

Edge Computing Lab

Class: TY-AIEC

School of Computing, MIT Art Design Technology University

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Experiment No. 6

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Title

Keyword Spotting Project like “OK, Google,” “Alexa,” on Edge Devices using Microphone

Objective: Build a project to detect the keywords using a built-in sensor on Nano BLE Sense / Mobile Phone

Tasks:

- Generate the dataset for keyword
- Configure BLE Sense / Mobile for Edge Impulse
- Building and Training a Model

Run the project Keyword Spotting like “OK, Google,” “Alexa

Introduction

Edge Impulse is a development platform for machine learning on edge devices, targeted at developers who want to create intelligent device solutions. The "Hello World" equivalent in Edge Impulse would typically involve creating a simple machine learning model that can run on an edge device, like classifying sensor data or recognizing a basic pattern.

Materials Required

- Nano BLE Sense Board

Theory

GPIO (General Purpose Input/Output) pins on the Raspberry Pi are used for interfacing with other electronic components. BCM numbering refers to the pin numbers in the Broadcom SOC channel, which is a more consistent way to refer to the GPIO pins across different versions of the

Here's a high-level overview of steps you'd follow to create a "Hello World" project on Edge Impulse:

Steps to Configure the Edge Impulse:

1. Create an Account and New Project:
 - Sign up for an Edge Impulse account.

- Create a new project from the dashboard.
2. Connect a Device:
 - You can use a supported development board or your smartphone as a sensor device.
 - Follow the instructions to connect your device to your Edge Impulse project.
 3. Collect Data:
 - Use the Edge Impulse mobile app or the Web interface to collect data from the onboard sensors.
 - For a "Hello World" project, you could collect accelerometer data, for instance.
 4. Create an Impulse:
 - Go to the 'Create impulse' page.
 - Add a processing block (e.g., time-series data) and a learning block (e.g., classification).
 - Save the impulse, which defines the machine learning pipeline.
 5. Design a Neural Network:
 - Navigate to the 'NN Classifier' under the 'Learning blocks'.
 - Design a simple neural network. Edge Impulse provides a default architecture that works well for most basic tasks.
 6. Train the Model:
 - Click on the 'Start training' button to train your machine learning model with the collected data.
 7. Test the Model:
 - Once the model is trained, you can test its performance with new data in the 'Model Testing' tab.
 8. Deploy the Model:

- Go to the 'Deployment' tab.
- Select the deployment method that suits your edge device (e.g., Arduino library, WebAssembly, container, etc.).
- Follow the instructions to deploy the model to your device.

9. Run Inference:

- With the model deployed, run inference on the edge device to see it classifying data in real-time.

10. Monitor:

- You can monitor the performance of your device through the Edge Impulse studio.

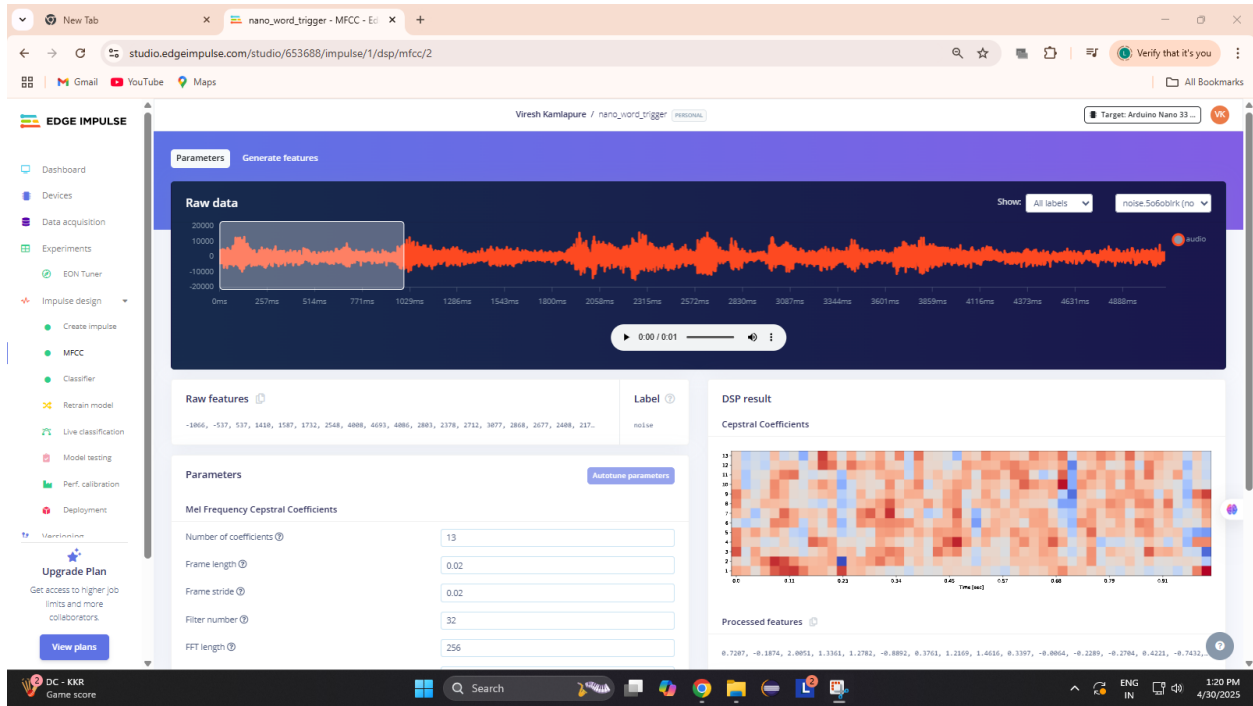
Edge Impulse project's Results:

The screenshot shows the 'Data acquisition' page in the Edge Impulse Studio. The left sidebar contains navigation links: Dashboard, Devices, Data acquisition (active), Experiments, EON Tuner, Impulse design, Create impulse, MFCC, and Classifier. The main area displays dataset statistics: 'DATA COLLECTED 5m 23s' and 'TRAIN / TEST SPLIT 76% / 24%'. Below this is a table of training data samples.

SAMPLE NAME	LABEL	ADDED	LENGTH
noise.5o6oblrk	noise	Apr 08 2025, 12:...	5s
noise.5o6oahvt	noise	Apr 08 2025, 12:...	5s
noise.5o6o9g0i	noise	Apr 08 2025, 12:...	5s
noise.5o6o8e9f	noise	Apr 08 2025, 12:...	5s
noise.5o6o7d3i	noise	Apr 08 2025, 12:...	5s
noise.5o6o68pg	noise	Apr 08 2025, 12:...	5s
noise.5o6o1q7r	noise	Apr 08 2025, 12:...	5s
noise.5o6o0btj	noise	Apr 08 2025, 12:...	5s
noise.5o6nsq98	noise	Apr 08 2025, 12:...	5s

On the right, there is a 'Collect data' section with a 'Connect a device' button and a 'RAW DATA' section with a 'Click on a sample to load...' prompt.

The screenshot shows the 'Create impulse' page in the Edge Impulse Studio. The left sidebar is the same as the previous screenshot. The main area is titled 'Impulse #1' and contains a description: 'An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.' Below this are four configuration panels: 'Time series data' (Input axes: audio, Window size: 1,000 ms, Window increase (stride): 500 ms, Frequency (Hz): 16000, Zero-pad data: checked), 'Audio (MFCC)' (Name: MFCC, Input axes (1): audio), 'Classification' (Name: Classifier, Input features: MFCC, Output features: 3 (green, noise, white)), and 'Output features' (3 (green, noise, white)). A 'Save Impulse' button is located at the bottom right.



```
nano_ble33_sense_microphone | Arduino IDE 2.3.4
File Edit Sketch Tools Help
Arduino Nano 33 BLE
nano_ble33_sense_microphone.ino
58 // comment out the below line to cancel the wait for USB connection (needed for native USB)
59 while (!Serial);
60 Serial.println("Edge Impulse Inferencing Demo");
61
62 // summary of inferencing settings (from model_metadata.h)
63 ei_printf("Inferencing settings:\n");
64 ei_printf("\tInterval: %.2f ms.\n", (float)EI_CLASSIFIER_INTERVAL_MS);
65 ei_printf("\tFrame size: %d\n", EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE);
66 ei_printf("\tsample length: %d ms.\n", EI_CLASSIFIER_RAW_SAMPLE_COUNT / 16);
67 ei_printf("\tno. of classes: %d\n", sizeof(ei_classifier_inferencing_categories) / sizeof(ei_classifier_inferencing_categories[0]));
68
69 if (microphone_inference_start(EI_CLASSIFIER_RAW_SAMPLE_COUNT) == false) {
70     ei_printf("ERR: Could not allocate audio buffer (size %d), this could be due to the window length of your model!\n", EI_CLASSIFIER_RAW_SAMPLE_COUNT);
71     return;
72 }
73
74
75 /**
76  * @brief Arduino main function. Runs the inferencing loop.
77  */
78 void loop()
79 {
80     ei_printf("Starting inferencing in 2 seconds...\n");
81     delay(2000);
82     ei_printf("Recording...\n");
83
84     bool m = microphone_inference_record();
85     if (!m) {
86         ei_printf("ERR: Failed to record audio...\n");
87         return;
88     }
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90     ei_printf("Recording done\n");
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The image shows a Windows desktop environment. The primary focus is a terminal window titled 'COM11'. The terminal's text area contains a series of data readings, each consisting of a label (noise, white, green) followed by a numerical value. These readings are grouped by 'Predictions' which specify parameters like DSP, Classification, and Anomaly. The bottom of the terminal window features a status bar with 'Autoscroll' and 'Show timestamp' checkboxes, and a dropdown menu showing 'Nevline'. Below the terminal window is the Windows taskbar. It includes the Start button, a search bar, and a collection of application icons: Hot weather, File Explorer, Microsoft Edge, Google Chrome, and others. The system clock in the bottom right corner indicates the time is 1:55 PM on 4/30/2023, with the language set to ENG US.