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Wildland fire detection and segmentation on aerial images using a vision transformer approach

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Abstract

Wildland fires are a worldwide natural disaster, causing significant damage to ecosystems, economy, property, and loss of lives. Wildfires contribute significantly to air pollution, disturbances in ecological balance, human and financial losses, and a wide range of environmental consequences (Ghali and Akhloufi, 2023). Wildland fires occur in numerous countries such as the United States, the Arabian Gulf, and the European Union countries (Aytekin, 2023). Moreover, in early May 2023, more than a hundred forest fires forced tens of thousands of people in British Columbia and Alberta provinces in Canada to evacuate (NASA, 2023). Many researchers devoted their time to develop early wildland fire detection systems to reduce the frightening statistics of wildfires as well as to prevent their devastating damages (Ghali and Akhloufi, 2023). More recently, drones or UAVs (Unmanned Aerial Vehicles) were employed to help manage fires thanks to their ability to monitor large areas and to provide real-time information (Akhloufi et al., 2021). Additionally, the integration of UAVs with infrared and/or visual sensors helps in detecting wildfires during daytime and nighttime. Recent work in wildland fire segmentation has shown impressive results thanks to the use of deep learning (DL) techniques. The fire segmentation results were employed to extract fire geometrical features and used as inputs to the wildfire propagation models. However, there are still various challenges such as the presence of smoke, detection of very small fires, background complexity, and image degradation. To address these challenges, we present, a wildland fire segmentation method based on DL models. Two vision transformers, TransFire and TransUNet, were employed in detecting and segmenting the visual surface of wildfires on aerial images. TransUNet and TransFire achieved excellent results with an accuracy of 99.9% and 99.83%, respectively, using very large aerial dataset, FLAME (Shamsoshoara et al., 2021). They also outperformed recently published models and showed the ability of vision transformers to correctly differentiate between wildfire scenes and no wildfire scenes (Ghali et al., 2022). More specifically, we demonstrated the ability of these models to extract the finer details of wildland fires on aerial images and overcome current challenges, such as the detection of very small fires, background complexity, the presence of smoke, and image quality.

Keywords: Wildfire, vision transformer, deep learning, aerial images, fire detection

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