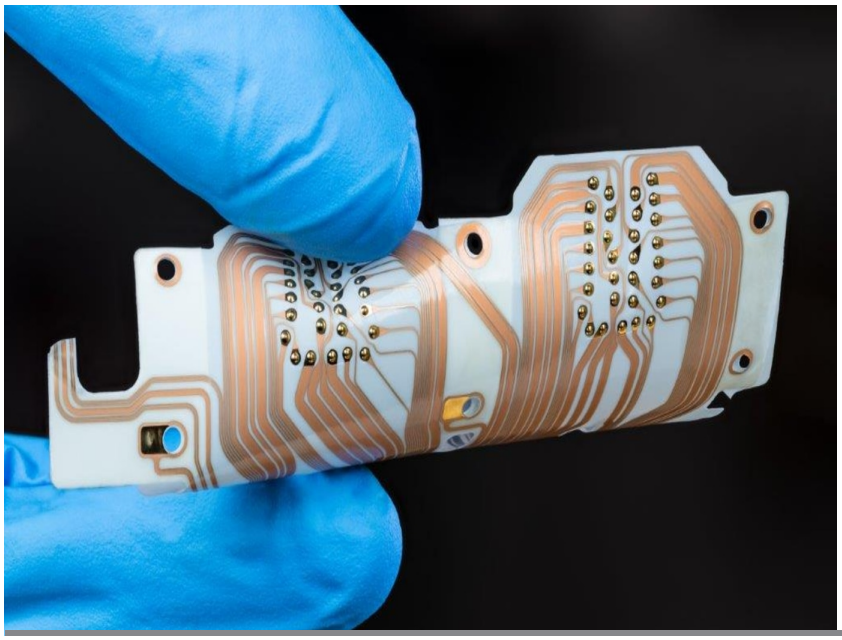


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Electrical and Electronics

Printable IoT sensor development platform

Low-power environmental sensor fusion on a flexible substrate

NASA inventors have developed a low-power wireless platform for the evaluation of sensors printed on flexible polyimide substrates. The platform simplifies development of novel environmental sensors and their end-use applications by merging Bluetooth® low energy (BLE) hardware, sensors, and sensor fusion software. It consists of a printed circuit board with programmable system on a chip (PSoC) microcontroller; commercially available inertial, environmental, and gas sensors; and area for deposition of novel printed sensing elements. Outputs can be configured to send sensor data over BLE connection for recording and analysis in third party software.

The platform's integrated nature reduces system size, cost, and power consumption; it includes all essential hardware to support development of IoT devices. It has been used for development of respiration and environmental monitoring sensors for astronauts aboard the International Space Station.

BENEFITS

- Printed sensors: Enables development and characterization of novel printed electronic sensors
- Sensor fusion: Fuses commercial and novel sensor data and streams wirelessly via Bluetooth controller
- Compact Efficiency: Low power consumption, small device suitable for IoT applications
- Flexibility: Device can be bent and adhered to surfaces with small diameters

APPLICATIONS

The technology has several potential applications:

- Flexible electronics: development and evaluation platform for printed sensors
- Medical: unobtrusive respiratory monitoring
- Environmental: personal and area wireless gas monitoring

THE TECHNOLOGY

Advances in additive manufacturing have enabled development of printable electronic sensor elements that can be deposited onto flexible substrates. To benchmark performance of printed sensors against the state of the art, NASA developed a low power flexible sensor platform. The platform integrates the following key components and features:

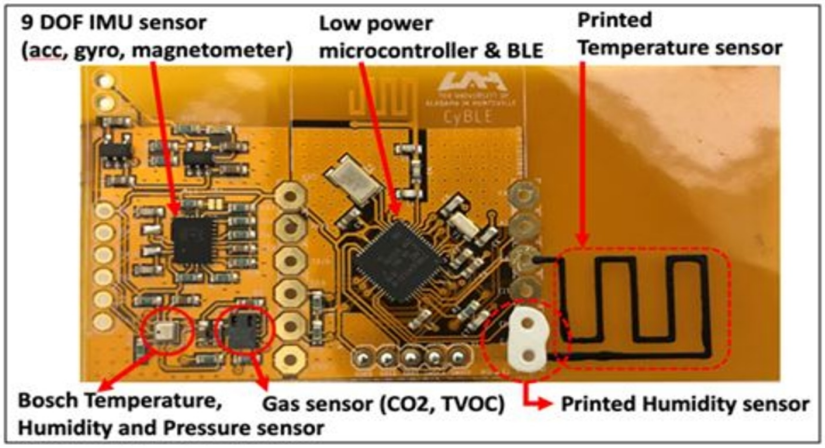
-Flexible substrate: DuPont™ Kapton® allows bending around cylindrical surfaces as small as ¾" in diameter.

-Embedded microcontroller: Cypress CY8C4248 LQI-BL583 Arm Cortex M0 processor with BLE wireless controller, max frequency 48 MHz. Supports low power modes of operation, capacitive sensing support, and a single-channel 12-bit AD converter.

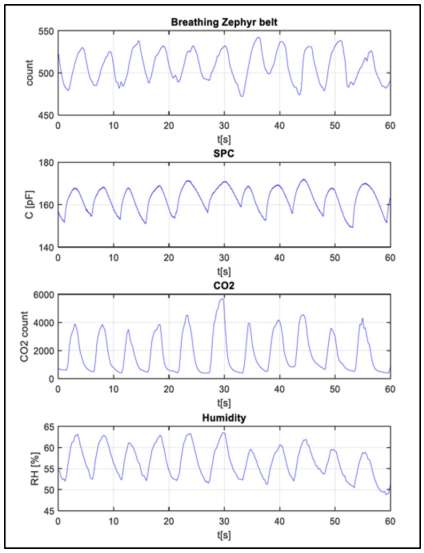
-Commercial sensor suite: Bosch BNO080 inertial sensor; Bosch BME280 humidity, pressure, and temperature sensor; AMS CCS811 air quality sensor (VOCs and CO2).

-Prototyping area for custom-printed sensors: 1) thermistor, uses carbon-based PTC resistor paste DuPont2792; 2) capacitive humidity sensor using a NASA-developed dielectric ink.

NASA researchers have used the platform to study performance of the printed capacitive humidity sensor. The 2x4 mm co-doped barium titanate sensing element is highly sensitive to water vapor and performs as an unobtrusive breathing monitor, sensitive to breath at distances of up to 20 cm. Average change of sensor capacitance at a distance of 7.5 cm was observed to be 6.2±3.5 pF.



NASA's low-power wireless platform for evaluation of sensors printed on flexible polyimide substrates. Printed sensors indicated at right.



Parallel comparison of breathing signals collected from a) chest belt, b) NASA's capacitive humidity sensor, c) CCS811 CO2 sensor and d) BME280 humidity sensor.

PUBLICATIONS

Patent No: 9,987,658

Patent Pending

Long Term Monitoring of Respiration and CO2 using Flexible Printed Sensors. Jovanov et al. 2020 IEEE Aerospace Conference. March 14, 2020.

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MFS-34088-1, MFS-33813-1, MFS-33214-1, MFS-TOPS-117

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