Accelerating Identification of the hillside disaster regions using GPUs

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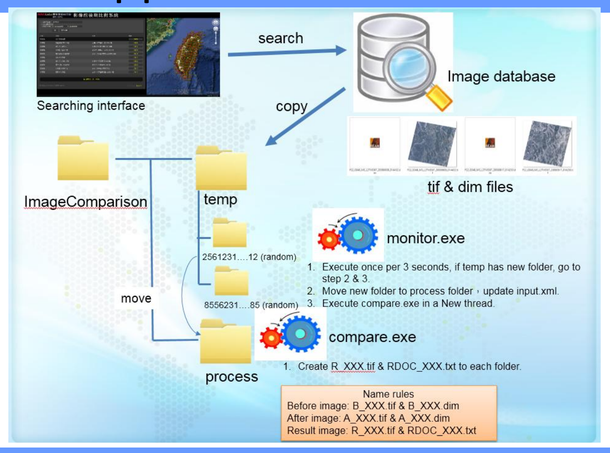
Background

Taiwan is one of the few countries facing a variety of natural disasters. In addition to the threats of heavy rains and typhoons, earthquake disasters often have to be faced in Taiwan. National Space Organization (NSPO) has long-term tasks of collecting land information and providing the information to the National Science and Technology Center Disaster Prevention and Reduction (NCDR) directly. When a natural disaster comes, NSPO can provide some rescue recommendations to the NCDR according to the analysis results of satellite images as soon as possible.

Purpose

Our purpose is to analyze the satellite images and to identify the disaster area for emergency relief. The system has to compare two images captured at different times, before and after the disaster, and identify possible disaster regions and report possible disaster reasons. We can know the effects of expanded collapsed regions after the major natural disaster events. In order to enhance the speed of images comparisons, we use GPUs to accelerate our program, so that we can provide disaster identification images to the control center when natural disasters occur as soon as possible.

Our Approach



The system will copy the target images into a image comparison folder named “temp”. There are two programs in the temp folder including monitor.exe and compare.exe. The monitor.exe will check whether unprocessed images existed in the folder every 3 seconds. If images existed in the folder “temp”, the program monitor.exe will move these images into folder named “process”, and then execute the program monitor.exe. The monitor can create several threads if there are several images need to be compared. Program compare.exe will create R_XXX.tif and RDOC_XXX.txt, and the identification results will be shown on GUI automatically.

Find out overlapped area of two images captured at different times

↓

Calculate each pixel’s NDVI value

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Use NDVI values to determine the differences of two images

↓

Find out the regions with differences over a threshold

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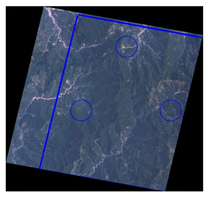
Output the result image and analyzed data

We use GPUs to calculate each pixel’s NDVI value to accelerate our program

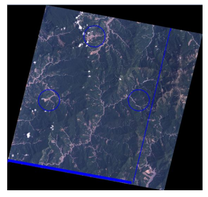
NDVI = (NIR-RED)/(NIR+RED)

Experiments and Results

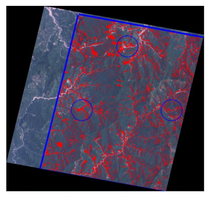
Case 1 - Kaohsiung Jiasian



Before disaster

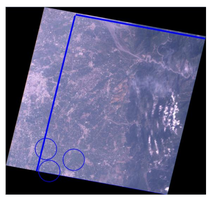


After disaster

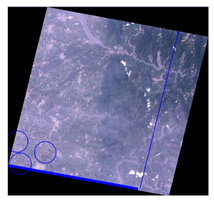


Identified results

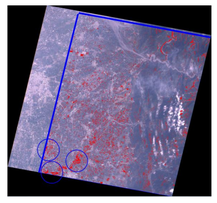
Case 2 - Pingtung Linbian



Before disaster



After disaster



Identified results

	CPU	GPU	Speedup
Kaohsiung Jiasian	1.083s	0.794s	26%
Pingtung Linbian	1.084s	0.870s	19%

Red pixels on the result Images show the differences between two images captured at different times. In the result images, the three blue circles represent three regions with most different pixels. The above table shows the calculation time of all pixel’s NDVI values for CPU and GPUs.

Influence and Contributions

When a natural disaster comes, the proposed system can suggest the NCDR recommendations and provide disaster regions identification based on the satellite images. The commanders can make some policies of disaster prevention and rescue as soon as possible. Use GPUs to accelerate the identification program can short the flow of making decision.

References

- Lixia Gong, Qiang Li, and Jingfa Zhang, Earthquake building damage detection with object-oriented change detection, 2013 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), pp. 3674-3677, 2013.
- Ranajoy Malakar and Naga Vydyanathan, A CUDA-enabled Hadoop cluster for fast distributed image processing, 2013 National Conference on Parallel Computing Technologies (PARCOMPTECH), pp. 1-5, 2013.