IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

Author: Ms. Sina Tabea Schulte Strathaus
School of Computing Science, University of Glasgow, United Kingdom, tabea.schultestrathaus@gmail.com

Mr. Jan Loettgen
School of Engineering, University of Glasgow, United Kingdom, j.loettgen.1@research.gla.ac.uk

DEEP LEARNING STRATEGIES FOR GENERATION OF ARTIFICIAL SATELLITE IMAGES AND INFRARED BAND PREDICTION

Abstract

Generative models are widely used in the field of machine learning to generate realistic artificial image data. This paper presents a diffusion model architecture that is able to generate artificial satellite data of specified characteristics, e.g. resolution, band wavelengths or biome. The proposed network is furthermore designed to construct additional image bands not collected during the mission, demonstrating its potential to significantly increase the efficiency of further satellite missions. The model generates artificial data and augments existing RGB imagery with predicted infrared bands, making missions cheaper and more efficient. Based on the idea of non-equilibrium thermodynamics, diffusion models are a type of generative model that models a random walk on a graph to learn complex distributions in large, high-dimensional spaces. This diffusion process is used to sample from the learned distribution and generate new data. The transition matrix, which represents the probability of moving from one node of the graph to another, is used to define a Markov chain to model the random walk. The main advantage of diffusion models is their ability to handle high-dimensional data and model complex distributions. They have been shown to be effective in various applications, such as generative modeling, representation learning, and denoising. Additionally, they have the advantage of being relatively simple to implement and train, making them a popular choice for researchers. The model was trained on data of the Sentinel-2 satellite. The dataset was chosen to represent different biomes of the Earth's environment, idealising it for training a neural network. The model was trained using a combination of supervised and unsupervised learning techniques based on diffusion models, generative adversarial networks and classical convolutional neural networks. With the proposed methodology, the model runs on the ground rather than depending on rigorous computational power for onboard machine learning. Furthermore, the model is capable of constructing synthetic NIR bands from RGB bands, demonstrating its potential to significantly reduce the cost and complexity of satellite missions by enabling the acquisition of image data in bands not captured by the sensors during the mission. Preliminary results of the experiments show that the model can produce satellite images and NIR bands that compare to the original data from the Sentinel-2 satellite. Further research is being done to improve the resolution, and establish what image data can be reliably and accurately predicted. The accuracy of band prediction is compared against other methods of predicting infrared image bands.