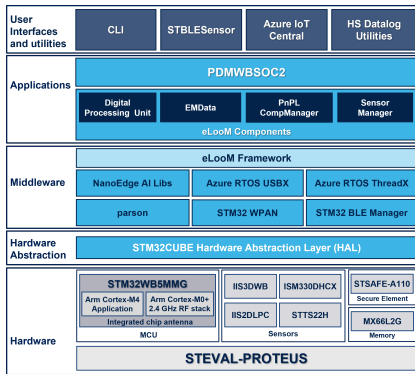


STM32Cube function pack for STEVAL-PROTEUS1 for AI anomaly detection and classification based on AzureRTOS



Features

- Firmware to develop a WPAN sensor node for predictive maintenance applications, featuring motion sensors and performing anomaly detection or classification controlled via Bluetooth® Low Energy connectivity
- STM32 wireless personal area network middleware developed within the STM32WB framework used to support Bluetooth® Low Energy 5
- Compatible with [NanoEdgeAIStudio](#) solution to enable AI-based applications
- On-board battery status monitor
- Compatible with [STBLEsensClassic](#) app (Android and iOS) to enable AI library control and monitoring, settings by PnP-Like protocol messages, firmware update via fast FUOTA, and bridging data to the Azure IoT central PnP cloud dashboard
- Based on accelerometer data up to 6 kHz bandwidth
- NanoEdge AI library generated to run in the STM32WB module. Anomaly detection model storable in the external NOR flash memory
- Firmware modular example based on the embedded light object-oriented framework (eLooM) to enable code reusability at application level
- Utilities: high speed datalog in binary format, python scripts and batch files to use it
- AzureRTOS: ThreadX, USBX
- Free, user-friendly license terms

Description

FP-AI-PDMWBSOC2 is an [STM32Cube](#) function pack for the [STEVAL-PROTEUS1](#), able to get motion sensor data, process them to make anomaly detection and faults classification, and send the results to the [STBLEsensClassic](#) mobile app, a PC terminal console and on Azure IoT central dashboard.

The function pack helps to explore the implementation and development of a predictive maintenance application that embeds the NanoEdge AI library middleware, capable to provide an AI-based solution (the NanoEdge AI libraries are generated using [NanoEdgeAIStudio](#)).

Using the datalogging binary file, the raw data can be extracted from the sensors inside the [STEVAL-PROTEUS1](#) board and provided to the [NanoEdgeAIStudio](#) software to extract machine learning libraries for anomaly detection and classification.

These NanoEdge AI libraries, customized and built on the classified set of data, can be easily updated inside the framework architecture proposed, facilitating the early detection of warning status and potential failure within the equipment.

FP-AI-PDMWBSOC2 implements two different HMI communication tools at user level: a wired interactive CLI (USB CDC) to configure the node and manage the learning, detecting and classifying phases, and the [STBLEsensClassic](#) app with dedicated pages to provide the same functionalities. The [STBLEsensClassic](#) mobile app works also as a bridge to display data on Azure IoT Central dashboard.

To start/stop the learning, detecting and classifying phases, an additional control, indicated by LEDs, can be performed by just pressing the user button.

Product summary	
STM32Cube function pack for STEVAL-PROTEUS1 for AI anomaly detection and classification based on AzureRTOS	FP-AI-PDMWBSOC2
Industrial sensor evaluation kit for condition monitoring based on the 2.4 GHz STM32WB5MMG module	STEVAL-PROTEUS1
BLE Sensor Classic application for Android and iOS	STBLEsensClassic
Automated Machine Learning (ML) tool for STM32 developers	NanoEdgeAIStudio
Applications	Condition Monitoring/ Predictive Maintenance IoT for Smart Industry

The NanoEdge libraries functionalities are based on a set of application-level modules (Sensor Manager, Digital Processing Unit, EM Data, PnPLCompManager), useful to reuse and easily extendable to build other customized applications.

1 Detailed description

1.1 What can you do with STM32Cube function packs?

STM32Cube function packs leverage the modularity and interoperability of STM32 Nucleo and X-NUCLEO boards together with STM32Cube and X-CUBE software to create function examples for some of the most common use cases of different application technologies.

These software function packs are designed to exploit the underlying STM32 ODE hardware and software components as much as possible to best satisfy the requirements of final user applications.

Moreover, function packs may include additional libraries and frameworks that are not present in the original X-CUBE packages, thus enabling new functionalities allowing real and usable system for developers.

1.2 What is STM32Cube?

STM32Cube is a combination of a full set of PC software tools and embedded software blocks running on STM32 microcontrollers and microprocessors:

- [STM32CubeMX](#) configuration tool for any STM32 device; it generates initialization C code for Cortex-M cores and the Linux device tree source for Cortex-A cores
- [STM32CubeIDE](#) integrated development environment based on open-source solutions like Eclipse or the GNU C/C++ toolchain, including compilation reporting features and advanced debug features
- [STM32CubeProgrammer](#) programming tool that provides an easy-to-use and efficient environment for reading, writing and verifying devices and external memories via a wide variety of available communication media (JTAG, SWD, UART, USB DFU, I2C, SPI, CAN, etc.)
- STM32CubeMonitor family of tools ([STM32CubeMonRF](#), [STM32CubeMonUCPD](#), [STM32CubeMonPwr](#)) to help developers customize their applications in real-time
- [STM32Cube MCU and MPU packages](#) specific to each STM32 series with drivers (HAL, low-layer, etc.), middleware, and lots of example code used in a wide variety of real-world use cases
- [STM32Cube expansion packages](#) for application-oriented solutions.

1.3 How does this function pack complement STM32Cube?

This software is based on the STM32CubeHAL. It extends [STM32Cube](#) by providing support for the [STEVAL-PROTEUS1](#) evaluation kit to develop specific industrial predictive maintenance applications for early detection of warning signs of potential failure.

The package is mainly based on the following mandatory key elements:

- The Azure ThreadX™ operating system middleware for real-time execution
- The eLoOM middleware to implement the object-oriented methodology for data management and processing with the AI library, easy to use at application level, which integrates four reusable software modules:
 - The sensor manager component retrieves sensor data and sets the sensor parameters. It is implemented as an acquisition engine that:
 - Controls multiple task accesses to the sensor bus
 - Defines interfaces to avoid implementation dependencies
 - Dispatches events to notify when a certain amount of data is available
 - The digital processing unit (DPU) component provides a set of processing blocks, which can be chained together, to create complex processing functions that use data stream coming from sensor manager. Available processing modules include:
 - Anomaly detection (AD)
 - N-Class classification (NCC)
 - The EM data component defines a common data model among eLoOM framework aligned to the standards used in data science tools. Around this data format, the component provides also some util classes and interfaces to address data driven use-cases.
 - The PnPL CompManager deals with PnP-Like messages parsing.

Further details are available in the "Documentation" folder of the function pack and in the "Doc" folder of each firmware module.

Revision history

Table 1. Document revision history

Date	Revision	Changes
20-Jun-2023	1	Initial release.

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