Exploring the Registration of Remote Sensing Images using HSI-KAZE in Graphical Units

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Abstract

Image registration is a central task in many image processing applications. We focus on multispectral or hyperspectral remote sensing images that are used, for example, to analyze changes in land use, or to monitor the environmental effect of natural disasters. In all these examples, different images of the same area are required. The registration objective is to calculate the geometric transformation that aligns the different captures of the same scene.

The images to be registered are obtained at different times and, in many cases, also by different sensors. And it is common that they present differences as a consequence of being obtained from different points of view, differences in the number of spectral bands captured by the sensors, in illumination and intensity, and also changes in the objects present in the images, among others. Dealing with this situation, feature-based methods try to detect interest points in the images at high level, extracting significant regions, lines or points. Knowing the correspondence between several points in two images, a geometrical transformation is then determined to map the target image to the reference image.

Feature-based methods are more efficient at registering than area-based methods when the images are very rich in geometrical details, as it is the case for remote sensing images. But they present, nevertheless, the problem of being computationally more costly because the number of distinctive points to be calculated for these images is high.

The standard algorithms use a single band of the images to solve the registration problem. The authors proposed HSI-KAZE, a version of A-KAZE using the M-SURF descriptor that is especially adapted to hyperspectral images, as the spectral information is taken into account. The spectral information is considered when a set of representative bands of the image are selected based on their entropy and spectral distance and the spectral signature is incoporated to the keypoint descriptor. The HSI-KAZE method presents high computational requirements, so it is a good candidate to be projected in high performance computing architectures such as GPUs.

In this paper the implementation of the HSI-KAZE registration algorithm on programmable GPUs is explored as an attempt to reduce its computational cost. The GPU implementation focuses on reducing the cost of the two most costly steps of the algorithm, keypoint detection and keypoint matching. The CUDA code runs on a Pascal NVIDIA GeForce GTX 1070 with 15 SMs and 128 CUDA cores each. A detailed analysis of the implementation issues as well as its cost is carried out, showing that commodity GPUs are an adequate platform to perform efficient registration even for large images.