A pipeline for comprehensive tracking of pulsating patches in All-Sky Imager data

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Pulsating aurora is a type of diffuse aurora with quasi-periodic variations in intensity. It is characterized as multiple on-off switching patches with a typical horizontal size from 10 to 200 km. The pulsating aurora is caused by intermittent precipitations of a few –tens keV electrons. With the development of auroral optical observations based on All-Sky Imager (ASI) system, it is expected to elucidate long-term variations, detailed spatiotemporal properties of pulsating aurora, including size evolutions, dominant frequencies, drift velocities, life times.

However, quantifications of comprehensive spatiotemporal properties of pulsating aurora are formidable task due to increasing amount of ASI data. In addition, an existence of non-pulsating background diffuse auroras often makes it difficult to identify individual patches. Hence, it is important to establish a fundamental technique for tracking multiple pulsating patches in ASI data undisturbed background arcs.

In this study, we built a new pipeline for comprehensive tracking of multiple pulsating patches over video sequences of the ASI. The process consists of three distinct steps: (i) extraction of pulsating patches to distinguish them from non-pulsating background arcs, (ii) segmentation individual patches over spatiotemporal domain and (iii) linking segmented regions lined up in time direction. The extraction step is carried out by a spatiotemporal filtering called Eulerian Video Magnification. This technique amplifies periodic color variations in a given temporal frequency band of interest. Since pulsating patches periodically switches in a characteristic frequency, we can successfully amplify them by selecting an appropriate frequency band. In the segmentation step, we apply a simple thresholding image binarization technique for each sequence over time. Then, we link identical patches by applying Hough transformation for identifying lines from a 3D point-cloud which describes centroid positions of segments in a spatiotemporal domain. This step is done under the assumption that an identical pulsating patch drifts roughly in a same direction affected by the global magnetospheric convection.

We examined the performances of our tracking pipeline using the WATEC ASI data obtained at Tromso, Norway. The exposure time of the WATEC ASI is second. In a visual inspection, our method successfully tracked noticeable pulsating patches in spite of the existence of background arcs. In the presentation, we demonstrate the tracking results showing trajectories of pulsating patches. Further, we will discuss some technical issues to be overcome for comprehensive tracking of pulsating patches. Moreover, we will discuss the MLT and geomagnetic activity dependence of the derived patch motions of the pulsating aurora.

Keywords: pulsating aurora, aurora all-sky imager, automatic tracking, Video Magnification

