A Computer Image Processing Technology Based on GPU Parallel Algorithm

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Abstract
With the increasing complexity and refinement of computer application methods, the requirements of image processing technology also need to be gradually improved. The production of GPU can be better consistent with the demand of image processing methods. Through continuous and in-depth research, the digital image processing method based on GPU has been widely used, which further promotes the sustainable development of computer technology in China. This paper mainly analyzes the related technology of GPU image processing, and then explores the GPU parallel computing design of digital image processing algorithm, and finally discusses the practical application of image processing technology algorithm.

Key words: Image Processing, Computer, GPU, Parallel Computing

1. INTRODUCTION
In the initial stage of computer technology, processing and operation of graphics is not complicated, so the hardware processing equipment and professional application needs little, with the help of CPU computing technology can effectively deal with a series of problems on the graphics (Kumar, Sathyadevi and Sivanesh, 2011). However, with the continuous update of information technology, graphic encryption and graphics resolution and other related graphics technology and quality parameters need to meet the higher requirements of the system, and further promote the emergence of GUP (EYK and Ung, 2011). In 1999, NVIDIA launched the first piece of GPU-Ge-Force256, which was the beginning of GPU development (Yong, Fok and Hakendorf, 2013). GPU products multiplied every six months. Compared with GPU and CPU, the former has faster processing speed, and it also has superior characteristics than CPU mainframe at low cost. Different from CPU processing and control needs, GPU is mainly to deal with a large number of data, the hardware structure has a better processing effect. By analyzing the GPU architecture, we can see that the number of transistors in data processing is obviously more than CPU, and the ability to cache data and flow control logic is gradually reduced, while the emphasis is on computing power. Although the logic of control has been weakened. But in this structure, GPU is easier to process and operate, and does not pay attention to some data of logical relation. It can solve the problem of GPU cache insufficiency by using efficient and fast computing method.

GPU specifically deals with graphics, and the application of GPU in the field of general computing still has great limitations (Inokuchi, Washio, Okada and Motoda, 2014). The limitations of this GPU lead to the limitations of CPU performance, coupled with the lack of memory space, which can not handle and run large-scale programs (Mathias, Agrawal and Feinglass, 2013). In order to break through this limitation, the programming idea of C language is applied to digital image processing by means of discrete analog computer. The practical operation shows that GPU can form hundreds of times of operation speed in the process of CPU processing unit.

Under the premise of the complexity of the current business, people in the process of image processing, such as fuzzy, sharpening and merging and other forms of digital image processing, according to the actual needs of people to actively transform the original graphics (Kozak, Agrawal, Machuy and Csucs, 2013). At the same time it is also on the quality of graphics processing system have higher requirements, the speed of CPU has been unable to adapt well to the requirements of the people and the urgent need to continue, GPU to improve the computational speed, and in computational science applications in general graphics, resulting in corresponding calculation, effectively solve the complex problem (Hsu, Tseng and Chen, 2012).

2. GPU PARALLEL COMPUTING DESIGN OF DIGITAL GRAPHICS PROCESSING ALGORITHM
Digital image processing is to store and process images stored in binary data by computer, and change the digital image information processing to further transmit the graphic data accurately.

2.1. Parallelization of Gauss Fuzzy Algorithm
In the process of using Gauss transform image fuzzy algorithm in the appropriate combination of multi thread GPU contains parallel processing features, the premise is the changes of the Gauss matrix showed no correlation in horizontal and vertical direction, the specific process is shown in Figure 1: the original image of
Gauss fuzzy processing program in CUDA under the framework of the whole reading need processing, then the resulting pixels block processing in horizontal and vertical direction, and is assigned to carry out operations of GPU thread block. The CUDA architecture forms the related API function, which helps the programmer to carry out the block operation better. In the corresponding thread block of GPU, the CUDA method is used to allocate the data scientifically to complete the operation.

![Gauss fuzzy processing flow chart based on GPU](image1)

**Figure 1.** Gauss fuzzy processing flow chart based on GPU

2.2. Parallelization of Color Negative Processing Algorithms

The color film processing of all pixels in the editing process, using the 255 minus steps are R, G, B value, to generate new negative image (Arriola, Walter, Curioso and Cruz-Encarnacion, 2015). Through the analysis to understand the process of negative calculation, the processing of all pixels are alone.

![Negative flow chart processing algorithm based on GPU](image2)

**Figure 2.** Negative flow chart processing algorithm based on GPU

Through the analysis of Figure 2 shows that the pixel is the basic premise to carry out independent operation parallel operation, if the pixels in the process cannot exist independently, to write a lot of code control,
program structure and operation mode of GPU can not meet the processing requirements, so this kind of statement is not suitable for processing by GPU.

2.3. Parallelization of Transparent Merge Processing Algorithm

The opaque material is set as $A$, and the transparent object is set as $B$. If the transparency value of $B$ is $\alpha$, then the mixed formula of $\alpha$ is calculated (Zhao, Guo and Yan, 2017)

$$
\begin{align*}
R(C) &= \alpha \times R(B) + (1 - \alpha) \times R(A) \\
G(C) &= \alpha \times G(B) + (1 - \alpha) \times G(A) \\
B(C) &= \alpha \times B(B) + (1 - \alpha) \times B(A)
\end{align*}
$$

In the formula, the RGB component pixel color X one by one expressed as $R(x)$, $G(x)$, $B(x)$, using the formula (1) shows that the a hybrid is relatively simple, this technique can get a variety of translucent effects such as flames, smoke and shadows.

In the CUDA framework, the GPU processor can process the mixed transparent image, first determine the specific scope of mixed processing, and it will be divided into a plurality of processing units, and then CPU to the multi thread processor GPU reasonable distribution of the unit, carry out further operations, processing procedures are as follows:

![Flow chart of a transparent hybrid processing method based on GPU](image)

Based on the CUDA framework, the transparent mixed content of the two images is processed by GPU, and a close connection is formed between different processing objects.

3. PRACTICAL APPLICATION OF IMAGE PROCESSING ALGORITHMS

Industrial visual speed and accuracy have higher requirements, but vision rarely make use of professional hardware acceleration, using simple CPU it is difficult to meet the requirements of GPU as a common hardware PC machine inside, have strong ability of computer processing. In industrial vision, in order to detect whether an object is qualified or not, it is usually necessary to compare the standard object strictly. The process of describing the visual language is to use template matching method for scientific detection. In the visual application, we must carry out a comprehensive inspection of the small parts of the motor, mainly to determine whether the three metal feet processing defects, and whether the assembly work is qualified.

3.1. Two Valued Processing

In the process of shooting, the illumination and the consistency of the parts themselves will affect the object, resulting in the image can not be directly detected, the need to implement its pretreatment. Due to the
presence of light and material factors, it is impossible to separate the three metal foot backgrounds. In order to remove the metal foot from the background, two value processing must be taken for the graphics. Both the dark target and the bright background are the contents of the whole image, so the image structure paradigm can divide the object and background scientifically by designing threshold value, and the gray level pixels generated become various domination modes. The analysis shows that the illumination conditions are very consistent, so the images taken have good consistency and can be successfully applied to the threshold.

Figure 4. Images after two valued processing

3.2. Circular Projection Template Matching

In the background, two valued processing can be used to obtain the corresponding target, and three metal feet are also found. Classical template matching method can be adopted (Zhao, Cai and Cheng, 2017)

\[ D(m, n) = \sum_{i=1}^{M} \sum_{j=1}^{M} \left( S_{mn}(i, j)^2 + T(i, j)^2 - 2S_{mn}(i, j)T(i, j) \right) \]  

The formula (2) in the first sub graph represents energy, with the changing (m, n) position and positive change; overall energy second representative template, considered fixed template constants; third represents the correlation of the subgraph with the template, which may be affected by the location (m, n) the change, when the template and target image to form a highly match will produce the maximum absolute value. The correlation coefficient of each pixel is calculated by moving the target template image, and the best matching position determines the location of the maximum correlation coefficient. Taking into account that the three metal pins in the component inspection have the same shape, the center rotates relatively. In the process of locating three metal pins, the circle projection template matching method can be selected.

The design template function is \( g(x, y) \), and the image function is \( f(x, y) \). The function of the image after rotation is \( f(x, y) \). The circular projection is defined as the process of calculating the gray values of all pixels of the distance between the central pixel of the subgraph and \( R \), and the process of reaching the number of the condition. Through the projection diagram, it shows the characteristics of rotation invariance. The following formulas can be used to describe each layer of eigenvalues.

\[ T_i(R) = \frac{\sum_{j=1}^{N} X_j}{N_i} \]  

It is divided into 43 layers, and each circle \( T_i(R) \) is calculated on the template image. Aiming at any point on the target image, the center domain is chosen as the target matching image. At the same time in the center of the image is divided into 43 rings, one by one calculation.

3.3. Algorithm Optimization

Through the analysis of the above algorithm, it can be seen that the similarity of any point on the image will produce a large amount of computation, so it must be optimized continuously.

Each point in the center of any field is relatively fixed, that is, the distance between the point and the center is fixed, so it is not sure where the point will be. If in the field can be calculated which point in which a ring at the same time, this part of the data storage, for any point in the target image is calculated, can in the field using the stored data to find which point in which a ring, which saves a lot of calculation process. Considering the computing speed of CPU and read the memory is different, influenced by semiconductor technology, CPU
computing speed is significantly more than the memory read speed, the program operation should be reduced as much as possible to read the memory process, it can be used to optimize the geometric knowledge query table.

Round includes various symmetry relations, for Figure 5 in area A and M, the B and N in areas with 45 degree diagonal symmetry, while in the D region also appeared symmetrical to X axis, the Y axis symmetrical to the point in the C region. Similarly, the N points form symmetric points in the C and D regions. So there are 7 points in the whole circle that are symmetrical with M.

![Figure 5 Various symmetry relations in a circle](image)

Through the above processing, the table can be reduced to the original 1/7. In the process of calculation, we can calculate the coordinates of 7 corresponding points by combining any point coordinates, which reduces the requirement of memory reading. According to the formula to calculate the similarity, the distribution similarity map of the whole map is obtained, as shown in Figure 5. The maximum similarity points of A, B and C can be found out in three regions from Figure 5. Using the concept of circle projection similarity, the closer the target area and template is, the greater the similarity is. Thus, the specific location of the three metal feet is the maximum similarity position of the region A, B and C.

![Figure 6. The distribution of similarity of all points](image)

The first metal foot position is the maximum point in all similarity data. By Figure 6, it is found that the similarity of points near the maximum point is still higher than that of other regions. Determination of second metal foot position must be clear all the similarity near the first match point value, because the template center and maximum point correspondence, taking into account the specific size of the metal pin, second metal feet will not appear in this range, you can set the zero range is equal to the size of the template. Carefully looking for the maximum similarity value can determine the location of the second metal feet, and then remove again, the largest similarity point in other areas continue to find the specific location of the third metal feet.

The corresponding positions of the three metal pins are obtained by the above method. Because the distance between the three metal feet and the symmetrical center of the qualified part is equal, the requirement of the three metal feet unified in the symmetrical center angle is considered to be qualified for the assembly parts. In the process of qualified assembly parts, the angle of the A, B, C position and center point of the three metal feet must be equal, and equilateral triangle is further obtained.
Therefore, after the three metal foot position, we can accurately determine whether the three metal foot assembly is qualified by the formula (Sinha and May, 2014). However, this calculation process is still very complex and needs to be optimized continuously. Using image pyramids encoding in image decomposition process generates a plurality of different resolution sub image, the high resolution sub image size is placed in the lower, small size and low resolution sub image is placed in the upper layer, further generate a pyramidial structure. Because of the strong correlation between adjacent elements of the image, the lower resolution sub images still have the characteristics of high resolution images. Take this into consideration, can use the interval of one row and one column to obtain a pixel acquiring original image pixels, a new image size is 1/4, the first use of new image circle projection template matching, after the combination of acquiring target position again, can be very precise, accurate location. Because the static matching does not need to deal with a large number of points, the amount of 3/4 computation can be reduced.

3.4. Algorithm GPU Implementation and Experimental Results

We take the look-up table method in the calculation process, all thread reads the query table and numerical template feature data from the grid, considering the GPU on each multiprocessor all have 64Kbytes constant memory, the above query table and special template can be incorporated into the numerical constant memory cache, therefore, we choose to join query table the model and characteristics of numerical constants in memory, when one-time to read all the data can be read again, constant memory cache. When reading the image data, because of the large scope involved, it is not suitable for memory sharing, but also the texture memory must be retrieved, and finally the image similarity data is stored in the global memory. Considering the maximum similarity value point search, matching, and calculating the angle of procedure and the calculation are very small, there is a serial calculation, not to take GPU, GPU can be used to implement the rough matching and other calculation using CPU. Practice shows that satisfactory results can be obtained by adopting optimization software and CPU acceleration.

4. CONCLUSIONS

With the progress and development of society, people have higher requirements for daily life, people's lives have been unable to leave the computer equipment. At the same time, the computer equipment in the development process presents a variety of characteristics, with the rapid development of society, image processing technology has also made a corresponding change. In the application of image processing technology, based on the CUDA framework, using GPU technology, to maximize the level of image processing, thus effectively expanding the scope of image processing technology applications. This paper briefly studies the GPU digital image processing algorithm, hoping to provide reference for professionals to study related content.

REFERENCES


