高解析正射影像及農路 360°環景照片整合深度學習之水稻自動判釋

Paddy field classification using deep learning integrated with high-resolution orthoimage and 360° panoramic photos

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摘　要

台灣降雨時空分布不均，豐水期與枯水期降雨量可以差距 1.5 倍至 9 倍，水資源是緊湊的資源，需要擬訂周全的用水計畫，水稻用水占全國總用水量 38.8%，水稻種植面積為用水計畫中重要參考資訊之一。我國農情調查方式採田間調查員於實地調查時攜帶紙圖調查種植作物及面積，之後於農情作業資訊系統登打調查結果資料後，逐級層報地方政府及農糧署彙整統計分析，以現代而言效率並不高。

本研究運用高解析正射影像及農路 360°環景照片建置水稻 AI 模型。高解析正射影像由遙控無人機空拍產製、農路 360°環景照片由 GoPro Max 架設於機車 2 秒/張延時攝影蒐集農路兩側作物資訊、AI 模型使用水稻之高解析正射影像及 Low Rank Adaptation (LoRA)方法微調 Meta AI 提出的 Segment Anything Model(SAM)預訓練模型。本研究開發之水稻 AI 模型運用於關渡平原高解析正射影像搭配農路 360°環景照片及農業部農田坵塊圖資將判釋成果 F1 score 達 0.95。

同時為提升現地調查作業效率本研究開發農路 360°環景照片水稻 AI 模型。深度學習模型採用水稻街景照片於預訓練物件偵測模型 DINO 進行遷移式學習。現地調查搜集照片後可快速進行自動判釋，將沿農路兩側種植水稻照片挑選出並標註，成果判釋正確率達 0.80。本研究整合 AI 技術於農田水利領域並成功研究出更高效率之蒐集現地資訊運用於灌溉需求。

關鍵詞：水稻判釋，高解析正射影像，農路 360°環景照片

Abstract

Rainfall in Taiwan is significant spatial and temporal variability, with precipitation during the wet season ranging from 1.5 to 9 times that of dry season. As a result, water resources must be managed through comprehensive and strategic planning. And paddy rice cultivation accounts for approximately 38.8% of the Taiwan national total water usage, making the area of rice cultivation a critical factor in irrigation planning. Currently, agricultural surveys in Taiwan rely on field investigators who record crop types and areas manually using printed maps during on-site visit. Collected data are then entered into the agricultural situation information system and reported to local governments and the agriculture and food administration for statistical analysis. However, this approach is inefficient by modern standards.

This study proposes an Artificial Intelligence (AI) deep learning model for paddy field classification, developed using high-resolution orthoimage and 360° panoramic photos of rural roads. The orthoimages were captured by UAV, while the 360° panoramic photos were collected using a GoPro Max mounted on a motorcycle, capturing one frame every two seconds. Paddy field AI model was fine-tuned on high-resolution orthoimage of rice fields using the Low-Rank Adaptation (LoRA) method based on Meta AI's pretrained Segment Anything Model (SAM). When applied to the Guandu Plain, incorporating both high-resolution orthoimage, 360° panoramic photos, and parcel map from the ministry of agriculture, the model achieved an F1 score of 0.95.

To further enhance the efficiency of on-site investigations, a separate AI model was developed specifically for interpreting paddy fields from 360° panoramic photos. This deep learning model leverages transfer learning using paddy field 360° panoramic photos on the pretrained object detection model DINO. After photos were collected during field surveys, the model enables automatic identification and annotation of paddy fields, achieving an interpretation accuracy of 0.80. This study demonstrates the integration of AI technologies into the agricultural water resource management domain, resulting in a more efficient method for collecting field information for irrigation planning.

Keywords: paddy field classification, high-resolution orthoimage, 360° panoramic photos