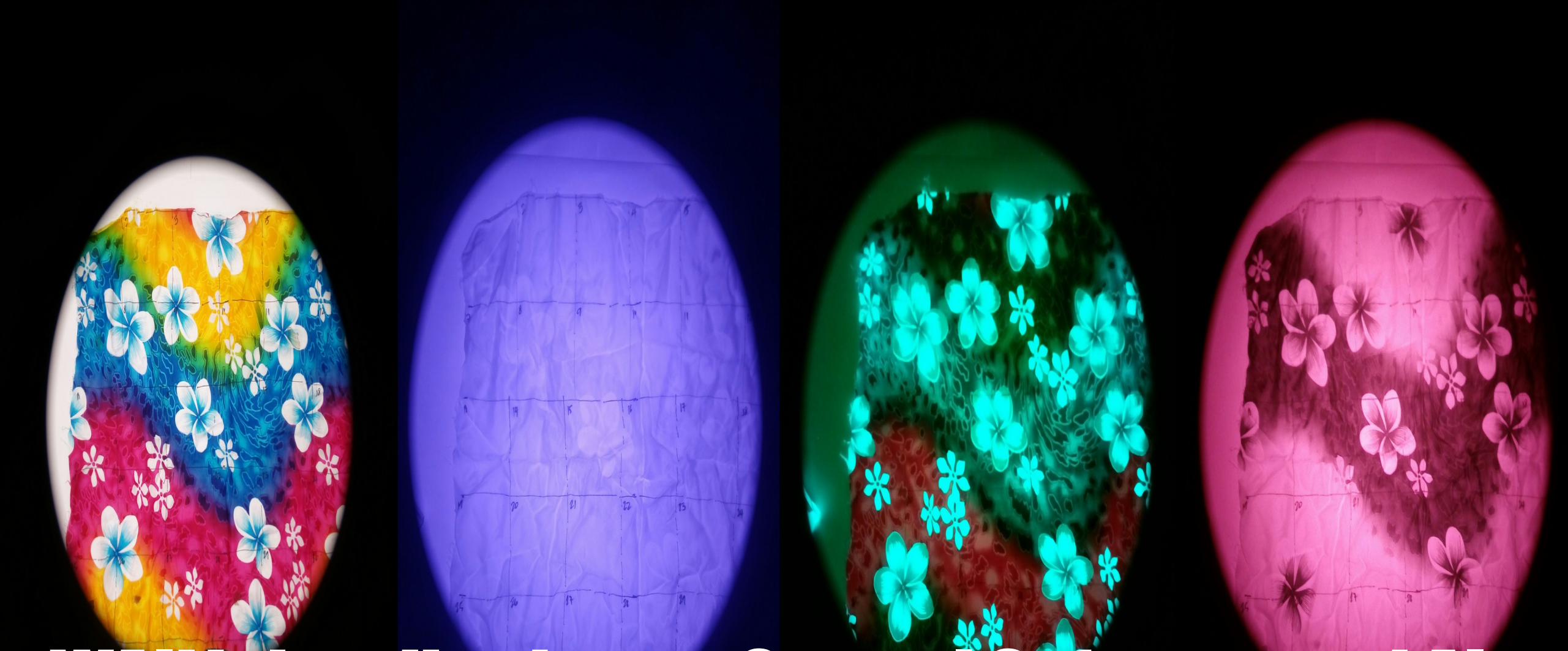


# WAILight – Hardware, Control Software and AI

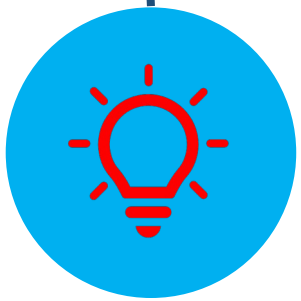
Sanush Abeysekera, Ye Chow Kuang, Melanie Po-Leen Ooi

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

# WAILight

*Waikato AI-Enabled Tunable Light*
*3 broad category of products*

(1) Custom-Designed Illumination (Hardware)

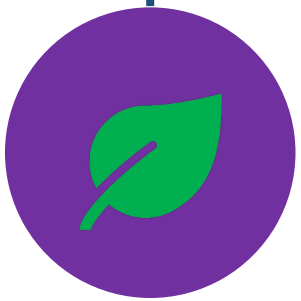


*Foundational product, bespoke, fixed-spectrum LED panel designed for a specific customer application*

(2) Tunable Illumination System (Hardware + Control Software)

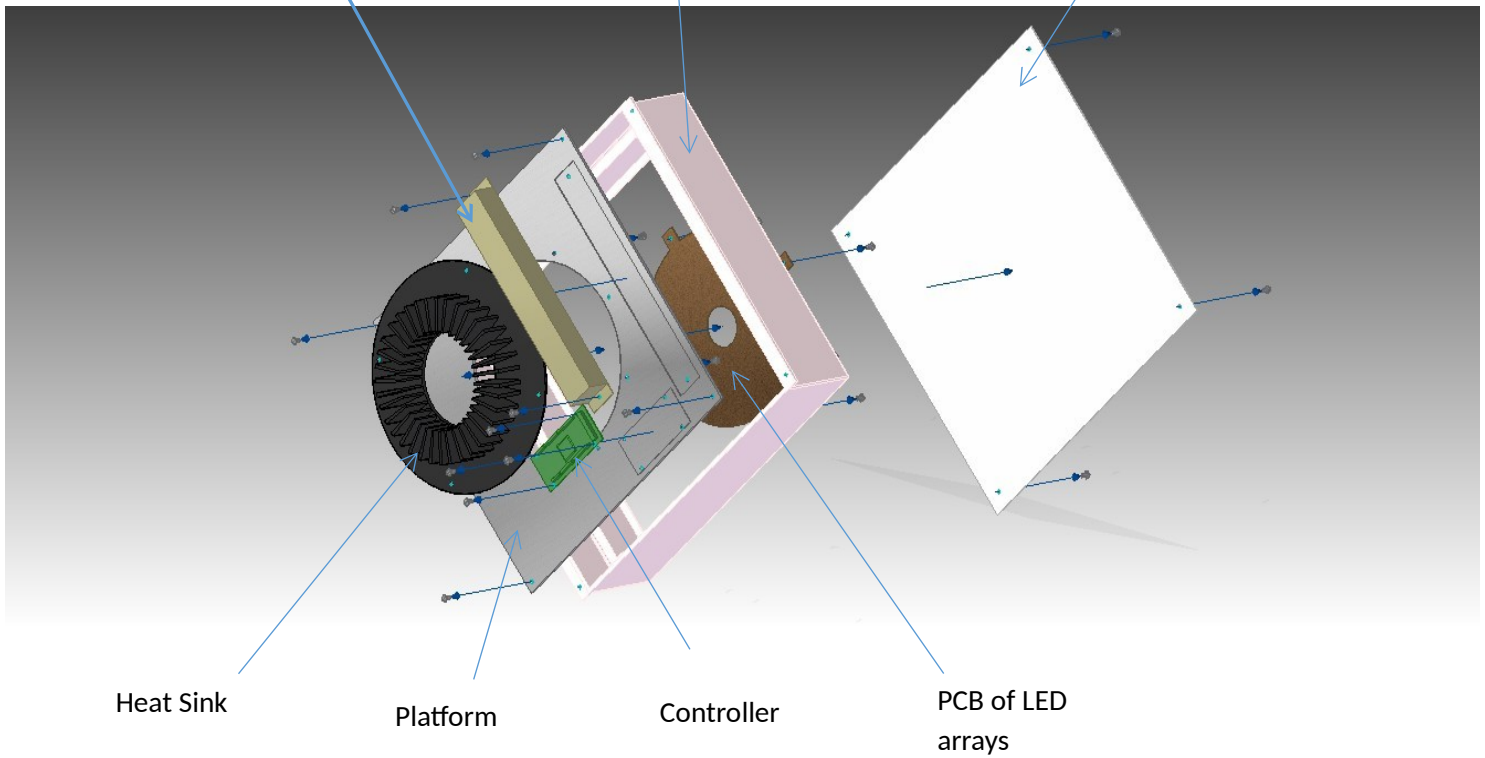
*Users can generate any spectrum they desire within the hardware's capabilities*

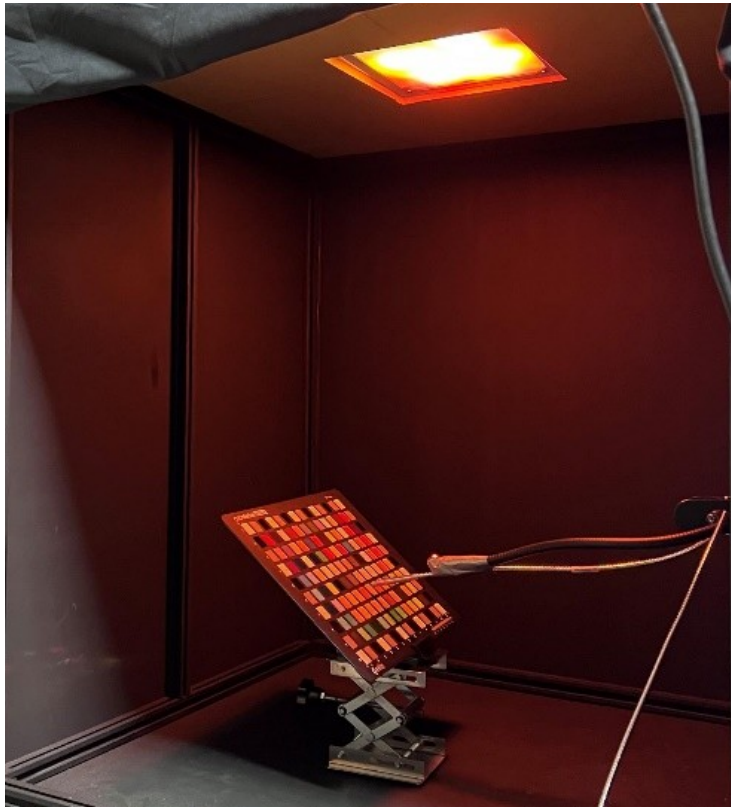
(3) Self-Auditing Measurement System (Full Turnkey Solution)



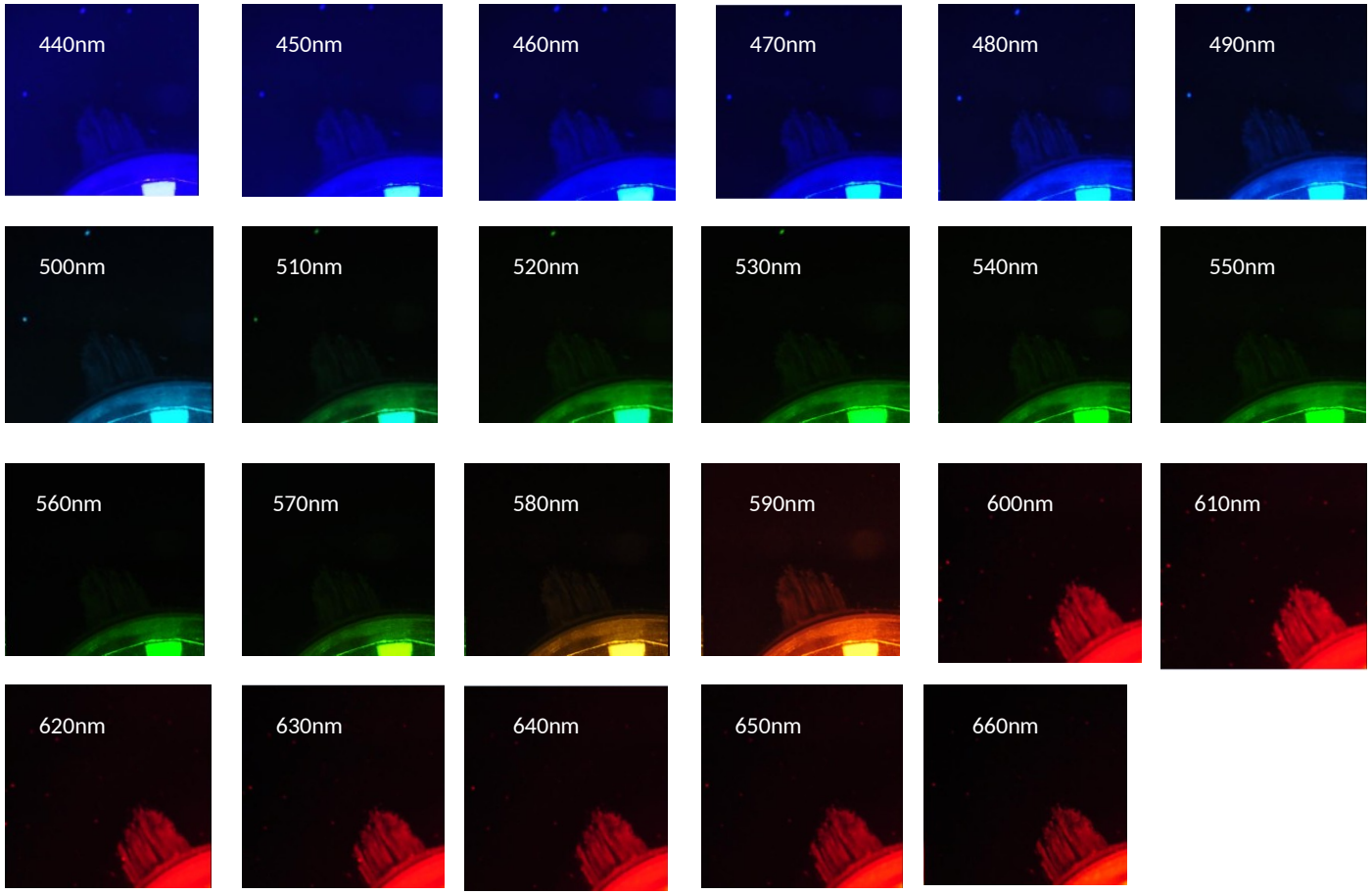
*Top-tier intelligent system with autonomy, reliability, and explainability*

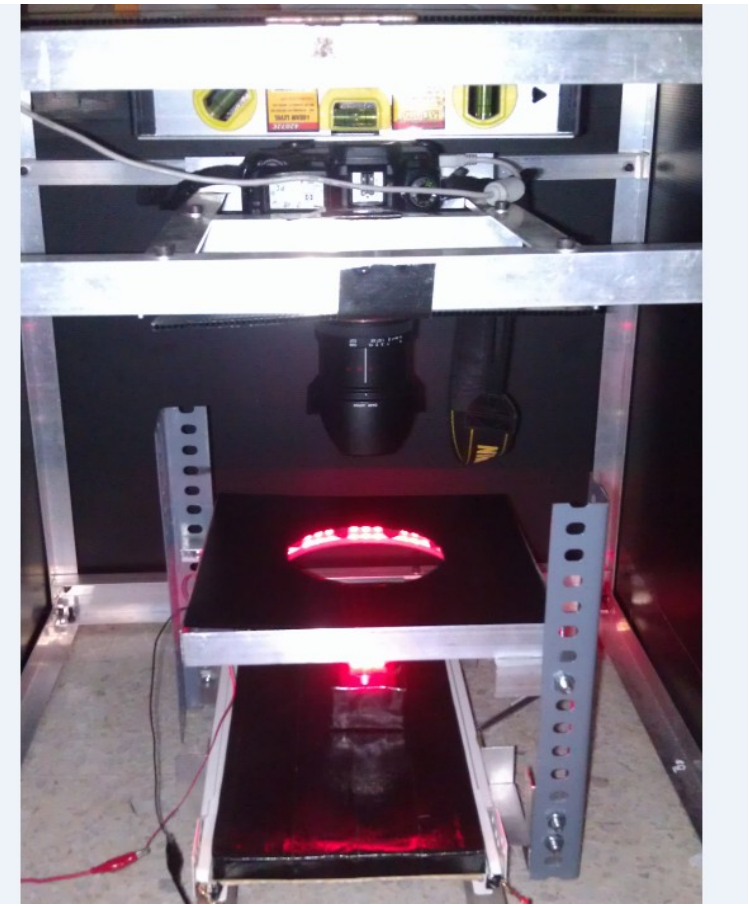
# WAILight Technology



# (1) WAILight Custom Designed Illumination



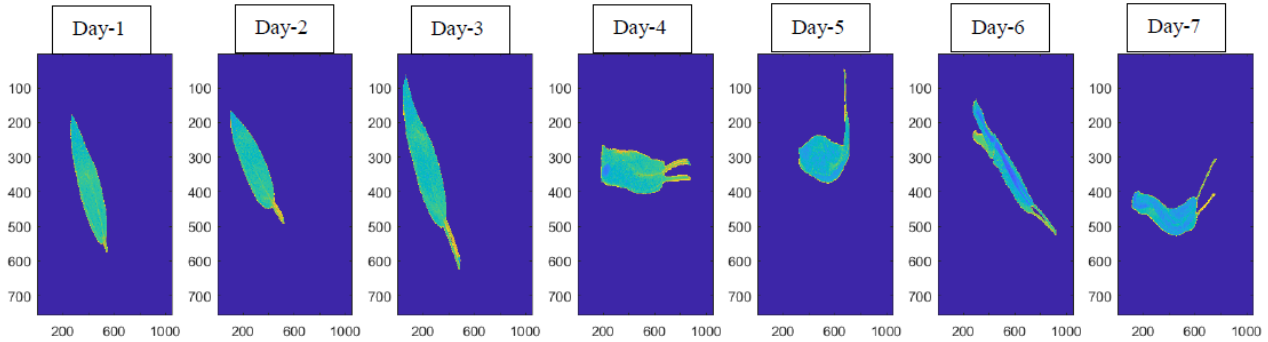
*Example of research with Western Digital on Hard Disk Drives. DOI: 10.1109/I2MTC.2012.6229423*

Custom vision-inspection system that maximises the relationship between incident light and detected defects

# (1) WAILight Custom Designed Illumination

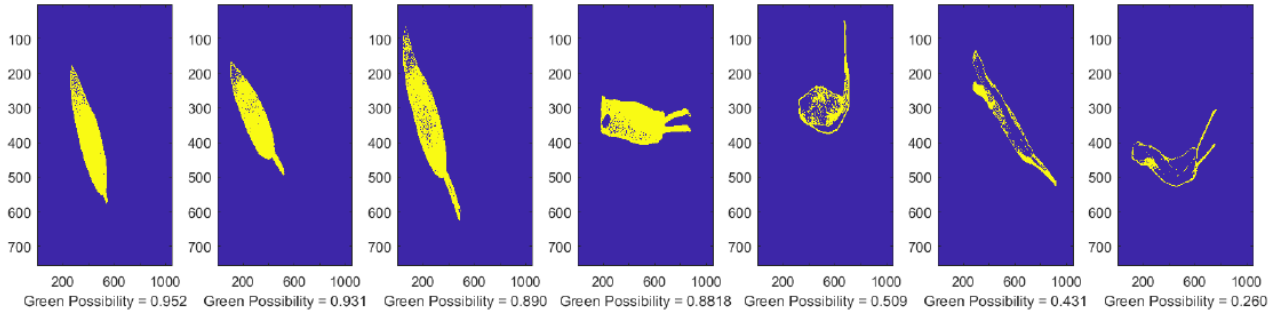
*Images of **<u>Unrefrigerated</u>** Sage from Day 1 to Day 7 under designed light*

D65 light bulb



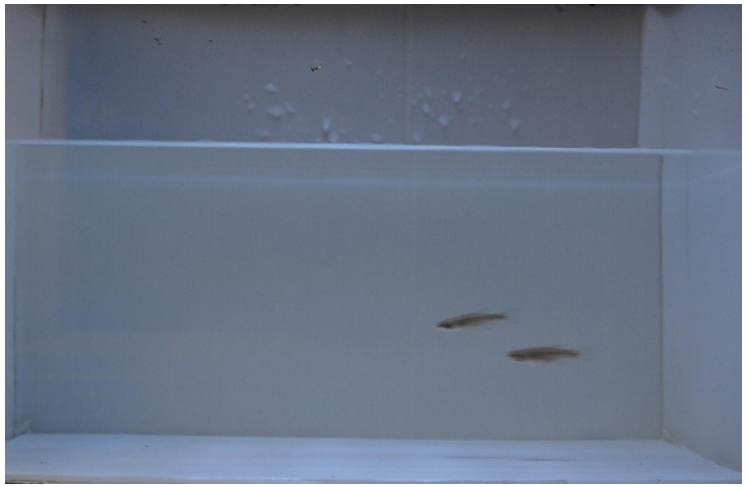

No discernible response captured from the camera

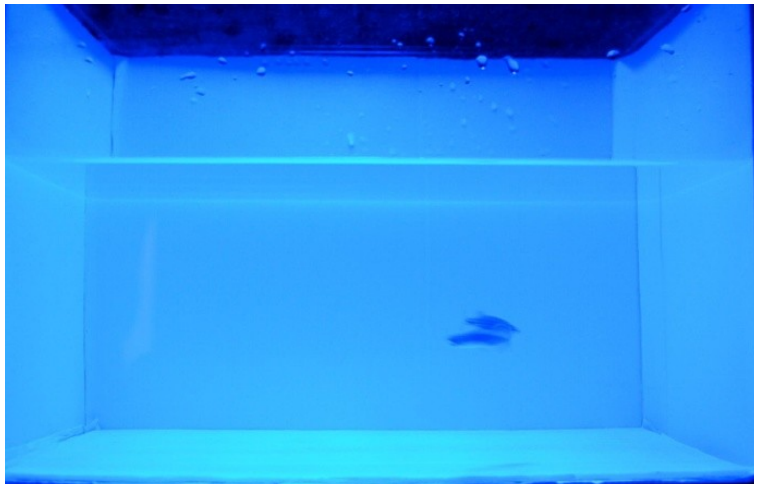
WAILight

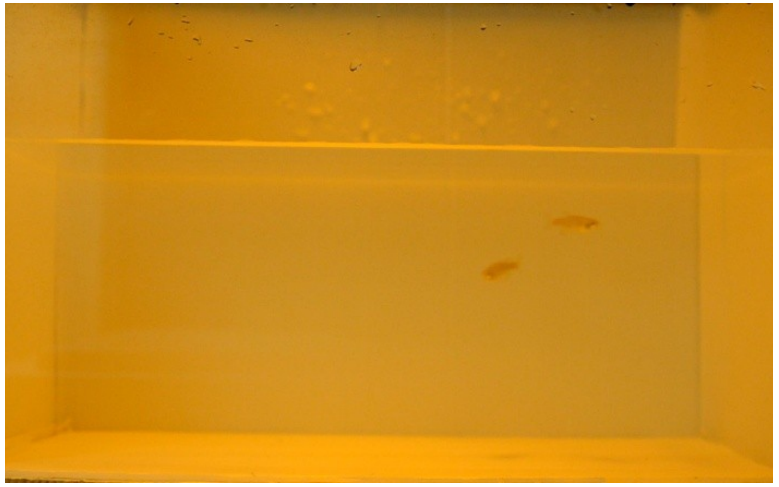



Direct detection of low “green” response from the camera, indicating that chlorophyll died approximate between Day 4 & 5, and freshness is gone

# (2) WAILight - Tunable Illumination System



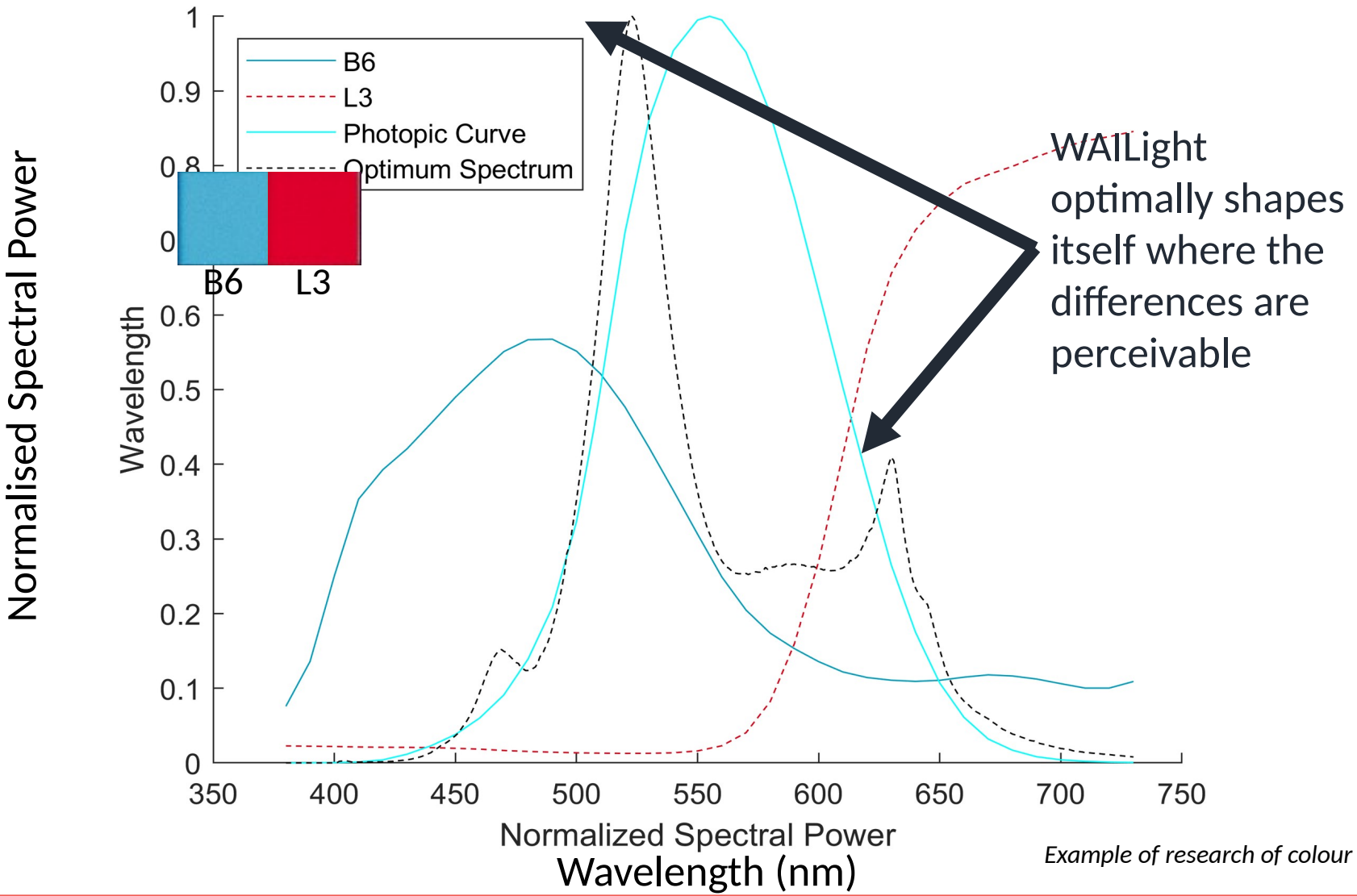


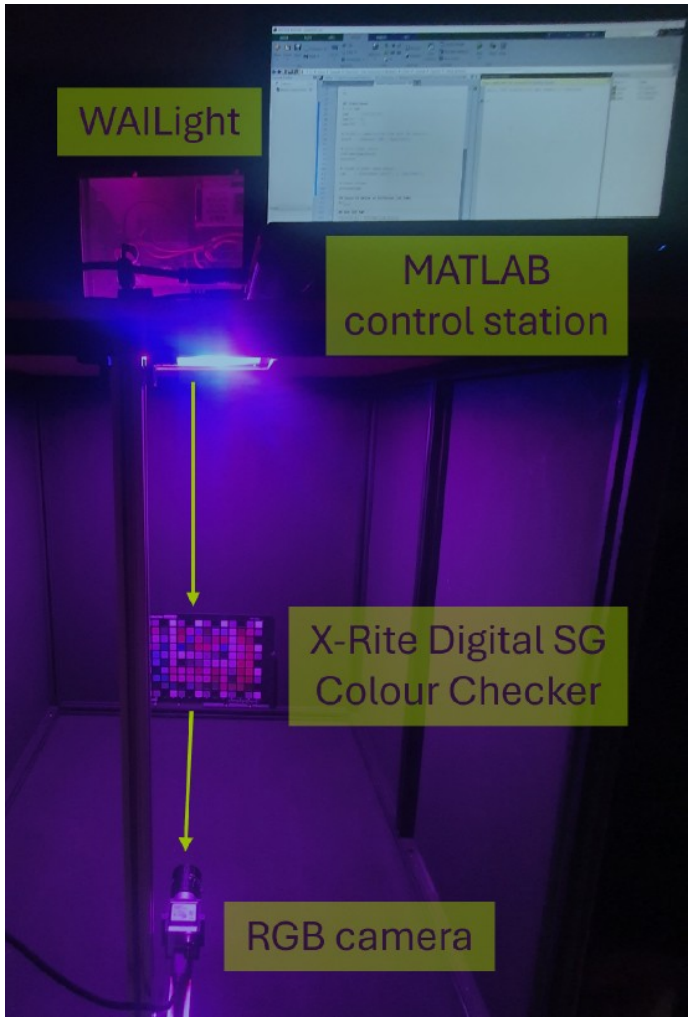



*Example of research with Monash University Brain Research Institute on Zebrafish. DOI: 10.1109/SAS.2014.6798944*

Real-time machine learning algorithms to model relationships between incident light and organism response

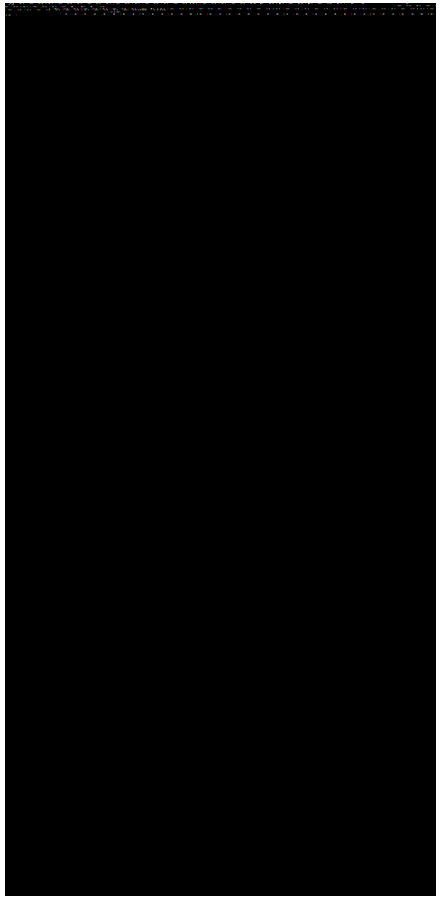
# (3) WAILight - Self-Auditing Measurement System

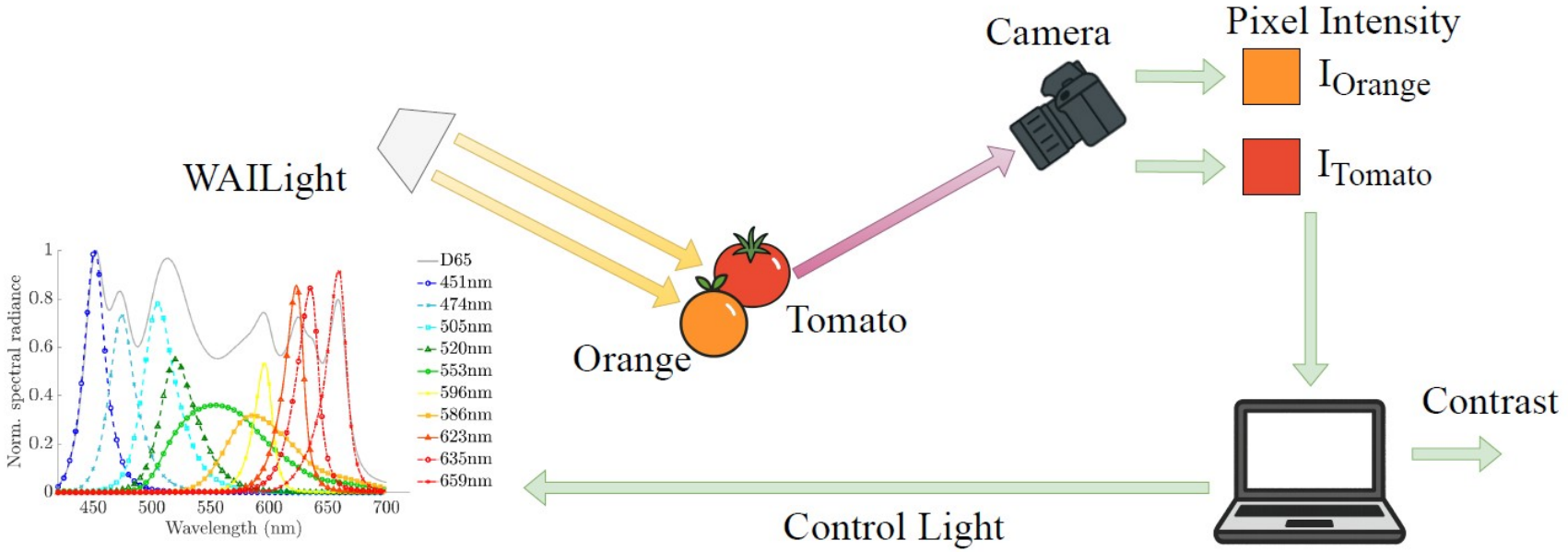



*Example of research of colour perception. DOI: 10.1109/I2MTC53148.2023.10176064*

# (3) WAILight - Self-Auditing Measurement System






AI can *act* on the measurement environment

**Illuminate & Measure**
Actively probe the scene.

→

**Symbolic Audit**
Check against learned rules.

→

**Calculate Gradient**
Determine error signal.

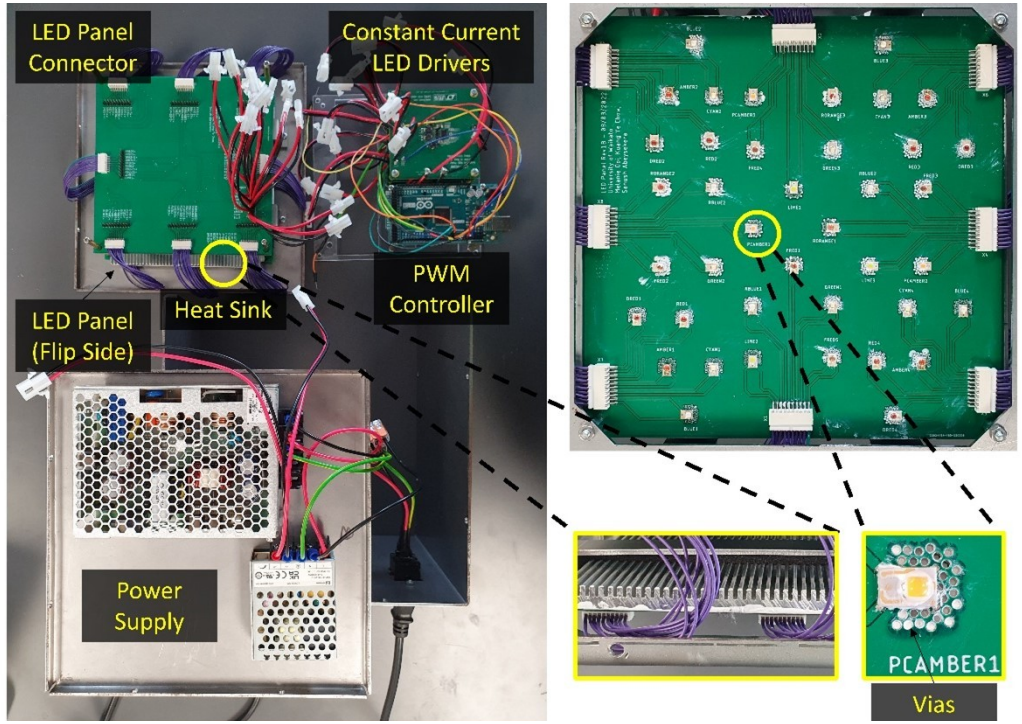
→

**Update Illumination**
Physically adjust sensing.

*Example of research with Public Health and Forensics (PHF)*

# WAILight – Next Generation Illumination Technology

- Spectrally tune for the “best” spectral contrast
- Convert contrast function into light intensity function
- Use this to drive LEDs on WAILight Hardware




Contrast function is a malleable within the computational imaging pipeline

Depending on the machine learning algorithm, a different choice of “best” contrast function is obtained

Autonomously adapt the illumination to maximize task-specific performance

# Experiment 1: Broccoli and Cabbage

- Objects are different shades of green
- Threshold levels chosen using histogram
- Broccoli is retained with intelligent light + threshold while cabbage is almost removed from view

| | With D65 Light | With Intelligent Light |
|---|---|---|
| Three Channels |  |  |
| Single Channel |  |  |
| After applying simple threshold |  |  |

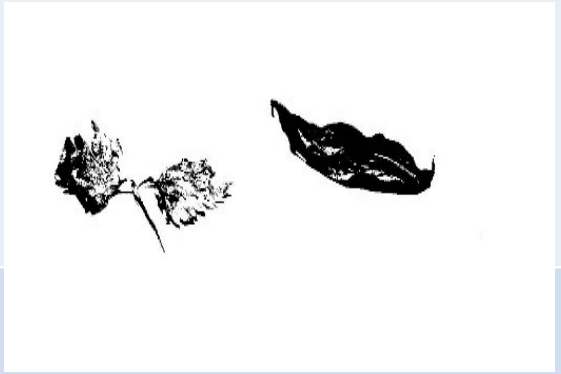
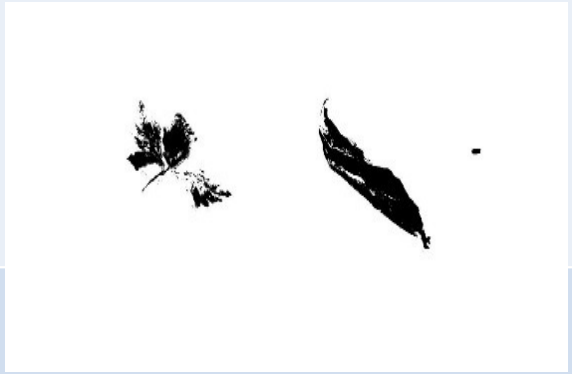
# Experiment 2: Carrot and CHili

- Objects in close color range (Orange and Red)
- Intensity of reflection in single channel is similar for both objects
- After thresholding, carrot is removed from view
- After color clustering, carrot is retained

| | With D65 Light | With Intelligent Light |
|---|---|---|
| Three Channels |  |  |
| Simple threshold |  |  |
| Colour K-Means Clustering |  |  |

# Experiment 3: Celery and Laksa Leaves

- Classification problem
- Objects are in different shades of green
- Use **same day (Day 5 vs. Day 5)** freshness, similar setup to Expt 2
- Simple threshold not as effective as colour-based clustering
- Able to cluster celery from laksa easily

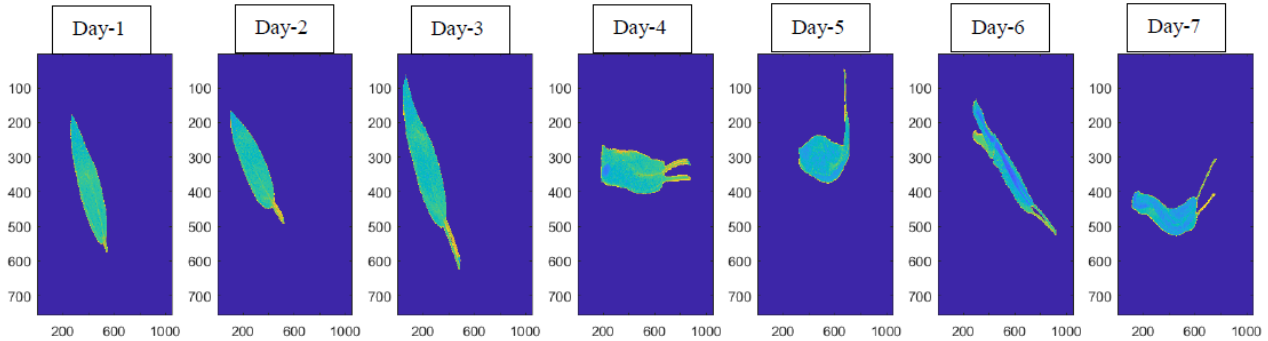
| | With D65 Light | With Intelligent Light |
|---|---|---|
| Three Channels |  |  |
| Simple threshold |  |  |
| Colour K-Means Clustering |  |  |

# Experiment 4: Assessment of Freshness

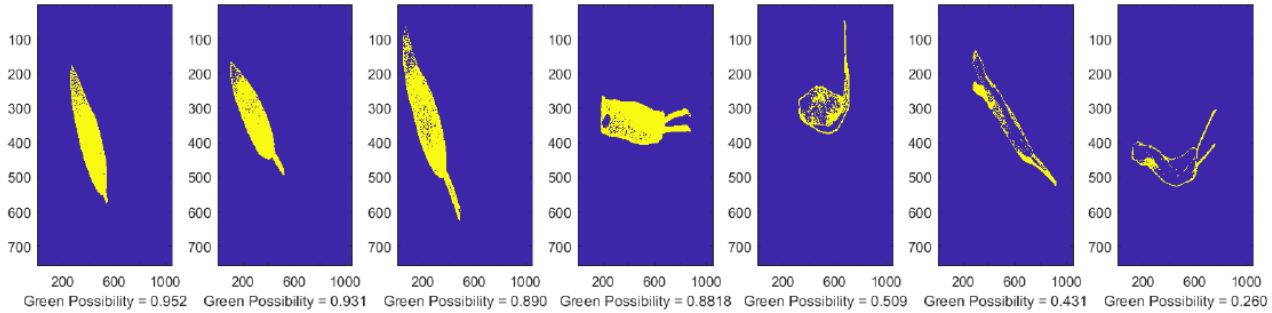
- Regression problem
- **Same camera**, same sample of sage leaf
- Under Intelligent Light, “Greenness” response from camera is greatly improved
- Greenness correlates with chlorophyll, which correlates with freshness
- **By just changing the light, we improve**

*Images of **<u>Unrefrigerated</u>** Sage from Day 1 to Day 7 under designed light*

D65 light bulb




Intelligent Light



# WAILight-Imagined by Whisk AI


- Automated decision-making for high level tasks
- Automated control of WAILight for performance-based perception
- Feedback control for accurate spectrum
- System optimisation (energy vs. growth rate)