Advanced Battery-Free Interface for Internet of Things Technologies (#8734)

Broadens interaction-specific circuit designs and reduces waste

This multi-channel ambiently powered rich-input sensing (MARS) innovation significantly advances "smart" technology with an eco-friendly design that eliminates the need for batteries. The MARS interface stickers' functionality improves efficiency in communication, continuous sensing, and power harvesting, allowing for greater scalability to implement Internet of Things (IoT) devices in more everyday objects and settings. Current interface technologies for various IoT devices have limitations in terms of power and form factor. With an extremely low power budget, MARS interface stickers have been successfully tested in reading various rich-input interactions—including swiping, multi-touch, and speech—via their multi-channel, fully analog, wireless interfaces.

[See also #7915, "A Sensor That Converts Everyday Objects into Microphones"](#)

Benefits/Advantages

- **Decreased power demand**: Uses zero-threshold voltage transistors and analog backscatter communication to allow for power supply via ambient power harvesting.
- **Eco-friendly**: Leverages a battery-free design for each tag to decrease the large number of bulky batteries disposed of each year
- **Wider range, greater intake**: Demonstrates distance capabilities three times (15 m) the range of existing radio-frequency identification (RFID) technology; MARS transistor allows for a larger volume of input tags to be received concurrently and continuously
- **Versatile input**: Allows for consumer interactions beyond a singular touch-function, including swipe-based gesture sensing, identity and relaying speech
- **Scalability**: Decreases operational power requirements and bulk of its power harvester to increase implementation and adoption of MARS's simpler circuitry for object and surface-based interactions
- **Low cost**: Requires less than 10 components, which significantly reduces the cost of the interface sticker

Potential Commercial Applications

- Multi-player gaming systems
- Residential consumer technology and security

- Internet of Things technology
- Hospitality engagement
- Professional event organization
- Health care technology

Background/Context for This Invention

Since the mid-2000s, IoT innovations have moved quickly beyond persuading new users to try the technology to confirmation and continual adoption. In recent years, making electronics more eco-friendly has become more important for consumers. There has also been an increased demand for innovators and developers to conform the technology to the consumer rather than the consumer adapting to the technology.

Georgia Tech's MARS interface sticker technology expands the accessibility and usability of rich-input sensing with objects and electronics by minimizing the size and weight of the technology as well as expanding its communication range and complexity of input. Eliminating the need for constant battery replacements answers key environmental concerns, and improving the technology's design functionality increases consumer adoption. For example, conference attendees would no longer have to travel to the microphone to ask questions at the end of a session as their conference folders could be fitted with a MARS tag microphone. Applications for MARS's wireless multi-touch sensing could also expand the food service industry's ordering process or decrease the number of bulky wires at a patient's bedside in the hospital.

How It Works

MARS interface stickers are built on the combination technology of zero-threshold voltage field-effect transistor and frequency-shifted analog backscatter communication. This design allows for an impressive performance by multi-channel analog wireless input interfaces with nanowatt power requirements. The startup voltage is merely 100 mV, and MARS activity can be powered by low-profile ambient energy sources (e.g., photodiodes, thermoelectric generators). Other technologies' limiting factors are complex energy harvesting techniques or cumbersome mechanical pieces such as coils and magnets. Continuous sensing of the capacitive, inductive, or voltage properties of the interface sensors supports strong and direct operational control of the sticker's oscillator for data transmission. The simple circuitry of MARS interface stickers elevates the capabilities of IoT technologies for greater adoptability and scalability.

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Patent/IP Information

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Publications

MARS: Nano-Power Battery-free Wireless Interfaces for Touch, Swipe and Speech Input, The 34th Annual ACM Symposium on User Interface Software and Technology, August 20, 2021

The Future of IoT (4:30 minute video), YouTube, October 13, 2021

MARS: Nano-Power Battery-free Wireless Interface for Touch, Swipe and Speech Input (30 second video), YouTube, Oct 6, 2021

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/advanced-battery-free-interface-internet-things-technologies