Complete Food Traceability for One Health with AIoT Technologies

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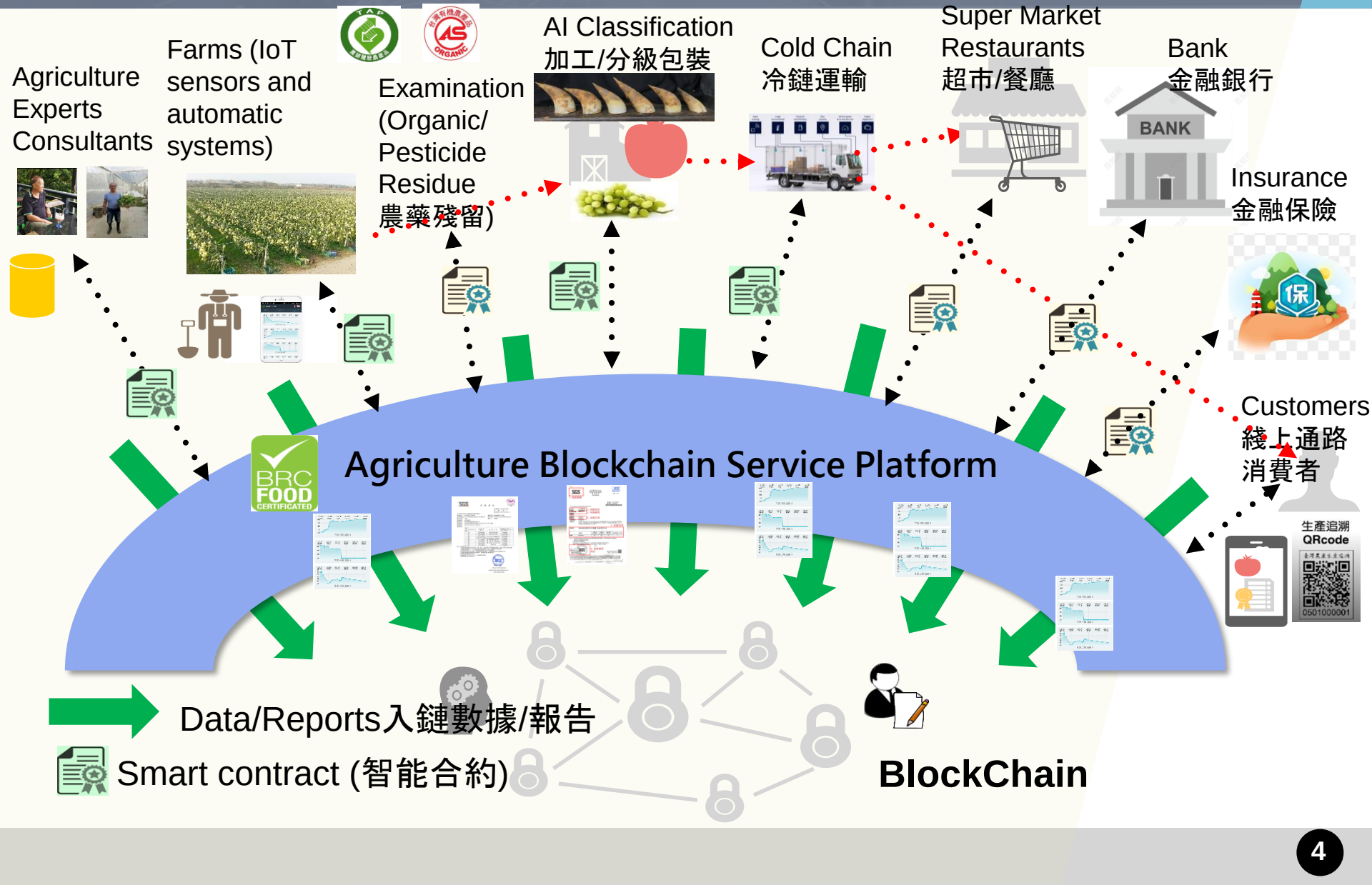
- Where is the Farm ?
- How they are planted ?
- Organic Certification ?
- Quality Level ?
- How they are delivered to here (clod chain logistic) ?

Open/Transparent/Secure Products Traceback Service

- Agriculture Data Analysis and Blockchain Service Platform
- Open/Transparent/Secure Products Traceback Service
- BlockChain Certified Foods (Crops/Fishes/Livestock/products)
- Core Technologies
  - IoT sensor hubs and LoRa/NB-IoT Transmission
  - AI agriculture big data analysis
  - Agriculture experts Knowledge Data Base
  - AI-based Farm Automatic control
  - AI crop identification/classification engine
  - Large scale farm management technologies
  - Smart Cold Chain transportation
  - Agriculture blockchain and smart contract service
  - Agriculture Finance

Agriculture Blockchain Architecture



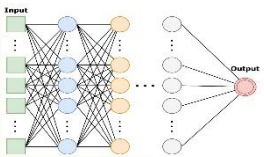
Smart Precise Agriculture Architecture

Drone 無人機

Outdoor Farms

LoRa Data

Bio-Tech Expert Farmers Knowledge DB



Data collected from farms

AI data analyzing + Planting Tech + Bio ch (organic fertilizer) know how

LoRa/NB-
Base Station

(Green houses)

LoRa Data

Data collected from farms

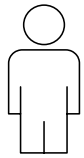
a platfo m

Data Monitor

Environ ment Control

Blockchain Service Platform

BlockChain



Farm Manag. App 田間紀錄

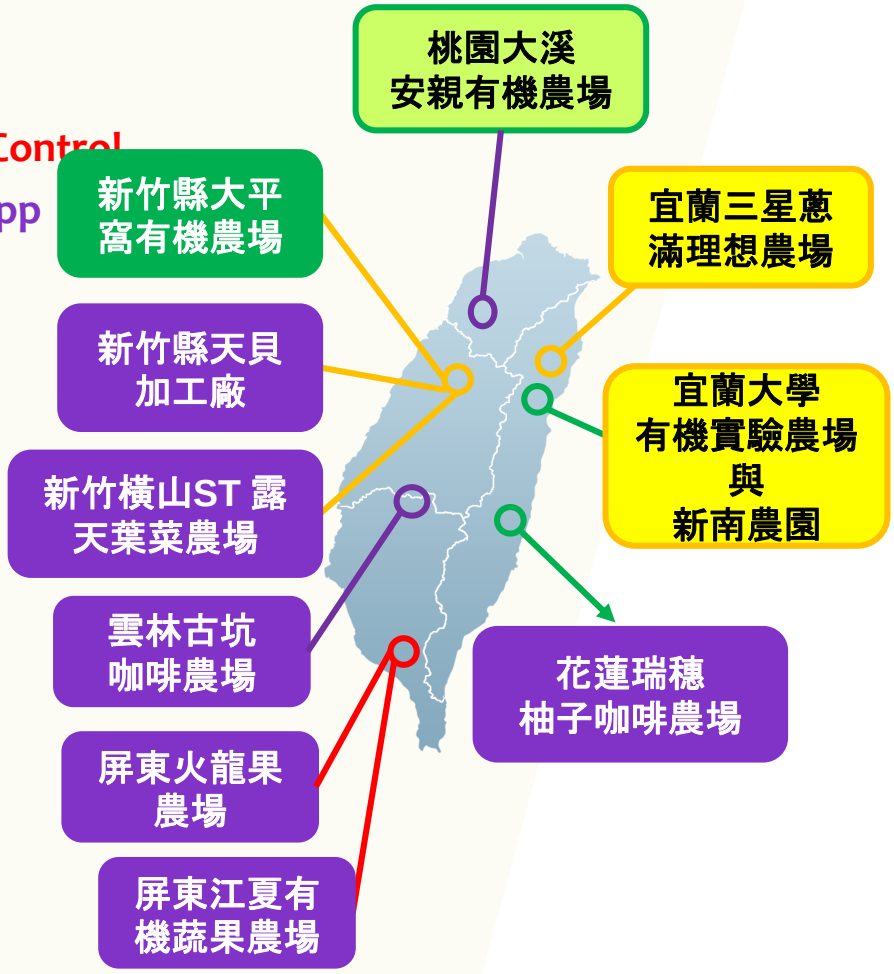
Experimental Achievements

4 key technologies and 2 smart agriculture platforms

- LoRaWAN/NB-IoT Sensor Hub
- LoRa P2P AI Precise irrigation System
- AI based Crops classification
- LoRa based Farms Monitoring and automatic Control
- IoT data analysis platform and Farm Manag. App
- Agriculture Blockchain Serivce Platform

10 Experimantal Fields

- 宜蘭新南農園(戶外+溫室)
- 桃園安親有機農場(溫室)
- 花蓮瑞穗柚子/咖啡農場(戶外)
- 雲林古坑咖啡農場(戶外)
- 宜蘭三星蔥滿理想農場 (戶外)
- 屏東火龍果園農場 (戶外)
- 新竹大平窩有機蔬菜農場(溫室)
- 新竹天貝加工廠(室內)
- 新竹橫山ST露天葉菜農場(戶外)
- 屏東江夏有機蔬果農場(戶外)



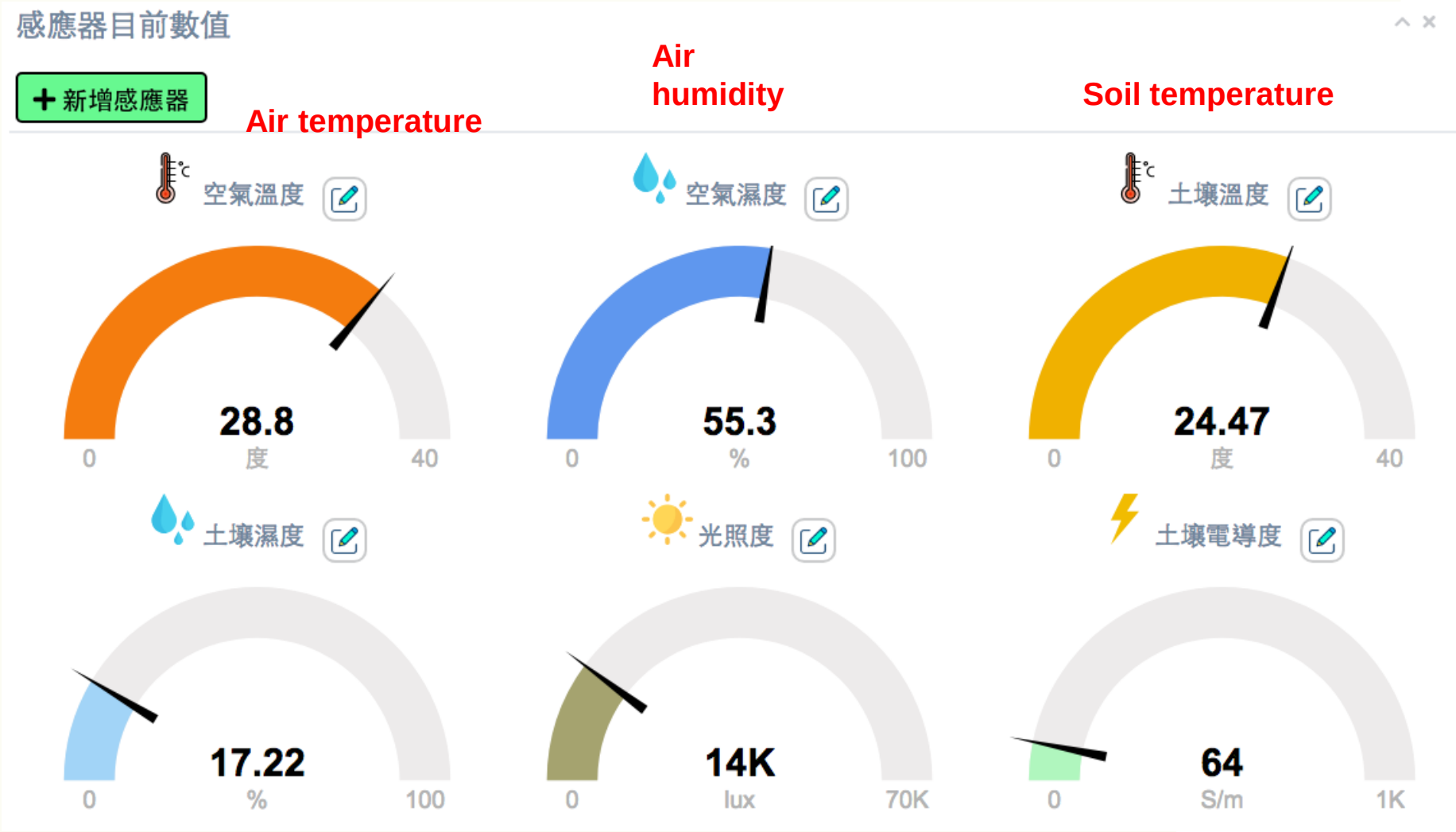
LoRa/NB-IoT based Sensor Hub

- LPWAN (Low Power WAN) technology
- LoRa/NB-IoT wireless communication, 2 – 15 Kms
- WiFi
- MTK LinkIt 7697 IoT chip
- Solar panel
- Air Temperature/Humidity,
- Soil Temperature/moisture, EC
- CO2, Light, Wind Speed,
- Water PH,
- PM2.5,
- Micro weather station, …

IoT Data Analysis Platform

- 清華大學智慧農業物聯網數據分析平台
- (http://nthu-smart-farming.kits.tw:8080/login.html)

IoT Data Analysis Platform



Air temperature

Air humidity

Soil temperature

Soil humidity

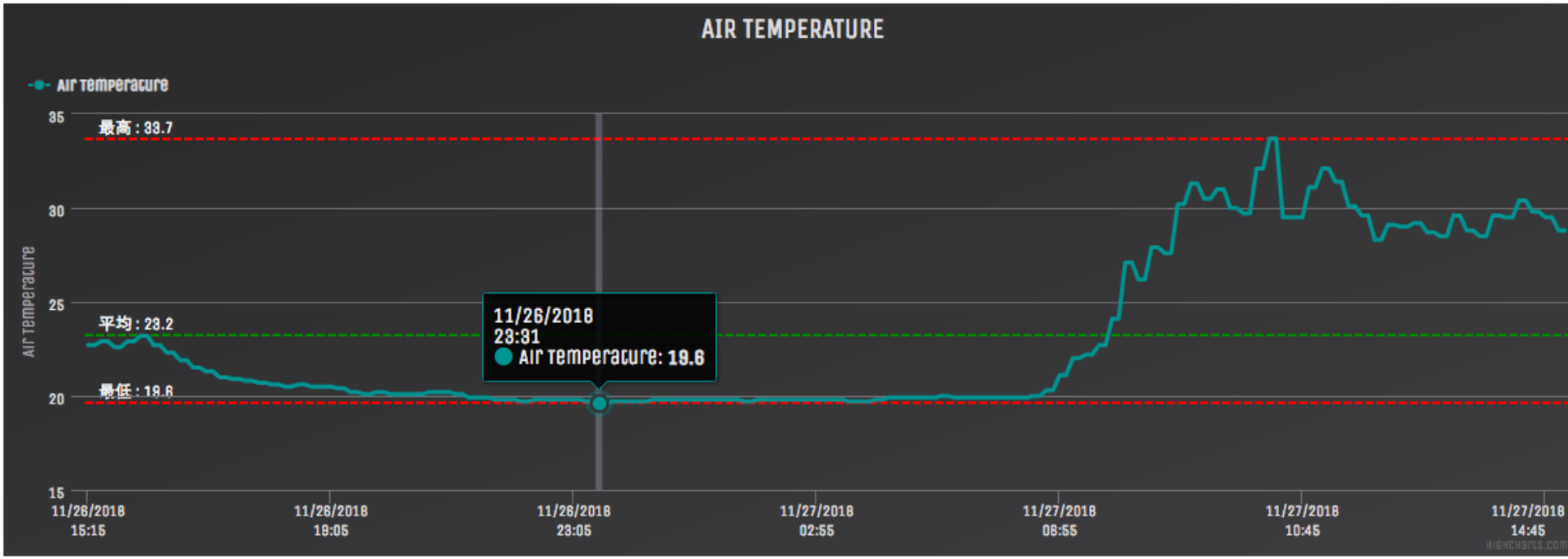
Illuminance

Soil electrical conductivity

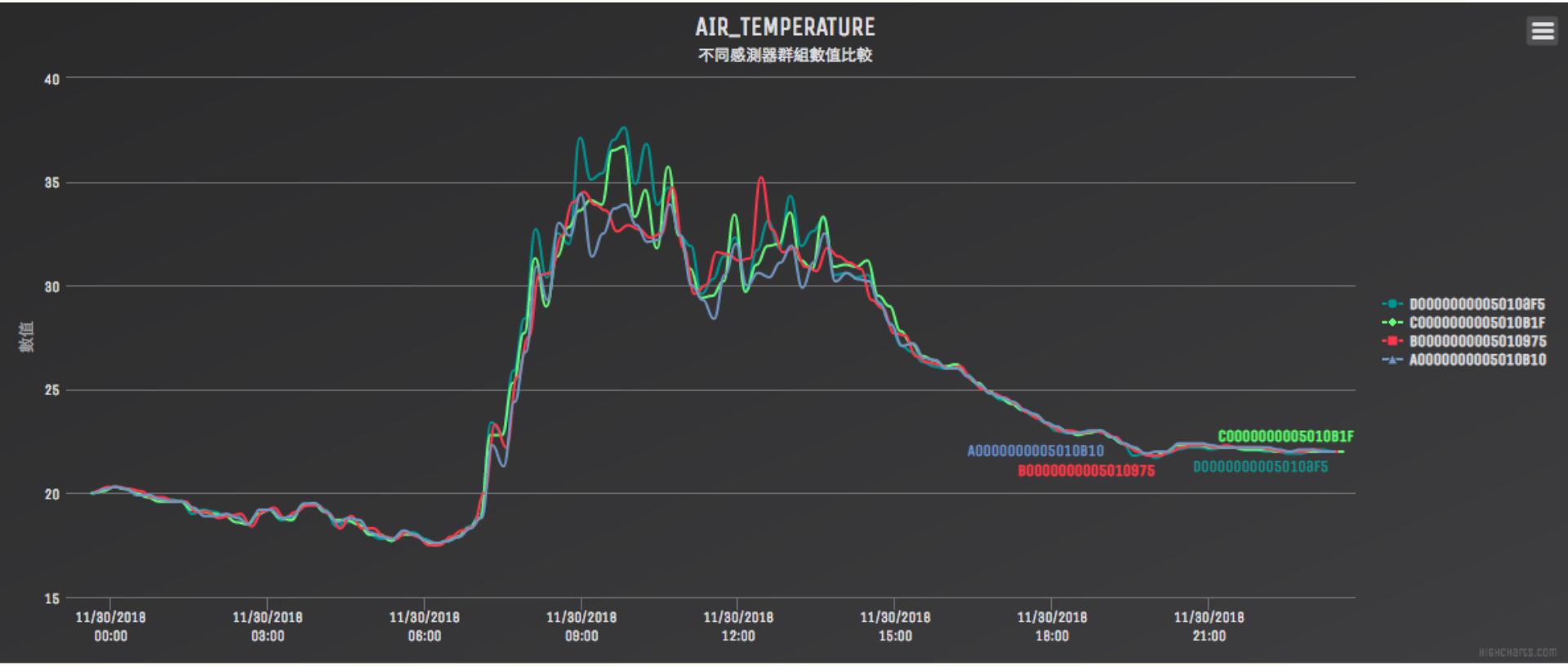
IoT Data Analysis Platform

感應器歷史數據

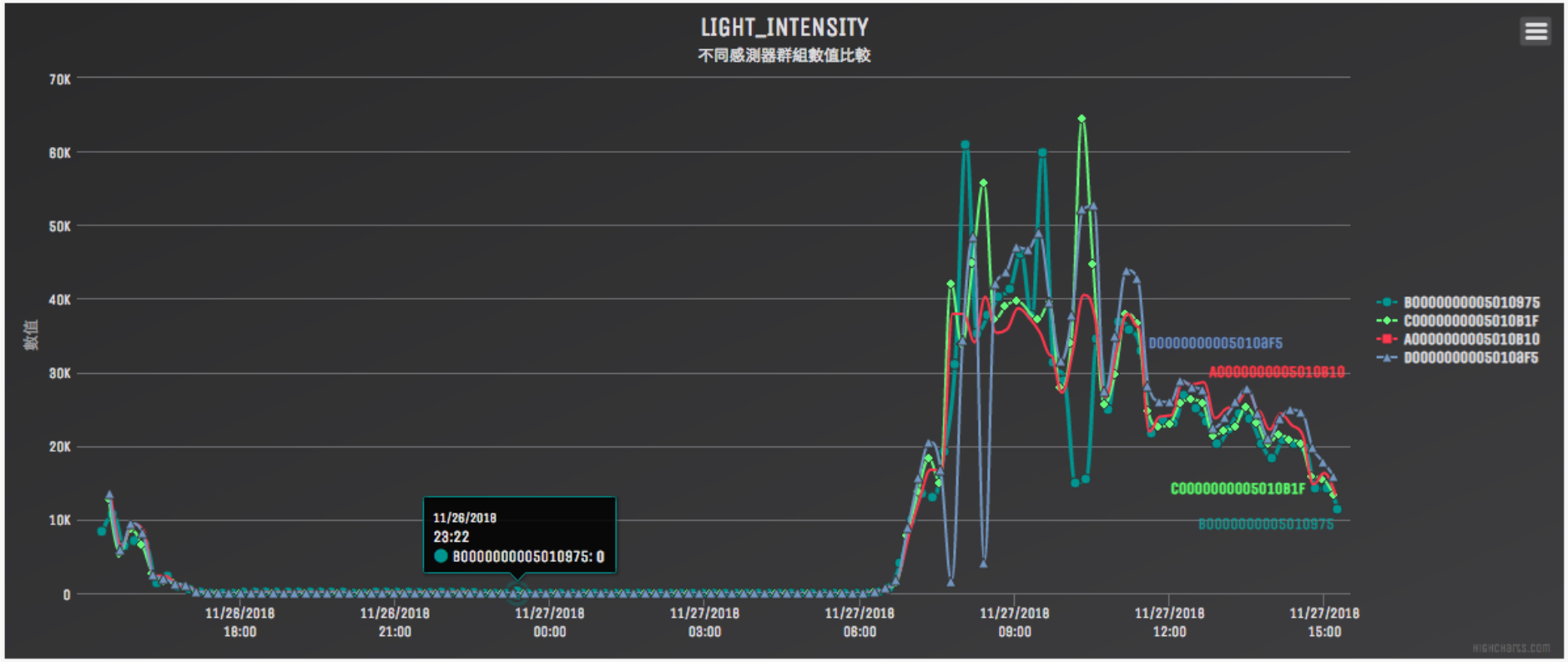
11/27/2018 00:00 - 11/28/2018 00:00



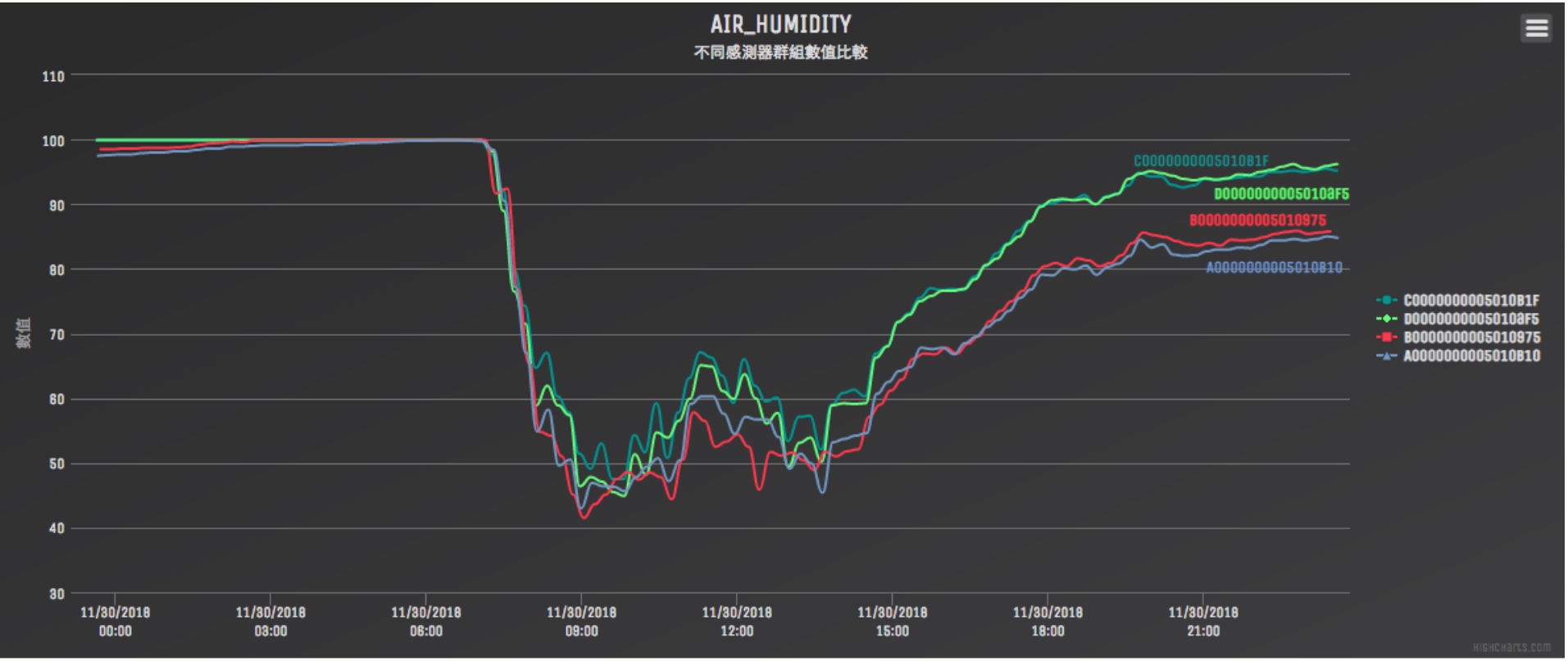
IoT Data Analysis Platform



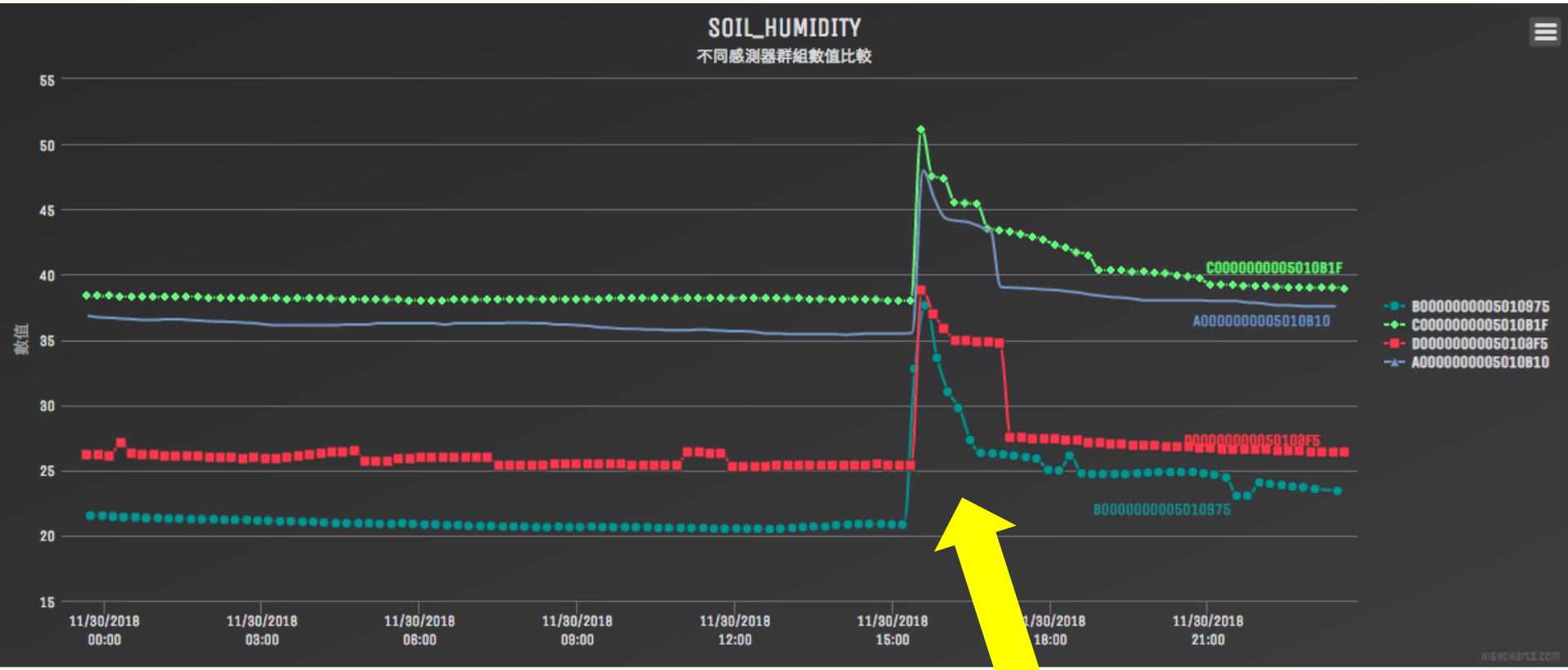
IoT Data Analysis Platform

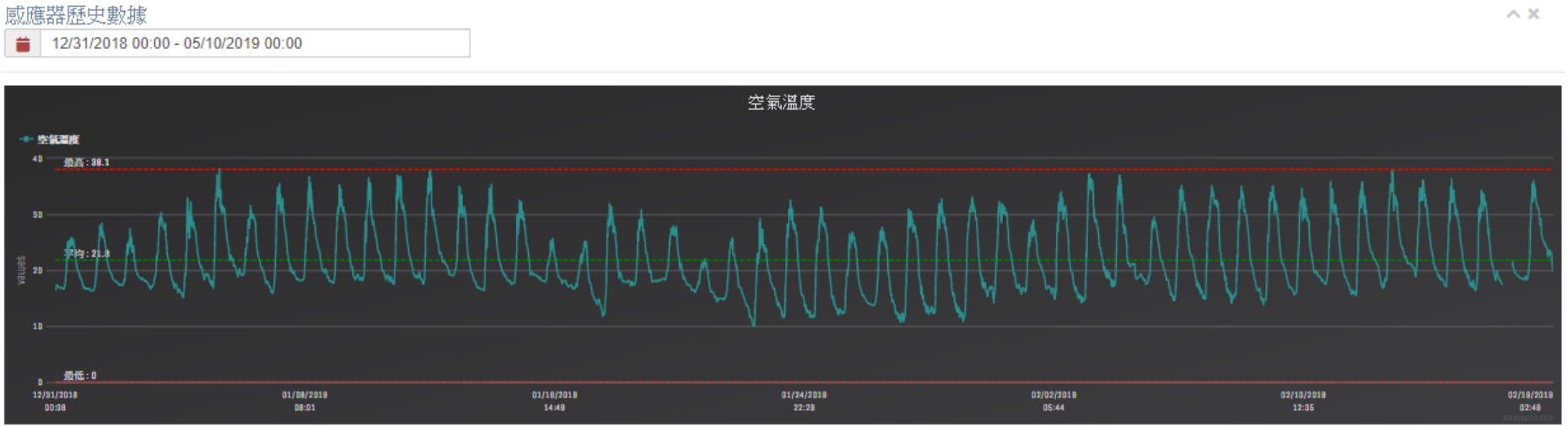


IoT Data Analysis Platform

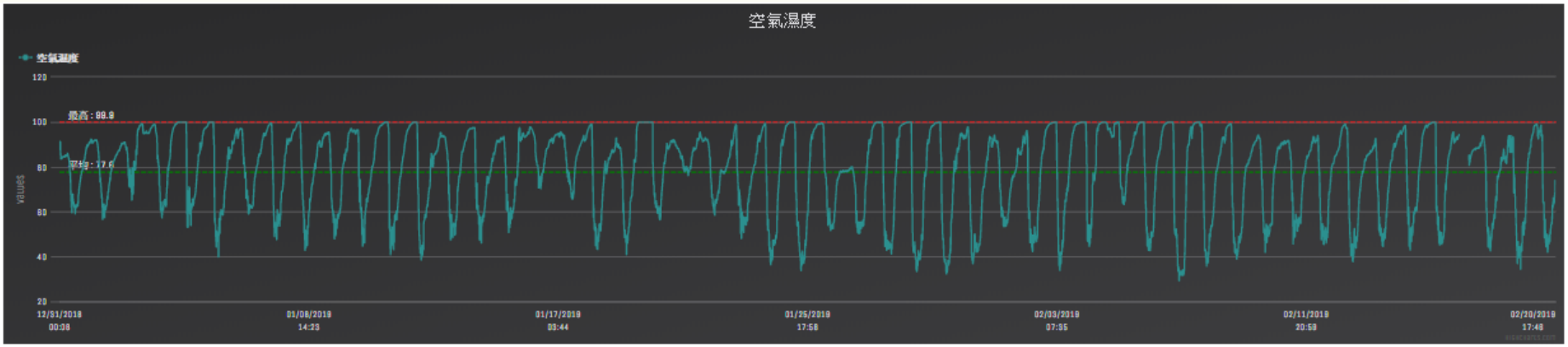


IoT Data Analysis Platform

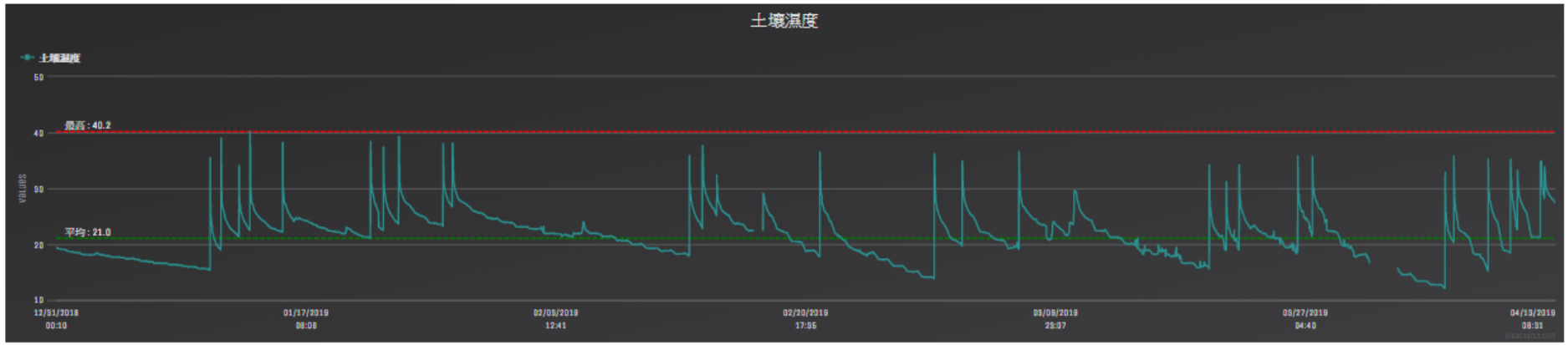




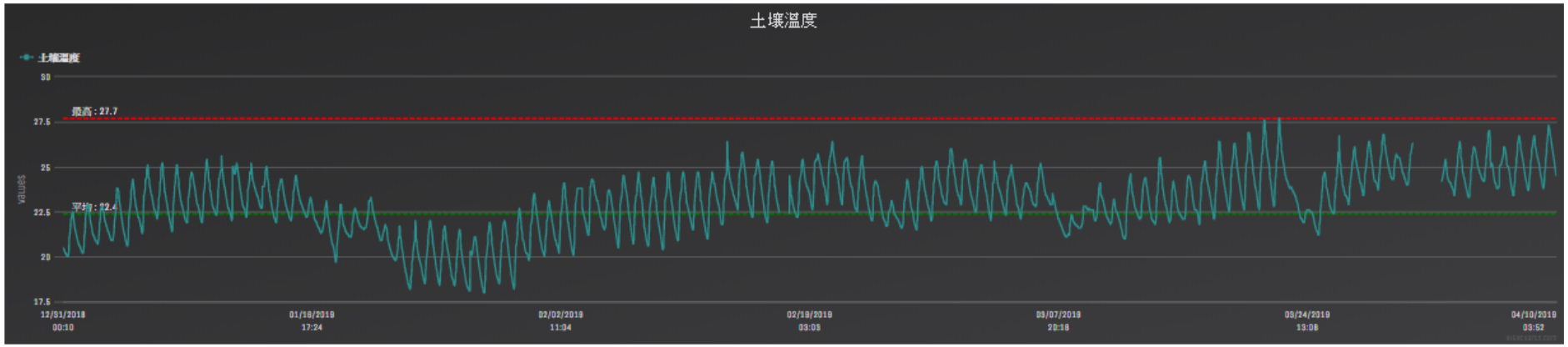
Air Temperature 空氣溫度的變化與趨勢圖 (12/31/2018-5/10/2019)



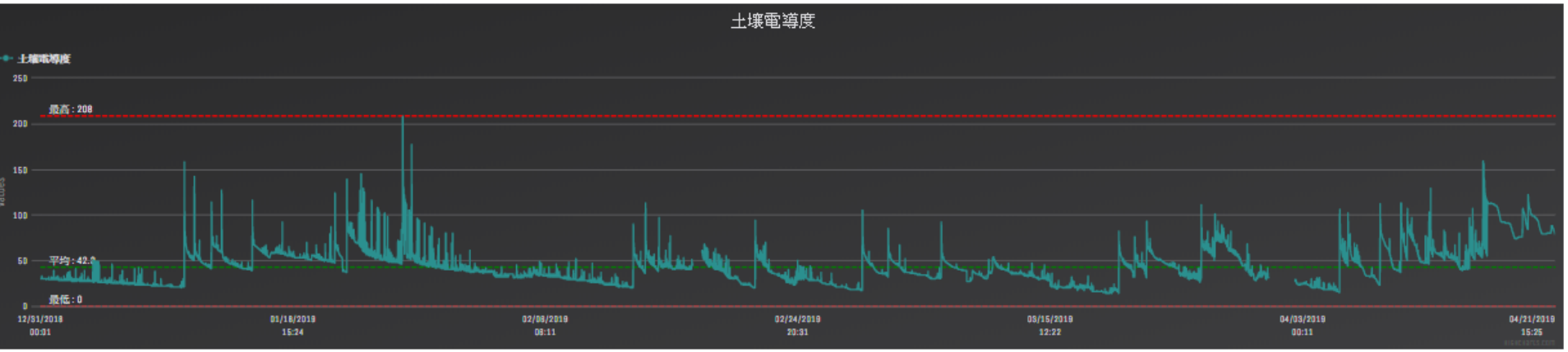
Air Humidity 空氣濕度的變化與趨勢圖 (12/31/2018-5/10/2019)



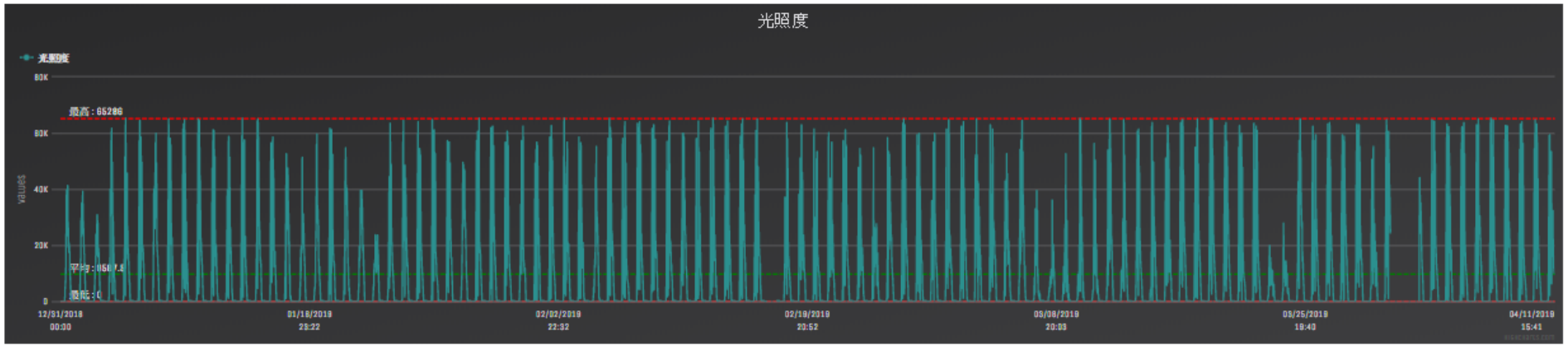
Soil Humidity 土壤溼度的變化與趨勢圖 (12/31/2018-5/10/2019)



Soil Temperature 土壤溫度的變化與趨勢圖 (12/31/2018-5/10/2019)



Soil EC value 土壤電導度的變化與趨勢圖 (12/31/2018-5/10/2019)



Light Intensity 光照度的變化與趨勢圖 (12/31/2018-5/10/2019)

農場管理 Farm Management APP

農場管理 APP
(Android, iphone)

Dragon Fruit Farm at Ping-Tung

- 11 Ha
- Largest single dragon fruit farm in Taiwan
- Sweet-baby (Pollination by workers)
- Harvest at winter for 6 months (December-May)
- Harvest twice every month
- 30,000 Kg each harvest
  300,000 Kg /year
- Average price USD 3 /Kg
- Revenue USD 1M/year
- Cost 0.3 M/year
- Profit 0.7 M/year

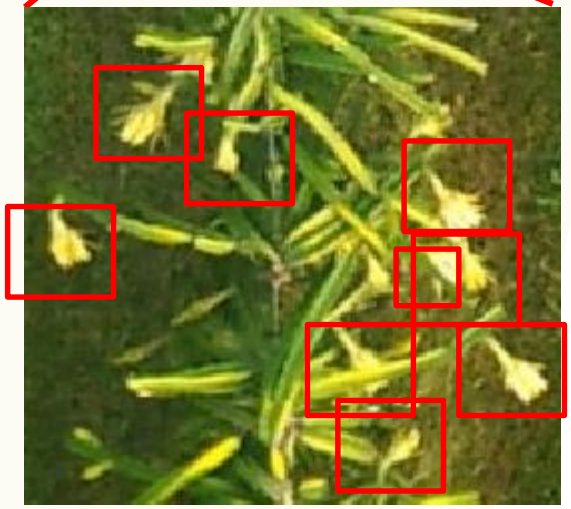
Total 4000 Ha dragon fruit in Taiwan
Big-red 3940 Ha (天然授粉, Summer, Low Price)
Sweet-baby 60 Ha, (人工授粉, Winter, High Price)

Precise agriculture 精準農業

Video

Dragon Fruit flowers

How many dragon fruit flowers?



10 flowers

AI Deep Learning Model

,10 flowers

,8 flowers

,1 flower

,.....

,0 flowers

Adjust Weights

Neural Network

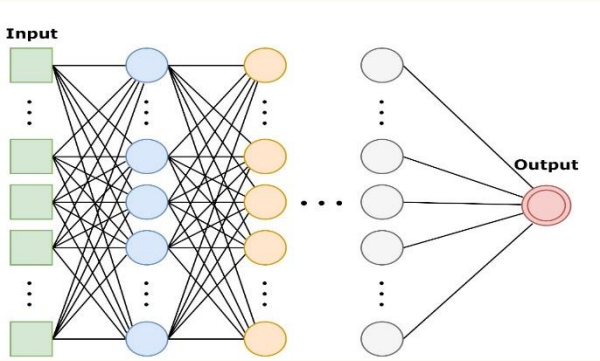
Output

Error

Σ

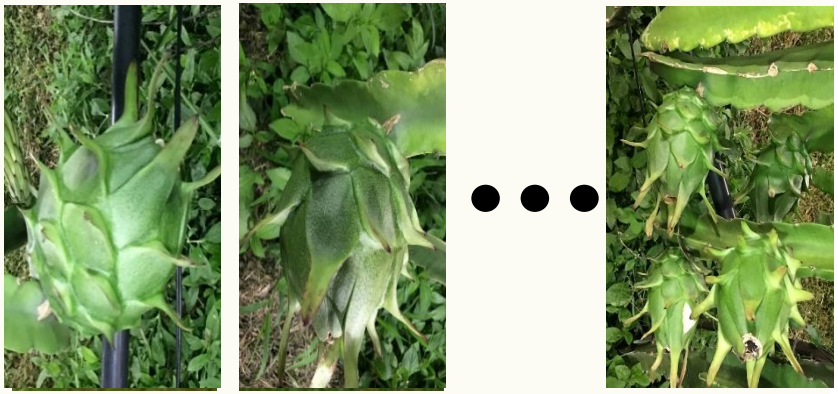
−

+

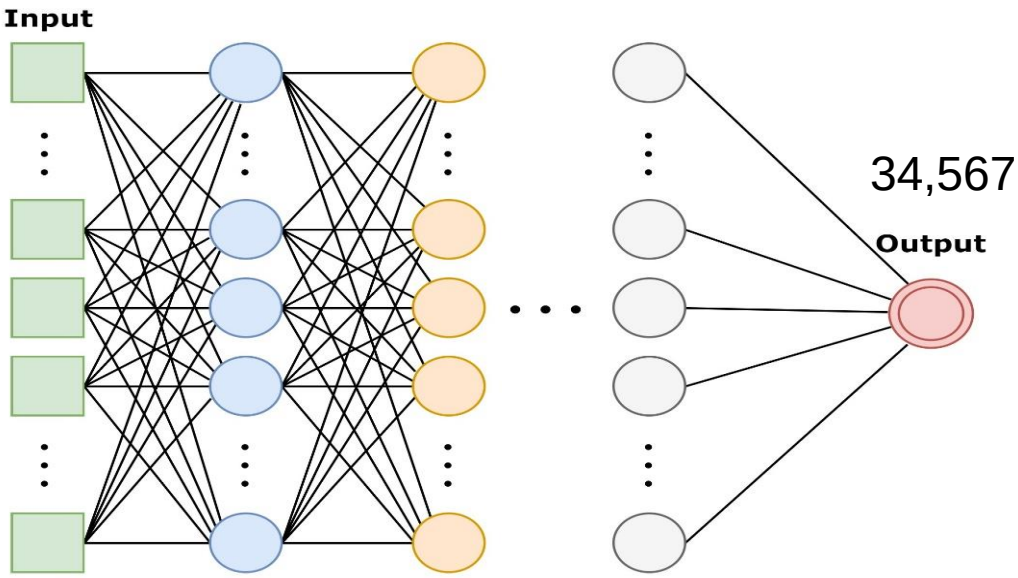


Desired Output

Counting Flowers/Fruits



1 2 …. 10000.



Get a good approximate count
(number of flowers in the image.)

Dragon Fruit flowers 屏東帝王火龍果

Dragon Fruit flowers 屏東帝王火龍果

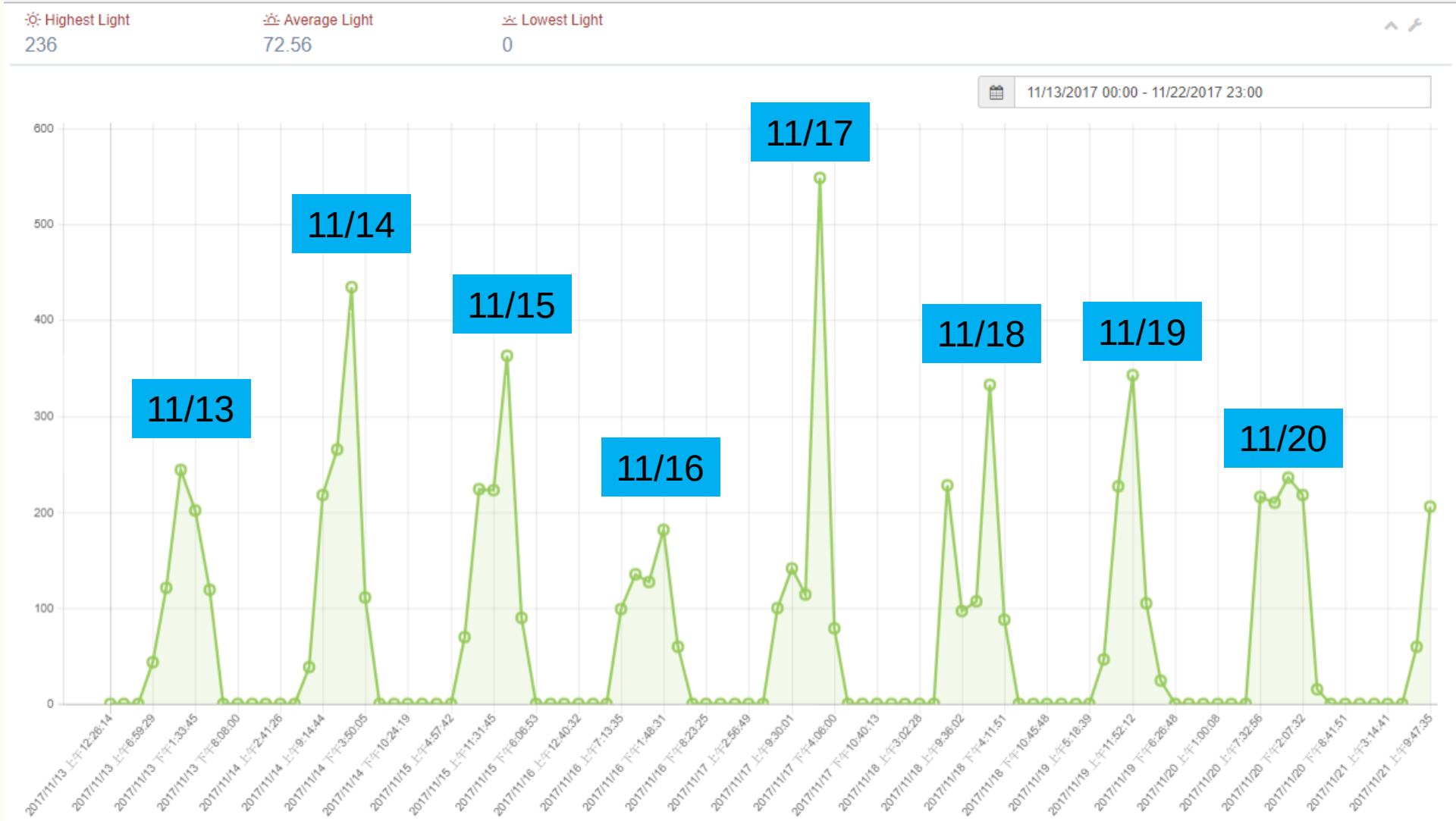

屏東帝王火龍果園園主


ROYAL SALUTE
21
BLENDED
SCOTCH WHISKY

Sensor Hub + LoRa Base Station

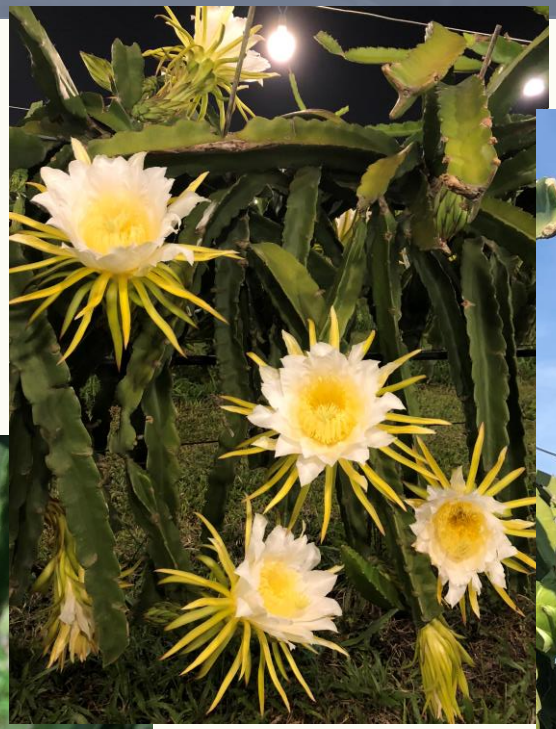
Lighting for generating flowers periodically

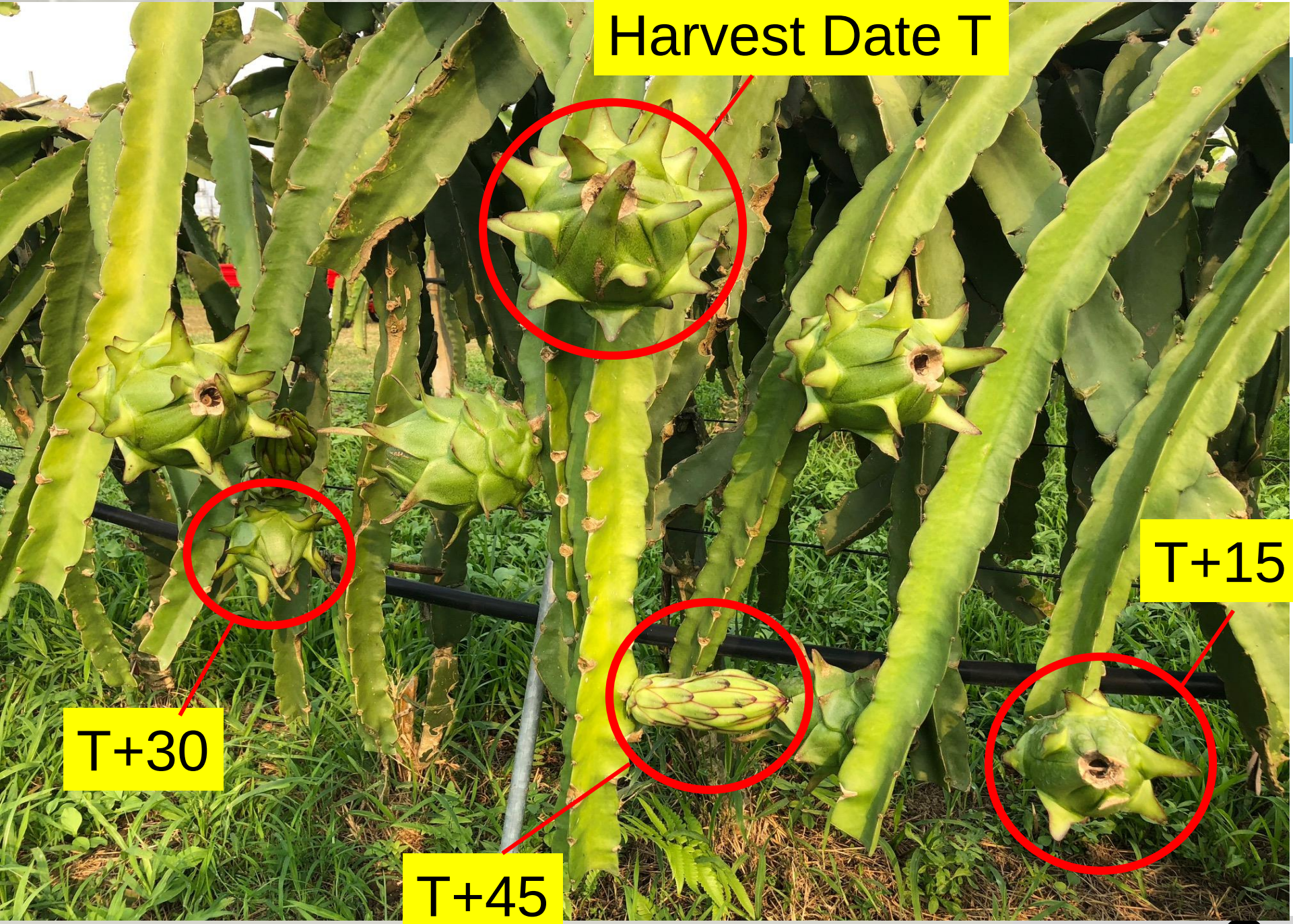
Light intensity calculation (光照度)

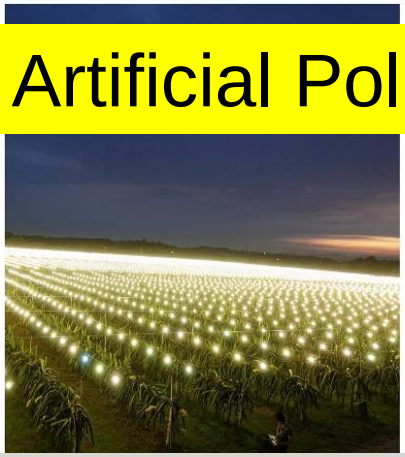


視頻播放 Video

Change Harvest time from Summer to Winter




Harvest Date T
T+15
T+30
T+45



Artificial Pollination

花粉收集 Pollen collection (Video)

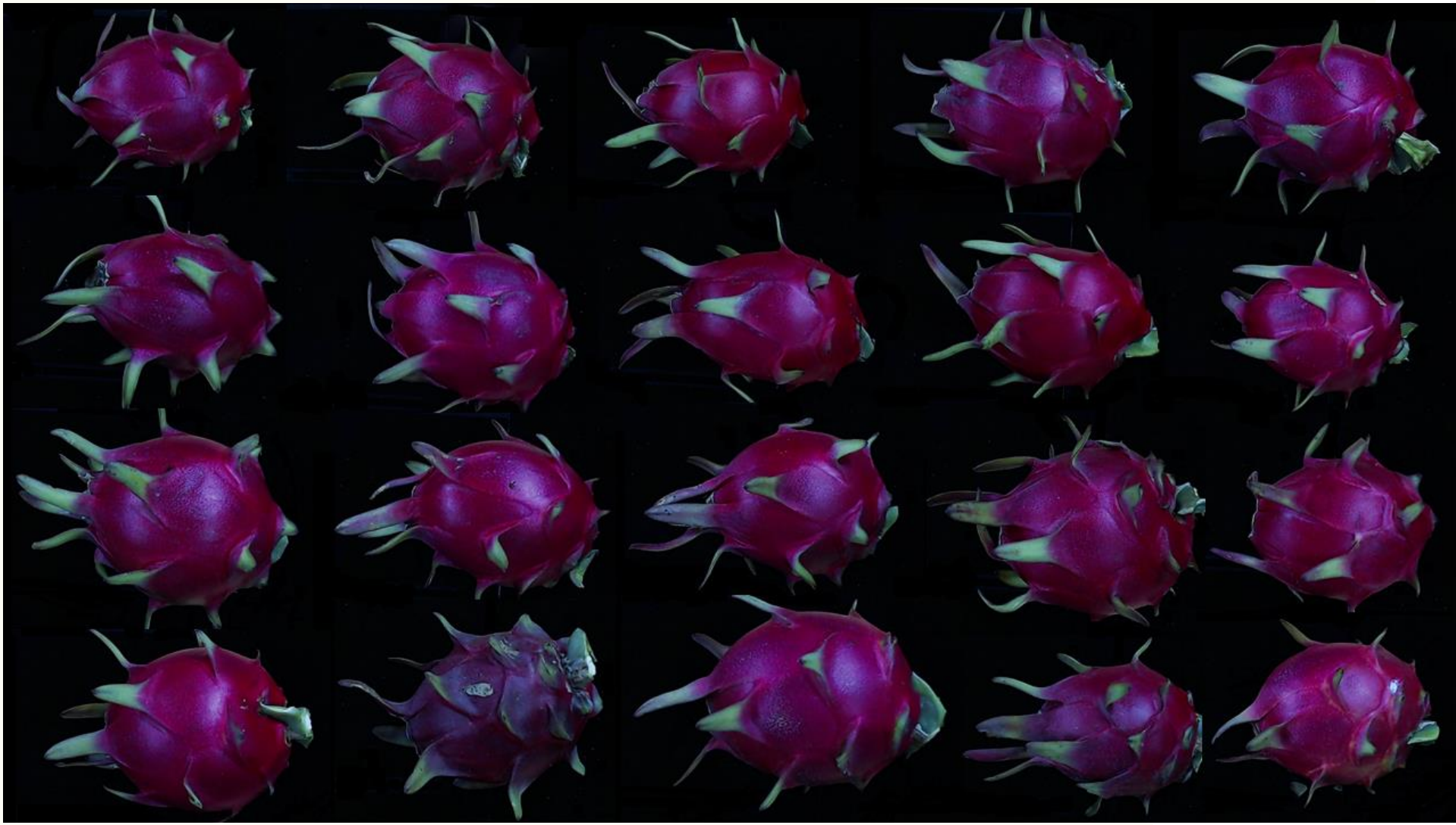
Video

Videos

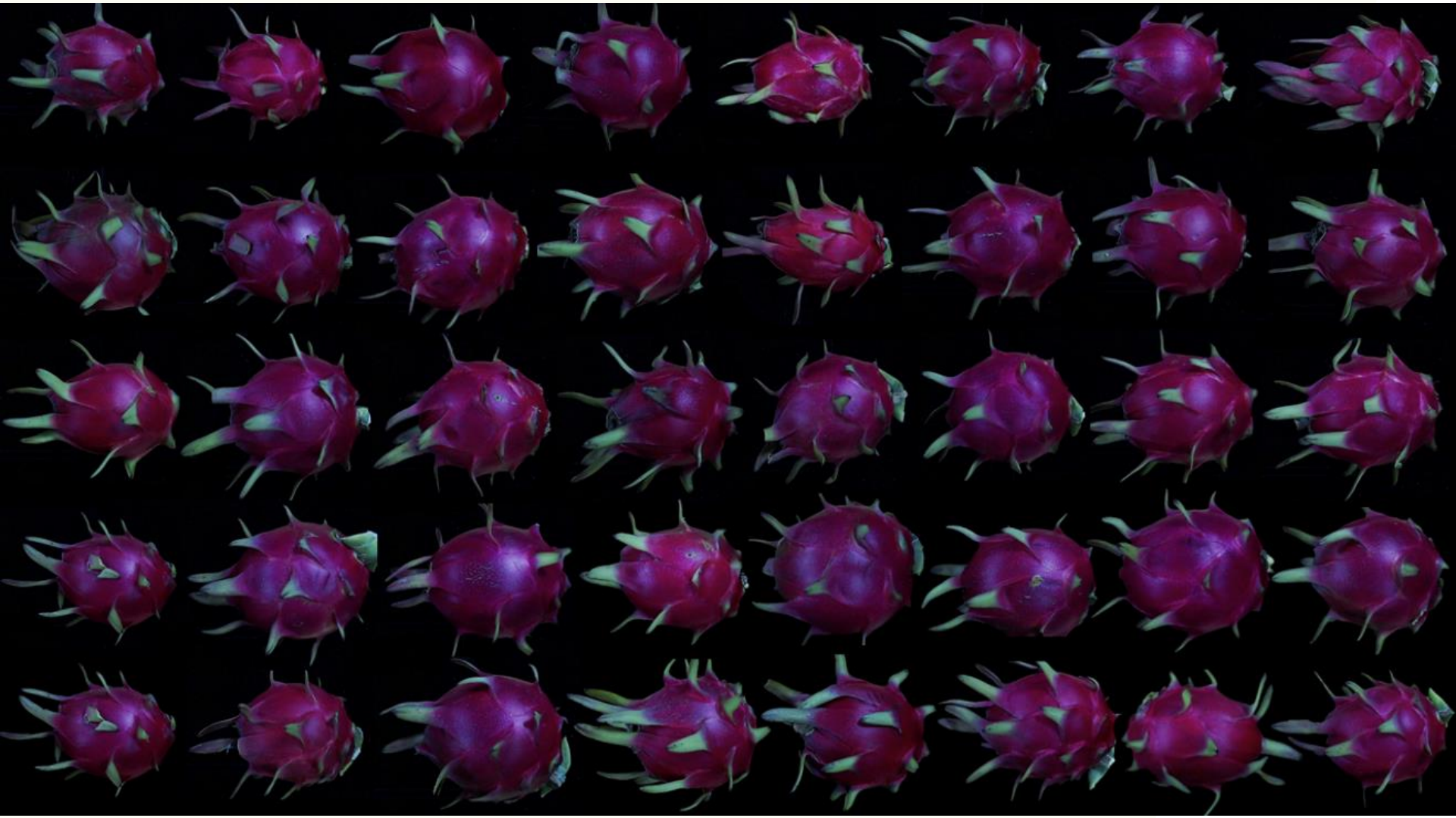
Crops Classification (by weight)

視頻播放 (Video)

AI-based Crops Classification (by ML)



AI-based Crops Classification (by ML)



LPWAN Wearable Sensors

- LPWAN（low power/long distance)
- LoRaWAN/NB-IoT wireless communication, 2 – 10 KMs
- Wearable sensors, put in workers pocket, cars, motors, etc
- Four LPWAN vibration sensors:
  - LoRa-2038: GPS + LoRaWAN + Bluetooth + G sensor + Temp/Humidity + Battery
  - LoRa-2033: LoRaWAN + Bluetooth + G sensor + Temp/Humidity + Battery
  - NB-4038: NB-IoT + GPS + Bluetooth + G sensor + Temp/Humidity + Battery
  - NB-4033: NB-IoT + Bluetooth + G sensor + Temp/Humidity + Battery

LoRa-2038

LoRa-2033

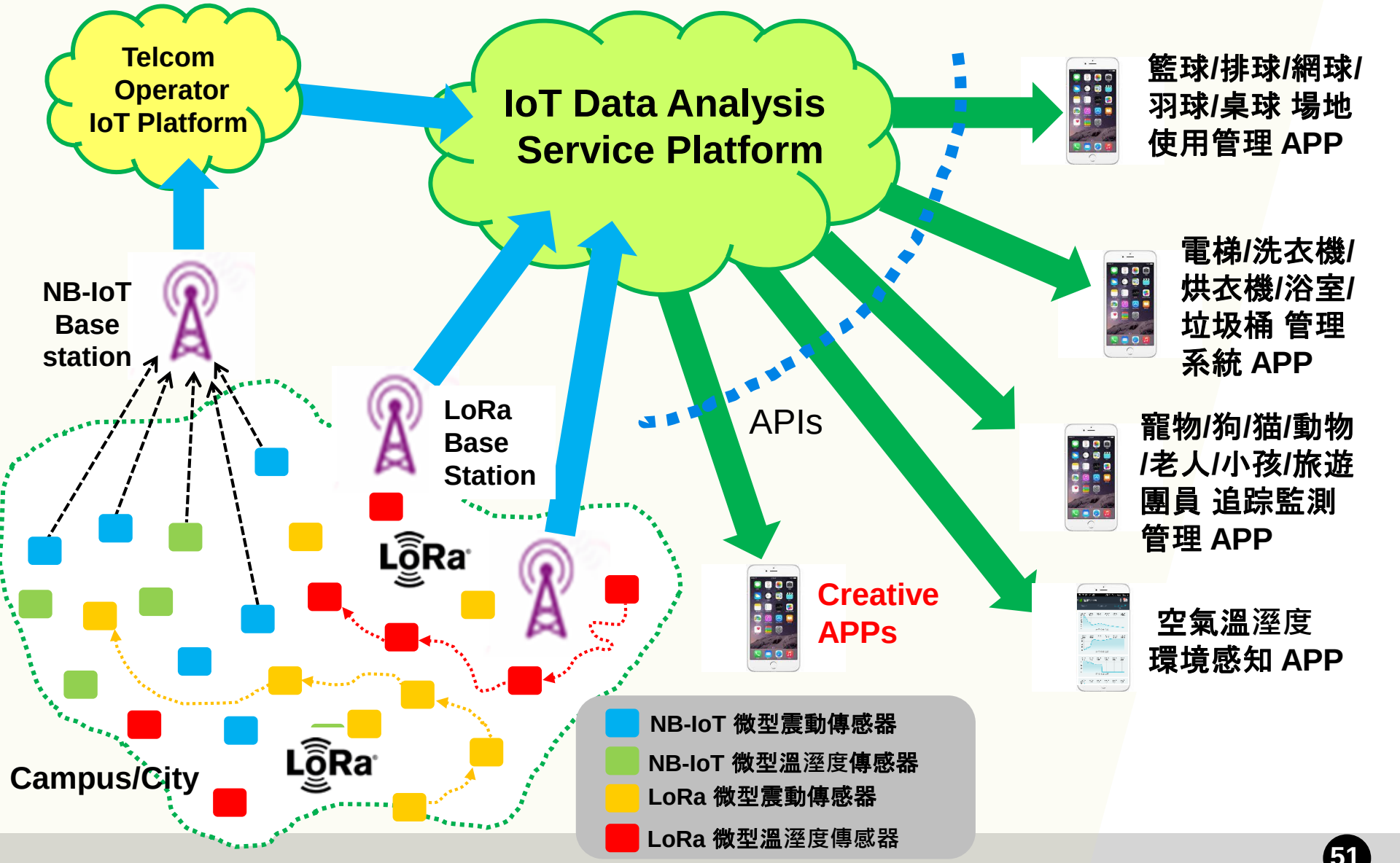
NB-4038

NB-4033

Smart Campus IoT Applications

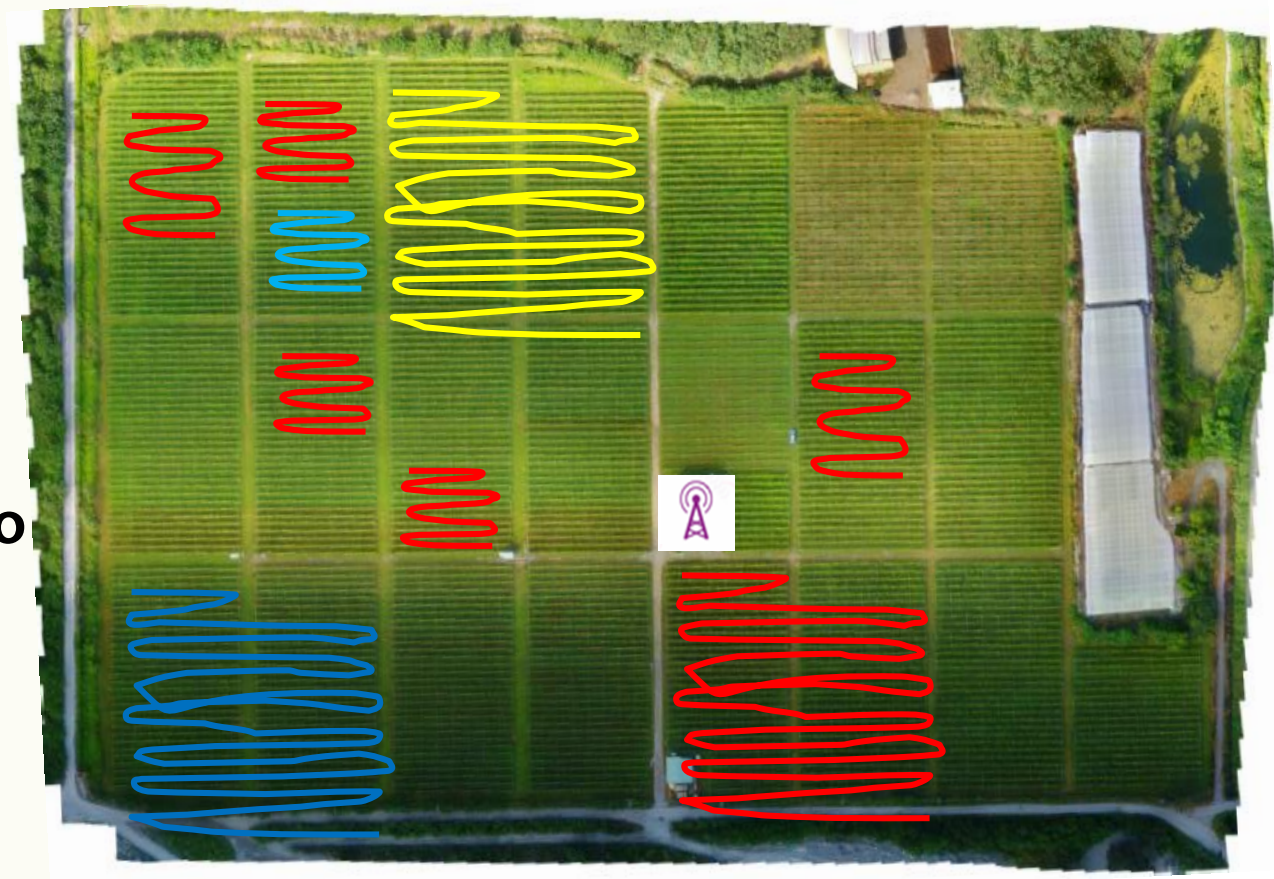
- **Sports Venus/Park/Courts Management**
  - basketball/Volleyball/tennis/badminton/Table tennis
- **Transportations Management**
  - Campus Bus/Cars/ Motorcycle/Bicycles
- **People Management**
  - Elder/Kids/Pets/Dogs/Cats/Animal
- **Facility Management**
  - Elevators/Washing machine/Dryer/Bathroom
- **Personal Objects**
  - Backpack
- **Campus Environment Management**
  - Air Temperature/Humidity, Soil Temperature/moisture, EC, CO_2, Light, Wind Speed, Water PH, PM2.5, etc

Campus IoT Data Analysis Platform



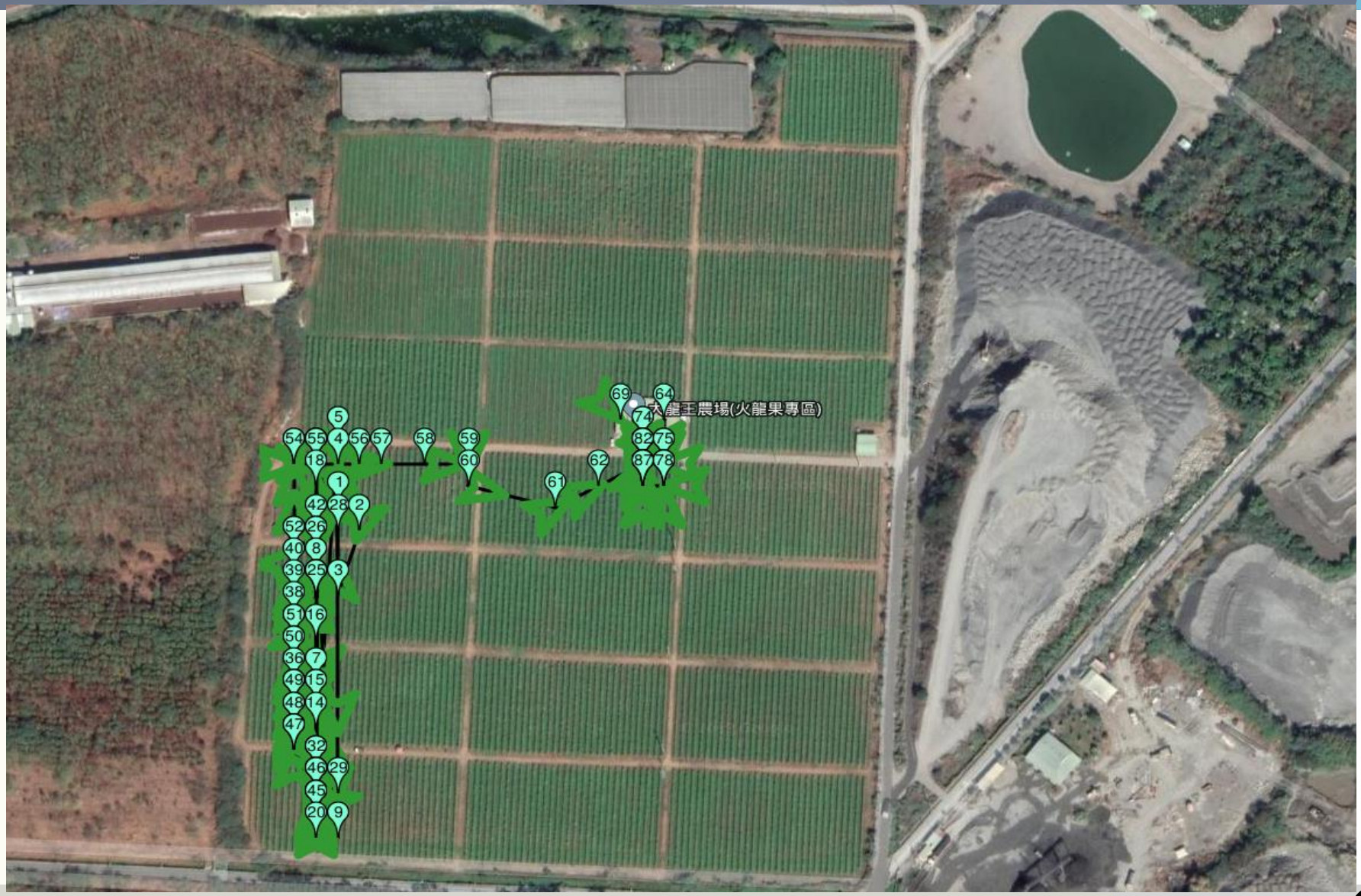
Large Scale Farm Management Technology

- Many works to do by workers in a large farm
  - Cutting Flowers
  - Pollination
  - Fertilization
  - Harvest
- Workers route trace
- Complete area/ratio
- Working Efficiency
- Worker safety care

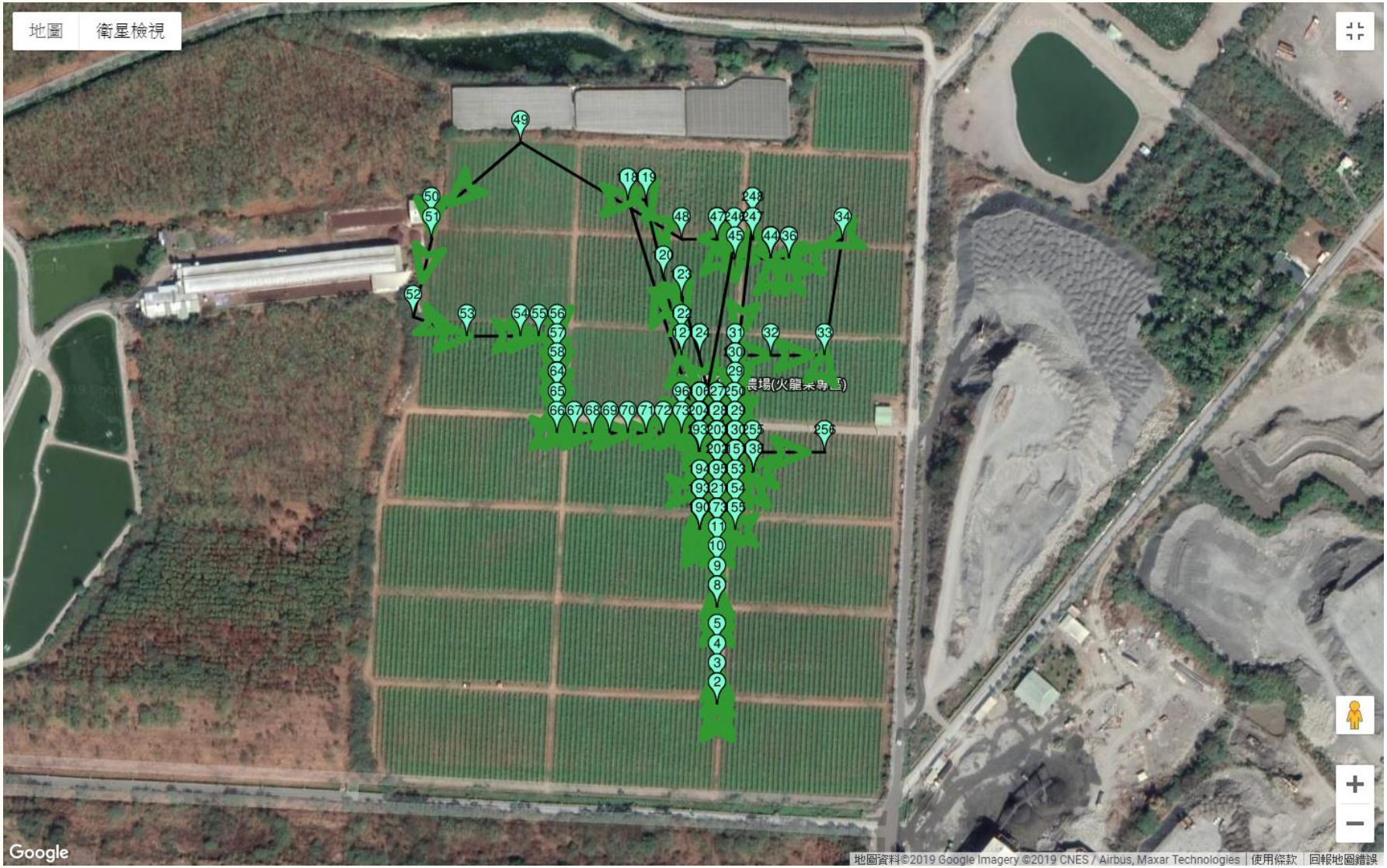


LoRa Base station

GPS tracking of workers



GPS tracking of workers



Opportunities and Challenges

- Traditional agriculture needs ICT technology to help
- IoT, Robotics, automation to increase crops Quality and Quantity
- AI ML Technology for crops classification
- Balance between products and channels
- Blockchain Technology to guarantee food security and increase farmers' revenue
- AI-Chip for measuring soil critical micro-elements, including N (氮), P (磷), K (鉀)
- AI-Edge computing with 5G and AR technologies, such as smart glass for crops processing

Smart Glasses for selecting buds (crops)

SONY

Google

Thank you for your attentions !

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Organic Green House

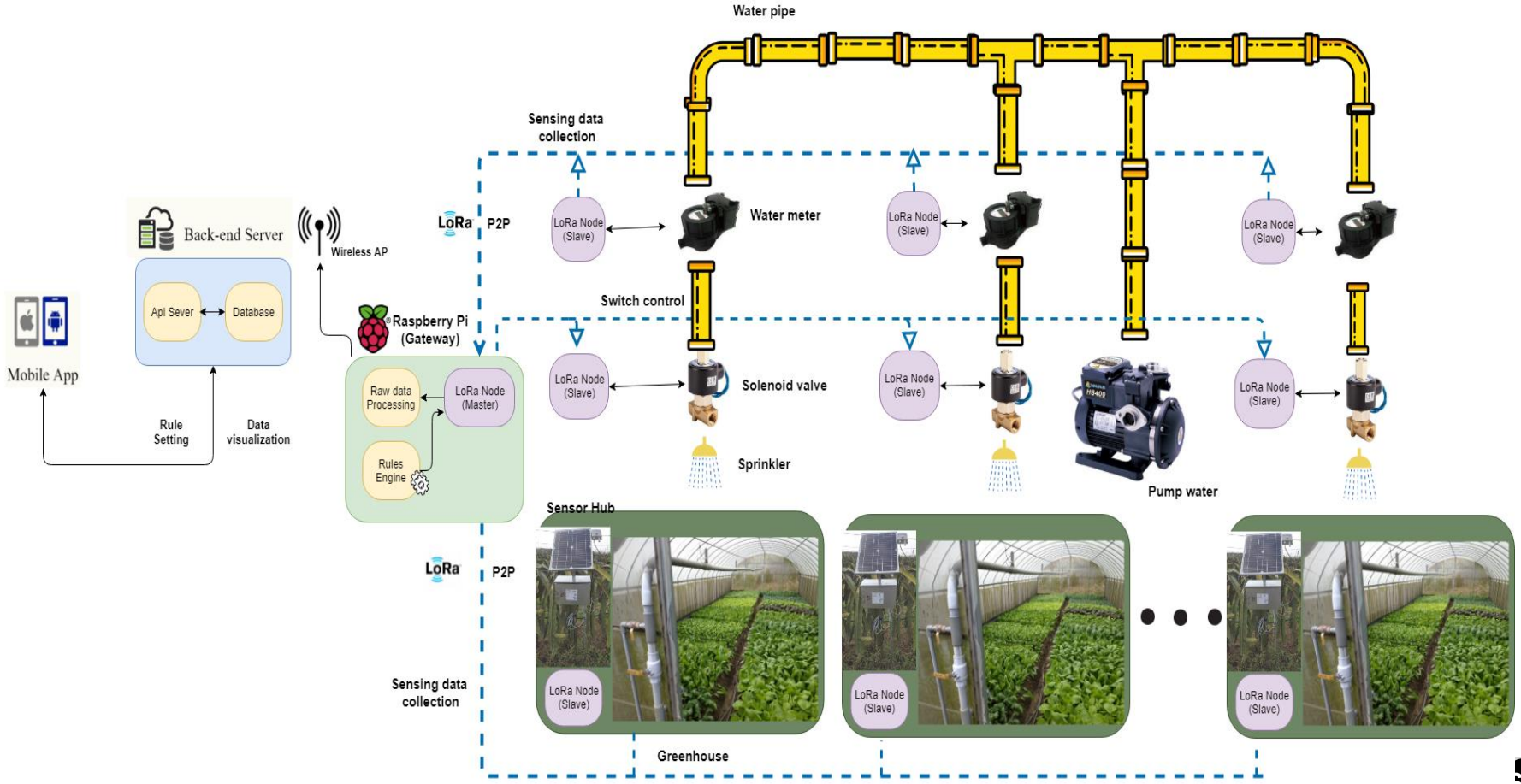
視頻播放
屏東江夏
有機蔬菜農場

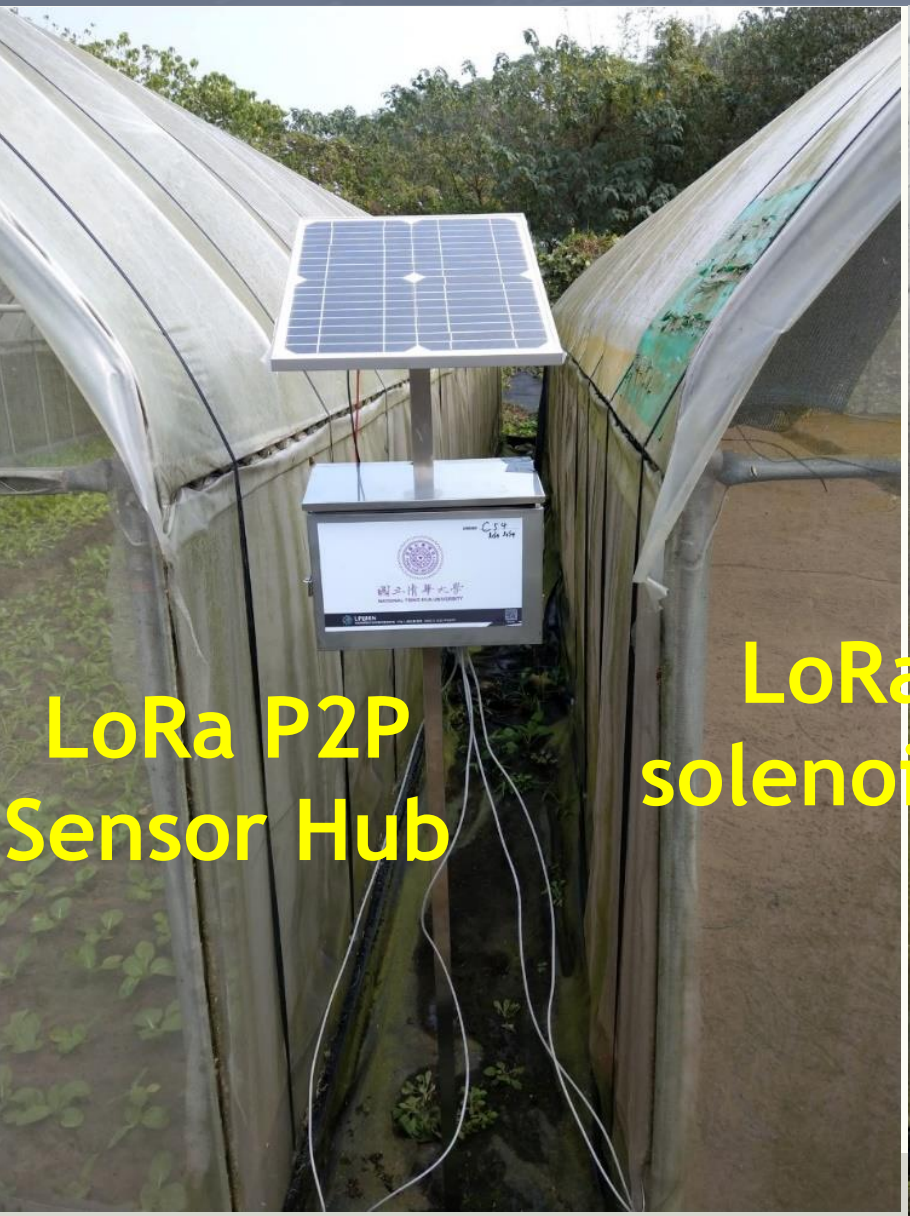
How Cat Loves Organic Vegetable ?

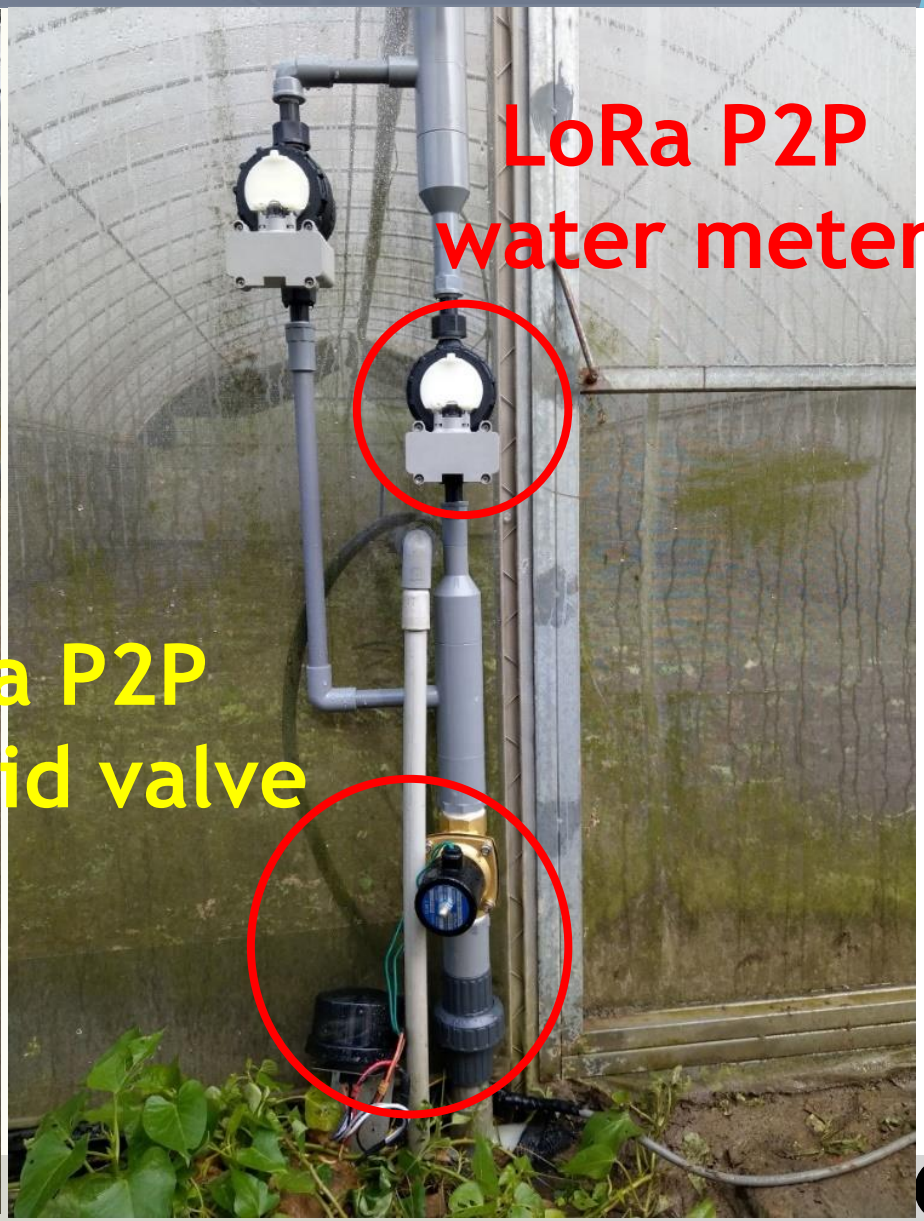
視頻播放 (video)

AI-based Precise Irrigation System

- AI machine learning algorithm to automatically learn Farmer's irrigation experiences
- Cost-effective, High-efficient, Accurate

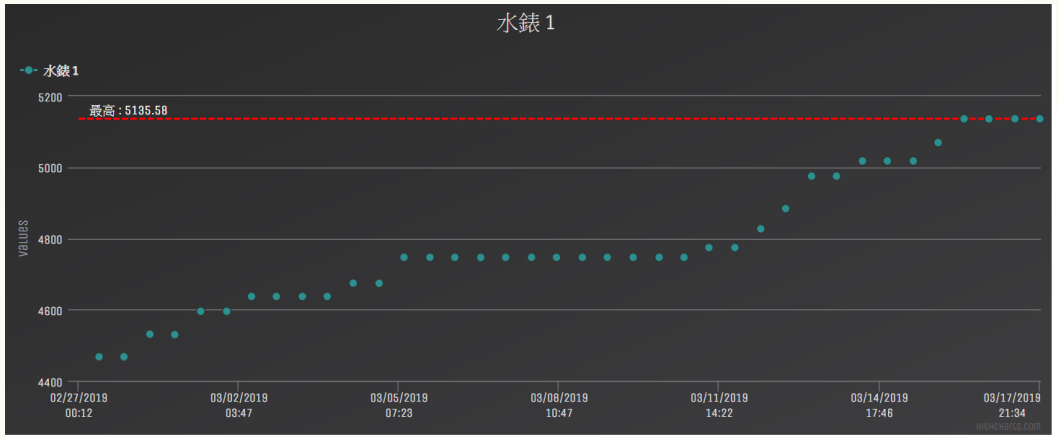



LoRa P2P
Sensor Hub

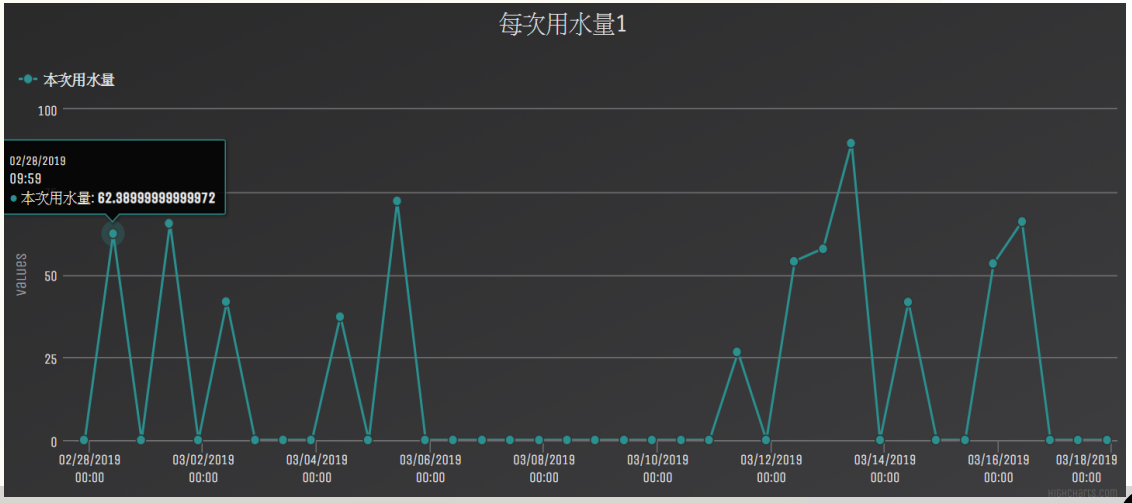

LoRa P2P
solenoid valve
LoRa P2P
water meter

LoRa P2P Water metering

- Cumulative water volume
  - (2/28~3/18)



- Watering volume each time
  - (2/28~3/18)



Coffee Beans

Typical Coffee Trees in Taiwan

Coffee Roasting

Selection of Defect Coffee Green Beans

- **Before roasting, defective beans (bad quality) should be eliminated**

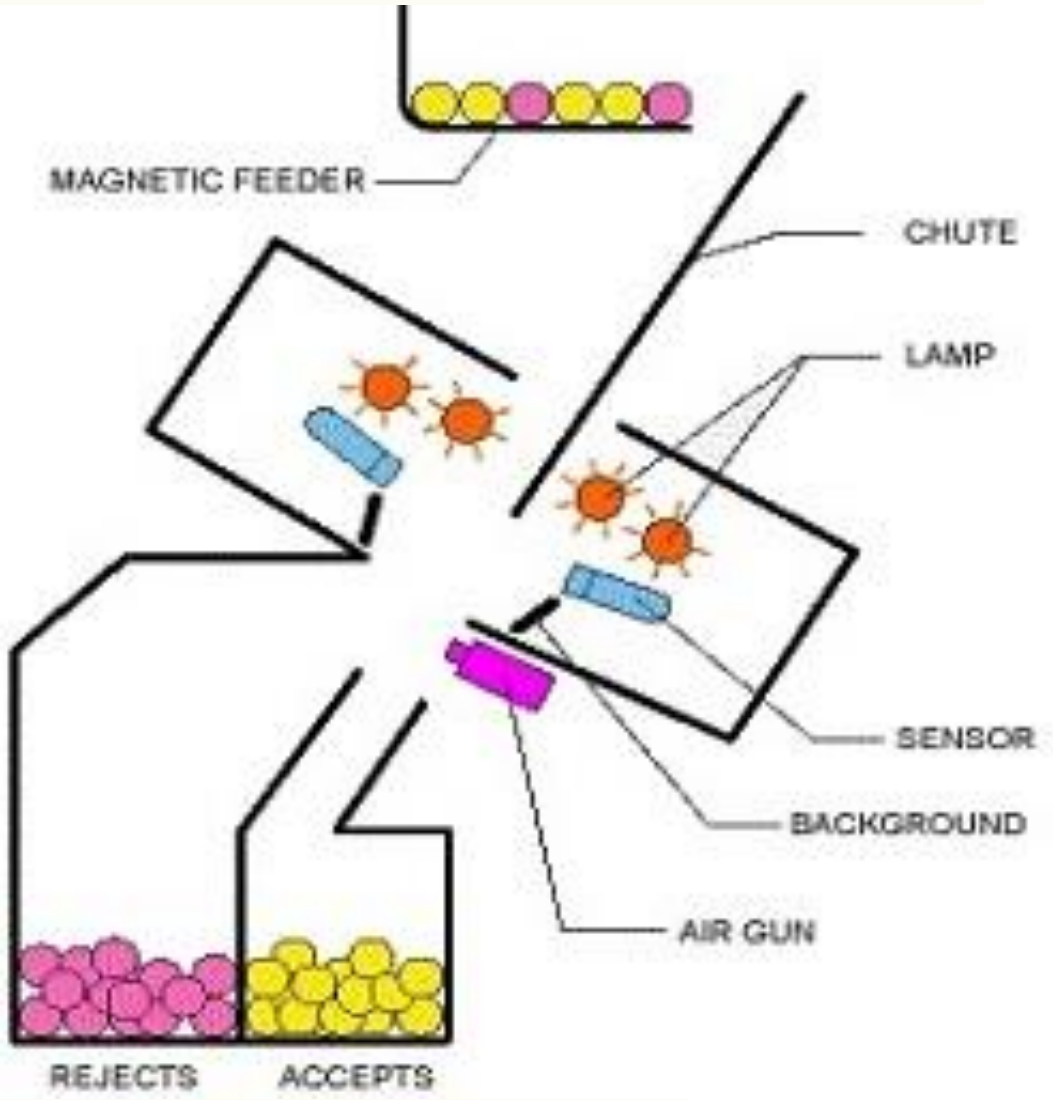
Selection of Defect Coffee Beans

- Usually, the defected beans were eliminated or pickup by hands.
- Time consumption, not accurate, hurt eyes

Color Sorter Machines

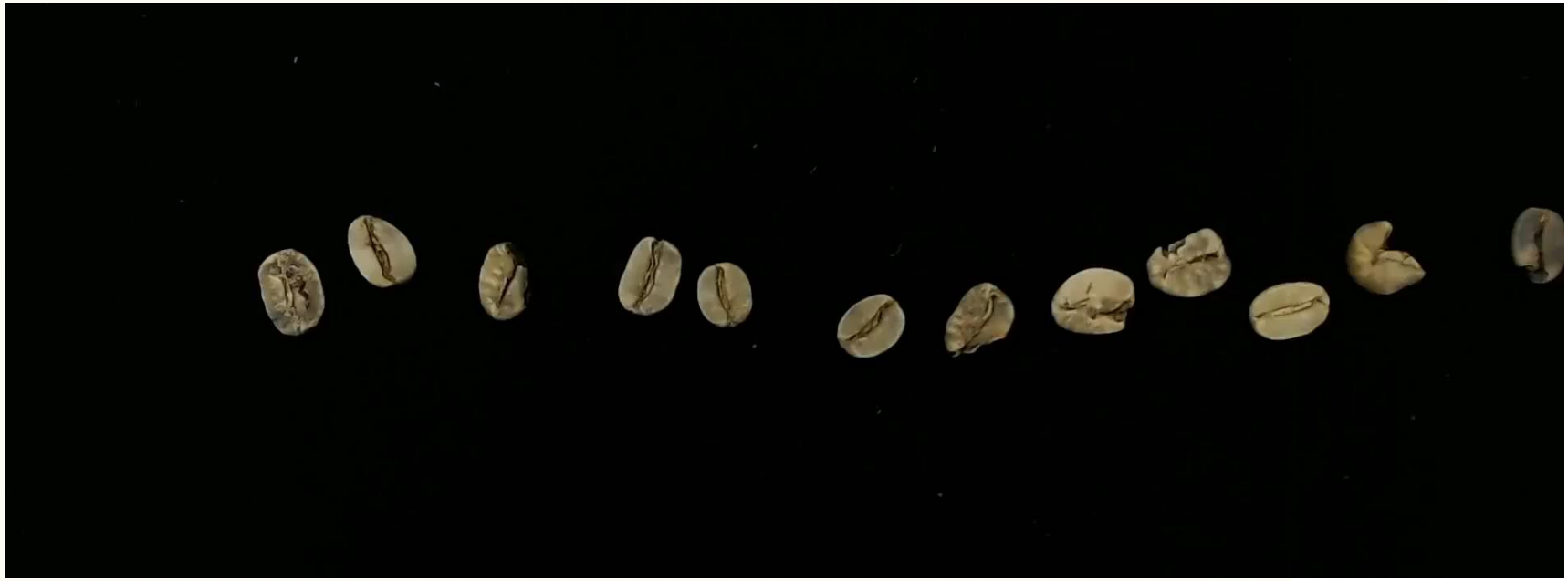
- Detect the quality and grading of objects
- Many sorting methods
  - Charge-coupled Device (CCD) technology
  - Infrared
  - X-ray
- Very Expensive

  USD 30,000 – 100,000



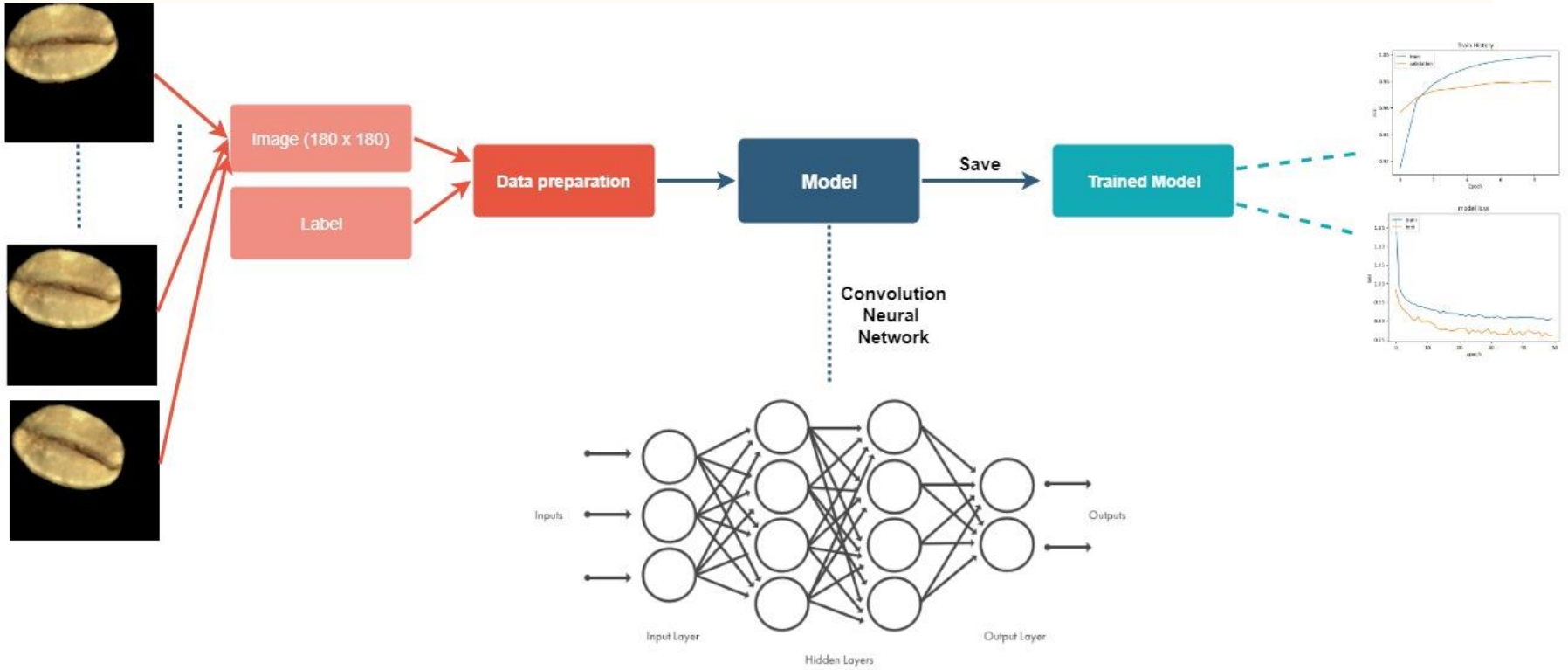
AI-based Coffee Green Beans Classification

- Image-processing based Technology
- Machine Learning Model with Google TensorFlow
- Fast, Accurate, Cost-effective (USD 3000)



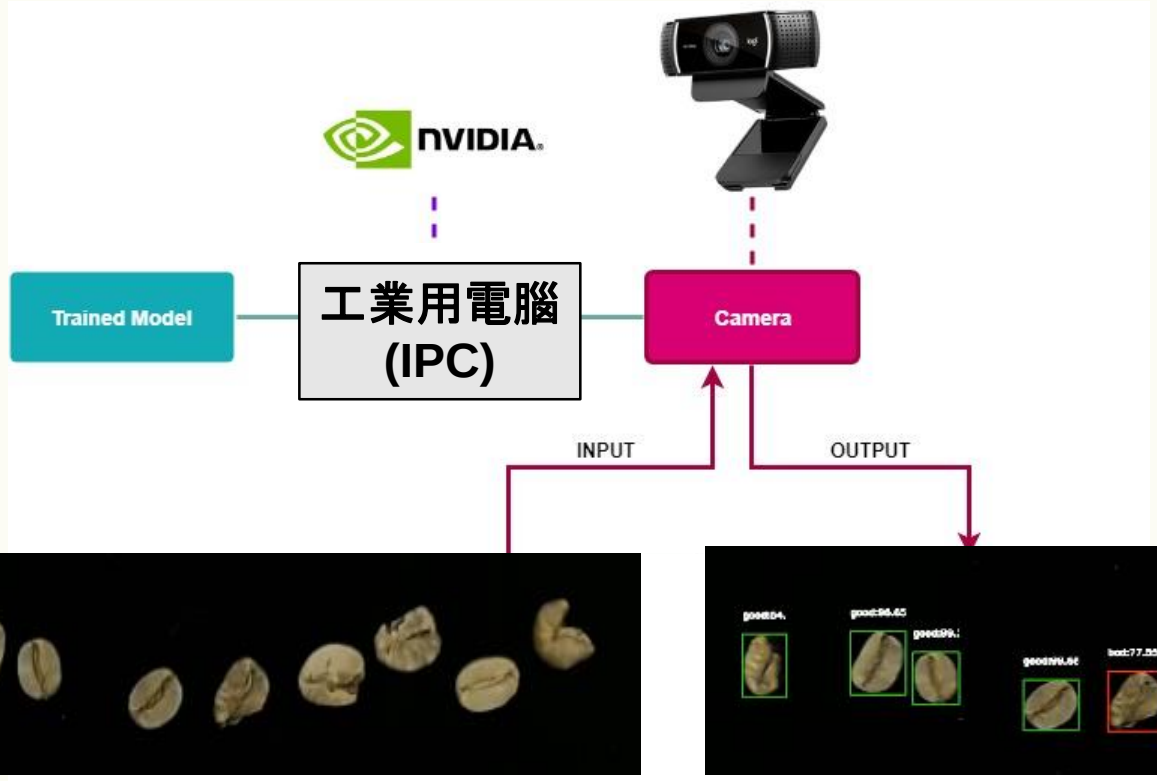
Build Training Model by CNN

- **Training process of CNN model**



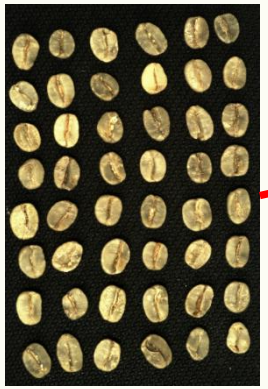
CNN Model

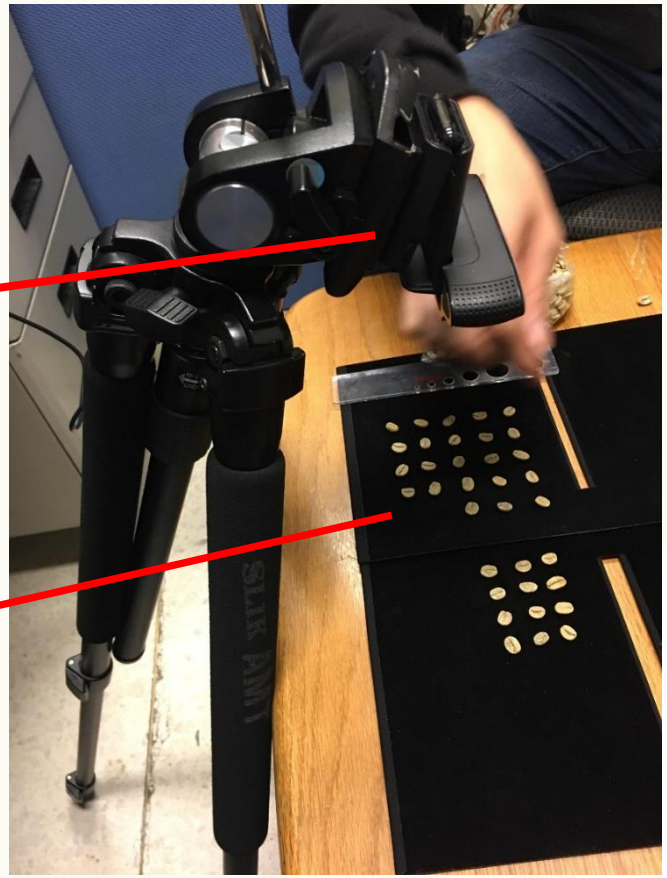
Real-time Identification



Data Collection (take pictures)

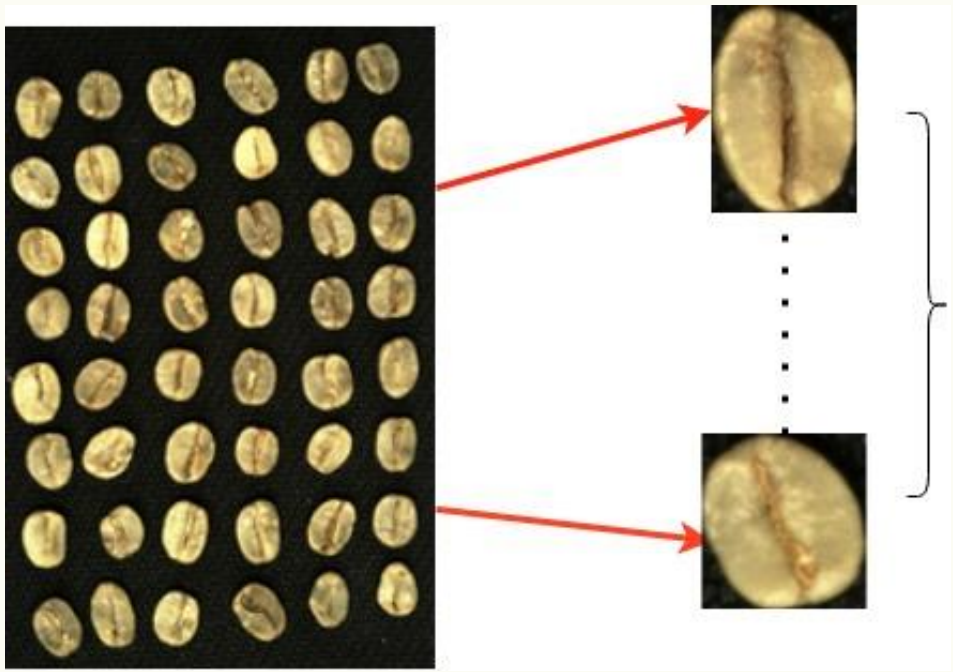
Camera: Webcam (1920x1080)





Data Pre-processing

- **Labeling good beans and bad beans by experts**
- **Automatic segmentation**



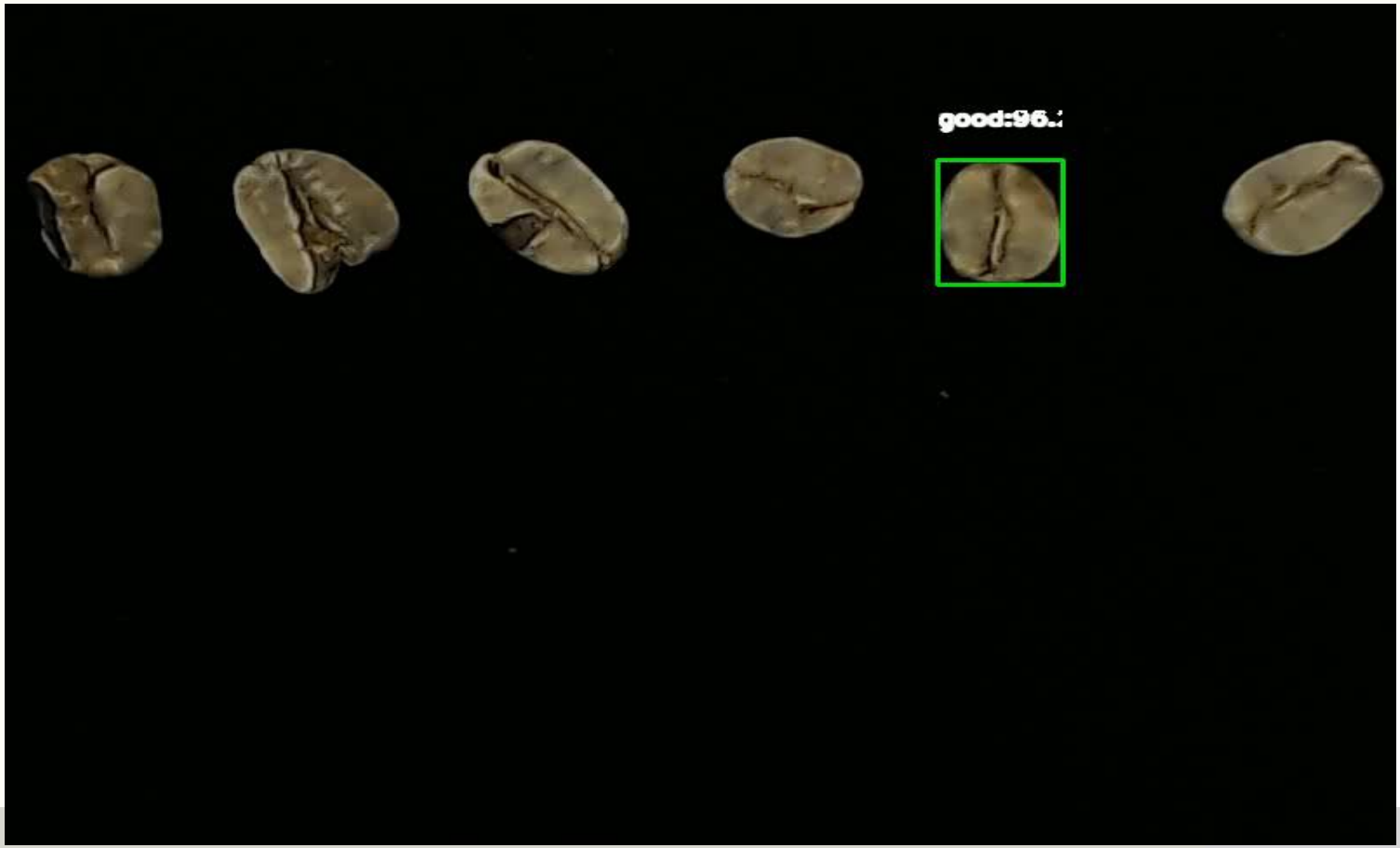
For example,
10000 Good beans
10000 Bad beans

Demo video

- 24 frames/second

Good

Bad



Improvements and Integration

- **Check both sides of coffee bean**
  - Take picture of both sides of coffee bean
  - Train the model with front and back images