Zijing Zhang

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Education

Cornell University, Ithaca, NY, USA *Aug. 2019 – (Expected) May. 2023*
Ph.D. Candidate, Electrical and Computer Engineering
Thesis: **RF Sensors for Medical and Cyber-physical Intelligence**
Nominated for Best ECE Ph.D. Thesis Competition Advisor: Edwin C. Kan

Huazhong University of Science and Technology, Wuhan, China *Sept. 2015- June 2019*
Bachelor of Engineering, Optoelectronic Information Science and Engineering, GPA: 3.92/4.0

Skills

Programming and tools: MATLAB; Python; PyTorch; LabVIEW; COMSOL; SPICE; C/C++; Verilog; CST.
Sensors: EMG; ECG; PPG; accelerometer, gyroscope; respiratory belt; polysomnography; IMU; infrared cameras.
Knowledge: circuit design, analog and mixed-signal system, electromagnetism, and statistical analysis.
RF equipment: Software-defined radios; network analyzers; spectrum analyzers; RF transceivers.

Experiences

Signal Processing and Machine Learning Intern *Analog Devices, Wilmington, MA, May – Aug. 2021*
Research Intern in Georgia Institute of Technology (Advised by Prof. Ali Adibi) *Atlanta, GA, Jun. – Oct. 2018*
Outstanding Undergrad Exchange Program in University of California, San Diego *San Diego, CA, Sep. – Dec. 2017*

Research Areas

- Non-invasive sensing of physiological signals including respiration, heartbeat, and muscle motion.
- Muscle monitoring system for hand gesture recognition, body/eye motion detection, and biometrics authentication, with applications in Human Computer Interaction (HCI).
- Machine learning, deep neural network, digital signal processing, and 2D/3D imaging reconstruction.

Publications

[1] **Z. Zhang**, and E. C. Kan, "Novel muscle monitoring by radiomyography (RMG) and its application to hand gesture recognition," 2nd review, *IEEE Trans. Hum. Mach. Syst.* link video

[2] **Z. Zhang,** J. Zhou, T. B. Conroy, S. Chung, J. Choi, P. Chau, D. B. Green, A. C. Krieger and E. C. Kan, "Objective dyspnea evaluation on COVID-19 patients learning from exertion-induced dyspnea scores," editor approval for 1st review, *Science Partner Journal BME Frontiers.* link

[3] **Z. Zhang,** T. B. Conroy, A. C. Krieger and E. C. Kan, "Identification and prediction of sleep disorder by covert bed integrated RF sensors," *IEEE. Trans. Biomed. Engr.*, 2022, doi: 10.1109/TBME.2022.3212619. link

[4] **Z. Zhang**, and E. C. Kan, " Radiooculogram (ROG) for eye movement sensing with eyes closed," in *21st IEEE Conf. on Sensors*, Dallas, TX, Oct. 30 – Nov. 2, 2022. link

[5] **Z. Zhang**, G. Xu, and E. C. Kan, "Outlooks for RFID-based autonomous retails and factories," *IEEE J. Radio Frequency Identification (RFID)*, 2022, doi: 10.1109/JRFID.2022.3211474. link

[6] **Z. Zhang**, G. Xu, and E. C. Kan, "3D geometry recognition by RFID Box based on deep learning," in *16th Intl. Conf. on RFID*, Las Vegas, NV, May 16 – 19, 2022. link video

[7] P. Sharma, **Z. Zhang**, T. B. Conroy, X. Hui, and E. C. Kan, "Attention detection by heartbeat and respiratory features from radio-frequency sensor," *Sensors*, vol. 22, no. 20, p. 8047, 2022. link

[8] **Z. Zhang**, P. Sharma, T. B. Conroy, V. Phongtankuel, and E. C. Kan, "Objective scoring of physiologically induced dyspnea by non-invasive RF sensors," *IEEE. Trans. Biomed. Engr.*, vol. 69, no. 1, pp. 432-442, 2021. link

[9] **Z. Zhang,** P. Sharma, J. Zhou, X. Hui and E. C. Kan, "Furniture-integrated respiration sensors by notched transmission lines," *IEEE Sens. J.*, vol. 21, no. 4, pp. 5303-5311, 2021. link

[10] X. Hui, J. Zhou, P. Sharma, T. B. Conroy, **Z. Zhang** and E. C. Kan, "Wearable RF near-field cough monitoring by frequency-time deep learning", *IEEE Trans. Biomed. Circuits & Sys*, vol. 15, no. 4, pp. 756 – 764, 2021 link

[11] **Z. Zhang**, et al., "Wideband and continuously-tunable fractional photonic Hilbert transformer based on a single high- birefringence planar Bragg grating," *Opt. Express*, vol. 26, pp. 20450-20458, 2018. link

[12] **Z. Zhang**, et al., "Design of a broadband achromatic dielectric meta-lens for linear polarization in the near-infrared spectrum," *OSA Contin.*, vol. 1, pp. 882-890, 2018. link
[13] **Z. Zhang**, et al., "Micro-machining for TE/TM mode phase matching in high-birefringence planar waveguide and implementation in continuously-tunable fractional Hilbert transform," *Intl. Photonics & Optoelectronics Mtg., OSA Tech. Dig.*, OT4A.2, 2018. link
[14] H. Sun, W. Zhou, **Z. Zhang** and Z. Wan. "A MEMS variable optical attenuator with ultra-low wavelength-dependent loss and polarization-dependent loss," *Micromachines*, vol. 9, no. 12, p. 632, 2018. link

Patent

[1] **Z. Zhang**, and E. C. Kan, "Radiomyography (RMG) for accurate hand gesture recognition by forearm wearable radio sensors", US Patent (Provisional)

Research Experiences

1 ***Hand gesture recognition system by non-invasive muscle monitoring sensors*** link pdf
Proposed a novel radiomyography (RMG) for continuous muscle actuation sensing that can be wearable and touchless, with high user comfort and low time latency, capturing superficial and deep muscle groups. Experimentally demonstration of high accuracy (99%) for 23 gestures by adopting vision transformer (ViT) as the deep learning model. RMG can be applied for assessment of muscle functions, fatigue, and neuromuscular disorders, as well as human-machine interface of exoskeleton robotic control and VR/AR.

2 ***Non-invasive eye movement monitoring*** link pdf
Prototyped radio-oculogram (ROG), a wearable RF sensor for non-invasive eye movement with eyes open or closed, which can applied to sleep rapid EM monitoring.

3 ***Air-writing recognition by forearm wearable RMG*** link
Enabled the user to hand-write in the air in an intuitive and natural way with non-invasive sensor on the forearm and demonstrated accurate detection of individual alphabets from A-Z.

4 ***Dynamic muscle fatigue detection using RMG and sEMG*** link
Demonstrated muscle sensing in fatigue vs. non-fatigue routines on forearms and legs assisted by machine learning models.

5 ***Biometric authentication based on muscle recognition***
Explored the new dynamic air signature biometric by recognizing the unique muscle pattern using wearable forearm RMG. Compared with traditional signature, this new technique requires dynamic recording of muscle activities which can be robust against presentation and replay attacks.

6 ***3D geometry recognition/reconstruction by RFID based on deep learning*** link pdf
Employed ambient low-cost passive RFID tags for recognition and reconstruction of 3D shape and geometry of hand gesture and foot size. Studied the tag deployment and antenna detuning.

7 ***Dyspnea evaluation on COVID-19 patients*** link pdf
Employed wireless and wearable sensors on COVID-19 patients (N = 12) with continuous (~16 hours) monitoring of respiratory metrics to evaluate dyspnea using machine learning models. Demonstrated diagnosis and prognosis of COVID dyspnea, which can be potentially applied to asthma and COPD.

8 ***Sleep apnea detection and prediction based on bed-integrated RF sensor*** link pdf
Collected data from overnight clinical study (N = 27) in Weill Cornell Sleep Center using covert bed-integrated sensors. Developed machine-learning algorithms that can autonomously detect and predict sleep apneic events with 90-s lead time on real patients with high fidelity.

9 ***Objective scoring of dyspnea with wearable respiratory RF sensor*** link pdf
Designed a testing protocol to perform human study (N = 32) on simulated dyspnea by exertion and airway blockage. Implemented algorithms to identify various features embedded in breathing waveforms and designed a learning model to predict objective dyspnea scores in comparison with the self-report scores.

10 ***Covert furniture-integrated RF sensors for respiratory pattern monitoring*** link pdf
Developed a non-invasive respiration sensor integrated into furniture that can be invisible to the user to enhance comfort, convenience and acceptance.

11 ***Respiration study in patients with advanced chronic obstructive pulmonary disease (COPD)***
Performed human study to identify the association between dyspnea and respiratory features of COPD patients in Weill Cornell Medicine (N = 15), collected data via wearable RF sensors in a clinical setting.