

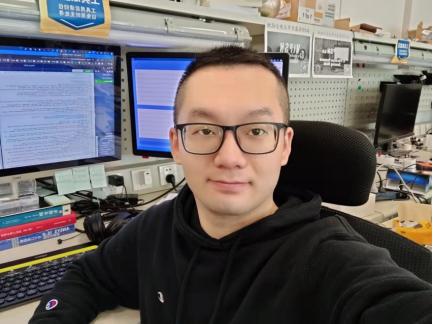
自我介绍

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Associate Professor

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Research interests: Energy harvesting, Self-powered IoT, Pervasive sensing.



Li Xin is currently pursuing the Ph.D. degree with the Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, and with the University of Chinese Academy of Sciences. He is also with the ShanghaiTech University, China, and the Nanyang Technological University, Singapore. His research interests include kinetic/vibration energy harvesting, intermittent computing, ubiquitous computing, and Internet of Things.

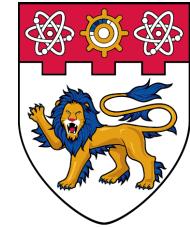
- Journal/Conference Papers: **18** (First-author: **10**)
- VEH 2021 「**Best Paper**」
- ASME SMASIS 2020 「**Best Student Hardware**」
- IEEE IES 2019 Inter-Chapter Paper Competition 「**1st Runner-up**」
- ACM/IEEE EWSN 2019 Dependability Competition 「**1st Place**」
- ACM/IEEE EWSN 2018 Dependability Competition 「**3rd Place**」



中国科学院大学
University of Chinese Academy of Sciences



中国科学院上海微系统与信息技术研究所
Shanghai Institute of Microsystem and Information Technology Chinese Academy of Sciences



NANYANG
TECHNOLOGICAL
UNIVERSITY
SINGAPORE



上海科技大学
ShanghaiTech University

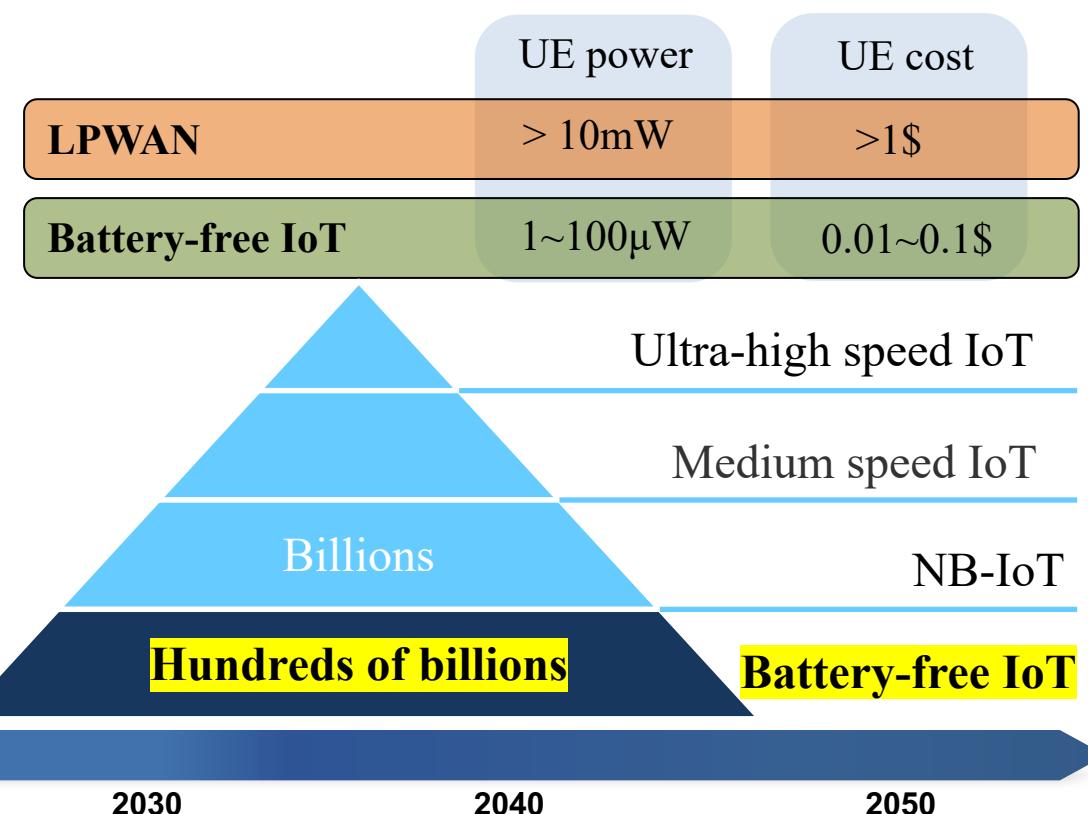
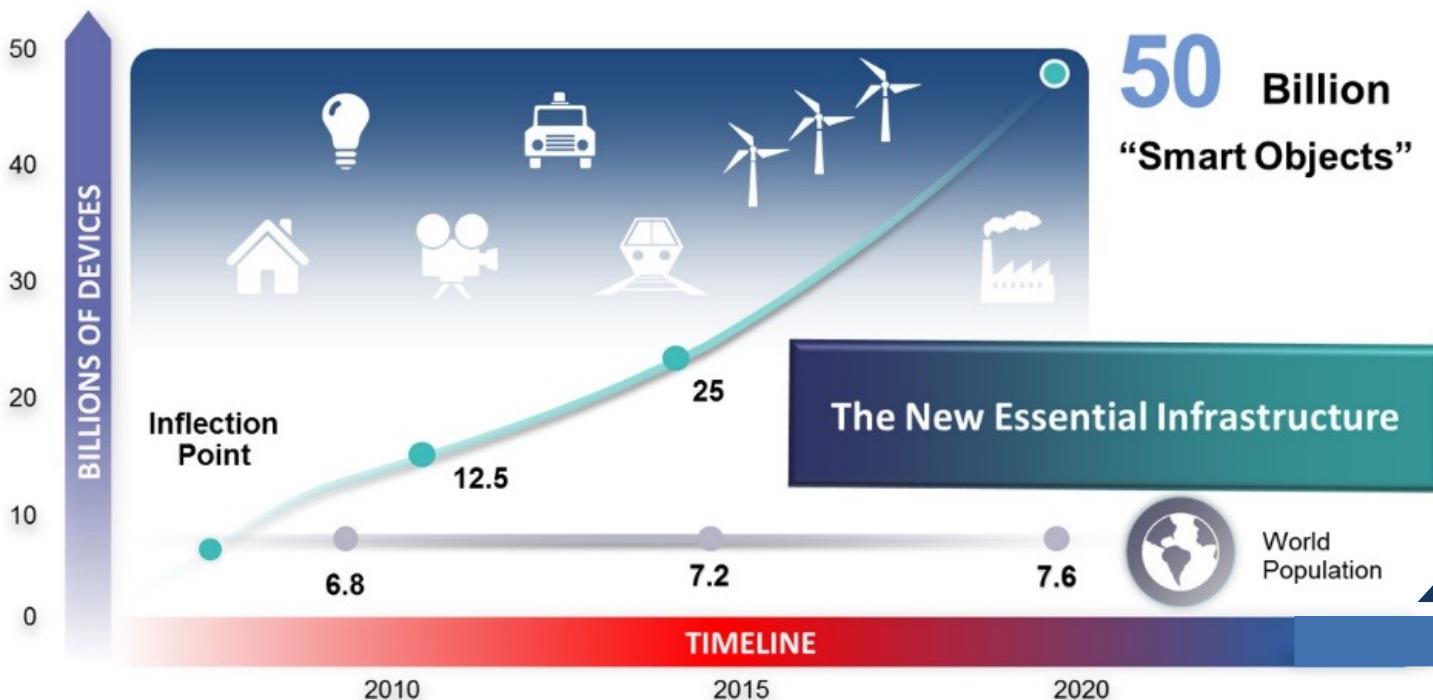
努力建设一所小规模、高水平、国际化的研究型、创新型大学

- 构建了一个无源物联网平台**ViPSN**
- 参加了一项国际无线网络可靠性竞赛
- 面向能量不确定下无源物联网系统设计的研究目标，我在过去做了**四项研究工作**：
 1. 超低功耗($\text{sub-}10\mu\text{W}$)能量管理
 2. 瞬态动能收集
 3. 基于NVM的间歇性计算
 4. 基于反散射通信的超微型($\text{sub-}1\text{cm}^2$)运/振动检测

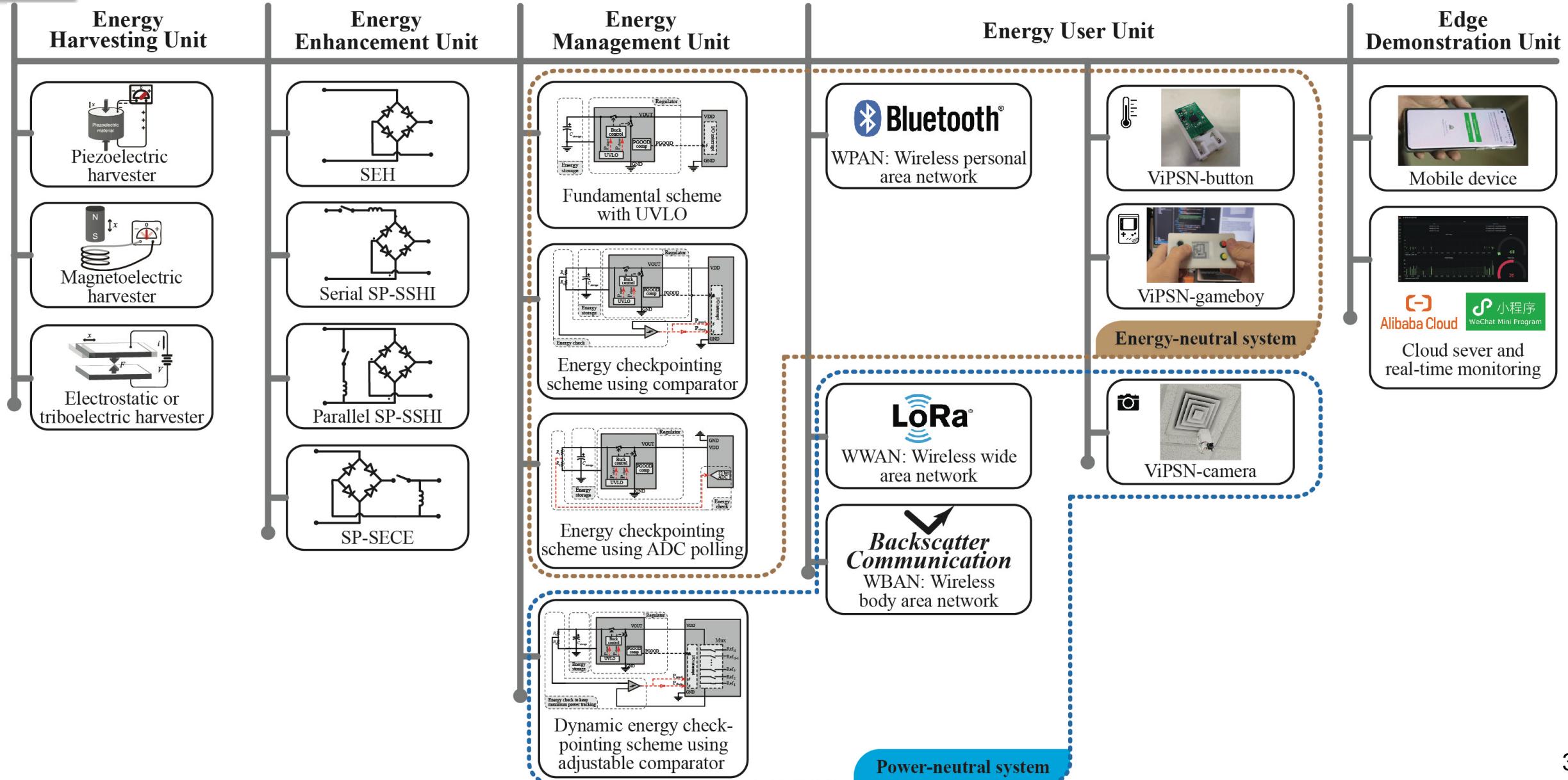
研究背景

The trending of 5.5G for 2030:

- Improve the experience of **connecting human** -> Towards real-time interaction with the virtual world.
- **Connecting things** is the foundation for building a smart world -> 5G is the cornerstone for carrying hundreds of billions of connectivity.
- Battery-powered IoT -> **Battery-free IoT** based on energy harvesting technologies.



I 基于动能收集技术的无源物联网平台(ViPSN)



I

ViPSN物联网平台的国内外学术合作



II

面向极强干扰下的无线网络协议设计



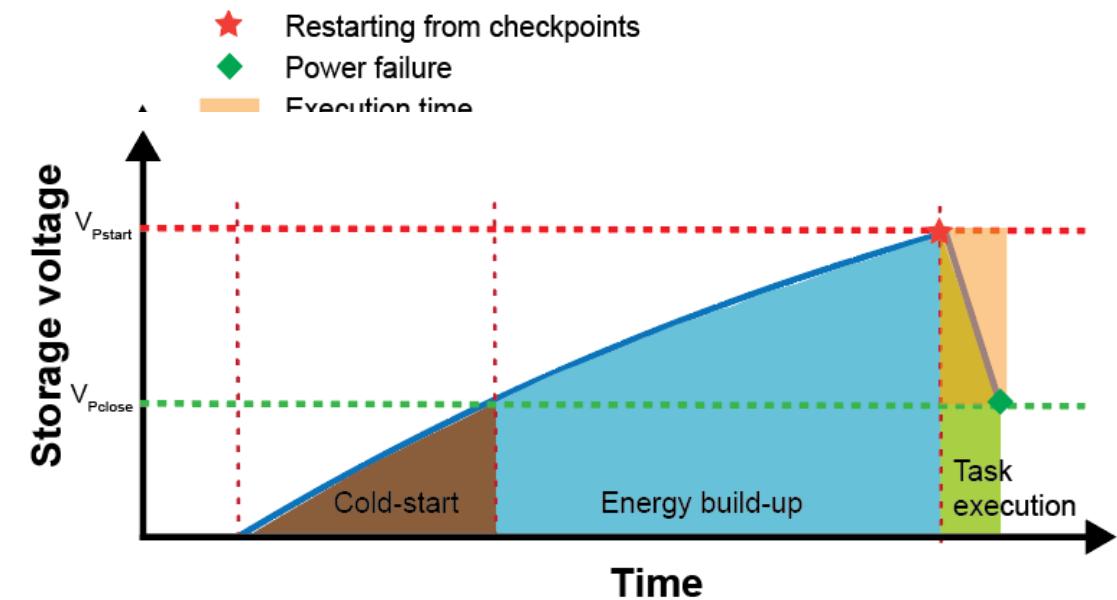
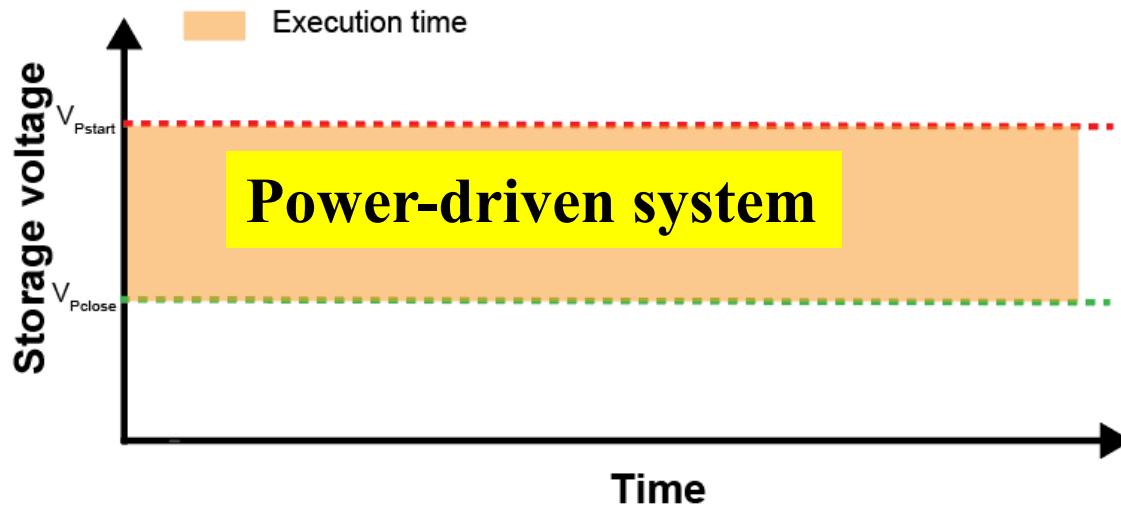
- IEEE 802.15.4 MAC Protocol
- 技术要点：
 1. **Flooding Strategy → Glossy (洪泛传输机制)**
 2. **Concurrent Transmission (并发传输机制)**
 3. Using Enhanced OFCOIN to Monitor Multiple Concurrent Events under Adverse Conditions
 4. Using DeCot+ to Collect Data under Interference



III

面向能量不确定下无源物联网系统设计

- Battery-powered system
- Energy-harvesting-powered system

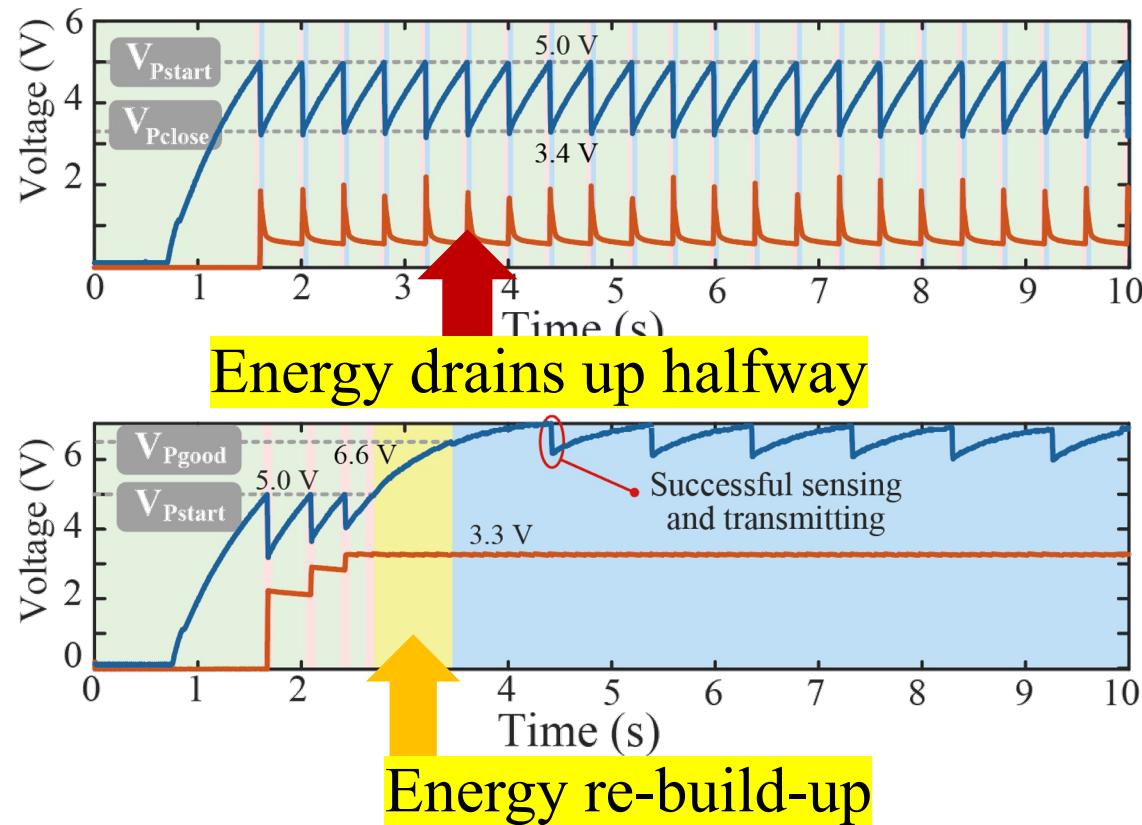


- ✗ Periods of no power
- ✗ Periods of scarce power
- ✗ Periods of ample power

III

工作1: 基于能量驱动型系统的超低功耗(sub-10μW)电能管理技术

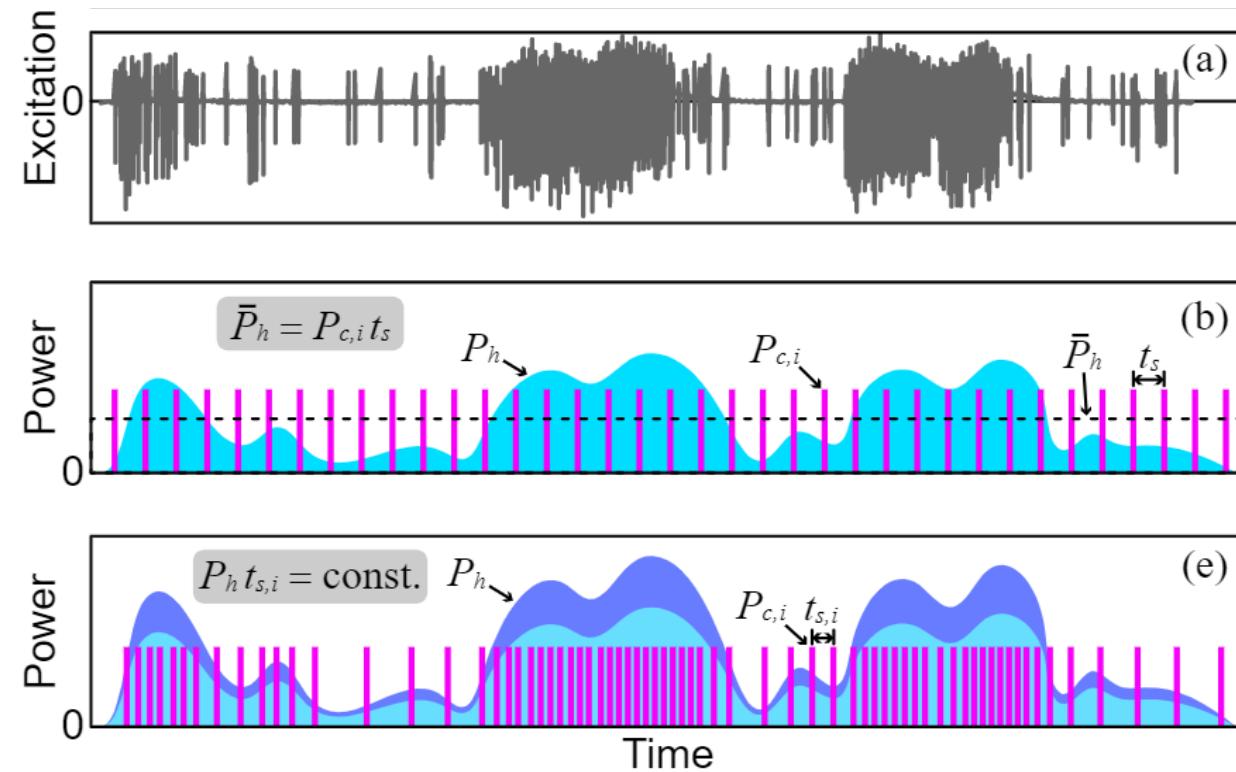
- Energy neutral



Xin Li and Junrui Liang, et al. "ViPSN: a vibration-powered IoT platform," *IEEE Internet of Things Journal*, 2020.

- Power neutral

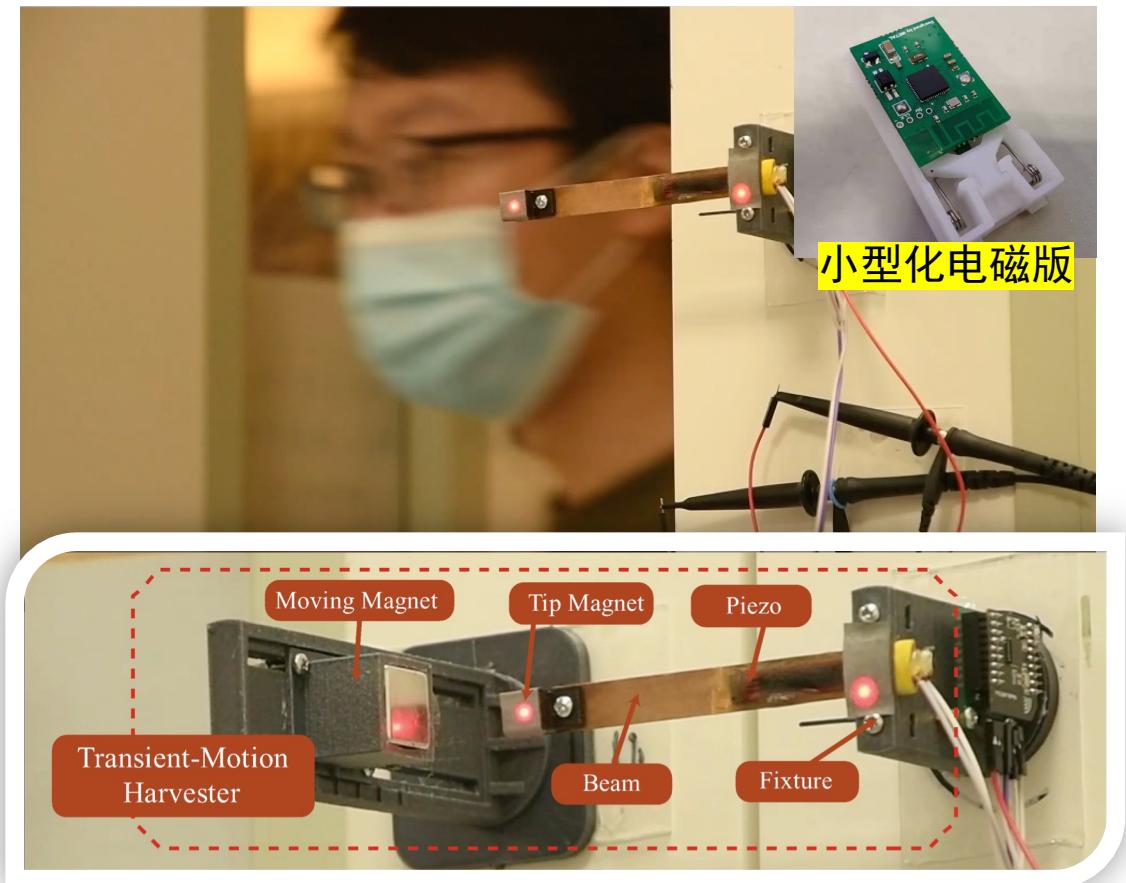
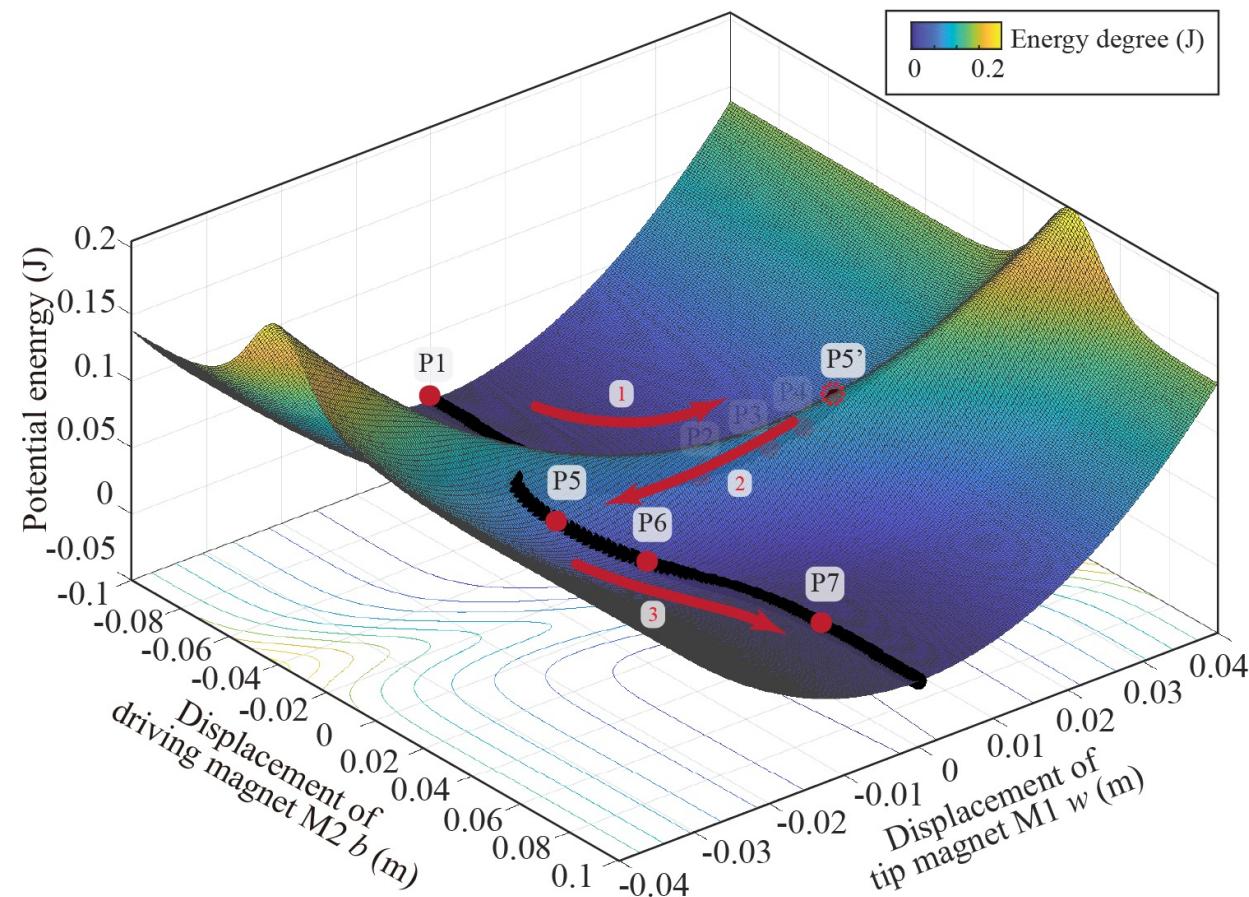
$$P_h(t) = P_c(t)$$



Hong Tang, Xin Li (Co-first author), Junrui Liang. "Power-neutral operation with Maximum PowerPoint Tracking for vibration-powered IoT node," *IEEE Internet of Things Journal*, to be submitted.

III

工作2: 基于机械势能预存储的瞬态动能收集技术

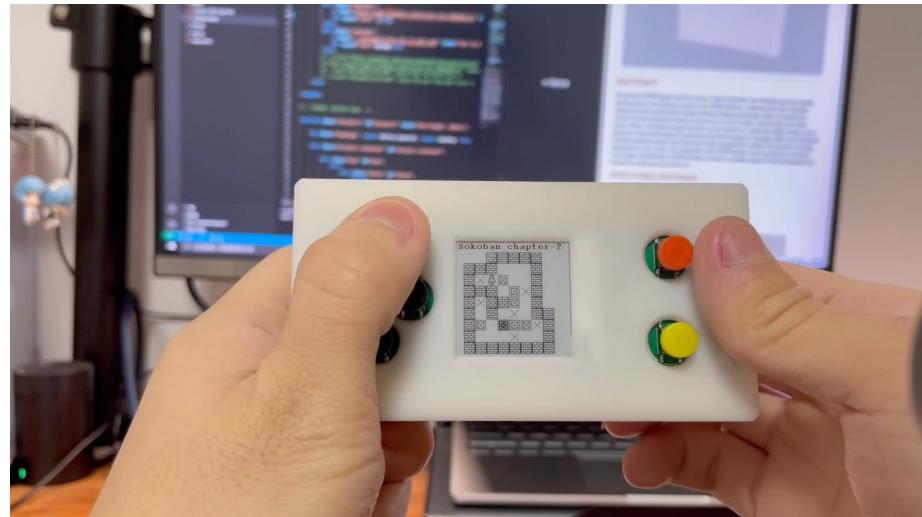


Xin Li, Guobiao Hu, and Junrui Liang, et al. "Dynamics Analysis of a Transient Plucking Energy Harvester," *IEEE/ASME Transactions on Mechatronics*, under review.

Xin Li, Guobiao Hu, and Junrui Liang, et al. "ViPSN-pluck: A Transient-motion-powered Motion Detector," *IEEE Internet of Things*, 2021.

III

工作3: 基于非易失性存储器(NVM)的间歇性计算系统设计

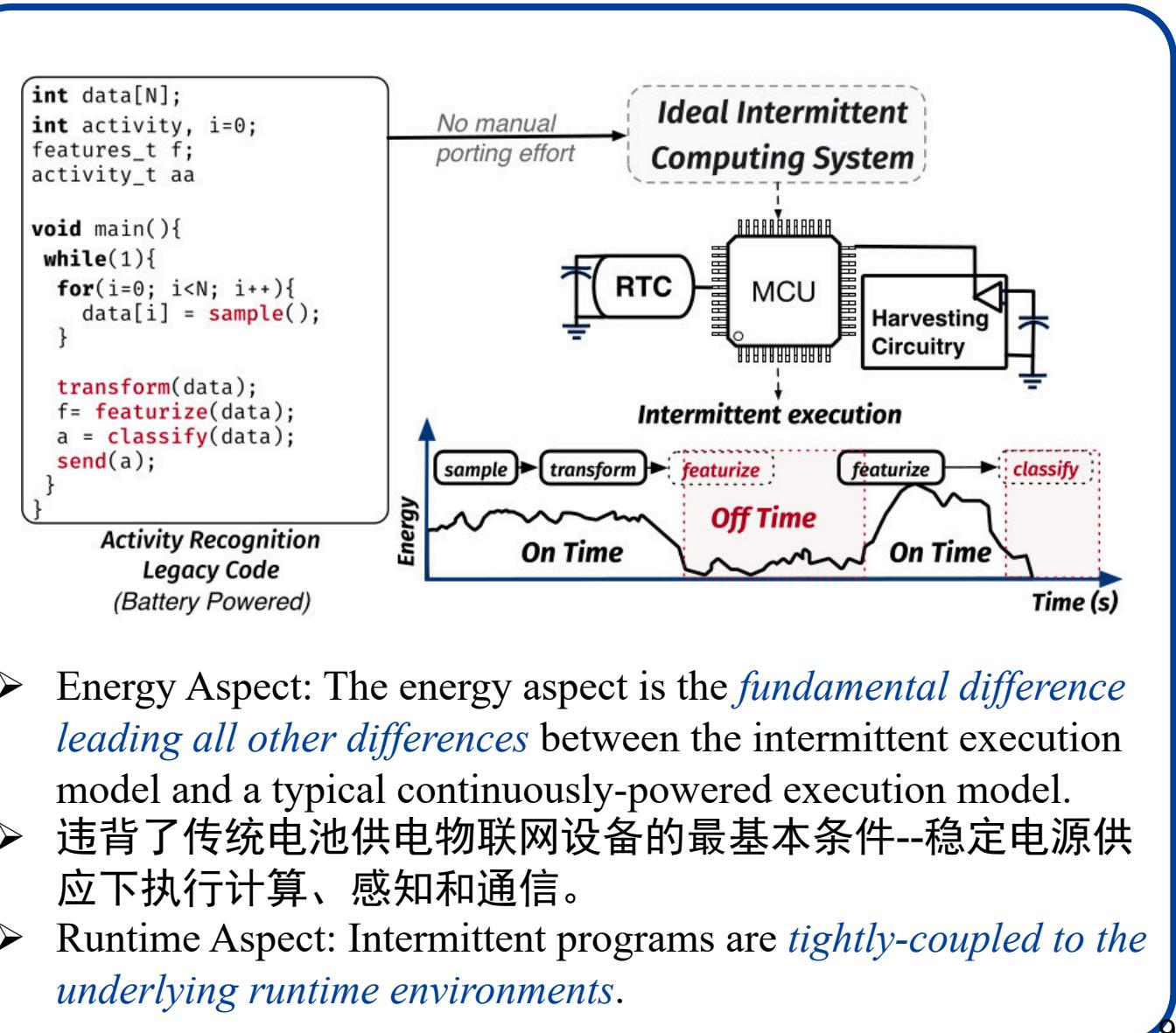


➤ 面向间断运动激励条件下可连续计算、感知与通信的无电池人-机交互系统

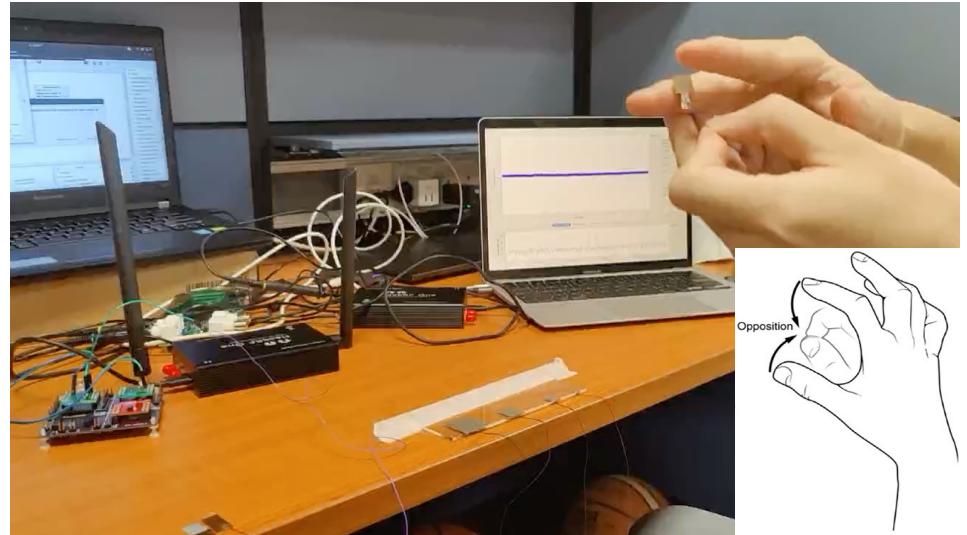
➤ 技术要点：

1. **FRAM**: ferroelectric RAM(铁电存储)
2. **Intermittent computing** (间歇性计算)
3. 存算一体化在移动设备上的实现
4. 瞬态动能收集

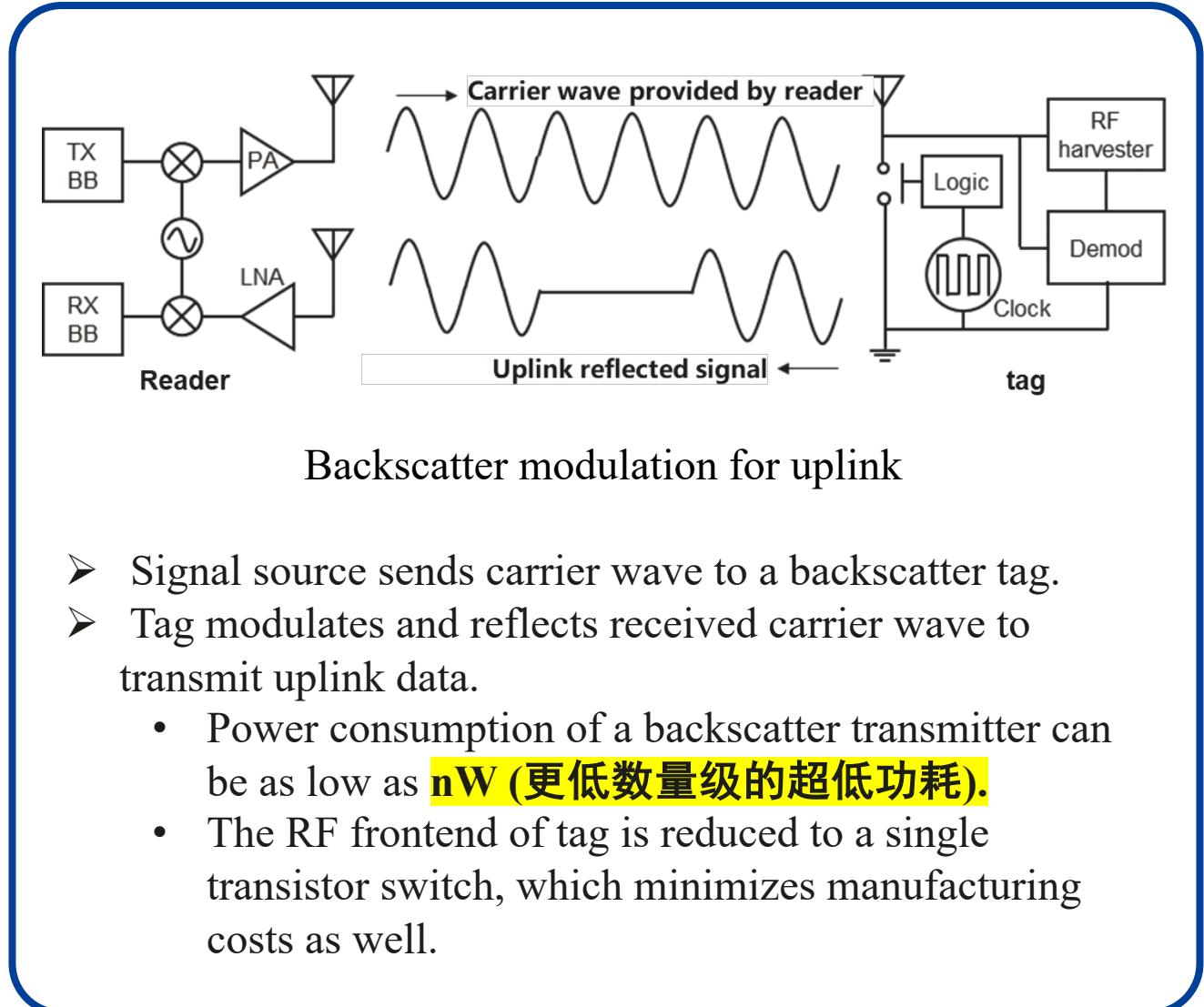
Xin Li, Yue Zhu, Guobiao Hu, Yaowen Yang, Junrui Liang.
“ViPSN-Eink: A Transient-motion-powered Gameboy,” IEEE transactions on Mobile Computing, to be submitted.



III

工作4: 基于反散射通信的超微型(sub-1cm²)运/振动检测系统设计

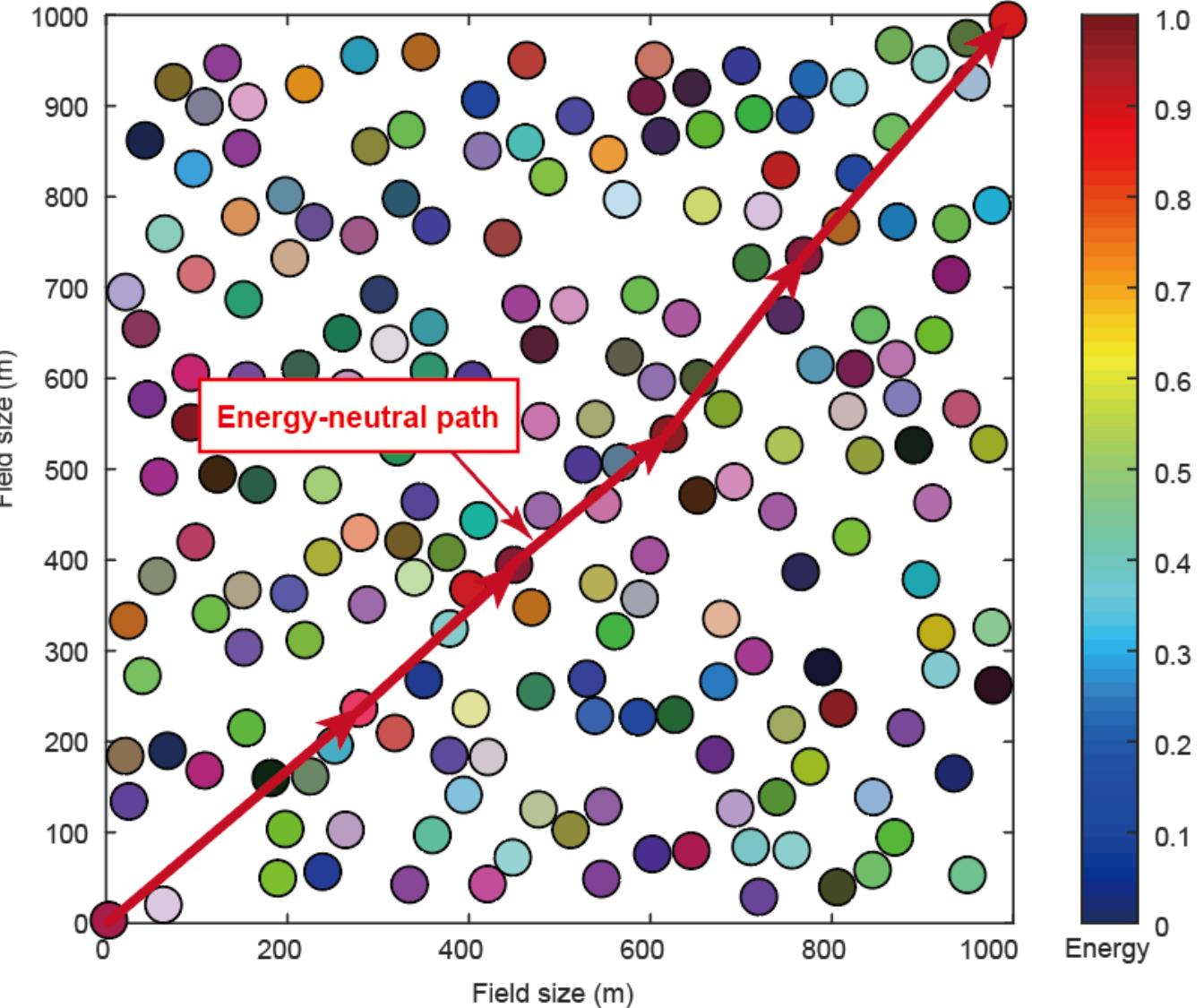
- Battery-free human motion sensing system.
- Focus on: **Backscatter communication**(反散射通信)
- **TengScatter**: A Paradigm Shift Battery-free Flexible Motion Sensing Solution Enabled by Triboelectric Nanogenerator and Backscatter Communication (to be submitted).
- In collaboration with **Nanyang Technological University**.



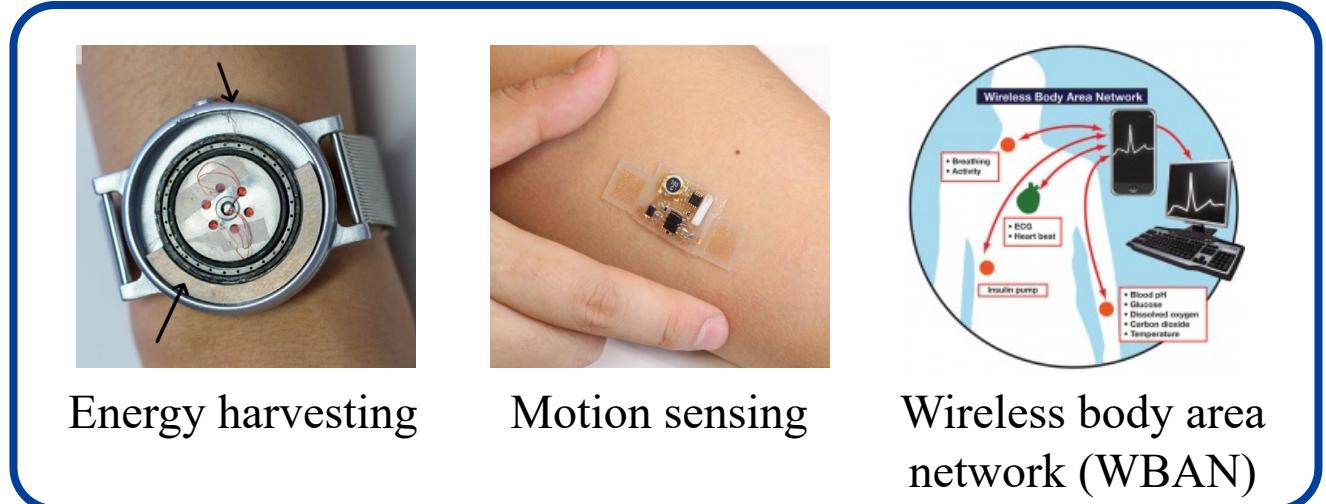
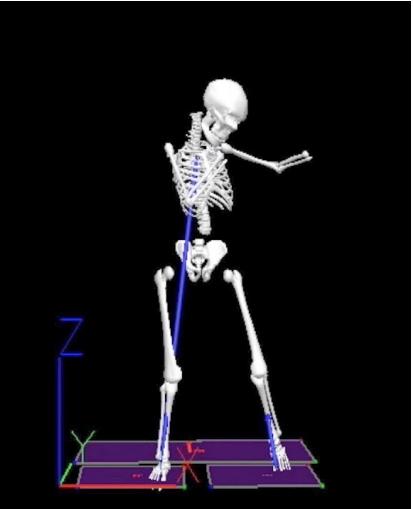
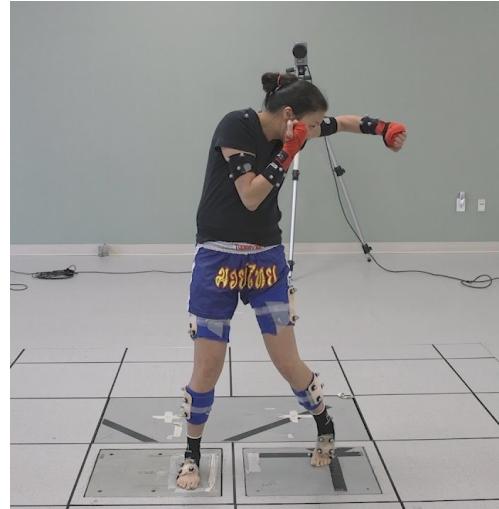
IV 应用1: 超大规模(免维护)分布式无线传感网



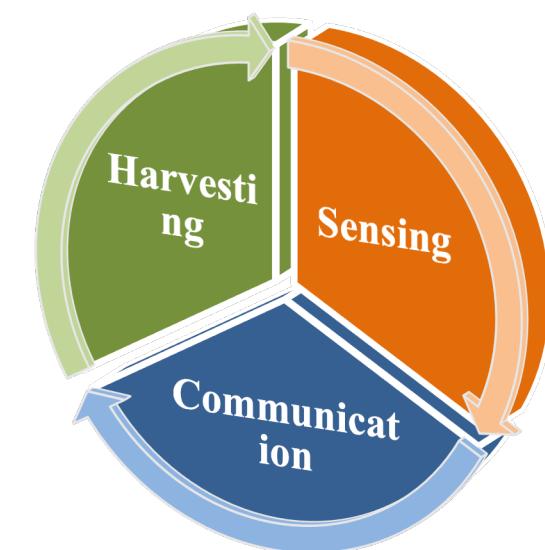
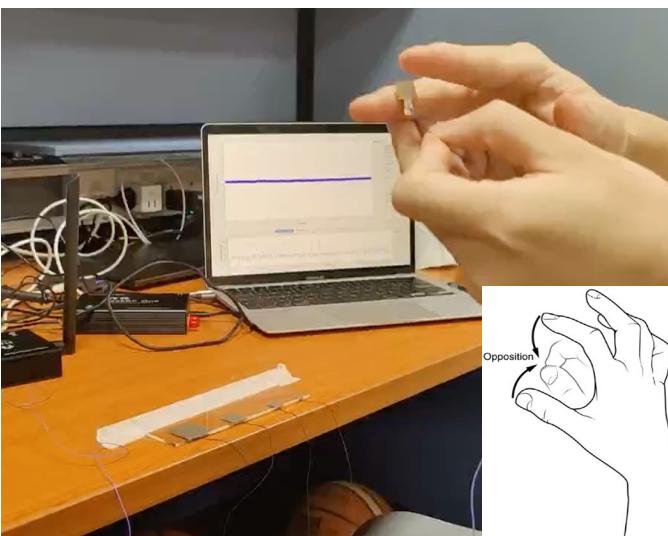
- Application 1: Battery-free wireless sensor network system
 1. **Energy-neutral network.** (能量不确定下的能量中和网络优化)
 2. Deep integration of energy and information(深度能量信息融合)
 3. 户外能量收集器(mW级)设计



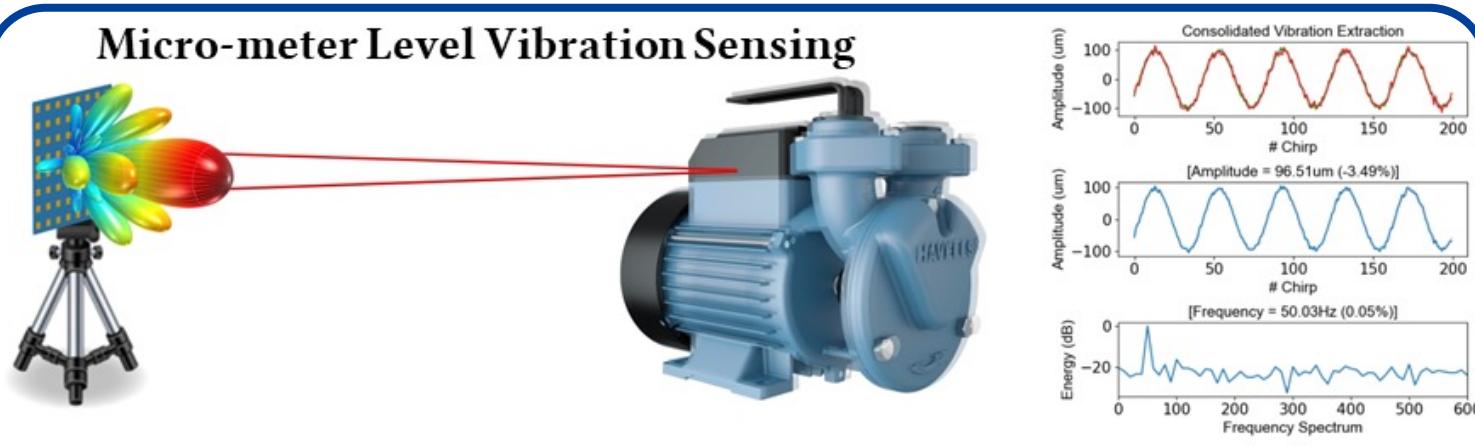
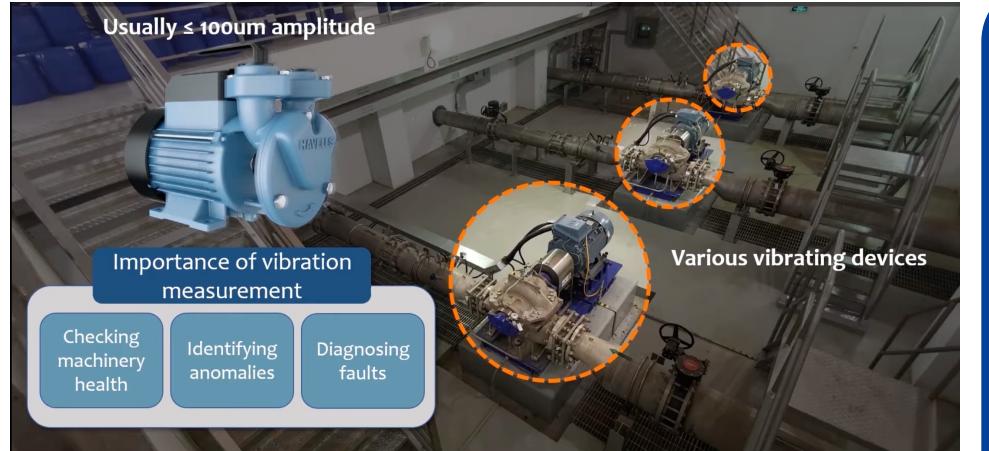
IV 应用2: 无源可穿戴式柔性运动感知



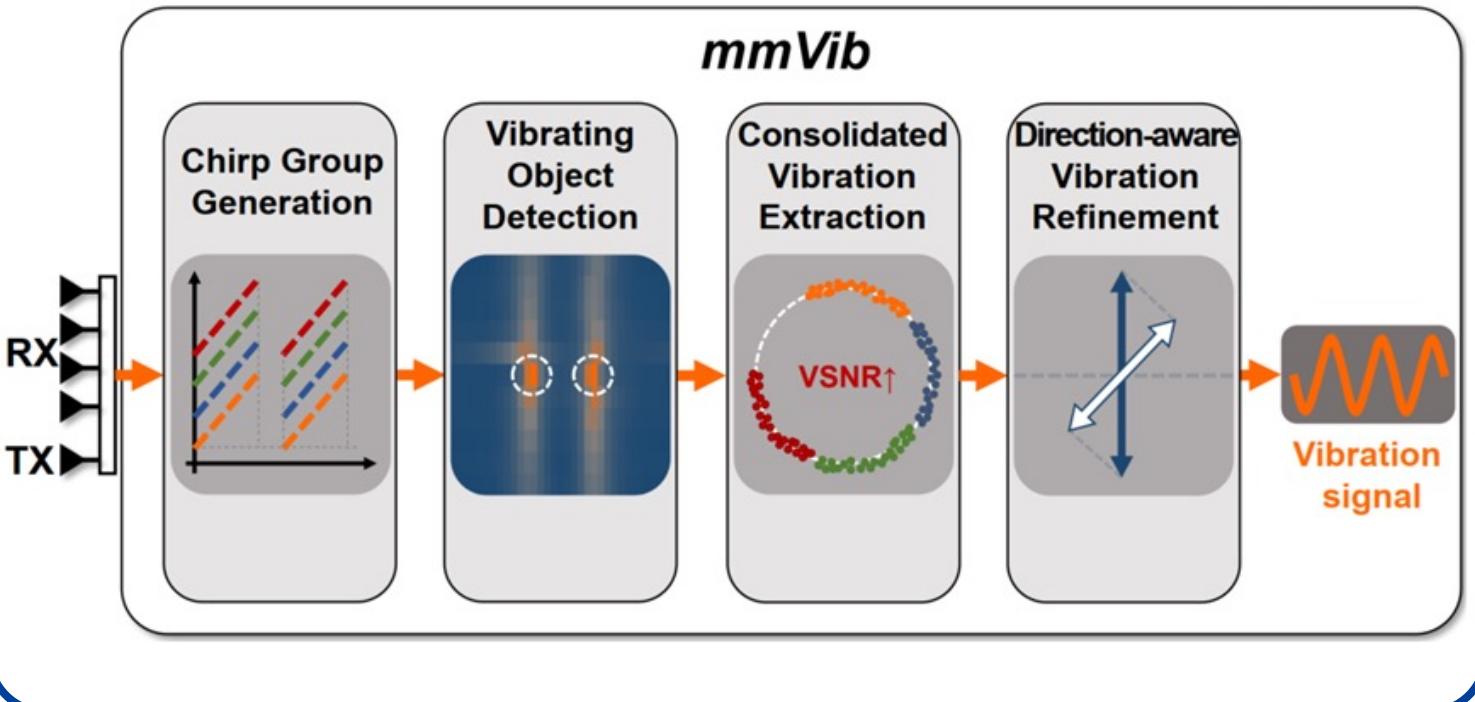
- Application 2: Battery-free human motion sensing system
 1. Backscatter communication (反散射通信)
 2. 柔性能量收集器设计
- TengScatter: A Paradigm Shift Battery-free Flexible Motion Sensing Solution Enabled by Triboelectric Nanogenerator and Backscatter Communication (to be submitted)
- In collaboration with Nanyang Technological University



IV 应用3: 无源振动监测



- Application 3: 无源振动监测
 1. **Backscatter communication** (反散射通信)
 2. 振动能量收集、振动感知与无线传输协同
 3. 振动特征提取
 4. 无线多径效应分析
 5. 机器学习



Yuan He, et al. mmVib: micrometer-level vibration measurement with mmwave radar, *Proceedings of the 26th Annual International Conference on Mobile Computing and Networking*, 2020.

IV 应用4: 面向工业装配过程的人-机交互



1. 工业生产



2. 物料装配



3. 物料补充呼叫(基于ViPSN-button)

- Application 4: 面向工业装配过程中工人与智能化过程装备管理系统的人-机交互系统
 - 1. 小型化瞬态动能收集器
 - 2. 复杂电磁环境下的高鲁棒无线通信
 - 3. 可靠性测试(ViPSN-button/无线网络/人机交互)



4. 物料管理



5. 物料配送