Kaiming Fu

Ph.D. Candidate

(765)-775-0255 kmfu@ucdavis.edu linkedin.com/in/kmfu kmfu.github.io

Skills

Programming Languages: C++, Python, R, Matlab.
Familiar with: CUDA, Pytorch, Scikit-Learn, TensorFlow, Neural Networks (YOLO, CNN, Fast RCNN, Faster RCNN, ResNet).

Education

University of California, Davis — **Davis, CA**
Ph.D. in Electrical and Computer Engineering (GPA: 3.92) — *Sep. 2019 - Present*
M.S in Statistics (GPA: 3.92) — *Sep. 2021 - May. 2023*
Purdue University, West Lafayette — **West Lafayette, IN**
M.S. in Mechanical Engineering (GPA: 3.77) — *Jan. 2018 - May. 2019*

Research Experience

Transformer-Enhanced Multispectral and Synthetic Imaging for Walnut Detection

- Developed a **transformer-based** method to merge RGB, NIR, and thermal imaging data, advancing multispectral walnut detection.
- Generated **synthetic images** (RGB and NIR) with a radiation model in Helios, employing reverse ray-tracing for accurate walnut labeling, to supplement real imaging datasets.
- Validated the improved detection system with YOLOv8 on augmented datasets, achieving accuracy gains of 8.7% in RGB, 18.9% in NIR, and 23.2% in thermal imaging.

Integrated 2D and 3D Fruit Mapping for Optimized Harvesting Simulation and Planning

- Analyzed 3D fruit distribution using a **fusion of sensors** (IMU, LiDAR, thermal camera) combined with SLAM techniques for precise localization of harvestable areas, facilitating GPS-independent harvesting planning.
- Unified high-resolution LiDAR data and radiative ray tracing methods to reconstruct detailed tree models, overlaying both actual and synthetic fruit distributions for comprehensive 2D and 3D mapping.
- Merged comprehensive datasets capturing fruit distribution through sensor fusion with detailed tree architecture from high-resolution LiDAR, enhancing neural network training for the generation of precise synthetic fruit distribution models.

Simulation Design and Optimization of Agricultural Robotics

- Established a comprehensive robot-tree-fruit simulation environment by creating precise digital models to accurately represent real-world agricultural scenarios.
- Conducted an interference study using **voxel-based** modeling accelerated by **CUDA**, enabling the evaluation and enhancement of harvester design through fruit collection efficiency metrics.
- Optimized a dynamic planning algorithm that leverages visible fruit distribution data, obtained from in-field computer vision systems, to inform and refine the robotic harvesting strategy.

Projects

Annual Farm Robotics Challenge
Team Leader. Grand Prize Winner among National-wide Universities and Colleges — *Feb. 2023 – May 2023*

- Designed a **DepthAI-based** real-time monitor system within a harvesting assistant robot, capable of autonomously tracking human operators and providing immediate posture analysis feedback, enhancing worker safety and efficiency through a custom Human Monitoring System.
- Optimized agricultural productivity by enabling the robot to transport harvested crops directly to storage, effectively eliminating the reliance on manual tractor transportation.

"Inceptio-Tsinghua AIR Cup" Autonomous Driving Challenge
1st Prize Winner among 1067 Teams — *Sep. 2022 – Dec. 2022*

- Utilized an Xbox controller to collect driving data for training a neural network with **Imitative Learning**, collaborating on semi-trailer acceleration control with the LCA lane keeping system.
- Employed a range of advanced problem-solving techniques, including two-way search, greedy algorithms, space pruning, convex optimization, and the deep reinforcement learning PPO algorithm.

Fine-Grained Classification in Plant Pathology
IEEE / CVF Computer Vision and Pattern Recognition Conference (CVPR) workshop — *Mar. 2021 – May. 2021*

- Preprocessed imbalanced dataset using a data sampler, employed ResNet50 as the baseline, achieving an F1 score of 0.70.
- Implemented a **Generative Data Augmentation** model for image augmentation and training dataset balance.
- Improved F1 score to 0.874 using a UNet-ResNet generator and a DenseNet discriminator.

Selected Publications

Computer-aided Design and Optimization of a Multi-level Fruit Catching System for Soft Fruit Harvesting.
Kaiming Fu, Stavros G. Vougioukas, Brian N. Bailey. Computers and Electronics in Agriculture. Submitted.

Enhanced 3D Reconstruction and Object Localization Using LiDAR-Inertial SLAM and Sensor Fusion.
Peng Wei, Kaiming Fu, Juan Villacres, Janna Freeman, Sarah Lagattuta, Christine K. Johnson and Zhaodan Kong. Sensors. Submitted.

The Probability Distribution of Absorbed Direct, Diffuse, and Scattered Radiation in Plant Canopies with Varying Structure.
Brian N. Bailey, Kaiming Fu. Agricultural and Forest Meteorology. Jul. 2022.

Test Set Optimization by Machine Learning Algorithms.
Kaiming Fu, Yulu Jin, Zhousheng Chen. 2020 IEEE International Conference on Big Data. Dec. 2020.