

# STM32Cube function pack for ultra-low power IoT node with artificial intelligence (AI) application based on audio and motion sensing

Application	FP-AI-SENSING1		
Middleware	BLE	NN ASC Library	NN HAR_GMP Library
	FatFs	NN Common Library	NN HAR_IGN Library
	USB Device	FreeRTOS	NN HAR_IGN_WSDM Library
Hardware Abstraction	STM32Cube Hardware Abstraction Layer (HAL)		
Hardware	STM32 Nucleo expansion boards X-NUCLEO-IDB05A1 (Connect) X-NUCLEO-IKS01A2 (Sense) X-NUCLEO-CCA02M1 (Sense)		STEVAL-STLKT01V1 evaluation board
	STM32 Nucleo development board		



## Features

- Complete firmware to develop an IoT node with BLE connectivity, digital microphone, environmental and motion sensors, and perform real-time monitoring of sensors and audio data
- Middleware libraries generated thanks to [STM32CubeMx](#) extension called [X-CUBE-AI](#), featuring example implementation of neural networks for real-time human activity recognition (HAR) and acoustic scene classification (ASC) applications
- AI utility for data logging and annotation on SD card
- Ultra-low power implementation based on the use of an RTOS
- Compatible with [STBLESensor](#) application for Android/iOS, to perform sensor data reading, audio and motion algorithm feature demo, and firmware update over the air (FOTA)
- Sample implementation available for [STEVAL-STLKT01V1](#) evaluation board and for [X-NUCLEO-CCA02M1](#), [X-NUCLEO-IKS01A2](#) and [X-NUCLEO-IDB05A1](#) connected to a [NUCLEO-L476RG](#) board
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

## Description

[FP-AI-SENSING1](#) is an [STM32Cube](#) function pack featuring examples that let you connect your IoT node to a smartphone via BLE and use a suitable Android™ or iOS™ application, like the [STBLESensor](#) app, to configure the device.

The package enables advanced applications such as human activity recognition or audio scene classification, on the basis of outputs generated by neural networks (NN). The NN are implemented by libraries generated by the [X-CUBE-AI](#) extension for STM32CubeMX tool.

The NN provided in this package are just examples of what can be achieved by combining the output of X-CUBE-AI with connectivity and sensing components from ST.

The package comes with an AI utility for data logging and annotation on SD card. You can record the data from the sensors and define which classes or events to record. With the recorded annotated data, you can train your own neural network on your PC/GPU/cloud, get the model, use X-CUBE-AI extension for STM32CubeMX tool for conversion, and then run it on the STM32 platform.

This package, together with the suggested combination of STM32 and ST devices, can be used to develop specific wearable AI applications, industrial predictive maintenance applications, smart things and building applications in general, where ultra-low power consumption is a key requirement.

The software runs on the STM32 microcontroller and includes all the necessary drivers for the [STM32 Nucleo](#) development board and expansion boards, as well as for the [STEVAL-STLKT01V1](#) evaluation board.

Product summary	
STM32Cube function pack for ultra-low power with artificial intelligence (AI) application based on audio and motion sensing	<a href="#">FP-AI-SENSING1</a>
Neural network library extension for STM32CubeMX tool	<a href="#">X-CUBE-AI</a>
Bluetooth low energy expansion board based on SPBTLE-RF module for STM32 Nucleo	<a href="#">X-NUCLEO-IDB05A1</a>
Motion MEMS and environmental sensor expansion board	<a href="#">X-NUCLEO-IKS01A2</a>
SensorTile development kit	<a href="#">STEVAL-STLKT01V1</a>
BLE sensor application for Android and iOS	<a href="#">STBLESensor</a>

## 1 Detailed description

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### 1.1 What can you do with STM32Cube function packs?

The [STM32Cube](#) function packs leverage the modularity and interoperability of STM32 Nucleo and X-NUCLEO boards, and STM32Cube and X-CUBE software, to create function examples, embodying some of the most common use cases, for each application area.

These software function packs are designed to exploit as much as possible the underlying [STM32 ODE](#) hardware and software components to best fit the requirements of final users' applications.

Moreover, function packs may include additional libraries and frameworks which do not present the original X-CUBE packages, thus enabling new functionalities and creating a real and usable system for developers.

### 1.2 What is STM32Cube?

[STMCube™](#) is an STMicroelectronics initiative that helps you reduce development effort, time and cost. STM32Cube covers the STM32 portfolio.

STM32Cube version 1.x includes:

- STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code using graphical wizards.
- A comprehensive embedded software platform specific to each series (such as the STM32CubeF4 for the STM32F4 series), which includes:
  - the STM32Cube HAL embedded abstraction-layer software, ensuring maximized portability across the STM32 portfolio
  - a consistent set of middleware components such as RTOS, USB, TCP/IP and graphics
  - all embedded software utilities with a full set of examples

### 1.3 How does this function pack complement STM32Cube?

This software is based on the STM32CubeHAL. It extends [STM32Cube](#) by providing a board support package (BSP) for the BLE, sensor and microphone expansion boards and middleware components for communication with other BLE devices.

The package contains several libraries implementing various neural network models.

It also provides an AI data logging and annotation utility and some sample applications to demonstrate, on a smartphone using the [STBLESensor](#) app, the use cases related to human activity recognition and acoustic scene classification.

## Revision history

**Table 1. Document revision history**

Date	Version	Changes
20-Nov-2018	1	Initial release.

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