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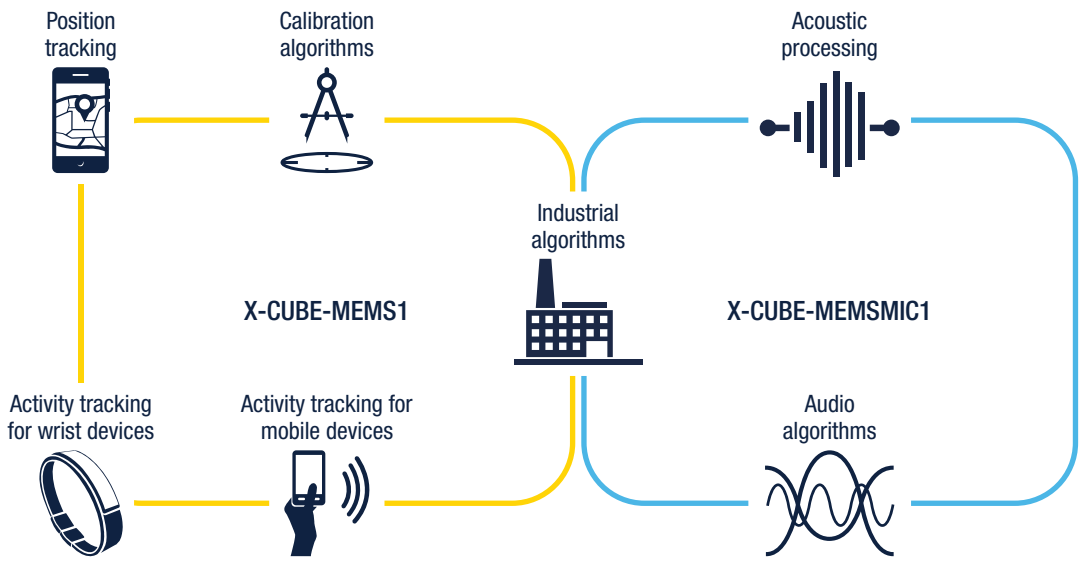
Sensor libraries software pack for STM32Cube

STM32 Open Development Environment



EXPLORE ST SENSOR SOFTWARE LIBRARIES WITH EXAMPLE CODE AND SAMPLE APPLICATIONS FOR STM32 OPEN DEVELOPMENT ENVIRONMENT

Discover the X-CUBE-MEMS1 and X-CUBE-MEMSMIC1 software expansion packages, including a wide set of examples and libraries which help developers to rapidly develop and evaluate applications based on real-time data from ST's MEMS sensors.

X-CUBE software packages are part of STM32 ODE program, and they are built on STM32Cube software technology for ease of portability across different STM32 microcontroller series, the expansion software packages provides advanced motion, environmental and, audio libraries for microcontrollers based on ARM Cortex-M3, M4, M7, M33 and M0+ architecture and also sample applications prepared for STM32 Nucleo-64 development boards with high-performance STM32F4, STM32F7 MCU or ultra-low-power STM32L0, STM32L1, STM32L4 MCU.

The X-CUBE-MEMS1 expansion software package for STM32Cube runs on the STM32 and includes drivers for configuring the sensors and collect temperature, humidity, pressure and motion data. The package also includes libraries for sensors calibration and algorithms for position and activity tracking.

The X-CUBE-MEMSMIC1 includes drivers for digital and analog microphones, ultrasound condition monitoring that calculates the Fast Fourier Transformation of the analog microphone signal, also libraries for advanced audio processing, like audio Beamforming and Source Localization.

KEY FEATURES

- Complete software and example code for building applications with ST's innovative sensors
- Compatible with STM32 ODE hardware and software ecosystem
- Compatible with the Unicleo-GUI graphical user interface to configure and display outputs from sensor and algorithm in real time
- Easy portability across different MCU families, thanks to STM32Cube development ecosystem
- Free, user-friendly license terms

The X-CUBE-MEMS1 contains following advanced motion libraries:

Action	Library	Description	MEMS sensor	Application
	MotionAC accelerometer calibration	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAC2 accelerometer calibration 2 axis	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAD airplane detection	Detect airplane mode from hand-held devices to automatically avoid potential hazards such as interference with wireless communication and battery explosion due to high current drawn by the airplane outlet.	Accelerometer, pressure and temperature	Mobile phone, laptop, tablet
	MotionAR activity recognition	Provides real-time information on the type of activity performed by the user including stationary, walking, fast walking, jogging, biking, or driving.	Accelerometer	Phone
	MotionAT active time	Based on type of activity, detects motion intensity and pedometer data in real time using wrist algorithms to determine the number of active seconds.	Accelerometer	Wearables
	MotionAW activity recognition for wrist	Provides real-time information on the type of activity performed by the user including stationary, standing, sitting, lying, walking, fast walking, jogging, or biking.	Accelerometer	Wearables
	MotionCP carrying position	Provides real-time information about how the user is carrying a device (e.g. cell phone). It is able to distinguish the following positions: on desk, in hand, near head, shirt pocket, trouser pocket, swinging arm and jacket pocket.	Accelerometer	Phone
	MotionDI dynamic Inclinometer	Provides information about the device position (quaternions, Euler angles, linear acceleration, gravity vector).	Accelerometer and gyroscope	Phone
	MotionEC eCompass	Provides real-time information about the device orientation and movement: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.	Accelerometer and magnetometer	Any
	MotionFA fitness activities	Provides real-time information about the repetition quantity of various fitness activities performed by a user.	Accelerometer and pressure sensor	Wearables
	MotionFD fall detection library	Provides real-time information about user fall events. It is able to distinguish if the user fell or not.	Accelerometer and pressure sensor	Wearables
	MotionFX sensor fusion	Provides real-time motion-sensor data from the accelerometer, gyroscope (6-axis fusion) and magnetometer (9-axis fusion) and provides real-time motion-fusion sensing. It also performs gyroscope bias and magnetometer hard iron calibration.	Accelerometer, magnetometer and gyroscope	Any
	MotionGC gyroscope calibration	Used to calibrate the gyroscope in real time using angular zero-rate level coefficients (offset). The gyroscope sensor can have significant offset, which can cause problems when using the gyroscope output data. The MotionGC library is able to minimize the offset and solve this issue.	Accelerometer and gyroscope	Any
	MotionGR gesture recognition	Provides real-time information about the gesture just performed by the user with the device, such as a cell phone, including pick-up, glance, wake up.	Accelerometer	Phone
	MotionID motion intensity detection	Provides real-time information about the user motion intensity. It is able to distinguish motion intensity in a range from 0 (still) to 10 (sprinting).	Accelerometer	Wearables

Action	Library	Description	MEMS sensor	Application
	MotionMC magnetometer calibration	Used to calibrate the magnetometer in real time using hard iron (HI) and scale factor coefficients.	Magnetometer	Any
	MotionPE pose estimation	Provides real-time information about the user current pose such as sitting, standing and lying down.	Accelerometer	Wearables
	MotionPM pedometer for mobile	Provides real-time information about the number of steps and cadence just performed by the user carrying the device, such as a cell phone.	Accelerometer	Phone
	MotionPW pedometer for wrist	Provides real-time information about the number of steps and cadence which the user just performed wearing the device on the wrist (e.g. a smart watch).	Accelerometer	Wearables
	MotionSD standing and sitting desk detection	Provides real-time information about the user working mode: sitting at the desk or standing desk position.	Accelerometer	Wearables
	MotionSM sleep monitoring	Provides real-time information if the man wearing the device is sleeping or not.	Accelerometer	Wearables
	MotionSP vibration monitoring	Provides frequency spectrum or accelerometer signal, acceleration RMS, speed RMS and acceleration peak values.	Accelerometer	Any
	MotionTL and MotionTL2 tilt sensing	Provides real-time information about the tilt angles of the user carrying the device, i.e. cell phone. The library is also able to perform 6-position accelerometer calibration.	Accelerometer	Any
	MotionVC Vertical Context	It provides real-time information about vertical movement. The library is able to detect a change of altitude and distinguish the type of vertical movement: stairs, elevator, and escalator.	Accelerometer and pressure	Any

The X-CUBE-MEMSMIC1 contains following advanced audio libraries and firmware examples:

Library	Description	MEMS sensor	Application
AcousticBF beam forming	Provides an implementation for a real-time adaptive beamforming algorithm: it creates a virtual directional microphone pointing in a fixed direction in space.	Two microphones	Any
AcousticSL sound localization	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.	Two or four microphones	Any
Microphone streaming via USB	This firmware example shows up how to build a USB microphone.	From one to four microphones	Any
Ultrasound FFT	This firmware example enables ultrasound condition monitoring by calculating the FFT of the analog microphone signal and by streaming the result to a PC GUI via USB.	One microphone	Any

STM32 ODE ecosystem

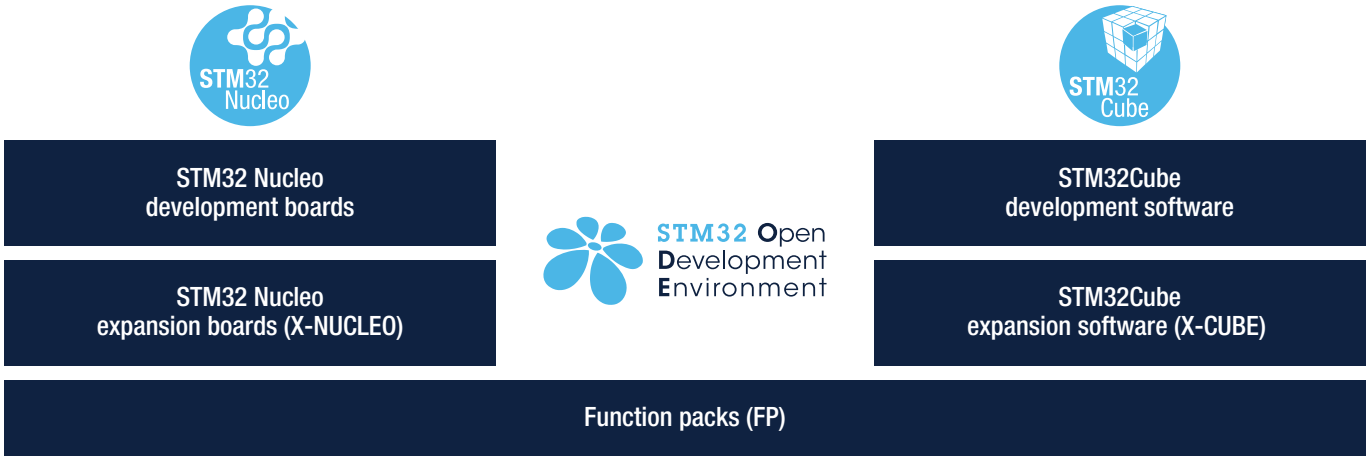
FAST, AFFORDABLE PROTOTYPING AND DEVELOPMENT

The STM32 Open Development Environment (ODE) is an open, flexible, easy and affordable way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs.

The STM32 ODE includes the following five elements:

- STM32 Nucleo development boards. A comprehensive range of affordable development boards for all STM32 microcontroller series, with unlimited unified expansion capability, and with integrated debugger/programmer
- STM32 Nucleo expansion boards. Boards with additional functionality to add sensing, control, connectivity, power, audio or other functions as needed. The expansion boards are plugged on top of the STM32 Nucleo development boards. More complex functionalities can be achieved by stacking additional expansion boards
- STM32Cube software. A set of free-of-charge tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer, middleware and the STM32CubeMX PC-based configurator and code generator
- STM32Cube expansion software. Expansion software provided free of charge for use with STM32 Nucleo expansion boards, and compatible with the STM32Cube software framework
- STM32Cube Function Packs. Set of function examples for some of the most common application cases built by leveraging the modularity and interoperability of STM32 Nucleo development boards and expansions, with STM32Cube software and expansions.

The STM32 Open Development Environment is compatible with a wide range of development environments including STM32CubeIDE, IAR EWARM, Keil MDK-ARM and GCC/LLVM-based IDEs, with the possibility to integrate the various components such as STM32CubeMX, STM32CubeProgrammer or STM32CubeMonitor.



FIND OUT MORE

www.st.com/stm32ode

EXPANSION BOARDS FOR MOTION SENSOR ALGORITHMS

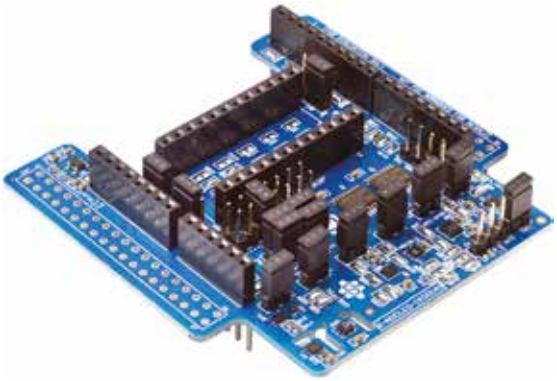
For quick and easy testing, the X-CUBE-MEMS1 contains examples to test sensor's features and sample applications for libraries. These examples and application are available in source code with projects for most common IDE. Already compiled binaries are available for even easier testing. The samples and application are prepared for the expansion boards: X-NUCLEO-IKS01A2, X-NUCLEO-IKS01A3 and X-NUCLEO-IKS02A1.

X-NUCLEO-IKS01A2

- LSM6DSL MEMS 3D accelerometer and 3D gyroscope
- LSM303AGR MEMS 3D accelerometer and MEMS3D magnetometer
- LPS22HB MEMS pressure sensor, absolute digital output barometer
- HTS221: capacitive digital relative humidity and temperature
- DIL24 socket for additional MEMS adapters and other sensors
- I²C sensor hub features on LSM6DSL available
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- RoHS compliant

X-NUCLEO-IKS01A3

- LSM6DSO MEMS 3D accelerometer and 3D gyroscope
- LIS2MDL MEMS 3D magnetometer
- LIS2DW12 MEMS 3D accelerometer
- LPS22HH MEMS pressure sensor, absolute digital output barometer
- HTS221: capacitive digital relative humidity and temperature
- STTS751: temperature sensor
- DIL24 socket for additional MEMS adapters and other sensors
- I²C sensor hub features on LSM6DSO available
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- RoHS compliant



X-NUCLEO-IKS02A1

- ISM330DHCX MEMS 3D accelerometer plus 3D gyroscope
- IIS2MDC MEMS 3D magnetometer
- IIS2DLPC MEMS 3D accelerometer low power
- IMP34DT05 MEMS digital omnidirectional microphone
- DIL 24-pin socket available for additional MEMS adapters and other sensors
- Available I²C sensor hub features on ISM330DHCX
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- RoHS and WEEE compliant

SUPPORTING MOTION SENSOR ALGORITHMS

- NUCLEO-F767ZI STM32F767ZI (ARM Cortex-M7)
- NUCLEO-F401RE STM32F401RE (ARM Cortex-M4)
- NUCLEO-L476RG STM32L476RG (ARM Cortex-M4)
- NUCLEO-L152RE STM32L152RE (ARM Cortex-M3)
- NUCLEO-L073RZ STM32L073RZ (ARM Cortex-M0+)

To learn more and to download the X-CUBE-MEMS1 Sensor and motion algorithm software expansion pack for STM32Cube, visit: **https://www.st.com/en/embedded-software/x-cube-mems1.html**

	Available for STM32 with architecture					Application out of the box availability		
	ARM Cortex M0+	ARM Cortex M3	ARM Cortex M4	ARM Cortex M7	ARM Cortex M33	X-NUCLEO-IKS01A2	X-NUCLEO-IKS01A3	X-NUCLEO-IKS02A1
MotionAC		X	X	X	X	X	X	X
MotionAC2	X	X	X	X	X	X*	X*	X*
MotionAD		X	X	X	X	X	X	
MotionAR		X	X	X	X	X	X	
MotionAT		X	X	X	X	X	X	
MotionAW		X	X	X	X	X	X	
MotionCP		X	X	X	X	X	X	
MotionDI		X	X	X	X	X	X	X
MotionEC	X	X	X	X	X	X	X	X
MotionFA		X	X	X	X	X	X	
MotionFD		X	X	X	X	X	X	
MotionFX	X	X	X	X	X	X	X	X
MotionGC	X	X	X	X	X	X	X	X
MotionGR		X	X	X	X	X	X	
MotionID	X	X	X	X	X	X	X	
MotionMC	X	X	X	X	X	X	X	X
MotionPE		X	X	X	X	X	X	
MotionPM		X	X	X	X	X	X	
MotionPW		X	X	X	X	X	X	
MotionSD		X	X	X	X	X	X	
MotionSP			X	X	X	X	X	X
MotionTL	X	X	X	X	X	X	X	X
MotionTL2	X	X	X	X	X	X*	X*	X*
MotionVC		X	X	X	X	X	X	
SoundMeter			X	X	X			X
MicrophoneFFT		X	X	X	X			X

Note: * With IIS2ICLX

EXPANSION BOARDS FOR AUDIO ALGORITHMS

For quick and easy testing of audio algorithms, the samples and application libraries contained in X-CUBE-MEMSMIC1 are prepared for the expansion boards: X-NUCLEO-CCA02M2 and X-NUCLEO-AMICAM1, and the compact solution board STEVAL-STWINKT1.

X-NUCLEO-CCA02M2

- 2 on-board MP34DT06J digital MEMS microphones
- 6 slots to plug in digital microphone coupon boards such as STEVAL-MIC002V1, STEVAL-MIC003V1, STEVAL-MIC005V1 and STEVAL-MIC006V1
- Synchronized acquisition and streaming of up to 4 microphones
- Compatible with STM32 Nucleo boards Equipped with ST morpho connector (upwards and downwards)
- Equipped with Arduino UNO R3 connector (upwards) to allow multiple boards
- RoHS and WEEE compliant

X-NUCLEO-AMICAM1

- 3 on-board MP23ABS1 analog MEMS microphones
- 5 slots to plug analog microphone coupon boards (e.g., STEVAL-MIC004V1)
- Synchronized acquisition and streaming of up to 4 microphones
- Amplification stage based on TSV91x wide bandwidth operational amplifiers
- On-board external ADC
- Direct acquisition of a single microphone exploiting STM32 embedded ADC
- Up to 192 KHz sampling frequency
- Free comprehensive development firmware library and audio capture plus USB streaming sample application compatible with STM32Cube
- Compatible with STM32 Nucleo boards
- Equipped with ST morpho connectors (top and bottom) and Arduino UNO R3 connectors (top) to allow stacking of multiple boards
- RoHS and WEEE compliant

STEVAL-STWINKT1B

- Multi-sensing wireless platform implementing vibration monitoring and ultrasound detection
- Built around STWIN core system board with processing, sensing, connectivity and expansion capabilities
- Micro SD Card slot for standalone data logging applications
- Wireless BLE4.2 (on-board) and Wi-Fi (with STEVAL-STWINWFV1 expansion board), and wired RS485 and USB OTG connectivity
- Wide range of industrial IoT sensors:
  - Ultra-wide bandwidth (up to 6 kHz), low-noise, 3-axis digital vibration sensor (IIS3DWB)
  - 3D accelerometer + 3D Gyro iNEMO inertial measurement unit (ISM330DHCX) with machine learning core
  - Ultra-low-power high performance MEMS motion sensor (IIS2DH)
  - Ultra-low-power 3-axis magnetometer (IIS2MDC)
  - Digital absolute pressure sensor (LPS22HH)
  - Relative humidity and temperature sensor (HTS221)
  - Low-voltage digital local temperature sensor (STTS751)
  - Industrial grade digital MEMS microphone (IMP34DT05)
  - Wideband analog MEMS microphone (IMPS23ABSU)

STM32 NUCLEO SUPPORTING AUDIO ALGORITHMS:

- NUCLEO-F401RE
- NUCLEO-F746ZG
- NUCLEO-L476RG
- NUCLEO-L4R5ZI
- P-NUCLEO-WB55

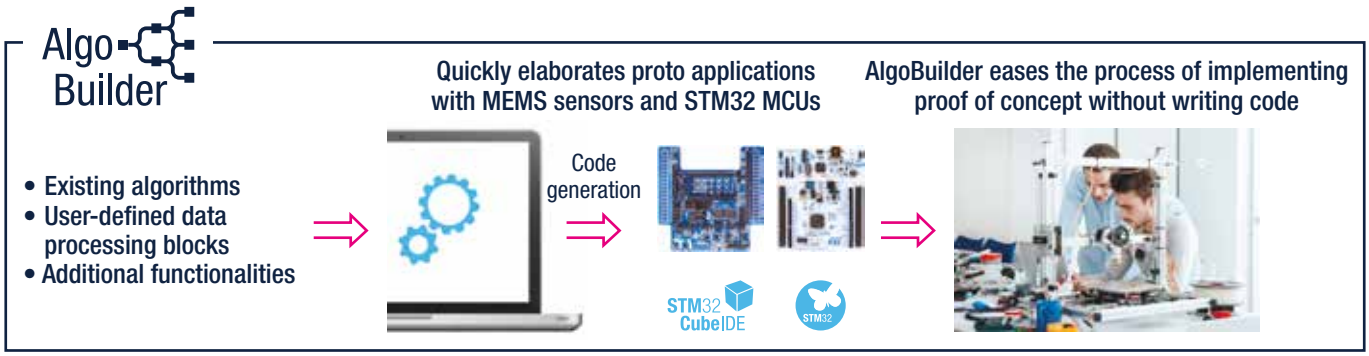
	Available for STM32 with architecture		Application out of the box availability		
	ARM Cortex M4	ARM Cortex M7	X-NUCLEO-CCA02M2	X-NUCLEO-AMICA1M1	STEVAL-STWINKT1B
Acoustic BF	X	X	X	X	
Acoustic SL	X	X	X	X	X
Ultrasound FFT	X			X	X
USB Streaming	X	X	X	X	X

ALGOBUILDER

Graphical design application to build and use prepared advanced motion algorithms in the user design project for STM32 microcontrollers and MEMS sensors

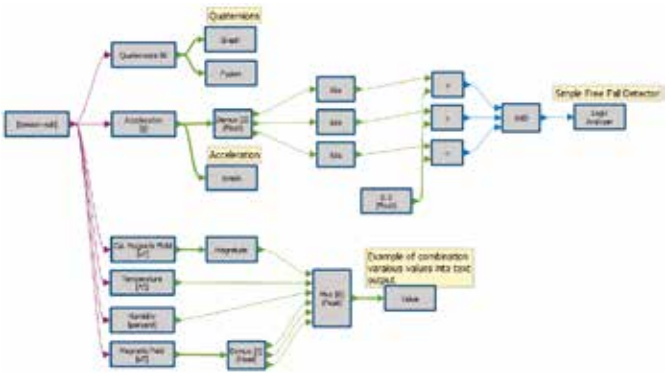
AlgoBuilder quickly elaborates prototypes of applications for STM32 microcontrollers and MEMS sensors, including already existing algorithms (i.e. motion libraries, sensor fusion or pedometer), user-defined data processing blocks and additional functionalities. The application facilitates the process of implementing proof of concept using a graphical interface without writing the code.

AlgoBuilder utilizes the STM32 ODE (Open Development Environment) ecosystem which combines STM32 Nucleo boards (STEVAL-MKSBOX1V1 or NUCLEO-L476RG), X-NUCLEO-IKS01A2, X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1 expansion board, or the STEVAL-STWINKT1 solution board together with the software (STM32 HAL drivers, BSP structure, low and high-level sensor drivers).



The software is distributed in two versions:

- AlgoBuilder – standalone AlgoBuilder software.
- AlgoBuilderSuite – all-in-one software package containing AlgoBuilder and two other software tools, Unico-GUI & Unicleo GUI that facilitate the programming of sensors for an easy and intuitive experience for the user.



To learn more and to download AlgoBuilder visit: **https://www.st.com/en/embedded-software/algobuilder.html**

The AlgoBuilder contains the following advanced motion libraries:

Action	Library	Description	MEMS sensor	Application
	MotionAC accelerometer calibration	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAW activity recognition for wrist	Provides real-time information on the type of activity performed by the user including stationary, standing, sitting, lying, walking, fast walking, jogging, or biking.	Accelerometer	Wearables
	MotionEC eCompass	Provides real-time information about the device orientation and movement: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.	Accelerometer and magnetometer	Any
	MotionFX sensor fusion	Provides real-time motion-sensor data from the accelerometer, gyroscope (6-axis fusion) and magnetometer (9-axis fusion) and provides real-time motion-fusion sensing. It also performs gyroscope bias and magnetometer hard iron calibration.	Accelerometer, magnetometer and gyroscope	Any
	MotionGC gyroscope calibration	Used to calibrate the gyroscope in real time using angular zero-rate level coefficients (offset). The gyroscope sensor can have significant offset, which can cause problems when using the gyroscope output data. The MotionGC library is able to minimize the offset and solve this issue.	Accelerometer and gyroscope	Any
	MotionID motion intensity detection	Provides real-time information about the user motion intensity. It is able to distinguish motion intensity in a range from 0 (still) to 10 (sprinting).	Accelerometer	Wearables
	MotionMC magnetometer calibration	Used to calibrate the magnetometer in real time using hard iron (HI) and scale factor coefficients.	Magnetometer	Any
	MotionPM pedometer for mobile	Provides real-time information about the number of steps and cadence just performed by the user carrying the device, such as a cell phone.	Accelerometer	Phone
	MotionPW pedometer for wrist	Provides real-time information about the number of steps and cadence which the user just performed wearing the device on the wrist (e.g. a smart watch).	Accelerometer	Wearables
	MotionTL tilt sensing	Provides real-time information about the tilt angles of the user carrying the device, i.e. cell phone. The library is also able to perform 6-position accelerometer calibration.	Accelerometer	Any

Watch our featured video to learn more about the AlgoBuilder application: **https://www.youtube.com/watch?v=FuSQXq1b3B0**

Recommended for you the AlgoBuilder webinar for a quick getting started:
https://www.st.com/content/st_com/en/about/events/events.html/st-algobuilder-webinar-2019.html

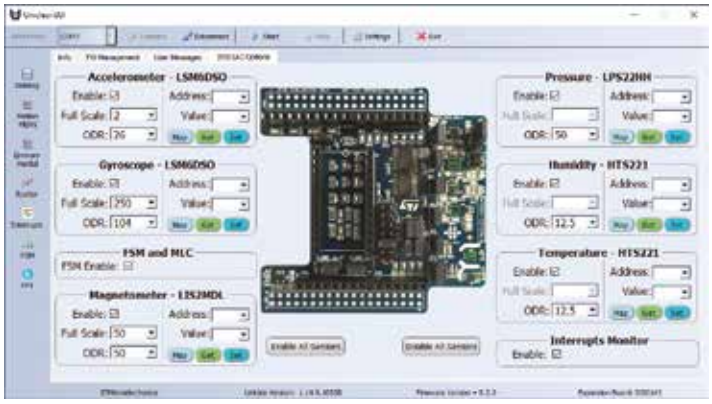
UNICLEO-GUI

Graphical user interface for X-CUBE-MEMS1, AlgoBuilder and STM32 Nucleo expansion boards (X-NUCLEO-IKS01A2, X-NUCLEO-IKS01A3 and X-NUCLEO-IKS02A1)

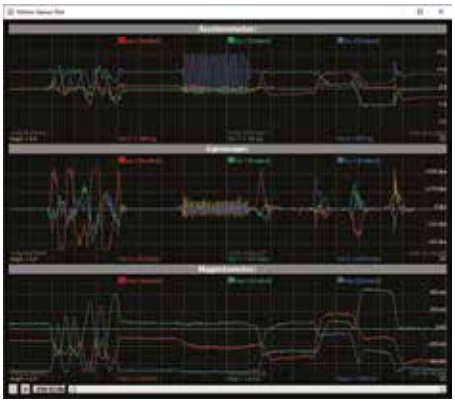
Unicleo-GUI is designed to demonstrate and evaluate ST MEMS sensors and algorithms. Sample applications and examples available in X-CUBE-MEMS1 work in conjunction with Unicleo-GUI. The application offers various display formats to show output data from sensors and algorithms. Sensor parameters can also be configured by using this tool. Unicleo-GUI can work with firmware created by AlgoBuilder application.

Three simple steps:

1. Connect your Nucleo and X-Nucleo boards to the PC
2. Run the GUI and setup the sensor parameters
3. Observe sensor data in real time and save them on file (TSV, CSV)



All the sensor parameters are available



It is possible to select timeplot, scatter plot or 3D plot

To learn more and to download Unicleo-GUI visit:
https://www.st.com/content/st_com/en/products/embedded-software/evaluation-tool-software/unicleo-gui.html

Watch our featured Getting Started video to learn more about the Unicleo-GUI graphical user interface.

https://youtu.be/45baO5Lxv-o

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