

# XIN ZHANG

## PROFILE

Xin Zhang, Ph.D., is currently a full-time Postdoctoral Researcher at the University of California, Davis, Department of Biological and Agricultural Engineering. Xin has been dedicating her efforts and time to developing 1) automated AI-driven pipelines to analyze aerial and ground image-based datasets; 2) decision-support tools for the U.S. west coast specialty crops using the advanced remote and proximal sensing technologies; and 3) automated and mechanized agricultural robots for solving the urgent issue of labor shortage worldwide. Xin has broad research experiences but is particularly interested in 1) RGB, multispectral, hyperspectral, thermal, and LiDAR capable sUAS remote and proximal sensing; 2) computer vision and deep learning-based field ag-robotics development; and 3) machine learning-based data science and feature engineering in the biological world.

## WORK EXPERIENCE

- Postdoctoral Research Associate, **University of California, Davis**; Davis, CA, USA (06/2020-Present)
- Teaching Assistant, **Washington State University**; Prosser, WA, USA (08/2019-12/2019)

## EDUCATION

- **Washington State University**, Pullman, WA, USA – Ph.D. in Biological and Agricultural Engineering; Major: Agricultural Automation Engineering (08/2016-05/2020)
- **Northwest A&F University**, Xianyang, China – M.S. in Agriculture; Major: Greenhouse Environmental Control and Engineering (09/2013-06/2016)
- **Gansu Agriculture University**, Lanzhou, China – B.S. in Agronomy; Major: Greenhouse Agriculture Science and Engineering (09/2009-06/2013)

## RESEARCH EXPERIENCE

1. Remote Sensing Technology for Accurate, Precise, and Early Almond Yield Forecasting (\$398,175 by Almond Board of CA) – **Co-PI/FAA Certified sUAS Pilot**, 02/2021-01/2024
  - Virtual Orchard
  - 3D modeling of orchards for total PAR estimation using aerial photogrammetry digital surface model

- Deep neural networks-based bloom density identification for almond yield prediction in early season
2. Development of a UAV-based Canopy Profile Mapping Technique to Replace the Mobile Platform Lightbar (\$69,000 by Almond Board of CA) – **Main Collaborator/ FAA Certified sUAS Pilot**, 05/2019-12/2020
  3. Shake and Catch Harvesting for Fresh Market Apples (\$495,480 by USDA-NIFA-AFRI) – **Main Collaborator**, 12/2014-11/2018
  4. Smartphone-based Crop-load Estimation Tool (\$24,434 by WA Grape and Wine Research Program) – **Main Collaborator**, 07/2018-06/2019
  5. Advancing Precision Pollination Systems to Improve Yield Security (\$149,190 by WA Tree Fruit Research Commission) – **Main Collaborator**, 01/2017-12/2019
  6. Precise Mechanical Solution for Vineyard Shoot Thinning (\$195,232 by WSDA-SCBG/ \$49,960 by WA Grape and Wine Research Program) – **Main Collaborator**, 07/2018-09/2021
  7. Unmanned Aerial Systems (UASs) for Mitigating Bird Damage in Blueberry Crops (by WA Blueberry Commission) – **FAA Certified sUAS Pilot**
  8. Apple Crop-load Estimation in a Block Fuji Orchard Using a Mobile Application – Participant, 01/2017-12/2017
  9. Intelligent Branch Training System Development for Trellis Trained Apple Trees (not funded) – Participant, 08/2016-07/2017
  10. Robotic Apple Harvesting – Participant

#### **AWARD**

1. Club of Bologna “Giuseppe Pellizzi Prize 2020” for **the Best Ph.D. Dissertation in Agricultural Engineering** (10/2020)
  - The prize is awarded every other year to the best Ph.D. dissertation on agricultural mechanization **worldwide** by the **Club of Bologna**, which is a highly-recognized international organization based in Italy
2. ASABE “**Rain Bird Engineering Concept of the Year Award**” (07/2020)
  - The award honors and recognizes an engineer or engineering team for a unique contribution to developing or advancing **a new engineering concept** every year
3. 3rd Prize of Presentation Award at WSU BSE Student Seminar (12/2019)

4. ASABE “**Superior Paper Award**” (07/2019)
  - The award gives in recognition of authorship of a contribution to agricultural and biological engineering literature of exceptional merit. **This is the highest award ASABE gives** for publications in its series of journals with the top 1% of the papers can be selected
5. 2nd Prize of “**Best Paper Award of University of Nottingham**” in Joint International Conference on Smart Agriculture and Bio-Robotics (07/2018)
6. WSU BSE Travel Awards (07/2018 & 07/2019)
7. WSU BSE **Scholarship Award**: Arnie & Marta Kegel Endowed Fellowship (12/2017)
8. NWAFU Excellent Graduate Students Award (09/2014)

#### **REFEREED JOURNAL PUBLICATION**

1. **Zhang, X.**, Karkee, M., Zhang, Q., & Whiting, M. D. (**2020**). Computer vision based tree trunk and branch identification and shaking points detection in dense-foliage canopy for automated harvesting of apples. **Journal of Field Robotics** (IF=3.581), 1-18. (DOI: 10.1002/rob.21998)
  - JFR is **one of the three top-tier journals in Robotics** (the other two are IJRR and IEEE TRO, respectively). It particularly emphasizes the field experiments and is highly-recognized in robotics research areas
2. **Zhang, X.**, He, L., Zhang, J., Karkee, M., Whiting, M. D., & Zhang, Q. (**2020**). Determination of key canopy parameters for mass mechanical apple harvesting using supervised machine learning and principal component analysis (PCA). **Biosystems Engineering** (IF<sub>5</sub>=3.417), 193, 247-263. (DOI: 10.1016/j.biosystemseng.2020.03.006)
3. **Zhang, X.**, He, L., Karkee, M., Whiting, M. D., & Zhang, Q. (**2020**). Field evaluation of targeted shake-and-catch harvesting technologies for fresh market apple. **Transactions of the ASABE** (IF<sub>5</sub>=1.381), 63(6), 1759-1771. (DOI: 10.13031/trans.13779)
4. **Zhang, X.**, He, L., Majeed, Y., Karkee, M., Whiting, M. D., & Zhang, Q. (**2018**). A precision pruning strategy for improving efficiency of vibratory mechanical harvesting of apples. **Transactions of the ASABE** (IF<sub>5</sub>=1.381), 61(5), 1565-1576. (DOI: 10.13031/trans.12825) (**2019 ASABE Superior Paper Award**)
5. **Zhang, X.**, Wang, H., Zou, Z., & Wang, S. (**2016**). CFD and weighted entropy based simulation and optimisation of Chinese solar greenhouse temperature distribution.

**Biosystems Engineering** (IF<sub>5</sub>=3.417), 142, 12-26. (DOI: 10.1016/j.biosystemseng.2015.11.006)

6. He, L., **Zhang, X.**, Ye, Y., Karkee, M., & Zhang, Q. (2019). Effect of shaking location and duration on mechanical harvesting of fresh market apples. **Applied Engineering in Agriculture** (IF=0.973), 35(2): 175-183. (DOI: 10.13031/aea.12974) (**2020 ASABE Rain Bird Engineering Concept of the Year Award**)
7. Majeed, Y., Zhang, J., **Zhang, X.**, Fu, L., Karkee, M., Zhang, Q., & Whiting, M. D. (2020). Deep learning based segmentation for automated training of apple trees on trellis wires. **Computers and Electronics in Agriculture** (IF<sub>5</sub>=4.008), 170, 105277. (DOI: 10.1016/j.compag.2020.105277)
8. Gao, F., Fu, L., **Zhang, X.**, Majeed, Y., Li, R., Karkee, M., & Zhang, Q. (2020). Multi-class fruit-on-plant detection for apple in SNAP system using Faster R-CNN. **Computers and Electronics in Agriculture** (IF<sub>5</sub>=4.008), 176, 105634. (DOI: 10.1016/j.compag.2020.105634)
9. Fu, L., Majeed, Y., **Zhang, X.**, Karkee, M., & Zhang, Q. (2020). Faster R-CNN-based apple detection in dense-foliage fruiting-wall trees using RGB and depth features for robotic harvesting. **Biosystems Engineering** (IF<sub>5</sub>=3.417), 197, 245-256. (DOI: 10.1016/j.biosystemseng.2020.07.007)
10. Zhang, J., Karkee, M., Zhang, Q., **Zhang, X.**, Majeed, Y., Fu, L., & Wang, S. (2020). Multi-class object detection using Faster R-CNN and estimation of shaking locations for automated shake-and-catch apple harvesting. **Computers and Electronics in Agriculture** (IF<sub>5</sub>=4.008), 173, 105384. (DOI: 10.1016/j.compag.2020.105384)
11. Zhang, J., He, L., Karkee, M., Zhang, Q., **Zhang, X.**, & Gao, Z. (2018). Branch detection for apple trees trained in fruiting wall architecture using depth features and Regions-Convolutional Neural Network (R-CNN). **Computers and Electronics in Agriculture** (IF<sub>5</sub>=4.008), 155, 386-393. (DOI: 10.1016/j.compag.2018.10.029)
12. **Zhang, X.**, Wang, H., Li, K., & Zhang, Q. (2015). The application of weighted entropy and fuzzy optimization method in the evaluation of comprehensive performance of north wall in Chinese greenhouse (in Chinese with English abstract). **Journal of China Agricultural University** (IF<sub>5</sub>=2.007), 20(5), 235-240. (DOI: 10.11841/j.issn.1007-4333.2015.05.32)
13. Fu, L., Song, Z., **Zhang, X.**, Li, R., Wang, D., & Cui, Y. (2020) Applications and research progress of deep learning in agriculture (in Chinese with English abstract). **Journal of China Agricultural University** (IF<sub>5</sub>=2.007), 25(2), 105-120. (DOI: 10.11841/j.issn.1007-4333.2020.02.12)

14. Bao, E., Zhang, Y., Cao, Y., Wang, Z., **Zhang, X.**, Cao, K., Yang, J., & Zou, Z. (2018). Performance of different material heat transfer pipes and CFD simulation of thermal storage soil temperature distribution (in Chinese with English abstract). **Transactions of the CSAE** (IF<sub>5</sub>=3.409), 34(4), 232-238. (DOI: 10.11975/j.issn.1002-6819.2018.04.028)

#### **REFEREED CONFERENCE PUBLICATION**

1. **Zhang, X.**, Fu, L., Karkee, M., Whiting, M. D., & Zhang, Q. (2019). Canopy segmentation using ResNet for mechanical harvesting of apples. **IFAC-PapersOnLine** (IF=0.96), 52(30), 300-305. (DOI: 10.1016/j.ifacol.2019.12.550)
2. **Zhang, X.**, Fu, L., Majeed, Y., He, L., Karkee, M., Whiting, M. D., & Zhang, Q. (2018). Field evaluation of data-based pruning severity levels (PSL) on mechanical harvesting of apples. **IFAC-PapersOnLine** (IF=0.96), 51(17), 477-482. (DOI: 10.1016/j.ifacol.2018.08.164) (**2018 Best Paper Award of University of Nottingham**)
3. Majeed, Y., Zhang, J., **Zhang, X.**, Fu, L., Karkee, M., Zhang, Q., & Whiting, M. D. (2018). Apple tree trunk and branch segmentation for automatic trellis training using deep learning. **IFAC-PapersOnLine** (IF=0.96), 51(17), 75-80. (DOI: 10.1016/j.ifacol.2018.08.064)
4. Fu, L., Feng, Y., Majeed, Y., **Zhang, X.**, Zhang, J., Karkee, M., & Zhang, Q. (2018). Kiwifruit detection in field images using Faster R-CNN with ZFNet. **IFAC-PapersOnLine** (IF=0.96), 51(17), 45-50. (DOI: 10.1016/j.ifacol.2018.08.059)

#### **CONFERENCE PUBLICATION**

1. **Zhang, X.**, He, L., Majeed, Y., Karkee, M., Whiting, M. D., & Zhang, Q. (2017). A study of the influence of pruning strategy effect on vibrational harvesting of apples. **ASABE Paper No. 1700812**. St. Joseph, MI: ASABE.
2. He, L., **Zhang, X.**, Karkee, M., & Zhang, Q. (2018). Fruit accessibility for mechanical harvesting of fresh market apples. **ASABE Paper No. 1801007**. St. Joseph, MI: ASABE.
3. Zhang, J., He, L., Karkee, M., Zhang, Q., **Zhang, X.**, & Gao, Z. (2017). Branch detection with apple trees trained in fruiting wall architecture using stereo vision and regions-convolutional neural network (R-CNN). **ASABE Paper No. 1700427**. St. Joseph, MI: ASABE.

#### **BOOK CHAPTER**

1. **Zhang, X.**, Zhang, Q., Karkee, M., Whiting, M. D. (2020). Chapter 16 - Machinery-canopy interactions in tree fruit crops. In **Fundamentals of Agricultural and**

**Field Robotics** (Karkee, M., & Zhang, Q. ed.), Springer Book Series: Agriculture Automation and Control. (**in print**)

#### **DISSERTATION & THESIS**

1. Ph.D. Dissertation (WSU): Study of canopy-machine interaction in mass mechanical harvest of fresh market apples (“**Giuseppe Pellizzi Prize 2020**” winner)
2. Master’s Thesis (NWAFU): CFD based simulation of heat charging/discharging process of phase change wallboard in Chinese solar greenhouse (in Chinese with English abstract)

#### **ACADEMIC PRESENTATION**

1. UAV-based orchard 3D mapping and estimation of photosynthetically active radiation (PAR) and bloom density for almond potential yield forecasting. UC Davis 6th Postdoctoral Research Symposium, **Davis**, CA, USA (03/2021)
2. Advanced sensing technologies to develop decision-support tools for west coast specialty crops. Mississippi State University Invited Research Seminar, **Mississippi State**, MS, USA (01/2021)
3. Study of canopy-machine interaction in mass mechanical harvest of fresh market apples. FEDER UNACOMA EIMA International Digital Preview (EDP) - Club of Bologna, **Roma**, Italy (11/2020)
4. Canopy segmentation using ResNet for mechanical harvesting of apples. The 6th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture, **Sydney**, Australia (12/2019)
5. Effect of shaking amplitude and capturing height on mechanical harvesting of fresh market apples. The 6th IFAC Conference on Sensing, Control and Automation Technologies for Agriculture, **Sydney**, Australia (12/2019)
6. Field evaluation of targeted shake-and-catch harvesting technologies for fresh market apple. ASABE AIM, **Boston**, MA, USA (07/2019)
7. Field evaluation of vibratory mechanical harvesting of cider apples: Fruit removal and harvest efficiencies. WA Tree Fruit Association Research News Flash, **Yakima**, WA, USA (12/2018)
8. Field evaluation of data-based pruning severity levels (PSLs) on mechanical harvesting of apples. The 6th IFAC Conference on Bio-Robotics, **Beijing**, China (07/2018)

9. Integration and interaction of canopy and mechanical parameters for vibratory harvesting of apple trees. ASABE AIM, **Detroit**, MI, USA (07/2018)
10. Design method and applied research of a planetary gear system mechanism based on solution region synthesis. ASABE AIM, **Detroit**, MI, USA (07/2018)
11. A precision pruning strategy for improving efficiency of vibratory apple harvesting. GPSA Research Exposition Event, **Pullman**, WA, USA (03/2018)
12. A precision pruning strategy for improving efficiency of vibratory apple harvesting system. ASABE AIM, **Spokane**, WA, USA (07/2017)
13. A precision pollination system for improving yield. CPAAS Open House Day, **Prosser**, WA, USA (07/2017)
14. The comprehensive performance of north wall in Chinese greenhouse evaluation model and application based on weighted entropy method. The 18th World Congress of CIGR, **Beijing**, China (09/2014)
15. Preparation of a novel composite phase change material (PCM) for energy storage in greenhouse. The 18th World Congress of CIGR, **Beijing**, China (09/2014)

#### **EXTENSION ACTIVITY**

1. "[myvirtualorchard.com](http://myvirtualorchard.com)" - Deliver Early Almond Yield Forecast Report to the growers using AI-driven Virtual Orchard data analysis pipeline during bloom stage. Davis, CA, USA (02/2021-03/2021)
2. Apple harvesting robot demo. Prosser Science Expo, Prosser, WA, USA (04/2019)
3. On-farm demo: Drones as pest bird deterrence tools. Pest Bird Management Workshop, Lynden/Sunnyside, WA, USA (03/2019)

#### **MEDIA COVERAGE**

1. West Coast Nut Article: "Almond yield forecasting by drone - Virtual orchard technology captures light interception for improved crop forecasting" (01/2021)
2. WSU Insider News: "Precision pruning can help machines safely, efficiently harvest apples" (07/2019)
3. Good Fruit Grower Magazine Article: "Shaking it up in the orchard: Video; WSU continues work on tiered shake-and-catch harvester" (08/2018)

#### **PROFESSIONAL DEVELOPMENT**

1. The U.S. FAA certified sUAS Remote Pilot (Certificate No. 4020550); Primary pilot for 5+ projects (06/2017-Present)
2. Full membership in Club of Bologna (10/2020-Present)
3. Full membership in IEEE Robotics and Automation Society - Agricultural Robotics and Automation (11/2020-Present)
4. Full membership in ASABE (01/2017-Present)
5. Regular reviewer for journals and conferences (40+): Computers and Electronics in Agriculture, Transactions of the ASABE, IEEE International Conference on Intelligent Robots and Systems (IROS), IEEE Transactions on Industrial Informatics, International Journal for Light and Electron Optics, Plant Methods, Scientia Horticulturae, etc.

#### **TEACHING & MENTORING EXPERIENCE**

1. Fu, L., **Zhang, X.**, Majeed, Y., & Li, R. (2019). Interactive teaching of digital electronics in agricultural universities in China. **International Journal of Emerging Technologies in Learning** (IF=1.00), 14(5). (DOI: 10.3991/ijet.v14i05.8855)
2. Mentoring 1 Ph.D. student and 1 undergrad student at UC Davis for automated AI-driven pipeline development on aerial imagery datasets (06/2020-Present)
3. Mentoring 1 Ph.D. student and 2 summer interns at WSU for field experimental design, data analysis, and imagery annotating used in deep learning neural networks (06/2017-05/2020)
4. Teaching Assistant for WSU BSE 598 Student Seminar (08/2019-12/2019)

#### **SELF-STUDIED COURSE**

1. System Dynamics, Python for Data Science and Machine Learning Bootcamp, Survey of Python for GIS Applications, Python for Computer Vision with OpenCV and Deep Learning, Feature Engineering for Machine Learning, Complete Tensorflow 2 and Keras Deep Learning Bootcamp, PyTorch for Deep Learning with Python Bootcamp, etc. (all degree required courses can be found on the corresponding transcripts)

#### **PROGRAMMING & TECHNICAL SKILL**

1. Programming: Python/MATLAB

2. Technical: UAV-based remote sensing and in-field proximal sensing (RGB, depth, point cloud, multispectral, hyperspectral, LiDAR, and thermal); agricultural mechanization and automation
3. Image processing: OpenCV in Python/MATLAB (machine learning, deep learning; TensorFlow 2.0, Keras; object detection, semantic/instance segmentation)
4. Data analysis: Numpy/Pandas/Scikit-Learn/Scipy in Python (data science and feature engineering); Matplotlib/Seaborn/Plotly in Python (data visualization); SAS (statistical analysis)
5. GIS application: QGIS/ArcGIS; GDAL/Rasterio/GeoPandas/Fiona/Shapely in Python

#### **PUBLIC SERVICE**

1. Publishing field imagery and annotation data repository for apple and grapes
2. Social Coordinator of WSU Prosser Graduate Student Association (PGSA) (09/2019-12/2019)
3. The President of WSU Agricultural Automation and Engineering Club (AAEC) (01/2018-12/2018)