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Predicting wildland fire propagation using deep learning

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Abstract

Forest fires have recently become one of the most serious hazards wreaking havoc on various parts of the globe. Recent research studies have demonstrated that examining both meteorological and terrain factors, in addition to satellite images, is critical for accurately predicting wildfire propagation (Surya et al. 2021, Khennou et al. 2021, Radke et al. 2019, Liang et al. 2019). With the recent progress in artificial intelligence, it is now more important than ever to apply effective algorithms to wildland fire science to better manage the complexity of the fire spread (Surya et al. 2021, Hodges et al. 2019). In order to limit damage and work in collaboration with fire detection systems, it is critical to track the fire spread in real time and predict its evolution over time. In contrast to detection systems, which have been widely implemented using various deep learning methodologies, we observe that there is still a gap in the research area of spread prediction using AI techniques. To this end, we introduce a new approach based on U-Net, one of the main deep neural networks' algorithms, which is widely used in satellite images applications, to automatically understand wildfire spread dynamics. In this study, we introduce FU-NetCastV2, a deep learning model based on U-Net, historical wildfire incidents, satellite maps, DEM, aspect, slope, and meteorological data from the rocky mountain region. This model is designed for forecasting the next burnt area after a 24-hour scale. The model achieved an accuracy of 94.6%, an AUC of 97.7% and an F1-score of 95.9% based on 400 fire perimeters, using the GeoMAC dataset from 2013 to 2019. This research also provides a significant performance improvement compared to the FU-Netcast model (Khennou et al., 2021), which was previously implemented based on 120 images. The proposed algorithm is well suited for assisting fire fighters in being more proactive, locating potential burnt areas and acting immediately to prevent the widespread of fires.

Keywords: Forest fires, Fire spread modelling, Deep learning, Convolutional Neural Networks, U-Net

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