Proceedings of the 9th World Congress on New Technologies (NewTech'23)
Brunel University, London, United Kingdom - August 09-11, 2023
Paper No. ICEPR 117
DOI: 10.11159/icepr23.117

Develop Smoke Detection Model Using GEMS to Respond Climate Change

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Extended Abstract

Wildfires have been an important factor affecting the Earth's surface and atmosphere for more than 350 million years [1]. Wildfires can affect atmospheric conditions on a variety of spatial-temporal scales through the release of gases, particles, water and heat. Forest fires release a large amount of air pollutants, which cause climate change [2][3]. The occurrence and intensity of wildfires are increasing with climate change [4]. While this vicious cycle is repeated, Specific climate changes caused by emissions from wildfire smoke include changes in the land-atmosphere system due to greenhouse gases and a catalytic role in the formation of cloud condensation nuclei [5].

The use of satellite product and machine learning is essential for detection of forest fire smoke. Until now, research on forest fire smoke detection has had difficulties due to difficulties in cloud identification and vague standards of boundaries. The purpose of this study is to detect forest fire smoke using Level 1 and Level 2 data of Geostationary Environment Monitoring Spectrometer (GEMS), a Korean environmental satellite sensor, and machine learning. In March 2022, the forest fire in Gangwon- do was selected as a case. And, we created two random forest model that smoke pixel classification model and regression model were performed by injecting GEMS Level 1 and Level 2 data. At this time, the input variables of the regression model were adjusted due to the problem of missing values in certain data.

In the classification model, the importance of input variables is Aerosol Optical Depth (AOD), 380 nm and 340 nm radiance difference, Ultra-Violet Aerosol Index (UVAI), Visible Aerosol Index (VisAI), Single Scattering Albedo (SSA), formaldehyde (HCHO), nitrogen dioxide (NO2), 380 nm radiance, and 340 nm radiance were shown in that order. Also, the smoke classification accuracy for 2,704 pixels showed the level of Accuracy = 0.998 and mIoU = 0.995. The input variable importance of the regression model is appeared in the order of FCC Grayscale image, Ultra-Violet Aerosol Index, radiance difference between 380 nm and 340 nm, Visible Aerosol Index, and formaldehyde. In addition, smoke probability for 4,695 pixels ($0 \leq p \leq 1$) are Mean Bias Error (MBE) was -0.001, Mean Absolute Error (MAE) was 0.028, Root Mean Square Error (RMSE) was 0.113, and Correlation Coefficient (CC) was 0.974.

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