**Intermittent power and reliable execution can co-exist**

- Energy harvesting is a clean, long-term supply of relatively low and volatile power.
- Burst-based application design can operate efficiently over a wide input power range.
- Burst-based design must satisfy certain constraints to provide application reliability:
  - **Minimum energy availability** - necessary to guarantee application progress.
  - **Temporal independence** - necessary for functional correctness.
  - **Non-voltaity** - necessary to guarantee data dependencies between bursts.

**Energy bursts**

Energy Conservation:

1) $E_{active} = \eta_{system} \times E_{in}$

2) $P_{active} \propto \frac{E_{load,min}}{t_{sleep}}$

**Quantized energy transfer [1]**

- Maximizes task-level energy efficiency.
- Power-point tracking for both source and load.
- Guarantees atomic task execution.
- Optimizes capacitor size for reduced wake-up times.

**Experimental evaluation**

**Motion estimation using MSP432**

- Controlled displacement to measure accuracy:
  Camera mounted on trolley without power constraints.
  Accumulated error: 57 cm over 42 m.

- Real-world experiment to estimate walking speed.

**Transient camera applications**

1) **Long-term logging [2]**

- Non-Volatile Memory Hierarchy (NVMH) reduces costs of logging images to SD Card.
- Burst-based application using NVMH:

2) **Walking speed estimation [3]**

- Track pixel displacement to estimate user’s walking speed.

**Long-term logging using MSP430FR**

- Evaluate cost/performance of different EMU configurations for a long-term logging app. For each, there is an associated:
  - Minimum energy guarantee (capacitance).
  - Cost for storing an image.
  - NVMH was configured with $N_{img}=10$.

**Cost vs performance trade-offs**

- Dynamic Energy Burst Scaling (DEBS) can reduce the capacitance and the cost per image.
- NVMH can reduce the cost per image further, but requires a larger capacitance.

**Energy scalability**

- Burst-based design guarantees functionality independently of harvester’s properties.
- Harvester selection relates only to application’s performance (execution rate).
- Efficient EMU design can minimize the required harvester area for a desired performance.

---

