Assignment 3: Motion detection using Edge Impulse

Embedded Machine Learning for Edge Computing

Deadline: 18th August 2024

In this assignment we will use machine learning to build a motion recognition system that could run on a microcontroller.

By the end of the project, compile a report that includes screenshots to prove the completion of tasks mentioned below.

We will be building a model to identify the following 4 movements of the edge device. (Development board/ mobile phone)

1. Idle – kept on the desk without any movement
2. Snake - moving the device over the desk as a snake
3. Wave - waving the device from left to right (with the device facing us)
4. Updown - moving the device up and down. (with the device facing up/down)

Since it is a tedious task to record enough data for training, we have provided you with the dataset. Download the provided zip file and extract its content. One folder will contain the dataset and the other will contain demonstrations. Go through the demonstrations to get a clear understanding of the movements if needed.

Task 1 – Dataset

Go to Edge Impulse and create a new public project named "A3_SKFnumber".

Upload the training and testing data to the project. View the signals.

- ✓ Briefly explain the reason for the shape of the waveforms of the 2 movements updown and snake. Think about the axes in which the device moves during each motion. (Eg:- When kept idle, the device does not move in any of the directions X,Y or Z. Hence, accX, accY and accZ remain constant)
- ✓ Include a screenshot to show that the dataset is properly loaded to the project.

Task 2 – Creating an impulse

Create an impulse for the task. Specify the input parameters as follows.

Window size = 2000 ms

Window increase = 80 ms

Frequency = 62.5 Hz

- ✓ Include a screenshot that clearly shows the impulse you have created.

Task 3 – Feature extraction

Extract features from your data in the feature extraction block. Play around with the parameters and set them in a way that optimum results are obtained.

Hints

- A good signal processing block will yield similar results for similar data. If you move the sliding window (on the raw data graph) around, the graphs should remain similar.
- When you switch to another file with the same label, you should see almost similar graphs.
- Use feature explorer for comparison. If you can visually identify some clusters by classes, then the machine learning model will be able to do so as well.
- For more information - https://docs.edgeimpulse.com/docs/edge-impulse-studio/processing-blocks/spectral-features

✓ Include screenshots to clearly show the selected parameters and the feature explorer.

Task 4 – Model training and testing

Design a neural network for classification. Select optimal parameters. Make sure the model is not overfitting. Include screenshots that clearly show the following.

✓ Neural network settings and network architecture
✓ Training performance. (Confusion matrix, metrics for the validation set and data explorer)
✓ Results obtained for the testing dataset.
✓ Simple reasoning of the parameters you have chosen. (Eg:- learning rate)

Task 5 – Deployment

In this section, we will deploy the model on an edge device. Since most of you don't have the Arduino Nano 33 BLE sense development board yet, let's perform a live classification using the mobile phone. Go to "Deployment" section in the menu and connect to your mobile phone using the QR code. Make sure you are in classification mode.

✓ Do the above 4 movements and see if you get proper results. Include a screenshot of the results obtained.

Eg:-

You are highly encouraged to deploy this on your Arduino Nano 33 BLE sense as well, if you already have one.

Deliverables

1. A report containing the solutions to the above tasks.
2. Link to your project on Edge Impulse. Make sure this is made public.