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Application of Parallel Processing - A Case Study in Image Processing

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***Abstract*—In computers, parallel preparing is the handling of program guidelines by separating them among various processors with the target of running a program in less time. In the most punctual personal computers (PCs), just a single program kept running at once. A computation-intensive program that took one hour to run and a tape duplicating program that took one hour to run would take a sum of two hours to run. An early form of parallel processing allowed the interleaved execution of both programs together. There are different studies related to parallel computing and one of them is image processing. The reason for this investigation is to investigate how parallel processing would help in the arrangement of picture preparing. Image processing has been the rapidly developing area and a promising field for analysis. Medicinal imaging, satellite imaging and military intention are those different fields that particular sort of images is prepared for. It is expected that by using parallel processing in image processing, it can speed up the time and decreased cost.**

Keyword: **image, processing, parallel, computing, digital**

I. INTRODUCTION

Parallel processing is especially valuable when running projects that perform complex calculations, and it gives a reasonable choice to the journey for less expensive processing choices. Supercomputers usually have countless microchips for this purpose. Parallel processing ought not to be mistaken for simultaneous, which refers to numerous errands that run at the same time [1]. Parallel processing can be utilized as a part of image preparing. Image processing is a kind of signal agreement in which input is image, similar to video casing or photo and yield might be image or attributes related to that image. Generally, Image Processing system incorporates regarding image of two-dimensional signs while applying effectively set signal processing techniques to them. It is among quickly developing advancements today, with its applications in different parts of a business. Image Processing forms centre research area inside engineering and computer science disciplines as well [2].

II. HISTORICAL BACKGROUND

The causes of genuine (MIMD) parallelism backpedal to Luigi Federico Menabrea and his Sketch of the Analytic Engine invented by Charles Babbage. In 1969, organization Honeywell presented its first Multics framework, a symmetric multiprocessor framework equipped for running up to eight processors in parallel. C.mmp, a 1970s multi-processor extend at Carnegie Mellon University, was among the primary multiprocessors with more than a couple of processors. The primary transport associated multiprocessor with snooping stores was the Synapse N+1 in 1984. SIMD parallel PCs can be followed back to the 1970s. The inspiration driving early SIMD PCs was to amortize the door deferral of the processor's control unit over various directions. In 1964, Slotnick had proposed assembling a greatly parallel PC for the Lawrence Livermore National Laboratory. His plan was financed by the US Air Force, which was the most punctual SIMD parallel-registering exertion, ILLIAC IV. The way to its plan was a genuinely high parallelism, with up to 256 processors, which enabled the machine to take a shot at vast datasets in what might later be known as vector handling. Be that as it may, ILLIAC IV was called "the most notorious of supercomputers", in light of the fact that the venture was just a single fourth finished, yet it took 11 years and cost right around four times the first gauge. When it was at last prepared to run its first genuine application in 1976, it was beaten by existing business supercomputers, for example, the Cray [3].

III. PAPER REVIEW

This section presents the paper involved in image processing using parallel processing.

A. Parallel Computing in Digital Image Processing

This paper focuses on parallel computing in advanced image handling tasks. Distinctive alternatives that accompanied parallel program and the necessities for better performance are given. The types of parallel processing in image processing received are data, task and pipeline parallelism. It has additionally been exhibited for the calculations for parallel image processing tasks. Parallel segmentation by region growing technique and figuring of various top elements of segmented areas, parallel segmentation by global thresholding of the picture and histogram equalization of an image by parallel computing would be the three calculations given in detail. A utilization of parallel registering in medicinal imaging is studied in detail. For medical imaging improvement, a work process motor called Taverna is discussed and its plan approach is likewise given [4].

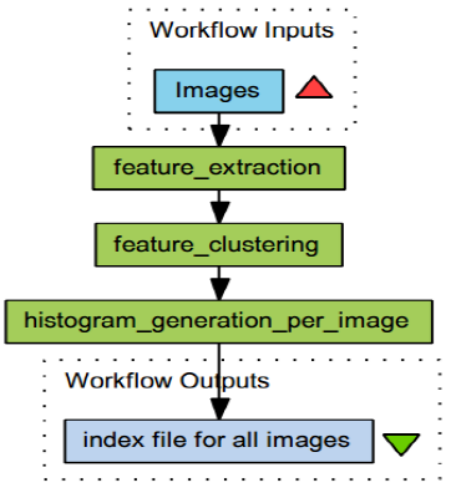

Fig. 1. Conceptual decomposition of a medical imaging workflow for feature extraction into basic components

B. *Parallel Processing for Image and Video Processing Issues and Challenges*

There are various open issues identified with the uses of parallel processing techniques in image and video processing. The inclination is to require progressively refined applications, in progressively little systems. The chip cannot answer essentially this double requirement, and their utilization, their volume and their cost are restrictive for certain applications - videophone on cell phone, disseminated checking, delocalized visual observing in apply autonomy, and so on. More often than not, generally basic systems are required, offering exhibitions coarsely practically identical with those of the chip, however with an electric utilization and an obstruction compatible with the applications. They will be most likely based on pipeline, perhaps reconfigurable, administrators, or SIMD cross sections of little size. All in all, it emphasises that picture and video preparing speak to an imperative down to earth area for parallel computational techniques. This exceptional issue gives a precise perspective of this field, and ideally, will prompt further advances and concentrated research endeavours along the issues laid out above [5].

C. *Parallel Image Processing in Heterogeneous Computing Network Systems*

The DCP design enables the client to efficiently run actual image processing calculations on heterogeneous systems presently while the integrated simulator system can be utilized to foresee the program execution and systems characteristics. For example, the number of processors and processor speed are shifted. Real points of interest of the DCP over the non-primitive-based are usability, automation, optimization. Future work will be to incorporate the visual programming interface and increment number of primitives as well as to examine adaptation to non-critical failure may issues. In spite of the fact that the DCP idea is currently executed utilizing PVM, there is no restriction in selections of communication libraries. Hence the researchers likewise plan to investigate the execution of the DCP utilizing MPI and RCP sooner rather than later [6].

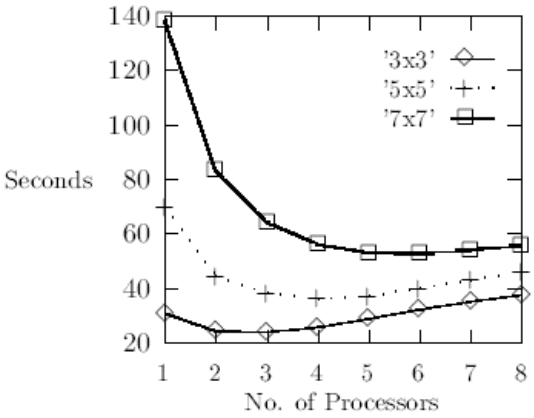

Fig. 2. Response time of DCP for median ltering

D. *A Data and Task Parallel Image Processing Environment*

The study displayed a domain for information and task parallel image processing. The information parallel system, in view of algorithmic skeletons, is anything but difficult to use for any picture preparing client. The task parallel condition depends on the IATG furthermore, registering the IATG correspondence and handling costs. The IATG is a standard very much adjusted chart assignment parallelism that can be connected without the need of these computations. The research demonstrated an illustration of using skeletons and the undertaking parallel system for the multi-gauge stereo vision application. The multi-gauge stereo vision is an illustration of a picture preparing application which contains parallel task, each of the undertakings being an extremely straightforward picture point or neighbourhood administrator. Utilizing both information and assignment parallelism is more productive than utilizing just information parallelism. The code for the information and assignment parallel condition, composed utilizing C and the MPI-Panda library [19, 20] can be effortlessly ported to other parallel machines [7].

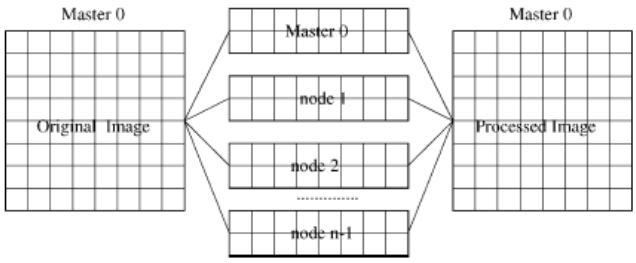

Fig. 3. DCG skeleton for point operators

E. *Digital Image Processing using Parallel Computing based on CUDA Technology*

The utilization of parallel components registering with the GPU can altogether quicken the execution of program. The level of parallelism and the speeding up are dictated by the quantity of free calculations performed all the while. Notwithstanding the way that the investigation of Nvidia

CUDA innovation has been introduced in the field of computerized picture handling PC tomography, it can be utilized for an extensive variety of different applications. For instance, lately, this innovation has quickly incorporated into the program for transformation of video, information, and projects. It implies that it can be material for proficient and at-home utilize, which demonstrates that the innovation is across the board not just in science or industry. Later on, it is prudent to adjust this product application for successive handling of an arrangement of images. Thinking about the consequences of the examination, it merits exchanging all the figuring to the GPU, in the meantime the CPU will give the planning of the following image for the procession [8].

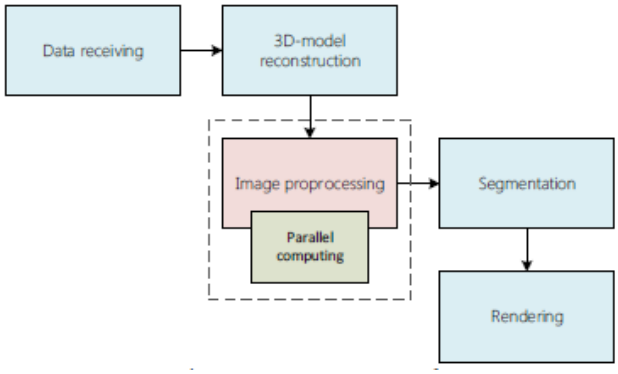

Fig. 4. A computer tomography process

F. A Software Architecture for User Transparent Parallel Image Processing

In this paper the researchers have portrayed a product engineering that permits an image processing researcher to create parallel applications in a straightforward way. The centre of the design is shaped by a broad information parallel image processing library. The use of the library is not anticipated and that would be viewed as 'unwieldy', as it completely sticks to the image preparing analyst's edge of reference. Taking everything into account, the way to deal with actualizing engineering for parallel image processing settle numerous issues regularly experienced in practically identical conditions. Above all, their work demonstrates that it is conceivable to guarantee design practicality, without compromising on the productivity of execution. Given this outcome, the researchers firmly trust that the approach is material in other research regions as all things considered, particularly when the arrangement of regular operations is limited - as is the situation in low level image preparing [9].

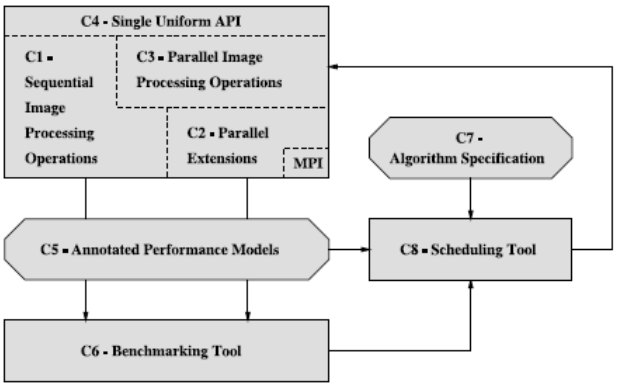

Fig. 5. Architecture overview

G. Analysis of Efficiency of Parallel Computing in Image Processing Task

From the examination of the outcomes for every calculation it can be implied that parallel solutions can enhance the productivity of picture preparing. This announcement is valid under a few conditions. The principal capability is a lot of information where there are arrangement of pictures or high determination images, and so the image preparing time is longer than correspondence and synchronization time. The second capability is a compound calculation subsequent to accepting information for figuring needs a processor for quite a while. Straightforward errands, such as perusing and sparing information, ought to be done on one PC called facilitator, though the calculations ought to be decayed on different hubs. From the examination of the results for each figuring it may be construed that parallel solutions can enhance the profitability of image to get ready. This declaration is legitimate under a couple conditions. The chief capacity is a great deal of data where there are course of action of images or high assurance images, so the image preparation time is longer than correspondence and synchronization time. The second ability is a compound computation that is ensuing to tolerating data for figuring needs a processor for a long time. Direct tasks, for example, examining and saving data, should be done on one PC called facilitator; however the computations should be rotted on various centre points [10].

H. Design and Performance Evaluation of Image Processing Algorithms on GPUs

In this paper, the researchers investigated the outline and usage issues of image processing calculations on GPUs with the CUDA system. They chose four noteworthy spaces 3D shape reproduction, highlight extraction, image compression, furthermore, computational photography and actualized Multiview stereo coordinating, direct element extraction, JPEG2000 picture encoding, and no photorealistic rendering as illustration applications. The chose calculations are parallelized proficiently on the GPU. An arrangement of measurements was proposed to parameterize quantitatively the qualities of parallel usage of chosen calculations. In expansion, these measurements can be utilized on the other hand to think about the two executions of a similar calculation on the GPU. Increasing speed accomplished for singular calculations is

assessed as far as the proposed measurements, while escalated examination is directed to demonstrate the propriety of the proposed measurements. These outcomes can be shared and utilized by different researchers to anticipate the suitability of their calculation for parallel execution [11].

TABLE 1
Dependency between the characteristics of image processing algorithms and the proposed metrics

('-' : None, '★' : Low, '★★' : Medium, '★★★' : High)

Characteristics / Metrics	Large Size Memory Buffer	Frequent Access to Memory Buffer	Sequential Access Pattern	Intensive FP Operations	Intensive Logical Operations	A Mixture of Subalgorithms
Parallel Fraction	-	-	-	-	-	★★
FP Computation to Memory Access Ratio	-	★★★	-	★★★	-	-
Per-Pixel FP Computation	-	★	-	★★★	-	-
Per-Pixel Global Memory Access	-	★★★	★	-	-	-
Branching Diversity	-	-	-	-	★★★	-
Task Dependency	★	-	★	-	-	★★★

I. Image Processing Application using Parallel Computing

CUDA is the product stages that are backing GPUs by Nvidia. In this study a couple of image processing applications are examined. The outcomes are analysed by actualizing those in CPU and in additional GPU. Many image processing applications have been produced and still the research is going on around there. GPU goes about as a registering co-processor for the utilization of image processing with the goal that profitable measure of time is spared. Analysts have utilized the figuring capacity of GPU and in addition multi-CPU framework [12].

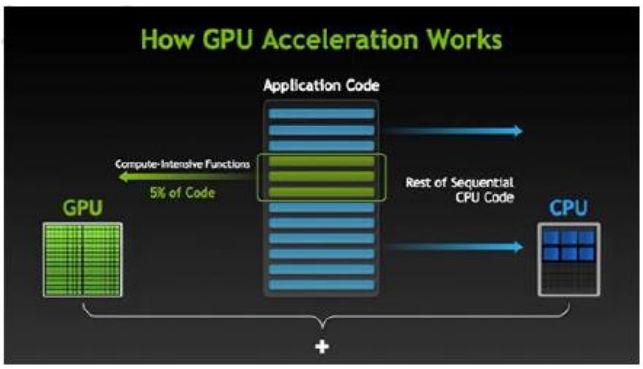

Fig. 6. Working of GPU

J. Parallel Computation in Medical Imaging Applications

There is as of now a quickly developing enthusiasm for parallel calculation application in different medicinal imaging and image preparing fields. This pattern is relied upon to proceed developing as more modern and testing restorative imaging, image preparing, and high-arrange information representation issues are being tended to. The progressing cost drop in computational instruments and their wide openness play a middle part too. Given its short history, this zone is as yet not an all-around characterized logical train. The chosen themes and papers for this unique issue shed all the more light on different parts of this extending field and its potential in quickening medicinal imaging applications [13].

K. Parallel Image Processing Applications on a Network of Workstations

In this paper, attempt was made to have actualized proficient parallel image convolution calculations for dim level images and twofold pictures on a system of IPC SUN Spare workstations associated by an Ethernet organize. The researchers conducted test to show that critical speedup can be accomplished in this processing condition for these applications. They likewise exhibited an execution forecast display that concurs well with the trial comes about and can be utilized to lessen the quantity of tests that ought to be conveyed to locate the most elevated execution for a given image preparing application on a system of workstations. The principle restricting component of this figuring condition is the transmission capacity of the system. Subsequently, with the development of fast systems, this figuring condition can be an alluring other option to customary MIMD and SIMD multiprocessors for computationally escalated applications particularly in the range of image preparing [14].

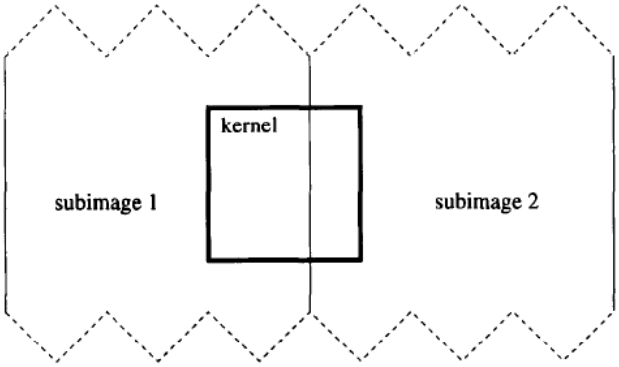

Fig. 7. Pixels on the boundary of a sub-image need neighboring pixels from another sub-image for the computation of their convolution values.

L. Parallel Image Processing System on a Cluster of Personal Computers

An operation-based parallel image processing framework for a bunch of PCs was introduced. The primary target is that the client of a computationally requesting application may profit by the computational power disseminated over the network while keeping other dynamic clients undisturbed. Other non-specific modules will be parallelised and tried so that a steadily expanding number of picture investigation techniques might be collected from them. Application areas other than picture examination may likewise profit by the proposed technique [15].

M. Parallel Processing Considerations for Image Recognition Tasks

All through the paper, many tests have been attempted to highlight how parallel computing can be utilized to play out the slower assignments - OCR, picture division, and so on in parallel. Speedier tasks, for example, voting or meta-algorithmic example application, can be promptly kept running in serial with practically zero impact on execution. In fact, turning this around, it is conceivable to consider how to

plan picture acknowledgment frameworks to upgrade their execution. Figure 8 demonstrates how a thought of the framework design unpredictability can be assessed in light of how information streams in arrangement, in parallel and through criticism circles in the engineering. The design in chart A crumples to a multifaceted nature rating of 15, which can be analysed against different models. As a rule, higher complexities will be all the more exceptionally trainable and hearty for a given errand. Be that as it may, this accompanies a value that is execution, multifaceted nature of framework design, the requirement for all the more preparing information, and so forth [16].

N. Point-to-Point Processing of Digital Images using Parallel Computing

Test were performed for handling and utilizing parallel figuring. For this reason, eight modules were executed utilizing CUDA for running in a GPU. Because of a few channels are not actualized in OpenCV, two channels were produced utilizing C without advancement; and this was reflected in the extensive contrast in execution times. At the point when the examination was finished with OpenCV capacities, the pickup extent was not as much as the C module. The reality of this vast contrast enables us to finish up two things: 1) CUDA builds the execution of a few undertakings that need a huge number of operations and 2) it is conceivable that it acquires better circumstances if the code is upgraded, for this reason, the pickup in parallel might be not extremely critical. In any case, from the outcomes it can be reasoned that CUDA acquired preferable outcomes by and large over OpenCV. Future works incorporate testing the way to deal with figure Haar-like elements for protest arrangement [17].

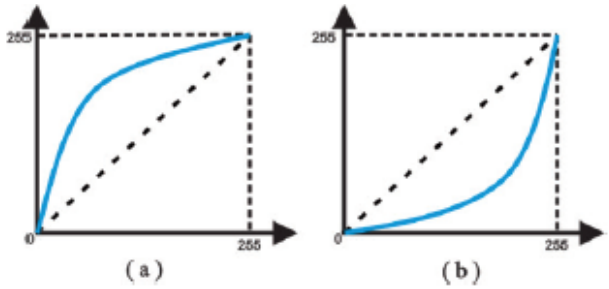

Fig. 8. Graphic for (a) bright image and (b) dark image

IV. CONCLUSION

In this paper, it can be concluded that by using parallel processing, image processing can be done with least cost and it can speed up time. It can also be seen that the development of parallel processing is mostly within the image processing. The most used application for these researches is CUDA and GPU software. In this world of development era, it can be considered that human want something to be done at the same time as well as through rapid way. Parallel processing has been used in various fields to accomplish the needs of humans so that many unfinished works can be done at the same time. As discussed, parallel implementation of image processing is found to be a great area of interests by different researchers because of its performance, suitability, and availability. Research projects realize that some techniques are discovered to provide limited applications and needs more computational knowledge. Finally, several cases have also been reviewed including applications of parallel image processing in medical imaging and some techniques are highly preferred to employ parallel image processing in various techniques of medical imaging for fast and efficient results for the purpose of treatment and medical planning.

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