Tools & Technologies to Support IoT Sonification Applications

IoT Apps 2021

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Device

The BBC micro:bit is enabled with many onboard peripherals which provide both sensing and output capabilities. Critical to any IoT application, varied means of communication and data transfer are also available to suit a wide array of possible uses.

Sensing

Buttons

The most obvious available inputs are the two front buttons, A and B. These are debounced in software, which also provides the ability to distinguish a short press, long press and both buttons pressed at once. The state of the buttons may also be exposed on the GPIO pins.

Capacitive Touch Sensors

The logo on the front of the board acts as a touch sensor. The 3 ring connectors numbered 0, 1 and 2 may also be used as capacitive touch sensors, provided the user is also in contact with the ground pin.

Microphone

A MEMS microphone provides sound input to the micro:bit. An LED indicates when the microphone is powered and listening.

Motion Sensor

A combined accelerometer and magnetometer chip provides 3-axis sensing and measurement of magnetic field strength. Onboard gesture recognition is provided, with free fall detection being implemented in hardware and other gestures being available through software (face up, face down and shake). An algorithm in the standard runtime automatically calibrates the chip for use as a compass, allowing for direction readings independent of board orientation.

Light Sensor

The LED matrix which provides the display for the micro:bit is also capable of estimating ambient light level by measuring voltage decay time within the diodes. The phenomenon measured is roughly proportional to ambient light, which provides ten discrete levels of light intensity detection.

Temperature Sensing

The Nordic nRF52 application processor is capable of measuring its own surface temperature. Uncalibrated, this allows for an approximation of ambient temperature ±5°C. It is easily calibrated in software by simply supplying the actual temperature so that an offset can be generated. The sensor has an operating range of -40 to 105°C.

Output

Display

A 5x5 red LED matrix is set on the front of the device. It is capable of 255 levels of light intensity via software control. The 5 columns of LEDs are also coupled to the GPIO pins, along with the associated light sensing mode.

Speaker

The micro:bit v2 has introduced an onboard speaker. It provides a considerable 80dB sound pressure level from 10cm, running on 5V. The sound output is mirrored on the GPIO pins via PWM.

Communications

Bluetooth & BLE

The Nordic S113 coprocessor supplies a fully qualified Bluetooth low energy stack. It operates at 2.4GHz, with 40 2MHz channels.

Micro:bit Radio

Making further use of the same 2.4GHz transceiver, a simple protocol was developed for use between micro:bits. It provides a small-packet broadcast radio interface, with simple user-managed device addressing achieved through radio group codes in the software runtime. 80 channels are provided, capable of 1Mbps transfer speeds with a default MTU of 32 bytes, configurable up to 1024 bytes. The transmission range is approximately 20m. Due to privacy considerations, micro:bits are not uniquely identifiable unless implemented through application code.

USB Interface Chip & SWD

The interface chip supplies a USB communications stack in firmware. This stack allows for the drag-and-drop flashing of application code, as well as serial communication at a rate of 12Mbps. It also provides the interface to the host debugger over CMSIS-DAP.

GPIO

19 assignable GPIO pins are provided, as well as 3 large IO rings (0, 1, 2) and 2 large power rings (3V, GND). Features include external I²C, SPI and UART, as well as up to 3 simultaneous PWM channels, 6 analog inputs and 3 capacitive touch sensor pads.

Platforms

Micro:bit Runtime

The micro:bit runtime written by Lancaster University provides a convenient abstraction of the necessary device drivers used to control the hardware capabilities of the micro:bit. It also provides useful runtime mechanisms such as lightweight multithreading, a scheduler, a memory allocator and management of the protocol stacks.

This runtime for C/C++ development also serves to support the higher level languages which target the micro:bit, such as Microsoft's Block Editor and Code Kingdom's JavaScript and MicroPython implementations.

Cloud Services (e.g AWS)

Should remote data processing or storage be required, there are a plethora of available cloud services, many of which target IoT applications specifically. An obvious example is the dominant Amazon Web Services, which provides both raw computing and networking resources as well as more abstract services. AWS markets its own offering for IoT applications appropriately named AWS IoT. The service offers straightforward integration of cloud applications with connected devices. Several features are available for the management of many IoT devices, as well as facilitating data collection, aggregation and analysis.