

# 結合 UAV 監測之智慧農業栽培支援系統

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## 摘要

本研究計畫目標為透過整合無人機 ( UAV ) 監測和人工智慧 ( AI ) 分析技術，建立 UAV 監測之智慧農業栽培支援系統。現今農業管理面臨各種挑戰，如農業經驗流失和人力短缺。本四年期計畫提出三個主要亮點以提供可能的解決方案，包含建構無人機多源影像資料庫、開發 AI 影像處理技術，建立無人機影像分析雲端平台，並擬定水稻生長監測的無人機飛行標準操作程序 ( SOP )。第一年，以台灣主要糧食作物-稻米為主，收集完整生命週期水稻生長影像，於 NCHU ( 國立中興大學 ) 實驗場，NCHU 農業實驗站和 TARI ( 農委會農業試驗所 ) 收集超過 10 TB 的無人機多源影像數據，影像來源包括可見光譜，多光譜，熱影像和高光譜影像。本計畫目前已開發各種模型和應用，例如秧苗定位/計數、葉色分析、植株高度分析、綠覆率分析、產量預測、穀粒水分含量評估、災損評估，計畫使用卷積神經網路 ( CNN ) 的農作物辨識和整合邊緣計算的深度神經網路 ( DNN ) 模型。本計畫亦開發農業航拍分析的雲平台，提供如影像鑲嵌、影像紋理分析、植生指數分析和 3D 模型建立功能。

## 關鍵詞

無人機 ( UAV )，無人機多源影像資料庫，無人機影像雲端平台，邊緣運算，卷積神經網路 ( CNN )，深度神經網路 ( DNN )。

## 技術創新

- 建立無人機農業多源影像資料庫，以涵蓋水稻完整生長週期。收集了超過 10 TB 的無人機影像，包括可見光譜、多光譜、熱影像和高光譜影像。
- 實施涵蓋水稻生長階段的各種圖像分析，用於秧苗定位/計數、葉色分析、植株高度分析、綠覆率分析、產量預測、穀粒水分含量評估、災損評估和作物辨識。
- 開發用於開發水稻的實時作物識別模型的卷積神經網路 ( CNN )、深度神經網路 ( DNN ) 與邊緣計算能力。
- 建立農業航拍分析雲平台，提供無人機影像分析和專家諮詢系統。


## 效益

- 截至目前為止，已完成了 354 次飛行任務，建立無人機農業多源影像資料庫，包括超過 10 個 TB 圖像，包括可見光、多光譜和熱影像數據。
- 通過無人機影像校正、三維建模、正射影像和數值地表模型 (DSM)，處理後的圖像和原始數據存一併儲存於資料庫中，並顯示在網站上進行數據共享。
- 進行各種實地調查，以確定處理後的無人機圖像與水稻生長之間的聯繫，方便進一步應用。
- 開發水稻栽培支援決策輔助應用，如幼苗定位/計數、葉色分析、植株高度分析、綠覆率分析、產量預測、穀粒水分含量評估、災損評估和作物辨識，可應用於未來其他農作物。
- 基於 CNN 和 DNN 開發具有邊緣計算能力的機器學習模型，用於即時分類和物件辨識。
- 建立農業無人機影像分析 (Beta) 雲平台，無人機影像上傳能夠自動正射影像鑲嵌與三維建模，並與 Google 地圖與 GPS 重疊。

### Intelligent Agricultural Cultivation Support System Integrating UAV Surveillance

Principal Investigator: Ming-Der Yang

#### Project Goal



- A smart rice paddy unmanned aerial vehicle (UAV) monitoring system will be established with cloud-based image processing techniques based on a combination of UAV images and a huge amount of environmental data.
- Artificial intelligent (AI) techniques will be implemented for agriculture applications such as growth monitoring, yield prediction, crop moisture content evaluation, damage assessment, and disease monitoring, etc.
- The proposed smart rice paddy UAV monitoring system is expected to provide scientific bases which are crucial in a labor-shortage modern community for efficient agricultural management strategies establishment.

#### Highlights

##### UAV agricultural image database

Establishing a UAV agricultural multi-source image database which covers the whole life cycle of rice growing stages, nutrient levels, and associated diseases.

High Mission: 1000+ UAV images captured

12TB UAV image database

##### UAV Image Analysis

Implementing a variety of image analyses combining AI techniques for growth monitoring, yield prediction, crop moisture content evaluation, damage assessment, and disease monitoring.

##### UAV Cloud-based Platform

Establishing a UAV cloud-based platform to combine functions of UAV image analysis and expert advice support system.

Modeling, Searching, Overlaying, Expert system on agricultural analysis

#### Multi-source Image Database



#### Agricultural Cloud-base Platform

- 3D Models can be established automatically and displayed on the agricultural cloud-based platform.
- A sparse point cloud mode is set as the quick view mode.
- The system provides functions such as UAV images uploading, automatic orthophoto mosaicking, and Google Map overlapping with GPS information.
- Multiple image tasks and historical tasks can be managed and displayed on the platform.

#### UAV Image Analysis & Applications

##### Growth Monitoring

In the seeding stage, missing shoot caused by disease or insufficient nutrient can be detected from UAV images to evaluate the cost of replantment for farmers.

##### Nutritional status monitoring

Provide essential information such as NDVI analysis as early as possible at the growing phase for nitrogen content analysis. Developing a proper image processing method can improve current manganese investigation method and provide comprehensive analysis results to help farmers make decisions.

##### Grain Moisture Content Assessment

Grain moisture content is important to determine the best timing of harvest. UAV images can be used to analyze the relationship between image spectral reflectance and grain moisture content which provide valuable harvest timing suggestions and prevent undermature grain harvest loss.

##### Phenotypic analysis

Phenotypes of rice are highly correlated with growth status. Through the UAV image analysis, the phenotypes such as plant height, green coverage and leaf color are automatically extracted.

##### Damage Assessment

Rice is vulnerable to natural disasters such as typhoon or flood. Research government offer compensation to farmers whose damages of crops over 20%. UAV images are helpful in assessing damage and can provide precise measurement to accelerate the current manual assessment process.

##### Disease Detection

Multi-source UAV images can provide deeper understandings of diseases. Integrated with edge computing techniques, precision agriculture practices such as site-specific fertilizing or pesticide application can be performed.

#### Prospects

UAV provides low-cost, high temporal and spatial resolution images which are helpful for agriculture applications such as growth stage monitoring, yield prediction, grain moisture content assessment, rice traceability system, damage assessment, disease detection, etc. The proposed smart rice paddy monitoring system alongside with AI techniques development is valuable to initiate a scientific-based management support system and expect to ease labor shortage and ensure a sustainable rice production in Taiwan and further southeast Asia countries.

#### Awards

- Future Tech 2019 Breakthrough Award & Highlight Innovation
- GOV grant 2019: Best proposal award
- CTCI AI Creative competition: Honorable mention
- Ag-Thon 2018: 2nd place
- Patent pending: 2
- Technology licensing: 1
- Industry-Academy cooperation: 9

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研究計畫網頁 Research Website

Drone and Computer Vision Team