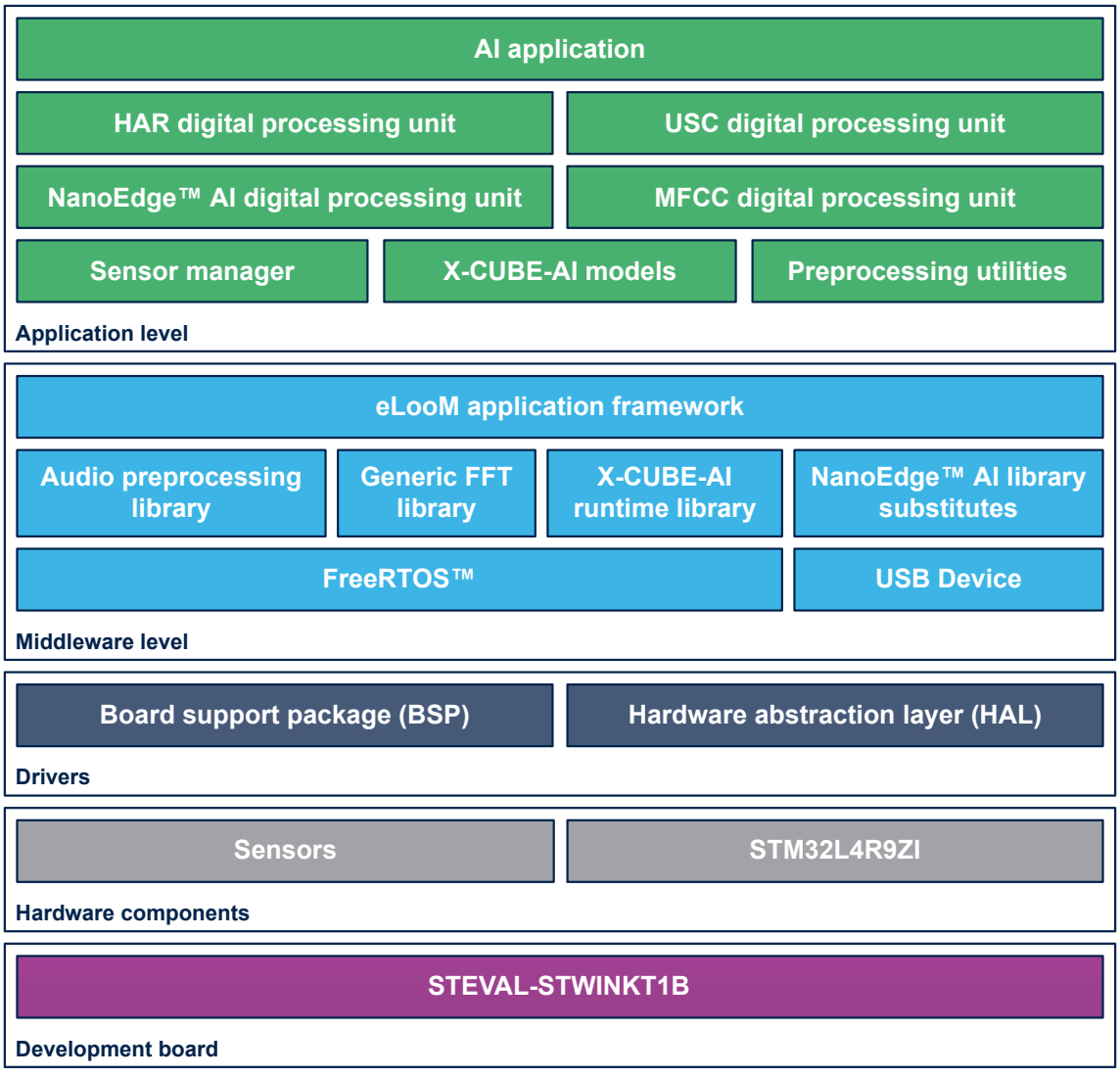
FP-AI-MONITOR1

Data brief

Multi-sensor AI data monitoring framework on wireless industrial node, function pack for STM32Cube



Product status link
FP-AI-MONITOR1

Features

- Application example of human activity classification based on motion sensors
- Application example of combined anomaly detection based on vibration and anomaly classification based on ultrasound
- Complete firmware to program an STM32L4+ sensor node for an AI-based sensor monitoring application on the STEVAL-STWINKT1B SensorTile wireless industrial node
- Runs classical Machine Learning (ML) and Artificial Neural Network (ANN) models generated by the X-CUBE-AI, an STM32Cube Expansion Package
- Runs NanoEdge™ AI libraries generated by NanoEdge™ AI Studio (NanoEdgeAIStudio) for AI-based sensing applications. Easy integration by replacing the preintegrated substitute
- Application binary of high-speed datalogger for STEVAL-STWINKT1B data record from any combination of sensors and microphones configured up to the maximum sampling rate on a microSD™ card
- eLooM (embedded Light object-oriented fraMework) enabling efficient development of soft real-time, multitasking, event-driven embedded applications on STM32L4+ Series microcontrollers
- Sensor manager eLooM component to configure any board sensors easily, and suitable for production applications
- Digital processing unit (DPU) eLooM component providing a set of processing blocks, which can be chained together, to apply mathematical transformations to the sensors data
- Configurable autonomous mode controlled by user button
- Interactive command-line interface (CLI):
  - Node and sensor configuration
  - Configuration of applications running either an X-CUBE-AI ML or ANN model, or a NanoEdge™ AI Studio (NanoEdgeAIStudio) model with learn-and-detect capability
  - Configuration of applications running concurrently an X-CUBE-AI ANN model, and a NanoEdge™ AI Studio model with learn-and-detect capability
  - Configuration of applications running a NanoEdge™ AI Studio model with classification capability
- Easy portability across STM32 microcontrollers by means of the STM32Cube ecosystem
- Free and user-friendly license terms

Description

The FP-AI-MONITOR1 function pack helps to jump-start the edge AI implementation and development for sensor-monitoring-based applications designed with X-CUBE-AI or with the NanoEdge™ AI Studio . It covers the entire design of the Machine Learning cycle from the data set acquisition to the integration on a physical node. The examples provided allow the user to create, in a matter of minutes, a proof of concept for a predictive maintenance solution with anomaly detection and classification based on both vibration and ultrasound, but also on activity recognition. These examples can be fine-tuned to fit the user's dedicated use cases by retraining the models with the user's data set.

X-CUBE-AI is an STM32Cube Expansion Package part of the STM32Cube.AI ecosystem. It extends the STM32CubeMX capabilities with the automatic conversion of pretrained Neural Network or Machine Learning models and the integration of the generated optimized library into the user's project. X-CUBE-AI offers also several means to validate AI models both on desktop PC and STM32, as well as to measure performance on STM32 devices without user handmade specific C code. The support vector classifier used for human activity recognition (HAR) example is generated by X-CUBE-AI. Other applications can be created using optimized ML and DNN code generated by X-CUBE-AI.

NanoEdge™ AI Studio (NanoEdgeAIStudio) simplifies the creation of autonomous Machine Learning libraries with the possibility of running training on target and inference on the edge. For instance, condition-based monitoring applications using vibration and motion data can be created easily by recompiling the function pack with NanoEdge™ AI anomaly detection models.

FP-AI-MONITOR1 runs the learning session and the inference in real time on an STM32L4R9ZI ultra-low-power microcontroller (Arm® Cortex®-M4 at 120 MHz with 2 Mbytes of flash memory and 640 Kbytes of SRAM), taking physical sensor data as input. The SensorTile wireless industrial node (STEVAL-STWINKT1B) embeds industrial-grade sensors, including very high frequency audio and ultrasound spectra detection, 6-axis IMU, 3-axis accelerometer, and vibrometer to record any inertial and vibrational data with high accuracy at high frequencies.

FP-AI-MONITOR1 implements a wired interactive CLI to configure the node, and manage the learn and detect phases. For simple operation in the field, a standalone battery-operated mode allows basic controls through the user button, without using the console.

1 General information

1.1 Ordering information

FP-AI-MONITOR1 is available to download from the *www.st.com* website as described in Table 1. Retrieve more information on STM32CubeMX and X-CUBE-AI on *www.st.com*.

Table 1. FP-AI-MONITOR1 ordering information

Order code	Target board	Target STM32	Detailed information
FP-AI-MONITOR1	STEVAL-STWINKT1B	STM32L4R9ZI	• Getting started (wiki) • User manual (wiki)

1.2 What is STM32Cube?

STM32Cube is an STMicroelectronics original initiative to improve designer productivity significantly by reducing development effort, time, and cost. STM32Cube covers the whole STM32 portfolio.

STM32Cube includes:

- A set of user-friendly software development tools to cover project development from conception to realization, among which are:
  - STM32CubeMX, a graphical software configuration tool that allows the automatic generation of C initialization code using graphical wizards
  - STM32CubeIDE, an all-in-one development tool with peripheral configuration, code generation, code compilation, and debug features
  - STM32CubeProgrammer (STM32CubeProg), a programming tool available in graphical and command-line versions
  - STM32CubeMonitor (STM32CubeMonitor, STM32CubeMonPwr, STM32CubeMonRF, STM32CubeMonUCPD) powerful monitoring tools to fine-tune the behavior and performance of STM32 applications in real time
- STM32Cube MCU and MPU Packages, comprehensive embedded-software platforms specific to each microcontroller and microprocessor series (such as STM32CubeL4 for the STM32L4+ Series), which include:
  - STM32Cube hardware abstraction layer (HAL), ensuring maximized portability across the STM32 portfolio
  - STM32Cube low-layer APIs, ensuring the best performance and footprints with a high degree of user control over hardware
  - A consistent set of middleware components such as RTOS, USB Host and Device, FAT file system, touch library, and graphics
  - All embedded software utilities with full sets of peripheral and applicative examples
- STM32Cube Expansion Packages, which contain embedded software components that complement the functionalities of the STM32Cube MCU and MPU Packages with:
  - Middleware extensions and applicative layers
  - Examples running on some specific STMicroelectronics development boards

2 License

FP-AI-MONITOR1 is delivered under the *Mix Ultimate Liberty+OSS+3rd-party V1* software license agreement (SLA0048).

The software components provided in this package come with different license schemes as shown in Table 2.

Table 2. Software component license agreements

Software component	Copyright	License
Arm® Cortex®-M CMSIS	Arm Limited	Apache License 2.0
FreeRTOS™	Amazon.com, Inc. or its affiliates	The MIT License
STM32L4xx_HAL_Driver	STMicroelectronics	BSD-3-Clause
Board support package (BSP)	STMicroelectronics	BSD-3-Clause
STM32L4xx CMSIS	Arm Limited - STMicroelectronics	Apache License 2.0
eLooM application framework	STMicroelectronics	Proprietary
Python™ scripts	STMicroelectronics	BSD-3-Clause
Dataset	STMicroelectronics	Proprietary
Application	STMicroelectronics	Proprietary
Sensor manager	STMicroelectronics	Proprietary
Audio preprocessing library	STMicroelectronics	Proprietary
Generic FFT library	STMicroelectronics	Proprietary
X-CUBE-AI runtime library	STMicroelectronics	Proprietary
X-CUBE-AI models	STMicroelectronics	Proprietary
NanoEdge™ AI libraries substitutes	STMicroelectronics	Proprietary
Signal processing library	STMicroelectronics	Proprietary
Digital processing units	STMicroelectronics	Proprietary
Trace analyzer recorder	Percepio AB	Percepio(1)

1. *Refer to PERCEPIO terms of use.*

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

arm

PERCEPIO terms of use

Terms of Use

This file is part of the trace recorder library (RECORDER), which is the intellectual property of Percepio AB (PERCEPIO) and provided under a license as follows.

The RECORDER may be used free of charge for the purpose of recording data intended for analysis in PERCEPIO products. It may not be used or modified for other purposes without explicit permission from PERCEPIO.

You may distribute the RECORDER in its original source code form, assuming this text (terms of use, disclaimer, copyright notice) is unchanged. You are allowed to distribute the RECORDER with minor modifications intended for configuration or porting of the RECORDER, e.g., to allow using it on a specific processor, processor family or with a specific communication interface. Any such modifications should be documented directly below this comment block.

Revision history

Table 3. **Document revision history**

Date	Revision	Changes
17-Sep-2021	1	Initial release.
25-Mar-2022	2	Updated for the V2.0.0 release of the function pack: • Updated the cover picture • Updated Features, Description, and License • Updated the links to the wiki pages in Ordering information