INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

Analog-to-Digital Conversion Circuit and Image Sensor Including the Same

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Engineering & Physical Sciences
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OVERVIEW

Ultra low-power, high-quality analog-to-digital conversion circuit for image sensors.

- Delivers high image quality with significantly reduced energy consumption and circuit area.
- IoT imaging, surveillance, mobile devices, battery-operated cameras, smart sensor networks.

BACKGROUND

Image sensors are integral to a wide range of modern technologies, from smartphones and IoT devices to security systems and medical imaging. Historically, analog-to-digital conversion (ADC) in image sensors has relied on single-slope architectures, particularly the 4T pixel structure, to achieve high fidelity. However, single-slope ADCs suffer from poor energy efficiency, especially as pixel resolution increases—a critical shortcoming for energy-constrained devices like IoT cameras. While SAR-based ADCs offer better energy efficiency and are popular in other contexts, they have seen limited use in image sensors due to area constraints and lower accuracy. As imaging plays a more pervasive role in battery-powered, miniaturized devices, there is an urgent need for an ADC solution that addresses both the high image quality expected in modern applications and the strict energy budgets and space limitations of next-generation devices.

INNOVATION

Researchers at the University of Michigan have developed a novel analog-to-digital conversion circuit, employing a capacitor-array-assisted charge-injection SAR ADC (c-ciSAR) structure. The innovation integrates charge-injection cells with a small capacitor array, achieving high energy efficiency and compactness while supporting 10-bit image quality. The c-ciSAR ADC significantly reduces full-frame power consumption and area requirements relative to previous approaches, enabling continuous low-power operation, especially in motion-triggered modes. In addition, an innovative in-column motion detection scheme leverages the SAR logic for hardware reuse, avoiding performance trade-offs typical in earlier solutions. The technology is ideally suited for real-world applications where device longevity and high image fidelity are paramount, such as IoT imaging, mobile devices, remote surveillance, and wireless sensor networks, thereby substantially extending battery life and enhancing device capabilities.

ADDITIONAL INFORMATION

REFERENCES:

"Energy-Efficient Low-Noise CMOS Image Sensor with Capacitor Array-Assisted Charge-Injection SAR ADC for Motion-Triggered Low-Power IoT Applications"

INTELLECTUAL PROPERTY:

US10594333 "Analog-to-digital conversion circuit and image sensor including the same"

KEYWORDS:

ADC, Image Sensor, IoT, Motion Detection