STM32Cube function pack for MEMS microphone acquisition, advanced audio processing and audio output
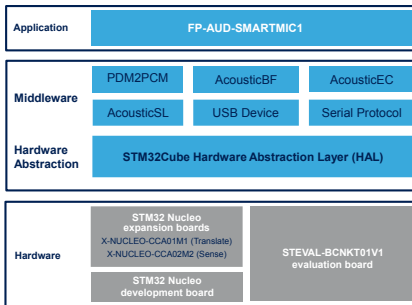

Features

- Software expansions for STM32Cube:
    - AcousticBF real-time beam forming
    - AcousticEC real-time acoustic echo cancellation
    - AcousticSL real-time sound source localization
- Complete application including all the acoustic functions in a single sample application
- Software graphic user interface to easily control parameters and algorithms from a host PC
- Free, user-friendly license terms
- Sample implementation available on a NUCLEO-F446RE development board when connected to an X-NUCLEO-CCA01M1 and an X-NUCLEO-CCA02M2 expansion board
- Sample implementation available on the BlueCoin starter kit (STEVAL-BCNKT01V1)

Description

FP-AUD-SMARTMIC1 is an STM32Cube function pack. This software package implements a complete application targeting advanced processing for MEMS microphone arrays, including digital MEMS microphone acquisition, beamforming, source localization and acoustic echo cancellation. The processed audio is sent to a USB host and a loudspeaker connected to the relevant expansion boards.

The function pack is built on STM32Cube software technology to ease portability across different STM32 microcontrollers.

This sample implementation supports two kind of systems: STM32 NUCLEO-F446RE development board equipped with the X-NUCLEO-CCA01M1 or X-NUCLEO-CCA02M2 expansion boards and the STEVAL-MIC001V1, STEVAL-MIC002V1, STEVAL-MIC003V1 or STEVAL-MIC005V1 digital microphone evaluation boards or the BlueCoin starter kit (STEVAL-BCNKT01V1).

The software is available also on GitHub, where the users can signal bugs and propose new ideas through [**Issues**] and [**Pull Requests**] tabs.

Product summary	
STM32Cube function pack for MEMS microphone acquisition, advanced audio processing and audio output	FP-AUD-SMARTMIC1
Sound terminal expansion board based on STA350BW for STM32 Nucleo	X-NUCLEO-CCA01M1
Digital MEMS microphone expansion board based on MP34DT06J for STM32 Nucleo	X-NUCLEO-CCA02M2
BlueCoin starter kit	STEVAL-BCNKT01V1
Applications	Sound Sensing Speakers Remote Controls

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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.

The FP-AUD-SMARTMIC1 firmware is based on the STM32CubeHAL hardware abstraction layer for the STM32 microcontroller, and exploits BSP and middleware layers to build a complete acoustic application based on a MEMS microphone array. The software acquires audio signals from four digital MEMS microphones, elaborates them using embedded DSP libraries and streams the processed audio to a USB host and a loudspeaker connected to the relevant expansion boards.

A software example which performs a set of operations to remotely control the device from a PC host is also provided.

The package includes several audio DSP libraries:

- the AcousticBF library provides an implementation for a real-time adaptive beamforming algorithm - using the audio signals acquired from two digital MEMS microphones, it creates a virtual directional microphone pointing to a fixed direction in space;
- the AcousticEC library provides an implementation for a real-time echo cancellation routine based on the well-known SPEEX implementation of the MDF algorithm;
- the AcousticSL library provides an implementation for a real-time sound source localization algorithm: using 2 or 4 signals acquired from digital MEMS microphones, it can estimate the arrival direction of the audio source.

The firmware provides a sample implementation supporting two systems:

- STM32 NUCLEO-F446RE development board equipped with the X-NUCLEO-CCA01M1 expansion board (based on the STA350BW Sound Terminal® 2.1-channel high-efficiency digital audio output system) or X-NUCLEO-CCA02M2 expansion board (based on the MP34DT06J digital MEMS microphones) and STEVAL-MIC001Vx, STEVAL-MIC002Vx or STEVAL-MIC003Vx digital microphone evaluation boards
- BlueCoin starter kit (STEVAL-BCNKT01V1)

Revision history

Table 1. Document revision history

Date	Version	Changes
12-Jun-2017	1	Initial release.
19-Apr-2018	2	Updated title and cover image.
24-Jan-2020	3	Added X-NUCLEO-CCA02M2 expansion board compatibility information.
11-Nov-2022	4	Updated cover page description.

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