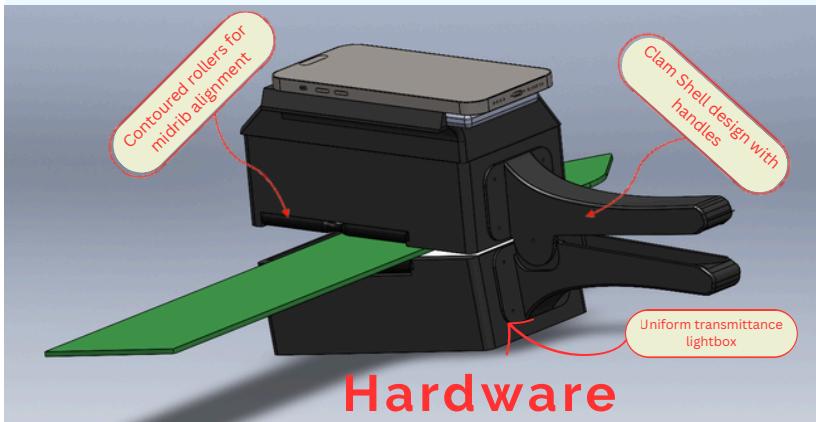


# CHARLES WANG

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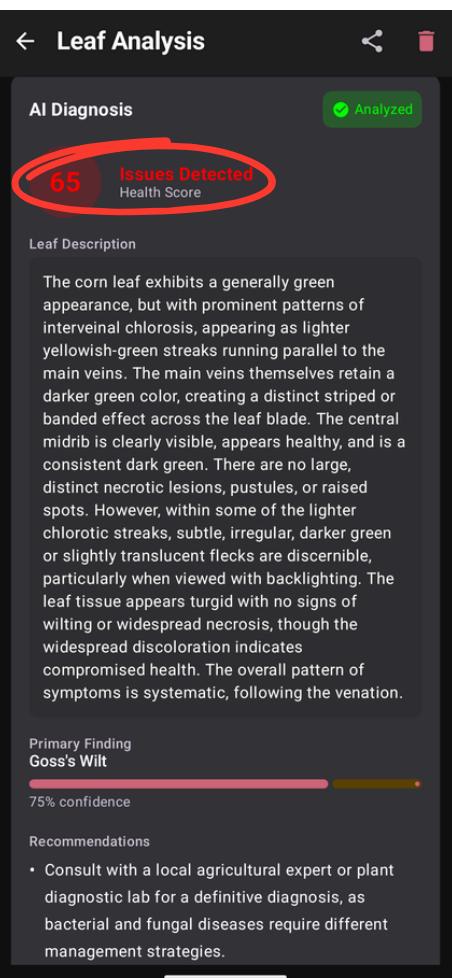
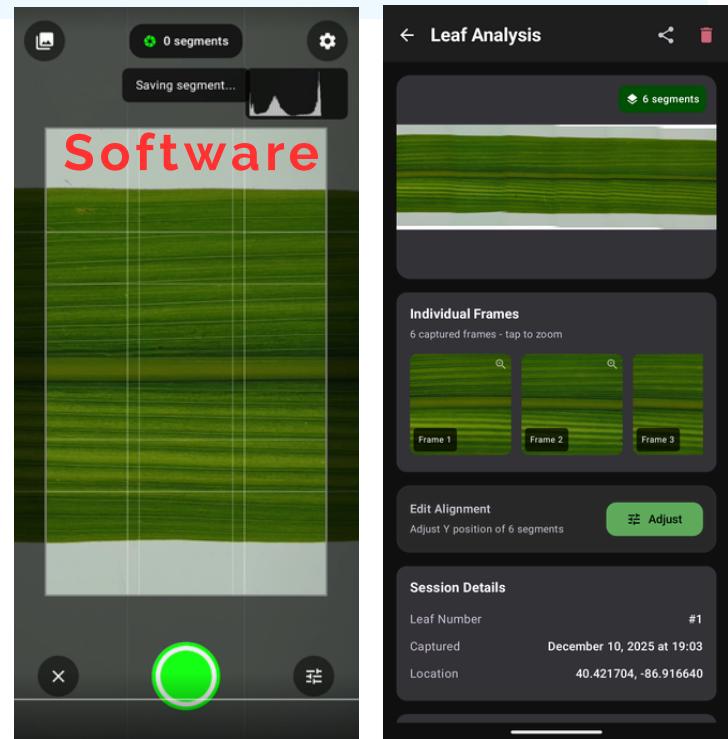
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## SMARTPHONE PLANT IMAGING SYSTEM WITH AI-POWERED DIAGNOSIS - LEAFDOC



### What?

- \$50 handheld lightbox smartphone attachment that blocks ambient light and provides uniform LED illumination
- Contoured rollers **flatten** and center the sample on entry, ensuring repeatable positioning without manual adjustment
- Lightbox blocks external noise and provides **uniform** illumination
- **MagSafe** mounting locks smartphone above the leaf in a fixed, repeatable position



**AI Diagnosis** >Analyzed

**65 Issues Detected** Health Score

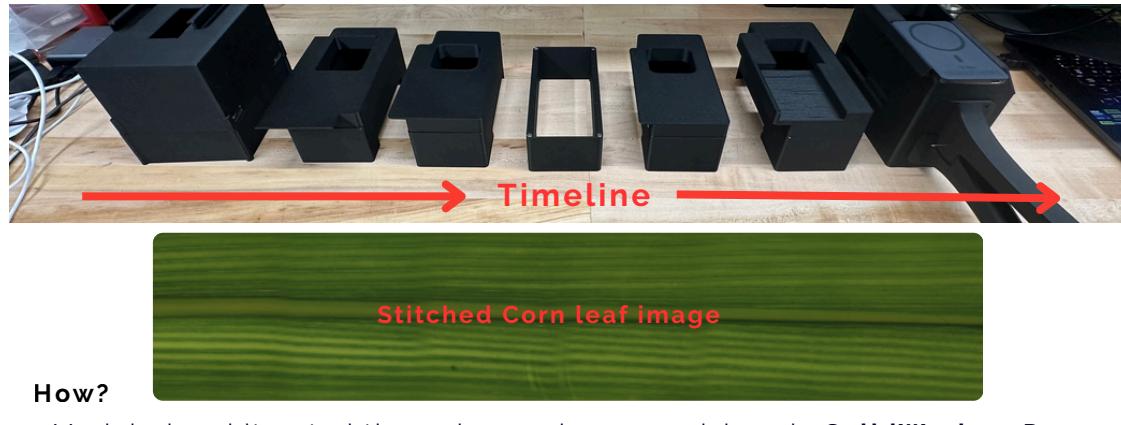
**Leaf Description**

The corn leaf exhibits a generally green appearance, with prominent patterns of interveinal chlorosis, appearing as lighter yellowish-green streaks running parallel to the main veins. The main veins themselves retain a darker green color, creating a distinct striped or banded effect across the leaf blade. The central midrib is clearly visible, appears healthy, and is a consistent dark green. There are no large, distinct necrotic lesions, pustules, or raised spots. However, within some of the lighter chlorotic streaks, subtle, irregular, darker green or slightly translucent flecks are discernible, particularly when viewed with backlighting. The leaf tissue appears turgid with no signs of wilting or widespread necrosis, though the widespread discoloration indicates compromised health. The overall pattern of symptoms is systematic, following the venation.

**Primary Finding** Goss's Wilt 75% confidence

**Recommendations**

- Consult with a local agricultural expert or plant diagnostic lab for a definitive diagnosis, as bacterial and fungal diseases require different management strategies.



### How?

- Modeled and iterated through 7 enclosure revisions in **SolidWorks**, 3D printing each to test light leak, roller clearance, and component fit
- Wrote an alignment stitching algorithm that assembles overlapping frames into a single full-length image
- Built a native **Android app** (Kotlin, CameraX) with manual camera controls and a multi-provider AI diagnostic pipeline

### Results

- User captures image using smartphone then can organize and manage on app
- Cloud based AI delivers a **health score**, primary finding, and confidence level in-app, no export or external tools needed

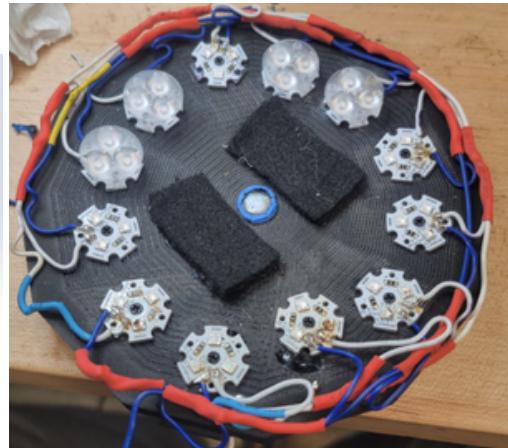
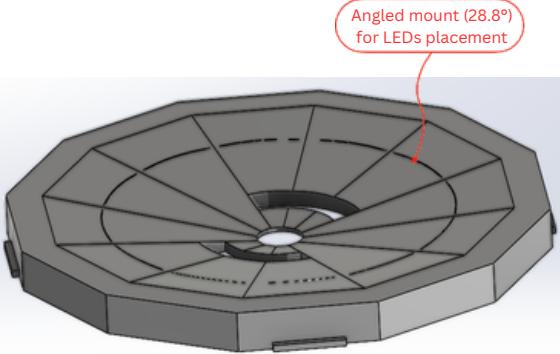


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## PORTABLE PHOTOSYNTHETIC EFFICIENCY IMAGING SYSTEM - FLUROSCAN



### How?

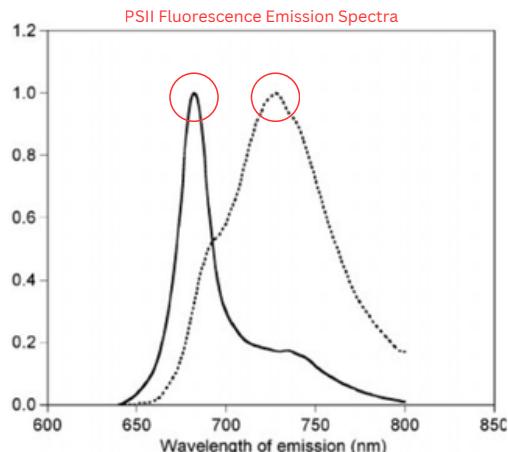
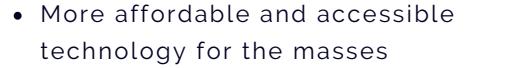
- Direct measurement of photosynthetic efficiency
- Real-time non-invasive imaging with **early detection** of plant stress
- More affordable and accessible technology for the masses

- Used **Solidworks** to prototype
- Used **Raspberry Pi** for camera and system control
- Used **Bambu Labs** to 3D print
- Dark adapted leaves to fully open PSII
- Saturated photosystems with 450 nm LEDs and captured images through a 680/720 nm filter

### Specifications

- Achieved 450 nm excitation light at 4000  $\mu\text{mol m}^{-2}\text{s}^{-1}$  using 12 LEDs in 3-up configuration

### What?



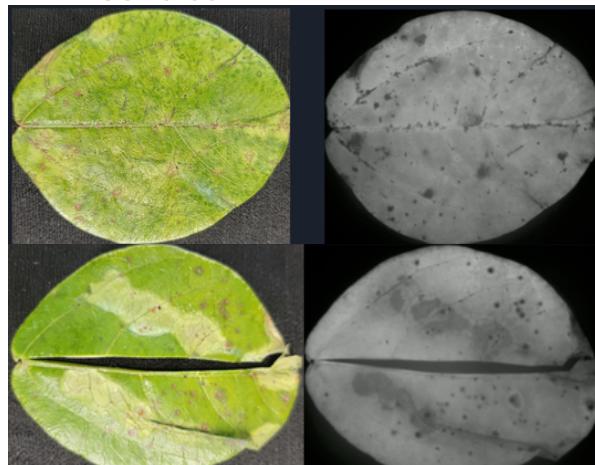
### Theory

- A weak, non-actinic light will excite and open PSII reaction centers and give the **baseline fluorescence** ( $F_0$ )
- A strong pulse of light will close all PSII reaction centers and give **maximum fluorescence** ( $F_m$ )
- **Ratio** represents maximum efficiency of PSII energy conversion

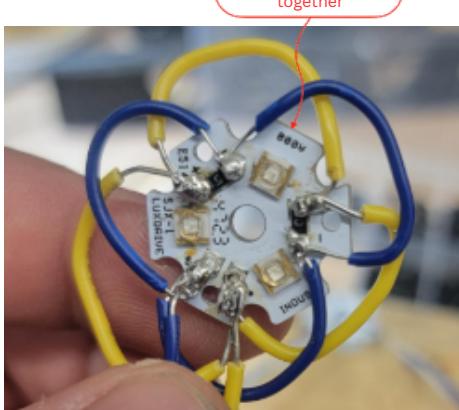
$$F_v = F_m - F_0$$

$$\frac{F_v}{F_m}$$

### Control



### Results

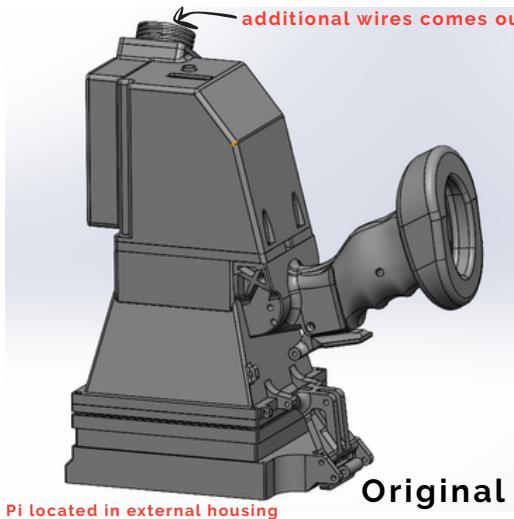


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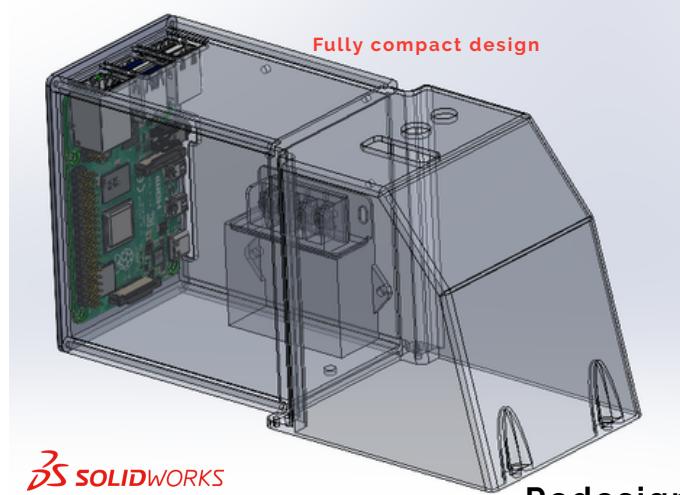
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## MULTISPECTRAL HANDHELD IMAGING DEVICE



Original



Redesign

### What?

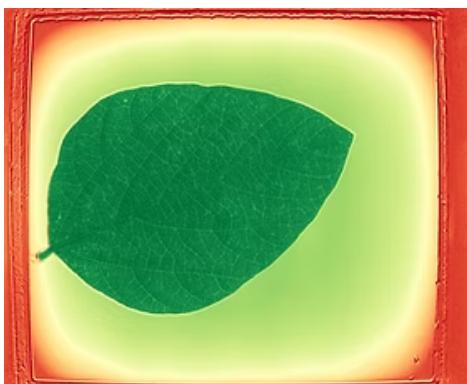
- Plant phenotyping device that collects **high resolution images** (0.04mm/pixel)
- Redesigned enclosure houses all electronics internally, eliminating external wiring for a fully field-portable system

### How?

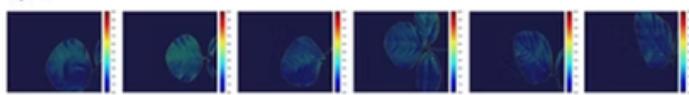
- Used **Solidworks** to prototype
- Used **Bambu Labs** to 3D print
- Used **Raspberry Pi** for camera and system control
- Reverse-engineered and documented all subsystems
- Soldered 120+ LEDs across 6 wavelength bands with MOSFET transistors and 12V/5V power conversion

### Results

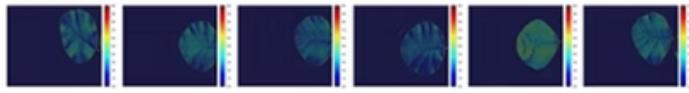
- **High signal to noise ratio** with ambient light blocked
- Clearly captured the secondary veins on leaves
- Detected plant stress days before visual symptoms
- Enabled co-researcher's ML model to achieve 90% classification accuracy in a peer-reviewed publication (co-author)



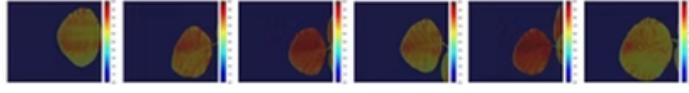
2,4-D



Dicamba



UTC

A presentation slide for the LeafSpec Multispectral Handheld Imaging Device. It features the Purdue University Institute for Digital Forestry logo and the text "LeafSpec® Multispectral Handheld Imaging Device" and "Charles Wang And Aiden Mo".

**ABSTRACT**  
Multispectral imaging (MSI) technology has been widely applied in plant phenotyping due to its capability to detect various plant properties through specific spectral bands. This study presents the development of a portable multispectral handheld device for plant phenotyping. The device, characterized by its ease of use, isolates the leaf eliminating outside factors; this provides a high signal-to-noise ratio. This device can capture details down to 0.04 millimeters, allowing for analysis at tissue level. This data can be leveraged to parse spatial and spectral features from the images. We utilize these additional features to find new plant stress signals. This enables the use of AI to develop early disease detection models.

**Scan**      **Process**      **Results**

**Portability**

- Lightweight and Portable
- Handheld
- Non-destructive
- Affordable
- Quick swap battery pack

**Artificial Intelligence**

- Automatic extraction of spatial and spectral features
- Auto-detect diseases
- Identifying Feature Importance

**Helps Environment**

- Less yield loss
- Detects ideal fertilizer usage (20%)
- Reduces runoff

**Convenience**

- One click
- Fast imaging (Multispectral in seconds)
- Wireless uploading
- Automatic GPS tracking

**Higher Quality Data**

- High signal-to-noise ratio
- Higher resolution
- Complete isolation from environment
- Uniform light source

**Cloud Based**

- Cloud based storage
- All data available
- Central collection source
- Leverages global data

**A: RGB**      **B: NDVI**      **C: Vein pattern**

**PRESENTER BIO INFORMATION**

**Charles Wang**  
Undergraduate Biological Engineering

**Aiden Mo**  
Undergraduate DATA (Data Analysis, Technologies, and Applications)

**Acknowledgement of funding support:**  
Purdue University Institute for Digital Forestry

**Confidential Content**

MEASURING EVERY TREE ON THE PLANET

LeafSpec App

LeafSpec

AE Sensor Lab