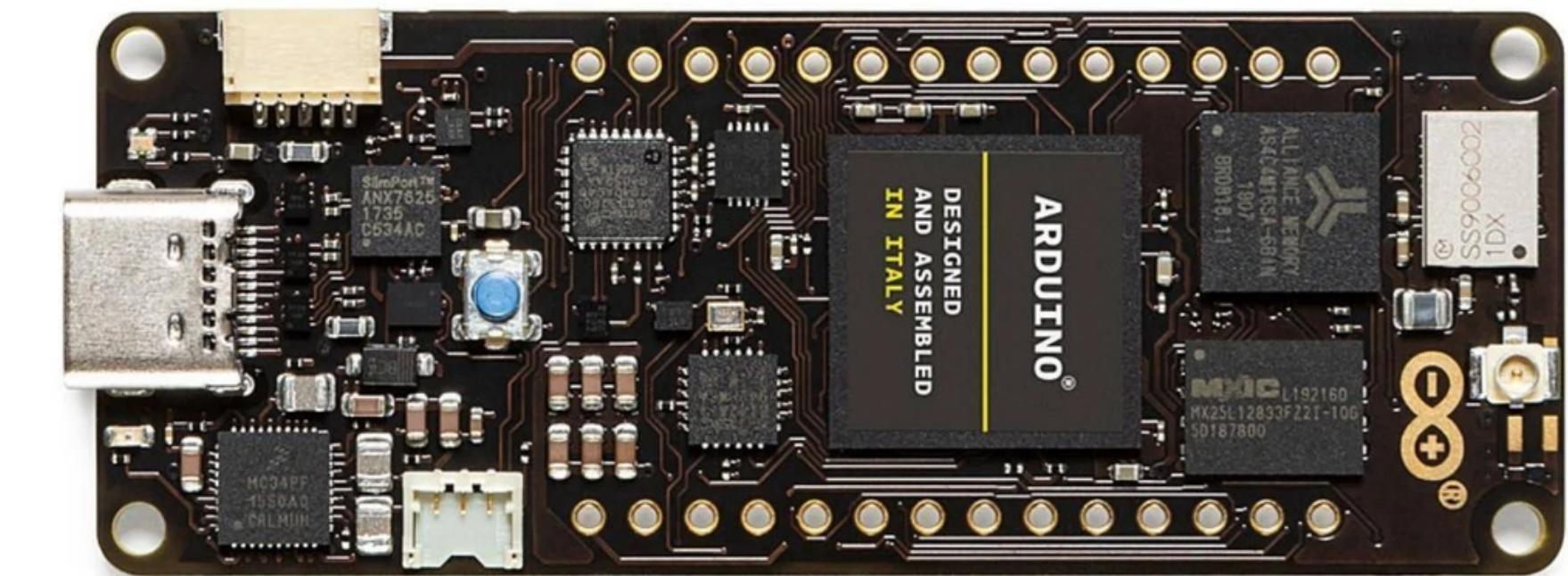
WATCH DOG TIME

Arduino Watchdog Timer:
Monitors program integrity.
If not reset, it triggers system reset, enhancing system reliability in critical applications.

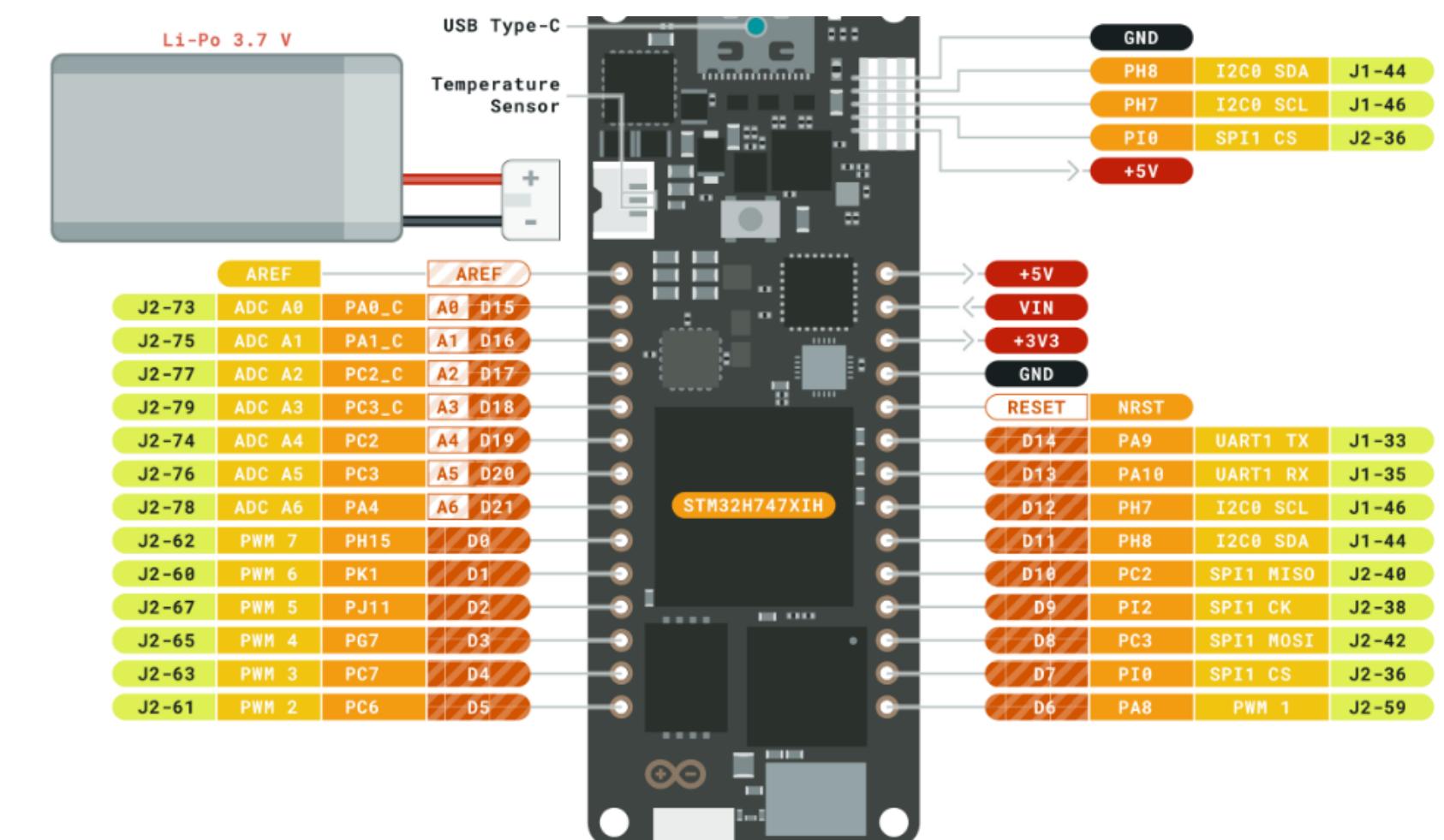
PORTENTA H7

04

- WiFi/BT Module
- External Antenna
- DisplayPort over USB-C
- Arduino IoT Cloud Compatible



- Portenta H7 Features:Dual-core, high-performance MCU
- Onboard connectivity (WiFi, Bluetooth, Ethernet)
- Industrial-grade reliability, rich I/O, and compatibility with Arduino code and peripherals.



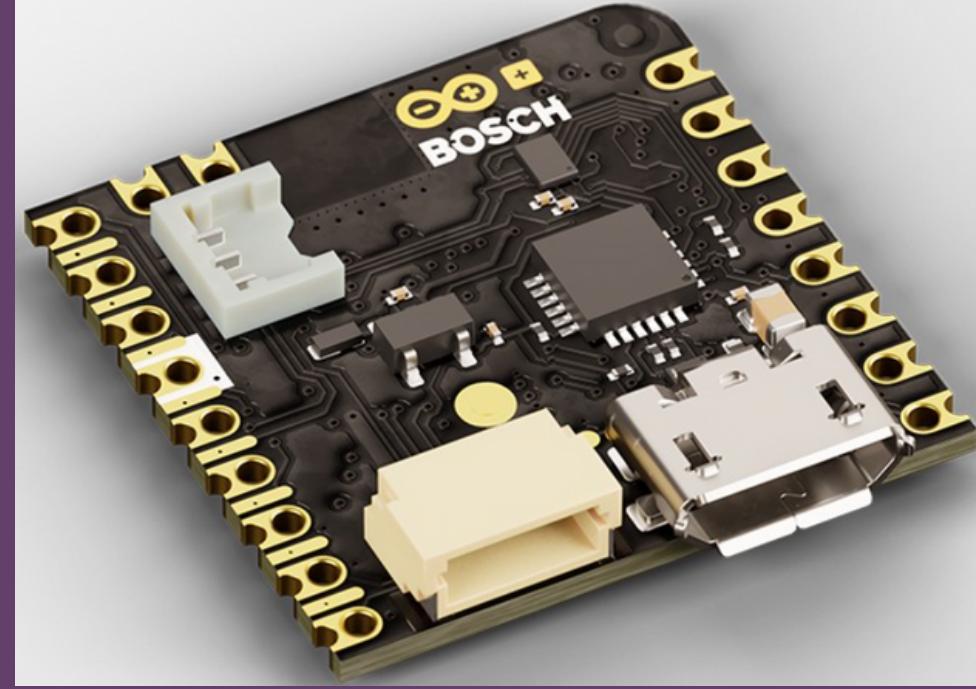
NICLA BOARDS

INTEGRATABLE WITH
EDGE IMPULSE

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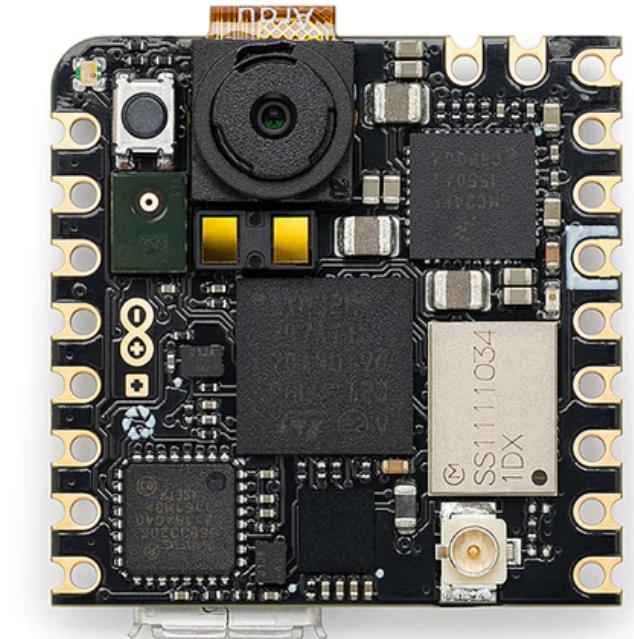
NICLA SENCE ME

- Measures motion and environmental parameters
- Robust hardware including industrial-grade sensors with embedded AI
- BLE connectivity maximizes compatibility



NICLA VISION

- M7/M4 IC processor with a 2MP color camera that supports TinyML,
- a smart 6-axis motion sensor, integrated microphone and distance sensor.



NICLA VOICE

- With its microphone, it features a smart 6-axis motion sensor and a magnetometer
- Making it the ideal solution for predictive maintenance, gesture/voice recognition and contactless applications.





EDGE IMPULSE



Analyse the NICLA board with the pins and micro parts it has



Connect NICLA VISION with the USB cable



Collect the real time data with motion sensor .



Design Impulse with spectral features and classifiers.



EON Tuner finds the most optimal architecture for your embedded ML application



Model Training with Spectral features & Classifiers and model deployment



Live classification of the existing sample with device , sample length , sensor , frequency manipulation



Data testing with model training and model accuracy for each and every type of sample data added .

Dashboard

Devices

Data acquisition

Impulse design

Create impulse

Spectral features

NN Classifier

Anomaly detection

EON Tuner

Retrain model

Live classification

Model testing

Versioning

Deployment

GETTING STARTED

Documentation

Forums

DATA COLLECTED
15m 50sTRAIN / TEST SPLIT
81% / 19%

Dataset

Training (85) Test (23)

SAMPLE NAME LABEL ADDED LENGTH

updown.1.cbor.1q53q102	updown	Dec 23 2020, 19:53:16	5s
idle.1.cbor.1q53ose9	idle	Dec 23 2020, 19:52:39	10s
wave.9.cbor.1q53osc8	wave	Dec 23 2020, 19:52:39	10s
updown.2.cbor.1q53oscv	updown	Dec 23 2020, 19:52:39	5s
snake.16.cbor.1q53oscm	snake	Dec 23 2020, 19:52:39	10s
idle.16.cbor.1q53osba	idle	Dec 23 2020, 19:52:39	10s
wave.31.cbor.1q53oscr	wave	Dec 23 2020, 19:52:39	10s
updown.12.cbor.1q53oscq	updown	Dec 23 2020, 19:52:39	10s
updown.13.cbor.1q53oscn	updown	Dec 23 2020, 19:52:39	10s
wave.14.cbor.1q53osb2	wave	Dec 23 2020, 19:52:39	10s
wave.15.cbor.1q53oscl	wave	Dec 23 2020, 19:52:39	5s
idle.7.cbor.1q53osca	idle	Dec 23 2020, 19:52:39	10s

Collect data

Device ?

phone_l8acjr7r

Label

updown

Sample length (ms.)

10000

Sensor

Accelerometer

Frequency

62.5Hz

Start sampling

RAW DATA
updown.1.cbor.1q53q102

Metadata

- Dashboard
- Devices
- Data acquisition
- Impulse design

- Create impulse
- Spectral features
- Classifier

- EON Tuner
- Retrain model

- Live classification

- Model testing



Try Enterprise Free

Get access to high job limits
and training on GPUs.

Start free trial

<https://studio.edgeimpulse.com>



An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.

Time series data



Input axes (6)

accX, accY, accZ, gyrX, gyrY, gyrZ

Window size

 2,000 ms.

Window increase

 80 ms.

Frequency (Hz)

 100

Zero-pad data

Spectral Analysis



Name

 Spectral features

Input axes (3)

accX

accY

accZ

gyrX

gyrY

gyrZ

Classification



Name

 Classifier

Input features

Spectral features

Output features

5 (grnd circle, idle, snake, updown, wave)

Output features



5 (grnd circle, idle, snake, updown, wave)

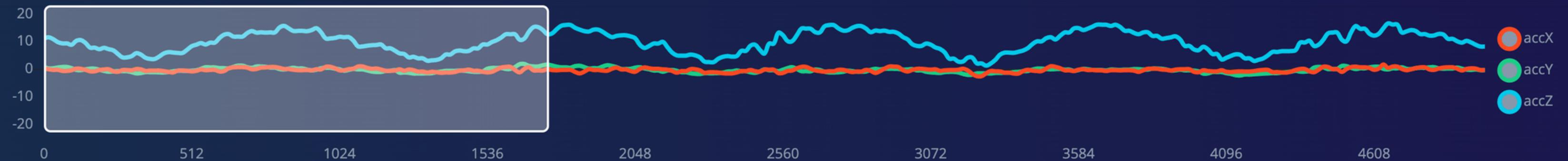
Save Impulse

IMPULSE DESIGN

Raw data

Show: All labels

updown.17.cbor.1q53os92 (updown)



Raw features

0.4300, 0.9400, 11.3200, 0.1300, 0.4300, 11.7400, -0.1200, 0.4700, 11.0600, -0.0900, 0.7600,...

Parameters

Autotune parameters

Filter

Scale axes

0.05005005119675151

Input decimation ratio

3

Type

low

Cut-off frequency

6.103515625

Order

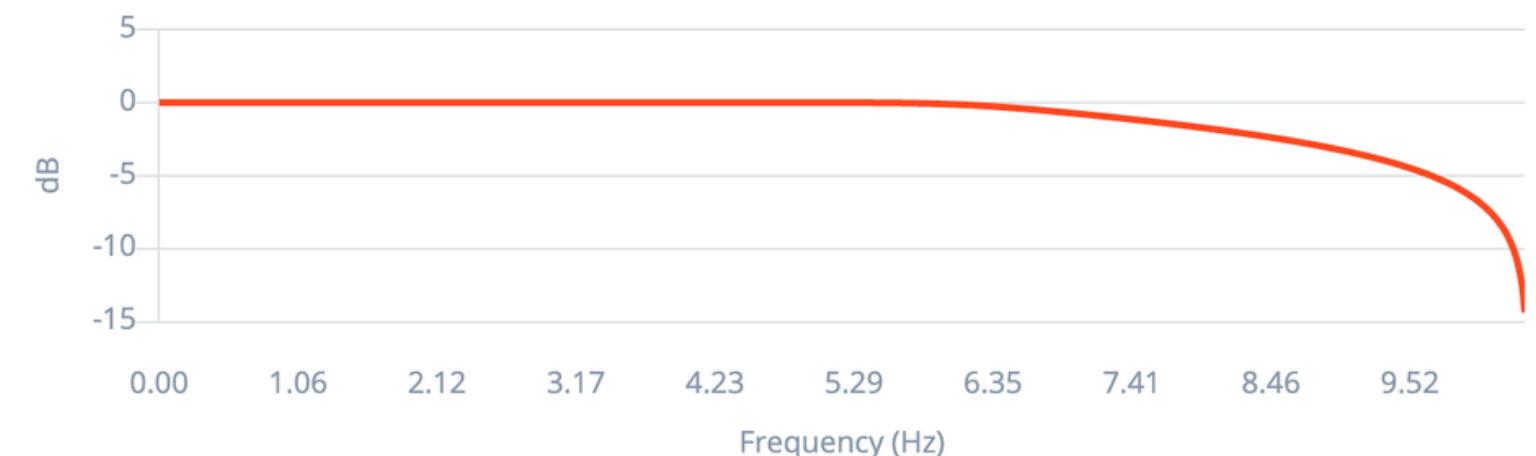
6

Analysis

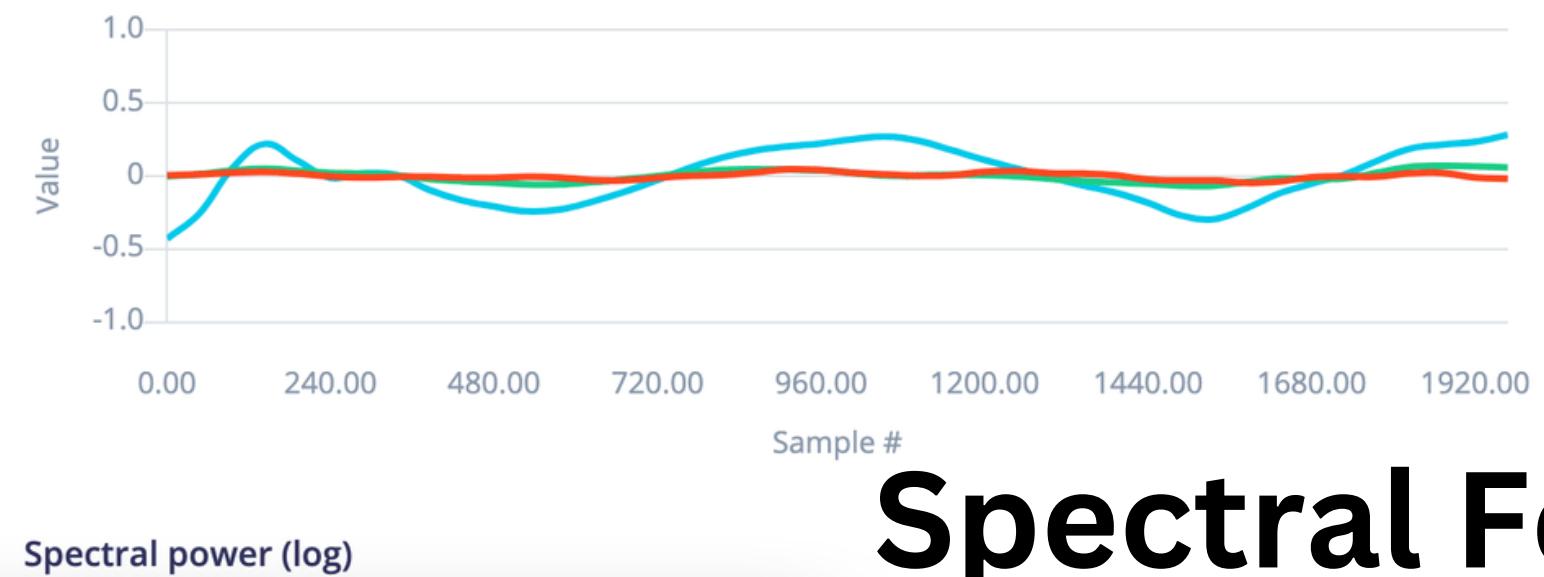
FFT

DSP result

Filter response



After filter



Spectral power (log)

Spectral Features

[Dashboard](#)[Devices](#)[Data acquisition](#)[Impulse design](#)[Create impulse](#)[Spectral features](#)[Classifier](#)[EON Tuner](#)[Retrain model](#)[Live classification](#)[Model testing](#)

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Neural Network settings

Training settings

Number of training cycles [?](#)

30

Learning rate [?](#)

0.0005

Advanced training settings

Validation set size [?](#)

20

%

Split train/validation set on metadata key [?](#)Batch size [?](#)

32

Auto-weight classes [?](#)Profile int8 model [?](#)

Neural network architecture

Input layer (84 features)

Dense layer (20 neurons)

Dense layer (20 neurons)

Training output

[CPU](#)

(0)

Creating job...

Failed to create job: success

Job failed (see above)

Model

Model version: [?](#)

Quantized (int8) ▾

Last training performance (validation set)



ACCURACY

98.8%



LOSS

0.07

Confusion matrix (validation set)

	GRND CIRCLE	IDLE	SNAKE	UPDOWN	WAVE
GRND CIRCLE	98.5%	0%	0%	0.7%	0.7%
IDLE	0%	100%	0%	0%	0%
SNAKE	0%	0%	100%	0%	0%

Classifier

#1 ▾ Click to set a description for this version

 Dashboard Devices Data acquisition Impulse design Create impulse Spectral features NN Classifier Anomaly detection EON Tuner Retrain model Live classification Model testing Versioning Deployment

GETTING STARTED

 Documentation Forums

Neural Network settings

Training settings

Number of training cycles 

30

Learning rate 

0.0005

Validation set size 

20

%

Auto-balance dataset 

Neural network architecture

Input layer (33 features)

Dense layer (20 neurons)

Dense layer (10 neurons)

Add an extra layer

Output layer (4 classes)

 Start training

Training output

Model

Model version: Quantized (int8) 

Last training performance (validation set)

ACCURACY
100.0%LOSS
0.00

Confusion matrix (validation set)

	IDLE	SNAKE	UPDOWN	WAVE
IDLE	100%	0%	0%	0%
SNAKE	0%	100%	0%	0%
UPDOWN	0%	0%	100%	0%
WAVE	0%	0%	0%	100%
F1 SCORE	1.00	1.00	1.00	1.00

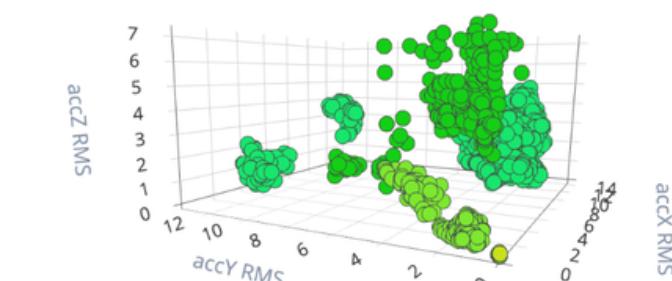
Feature explorer (full training set) 

accX RMS

accY RMS

accZ RMS

- idle - correct
- snake - correct
- updown - correct
- wave - correct

On-device performance INFERENCING TIME
1 ms.PEAK RAM USAGE
1.5KFLASH USAGE
15.4K

MODEL Training



- Dashboard
- Devices
- Data acquisition
- Impulse design
 - Create impulse
 - Spectral features
 - Classifier
 - Anomaly detection
- EON Tuner
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GETTING STARTED

- Documentation
- Forums

This lists all test data. You can manage this data through Data acquisition.

Test data

Classify all

Set the 'expected outcome' for each sample to the desired outcome to automatically score the impulse.

SAMPLE NAME	EXPEC...	LENGTH	ANOM...	ACCUR...	RESULT	⋮
idle.3.cbor.1...	idle	10s	-0.25	100%	34 idle	⋮
updown.2.cbor...	updo...	10s	-0.21	100%	34 updown	⋮
snake.1.cbor...	snake	10s	-0.11	100%	34 snake	⋮
updown.3.cbor...	updo...	10s	-0.19	100%	34 updown	⋮
wave.1.cbor....	wave	10s	-0.14	100%	34 wave	⋮
wave.2.cbor....	wave	10s	-0.19	100%	34 wave	⋮
snake.2.cbor...	snake	10s	-0.31	100%	34 snake	⋮

Model testing output

(0) ▾

Model testing results

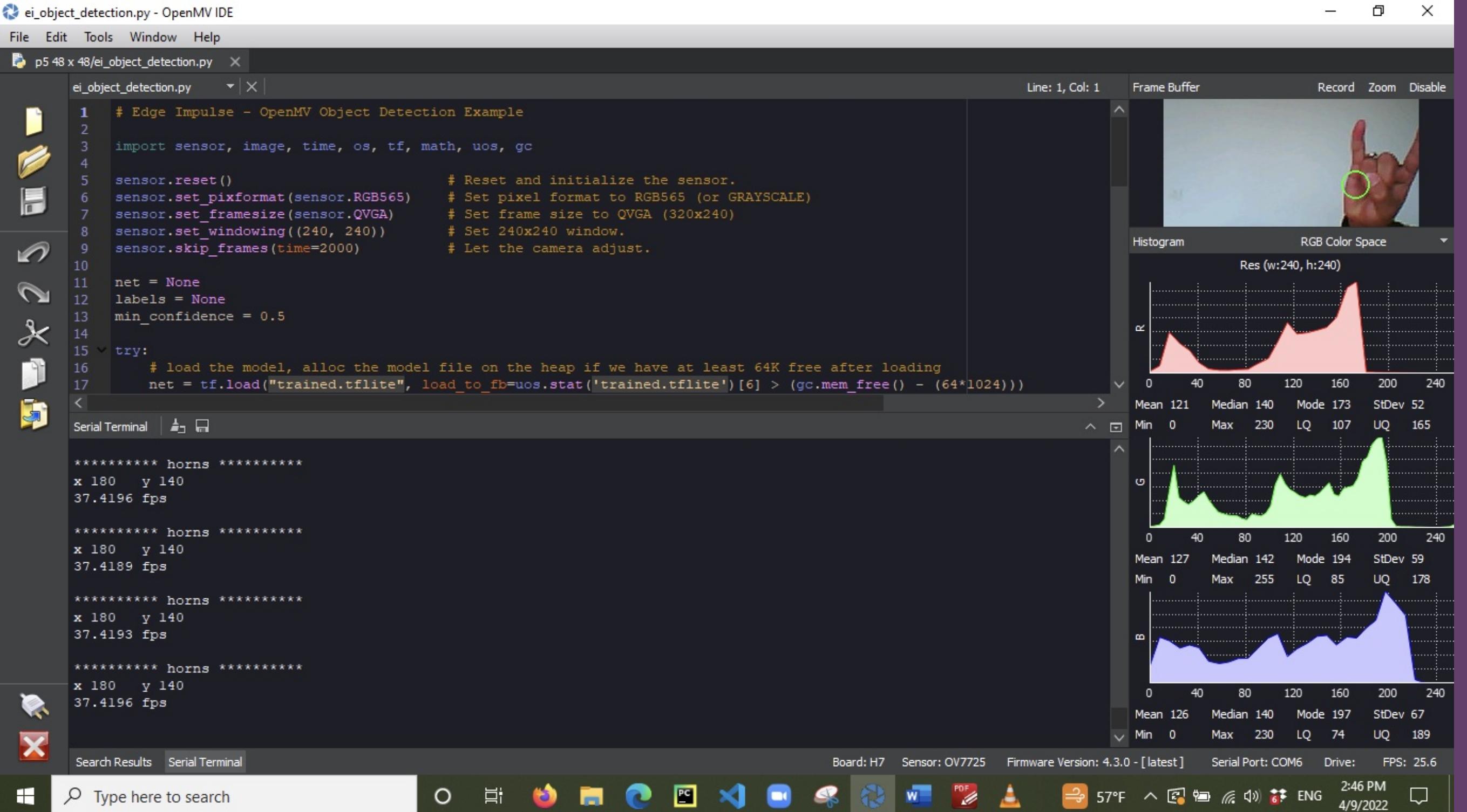
ACCURACY **99.80%**

	IDLE	SNAKE	UPDOWN	WAVE	ANOMALY	UNCERTAII
IDLE	100%	0%	0%	0%	0%	0%
SNAKE	0%	100%	0%	0%	0%	0%
UPDOWN	0%	0%	99.1%	0%	0.9%	0%
WAVE	0%	0%	0%	100%	0%	0%
ANOMALY	0%	0%	0%	0%	100%	-
F1 SCORE	1.00	1.00	1.00	1.00	0.96	

Feature explorer

anomaly - correct
idle - correct
snake - correct
updown - correct
wave - correct
updown - incorrect

Model Testing & Deployment



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OPENMV

- The OpenMV Cam is like a super powerful Arduino with a camera on board that you program in Python.
 - We make it easy to run machine vision algorithms on what the OpenMV

MQTT

MQTT supports messaging between devices to the cloud and the cloud to the device.

Thankyou