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HIGHLY PARALLEL IMPLEMENTATION OF RETINA IMAGE ENHANCEMENT ON GPU TO ENABLE FASTER EXECUTION

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ABSTRACT

The analysis of retinal images is becoming a vital medical tool to predict retinopathy and other retinal impairments. The algorithms implemented on CPU are able to process retinal images. However, the algorithms running on CPU are executed sequentially. This is due to the hardware limitation of CPU. GPU are having inherent hardware architecture to enable parallel implementation of image processing task and thus bringing an upshot in fleetness. This paper discusses about retinal image enhancement by using algorithm running on GPU. The hardware used is NVIDIA GeForce GT 720M.

Keywords: retinal fundus image, GPU, image enhancement, hardware, NVIDIA.

INTRODUCTION

GRAPHICS Processing Unit (GPU) has a highly parallel architecture and is used for gaming and display. This inherent parallelism can provide acceleration when applied to complex image processing tasks. The GPUs can be used to accelerate image processing tasks. The retinal image enhancement, for medical analytical applications can be advanced from the acceleration provided by GPUs. Image processing procedures are often relatively complex, because computers are not capable to logically interpret and extract information as seen by human beings and therefore often need a lot of steps. As a result, image processing algorithms can become very computation demanding and time consuming. Therefore this work uses graphical processing units to accelerate retinal image enhancement.

RETINAL FUNDUS IMAGE PROCESSING

The assessment of retinal images is a diagnostic tool usually used to collect significant evidence about patient retinopathy. Retinal injuries, related both to vascular characteristics, like increased vessel tortuosity [1], [2] or focal narrowing [3], and to nonvascular structures, like exudates, hemorrhages, and so on [4], are decisive pointers of severe universal maladies, such as diabetes or hypertension. It is thus imperative for the specialists to be able to evidently detect, appreciate and identify the injuries among the several vessels and nerve present in the image.

Retinal images captured by the fundus camera with back- mounted digital camera [5] deliver expedient evidence about the importance, nature, and prominence of the consequence of diabetes on the eye. These images help ophthalmologist to evaluate patients in order to diagnose and observe the advancement more proficiently [6].

If retinal issues are identified at the commencement itself, laser photocoagulation can be used to treat the progression of diabetic retinopathy. In order to ensure that treatment is done on time, the eye fundus image of diabetic patients needs to be reviewed intermittently. Automated recognition of clinical signs of retinopathy can benefit ophthalmologists in the analysis of the malady, with the subsequent cost and time savings.

The retinal image may have lack of contrast, low lighting or even be poor in sharpness, or can have noise. In this work, the retinal image with noise was chosen and enhancement step was to remove the noise.

GRAPHICAL PROCESSING UNIT

A humble approach to realize the modification amongst a CPU and GPU is to associate how they implement tasks. A CPU comprises of a little cores boosted for sequential serial processing whereas a GPU has a tremendously parallel architecture comprising of thousands of minor, more efficient cores designed for managing multiple tasks concurrently. In [7] it was revealed that noteworthy speed-up can be obtained using GPU. GPUs were applied for target recognition and grouping, resulting in fast and dependable applications and bestowing the requirement of resolving memory storage concerns to realize more speed [8], [9]. Significant speed-up factors are also obtained for compression and decompression schemes for satellite data, as shown in [10] and [11]. Regarding hardware oriented compression, a GPU execution of a lossless compression procedure for hyperspectral images was developed in [12], and [13] showing promising results.

HOW GPU ACCELERATES ALGORITHM

GPU-accelerated computing gives in comparable algorithm efficiency by divesting compute-intensive slices of the algorithm to the GPU, even though the rest of the code still runs on the CPU.

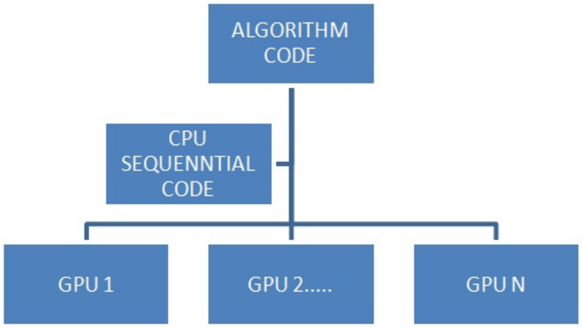

Figure-1. Demonstration of how GPU acceleration work.

As shown in Figure-1, the application code will run mostly on the CPU. However, the computationally intensive part runs on the GPU. There are typically over hundreds of hardware units to handle the task parallel in a GPU. From a user's perspective, applications simply run significantly faster.

WORK

The hardware used was NVIDIA GEFORCE 720M GPU. This GPU supports CUDA and has good computational capability. The image used for the work is taken from STARE database available online. The image was mixed with salt and pepper noise and the resulting image after the distortion with noise is given in Figure-2.

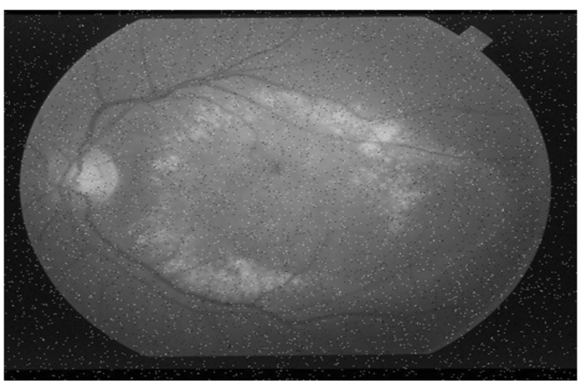

Figure-2. Retinal image with salt and pepper noise.

The retinal image shown in Figure-2 above was used to evaluate the performance upshot GPU will be able to make in the domain of retinal image enhancement. The image was enhanced using median filter. The median filtering of retinal image was done in two dimensions. Each output pixel contains the median value in the window neighborhood around the corresponding pixel in the input image. There is a zero padding to the image on the edges, so the median values for the points closer to the edges of the image would be appearing distorted. The Figure-3 below shows the retinal image after enhancement on GPU.

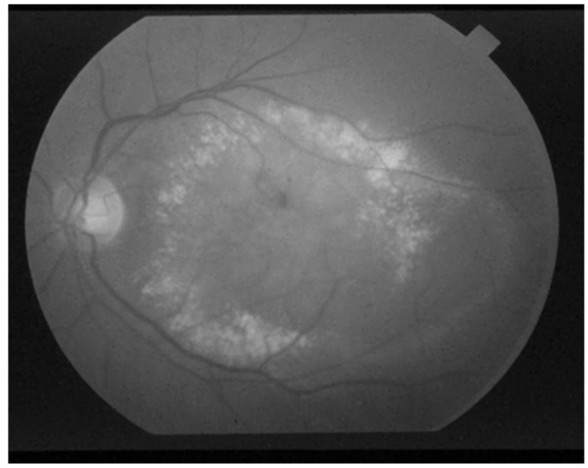

Figure-3. Retinal image enhanced on GPU using median filtering.

RESULT

The retinal image enhancement was implemented on GPU with appreciable results. The resulting image was enhanced and is shown above in Figure-3. The median filtering was implemented on CPU for the same image in Figure-2 as input. The time taken on CPU was 0.11653seconds. The time taken for the GPU implementation was 0.08109seconds. The Figure-4 below shows the graphical comparison between the CPU and GPU implementation of image enhancement.

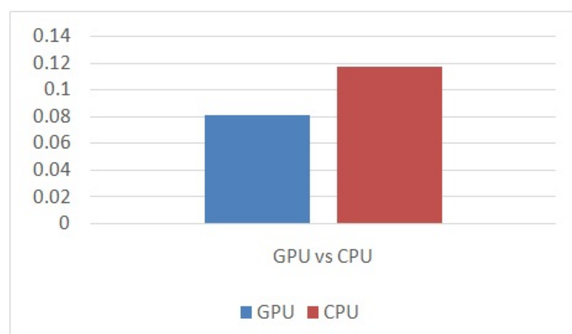

Figure-4. GPU versus CPU execution time comparison for retinal image enhancement.

CONCLUSIONS

It was noted in the experimental results that GPU enable retinal image enhancement an upshot in speed. Retinal image enhancement while harnessing the hardware architecture inherent parallelism of GPU can be a great asset for evaluating a very large database of retinal fundus images. There are several methods to be explored to harness the effectiveness and power of GPUs. When a large number of retinal images are to be mass evaluated an accelerated technique for retinal image enhancement is of great interest. Thus, there is a need for a consistent and accelerated technique for retinal image enhancement. In this work this aspect of retinal image enhancement was dealt with good results. In future, we would try new techniques applied on enhancing retinal image on GPU.

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