RETINAL FUNDUS IMAGE ENHANCEMENT USING CUDA ENABLED GPU NVIDIA GT 720M

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Abstract: Graphical processing unit has several cores which can do parallel computing. The use of parallel computing for image processing applications is of great advantage. This paper discusses the retinal fundus image enhancement done on NVIDIA GT 720M GPU. The performance improvement while using GPU is studied and compared with the CPU implementation of the same algorithm to enhance retinal fundus image.
Index Terms: Image Enhancement, Retinal fundus image, accelerated parallel image processing, kernel.

I. INTRODUCTION

THE enhancement of retinal fundus image is a vital step towards better diagnosis and analysis. Retinal fundus image vein enhancement is significant step towards better analysis of malignancies. Graphical Processing Unit (GPU) is mostly used for displays and graphics and gaming. However it has been recently observed that great computational speeds can be achieved by using GPU. Thus in fields of medical image processing where large amount of data is to be processed GPU finds a lot of use. The GPU is a vital tool for scientific computing and research. There is a lot of inherent parallelism in the hardware architecture of GPU which can be utilized for processing at greater speeds. In this work retinal image is processed by using a custom designed mask to get the retinal veins enhanced. The algorithm is run on GPU and CPU and the performance is studied.

II. REVIEW OF LITERATURE

Literature review helps to understand the recent works in the area of concern. Several techniques are used for processing fundus image. Image processing can be applied to do most of the tasks automatically in the field of medical image analysis. The work [7] is using technique of multilevel thresholding to enhance retinal fundus image. The work [10] introduces solution for localization of optic disc by using specialized template matching and segmentation. Adaptive thresholding technique is used to detect lesions in the work [14]. Difference approach of detection in medical images is described in the literature reviewed [13]. Local contrast enhancement methods attempt to enhance the details of image which are ignored in global histogram equalization techniques. Some methods combine local features in image such as edges with original histogram to improve the image quality. Many image enhancement techniques use this technique; however, complexity of these methods still remains an issue [6][1]. Many algorithms were introduced for image enhancement, each having its own features and benefits. One of the algorithm suggested by Zimmerman and Pizer[5], is histogram equalization. Some of the more advanced methods such as unsharp masking introduced by Polesel et al. [12]; Yang et al. [15] and local normalization suggested by Joes et al. [8], have been proposed to enhance the image contrast. K.S Sim et.al.[9] and Pei-Chen Wu et.al [11] have also used piece-wise histogram equalization for image enhancement. Some of the other techniques based on the matched filters have also been introduced [14][4].These techniques especially for blood vessel in a small area, but when applied for the whole image, the complexity of computation increases due to the need of various matched filters. Wavelet is one of the wide used multi-scale processing. Wavelets may not be suitable for enhancing the retinal image contrast because they are blind to the smoothness along the edges commonly found in such images.

III. GRAPHICAL PROCESSING UNIT

It is of great advantage and in the modern era to have great speed in implementation of algorithms for medical image processing. The implementation on GPU as given in works [3] and [2] shows promising results. A sample of image taken for processing is shown in figure 1 below.

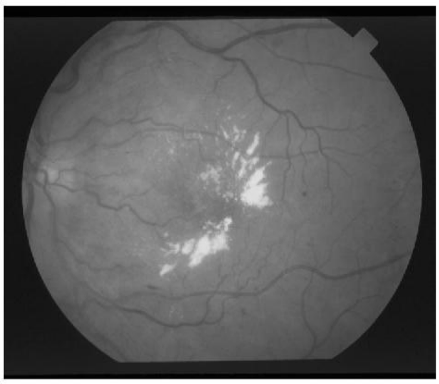

Fig. 1. Retinal image to be enhanced on GPU

The retinal image shown in figure 1 above is a sample of several images used to evaluate the performance improvement GPU can make in the field of retinal image enhancement. The image was enhanced using custom designed mask. The mask filtering of retinal image was done in two dimensions. The figure 2 shows the retinal image after enhancement on GPU.

The custom designed mask is given below

C1 = [-2, -1.66, -2; 0, 0, 0; 2, 1.66, 2];

C2 = [-2, 0, 2; -1.66, 0, 1.66; -2, 0, 2];

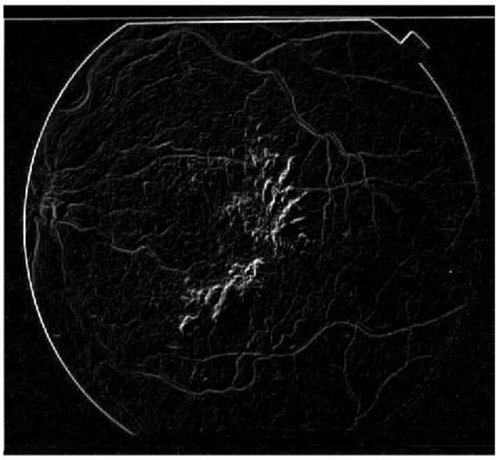

Fig. 3. Retinal image enhanced on GPU

There were 50 retinal images that were used to study the performance improvement. The average time to process the 50 retinal fundus images on GPU and on CPU were recorded. The implementation was done and graphs were plotted and are given in the result section. The images were taken from online databases; the study was done further on retinal images collected from clinics and hospitals.

IV. RESULT

The retinal image enhancement was implemented on GPU with remarkable results. The resulting image was enhanced and is shown above in figure 3. The custom mask filtering was implemented on CPU for the same sample image in figure 2 as input. The process was repeated on a set of 50 retinal fundus images and the average time of implementation was found out. The average time taken on CPU was 0.32 seconds. The average time taken for the GPU implementation was 0.53 seconds. The figure 3 shows the graphical comparison between the CPU and GPU implementation of image enhancement.

V. CONCLUSION

The use of GPU for retinal fundus image processing is of great benefit. The speed up is of remarkable margin. The custom designed mask C1 and C2 were used to get two sub images and they were added to form the output as given in figure 3. The algorithm was further run on GPU to improve the speed of execution. Retinal image enhancement while coupling the hardware architecture intrinsic parallelism of GPU can be an extravagant advantage for assessing a very large database of retinal fundus images. There are numerous algorithms to be designed to use the effectiveness and power of GPUs. For the mass evaluation of large amount of retinal images an accelerated algorithm for enhancement of retinal image is of interest. In future work the retinal image enhancement would be extended by better algorithms on GPU.

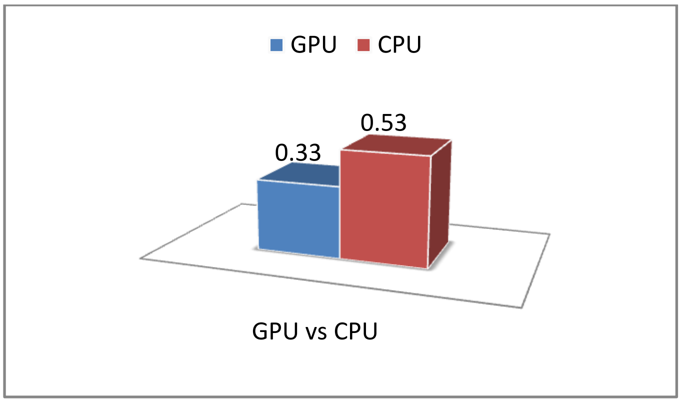

Fig. 3. GPU versus CPU implementation time comparison for the enhancement of retinal fundus image

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