Automatic detection and recognition of major solar radio burst events of type (II III and IV).

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1. Abstract

Various types of solar radio emissions [1] can affect a wide variety of modern technologies, specifically radio communications and airborne technology. Electromagnetic emissions are the first signatures of a solar radio burst event which depending on wave propagation in the ionosphere.

Using the solar radio spectral data provided by the spectrographs of Nançay in the band 10 MHz – 1GHz, we develop in this work a new method to automatically recognize solar radio bursts. The proposed algorithm is focused to identify three types of radio emissions, i.e. bursts emitted by electron beams travelling to the interplanetary space (type III bursts), by shock waves (type II bursts) and by trapped non thermal electron populations in CMEs (type IV bursts).

The proposed algorithm proceeds in three steps. First, In order to highlight solar events we proceed to eliminate unwanted signals (Radio-Frequency Interference RFI, Calibration…) by analyzing and filtering the dynamic spectra of the signal. Second, an automated system is applied to detect the spectra of major solar bursts. This method is based on an adaptive constant-false-alarm rate (CFAR like) aimed to detect hierarchically from the most to the least significant solar events. Third, we try to classify the detected events on four classes referred to as: type IV bursts or type III bursts or type II bursts or all other events. Based on the features extracted from the detected events (Histogram of Oriented Gradient HOG, event duration, base reference of the signal…), different classifiers (Deep learning [2], support vector machine [3], random forest [4]) are applied to recognize the type of solar radio bursts emitted.

To validate the method, a semi-automatic software package is developed to create a data set of all possible events (type II, III or IV) that could be recognized. Results were compared to this created data set. Both our proposed system and the Automated Radio Solar Burst Identification System (ARBIS) proposed by Lozbin et al. are also discussed and evaluated.

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2. References

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