Hemispherical Imaging System for Subterranean Root Detection

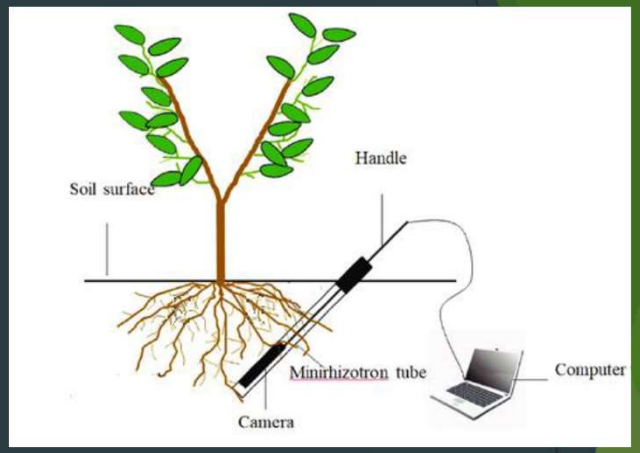
Sr Design Project

Main Focus of Agriculture Research

- Create New Breeds of Food Crops Resistant to Climate Change
- Grow Test Plots and Collect Phenotype Data to Evaluate
- Continue Process Until Water Efficient Breed is Established

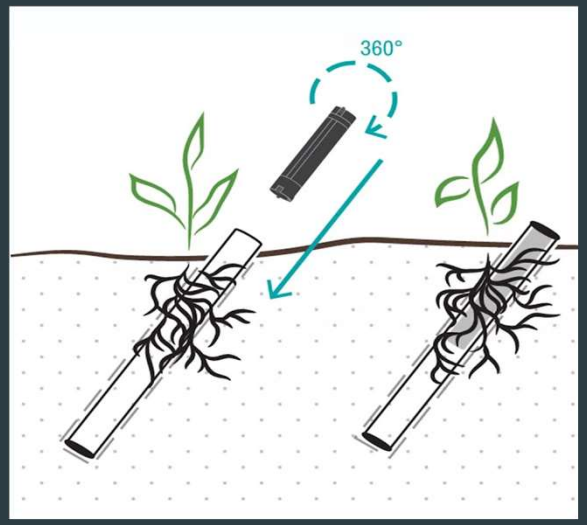
Data Collection in the Field

- Collect Phenotype Data of Roots
- Clear Acrylic Tubes Placed in Ground Under Plants
- Camera Inserted to Capture Root Growth
- Tedious and Time-Consuming Method



Difficulties of Current Approaches

- Image Collection Susceptible to Errors
- Image Quality Must be Enhanced for Research
- Scanner Components are Not Durable Enough for Extended Field Use
- Solution is Not Portable



Innovative Approach Desired

- Meet with Agriculture Group
- See Demo of Existing System
- Use Automation and State of the Art Equipment
- Design for Ruggedization
  - Water and Dirt Resistance
  - Heavy Usage (100K+ images a season)
  - Transported All Over Midwest
  - Drop and Vibration Resistant

Goals for Optimization Project

- Enhance a current prototype for efficient image capture of roots that utilizes hemispherical cameras
  - Provide Improved Resolution for Research
  - Improve Image Collection Accuracy
  - Increase Durability of Components for Extensive Field Use
  - Provide System Portability
  - Perform Durability Tests in Green House and in The Field

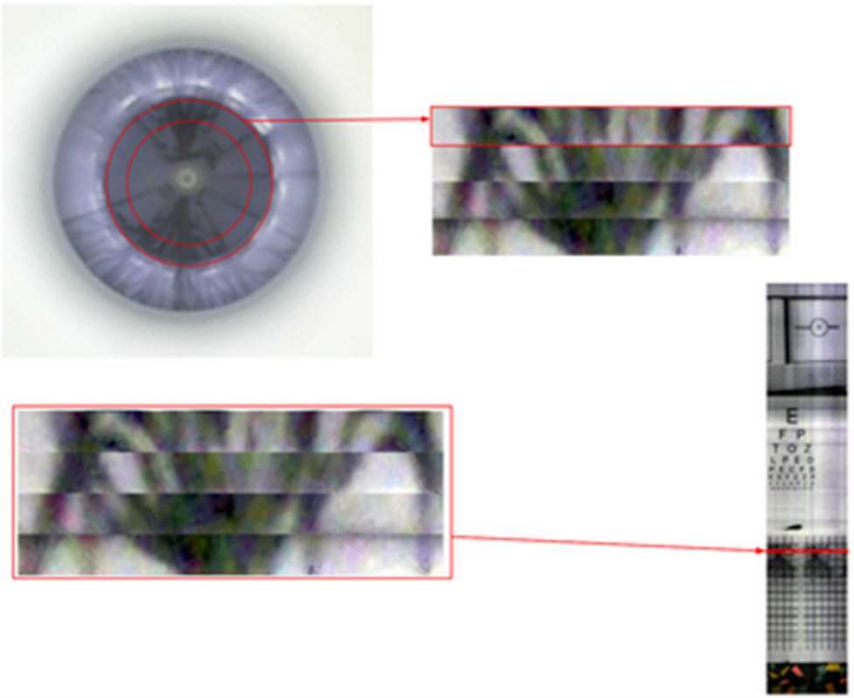


Figure 7: Visual representation of image construction

Relevant Skills and Interests

- Image processing and Camera Synchronization
- Lighting for Even Illumination
- Microcontroller Motion Coordination
- Highspeed PCB Design and Surface Mount Soldering
- 3D Printing of Components

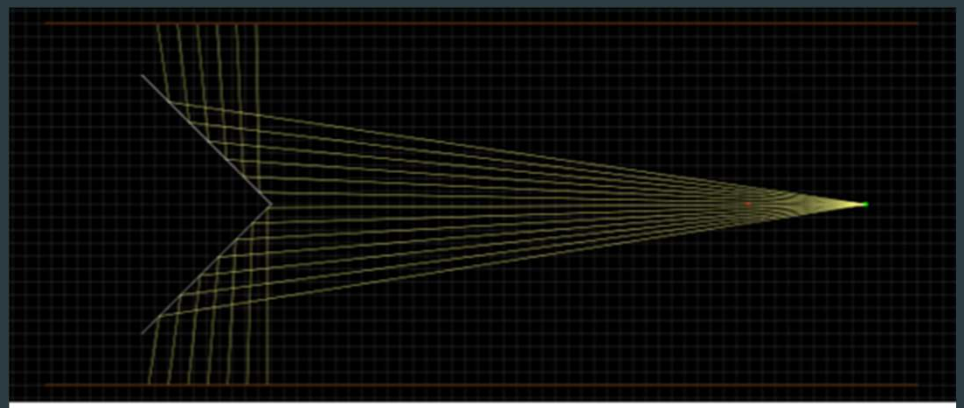


Figure 3: Ray simulation of image capture system

Figure 6: A) Glare mitigation cone light reflection analysis B) Autodesk Fusion light cone model C) Shuttle implementation with light cone (white)

Project Support Group

- Professor Andrew Leakey
  - *Michael Aiken Chair* Professor of Plant Biology (IGB)
- Jeremy Ruhter
  - Farm Field Technician
- John M. Hart
  - Principal Research Engineer (CSL) and
  - Manager and Coordinator of the CfA Robotics Labs
- Sam Walker
  - Graduate Student in Plant Biology