Taras Shevchenko National University of Kyiv
Astronomical Observatory

Astronomy and Space Physics in the Kyiv University

Book of Abstracts

International Conference
in part of the Science Day in Ukraine

May 23 – May 26, 2023

Kyiv, Ukraine

Addressing non-local relations in differently digitized spectra using machine learning

I.I. Yakovkin[1], A. O. Bartenev[2], and N. V. Petrova[3]

[1]Astronomical Observatory, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
[2]Department of Physics, University of Puerto Rico, Mayaguez, Puerto Rico 00681, USA
[3]Institute of Physics of National Academy of Sciences of Ukraine, Kyiv, Ukraine

The study explores the potential of machine learning in the processing of spectra, specifically with regard to its ability to transform between differently digitized spectra and fill the gaps in unique experimental data. When dealing with sets of data that have been digitized differently (for example, using various scanning techniques), it is crucial not only to consider the difference in characteristic curves but also the potential non-local differences due to the impact of different transmission/reflection curves, additional reflections, etc. By utilizing machine learning, we can transform between differently digitized spectra, effectively removing nonlocal effects if present in one of the sets.

In this study, a convolutional neural network was developed to transform between reflective and transmissive scans of a solar flare spectrogram. The performed analyses demonstrated that the transformation results closely matched the target data (Figure 1). These findings contribute to the development of novel techniques in spectra processing and underscore the potential of modern machine learning methods in the field.

The techniques established in this study can be applied to a broad range of spectroscopic measurements, encompassing those obtained using older technologies such as photoplates. This makes them a valuable tool for researchers working in the field of spectroscopy.

The authors would like to express their gratitude to V.G. Lozitsky for generously providing the spectra used in this study.

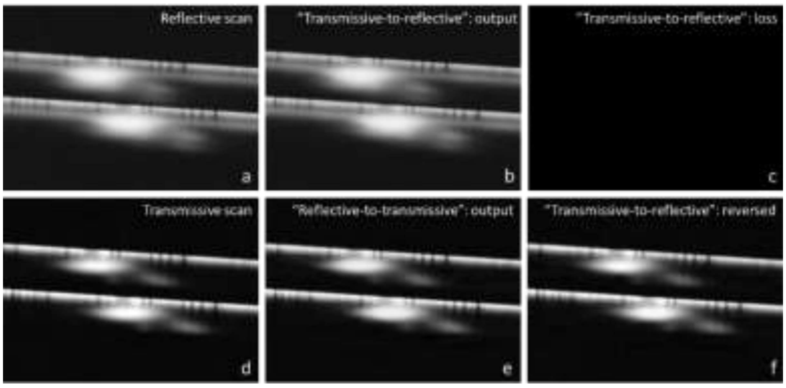

Figure 1. Training results for the Hγ spectral line of the limb solar flare on July 17th, 1981: (a) target reflective scan for the "transmissive-to-reflective" model, (b) model output, (c) loss function, (d) target transmissive scan for the "reflective-to-transmissive" model, (e) model output, and (f) output from the reversed "transmissive-to-reflective" model.

Detecting and addressing spectral contamination through machine learning

I. I. Yakovkin[1], A. O. Bartenev[2], and N. V. Petrova[3]

[1]Astronomical Observatory, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
[2]Department of Physics, University of Puerto Rico, Mayaguez, Puerto Rico 00681, USA
[3]Institute of Physics of National Academy of Sciences of Ukraine, Kyiv, Ukraine

The study introduces a technique for detecting and excluding impurities from final spectral images using a Convolutional Neural Network (CNN). The CNN transforms spectra between reflective and transmissive scans, effectively learning the relationship between both types of scans. CNNs excel in image processing tasks and minimize the risk of overfitting.

When applied to spectra with impurities, the models adeptly reproduce the true darkness of the photoemulsion while exhibiting high loss for scratches and impurities. Figure 1 illustrates the models' performance on contaminated spectra, revealing that areas of high loss correspond to the