Lawrence Arthur

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Department of Agricultural and Biological Engineering, The Pennsylvania State University

RESEARCH INTEREST

Specialty crop automation; agricultural robotics; machine vision and AI; agricultural modeling and decision support

EDUCATION

Pennsylvania State University, Pennsylvania, USA Sept 2023 - Expected Fall 2026
Doctor of Philosophy in Agricultural and Biological Engineering | CGPA: 3.96/4.0
Advisor: Dr. Long He
Dissertation: Development and Evaluation of an AI-Driven Vision-Guided Precision Herbicide Spraying System for Sustainable Weed Management in Apple Orchards

University of Cape Coast, Cape Coast, Ghana Sept 2018
Master of Philosophy in Agricultural Mechanization
Advisor: Prof. Stephen Hills Mends Aikins
Thesis: Influence of Tillage on African Black Beauty Eggplant Performance and Soil Physical Properties

University of Cape Coast, Cape Coast, Ghana May 2015
Bachelor of Science in Agriculture
Advisor: Prof. Ernest Ekow Abano
Thesis: Kinetics and Quality of Microwave-Assisted Drying of Mango (Mangifera indica)

PUBLICATIONS

Journal Articles

1. Mahnan, S., **Arthur, L**., Long, H., Ghatrehsamani, S., Heinemann, P., & Pecchia, J. (2026). Development of a decision-making algorithm to identify picking strategies for robotic mushroom harvesting. Computers and Electronics in Agriculture, 247, 111753.
2. Yang, Y., Mali, P., **Arthur, L**., Molaei, F., Atsyo, S., Geng, J., Long, H., & Ghatrehsamani, S. (2025). Advanced technologies for precision tree fruit disease management: A review. Computers and Electronics in Agriculture, 229, 109704.
3. **Arthur, L**., Mahnan, S., He, L., Hussain, M., Heinemann, P., & Brunharo, C. (2025). YOLOv7-C BAM and DeepSORT with pixel grid analysis for real-time weed localization and intra-row density estimation in apple orchards. Computers and Electronics in Agriculture, 239, 111071.

Conference Publications

1. **Arthur, L**., Mahnan, S., He, L., Hussain, M., Heinemann, P., & Brunharo, C. (2025). Real-time weed species localization and tracking for intra-row weed density estimation in apple orchards. In 2025 ASABE Annual International Meeting. American Society of Agricultural and Biological Engineers.

Technical Publications

1. **Arthur, L**., He, L., & Brunharo, C. (2024). An Overview of Advanced Weed Management Technologies for Orchards. Penn State Extension.

Manuscripts in Preparation

1. **Arthur, L**., Hanjie, D., Mahnan, S., He, L., Hussain, M., Heinemann, P., & Brunharo, C. (2026). Design and performance evaluation of a vision-guided multi-servo nozzle system for precision intra-row weed spot spraying in an apple-orchard mockup. Under internal review.
2. Mahnan, S., **Arthur, L**., Long, H., Ghatrehsamani, S., Heinemann, P., & Pecchia, J. (2026). 3D perception for selective robotic harvesting of button mushroom. Under internal review.
3. **Arthur, L**., Hanjie, D., Mahnan, S., He, L., Hussain, M., Heinemann, P., & Brunharo, C. (2026). Autonomous navigation and targeted precision herbicide application in varied apple orchards: Field integration of a robotic see-and-spray platform. In preparation.

CONFERENCE PRESENTATIONS

Oral Presentation

1. **Arthur, L**. & He, L. (2026). Development of an integrated vision-guided multi-servo-nozzle system for precision spot spraying of intra-row weeds in apple orchards. Presented at AI in Agriculture 2026, NC State University, Raleigh, NC.
2. **Arthur, L**. & He, L. (2026). AI-driven precision herbicide spraying system for sustainable weed management in apple orchard. Presented at the Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.
3. **Arthur, L**. & He, L. (2025). Development of a machine vision system for weed detection and localization in tree fruit intra-rows. Presented at the NABEC Annual International Meeting, Ithaca, NY.
4. **Arthur, L**. & He, L. (2025). YOLOv7-CBAM and DeepSORT with pixel grid analysis for real-time weed localization and intra-row density estimation in apple orchards. Presented at the ASABE Annual International Meeting, Toronto, Ontario.
5. **Arthur, L**. & He, L. (2025). Precision weed management in tree fruit orchards. Presented at the Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.
6. **Arthur, L**. & He, L. (2024). Optimizing precision herbicide application in apple orchards: A YOLO-CBAM based decision-making algorithm for weed detection and classification. Presented at the ASABE Annual International Meeting, Anaheim, CA.
7. **Arthur, L**. & He, L. (2024). An advanced robotic system for precision herbicide application of weeds in apple orchards. Presented at the NABEC Annual International Meeting, State College, PA.

Selected Poster Presentations

1. **Arthur, L**., Mahnan, S., Hussain, M., Brunharo, C., Heinemann, P., & He, L. (2026). Development and evaluation of an integrated vision-guided intra-row weed spot spraying system for apple orchards. Presented at the 2026 Graduate Exhibition, Penn State, University Park, PA.
2. **Arthur, L**., Mahnan, S., Hussain, M., Brunharo, C., Heinemann, P., & He, L. (2026). Development and evaluation of an integrated vision-guided intra-row weed spot spraying system for apple orchards. Presented at the 2026 Gamma Sigma Delta Research Exhibition, Penn State, University Park, PA.
3. **Arthur, L**., Mahnan, S., Hussain, M., Brunharo, C., & He, L. (2025). Optimizing intra-row weed management in apple orchards: Enhancing detection and localization through advanced machine vision technique. Presented at the 2025 Graduate Exhibition, Penn State, University Park, PA.
4. **Arthur, L**., Mahnan, S., Hussain, M., Brunharo, C., & He, L. (2025). Precision weed management in tree fruit orchards. Presented at the Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.

RESEARCH EXPERIENCE

Ph.D. Candidate, Graduate Research Assistant (Advisor: Dr. Long He) **Sept 2023 – Present**

Automated Precision Herbicide Spraying System for Sustainable Weed Management in Apple Orchards

- Developed a real-time vision-based perception framework for detecting, tracking, localizing, and estimating the density of intra-row weed targets in apple orchard environments.
- Designed and implemented a vision-guided multi-servo nozzle prototype that converts weed target locations into nozzle steering angles, spray-zone assignments, and sequential actuation commands for site-specific herbicide application.
- Conducted controlled greenhouse experiments to evaluate spray deposition performance under varying weed sizes, target positions, travel speeds, nozzle angles, and spray durations.
- Integrated perception, nozzle actuation, motion timing, and field-operation procedures to support robotic deployment of the spraying system on an Amiga platform in orchard environments.

WORK AND TEACHING EXPERIENCE

Technical Officer **2020-2023**

Ghana Cocoa Board (COCOBOD), Catography Department – Prestea, Ghana

- Supported agricultural planning and cocoa field operations through farm mapping, GPS data collection, ArcGIS-based map preparation, field data management, and farmer outreach.
- Generated and maintained geospatial records for over 1,000 hectares of cocoa farms, supporting land-use planning, farm verification, extension planning, and improved decision-making.
- Trained farmers, extension personnel, and field staff in GPS use, ArcGIS workflows, mobile data collection, and basic geospatial interpretation for cocoa farm management.
- Conducted field visits to verify farm boundaries, collect location data, resolve mapping inconsistencies, and support improved documentation of cocoa production areas.

- Collaborated with field officers, survey teams, farmers, and local stakeholders to improve data quality, farmer communication, and adoption of digital tools in cocoa production systems.

Research Assistant **2018-2020**
University of Cape Coast - Cape Coast, Ghana
- Analyzed experimental datasets and prepared technical reports to support faculty-led engineering research.
- Assisted with course preparation, laboratory demonstrations, and instructional delivery for undergraduate engineering students.
- Guided students in basic measurement procedures, hands-on engineering exercises, and interpretation of experimental results.
- Supported grading and academic advising.

GRANTS

2026 State Horticultural Association of Pennsylvania Grant | Approved | 04/2026-04/2027 | $9,000
- Project: Precision weed management with spot spraying in orchards.
- Investigators: Long He, Lawrence Arthur, and Hanjie Dou.
- Role: Co-PI.

HONORS AND AWARDS

- Outstanding Reviewer Recognition, ASABE Technical Communities, American Society of Agricultural and Biological Engineers, 2026.
- Outstanding Doctoral Student Award, Department of Agricultural and Biological Engineering, The Pennsylvania State University, 2026.
- Penn State Extension Center for Ag Conservation Assistance Training Scholarship for the 2025 Northeast Agricultural and Biological Engineering Conference, Cornell University, Ithaca, NY.
- Outstanding Oral Presentation, Second Place, Northeast Agricultural and Biological Engineering Conference, 2025.
- AG2PI Student Conference Travel Award for the 2024 ASABE Annual International Meeting, Anaheim, CA.

PROFESSIONAL SERVICE AND MEMBERSHIPS

- Member, International Society of Precision Agriculture, 2026-Present.
- Event Planner, Agricultural Robotics Club at University Park, 2025-Present.
- Member, The Society for Collegiate Leadership & Achievement, 2025-Present.
- Member, The Honor Society of Phi Kappa Phi, 2025-Present.
- Reviewer, Information Processing in Agriculture, 2025-Present.
- Reviewer, American Society of Agricultural and Biological Engineers Journal, 2025-Present.
- Reviewer, Computers and Electronics in Agriculture, 2025-Present.
- Reviewer, Heliyon, 2024-Present.
- Member, American Society of Agricultural and Biological Engineers, 2024-Present.

EXTENSION, OUTREACH, AND PUBLIC ENGAGEMENT

- Career Day at Upper Adams Intermediate School, Biglerville, PA, 2026. Demonstrated robotic and precision weed management systems to more than 80 sixth-grade students and teachers.
- Plant Yourself in Ag Day, Russell E. Larson Agricultural Research Center, PA, 2025. Presented and demonstrated robotic weeding systems to high school students, teachers, and agricultural audiences.
- Penn State Ag Progress Days, Russell E. Larson Agricultural Research Center, PA, 2025. Exhibited and demonstrated robotic weeding systems to growers, students, educators, and public audiences.
- FREC Grower Field Day, Biglerville, PA, 2025. Presented and demonstrated robotic weeding systems to growers and agricultural stakeholders.
- Penn State Crop Protection Field Day, Fruit Research and Extension Center, Biglerville, PA, 2024. Presented research updates on robotic weed management systems to growers and stakeholders.
- Technology Field Day at Ruppert Nurseries, Laytonville, MD, 2024. Presented and demonstrated precision spraying technologies for tree fruit growers and stakeholders.

INVITED TALKS AND SELECTED HIGHLIGHTS

- AI-Driven Precision Herbicide Spraying Approach for Sustainable Weed Management in Apple Orchards. Invited

seminar, ASABE Young Professionals Community Global Engagement Initiative, Virtual, Apr 2026.

- Featured/Interviewed in Penn State News, ASME Mechanical Engineering Magazine, Digital CxO, Imaging & Machine Vision Europe, Phys.org, Breakthrough Marketing Technology, ScienceSprings, TIISYS Japan, and related media coverage on AI-enabled robotics and precision spraying

TECHNICAL SKILLS

Programming and Data Analysis: Python, C++, MATLAB, R, Excel.

Machine Vision and AI: OpenCV, PyTorch, TensorFlow, YOLO, DeepSORT, object detection, segmentation, tracking, image analysis.

Robotics and Automation: ROS/ROS2, Gazebo, RViz, autonomous navigation, robotic actuation, servo control, relay/pump control, TCP/IP control.

Sensors and Hardware: ZED stereo cameras, LiDAR, GPS/GNSS, Raspberry Pi, Arduino, NVIDIA Jetson.

Agricultural and Geospatial Systems: Precision agriculture, field experimentation, greenhouse and orchard trials, GIS/ArcGIS, remote sensing, experimental design.

Design and Documentation: CAD/SolidWorks, technical writing, manuscript preparation, grant support, research presentations.

REFERENCE

Dr. Long He

Associate Professor, Department of Agricultural and Biological Engineering, The Pennsylvania State University

Fruit Research and Extension Center, 290 University Dr., Biglerville, PA 17307

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