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Computational Benefits, Limitations and Techniques of Parallel Image Processing

[1]Maha Heng Li and [2]Marinka Yu Zhang
[1,2] Department of Biomedical Informatics, Harvard Medical School, Boston, USA.
[1]mahahengli@yahoo.com

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Abstract - The main purpose of digitalized image processing is to enhance the quality of images and subsequently to facilitate the process of feature classification and extraction. This process is effectively utilized in healthcare imaging, computer visioning, astronomy, meteorology, and remote sensing among other essential fields. The main issue is that this technique takes a lot of time even though it provides convenient and efficient means of addressing the prevailing issue. In this paper, we shall provide a comparative evaluation of the present contributions adding to the application of parallel image processing including their limitations and benefits. Another key segment of research in this paper is to evaluate parallel computing, presently available techniques, tools and architecture in different image processing applications. As such, this paper is purposed to critically evaluate the role of parallel imaging in the field of healthcare imaging.

Keywords - Parallel Image Processing (PIP); Graphic Processing Unit (GPU); Healthcare Imaging; High Performance Computing (HPC).

1. Introduction

Currently, image processing is vital and applicable in various fields such as computer science, optics, surface science, mathematics and visual analysis for fields such as meteorology, feature extraction, remote sensing, optical sorting, argument reality, astronomy, lane evaluation and microscope imaging among others. In most cases, it might take a lot of time to properly execute a number of applications for instance the point processing of the grey scale imaging in the Central Processing Unit (CPU) in the process of executing more than a million operations. As for colour imaging, the case is multiplied by multiple channels based on High Performance Computing (HPC). In the present years, parallel processing segment has been viewed as an incredible tool for the process of implementing high speed computing. In the process of implementing image processing a number of contributions and researches have been done based on the application of Graphic Processing Unit (GPU), Java, OpenCV and Computed Unified Device Architecture (CUDA) among others. Nonetheless, it is essential to identify the most effective technique of parallel computing for certain applications of image processing. In this paper, we have focussed on various researchers and scientists concerning the present parallel image processing methods and tools that are globally applicable. Moreover, we have mentioned the limitations and benefits of the prevailing architecture, tools and contributions of parallel computing.

Image processing is two-dimensional form of contribution of minor image segments which are typically known as pixels. It might be considered as a functional element of two different variables; for instance, f (x, y) with the f known as the amplitude, for instance the brightened images at the x, y position. The aspect of image processing represents the manipulation and enhanced images to effectively extract meaningful datasets. Apart from that this aspect is gradually becoming a meaningful segment of research which projects from professional photography to various fields like astronomy and photo shop. Spacing imaging, for instance interplanetary probing images and telescope images including biological or medical images of CT Scans, Microscopic images and PET scanning represent the automated feature of image recognition [1]. The automated elements include face recognition, remote sensing and satellite recognition. There are various methodologies utilized in the segment of image processing, since they make it possible to extract data from the images. A number of researches have classified image processing into three broad segments: low level, intermediate level and high level.

The pre-processing of pictures is typically engaged in the elimination of minimal-frequency in the background noises hence normalizing the intensiveness of particular images. Moreover, the aspect of pre-processing also enhances the quality of data images before image computation. In this research, we have proposed a methodology to boost the quality of image edges and minimizing the noise intensiveness of certain images in the image segmentation process. Pre-processing incorporates histogram equalization, image sizing, median filtration and image cropping. In this technique, globalized histogram equalization was utilized as a perfect methodology for texture and contrast enhancement in medical imaging.

Corresponding author at: Maha Heng Li, Harvard Medical School, Boston, USA.

Researchers have also projected the healthcare image edge identification aspect where pre-processing is viewed as prevalent healthcare image for conventional techniques which is not effective in the filtration of pepper or salt noises. Morphological erosions have been considered to be the most effective filters for eliminating pepper noises and salt [2]. The experimental findings are ineffective for healthcare imaging cancellation of noises. Pre-processing has been categorized into grouped pixel which is graduated into super pixels.

Healthcare researchers have collaborated with the manufacturers of super pixels that are coherent and localized in structural segmentations. This is applied in the normalization of the cut algorithms to project super pixels and mapping. Both the texture cues and contours are utilized in pre-processing. Image compression is considered as an application of information comprehension to encode the initial image with some form of bits. The main purpose of image comprehension is to minimize the redundancy of images and encrypt or transmit them into a more efficient manner. The vital purpose is to minimize the storage quantity incredibly and to decode images being projected in the monitors and just the same as the initial images. In that regard, this paper presents an evaluation for the G band chromosome in edge imaging detection. This form of detection is viewed in four various techniques: Sobel, Robert's, Laplacain and Canny in the G band chromosome. The findings in their analysis show that the Robert's technique obtains a significant form of accuracy in comparison to the other remaining algorithms. The watershed change algorithm signifies a novel methodology which is applicable in the segmentation of images based on a mathematical morphology. The segment is centred on the watersheds changes [3]. To effectively control over-segmentation, it is essential to recommend the adaptation of topological gradient techniques.

2. Background Analysis

In the lower level image processing, images are converted to image data. For instance, object categorization and pattern recognition. In the typical flow diagram of various steps of image processing, various segments of image processing include image pre-processing and image acquisition as shows in the Fig 1 below.

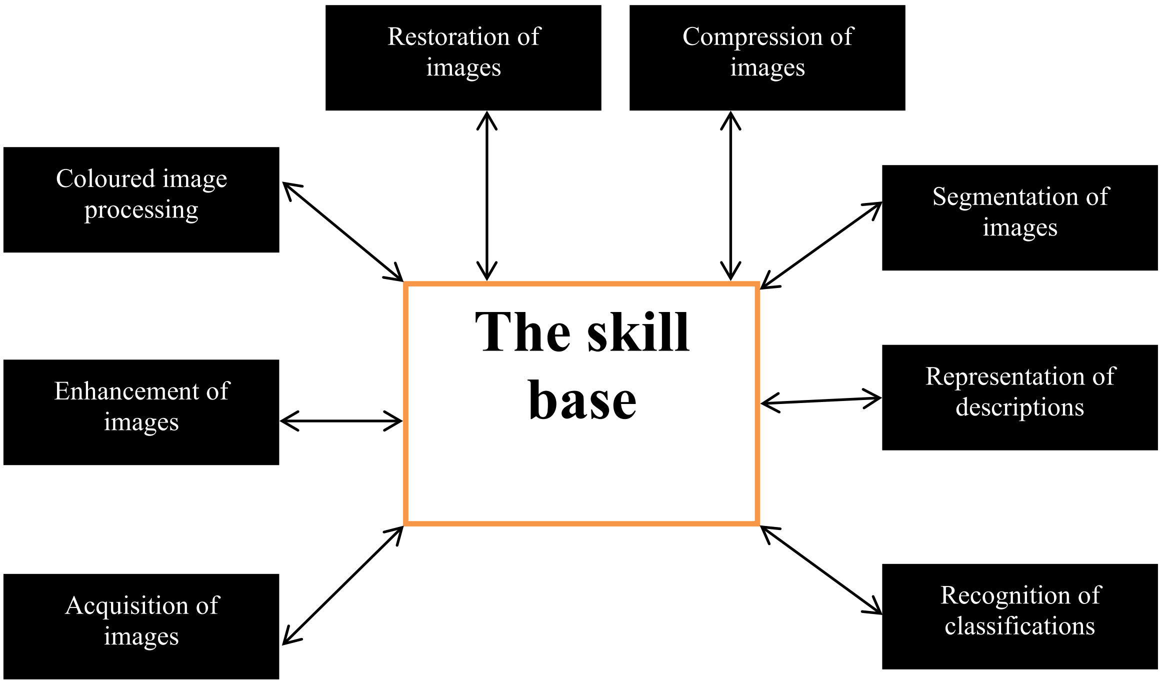

Fig 1: The various major steps of imaging pre-processing

In Fig. 1, we have visualized the various major steps of imaging pre-processing which will be discussed critically in this paper to evaluate more about parallel computing is significant to image processing. In this paper, we have projected a highly-scalable imaging compression framework, in respect to researchers' proposal of the Set Partition in Hierarchical Tree algorithm known as HS SPIHT. These researchers have proposed the algorithm to provide researches with effective scalability to minimize the sizes of images and also assure an effective compression ratio. Lastly, it was deemed that the algorithm is meant to diminish the bit stream and scalability. Image edge detection is a terminology used to explain and establish mathematical techniques that focus on identifying certain points in digitalized imaging where image brightness transforms incredibly or with discontinuities. In the present literature, to methodologies of segmentation algorithm such as Otsu threshold and Canny edge imaging detection has been projected. The efficiency of the projected algorithms has been analysed for both medical

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and non-medical images. As for non-medical pictures, two algorithms have been seen to turn into good segmented pictures [4]. The Canny segmentation is considered more suitable compared to the Otsu segmentation concerning the tested endoscopic pictures due to the unclear variations of elements and objects available in the background and also for MRI grey scaled pictures.

Picture segmentation centred on watershed and edge determination methods has widely been recognized in research which represents K-means, Different in Strength (DIS) and watershed segmentation techniques in the process of performing image segmentation and edge determination tasks. These researchers have utilized two methodologies: watershed methods with novel merging processes centred on the mean intensity value which is focused on the segmentation of the picture region and boundaries. Another technique is the edge strength methodology that is targeted on obtaining accurate edge mapping of an image without the application of watershed technique. The researchers mitigated the issue of unwanted over-segmentation findings through the application of the watershed algorithm when utilized with raw information images [4]. Moreover, edge mapping methodology is reported to have limited broken lines on the complete images. Whereas, the final edge detection finding was locked boundaries in reference to the actual images.

This research has evaluated the close connection of graduated non-linear scale space representation: morphological levels and anisotropic diffusion filtration that forms the process framework through the mode of combination. The recommended framework was incorporated to watershed segmentation and edge detection obligations. Experimental findings on automated olive tree extraction and the watershed segmentation indicated its efficiency as the pre-processing framework for edge segmentation and detection from remote sensing pictures. These findings were projected on the panchromatic spatial resolution satellite sensing information process. However, the enhanced scheme might be applicable to multidimensional and coloured images through the mode of processing every channel as a separated framework.

The researchers have presented techniques for edge segmentation of satellite pictures. They made use of 7 critical methodologies for this segment: Sobel, Prewitt, Kiresh, Laplacian, Canny, Roberts and Edge Maximization. The kind of experiments was executed based on various techniques Perwitt, EMT and Kiresh methods which represent the most effective methodologies for edge detection in the developed Watershed Image procedural segmentation. The picture was transformed into the grayscale then the canny edge detectors which were applied after some form of enhancement processing where watershed was finally applied. The process of evaluation in segmentation was projected based on the comparison of every object in typically segmentation with elements in maker and controller watershed segment or the projected methodology.

3. Literature Review

Researchers have projected a framework that will maintain the quality of pictures after the compression of images through the Wavelet Algorithm. In their research assumption, PNG and JPEG images have been utilized. In their assumption, it was noted that JPEG images reduced by typically a half the original image through the application of the HaaR wavelet algorithms which means that JPEG pictures was utilized in the Lossy compression framework by still was reported to maintain its quality and image data. In that case, the researchers projected a remedy which was meant to enhance the quality of images. The project image enhanced in quality was segmented based on the application of modified watershed algorithms which applies the mean-shifting clusters. The boosting methodology project a hybrid segment which interlinked wavelets, CLAHE and enhanced anisotropic diffusion to effectively enhance the input satellite pictures. Three vital algorithms have been utilized in the process of segmentation to represent the conventional mean-shifting algorithm: the clustering-centred, K-means and the modified watershed algorithms.

Different experiments have certified that modified watershed algorithms projected effective segmentation findings when contrasted to other forms of algorithms. The projected watershed algorithms considered the over-segmentation procedure more effectively, but the under-segmentation procedure has not been considered critically. In medicinal segments, the compression of images utilising inter multiple wavelets transformation for the tele-medicinal application has critically been considered effective encoding technique for the integer wavelet transformation scheme for healthcare application. The projected algorithms amounted to effective quality of images. The research also concentrated on the application of the lossless of data in the images. They projected the multiwavelet considering the compression of this issue that has been viewed to have effective coding effectiveness and minimal computing complexity compared to the present methodologies. The effectiveness of high PSNR was as a result of the enhancement of the compressing ratio. Researchers have discussed the comprehension methodologies like JPEG 2000 [5].

The projected methodology enhances the findings of the marker controller watershed. The researchers evaluated the interaction defining the segmentation of images based on the application of various edge detection methodologies and object identification. Edge detection methodologies such as Sobel, Prewitt, Kiresh, Laplacian, Canny, Roberts and Edge Maximization are utilized in image segmentation. Genetic algorithm, OTSU threshold algorithm and Edge Maximization were applied to showcase the synergy defining the image segmentation and the recognition of objects. The OTSU algorithms and Edge Maximization algorithm showcased steady segmentation result. The researchers have also discussed the number of picture segmentation methods which are applicable in privacy and security frameworks. Edge detection is known widely as an approach for the identification of useful discontinuity on the grey level.

Corresponding author at: Maha Heng Li, Harvard Medical School, Boston, USA.

The comparison evaluation of different image edge identification methods have been represented on the finger print image. The image evaluation framework indicated that Sobel, Prewitt, Kiresh, Laplacian, Canny, Roberts and Edge Maximization are better in performance categorically [6]. The evaluation of quality in edge identification of the G band chromosome for segmentation analysis is applicable in edge detection of the G band chromosome type of images. It is also considered as a fundamental pre-processing stage in the process of image segmentation. The G band chromosome is known for its noisy and poor-quality images. Majority of edge as a result of chromosome might mislead the edge detection algorithms. The watershed alteration linked with the rapid algorithm centred on the topology gradient aspect assures the best results.

The vibrant watershed segmentation of the noisy pictures based on the application of the wavelet has critically been evaluated by researchers as an incredible measure in the process of dealing with de-noising. The soft threshold methods have also be applied in the analysis of de-noising techniques due to their effective performances compared to other forms. In this paper, we have attempted to prove the relevance of soft threshold wavelets in part concerted on the segmentation of watersheds on the noisy pictures which has seen to bear fundamental results. It is also projected that rapid watershed transformation determines salient elements in a particular picture. This form of transformation is significantly different compared to the ancient watershed as it doesn't depend on the mathematical morphology any longer.

The transformation began with the sorting of images and pixels in reference to their levels of intensity before storing them in their FIFO structures. It was easier to implement this strategy based on the application of the chain codes and algorithms. Moreover, it was considered rapid compared to any other forms of watershed algorithms. Incorporating this rapid watershed with the power-centred segmentation usually amounts to a novel segmentation technique known as the rapid water snake. This methodology minimizes the over-segmentation and aspects of under-segmentation as a result of thick water sheds without necessarily involving the markers.

Researchers have also projected fundamental image segmentation technique for the fingerprints and its segmentation through the capture of ideas from the frictional ridges of the human fingers which also covers the effective storage capability for the pictorial segmentation. Watershed algorithms are dependent on the ridges meant to perform effective forms of segmentation which is typically based on the contour identification where object boundaries have been determined by ridges. This aspect of watershed algorithms was utilized in the process of segmentation. The dataset sizes are considered a major issue in this entire process. In that case, the researchers had to encrypt these image segmentations of fingerprints other than the ancient images to effectively minimize the sizes of the image databases. It is also projected that there is an algorithm centred on the merging morphology of the watershed amounting to the advanced edge detection findings.

Considered as a post-processing aspect, to every segmented part found the coloured histogram algorithms have been applied to determine the general performance of the watershed algorithms. The recommended methodology boosted the result of the marker controllers of watersheds for the degraded pictures. It has also been discussed by the same researchers to recommend a novel approach related to the watershed algorithms based on the application of distance transformation of image segmentation. Following the application of the watershed algorithms, the research achieved an over-segmentation form of imaging. These watershed algorithms in conjunction to the Laplacian of Gaussian edged detectors have been applied in the process of detecting the edges of the pictures and producing images that are somewhat over-segmented [7]. It is also presented to project an approach meant to count the variation of the blood cell in the process of smearing blood in a lab test. The technique was projected based on the application of segmentation that significantly involved the morphology of watershed transformations. The operations of morphology have been applied in the process of creating masks and the marker-centred watersheds and transformations applicable in the cell segmentation. The masks for every form of cell might be obtained based on the application of the morphological operations and conversion of colours.

4. A Critical Evaluation of Parallel Computing and its Ecosystem

Parallel computing, typically known as parallel processing represents a procedure of simultaneously using different computing resources to mitigate computing issues, works and tasks. The vital element of parallel computing is to effectively subdivide tasks in a manner that operators can execute them within a minimal timeframe with maximum efficacy. To effectively implement parallel computation, operators have to utilize some form of parallel machines which involves a collection of computers that are linked to a wide-range of PCs linked to the elevated rapid networks. This further represents a shared memory and multiple processes through the connection of multiple system processors in one memory framework which the Chip Multiple Processor is including the processors typically known as cores on a chip [8]. There is various application of rapid performance in parallel computing in different fields such as atmosphere, ecosystem, earth, nuclear, applied physics, mathematics, engineering and computer science among others.

4.1 The Foundational Concepts of Parallel Computing

Researches have recommended a generalized terminology that represents parallel computing. This represents a user 'computing in a box' and incorporates a wide-range processors, cores and CPUs. These elements are networked incredibly to incorporate the supercomputers

- The core, processors and CPUs: The Central Processing Units (CPUs) have for a long time now been considered as a major element of the computer. In that case, multiple CPUs have been incorporated in nodes. As such, an individual CPU has been grouped into a number of cores whereby each of them incorporates exclusive unit segments.

- Task: This is considered as a logically-variant element of computing efforts. The tasks are typically known to be programs and commands that have been executed by processors and cores. The parallel programs which incorporate the various tasks operate in the various processors.
- Pipelining: This aspect is known as the breaking of a job or task into a series of steps that are executed by dissimilar processing elements, where imputing streams have been included in the assembly stripes.
- Shared Memories: In the viewpoint of hardware systems, this element is viewed as a computer framework whereby all the processors and cores have effective accessibility to the regular memories in the physical architecture. According to the programing perspective, it is considered as a framework or model where concurrent jobs and tasks have one picture of the memory which can effectively access and address simple logical memory geography other than the places where physical memories exist.
- Symmetrical Multiple Processors (SMP): This element represents the hardware system whereby a number of processors have shared a solitary address avenue with the capacity to access a number of resources in what is typically known as shared memories in computing.
- Distributed Memories: According to the perspective of hardware, this element is considered as a network-centred memory access point utilized for physical memory assumption. According to the programming view point, obligations and tasks might rationally visualize machine memories which have to apply communication modes to effectively access the memories included in other machines whereby the incorporated tasks have been executed.
- Communications: As for this element, parallel tasks typically require the swapping data. This element can be attained using a number of ways such as shared memories bus or through a system of networks or through actual events of information exchange, typically known as methodology employed in communication.
- Synchronization: This applies to the synchronization of parallel tasks in a timely manner and mostly efficient connected to communication. The process is typically implemented through the establishment of coordinated points in the application systems where jobs might not be executed until further jobs attain a specific logically comparable aspect. In general, synchronization incorporates the patience of waiting on a single job which can affect the concurrent application as the time for execution increases.
- Granularity: In the segment of parallel computing, this mode is considered as a qualitative segment of proportional computing in the segment of communication.
- Parallel Overheads: This element represents the timeframe required in the process of coordinating parallel tasks which is contrary to the execution of fundamental tasks.
- Scalability: This element represents a parallel framework that is representing the capacity to divulge the balanced increment in the parallel speeds based on the incorporation of computing resources.
- Performance Measure: The measures of performance represent a number of metrics which are utilized in the quantification of algorithm quality. Based on the assumption of the quality measure of sequential algorithm, this mode is typically considered in terms of space and time. Nonetheless, for the quality measure of parallel algorithms, this segment is dependent on the parallel systems and the kind of processors incorporates in them. In this measure, we will critically evaluate the measures and metrics used to determine the performance of parallel processing framework which have been evaluated in a number of literature sources.
- Parallel operation time: This represents the timeframe taken by programs that are executed based on the n-processors in parallel computing. Whenever n equate to 1, T (1) represents the sequential operation time for the program with a single processor. This is essential as a measure to evaluate parallel computing. As such, this element determines the manner in which parallel algorithms operate considering the most effective sequential aspect. For the issue of the n size, the speeding expression is considered as below.

$$Sp = T(n,1)/T(n,p) \qquad (1)$$

In the above expression, Ts (n, 1) represents the timeframe of the most essential sequential algorithms: $Ts\ (n,1) \leq T(n,1)$ and $T(n,p)$ which represents the timeframe of parallel algorithms considering the 'p' processors in the process of mitigating the same issue. Presently, there are assumptions that the speedups are linear in the aspect of super linear measurements and the various frameworks of the speedup operation such as the fixed timeframe, scaled speedups and fixed sizes. Let us now evaluate the speedup measurement laws which include Ni's, Sun's, Gustafson's and Amdahl's laws that are typically known as speedup protocols [9]. The Amdahl's law is typically utilized in the process of projecting the

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theoretical speeds at a high measure based on the application of many processors. According to this law, the speedups representing a specific program utilizing many processors in parallel computation has been restricted by the sequential program portions.

For instance, for the 95% program which is parallelized the theoretical frameworks utilized the parallel computation framework might be considered to be twenty times more [10]. However, this doesn't govern the processors' number being utilized. According to the Gustafson's law, the increment in the issue for the massive machines might possibly retain the mode of scalability according to the processor dimension. In the Ni's and Sun's law, the idea of memory bound and its models is incredibly modelled. This results to the speedup computing by the issue size which is limited by the present memory available in the n-processor framework. As such, this amounts to the generalization of the Gustafson's and Amdahl's protocol. Efficiency is considered a measure of the manner in which processors are deemed efficient following their application in parallel programming. This mode is expressed mathematically as shown below:

$$Ep = \frac{Sp}{p} = \frac{Ts(n,1)}{pT(n,p)} \leq 1 \qquad (2)$$

In the above expression, Sp represents the speedup operation, whereas Ep is the algorithm efficiency with the p processors and $T(n,1)$ is the timeframe of the most effective sequential algorithm: : $Ts\,(n,1) \leq T(n,1)$ and $T(n,p)$ which represents the actual time for the parallel algorithm in the p processors with the capacity to mitigate the same issue. The elements above are fundamental performance elements in the process of parallel programming which are applicable by various researches. Other than these metrics, there are others such as the memory bandwidth, watt performance, Work and Span Flop in the process of evaluating parallel programming.

4.2 Implementation of Parallel Imaging Processes

There are advantages and disadvantages in the sector of parallel computing which has incredibly been evaluated in literature. Until now, there are several approaches that have been put in place to implement parallel image processing and computing. These approaches include: OpenCL, Hadoop, CUDA and GPU among others. A number of these approaches are informative and significant. Nonetheless, there are some other methodologies which are implemented by various researches that have not been evaluated in CUDA and GPU in the segmentation of time.

5. Parallel Systems, Methodology and Tools in the Implementation of Image Processing

As seen in the section above, various researchers have implemented various methodologies and algorithms in parallel imaging utilizing various tools and architecture such as CUDA, MATLAB and Hadoop among others. At the moment, this subsection is going to evaluate some of these techniques in an in-depth evaluation: advantages and disadvantages. The graphic processing units represent some of the cores of parallel imaging with a number of cores. This segment is also referred to as the Visualized Processing Unit (VPU). It includes a wide-range core whereas the novel CPU's includes about four to eight elements. In the meantime, a fundamental issue in image processing considers a number of application that require a significant amount of energy to effectively attain a massive amount of precision and actual-time performance that cannot be achieved easily with the CPU.

5.1 Graphic Processing Units (GPU)

Each NVIDIA-GPU incorporates approximately 8 to 240 parallel cores whereby every core includes approximately four units: compare unit, logical unit, point unit and the branch unit. The core available in GPU is controlled by the manager thread with the capacity to control more than 12,000 threads in a single core. This element has been formulated to be bendable and can be applied based on the application of high level languages. Moreover, it can effectively support the 64-bit and 32-bit floating points which also provide significant GFLOPS application in clusters, desktops and laptops. It can be noted that GPU parallelism can possibly be doubled about each year [11]. Apart from that, GPU projects high densities of parallel computing whereby it possibly executes the program in a specific time plan. In this manner, it can make calculations through the CPU and GPU cycles and utilized in mostly prioritized obligations

Advantages

The merits of utilizing GPU have been evaluated extensively in literature. These include:

- More condensed consumption of energy
- Genuine programmability and the capacity to hold energy with high precision in a specific pipeline
- Assures high flexibility, programmability and portability
- In the GPUs, CPU operates with this framework in a co-processing and heterogeneous manner.

Disadvantages

There are a number of demerits or drawbacks associated with GPUs. These include:

- Achieving speedup which necessitates that algorithms have been coded to correspond to the GPU programming and architectural frameworks for the GPUs structured for traditional CPUs. Certainly, including GPUs into the existing codes is considers more difficult compared to simply transiting CPU to another segment or programmer. The programmers have to dig into the codes and executing significant transitions based on the essential elements.
- Including GPU hardware in the system adds asset in the consumption of power and the production of heat. A number of job mixes might as well be

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considered economical through the systems that potentially maximize the CPUs.

5.2 Computed Unified Devices' Architecture (CUDA)

This is a scalable parallel process aspect and software ecosystem utilized for parallel processing. CUDA is also applicable as a programming standard since its release in 2007.

Advantages

- It is utilized to enhance software which are typically applied for graphic processing and to enhance the diversity of generalized application in GPUs and running a wide-range cores and processors. Moreover, it utilizes the language which is analogous compared to the typical C language with an incredible learning curve.
- CUDA incorporates a significant extension to the kind of language used in programming. Moreover, it includes certain features such as API calls and a number of novel quantifiers to apply system variables and functions.
- CUDA has certain elements and functions known as kernels which might be an element of complete programs in the CPUs. As such, it provides the same synchronization and memory assumptions of GPUs-centred Tesla framework. The graphic card which supports the framework includes Tesla, Quadro and Ge-Force 8 series.

Disadvantages

- Only formulated to run in non-graphic interfaces.
- The software enhancement kit incorporates debugging, compiling, profiling and library tools.
- The programming obligations are not complex and sophisticated and in the C language.
- It is typically encrypted to the NVIDIA-GPU only.
- Operates host codes via the C++ compilers which means that the C standard is not fully supported.
- It does not support the texture rendering.

5.3 Multiple Thread Java

In parallel computing, a thread is considered as a unit of task that can be dispatched. These elements are light-weighted procedures within a specific procedure. A single procedure represents a collection of typically more than a single thread connected to a resourceful framework. Apart from that, Java incorporates a thread-centred multiple tasks which are conceptual programming elements whenever a process or a program have been categorized into more than two sub-processes and are executed at the same timeframe [12]. The multithreaded programs incorporate more than two elements that operate a coherent manner. Every segment of the process is known as a thread and dispatched as a unit of operation. They are light-weighted procedures in a specific process. The life cycle process in this measure represents a single thread that is connected to a system of resources as shown in Fig 2 below.

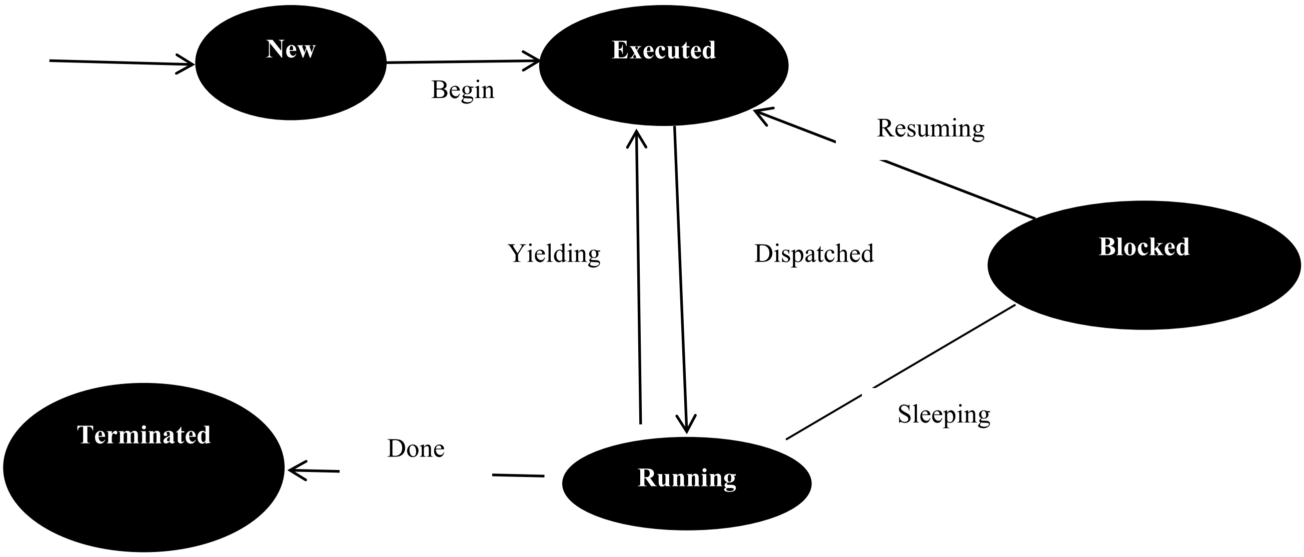

Fig. 2: The Thread Life Cycle

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Advantages

- The threads have the capacity to share a single address and space.
- In general, the context switch in the thread is typically considered economic.
- The thread inscribes the connection between it which is typically affordable.
- It enhances system performance and concurrency.

1) Disadvantages

- It is not easy to inscribe multithreaded processes and programs also, expert programmers are encouraged to do the coding of different applications.
- It is not easier to replicate bugs in multiple threads or multi-contexted application compared to a single thread application or a single-contexed application. In that case, it is challenging to verify and identify the cause or mistakes that occur in the system.
- Many threads can hinder their performances in many cases of connecting hardware caches.
- The time of execution is not boosted hence degraded, even when a single thread is being executed. This is typically the case for slower frequencies or the pipeline stage that are essential for the accommodation of hardware in the thread switch.
- It is significantly observable to support the hardware system which is more observable hence requiring constant transformation of applications and operating systems compared to simple multi-processing.

5.4 Hadoop

This is an open-sourced software project which permits the parallel processing of massive amounts of data in commodity services. The software is certainly designed to scale from one server compared to simply depending on several machines with massive measures of error lenience. Instead of depending on the high-end software, the mode of resilience in the cluster originates from the capacity of these hardware applications to handle and mitigate the faults evident in applications.

Advantages

- It is possible to add novel nodes as required without necessarily transforming the formats of data, the manner in which data is loaded or how tasks are written.
- It brings about the concurrent computation capability of services which results in the massive storage of big data.
- It is considered schema-effective with the capacity to communicate with any form of data, whether structured or unstructured. Information from numerous sources might be aggregated and connected in a number of means which permits effective evaluation compared to a single structure.

Disadvantages

- HDFS, Hadoop and MapReduce are considered sophisticated since the software in active enhancement requires sophisticated expertise.
- The programming framework is considered significantly restricted.
- Interlinks multiple sets of data which are considered slow and tricky to comprehend.
- Clustered processing is considered challenging.
- Not useful for small data.

6. The Requirement of Parallel Computing in the Processing of Images

There are a number of studies defining parallel computing and its requirements in image processing. Just like we have evaluated in grey scale processing of images with the dimension sizes of about 1024 by 1024 for the CPU, more than a million operation for coloured imaging can be multiplied by the channel numbers. In that regard, effectively implementing the mode of parallel computing might diminish the timeframe for processing. A number of techniques of image processing necessitate parallel computing illustrated by a number of researches such as operating with images comprising massive resolution power and pixel of 1000 by 1000 requiring enough computing energy to execute operations within an actual time plan [13]. Researchers in [14]-[15] have evaluated the performance evaluation the parallel images and filtration of the multiple core architecture based on the application of the Java Threads and basic picture processing methodologies such as brightness enhancement and contrast enhancement for high computing energy that tend to consume a lot of time. A number of applications in the processing of images based on the application of Java threads have been applied by a number of researches in various fields. In this form of comparison, there are some limitations and benefits that have been reported to have significant application in various fields.

7. Conclusion and future directions

In conclusion, we have evaluated parallel computing as a significant aspect of image processing technologies: noise cancellation, edge detection, image segmentation, image optimization and feature extraction among other. In the sector healthcare, this technology is vital for the process of image evaluation. Over the present years, a wide assumption of approach has been projected for the purpose of enhancing parallel image processing. However, there are disadvantages attached to it, as discussed in this research paper. Parallel systems, techniques and tools for image processing have also been evaluated in this paper to showcase its computational advantages, performance and appropriateness in its actual-time applicability. Since there

Corresponding author at: Maha Heng Li, Harvard Medical School, Boston, USA.

are a number of technologies which seem to be limited in parallel computing application, more research on parallel computing technology is essential. Future research should consider on the enhancement of parallel computing techniques and how they can be applied intelligently in the healthcare systems. Lastly, future research should focus on improving the quality of images in medical imaging using up-to-date techniques. This is projected to enhance the process of delivering patients' results and boosting the quality of treatment planning.

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Corresponding author at: Maha Heng Li, Harvard Medical School, Boston, USA.