SciTinyML
Scientific Use of Machine Learning on Low Power Devices

Regional Workshops
TinyML Kit Overview - HW and SW Installation & Test

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TinyML Kit Overview
Nano 33 BLE Sense (+ USB cable)

Purpose

AI-enabled developmental **microcontroller board** with USB-A to microB cable

Specifications

- **MPU**: Nordic nRF52840 (ARM Cortex-M4 w/FPU): 3.3V, 64MHz, 1MB flash, 256 kB RAM
- **Sensors on board**: microphone, IMU (9 axis), color, light, proximity, barometric, temperature, humidity*, gesture, and light intensity.
- BLE module covered by ArduinoBLE library
- RGB LEDs

*Not included in the package. For projects we will use the external Grove - Temp&Hum&Barometer Sensor (BME280)
Nano 33 BLE Sense (Development board)

- **Power-On LED (Green)**
- **IMU**
- **RGB LED**
- **I/O (USB)**
- **Built-In LED (Yellow)**
- **Reset & Boot Button**
- **Microphone**
- **Temperature + pressure**
- **Gesture, proximity, light color and light intensity**
- **Processor + Bluetooth**

- **System / Comm**
- **Input Sensors**
- **Output**
Purpose
Breakout PCB for *tiny* camera.

Specifications
- Low-cost, Low-voltage, **0.3 MP** CMOS VGA (can step down to **QVGA**, **QQVGA**) image sensor
- Serial Camera Control Bus (SCCB) + Camera Parallel Interface (CPI) / Digital Video Port (DVP) interface
- Breaks ribbon cable out to 2x10 pin array
- **1 or 5 fps** (Frames per Second)
Tiny Machine Learning Shield

Purpose
A daughter PCB designed to **breakout the I/O** from the Nano 33 BLE sense to permit easy, reliable **communication with** other local, **off-board elements**

Specifications
- Grove connectors (3.3V I2C and simple digital / analog - see pinouts)
- 2x10 pin array for OV7675 camera module
- Voltage input terminal block, accepts 4.5 to 21V (down regulated to 3.3V on Nano 33)
TinyML Shield

Two rows of 1x15 headers that you can slot the Nano 33 BLE sense into.
TinyML Shield

2x10 header that is intended to receive the corresponding pins of the OV7675 camera module
TinyML Shield

A easily programmable button on the left

Screw-in terminal block for external (battery) power (4.5V to 21V)
TinyML Shield

Standard Grove connectors, to permit serial communication (I2C = power + data + clock) with modules (both sensors and actuators)
TinyML Shield

Grove connectors that break out analog and digital GPIO
Grove Connectors

Purpose
Facilitate **plug-and-play connections** to off-board modules to extend the possible scope of functionality to new **TinyML** applications.

Specifications
- Proprietary connection system from SeeedStudio, similar to JST PH-type connectors
- Large catalog of sensors, actuators available at [seeedstudio.com](http://seeedstudio.com)
- Be sure to check the voltage requirements and pinout of any new Grove module for compatibility with this shield before purchasing or connecting said module.
TinyML Kit Installation
- Hardware Set-up
- Software Set-up
Installing the Hardware
Installing the Arduino IDE
Installing the Board Files
Installing the Main Libraries

Includes the OV767X library

Includes the OV767X library
TinyML Kit Test
- MCU test (Blink)
- Sensors Test (IMU, MIC, CAMERA)
MCU installation test (Blink)
Testing Microphone

Note: Close the Serial Monitor before open the Plotter
Testing IMU

Notes: Close the Serial Monitor before open the Plotter
Repeat test for 'g' and 'm'
Note: You can Press Button instead of send ‘capture’
Testing Camera

Image data will be printed out in 3 seconds... 8x9586, 8x7586, 8x9586, 8x7586, 8x5586, 8x7486, 8x7486, 8x7586, 8x7586, 8x7486, 8x7486, 8x7486, 8x7486
Optional Tests (RGB LEDs)

```cpp
void setup() {
  // Pins for the built-in RGB LEDs on the Arduino Nano 33 BLE Sense
  pinMode(LED_R, OUTPUT);
  pinMode(LED_G, OUTPUT);
  pinMode(LED_B, OUTPUT);

  // Note: The RGB LEDs are ON when the pin is LOW and off when HIGH.
  digitalWrite(LED_R, HIGH);
  digitalWrite(LED_G, HIGH);
  digitalWrite(LED_B, HIGH);
}
void loop() {
  digitalWrite(LED_R, LOW);
  delay(1000);
  digitalWrite(LED_G, LOW);
  delay(1000);
  digitalWrite(LED_B, LOW);
  delay(1000);
  digitalWrite(LED_R, HIGH);
  delay(1000);
  digitalWrite(LED_G, HIGH);
  delay(1000);
  digitalWrite(LED_B, HIGH);
  delay(1000);
}
```
Optional Tests (KeyWord Spotting)

```cpp
#include <TensorFlowLite.h>
#include "main_functions.h"
#include "audio_provider.h"
#include "command_responder.h"
#include "feature_provider.h"
#include "micro_features_micro_model_settings.h"
#include "micro_features_model.h"
#include "recognize_commands.h"
#include "tensorflow/lite/micro/micro_error_reporter.h"
#include "tensorflow/lite/micro/micro_interpreter.h"
#include "tensorflow/lite/micro/micro_mutable_op_resolver.h"
#include "tensorflow/lite/schema/schema_generated.h"
#include "tensorflow/lite/version.h"

// Globals, used for compatibility with Arduino-style sketches.
namespace {
  tflite::ErrorReporter* error_reporter = nullptr;
}

Done in 0.001 seconds
Write 171992 bytes to flash (42 pages)

100% (42/42 pages)
Done in 6.733 seconds
```
Optional Tests (Person Detection)
Thanks
And stay safe!