

# CE 6302.001 – Microprocessor and Embedded Systems – F22

<b>Dhavalashri Prasad</b> Net-ID : dxp210085	<b>Sanmati Marabad</b> Net-ID : sxm210368
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## **TinyML-Motion Recognition**

The main aim of this project is to train TICC1352P Launchpad connected to BoostExcel-sensors board for different kinds of motion recognition.

### **Softwares Used**

- Edge Impulse CLI
- NodeJS
- Texas Instruments Uniflash

### **Steps to connect development board to Edge Impulse**

- Flash the board using Texas Instruments Flash Batch 5.
- Create an account on Edge Impulse which is used to collect the data and train the system.
- Connect to the board using Edge Impulse daemon command.
- Now we can access the device on the Edge Impulse website
- After the connection is succeeded, we start training the system for different kind of movements.

### **Data acquisition**

This is the process of collecting different data sets in order to train the system.

- For each kind of movement, we create a different label like up-down, wave, snake and idle.
- The sample length is set to 10,000 and frequency is set to 62.5Hz
- We use the built-in accelerometer in the booster sensor pack for motion recognition.
- Each sample data was 30 seconds long. Similarly, for each movement, data was collected 6 times (6 samples).

EDGE IMPULSE

Dashboard

Devices

Data sources

Data acquisition

Impulse design

Create impulse

EON Tuner

Retrain model

Live classification

Model testing

Versioning

Sanmati Marabad / SANMATIMARABAD-project-1

SM

Training dataTest dataData explorerUpload dataExport data

Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options

DATA COLLEC...12m 0s

TRAIN / TES...100...

Record new data

Connect using WebUSB

Device ?  
motion

Label  
snake

Sample length (ms.)  
10000

Sensor  
Accelerometer

Frequency

Collected data

SAMPLE NAME	LABEL	ADDED	LENGTH
snake.3j4e7rs5	snake	Today, 15:3...	10s
snake.3j4e7eee	snake	Today, 15:3...	10s
snake.3j4e6v27	snake	Today, 15:3...	10s

## Data Acquisition

EDGE IMPULSE

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Create impulse

Spectral features

Classifier

EON Tuner

Retrain model

Live classification

DATA COLLEC...12m 0s

TRAIN / TES...100...

Record new data

Connect using WebUSB

No devices connected to the remote management API.

RAW DATA

snake.3j4e7rs5

20

15

10

5

0

-5

-10

-15

-20

0

1040

2080

3120

4160

5200

6240

7280

8320

9360

accX

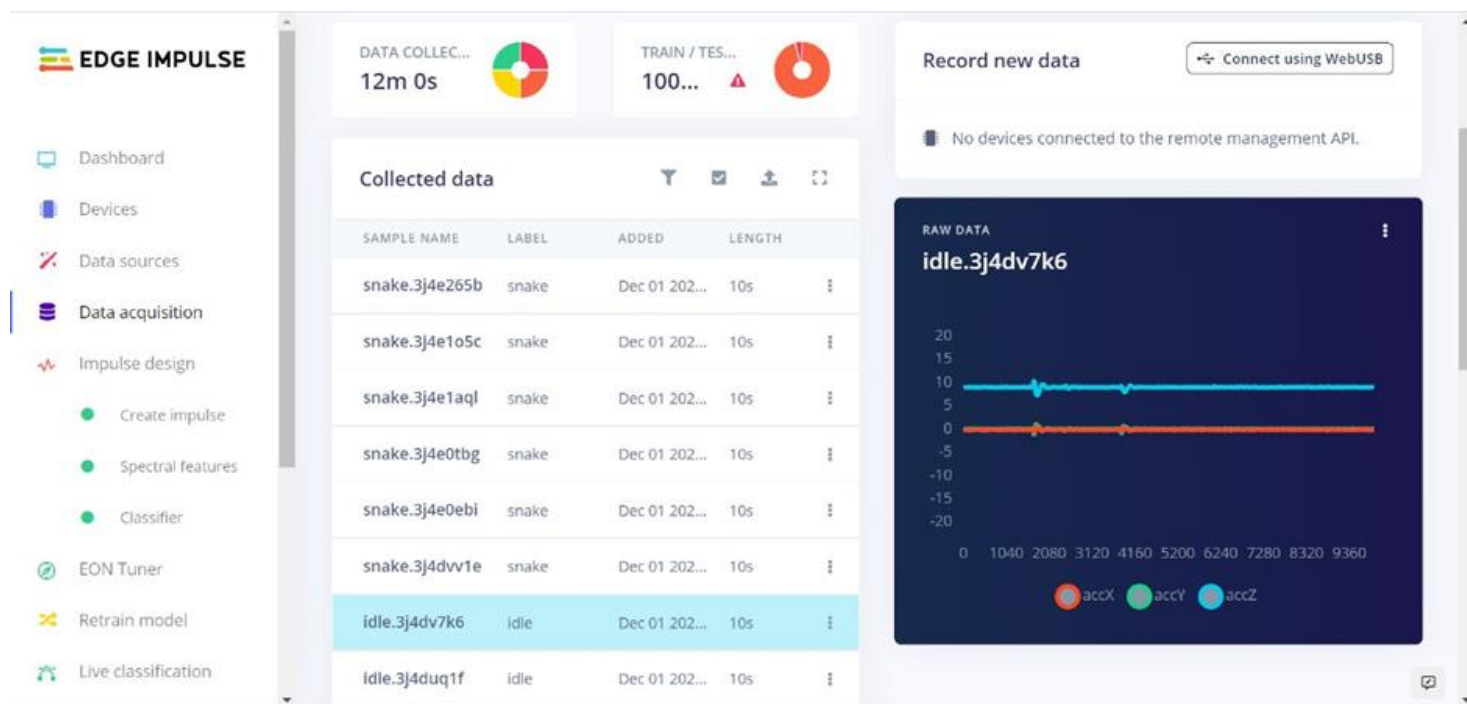
accY

accZ

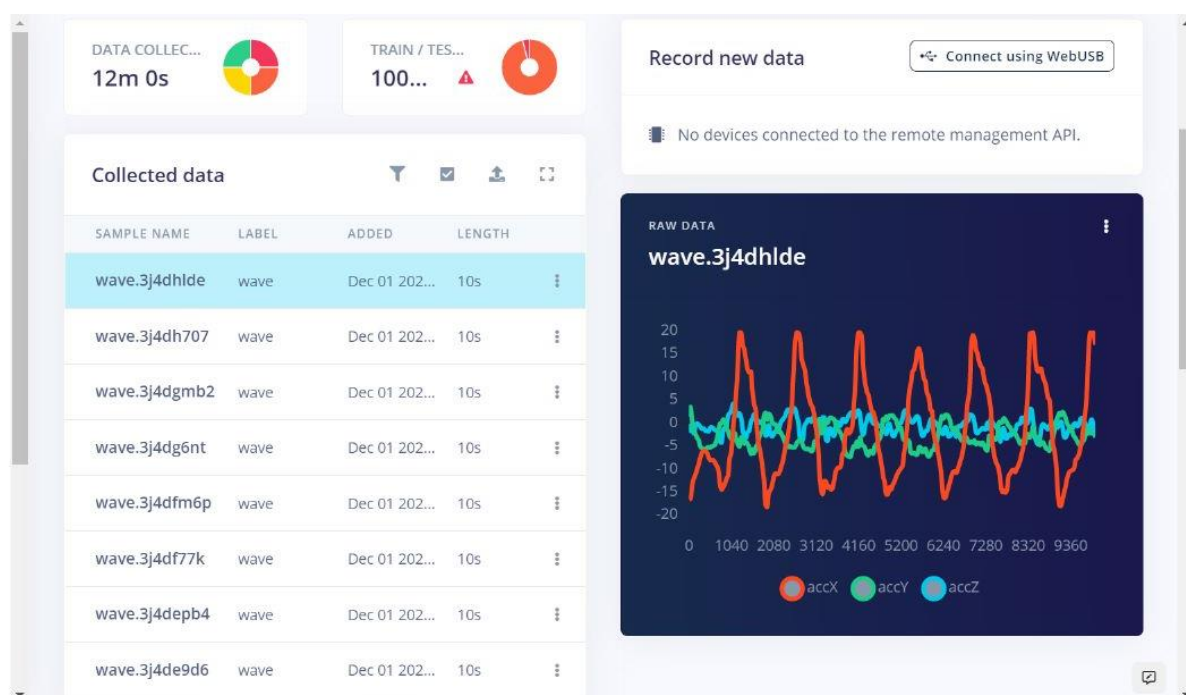
Collected data

SAMPLE NAME	LABEL	ADDED	LENGTH
snake.3j4e7rs5	snake	Dec 01 202...	10s
snake.3j4e7eee	snake	Dec 01 202...	10s
snake.3j4e6v27	snake	Dec 01 202...	10s
snake.3j4e6hp9	snake	Dec 01 202...	10s
snake.3j4e645l	snake	Dec 01 202...	10s
snake.3j4e5lua	snake	Dec 01 202...	10s
snake.3j4e58hk	snake	Dec 01 202...	10s
snake.3j4e4q1n	snake	Dec 01 202...	10s

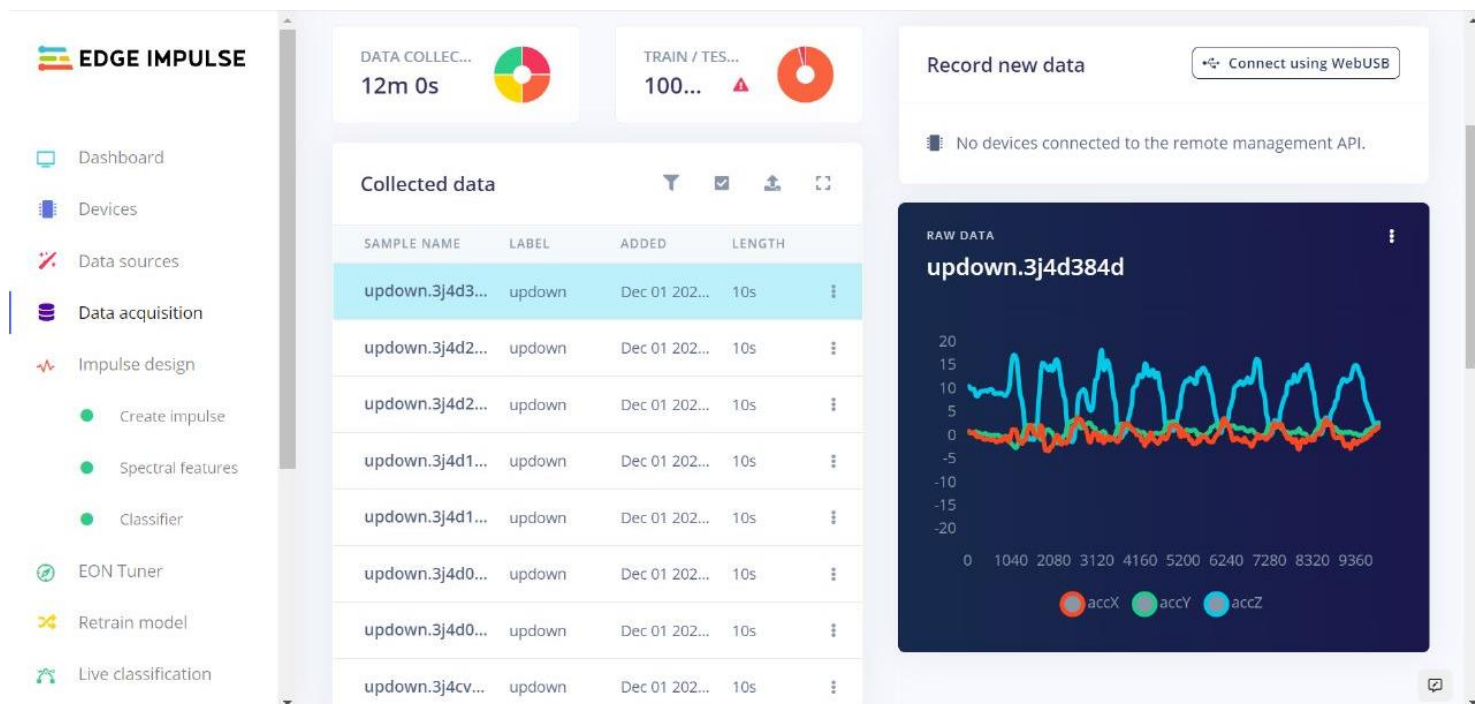
## Raw data acquisition for Snake training sample



Raw data acquisition for idle training sample



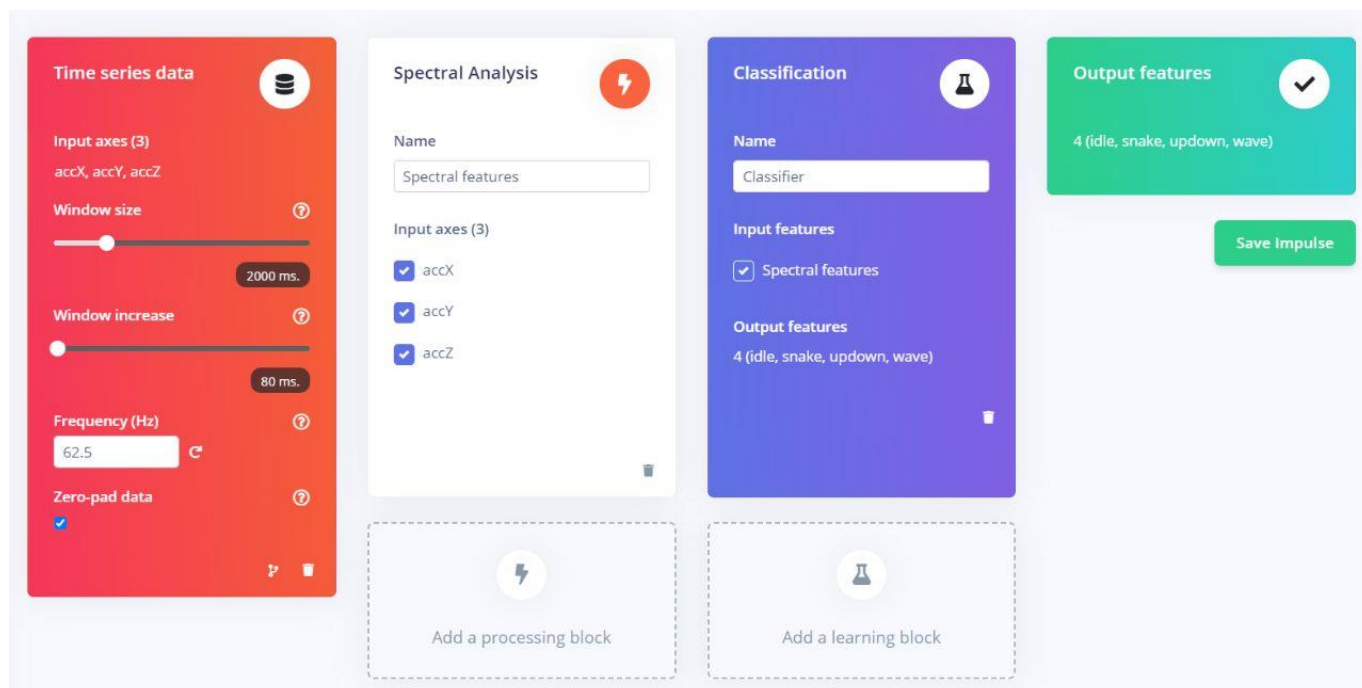
Raw data acquisition for Wave training sample



Raw data acquisition for Up-Down training sample

## Impulse Design

Your Impulse may now be made when you have gathered the necessary facts for your project. Three primary building components will make up a full Impulse: an input block, a processing block, and a learning block.



### ❖ Input Block

- The input block indicates the type of input data that the system is getting trained. This can be audio, motion or images.
- The inputs to input block are 3 axes: Accx, Accy and Accz and a window size of 2000ms and window increase of 80ms.
- The frequency is set to 62.5Hz.

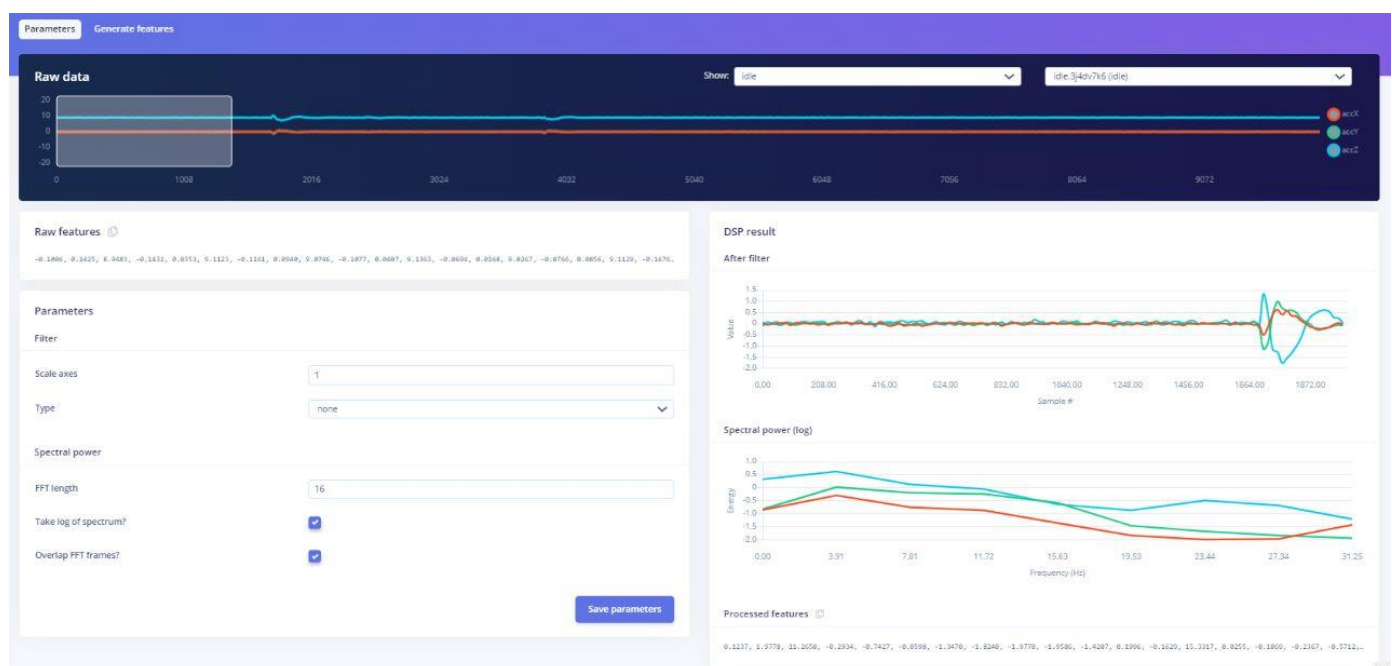
### ❖ Processing Block

- A processing block is a feature extractor which processes the input data and extracts the features from it so that the machine learning model can be trained using the extracted features.
- For motion recognition, we use the spectral analysis as a processing block.
- The inputs to spectral analysis are 3 axes: Accx, Accy and Accz

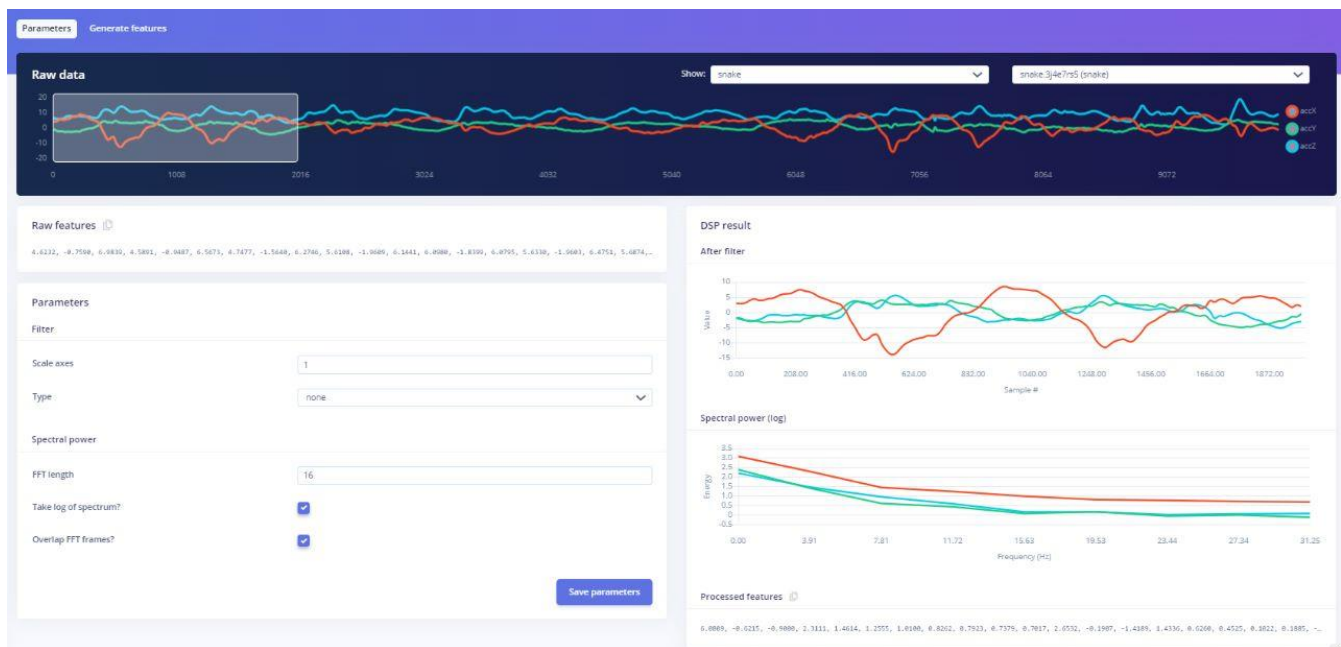
### ❖ Learning Block

- A learning block is a neural network that is trained to learn the input data.
- In the current project, we use classification as the learning block where it classifies and outputs four features: idle, snake, up-down and wave.

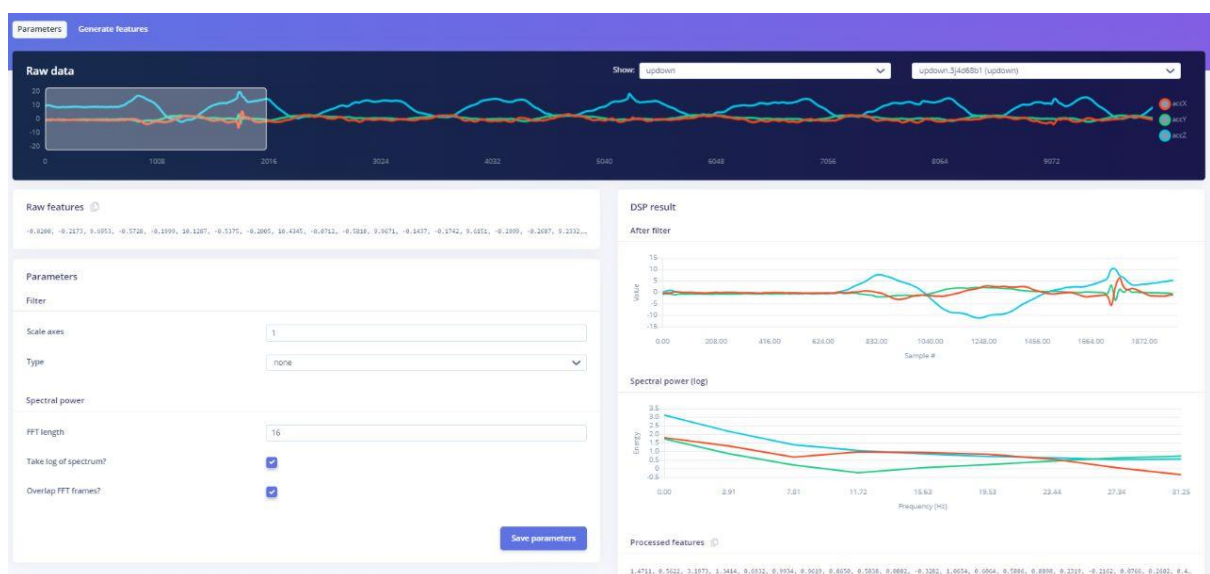
After selecting the impulse blocks, we need to save the impulse and next step is to generate the features using spectral features. This step extracts and generates features from the raw input data.



Parameters for idle class

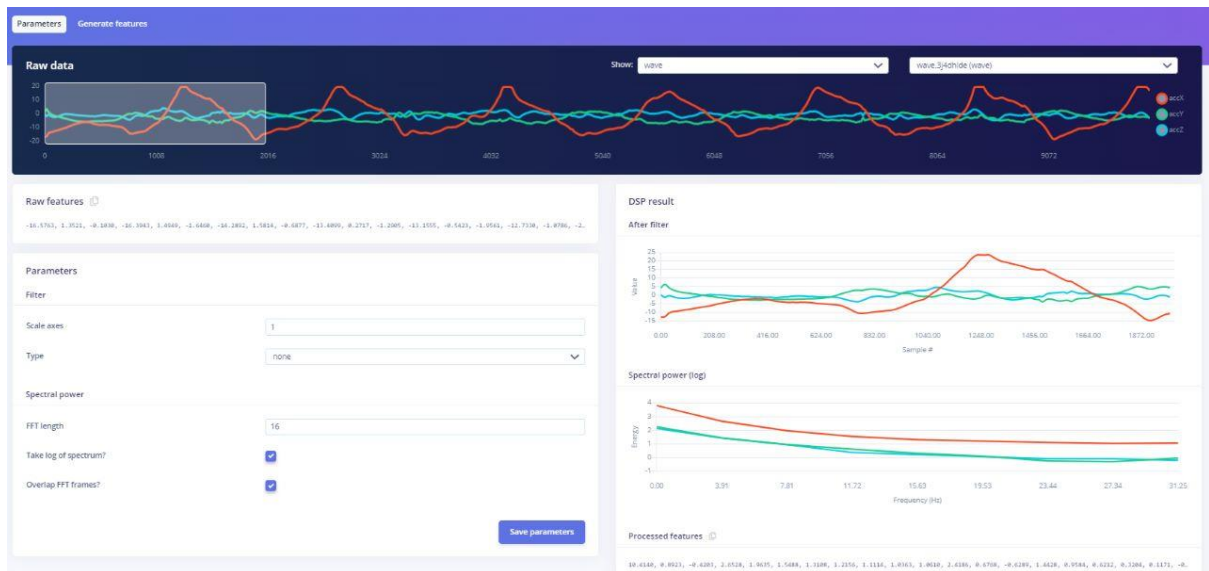


Parameters for Snake class

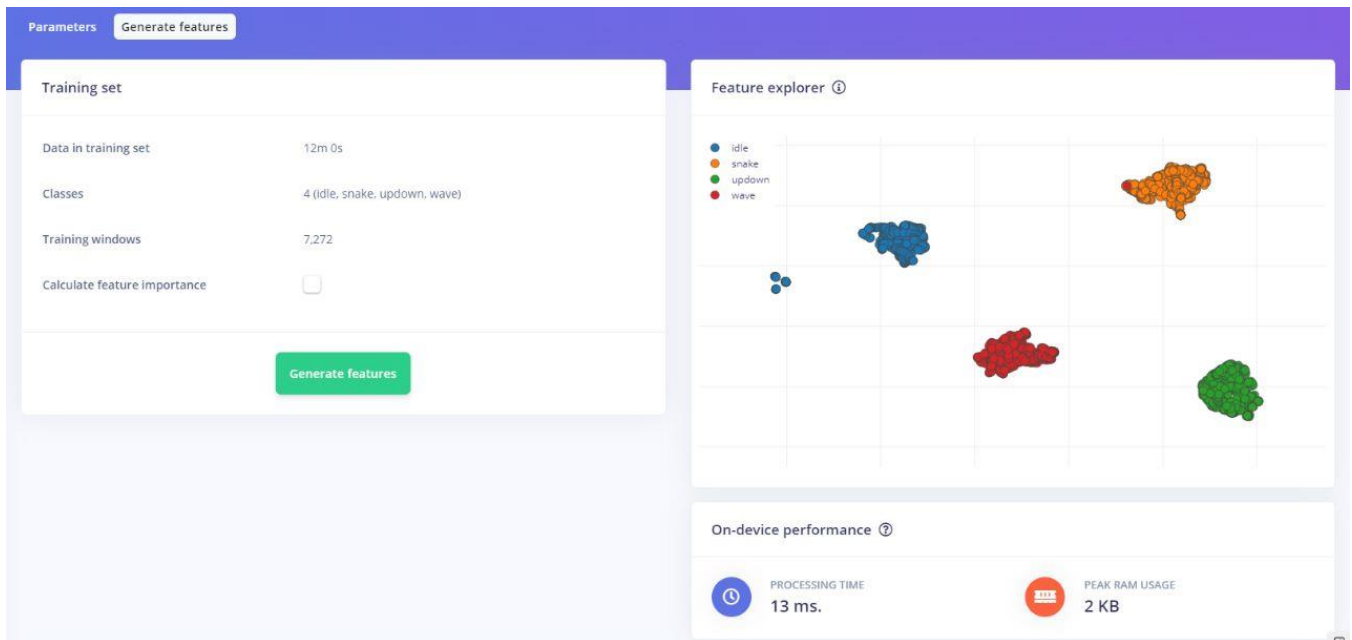


Parameters for Up-Down class





## Parameters for Wave class



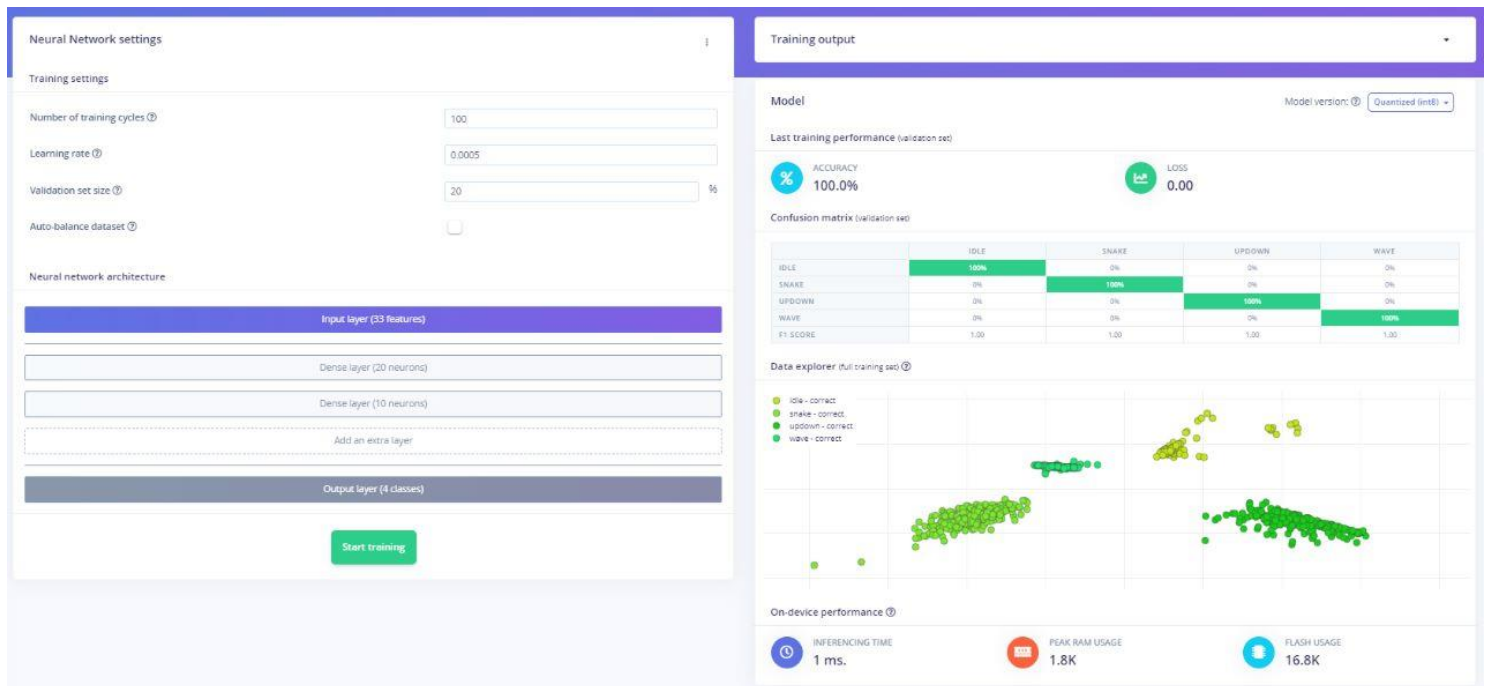
## Features generated for different types inputs

### Classifier

In order for the system to learn the features extracted from the input data, we need to train it using classifier.

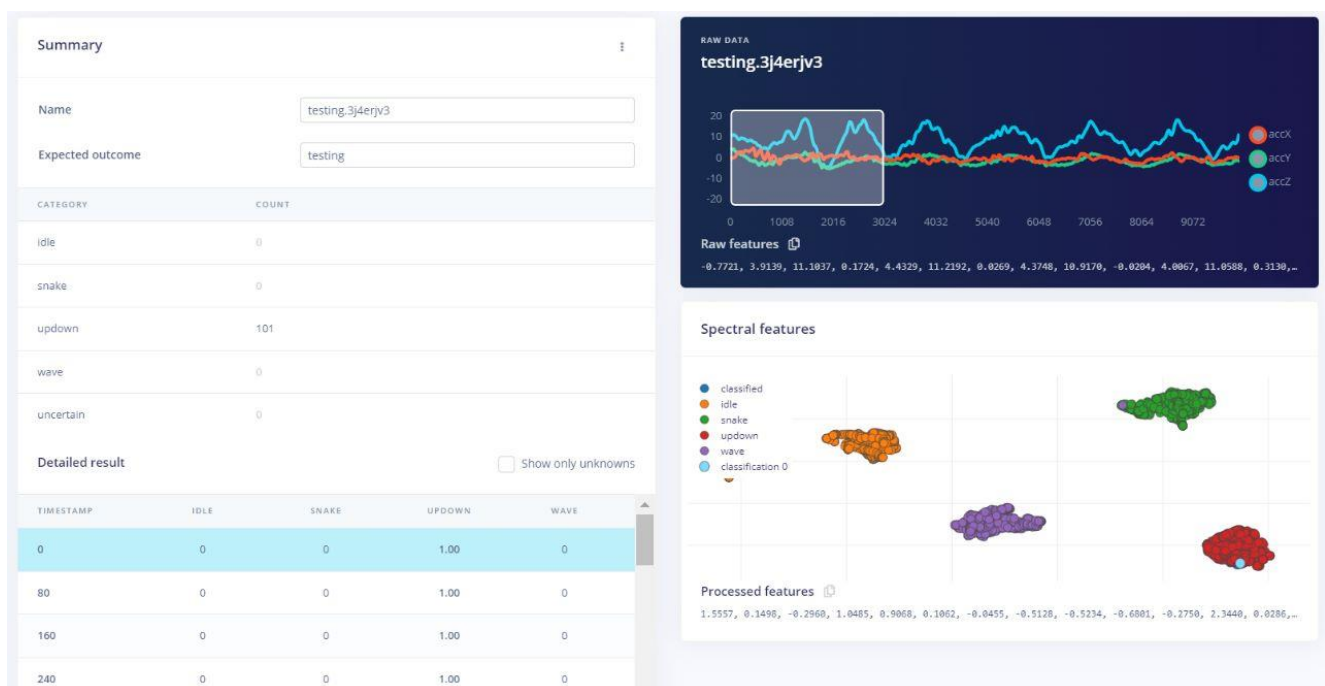
## Results of training

The accuracy for each class is found to be 100% and there was no loss of data observed since the selected features were distinct from each other.



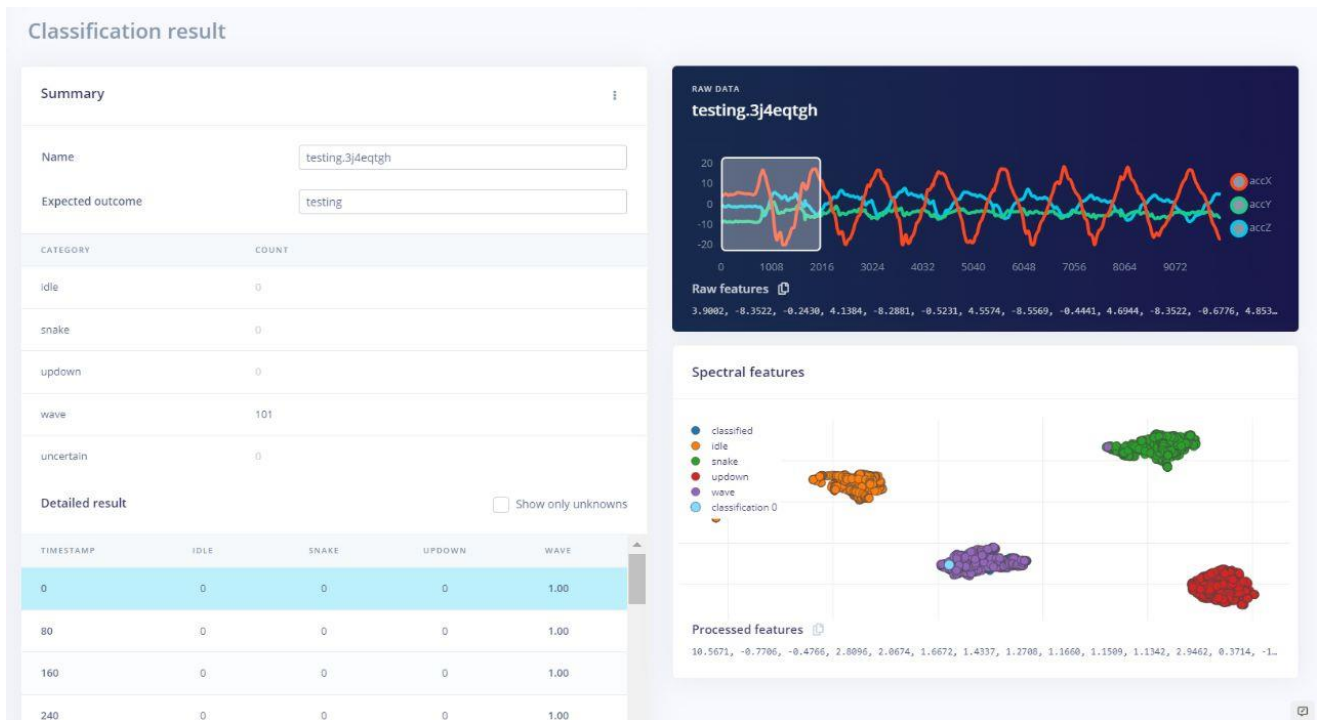
## Testing using Live Classification

Before dumping the trained model into the board, testing it using Live Classification is necessary. The classification results were observed to be 100% accurate for all the different inputs that were given.

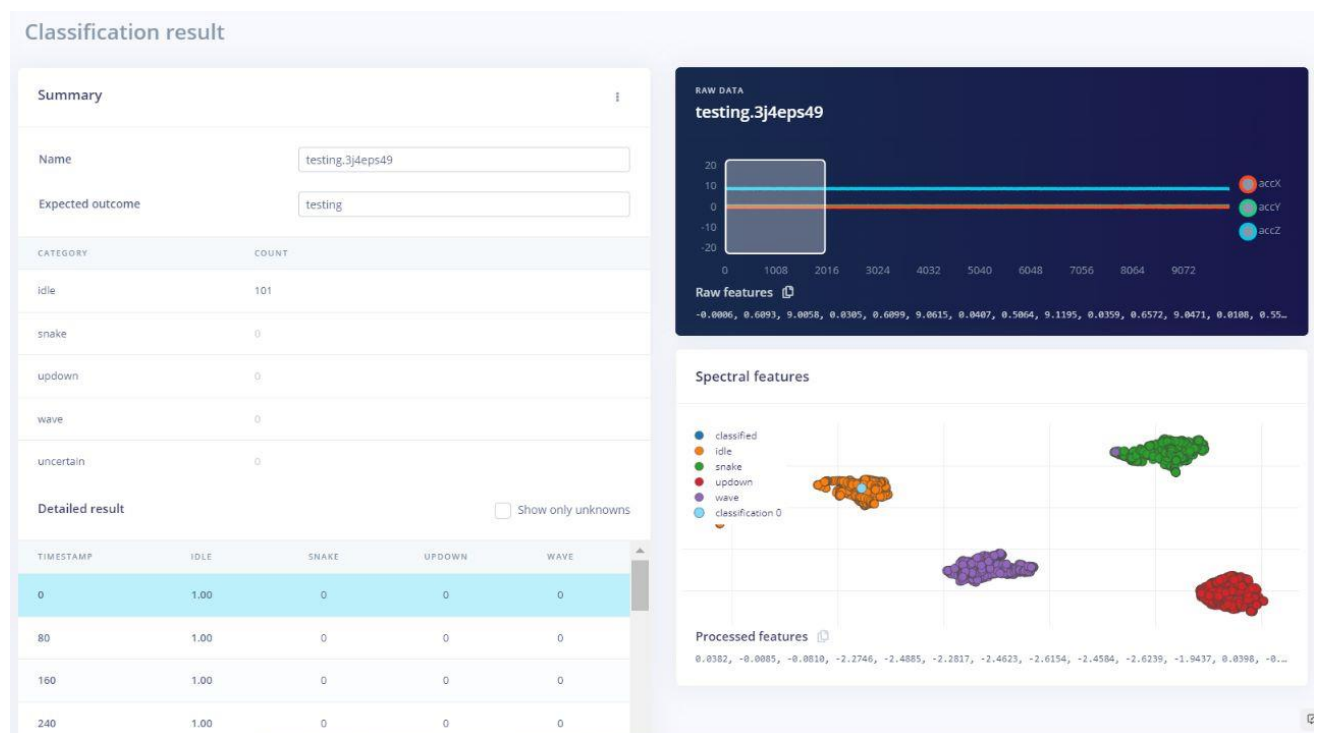


## Testing of Up-Down feature



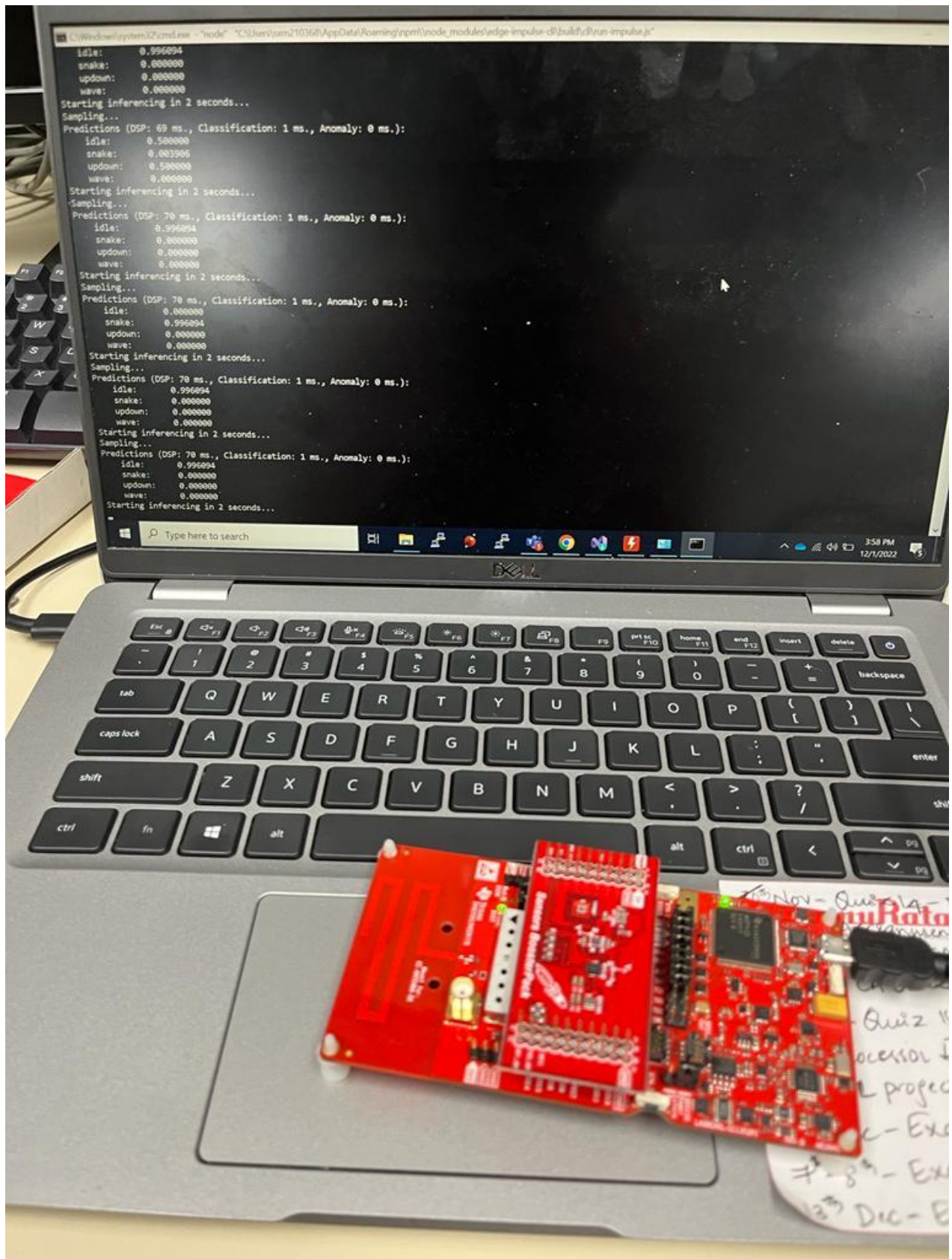


Testing of Wave feature



Testing of Idle feature

After live classification is tested, the code is dumped to the board and now we can use the board as a trained model to classify the input data.



Testing the trained-model the development board

From the output, we observed 100% accuracy in the results of the trained model.