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Author: Ms. Irina Sliusareva
Moscow Institute of Physics and Technology (MIPT), Russian Federation

Ms. Anna Zharkova
Moscow Institute of Physics and Technology (MIPT), Russian Federation
Mr. Ivan Trofimov
Moscow Institute of Physics and Technology (MIPT), Russian Federation
Mr. Egor Kasulin
Moscow Institute of Physics and Technology (MIPT), Russian Federation

ANALYSIS OF VARIOUS METHODS OF PROCESSING HYPERSPECTRAL IMAGES FROM A REMOTE SENSING SATELLITE FOR SOLVING CIVIL TASKS

Abstract

At the moment, there is a rapid development in space hyperspectrometery, which is contributing to the civilian use of hyperspectral imaging in areas such as agriculture and forestry. This technology is used for both environmental monitoring and the timely detection of various emergency situations. This type of imaging has the unique ability to collect a wide range of spectral information across the entire electromagnetic spectrum, in addition to producing two-dimensional images of the area under observation. The data collected from these devices can be used to address a variety of tasks, such as the rapid identification and delineation of burned areas in forests, geological surveying, the detection of illegal logging, and monitoring changes in cultivated areas. As a result, there has been a steady increase in demand for effective algorithms to process hyperspectral data every year. Classification and segmentation techniques are used to address the above-mentioned tasks. In order to accurately classify, both "classical" algorithms can be employed: the support vector machine (SVM), k-nearest neighbors method, and deep learning algorithms, including 2D and 3D convolutional neural networks (CNN), 3D-2D CNN and FuSENets. However, except for the last two methods, none of these approaches consider both spectral and spatial features for the hyperspectral classification process, leading to subpar performance. The paper compares the performance of two classical methods: k-nearest neighbors using principal component analysis (PCA), and SpectralNET, a progressive neural network that uses a convolutional neural network combined with a wavelet transformation. SpectralNET is a type of two-dimensional CNN for hyperspectral classification, and the wavelet transform is used to isolate spectral features. Calculating wavelet transformations is faster and more efficient than calculating three-dimensional CNNs. After extracting spectral data, it is connected to a 2D CNN that highlights spatial features creating a vector of spatial-spectral features for classification. The study involved hyperspectral images captured from an airplane. In future, we plan to test the proposed models on the hyperspectral images acquired from the scientific instrument "Hyperspectrometer", developed by MIPT (Moscow Institute of Physics and Technology) at the request of PJSC RSC (Rocket and Space Corporation) Energia, which will be delivered to the International Space Station (ISS) in June 2024. Our research will aim to find a more optimal model that can solve the specific tasks performed by this scientific instrument.