初步建立二維淹水深度學習預測模型

—以彰化縣二林鎮為例

**A preliminary deep learning model for 2D flooding prediction—
Taking Erlin Town, Changhua County as an example**

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摘 要

本研究整合國網中心淹水大數據平台、國網中心 TWCC、及 AI 淹水預測模式，完成可建立一區域之深度學習淹水預測模型的機制，並以彰化縣二林鎮作為模型模擬場域。NCDR 曾依據水利署第二代淹水潛勢圖資(一日暴雨 600mm 淹水潛勢) 分析，二林鎮等區域可能淹水深度達 1 公尺。淹水大數據平台以實際降雨事件、單站序降雨特性模擬機制為基礎(Wu 等，2006)，考量降雨量及雨型在時間及空間之變異性，採用不同平均值及標準偏差的倍數以模擬極端降雨事件，並以物理模式 SOBEK 產製對應的二維淹水歷程。本研究採用 1056 組降雨數據及對應的洪水模擬結果進行訓練，模型採用 Inception 的 CNN 架構，訓練過程以均方根誤差作為訓練的損失函數，預測之淹水地圖與原物理模式結果，使用常用於識別圖像結構相似性的 SSIM 相似性指數比對。

本研究分別取出第 500、2000、及 4000 疊代次數時的訓練模型，以 6 組不同強度的雨量資料(其中包含三場為模擬超過過去造成彰化縣普遍淹水的強降雨)進行淹水預測結果的分析。除了雨量過小之數據組外，其圖形均有不錯的相似度，隨著疊代次數增加，各成份相似度及總相似度不斷增加。觀察雨量較小時產生較差相似度的原因，以 SSIM 各成份變化及二維淹水分佈圖進行比對。收斂至最後時，淹水位置逐漸集中、且淹水深度更接近實際值，致使明亮度及對比相似度提升，但，因為淹水位置極少又位置有差異性，致使淹水的結構性比對結果不佳。但，大雨量所造成的淹水災害是大家所關心的，大部份的 SSIM 相似度可超過百分之九十。本研究已建立模型的整體流程，未來可參考此案例流程建立不同的 AI 淹水模型，搭配中央氣象局的數值天氣模擬模式，將可在各區域以數秒至分鐘內預測未來 72 小時的淹水風險評估。當然，隨著各區域的開發致地形地貌的不斷改變，利用物理模式產生的淹水數據及其調校為不可少的重點工作，方能使深度學習模型維持其準確性。

關鍵字：捲積神經網路、二維淹水預測、SSIM

Abstract

This research integrates the flooding big data platform, the TWCC of NCHC, and the AI flooding prediction model to complete the mechanism to establish a deep learning flooding prediction model for an area. And we used Erlin Town, Changhua County, as a study field to establish a model. According to the analysis by NCDR based on the second-generation flooding potential map of the Water Resources Agency (the flooding potential of 600mm in one-day heavy rain), areas such as Erlin Town may be flooded to a depth of 1 meter. The flooding big data platform is based on the simulation mechanism of actual rainfall events and single-station sequence rainfall characteristics (Wu et al., 2006). The scenario rainfall data are considered the variability of rainfall and rainfall patterns in time and space and using different multiples of averages and standard deviations to conduct scenarios of extreme rainfall events. Then, using the physical model SOBEK to generate the corresponding two-dimensional flooding. This study uses 1056 sets of rainfall data and corresponding flood simulation results for training. The model uses Inception's CNN architecture. The predicted flooding maps were compared with the actual physical model results using the SSIM similarity index commonly used to identify structural similarity in images.

In this study, the training models at the 500th, 2000th, and 4000th iterations were taken out, respectively, and six groups of rainfall data of different intensities (including three events were simulated to exceed the heavy rainfall that caused widespread flooding in Changhua County in the past) for flooding prediction. Except for the rainfall data set with too little, the graphs have a good similarity. As the number of iterations increases, the similarity of each component and the total similarity increase continuously. We compare the changes of each component of the SSIM and the two-dimensional flooding distribution map to observe the reasons for the poor similarity when the rainfall is slight. Convergence to the end, the flooded locations are gradually concentrated, and the flooded depth is closer to the actual value, resulting in improved brightness and contrast similarity. However, the structural comparison of inundation results is poor because of the few and different locations of inundation. Fortunately, the flooding disaster caused by heavy rainfall concerns everyone, and the SSIM of most events can exceed 90%. In the future, different AI flooding models can be established with reference to this case process. Combined with the numerical weather simulation model of the Central Weather Bureau, the flooding risk assessment in the next 72 hours can be predicted within seconds to minutes. Of course, with the continuous change of topography due to the development of various regions, the flooding data generated by physical models and the model adjustment are essential tasks to maintain the accuracy of the deep learning model.

Keywords: Convolutional Neural Networks, 2D Flood Prediction, SSIM