CMOS Switched-Capacitor Circuits for Bio-Medical and RF Applications

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Abstract:

The switched-capacitor technique has been used in high-volume data converters and signal processing ICs for more than three decades. It is also ubiquitous in RF transceiver circuits be-cause it uses capacitors, which are area-efficient native devices in CMOS technologies, and MOSFETs operating as switches.

The RF power amplifier dissipates a large fraction of the total power of a transceiver because of its low efficiency. Despite more than two decades of extensive research, the challenge of on-chip RF PAs with high efficiency in digital-friendly CMOS technologies has not been met. Switching PA topologies with relatively high efficiency have gained momentum, and relatively high output power is being delivered using power combining techniques. Supply regulation techniques have enabled higher efficiency when amplifying non-constant envelope modulated signals. The switched-capacitor RF power amplifier techniques which meets many of the remaining challenges is described.

Body-area-networks (BAN) that integrate multiple sensor nodes in portable and wearable bio-medical systems are revolutionizing healthcare. A typical BAN comprises several bio-signal and motion sensors and uses ultra-low-power short-haul radios in conjunction with nearby smart-phones or handheld devices (with GPS capabilities) to communicate via the internet with a doctor or other healthcare professional. Higher energy efficiency is critical to the development of feature-rich, wearable and reliable personal health-monitoring systems.

The amount of data transmitted to the smart-phone increases as more sensors are added to the BAN. Because the energy consumed for RF transmission is proportional to the data rate, it is advantageous to compress the bio-signal at the sensor prior to digitization and transmission. This energy-efficient paradigm is possible using compressed sensing—a sampling theory wherein a compressible signal can be acquired

using only a few incoherent measurements. For ECG signals, for example, large compression factors are achievable which means similar reductions in energy consumption. The second part of this talk overviews compressed sensing techniques and describes switched-capacitor analog front-ends for bio-signal acquisition.