A PARALLEL DIFFERENTIAL BOX COUNTING ALGORITHM APPLIED TO HYPERSPECTRAL IMAGE CLASSIFICATIONS

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1. INTRODUCTION

With the revolutionizing advents in sensor technology, high spatial and/ or spectral resolution remote sensing images are increasingly produced. For example, hyperspectral images with hundreds of narrow spectral channels are currently available and instruments with thousands of spectral bands are under development. The nearly-continual stream of high-dimensional data has rapidly created new processing challenges. Considering the amount of data in need of processing and the high computational costs required by image processing algorithms, conventional computing environments are simply impractical. Therefore, it is necessary to develop techniques and models for efficiently processing large volume of remote sensing images. High performance computing techniques such as cluster computing, grid computing, and parallel algorithm on a multi-core processor are very good answers to increase the computational performance. Multi-core processors present an opportunity for speeding up the computation by partitioning the load among the cores [1-2]. As multi-core processor systems become more and more widespread, the demand of efficient parallel algorithms also propagates into the field of remote sensing images processing.

2. THE EXPERIMENTAL ENVIRONMENT

In this study, classification of land cover types in a hyperspectral image is demonstrated. A dynamic learning neural network (DLNN) [3] is utilized as a supervised classifier. In addition to the spectral information, texture information is applied to get better classification accuracy. Fractal dimension, the texture information applied, is estimate by a differential box-counting (DBC) technique [4] which has proved to be computationally the least complex and to be easy to implement. The fractal dimension of each pixel is computed by counting the total number of boxes in a window of size M centered at the corresponding pixel. The window is further partitioned into several grids. Each grid is of size s. The total number of boxes in the window is simply the summation of the number of boxes in all grids. The original DBC is inefficient because the fractal dimension is evaluated sequentially. It is not a big issue, as the volume of image data is small. However, it becomes troublesome when the original DBC is applied to hyperspectral images. Therefore, a parallel DBC is proposed in this study to improve its efficiency. The parallel DBC is implemented on a multi-core PC. Multi-threading technique is adopted to fully explore its multi-core capability. Besides, a 64-bit programming environment was supported in Visual Studio 2005 Professional.

3. RESULTS AND DISCUSSION

A plantation area in Au-Ku on the east coast of Taiwan was chosen as an investigated test site. The test site mainly contained six ground cover types which were sugar cane A, sugar cane B, bare soil, rice, grass, and seawater. On September 27, 2000, the experimental data was gathered by the Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) and Moderate Resolution Imaging Spectroradiometer (MODIS), MODIS/ASTER (MASTER), airborne simulator. A ground survey was collected on the same day. The MASTER data was available in 50 contiguous bands covering the wavelengths 400 to 1300 nanometers, with a spatial resolution of 10-30 meters. Because there were many redundant bands in the data, proper bands were selected by applying a band reduction procedure according to its spectral characteristics. The image acquired over the test site had a size of 834 samples and 652 lines. Texture information was then extracted by applying the proposed parallel DBC. Along with the spectral information, the extracted texture information was applied to DLNN to classify land cover types. All classes were properly classified. The parallel DBC was implemented on two different platforms, one had a 64-bit Intel Celeron Core 2 Duo CPU and the other had a 64-bit Intel Celeron Core 2 Quad CPU. The parallel DBC algorithm performed much faster than that of the original DBC. The improvement in computation time was depended on the ratio of window size M and grid size s. In addition, multi-threading techniques provided further improvement on our multi-core PCs. The improvement was linearly proportion to the number of cores. By using a platform with more cores, further improvement is expected.

Keywords: multi-core processor, multi-threading, parallel differential box counting algorithm

4. REFERENCES

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