Bing Zhou

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Research Interests

- **AR & 3D Perception**: Fine-grained visual recognition in AR/VR; 3D scene reconstruction and understanding; depth completion for AR; 3D device motion tracking.
- **HCI & Health Sensing**: Non-contact human gesture tracking and health monitoring based on wireless signal; 3D face authentication based on sound; wearable device for motion tracking.
- **Location Based Services**: Indoor map construction; indoor localization/navigation; context aware services.

Current Position

- **IBM Thomas J. Watson Research Center** — Yorktown Heights, NY
  Research Staff Member (Interactive and Immersive AI Group) — *May 2019 - Present*

Education

- **Stony Brook University** — Stony Brook, NY
  Ph.D. in Electrical and Computer Engineering (Advisor: Dr. Fan Ye) — *August 2014 – May 2019*
- **University of Chinese Academy of Sciences** — Beijing, China
  M.E. in Electronic and Communication Engineering — *September 2011 – May 2014*
- **University of Science and Technology of China (USTC)** — Hefei, China
  B.S. in Applied Physics (School of the Gifted Young) — *September 2007 – May 2011*

Research Experience

- **AR for Technical Support**: Lead the R&D agenda around AR and Computer Vision for AR Project.
  - ***Visual Recognition.*** Enable ultra fine-grained visual recognition capability in mobile AR for real-time hardware repair status analysis, providing step-by-step guidance automatically.
  - ***Depth Prediction.*** Develop machine learning models and optimization algorithms for depth prediction from RGB image and sparse depth samples obtained from AR for fast 3D environment sensing.
  - ***3D Reconstruction.*** Reconstruct object 3D model from AR session meta data for offline annotation, develop segmentation models to generate hardware parts 3D models.
  - ***AR Content Creation.*** Consolidate remote assist AR session data and create AR experience at scale for reuse.
- **Mobile Sensing & HCI**: Develop prototypes and novel techniques for mobile sensing and HCI applications.
  - ***3D Face Authentication.*** I design *EchoPrint*, a "FaceID alternative" system, which leverages acoustics and vision for secure and convenient user authentication, without requiring any special hardware. It actively emits inaudible acoustic signals from the earpiece speaker to "illuminate" the user's face and authenticates the user by the unique features extracted from the echoes bouncing off the 3D facial contour.
  - ***Device Motion Tracking.*** I design *BatTracker*, a sensor fusion algorithm which incorporates inertial and acoustic data for infrastructure-free mobile device tracking. It leverages echoes from nearby objects and uses distance measurements from them to correct error accumulation in inertial based device position prediction.
  - ***Human Gesture Tracking.*** I develop a non-contact wireless sensing system for human upper body gesture tracking in driving scenarios. It leverages mmWave signals and machine learning to tracking the head, torso and arms movements when driving.
  - ***Human Health Sensing.*** I develop wireless sensing systems for indoor human vital sign sensing and activity monitoring. It enables concurrent non-contact multi-user monitoring leveraging depth camera and mmWave/UWB radio sensing.
- **Location Based Services**: Design and develop prototypes for indoor map construction using smartphones.
  - ***Indoor Mapping (Vision).*** We propose *Knitter*, a system which extracts floor layout information from single images and inertial data. It uses a multi-hypothesis map fusion framework that updates landmark positions/orientations and accessible areas incrementally according to evidences from each measurement.
  - ***Indoor Mapping (Acoustic).*** I develop *BatMapper*, a mobile application which leverage acoustics on commodity smartphones for fast, fine-grained and low cost floor plan construction. A few minutes' walk can produce fine-grained corridor shapes, detect doors with about 90% precision. Compared to latest work, It builds fine grained maps of comparable accuracy at 1-2 orders of magnitude less data amounts and user efforts.
  - ***AR Indoor Navigation.*** I design a software/hardware system for indoor navigation and fast object finding. Augmented reality tracking is used for map building and localization, a Raspberry Pi controlled laser pointer highlights the target object under your voice commands.

Honors and Awards

- **Outstanding Technical Achievement Award**: IBM Research, 2020
- **IBM Research Accomplishment Award**: IBM Research, 2019
- **Entrepreneur Challenge First Prize**: Stony Brook University, 2019
- **Finalist Award**: Entrepreneur's Choice, Hackathon@CEWIT, Stony Brook University, 2018
- **Finalist Award**: Most Ambitious, Hackathon@CEWIT, Stony Brook University, 2017
- **NSF Student Travel Grant Award**: ACM MobiCom, 2017
- **ACM SigMobile Travel Grant Award**: ACM SenSys, 2017

Professional Activities

- **External Reviewer**:
  - IEEE Transaction on Mobile Computing
  - IEEE Internet of Things Journal
  - IEEE Access
  - IEEE Sensors Letters
  - Advances in Science, Technology and Engineering Systems Journal
  - The Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT) 2019
  - International Conference on Control, Electronics, Renewable Energy, and Communications (ICCEREC) 2016
- **Grant Activity**:
  - Contributed to proposal ideas and drafting (neither PI or Co-PI) in an awarded NSF grant "Opportunistic Learning on Wheels: Peer-wise Training of Machine Learning Models among Connected Vehicles" 10/1/20-9/30/23.
  - PI of the project, writing proposal and give presentations (Small Business Development Center, Stony Brook University). Easy-Find: A Comprehensive Solution for Fast Object Finding, Indoor Navigation, and Store Inventory Management. Awarded $10,000. April, 2019.

Conference Papers

[1] **Bing Zhou** Matias Aiskovich and Sinem Guven Kaya. Sparse Depth Completion with Mesh Deformation Optimization. In *The Conference on Computer Vision and Pattern Recognition (CVPR)*, 2021. **(Under review.)**

[2] **Bing Zhou** and Sinem Guven Kaya. Fine-grained visual recognition in mobile augmented reality for technical support. In *IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, 2020. **(Accepted to IEEE TVCG special issue, 18 out of 302, Acceptance rate 6%.)**

[3] **Bing Zhou**, Zongxing Xie, and Fan Ye. Multi-modal face authentication using deep visual and acoustic features. In *IEEE International Conference on Communications*. IEEE, 2019.

[4] **Bing Zhou**, Jay Lohokare, Ruipeng Gao, and Fan Ye. Echoprint: Two-factor authentication using vision and acoustics on smartphones. In *Proceedings of the 24th Annual International Conference on Mobile Computing and Networking (MobiCom)*, 2018. **(Acceptance rate: 22.4%)**

[5] **Bing Zhou**, Mohammed Elbadry, Ruipeng Gao, and Fan Ye. Battracker: high precision infrastructure-free mobile device tracking in indoor environments. In *Proceedings of the 15th ACM Conference on Embedded Network Sensor Systems (SenSys)*, page 13. ACM, 2017. **(Acceptance rate: 17%)**

[6] **Bing Zhou**, Mohammed Elbadry, Ruipeng Gao, and Fan Ye. Batmapper: acoustic sensing based indoor floor plan construction using smartphones. In *Proceedings of the 15th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys)*, pages 42–55. ACM, 2017. **(Acceptance rate: 18%)**

[7] Ruipeng Gao*, **Bing Zhou***, Fan Ye, and Yizhou Wang. Knitter: fast, resilient single-user indoor floor plan construction. In *INFOCOM 2017-IEEE Conference on Computer Communications*, pages 1–9. IEEE, 2017. **(Equal contribution, acceptance rate: 20.9%)**

[8] **Bing Zhou** and Fan Ye. Explore hidden information for indoor floor plan construction. In *IEEE International Conference on Communications*, pages 1–6. IEEE, 2017.

[9] Wenjuan Song, **Bing Zhou**, and Shijie Ni. Intelligent environment monitoring and control system for plant growth. In *International Conference on Mobile Ad-Hoc and Sensor Networks*, pages 473–482. Springer, Singapore, 2017.

[10] Xianxiang Chen, Xinyu Hu, Ren Ren, **Bing Zhou**, Xiao Tan, Jiabai Xie, Zhen Fang, Yangmin Qian, Huaiyong Li, Lili Tian, et al. Noninvasive ambulatory monitoring of the electric and mechanical function of heart with a multifunction wearable sensor. In *Computer Software and Applications Conference Workshops (COMPSACW), 2014 IEEE 38th International*, pages 662–667. IEEE, 2014.

[11] Jiabai Xie, Xianxiang Chen, **Bing Zhou**, Xinyu Hu, Xiao Tan, Ren Ren, Yangmin Qian, Huaiyong Li, Lili Tian, and Shanhong Xia. A reconfigurable wireless health monitoring system with undecimated wavelet transform implemented. In *Electronics, Computer and Applications, 2014 IEEE Workshop on*, pages 848–851. IEEE, 2014.

[12] **Bing Zhou**, Xianxiang Chen, Xinyu Hu, Ren Ren, Xiao Tan, Zhen Fang, and Shanhong Xia. A bluetooth low energy approach for monitoring electrocardiography and respiration. In *e-Health Networking, Applications & Services (Healthcom), 2013 IEEE 15th International Conference on*, pages 130–134. IEEE, 2013.

[13] Xiao Tan, Xianxiang Chen, Ren Ren, Xinyu Hu, **Bing Zhou**, Zhen Fang, and Shanhong Xia. Real-time baseline wander removal in ecg signal based on weighted local linear regression smoothing. In *Information and Automation (ICIA), 2013 IEEE International Conference on*, pages 453–456. IEEE, 2013.

Journal Papers

[1] **Bing Zhou**, Zongxing Xie, Yinuo Zhang, Jay Lohokare, Ruipeng Gao, and Fan Ye. Robust human face authentication leveraging acoustic sensing on smartphones. *IEEE Transactions on Mobile Computing (TMC)*, 2021.

[2] **Bing Zhou** and Sinem Guven Kaya. Fine-grained visual recognition in mobile augmented reality for technical support. In *IEEE Transactions on Visualization and Computer Graphics (TVCG)*, 2020.

[3] **Bing Zhou**, Mohammed Elbadry, Ruipeng Gao, and Fan Ye. Towards scalable indoor map construction and refinement using acoustics on smartphones. *IEEE Transactions on Mobile Computing (TMC)*, 2019.

[4] Ruipeng Gao, **Bing Zhou**, Fan Ye, and Yizhou Wang. Fast and resilient indoor floor plan construction with a single user. *IEEE Transactions on Mobile Computing (TMC)*, 2018.

[5] Xinyu Hu, Xianxiang Chen, Ren Ren, **Bing Zhou**, Yangmin Qian, Huaiyong Li, et al. Portable health monitoring device for electrocardiogram and impedance cardiography based on bluetooth low energy. *Journal of Fiber Bioengineering and Informatics*, 7(3):397–408, 2014.

[6] Xiao Tan, Xianxiang Chen, Xinyu Hu, Ren Ren, **Bing Zhou**, Zhen Fang, and Shanhong Xia. Emd-based electrocardiogram delineation for a wearable low-power ecg monitoring device. *Canadian Journal of Electrical and Computer Engineering*, 37(4):212–221, 2014.

[7] Ren Ren, Xian Xiang Chen, Xin Yu Hu, **Bing Zhou**, Xiao Tan, Yu Wang, and Shan Hong Xia. A bluetooth-based portable design device with wireless power module for electrocardiogram and respiration measurement. In *Applied Mechanics and Materials*, volume 441, pages 129–132. Trans Tech Publ, 2014.

[8] Xinyu Hu, Xianxiang Chen, Ren Ren, **Bing Zhou**, Yangmin Qian, Huaiyong Li, and Shanhong Xia. Adaptive filtering and characteristics extraction for impedance cardiography. *Journal of Fiber Bioengineering and Informatics*, 7(1):81–90, 2014.

Demos and Posters

[1] **Bing Zhou**, Sinem Guven, Shu Tao, and Fan Ye. Poster: Pose-assisted active visual recognition in mobile augmented reality. In *Proceedings of the 24th Annual International Conference on Mobile Computing and Networking*, 2018.

[2] Mohammed Elbadry, **Bing Zhou**, Fan Ye, Peter Milder, and YuanYuan Yang. Poster: A raspberry pi based data-centric mac for robust multicast in vehicular network. In *Proceedings of the 24th Annual International Conference on Mobile Computing and Networking*, 2018.

[3] **Bing Zhou**, Mohammed Elbadry, Ruipeng Gao, and Fan Ye. Demo: Acoustic sensing based indoor floor plan construction using smartphones. In *Proceedings of the 23rd Annual International Conference on Mobile Computing and Networking*, pages 519–521. ACM, 2017.

Patents

[1] **Bing Zhou**, and Sinem Guven Kaya. System and Method for Automatic 3D Model Generation and Tracking in Augmented Reality. In *U.S. Patent No. 17,101,870. 23 Nov. 2020.*

[2] **Bing Zhou**, Shu Tao, and Sinem Guven Kaya. System and method for augmented reality driven visual recognition. In *U.S. Patent No. 16,732,424. 02 Jan. 2020.*

[3] **Bing Zhou**, Shu Tao, and Sinem Guven Kaya. System and method for active visual recognition in mobile augmented reality. In *U.S. Patent No. 95,210,510. 01 Feb. 2019.*

[4] Hongtan Sun, Larisa Shwartz, Rohit Madhukar Khandekar, Qing Wang, and **Bing Zhou**. A system and method to assess technical risk in it service management using visual pattern recognition. In *U.S. Patent No. 95,645,683. 14 Sep. 2019.*

[5] **Bing Zhou** and Fan Ye. System and method associated with expedient determination of location of one or more object(s) within a bounded perimeter of 3d space based on mapping and navigation to a precise poi destination using a smart laser pointer device. In *International application No. PCT/US19/35400. June 4, 2019.*

[6] **Bing Zhou** and Fan Ye. System and method associated with user authentication based on an acoustic-based echo-signature. In *International application No. PCT/US2018/057951. Oct. 29, 2018.*

[7] Fan Ye, **Bing Zhou**, and Yuanyuan Yang. High precision infrastructure-free mobile device tracking in indoor environments. In *US provisional patent application 62/578,641.*

[8] Fan Ye and **Bing Zhou**. Method for acoustic based accurate, low cost indoor map creation using mobile devices. In *US provisional patent application 62/518,649.*

Industry Experience

- **IBM Thomas J. Watson Research Center** — Yorktown Heights, NY
  Research Staff Member - lead the AR and CV exploratory research. — *May 2019 - Present*
- **IBM Thomas J. Watson Research Center** — Yorktown Heights, NY
  Research Intern - work on fine-grained visual recognition in AR. — *May 2018 - August 2018*