Derivation of dust optical depth from images taken by a Mars rover using deep learning method

*Itsuki Kashimura[1], Takeshi Kuroda[1], Tomohiro Sato[2], Hironobu Iwabuchi[1], Naoki Terada[1]

1. Tohoku Univ., 2. National Institute of Information and Communications Technology (NICT)

To date, various observations from orbiters and rovers and simulation studies have been conducted to elucidate atmospheric phenomena on Mars, such as dust storms. Our research aims to establish a weather forecasting system on Mars.
The dust dominates the weather on Mars. To realize the weather forecast there, it is desirable to make multi-point observations of the optical depth which can be used as an indicator of the amount of dust, like AMeDAS (Automated Meteorological Data Acquisition System) on Earth. At present, the conventional Mars rovers have observed the optical depth by direct solar imaging or spectroscopy, which consume many resources due to their difficulties in instrument development and observation process. Therefore, we are developing a new and much more convenient observational method of optical depth as an alternative to those instruments.
We are developing a deep learning model to estimate optical depth from images taken by a Mars rover, taking advantage of the fact that the visibility of the atmosphere varies depending on the amount of dust. Similar methods have been practiced on Earth (Chakma et al., 2017; Ma et al., 2018; Sato et al., 2023). However, such methods have never been used on Mars, and this study is the first attempt. In this study, a convolutional neural network model with a simple structure was created using TensorFlow/Keras, and images taken by the Mars rover Curiosity on MY31-35 were trained to predict the subsequent optical depth on MY36. We have just got the preliminary results, and aim to improve the results to be closer to the observations by reviewing the architecture of the model and the image data processing methods.
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