Traits Research and Documentation

Our research findings over the winters focused on identifying and implementing measurable plant traits from RGB images and their masks using our segmented leaf outputs. We conducted an extensive literature review of recent research papers and the techniques that are currently being used for processing of plant and leaf images, we discovered that while there's significant progress in plant phenotyping, many advanced measurements require 3d structures or images, and instrumental readings .

Research Findings

Recent research primarily focuses on:

1. Segmentation techniques and improvements
2. Disease detection through deep learning
3. Advanced trait measurements requiring specialized equipment

Key Observations:

- Most papers focus on segmentation methods rather than trait calculations
- Advanced measurements (photosynthesis rate, nutrient content) require specialized instruments like:
    - Hyperspectral cameras
    - SPAD meters
    - Fluorescence imaging
    - Gas exchange analyzers

Implementation Challenges

Many promising approaches face accessibility issues:

1. Closed-source implementations:
   - DeepLeaf: Model architecture published but weights not available
   - PlantDoc Dataset (PDD): Pre-trained models without weights
   - Commercial solutions with proprietary algorithms
2. Hardware Dependencies:
   - Many papers use multi-spectral imaging
   - Controlled lighting conditions
   - Calibration equipment

Our Approach

Based on these findings, we implemented traits that can be reliably measured from RGB images:

1. Morphological Traits:
   - Area and perimeter measurements
   - Shape descriptors (circularity, solidity)
   - Aspect ratio analysis
   - All validated through published research
2. Color-based Analysis:
   - Vegetation indices (EVI, MCARI, PSRI)
   - Chlorophyll estimation from color spaces
   - Texture analysis for uniformity
3. Stress Detection:
   - Color-based stress indicators
   - Location-based analysis
   - Overall health scoring

Validation and Future Work

Proposed Validation Strategy:

1. Local Validation:
   - Collect samples from LUMS campus
   - Manual measurements for morphological traits
   - Compare with standard measurement tools
   - Statistical validation of results
2. Future Improvements:
   - Correlate with actual plant health metrics
   - Integrate with growth monitoring