

AG2PI SEED GRANT - PROJECT FINAL REPORT

PROJECT NAME	Optimizing 3D Canopy Architecture for Better Crops
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PROJECT PRINCIPAL INVESTIGATOR	TODAY'S DATE	PROJECT START DATE	DATE OF COMPLETION
Bedrich Benes, Professor of Computer Science, bbenes@purdue.edu	08/09/2022	05/15/2021	05/31/2022
TEAM MEMBERS (co-PI, co-I, personnel)	COLLABORATORS		
Co-PI: Duke Pauli, Assistant Professor, University of Arizona, dukepauli@email.arizona.edu , Co-PI: Fiona McCarthy, Professor, University of Arizona, fionamcc@arizona.edu , Co-PI: James Schnable, Associate Professor, University of Nebraska-Lincoln, schnable@unl.edu			

ACCOMPLISHMENTS

We have completed the sorghum **procedural model**. We can generate a wide variety of 3D plants with photorealistic textures and shapes.

We have completed the **illumination model**. We can simulate widely varying lighting conditions and photon-level illumination of plant parts.

We have completed the **labeled point cloud** generation. Our system can produce arbitrary complex point clouds with defined labels.

We have completed a deep neural network approach that can detect sorghum leaves from phenotyping facilities by using training data from our synthetic model

We are working on validation with the above part on data captured in AZ.

We are working on several publications.

We have designed a three-part workshop (3, 2-hour sessions) to introduce scientific computing to individuals with limited computational skills. Will begin advertising this broadly in two weeks. The target audience is anyone in the sciences, as we hope to reach a broad community.

We developed and delivered a three-part workshop series through AG2PI entitled "Introduction to Scientific Computing Workshop Series." This was hosted through AG2PI with broad advertising nationally and targeted advertisement to underrepresented groups at the University of Arizona. The workshop series registered 330, 350, and 377 for parts I, II, and III, respectively. This workshop was in place of our targeted workshop for ASEMS as we realized we could reach a much broader audience.

We are developing a two-hour workshop for AG2Pi that will cover the use of the procedural model developed within this project, and plan to host it this fall semester.

Products

ACTIVITY / PRODUCT	DESCRIPTION (include URL, if applicable)	OUTCOME / METRICS
Sorghum procedural model	Will be hosted on our server upon paper acceptance	Done
Labeled point cloud generation	Will be hosted on our server upon paper acceptance	Done
Validation of models	Submitted paper	In progress. We have captured the data. Now we are comparing them
Plant, manage and harvest AZ field trial	Paper in preparation	Done, the field trial was successfully carried out and plants harvested
Deploy PAR sensors in the plant canopy	Paper in preparation	Done. We have gathered the data
Phenotyping of AZ trial with UA Field Scanner	Paper in preparation	Done, experimental plants were scanned with the UA gantry
Parallel path tracer development	Paper in preparation	Done.
Validation of 3D models	Paper in preparation	Done
Engagement with the animal research community		In progress
Host AG2PI workshop, host ASEMS workshop		In progress, the workshop on scientific computing has been completed. The workshop on the use of procedural models will be hosted this fall through AG2PI

Audience

Researchers who are focusing on similar problems.

We will need help promoting the workshop focused on the use of procedural models; this would be similar to what AG2PI has done for us previously. We would ask that the workshop flier be distributed through AG2Pi's mailing list and other outlets used by the group. We will also be using CyVerses's mailing list to distribute information

CHALLENGES

The main challenge was the delayed arrival of funds that precluded us from having students work on the project. This is why we asked for an extension. We are currently on time.

The other challenge encountered is transferring these technologies to animal sciences. Given the difference in the scale of organisms and the ability of animals to move, the availability of 3D data on stationary animals is limited. We are trying to address the problem through conversations with Dr. McCarthy to understand how to best integrate this work with the needs of animal scientists. Presently, acquiring the same type of data, both volume, and resolution with respect to full animal scans, is limiting.

Another challenge was that by the time we learned of the award, ASEMS had already set its schedule for workshops. We worked with the ASEMS coordinators, but they were unable to accommodate us. Although initially perceived as a problem, it led to the development of a more generalizable course that was offered to a broader community (and was still advertised to the ASEMS students). The outcome of this situation resulted in a workshop series that reached a vastly larger population, based on registration numbers, exceeding what we were initially hoping for.