Image Processing using Precision Solar Photometric Telescope (PSPT)

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Abstract:

To understand Earth's climate, we must first understand the Sun. However, there are still significant uncertainties associated with both the fundamental mechanisms of solar variability and how they enter into the Earth's climate system. An important method to study the causes of solar variability can be found through the analysis of solar images. The Precision Solar Photometric Telescope (PSPT) located at the Mauna Loa Solar Observatory (MLSO) acquires images of the Sun in three different photometric bands to monitor the evolution of the solar surface features that change over the course of a solar cycle. These images provide a complete knowledge about the Sun by focusing on different layers of the solar atmosphere. Though raw images are meaningful and important, precision image processing is required to remove instrumental artifacts and false features that may appear in these images prior to usage for scientific purposes. Foremost among the artifacts that must be removed is the detector flat field that is determined by analysis of sixteen offset images that are analyzed through the Kuhn-Lin method. This algorithm is computationally intensive and the usage of a graphic processor unit (GPU) was studied to evaluate its effectiveness in improving code efficiency. A scientific application of the high precision solar images is investigated by analyzing a set of narrow bands of Calcium II K core and wing images. The core and wing images are processed to remove the influence of the center-to-limb variation; the resultant core-to-wing ratio image enhances the appearance of network structures on the entire solar disk along with the more obvious facula and plage brightening associated with the passage of active regions.