摘要

本案為發展 UAS 技術及推廣應用，辦理發展空中及地面移動測繪技術、整合空中及地面不同載具蒐集空間資訊與提升 UAS 航拍及影像處理技術及協助其他政府機關辦理特定區域航拍作業。本案主要的目的在於使用無人機系統（Unmanned Aerial System；UAS）作為空間資訊蒐集的平台。利用無人飛行載具自動化、精確、快速、安全與大範圍的特性，配合經過整體規劃的航拍作業流程，可以快速取得特定地點航拍資料。

本案總計完成 4 區之航拍作業，需求面積合計 2,178 公頃（實際航拍面積 5,404 公頃）。本案相關成果應用於出具校正報告、協助財政部國有財產署航拍漁電共生區域範圍進行國土監測、臺灣通用電子地圖局部區域正射影像更新等，達成提升圖資更新效率及增進政府機關橫向協調聯繫等成果效益。

關鍵字：無人飛行載具、航空拍攝

Summary

This project is improving UAS technology and promote its application, developing air and ground mobile mapping technology and integrating air and ground vehicles for assisting government agencies in handling aerial photography. The objectives of this project is to use the unmanned aerial system (UAS) for spatial information collection. Based on the characteristics of its automation, accuracy, speed, safety and wide application range, aerial photography data can be obtained quickly by planned aerial photography operation process.

In this case, 4 districts covering a total area of about 2,178 hectares is included. The results of this project are applied to Land-Use monitoring and update ortho images of Taiwan e-Map, etc, achieving the higher efficiency of map resource updating and improving the parallel communication between government agencies administrative.

Keywords: unmanned aerial system, aerial photography

摘要

本案為發展 UAS 技術及推廣應用，辦理發展空中及地面移動測繪技術、整合空中及地面不同載具蒐集空間資訊與提升 UAS 航拍及影像處理技術及協助其他政府機關辦理特定區域航拍作業等。本案於 108 年完成建置多旋翼型 UAS，並於 109 年投入局部區域圖資更新與協助其他機關航拍辦理國土監測及防救災資訊蒐集等相關領域航拍作業。

本案總計完成 8 區，需求面積合計 2,678 公頃、實際面積合計 6,599 公頃航拍與相關影像處理作業，並完成合約期間 3 月至 12 月保養維護工作。其中航拍作業包含協助陽明山國家公園管理處拍攝臺北市士林區、臺北市政府工務局水利工程處拍攝臺北市北投區與萬華區、臺南市鹽水區地政事務所拍攝臺南市柳營區，並製作正射影像成果；另辦理財政部國有財產署委託雲林縣臺西鄉、口湖鄉及高雄市永安區之國土測繪一號航拍影像處理作業，相關應用可增進政府機關橫向協調聯繫效益。另執行期間也辦理國土測繪中心於南投縣南投市南崗工業區小像幅航拍攝影機航拍校正作業，並提供原始航拍影像資料。

依契約規定辦理自 111 年 3 月起至 12 月共計 10 次 UAS 保養維護作業，並更換已達兩年使用年限設備零組件及升級圖傳模組，以確保任務執行安全及提升航拍效率。

關鍵字：遙控無人機系統、移動測繪系統、正射影像、空三計算

Abstract

In order to develop UAS technology and promote its application, this project develops and integrate the spatial information from aerial and ground mobile mapping technology, improves UAS aerial photography and image processing technology, and assists government agencies to execute aerial photography in specific region.

The required area of 8 places were about 2,678 hectares, and actual area of 6,599 hextares. UAV maintenance over the contract period (March to December) is conducted. Aerial photography and image processing is conducted for several government agencies in Taipei Shilin, Beitou, Wanhua district and Tainan Liuying district. Image processing is conducted for National Property Administration in Yunlin Taixi, Kouhu township and Kaoshiung Yongan district. Orthophotos were provided after processing for government agencies communication. Besides, the photography in Nantou was conducted for NLSC for aerotriangulation camera correction.

According to the contract, a total of 10 times of UAS maintenance from March to December in 2022 were conducted. Some parts of the UAS had reached its expiration date, therefore, were replaced with new parts. New video transmission model was equipped to improve efficiency.

Keypoint: UAS, Mobile Mapping System, Orthophoto, aerotriangulation

摘　要

數值高程模型(Digital Elevation Model, DEM)係我國國土資訊之重要基本底圖，資料記錄之地形網格資訊可運用於各大建設之基礎。隨著測繪技術之更新，數值地形資料之取得及應用逐漸多元，而應用空載光達點雲資料產 DEM 自民國 99 年起，在各方努力下，至今已完成全臺之空載光達點雲測製及分類成果，為相當成熟之資料處理技術。有鑑於我國國土易受風災或地震因素導致地貌大規模變動，且變化速度尤甚，現實地貌變化情形可能已無法與資料更新頻率相呼應，後續資料應用資料時更可能導致資訊落差等問題。再者，雖然目前在都市區及平原區已可透過半自動方法獲取精度相對穩定之產製成果，然而在丘陵區及山區等植被覆蓋較密集之區域，由於雷射點無法有效穿透到達地面，尚須以大量人工方式篩選出地面點。

近年來，由於硬體設備之快速發展，大數據配合人工智慧(Artificial Intelligence, AI)技術在許多領域都得到嶄新之突破。因此，本研究著手規劃以人工智慧技術開發基於空載光達點雲資料之 AI 自動地面點分類器，透過全國之空載光達點雲測製及分類成果即可做為人工智慧之訓練數據來源。藉由自動化工作之產製可望提升產製效率，提供基本圖資工作及後續加值服務之助益。

本研究參考文獻之作法設計 AI 自動地面點分類器，並建立空載光達點雲資料之前處理機制，以 MobileNet-UNet 網路架構設計，訓練出 4 種 AI 模型。透過分類結果及產製 DEM 品質評估，結果顯示資料使用合適模型時，能獲得較接近於參考 DEM 之精度表現，同時亦能降低時間成本。

關鍵詞：空載光達點雲資料、數值高程模型、人工智慧。

Abstract

The Digital Elevation Model (DEM) is an important basic base map of NGIS, and the topographic grid information recorded in the data can be used as the foundation of various constructions. With the update of surveying and mapping technology, the acquisition and application of digital topographic data are gradually diversified. Since 2011, with the efforts of all departments, the use of airborne lidar point cloud data to produce DEM of the whole Taiwan has completed. Point cloud measurement and classification results are quite mature data processing technology. In view of the fact that our country's land is prone to large-scale changes in landforms caused by wind disasters or earthquakes, and the speed of change is particularly high, the actual changes in landforms may no longer correspond to the frequency of data updates, and subsequent application of data may lead to information gaps and other problems. Furthermore, although semi-automatic methods can be used to obtain relatively stable production results in urban areas and plain areas, in areas with dense vegetation such as hilly areas and mountainous areas, since the laser points cannot effectively penetrate to the ground, the ground points still need to be screened out by a large number of manual methods.

In recent years, due to the rapid development of hardware equipment, big data combined with artificial intelligence (AI) technology has achieved new breakthroughs in many fields. Therefore, this project plans to use AI technology to develop an automatic ground point classifier based on airborne lidar point cloud data. The results of airborne lidar point cloud measurement and classification across the country can be used as training data for AI source. It is expected to improve the efficiency of production through the production of automated work, and provide the assistance of basic graphic work and subsequent value-added services.

Based on the references in this project, an AI automatic ground point classifier was designed, and a pre-processing mechanism for airborne lidar point cloud data was established. Four AI models were trained with the MobileNet-UNet network architecture design. Through the classification results and the

quality evaluation of the produced DEM, the results show that when the data is used with an appropriate model, the accuracy performance closer to the reference DEM can be obtained, and the time cost can also be reduced.

Keywords: Airborne lidar cloud point data, DEM, AI.