# **Zhichuan Huang**

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## **Research Interests**

- Incorporating **big data analytics** in **Cyber-Physical Systems** (also known as **Internet of Things** under some contexts) from data collection, communication, computation and control in data driven applications in **Smart Connected Communities**.
- Particularly interested in smart **energy** systems from streaming data collection to data analytics, system modeling, control, application design and deployment in different scenarios.
- Other data problems in cyber-physical system such as data **privacy** leakage and protection, **networking** for data transmission over large-scale Internet of Things devices.

## Education

Ph. D. in Computer Science 2014-2017, University of Maryland, Baltimore County Baltimore, MD Ph. D in Computer Science (transferred to UMBC with advisor) 2012-2014 State University of New York at Binghamton Binghamton, NY M. S. in Computer Science 2009-2012 Southeast University Nanjing, China 2005-2009 **Bachelor in Electrical Engineering** Southeast University Nanjing, China

### Academic Honors

- Best Paper Runner-up Award, BuildSys, 2014.
- Multiple Travel Grants from conferences organizers for SenSys 2014, IEEE BigData 2014, MilCom 2015, CPSWeek 2016, e-Energy 2016, RTSS 2016 and IEEE BigData 2016.
- Multiple Travel Grants from University of Maryland, Baltimore County for IGCC 2014, CPSWeek 2015.

### **Selected Conference Paper Publications**

#### **Cyber-Physical Systems**

- [C1] **Zhichuan Huang** and Ting Zhu. Real-Time Data and Energy Management for Microgrids. In IEEE Real-Time Systems Symposium (RTSS), 2016.
- [C2] Zhichuan Huang, Ting Zhu, Haoyang Lu and Wei Gao. Accurate Power Quality Monitoring in Microgrids. In ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), 2016.

- [C3] Zhichuan Huang, Ting Zhu, Yu Gu and Yanhua Li. Shepherd: Sharing Energy for Privacy Preserving in Hybrid AC-DC Microgrids. In ACM International Conference on Future Energy Systems (e-Energy), 2016.
- [C4] Zhichuan Huang, David Corrigan, Ting Zhu, Hongyao Luo, Xiaoxiong Zhan and Yu Gu. Exploring Power-Voltage Relationship for Distributed Peak Demand Flattening in Microgrids. In ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS), 2015.
- [C5] Zhichuan Huang, Ting Zhu, Yu Gu, David Irwin, Aditya Mishra and Prashant Shenoy. Minimizing Electricity Costs by Sharing Energy in Sustainable Microgrids. In ACM International Conference on Embedded Systems for Energy-Efficient Buildings (BuildSys), 2014. Best Paper Runner-up.
- [C6] Ting Zhu, Zhichuan Huang, Ankur Sharma, Jikui Su, David Irwin, Aditya Mishra, Daniel Menasche and Prashant Shenoy. Sharing Renewable Energy in Smart Microgrids. In ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS), 2013.
- [C7] Shengyang Li, Ping Yi, **Zhichuan Huang**, Tiantian Xie and Ting Zhu. Energy Scheduling and Allocation in Electric Vehicles Energy Internet. IEEE Innovative Smart Grid Technologies Conference (ISGT), 2016.

#### **Big-Data Analytics**

- [C8] **Zhichuan Huang** and Ting Zhu. Leveraging Multi-Granularity Energy Data for Accurate Energy Demand Forecast in Smart Grids. In IEEE International Conference on Big Data (IEEE BigData), 2016.
- [C9] Zhichuan Huang, Tiantian Xie, Ting Zhu, Jianwu Wang, and Qingquan Zhang. Application-Driven Sensing Data Reconstruction and Selection Based on Correlation Mining and Dynamic Feedback. In IEEE International Conference on Big Data (IEEE BigData), 2016.
- [C10] Zicheng Chi, Yao Yao, Tiantian Xie, Zhichuan Huang, Michael Hammond and Ting Zhu. Harmony: Exploiting Coarse-Grained Received Signal Strength from IoT Devices for Human Activity Recognition. In IEEE International Conference on Network Protocols (ICNP), 2016.
- [C11] Zhichuan Huang, Hongyao Luo, David Skoda, Ting Zhu and Yu Gu. E-Sketch: Gathering Large-scale Energy Consumption Data Based on Consumption Patterns. In IEEE International Conference on Big Data (IEEE BigData), 2014.

#### **Networking and Others**

- [C12] Zhichuan Huang, Ting Zhu. Distributed Real-Time Multimodal Data Forwarding in Unmanned Aerial Systems. To Appear in IEEE International Conference on Sensing, Communication, and Networking (SECON), 2017.
- [C13] Zicheng Chi, Zhichuan Huang, Yao Yao, Tiantian Xie, Hongyu Sun and Ting Zhu. EMF: Embedding Multiple Flows of Information in Existing Traffic for Concurrent Communication among Heterogeneous IoT Devices. In IEEE International Conference on Computer Communications (INFOCOM), 2017.
- [C14] Zhichuan Huang, David Corrigan, Sandeep Narayanan, Ting Zhu, Elizabeth Bentley and Michael Medley. Distributed and Dynamic Spectrum Management in Airborne Networks. In Premier International Conference for Military Communications (MILCOM), 2015.
- [C15] Qingquan Zhang, Wei Xu, Zhichuan Huang, Ziqiao Zhou, Ping Yi, Ting Zhu and Sheng Xiao. Context-Centric Target Localization with Optimal Anchor Deployments. In IEEE International Conference on Network Protocols (ICNP), 2015.
- [C16] Zhichuan Huang, Ting Zhu and Hongyao Luo. Scheduling for Wireless Energy Sharing Among Electric Vehicles. In IEEE PES General Meeting, 2015.

- [C17] Zhichuan Huang, Ting Zhu and Hongyao Luo. Energy Efficient Air Quality Control in Residential Buildings. In IEEE PES General Meeting, 2015.
- [C18] Zhichuan Huang, Ting Zhu and Hongyao Luo. Signature-based Detection for Activities of Appliances. In IEEE PES General Meeting, 2015.
- [C19] Zhichuan Huang, Weigang Zhong, Ting Zhu, Yu Gu, Qingquan Zhang, Ping Yi, Dingde Jiang and Sheng Xiao. iDES: Incentive-Driven Distributed Energy Sharing in Sustainable Microgrids. In IEEE International Green Computing Conference (IGCC), 2014.
- [C20] Ziqiao Zhou, Mengjun Xie, Ting Zhu, Wei Xu, Ping Yi, Zhichuan Huang, Qingquan Zhang and Sheng Xiao. EEP2P: An Energy-Efficient and Economy-Efficient P2P Network Protocol. In IEEE International Green Computing Conference (IGCC), 2014.

### **Selected Journal Article Publications**

- [J1] Zhichuan Huang, Ting Zhu, David Irwin, Aditya Mishra, Daniel Menasche and Prashant Shenoy. Minimizing Transmission Loss in Smart Micrgrids by Sharing Renewable Energy. ACM Transactions on Cyber-Physical Systems, 1(2), 2017.
- [J2] Hongyao Luo, **Zhichuan Huang** and Ting Zhu. A Survey on Spectrum Utilization in Wireless Sensor Networks, In Journal of Sensors, 2015.
- [J3] Yichuan Jiang and **Zhichuan Huang**. The Rich Get Richer: Preferential Attachment in the Task Allocation of Cooperative Networked Multiagent Systems with Resource Caching. IEEE Transactions on Systems, Man, and Cybernetics-Part A, 42(5), 1040-1052, 2012.

### **Conference Poster and Workshop Publications**

- [P1] Jianwu Wang, Zhichuan Huang, Wenbin Zhang, Ankita Patil, Ketan Patil, Ting Zhu, Eric Shiroma, Mitchell Schepps, and Tamara Harris. Wearable Sensor based Human Posture Recognition. In Big Data Analytic Technology For Bioinformatics and Health Informatics Workshop (KDDBHI in conjunction with IEEE BigData), 2016.
- [P2] Zhichuan Huang and Ting Zhu. eAir: An Energy Efficient Air Quality Management System in Residential Buildings (Poster). In ACM International Conference on Embedded Systems for Energy-Efficient Buildings (BuildSys), 2014.
- [P3] Zhichuan Huang and Ting Zhu. SBD: a signature-based detection for activities of appliances (Poster). In ACM International Conference on Embedded Systems for Energy-Efficient Buildings (BuildSys), 2014.

### **Under Submission**

- [S1] **Zhichuan Huang**, Ting Zhu, Yu Gu, David Irwin, Aditya Mishra and Prashant Shenoy. Minimizing Electricity Cost in Energy-Shared Sustainable Microgrids. Submitted to ACM TCPS.
- [S2] **Zhichuan Huang** and Ting Zhu. Distributed Peak Demand Flattening By Exploiting Power-Voltage Relationship in Microgrids. Submitted to ACM TCPS.
- [S3] **Zhichuan Huang**, Ting Zhu and Yu Gu. Minimizing Data Storage for Large-Scale Energy Consumption Data Collection Based on Consumption Patterns. Submitted to IEEE TBD.
- [S4] **Zhichuan Huang**, Ting Zhu, Yu Gu and Yanhua Li. Exploring Energy Sharing to Minimize Privacy Leakage in Hybrid AC-DC Microgrids. Submitted to ACM TCPS.

- [S5] Zhichuan Huang, Ting Zhu. Real-Time Demand and Generation Management in Microgrids. Submitted to ACM TCPS.
- [S6] **Zhichuan Huang**, Ting Zhu. Accurate Demand Forecast with Multi-Granularity Data for in Smart Grids. Submitted to IEEE TBD.

## Talks

- [T1] Leveraging Multi-Granularity Energy Data for Accurate Energy Demand Forecast in Smart Grids. Conference presentation in IEEE BigData 2016.
- [T2] Application-Driven Sensing Data Reconstruction and Selection Based on Correlation Mining and Dynamic Feedback. Conference presentation in IEEE BigData 2016.
- [T3] Real-Time Data and Energy Management for Microgrids. Conference presentation in RTSS 2016.
- [T4] Shepherd: Sharing Energy for Privacy Preserving in Hybrid AC-DC Microgrids. Conference presentation in e-Energy 2016.
- [T5] Accurate Power Quality Monitoring in Microgrids. Conference presentation in IPSN 2016.
- [T6] Distributed and Dynamic Spectrum Management in Airborne Networks. Conference presentation in MIL-COM 2015.
- [T7] Exploring Power-Voltage Relationship for Distributed Peak Demand Flattening in Microgrids. Conference presentation in ICCPS 2015.
- [T8] Gathering Large-scale Energy Consumption Data Based on Consumption Patterns. Conference presentation in IEEE BigData 2014.
- [T9] Minimizing Electricity Costs by Sharing Energy in Sustainable Microgrids. Conference presentation in BuildSys 2014.
- [T10] iDES: Incentive-Driven Distributed Energy Sharing in Sustainable Microgrids. Conference presentation in IGCC 2014.
- [T11] EEP2P: An Energy-Efficient and Economy-Efficient P2P Network Protocol. Conference presentation in IGCC 2014.
- [T12] Minimizing Data Storage for High Granularity Energy Data Collection, MPE 2013+ Workshop on Dataaware Energy Use, 2014.

### **Research Experiences**

#### Research Assistant, University of Maryland, Baltimore County, Sep. 2014 - Present.

- Designed a novel approach for real-time distributed control with unreliable data collection in extreme situations. The data recovery accuracy is more than 99% and our distributed control can reduce the operational cost by 23% (published in RTSS 2016)
- Leverage multi-granularity energy data from smart meters for accurate energy demand forecast in power grid. The accuracy for demand forecast in the next hour is more than 97%. (published in IEEE BigData 2016)
- Develop the appliance usage detection algorithm based on energy consumption in homes. To protect users privacy, we propose to leverage the existing infrastructure of a microgrid to hide power consumption information by allowing homes to share energy. (published in e-Energy 2016)
- Design the sensing hardware to monitor power quality over the power line with low cost, which can be deployed in smart communities in large scale. (published in IPSN 2016)

Research Assistant, State University of New York, Binghamton, Sep. 2012 - Aug. 2014

- Utilize the power-voltage relationship in microgrid to enable each home infer the aggregated power consumption in the community by its own voltage level. The inferred information is then used for homes to flatten peak demand (29% off) of the microgrids with existing thermal appliances. (published in ICCPS 2015)
- Investigate the power consumption patterns of residential homes for power consumption data collection. We propose E-Sketch, a middleware to gather accurate data (99% accuracy) from smart meters with much less storage (90% off) and communication overhead. (published in IEEE BigData 2014)
- Minimize the costs of electricity from a utility for a microgrid under market-based TOU pricing models. System architecture for energy sharing microgrid and optimal energy sharing algorithms to minimize utility costs (25% off) is proposed. (published in BuildSys 2014)

## Research Assistant, Southeast University, China, Sep 2009 - Aug. 2012

- Model the information propagation process in the transportation system. Build simulation platform for different information propagation models in transportation network. (published in IEEE Transactions on Systems, Man, and Cybernetics 2012).
- Transportation simulation platform is used for other members in the lab for Multi-Agent research paper in AAMAS 2012.

# **Teaching Experiences**

- Teaching Assistant. CS 428/528: Computer Networks, Prof. Yao Liu, Spring 2014, Binghamton University.
- Teaching Assistant. CS 426/526: Wireless Sensor Networks, Prof. Ting Zhu, Spring 2014, Binghamton University.
- **Teaching Assistant.** CMSC 203: Discrete Structures, Prof. Yaacov Yesha and Arnie Horta, Fall 2016, University of Maryland, Baltimore County.
- Mentored three graduate students for their master theses.

# **Professional Services**

- Reviewer (Journals) IEEE/ACM Transactions on Networking, IEEE Transactions on Sensor Networks, IEEE Transactions on Computers, Journal of Sensor Networks, Advances In Engineering Software.
- Reviewer (Conferences) *IEEE INFOCOM 2014, e-Energy 2015, BuildSys 2015, IEEE PES General Meeting 2015, DCOSS 2017.*

# Dissertation

**Title**: Data, Energy, and Privacy Management Techniques for Sustainable Microgrids. **Advisor**: Prof. Ting Zhu

- The increased reliance on burning fossil fuels to generate electricity is rapidly depleting our planets finite resources and contributing to climate change. Recent studies show that cities consume 80% of the global energy supply and as the main consumption sector in cities, buildings consume 40% of the annual energy consumption. Consequently, techniques to make buildings self-sustainable, while ensuring user well-being and comfort, are crucial for achieving a sustainable energy future in smart cities. Recently, the growing adoption of renewable energy sources has shifted the emphasis from large-scale centralized utility control of power grids to more localized energy system in smart connected communities, which comprises of residential and commercial buildings; and generate, store, and share electricity to balance local generation and consumption.
- In this thesis, we propose to investigate three key techniques to address three main challenges: data, energy and privacy management in microgrids. To realize sustainable microgrids, i) the first step is to collect energy data in microgrids for different applications. Thus, we deploy multiple energy meters in residential homes

to collect energy data for every second and present E-Sketch, a middleware for utility companies to gather data from smart meters with much less storage and communication overhead; ii) the second step is to conduct energy management in microgrids especially under the scenarios with renewable energy (e.g., solar energy) and we study the theoretical, technical and economic feasibility of sustainable microgrids; iii) the final step is to protect data privacy of homeowners. We leverage the unique feature of hybrid AC-DC microgrids and propose Shepherd, a privacy protection framework to effectively protect occupants privacy. In Shepherd, we provide a generic model for energy consumption hiding from different types of detection algorithms.

• We implement and evaluate our proposed management techniques based on large energy datasets collected from more than 700 residential homes. The evaluation results show that i) E-Sketch can store the energy data by reducing 90% data storage compared to raw data while preserving the useful information; ii) our design can reduce energy cost up to 30% in sustainable microgrids; iii) Shepherd can effectively protect users privacy of energy consumption information from multiple detection algorithms.

### References

**Ting Zhu**, Assistant Professor (Thesis Advisor) Department of CSEE University of Maryland, Baltimore County Email: zt@umbc.edu Phone: 410-455-3315

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