



Survey on Medical Image Registration using Graphics Processing Unit

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Abstract-Medical Image registration is a preprocessing step for the medical images analysis which requires large computations when executed on sequential processors. To increase the execution speed, the registration process executed on the graphics processing unit which execute the registration process parallel. Registration process is divided into the parts in the form of kernels which are evaluated by using the different number of threads on GPU. In this paper we compare the results obtained from CPU and GPU to register the two medical images. The data set includes the MRI and CT scan images for the analysis which are taken at different times of same object or images of the different objects taken at the same time. This problem is basically formulated to minimize the cost function by implementing the process on the parallel platform.

Keywords- GPU, Image Registration, MRI, CT, CPU.

I. INTRODUCTION

Medical Image registration is extremely essential task of Image Processing as it is the procedure of aligning two images so that the point in one image corresponds to the same anatomical position in the other [1]. Different modalities are used to acquire the images for the register purpose, images of the same objects taken at same time and images of the different objects taken at the same time [1]. Images are acquired from the different modalities analyzed into the same coordinate system. Image registration technique as number o application in medical clinics and research laboratories basically used to solve the complex problems. There is the number of techniques to register the two images, some methods are based on mutual information and some are based on correlation factors. Mutual information is basically the dependency between the two variables which measure how the one image similar with the other. The MI can be applied for both intra and inter-modal registration, and should have the highest value when the input images are correctly registered [4]. In order to maximize the alignment between the images the degree of alignment must be quantified [5]. This measure is achieved using a similarity metric. Image registration used in various clinical applications to monitor disease progress and growth of abnormal structures [6][7]. It interpolates the target image with the reference image to register both the images. The main components of the image registration are transformer, optimizer and a measure. Both the images are transformed within the predicted parameters for the perfect alignment and this process is iterated number of times. Optimization scheme computes the step sizes to be fed into the transformation processing stage. At each iteration, a small transformation is computed such as to increase the overall alignment as measured by the similarity metric, where the similarity metric is calculate similarity between the reference image and the target image. This paper contributes the following objectives:

- To study the image registration process by using mutual information methods and correlation index methods.
- To decrease the cost function for the registration process in the form of speed and other parameters by implementing it on GPU.
- To compare and analyze the results obtained from CPU and GPU.

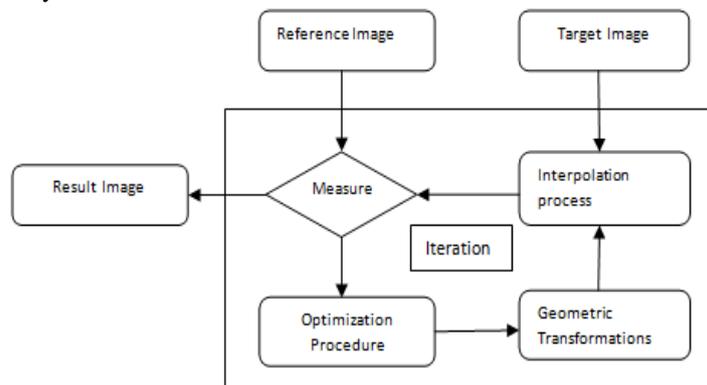


Figure 1.1 Flow chart of Image registration process

II. GRAPHICS PROCESSING UNIT

GPU is also known as visual processing unit (VPU) used for the graphics applications as well for the general purpose applications. GPU basically a electronic circuit initially designed to run high definition graphics on PC but now days used to provide parallel computing as it contain hundreds of cores. The main objective of parallel computing is to dividing a task into sub tasks and executing them concurrently to produce high performance by reducing execution time to improve efficiency and better utilization of resources[8].

GPU computation has provided a huge edge over the CPU with respect to computation speed. Hence it is one of the most interesting areas of research in the field of modern industrial research and development. Like the CPU (Central Processing Unit), it is a single-chip processor but as shown in Fig. 1.2 the GPU has hundreds of cores as compared to the 4 or 8 in the latest CPUs. The primary job of the GPU is to compute 3D functions because these types of calculations are very heavy on the CPU and GPU can help the computer run more efficiently as compared to the CPU. GPU uses the concept of kernels which are executed by the number of threads in parallel, where the threads are grouped in the form of the grids. GPU computing follows a model in which it use a CPU and GPU together in a heterogeneous computing model[9][10]. The sequential part of the application runs on the CPU and the part of the process require large computations run on GPU. From the user's point of view, the application is faster because it is using the better performance of the GPU to improve its own performance.

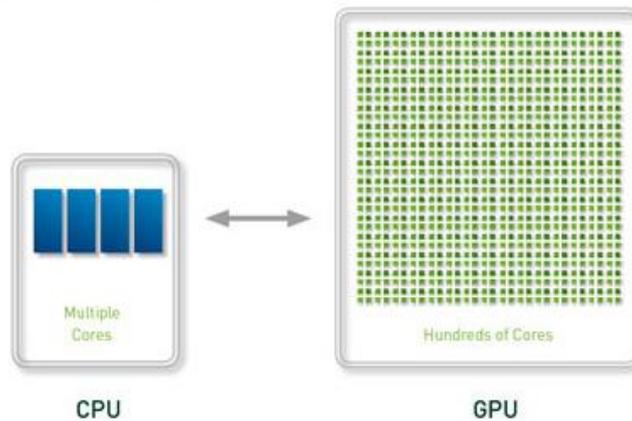


Figure 1.2 Parallel cores in CPU vs GPU

III. LITERATURE SURVEY

Frederik maes et al. [15] said that Analysis of multispectral or multitemporal images requires proper geometric alignment of the images to compare corresponding regions in each image volume. Maximization of mutual information analyze all voxels in images to register the images. Both the images are correctly aligned when statistical dependence between voxel is maximum.

Jayshree Ghorpadel et al. [16] said that the future of IT is parallel computing. Parallel computing focuses on the concepts of threads and blocks in which the code is running parallel in the form of threads. It increases in computing performance, by utilizing the power of the multiple GPU cores.

Preeti Kaur[18] implemented the image processing algorithms on parallel platform to take the advantage of multiple cores on the parallel platform. They calculated various parameters related to time and compare them with the sequential systems.

Xiang Huang [19] implemented non rigid image registration [19] by using mutual information and sum of squared methods. They classified various image registration methods and compare them by using these two similarity measure methods.

Prakash N Ekhande et al.[20] proposed system uses parallel approach for the edge detection from the degraded image. They designed a image segmentation algorithm which works on each pixel of the image. Each pixel in the image has its own threshold value.

Sanjay Sexena et al. [21] implemented medical image registration using multithreaded approach by mutual information on multicore environment to perform the medical applications. They used the different modalities to obtain the data set from different viewpoint and use the CT and PET images for the analysis purpose. They included the concept of mutual information and run that process on multiple cores to reduce the cost function.

IV. SUMMARY OF THE SURVEY

Researchers have used various methods in the registration process to present their analysis and results. They used various kinds of data sets in their implementation and compare the CPU implementation with GPU. Comparison of different results is very complicated because it depends upon the number of factors, data set used for the result analysis, resolution of the images, method used for the registration process and number of cores of the processor used for the implementation. After the survey we concluded the registration process in the following steps:

1. Read input images, source image and target image.
2. Calculate the number o rows and number of columns in the image.
3. Calculate the Mutual information of both the images.

$$I(M;N) = H(N) - H(M|N) = H(M) - H(M|N)$$

4. Compute the joint histogram of source image and target image. Each entry in the histogram is the number of times intensity a in one image corresponds to an intensity in the other image.
5. Normalized the joint histogram.
6. Assign the number of rows and columns to the cores available in the GPU.
7. Calculate the step sizes to be fed into the Transformation processing stage.
8. Initialize the kernels required to execute the process on GPU.
9. Evaluate the kernels on GPU.
10. Transformed moving images.
11. Generate the resultant image from the resultant histogram. Same grey value will be plotted as a single pixel but the values which are not matched in the images will be plotted differently.

V. CONCLUSION

We compare the different medical image registration algorithms which use the different methods to register the two images such as mutual information method, sum squared method and correlation coefficient methods. All the medical image registration methods require large computations and sequential processors slow down the process speed. To overcome the problem the registration process can be executed on GPU which has multiple cores to execute the process parallel. Registration process can be divided into two parts, first part of the process which can be executed parallel is divided into the number of kernels and kernels executed parallel in the form of threads on GPU, second part of the procedure which cannot be divided run on CPU. We analyzed and study number of registration methods which can be executed at high speed on GPU, which results reduction in the cost.

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