ALS 5984-21396 High-Throughput Phenotyping in Agriculture
2 credits

Spring 2021

Instructors

Dr. Song Li
Office: 508 Latham Hall
Email songli@vt.edu
Phone: 540-231-2756
Web: https://lilabatvt.github.io/research/
Office Hours: By appointment

Dr. Gota Morota
Office: 368 Litton Reaves Hall
Email: morota@vt.edu
Phone: 540-231-4732
Web: http://morotalab.org/
Office Hours: By appointment

Time and Location

- Mon/Wed 12:20 - 1:10 pm

Course Description

This course will cover the application of computer vision to plant and animal sciences. Smart agriculture is innovative technology that integrates advances in engineering and computer science into agriculture to optimize production while ensuring sustainability. In particular, the use of image-based high-throughput phenotyping technologies enables us to collect a large number of phenotypes in an automated fashion with less human labor and reduced costs, and evaluate phenotypes that were previously difficult to be measured manually. We will discuss the most recent high-throughput phenotyping technologies that can be used in agriculture. The course will combine instructions and hands-on plant and animal phenotypic data analysis. You will be provided with Python or GNU Octave image processing scripts and learn how to apply them to image data.

Learning Objectives

After taking this course, the student will be able to:

- understand computer vision technologies commonly used in high-throughput phenotyping
- set up phenotyping systems, perform image acquisition, and analyze image data using image processing tools
- critically review current literature in computer vision and high-throughput phenotyping

Texts and Reading Materials

Lecture slides will be provided on the class website. There will be no required textbook.

Topics covered

1. High-throughput phenotyping
    - Manual phenotyping
    - Image data type (RGB, Infrared, depth, thermal, multispectral, hyperspectral
    - Computer vision-based systems (e.g., videos, images)
    - Wearable-sensor-based systems (e.g., RFID tag, accelerometer, wearable plant sensors)
2. Data acquisition
    - static object
    - movable (non-static) object
    - Imaging system (farm, greenhouse, field robots, drones)
3. Image processing
    - Commercial software
    - Open-source software
    - Custom scripting
4. High-throughput phenotyping demonstration
    - Depth sensor cameras
    - GIS/GPS mapping with drones
    - Drones
5. Real data analysis
    - Drones to track canopy expansion in soybeans. Analyze the raw data from drone images to field map to trait matrix
    - Deep learning based object detection in corn stand counting work
    - Estimate morphological characters from the depth image data of cattle and swine
6. Applications
    - Connecting high-throughput phenotyping traits with omic data
    - Genome-wide association study and Genomic prediction

Grading

There will be bi-weekly take-home assignments to analyze image data sets. There will be a final project at the end of course. Grades will be based on the assignments (worth 65% of grade or 65 points), a final project (worth 25% of grade or 25 points), and class presentation/discussion sessions (worth 10% of grade or 10 points). The final grade will be based on the following scale:

Points	Grade

≥ 85	A
80-84	A-
75-79	B+
70-74	B
65-69	B-
60-64	C+
55-59	C
50-54	C-
≤49	F

The Fundamental Beliefs of the VT Graduate Honor Code
The fundamental beliefs underlying and reflected in the Graduate Honor Code are that

- to trust in a person is a positive force in making a person worthy of trust,
- to study, perform research, and teach in an environment that is free from the inconveniences and injustices caused by any form of intellectual dishonesty is a right of every graduate student,
- to live by an Honor System, which places a positive emphasis on honesty as a means of protecting this right, is consistent with, and a contribution to, the University's quest for truth

To read more about honor code policies: http://ghs.graduateschool.vt.edu/constitution

Principles of community
Virginia Tech is a public land-grant university, committed to teaching and learning, research, and outreach to the Commonwealth of Virginia, the nation, and the world community. Learning from the experiences that shape Virginia Tech as an institution, we acknowledge those aspects of our legacy that reflected bias and exclusion. Therefore, we adopt and practice the following principles as fundamental to our on-going efforts to increase access and inclusion and to create a community that nurtures learning and growth for all of its members:

- We affirm the inherent dignity and value of every person and strive to maintain a climate for work and learning based on mutual respect and understanding.

- We affirm the right of each person to express thoughts and opinions freely. We encourage open expression within a climate of civility, sensitivity, and mutual respect.
- We affirm the value of human diversity because it enriches our lives and the University. We acknowl- edge and respect our differences while affirming our common humanity.
- We reject all forms of prejudice and discrimination, including those based on age, color, disability, gender, national origin, political affiliation, race, religion, sexual orientation, and veteran status. We take individual and collective responsibility for helping to eliminate bias and discrimination and for increasing our own understanding of these issues through education, training, and interaction with others.
- We pledge our collective commitment to these principles in the spirit of the Virginia Tech motto of Ut Prosim (That I May Serve).

Students with disabilities
If you have a physical, sensory learning, or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with, and provide documentation of your disability to, Services for Students with Disabilities at http://www.ssd.vt.edu/.