人工智慧技術於機場能見度預報作業之應用
Application of Artificial Intelligence Technology in Airport Visibility Forecasting Operations

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摘　要

桃園國際機場每年 1 至 3 月易受濃霧影響，導致長時間低能見度天氣。此現象嚴重影響航空管制、簽派作業及機場營運效率，對航管人員、簽派員及機場公司構成極大挑戰。本研究旨在結合人工智慧(AI)模型與桃園機場觀測資料，發展一套客製化 AI 能見度預報模型。此系統預期能提升預報的準確性與精緻度，進而優化航空氣象服務品質，並確保臺北飛航情報區的飛航安全。

本研究採用長短期記憶神經網路（LSTM）機器學習模型，利用 1979 年至 2022 年間 1 至 3 月桃園機場的觀測資料進行訓練。目前已成功建置 6 小時能見度預報模型，其平均預報誤差約為 1500 公尺。透過 2023 年 1 至 3 月的個案分析顯示，模型的誤差一部分源於 LSTM 模型難以精確區分雨及靄對能見度的影響。

比較 2023 年 1 至 3 月桃園機場 LSTM 模型的預報結果與實際觀測資料，並分別以 1600 公尺和 5000 公尺作為低能見度標準。結果顯示，在此兩種標準下，預兆得分分別為 0.29 和 0.3。值得注意的是，能見度低於 1600 公尺的天氣主要集中在 2 月份，該月份的預兆得分分別為 0.27 和 0.4。這進一步證明 LSTM 模型對於濃霧事件（即能見度低於 1600 公尺）造成的能見度變化具有較佳的掌握度。

關鍵字：長短期記憶神經網路、能見度預報、預兆得分

Abstract

Taiwan Taoyuan International Airport (RCTP) frequently experiences prolonged periods of low visibility due to dense fog from January to March each year. This phenomenon significantly impacts air traffic control, dispatch operations, and overall airport efficiency, posing considerable challenges for air traffic controllers, dispatchers, and airport authorities. This study aims to develop a customized AI-driven visibility forecasting model for RCTP by integrating artificial intelligence (AI) models with historical observational data from the airport. This system is expected to enhance the accuracy and precision of visibility forecasts, thereby optimizing aviation meteorological services and ensuring flight safety within the Taipei Flight Information Region.

This research employs a Long Short-Term Memory neural network (LSTM) machine learning model, trained on RCTP observational data collected during the January-March periods from 1979 to 2022. It has successfully established a 6-hour visibility forecasting model, which exhibits an average forecast error of approximately 1500 meters. A case study analysis of the January-March 2023 data indicates that a portion of the model's error stems from the LSTM model's difficulty in precisely distinguishing the effects of rain versus haze on visibility.

Comparing the LSTM model's forecasts with actual observations at RCTP from January to March 2023, using 1600 meters and 5000 meters as low visibility thresholds, the threat scores were found to be 0.29 and 0.3, respectively. Notably, the occurrences of visibility below 1600 meters were predominantly concentrated in February, with threat scores for that month reaching 0.27 and 0.4. This further demonstrates the LSTM model's superior ability to capture visibility changes caused by dense fog events (i.e., visibility below 1600 meters).

Key words : Long Short-Term Memory Neural Network, Visibility Forecasting, Threat Score