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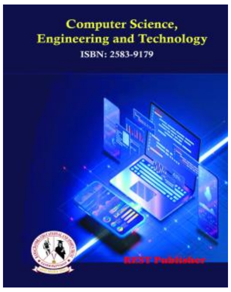

Analysis of High-Performance Parallel Computing using TOPSIS Method

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Abstract. *High-performance parallel computing involves the simultaneous execution of multiple tasks or processes, orchestrated to achieve improved computational speed and efficiency. This approach leverages the power of parallelism, exploiting both multi-core CPUs and GPUs, distributed computing clusters, and specialized hardware accelerators. The fundamental idea is to divide a task into smaller sub-tasks that can be executed concurrently, thereby reducing processing time and enhancing overall performance. High-performance parallel computing is a transformative approach that enables us to tackle computationally intensive tasks efficiently. This abstract highlight its significance in contemporary computing and sets the stage for further exploration of the intricacies and innovations within this dynamic field. Researchers and practitioners continue to push the boundaries of what is achievable, making high-performance parallel computing a cornerstone of modern computational science and technology. High-performance parallel computing research is of paramount significance due to its transformative impact across diverse fields. It empowers scientists to tackle complex problems that were once computationally intractable, unlocking new frontiers in scientific discovery. It drives innovation in engineering and design, optimizing product development and manufacturing processes across industries. In healthcare, it accelerates genomics research and drug discovery, offering hope for improved medical treatments. Financial institutions rely on it for data analysis and risk assessment, shaping the global economy. Weather forecasting and environmental modelling are enhanced, aiding disaster preparedness and conservation efforts. In the digital age, parallel computing underpins artificial intelligence, enabling advancements in natural language processing and machine learning. Furthermore, it has vital applications in national security, space exploration, and materials science. In essence, high-performance parallel computing research serves as the backbone of technological progress, fostering innovation, efficiency, and problem-solving across a wide spectrum of disciplines, ultimately shaping the future of our world. TOPSIS, this method involves evaluating the geometric distance between each alternative solution and two reference solutions: the positive ideal solution and the negative ideal solution. The underlying principle of TOPSIS assumes that the criteria being assessed are of an ascending nature, where larger values represent better performance. To account for disparate dimensions or scales among the criteria, normalization is often employed within the TOPSIS framework. From the result Scatter- free imaging is got the first rank and object-scatter imaging is having the lowest rank.*

Keywords: *Cloud, Virtualization, Map Reduce, Dryad, Parallel Computing,*

1. INTRODUCTION

Cloud providers' infrastructure services, known as Infrastructure-as-a-Service (IaaS), offer a straightforward way for customers to rapidly and effortlessly provision a significant number of computing instances. To perform data-intensive or computationally intensive tasks using these virtual resources, various parallel runtimes are required, whether they are leased from public cloud providers or allocated from private cloud resources. A large portion of tasks that lend themselves well to parallelization, often referred to as "pleasingly parallel" applications, can be efficiently executed using technologies like Hadoop, CGL-MapReduce, and Dryad, which are based on the MapReduce paradigm. These technologies simplify the parallelization of numerous tasks that share similar characteristics. However, many scientific applications still demand low-latency communication methods and benefit from the extensive range of communication tools provided by runtimes such as MPI (Message Passing Interface), even though they involve complex communication patterns. [1] Computational fluid dynamics (CFD) is the process of simulating fluid flow behaviour through the application of computational methods. These methods are used to solve equations derived from the Navier-Stokes equations, and CFD has evolved from a purely scientific discipline into an essential tool for various industries, particularly in the design phases. It finds applications across a wide range of fields, including nuclear and aeronautical engineering. In the domains of propulsion and aeronautics, CFD flow solvers are considered the standard for design and development due to their ability to replicate physical flow phenomena quickly and cost-effectively compared to experimental techniques. However, working with CFD in industrial settings remains complex, as CFD algorithms often require powerful processing systems to generate flow solutions efficiently. High-Performance Computing (HPC) plays a crucial role in this context, referring to parallel processing methods that enable rapid execution of application programs. In the realm of supercomputing architectures, HPC is specifically associated with systems that operate at speeds exceeding 10^12 Floating-Point Operations Per Second (FLOPS). Modern HPC systems utilize symmetric multi-processing nodes linked by superscalar cache-based computing cores. This technology has seen rapid advancement over the past decade, with its affordability stemming from the use of consumer-grade computer technology, as exemplified by the list of Bell Prize winners. However, challenges persist, especially concerning cache-based processors, which are not well-suited for many CFD applications. These processors typically exhibit an average computing efficiency of only 20% for these codes. One of the primary reasons for this inefficiency is the substantial amount of data that flow solvers handle, necessitating extensive communication between various processors and cache levels. To harness the potential of parallel platforms and make them more attractive for CFD applications by reducing computational time and providing access to ample memory, there is a growing need to distribute tasks across an ever-increasing number of processing cores.[2] The advancement of electro holography, specifically the development of holographic 3D screens, has been made possible thanks to the widespread availability of computers. This technique involves capturing and reproducing three-dimensional (3D) images. However, one significant challenge in implementing this technology in practical applications has been the enormous amount of data required for holograms, surpassing the current processing capacity for real-time manipulation. we present a solution to this challenge by introducing a method for generating 108-pixel holograms that can be updated at the rate of a video frame. This achievement is made possible through the use of a specialized holography computer board equipped with eight large-scale FPGAs (Field-Programmable Gate Arrays). By utilizing this approach, we can simultaneously run 4,480 holographic calculation circuits on a single board. When eight of these boards are combined, we can achieve an impressive 35,840 parallel calculations. Consequently, we can update 108-pixel holograms at video speed, opening up possibilities for projecting 3D movies, utilizing 3D images comprised of 7,877 data points. Furthermore, our research demonstrates that as the number of parallel circuits increases, the system's speed scales linearly. Our system operates at 0.25 GHz, a performance level comparable to a high-end computer's effective speed of 0.5 petaflops (equal to 10^15 floating-point operations per second) [3]. Due to the advancement of new technologies, like enhanced connectivity and automation, transportation systems are growing in complexity. This complexity necessitates the implementation of more advanced control mechanisms to ensure efficient operation in terms of energy consumption, mobility, and productivity. Various stakeholders, including governmental organizations, businesses, and local communities, share a common interest in achieving effective outcomes. However, there is a scarcity of resources available for developing a comprehensive understanding of urban dynamics. While simulating large-scale, high-fidelity transport networks can be beneficial, it remains a challenging task. This difficulty arises from the substantial computational burden involved in processing vast amounts of data and the intricate nonlinear interactions between system components and traveling agents. various applications, such as electronic transactions and the operation of Bitcoin, the SHA-256 algorithm plays a critical role. Enhancing the processing capability of SHA-256 is a crucial aspect of advancing this hashing algorithm to boost profitability. This research introduces a high-performance hardware design for SHA-256 hashing. The calculation of SHA-256 is restructured to align with the hardware's characteristics. To mitigate the extended critical path and compartmentalize the computation process, the round functions' critical path is substituted with three distinct pipelines. This approach enables parallel computation of SHA-256, potentially tripling the computational capacity compared to the conventional implementation. The proposed SHA-256 hardware architecture is implemented and synthesized using Intel's 14nm technology. Simulation and synthesis data indicate that this approach can increase SHA-256 hashing performance by a factor of three while reducing power consumption by 50.7%. However, it comes at the expense of requiring 2.9 times the area compared to the traditional implementation [5]. The transition into the petascale and exascale eras of high-performance computing (HPC) is currently driven by the increasing number of cores found in modern microprocessors. This presents a challenge for application developers due to the complex memory hierarchy in hybrid systems, which involve distributed memory between nodes and non-uniform memory access within each node. To address this challenge, a hybrid programming approach that combines both MPI and OpenMP paradigms is employed.To illustrate the performance of this approach, we conducted tests on various multi-core based systems, including an SGI Altix 4700, an IBM p575+, and an SGI Altix ICE 8200EX. Additionally, we implemented enhancements to better align OpenMP with the hierarchical memory structure of multi-core architectures, thus improving data locality [6]In many scientific and engineering applications, huge sparse symmetric positive definite systems Axe 14 b of linear equations must be solved. This process is time-consuming. As a result, numerous parallel techniques for sparse matrix factorization have been researched and applied; for a thorough overview of high speed sparse factorization, see [12]. Practically speaking, our main focus has been on the parallelization of a 2D and 3D nonlinear finite element code for structural mechanics that has been industrially vectorized. Problems involving plasticity (or thermo-plasticity, sometimes coupled with substantial displacements) are solved computationally using finite elements. The performance of standard iterative approaches is poor because the matrices of these systems don't have desirable features. Therefore, high-performance direct sparse solvers are required if we are to produce an industrial software tool that is reliable and versatile. In addition, parallelization is required because very large sparse systems (more than one million unknowns for 3D problems) must be solved [7]The RHiNET (RWCP High Performance Network) local area distributed computing system is being developed, allowing for the high-speed optical interconnection of thousands of common personal PCs and workstations. Network interfaces, network switches, and optical linkages make up RHiNET. RHiNET will provide high performance parallel computing and offer consumers a single system picture An important parallel computing environment has gained attention: network-based parallel processing employing common components like personal PCs. Connecting personal computers is a more practical way to realise a cheap, high performance computing system when compared to the expense and time required for the construction of dedicated massively parallel machines. However, a system area network (or a server area network: SAN) like Myrinet[11] serves as the connectivity for the majority of high performance cluster systems made up of personal computers or workstations. Although SANS use wormhole or virtual cutthrough routing to deliver low latency and high bandwidth communication, they are made to connect specialised computers in a limited space. In order to obtain good performance, the network's topology and link length are constrained [8]High-performance I/O for massively parallel computers presents both challenges and opportunities in the realm of high-performance computing. One of the primary problems is the need to efficiently handle the immense volume of data generated and processed by these systems. Massively parallel computers consist of numerous interconnected processors, which can lead to substantial I/O bottlenecks if not properly managed. Additionally, ensuring data consistency and synchronization across multiple nodes can be complex. However, there are promising prospects on the horizon. Advancements in parallel file systems, network technologies, and storage solutions have the potential to significantly enhance I/O capabilities. The development of parallel I/O libraries and optimizations for specific applications can also mitigate performance issues. Moreover, the increasing availability of high-speed interconnects and improved software design practices can contribute to more efficient I/O operations. As researchers and engineers continue to innovate in this field, high-performance I/O for massively parallel computers holds the promise of enabling even more powerful and data-intensive scientific simulations, data analytics, and other computation-intensive tasks [9]High-performance computing (HPC) in the context of geographical data refers to the utilization of advanced computing systems and techniques to process, analyze, and visualize large and complex geospatial datasets. Geographical data encompasses a wide range of information, including maps, satellite imagery, climate models, and location-based sensor data. HPC systems play a crucial role in this domain by enabling rapid processing of these datasets, allowing for tasks such as climate modeling, disaster prediction, urban planning, and resource management. With the immense computational power offered by HPC clusters and supercomputers, researchers and organizations can conduct simulations, conduct spatial analysis, and develop predictive models with high precision and speed. This capability is particularly valuable for addressing pressing global challenges, such as climate change, natural disaster mitigation, and sustainable urban development, by harnessing the power of high-performance computing to derive insights and make informed decisions based on geographical data [10]The Strassen method is an advanced algorithmic approach for multiplying matrices rapidly by dividing large matrices into smaller submatrices and then recursively performing matrix operations. This technique offers substantial speed advantages, particularly for large matrices, as it reduces the number of multiplicative operations required for matrix multiplication. Additionally, it leverages multiple processor cores or units in a parallel implementation to further accelerate the computation. The parallel Strassen implementation is particularly well-suited for applications where matrix multiplication is a significant bottleneck, as it distributes the workload across multiple threads or processors, with each responsible for processing a portion of the matrix. To maximize parallelism while avoiding bottlenecks and ensuring efficient resource utilization, careful attention to load balancing, synchronization, and memory management is essential. This results in a high-performance solution for handling large-scale matrix multiplication tasks [11].An extensive examination of the techniques, approaches, and plans employed for the efficient distribution and management of computer resources within intricately interconnected environments forms the basis of a research investigation into resource allocation within high-performance distributed computing systems. In order to sustain peak performance and efficiency, these systems, which often comprise clusters of robust workstations or cloud-based infrastructure, require the judicious allocation of resources like CPU, memory, and network bandwidth. To gain insight into how these components impact system performance and dependability, the research delves into several areas including load balancing, job scheduling, fault tolerance, and scalability. Such a comprehensive review yields valuable insights and recommendations for the design and optimization of distributed computing systems by consolidating prior research and advancements in the field, facilitating progress in high-performance computing, data analytics, and other critical domains reliant on distributed computing resources [12].The NWChem umbrella package encompasses high-performance software tools, collectively referred to as ParSoft, alongside chemistry-based components and application programmer interfaces (APIs). ParSoft tools serve as a means to provide scalable and serialized services to application developers. These services include memory allocation, global arrays, shared files, message forwarding, and linear algebra, among others.On the other hand, NWChem objects and APIs, often denoted as "domain-specific APIs" (DSAPIs), offer information and functionalities specifically tailored for computational chemistry applications. The architecture of NWChem can be portrayed as a whole, where high-level operations connect with various chemistry modules. These chemistry modules themselves incorporate unique features reliant on DSAPIs and the ParSoft libraries.This section delves into the essential components of the ParSoft tools and DSAPI software [13].Using advanced computing techniques and parallel processing capabilities, cutting-edge microscopic traffic modeling is employed on high-performance parallel computers to simulate and analyze intricate traffic behavior. This approach empowers traffic engineers and scholars to replicate the individual interactions, choices, and maneuvers of vehicles within a traffic network. These simulations excel at handling large and complex traffic scenarios with remarkable precision and computational efficiency, leveraging the capabilities of high-performance computers like clusters or supercomputers. This meticulous modeling facilitates a deeper comprehension of traffic dynamics, congestion patterns, and the consequences of various measures or policies on traffic flow. Moreover, it plays a pivotal role in advancing intelligent transportation systems, urban planning, and optimizing traffic management strategies to enhance traffic efficiency and safety in urban environments.[14]The phase-field approach is gaining traction in emerging research areas, and the increasing reliance on extensive parallel computing is consistently boosting the need for the capability to simulate larger domains. Through an analysis of the scalability of 1D domain decomposition, 3D domain decomposition, the runtime behavior of frequently employed moving simulation domains, and 1D load balancing in a finite difference phase-field implementation, we underscore the efficient utilization of high-performance computing resources. Our measurements and a straightforward performance model for blocking communication underscore the necessity of employing 3D domain decomposition to enable scalability on high-performance clusters for 3D domains[15]

2. MATERIALS AND METHOD

2.1Scatter-free imaging: "Scatter-free imaging" refers to a type of imaging technique or process that aims to produce clear and detailed images by minimizing or eliminating the effects of scattering. Scattering occurs when light or other forms of radiation interact with particles or objects in a medium, causing the radiation to change direction and spread out. This scattering can reduce the quality and clarity of images obtained through various imaging methods, such as in medical imaging (e.g., X-ray, ultrasound) or remote sensing (e.g., satellite imaging). To achieve scatter-free imaging, scientists and engineers employ various strategies and technologies to reduce or compensate for scattering effects. This can include using specialized equipment, software algorithms, or physical techniques to enhance the contrast and resolution of images, making it easier to identify and distinguish objects of interest in the presence of scattering.In medical imaging, for example, scatter-free imaging techniques might involve the use of advanced reconstruction algorithms to correct for scattering effects in X-ray or ultrasound images. In remote sensing, techniques such as deconvolution or adaptive optics might be employed to improve the quality of satellite or aerial images by reducing the impact of scattering caused by the Earth's atmosphere.The goal of scatter-free imaging is to enhance the accuracy and utility of imaging systems by mitigating the interference caused by scattering, ultimately leading to clearer and more informative images.

2.2Detector-scatter imaging: Detector-scatter imaging is a medical imaging technique used to visualize the interior of the human body for diagnostic purposes. It relies on the interaction between radiation, typically X-rays, and the body's tissues. In this method, a detector captures the primary X-ray beam after it has passed through the body, but it also records scattered radiation that occurs when the primary beam interacts with the body's tissues. The scattered radiation contains valuable information about the composition and density of the tissues it encountered. By carefully analyzing the patterns and intensity of scattered radiation, radiologists can create detailed images of the internal structures, such as bones, organs, and soft tissues. Detector-scatter imaging enhances the diagnostic capabilities of traditional X-ray imaging by providing more comprehensive information about the body's internal anatomy and can aid in the detection and characterization of various medical conditions.

2.3Object-scatter imaging: Object-scatter imaging is a novel and advanced imaging technique that combines principles of computational photography and computer vision to capture high-resolution images of objects that are hidden from the direct line of sight, obscured by obstacles, or located in challenging environments. Unlike traditional cameras, which rely on direct line-of-sight to capture images, object-scatter imaging leverages the scattering of light. It involves projecting controlled patterns of light onto the scene, which interacts with the hidden or obscured object and scatters back toward a camera sensor. Through sophisticated algorithms and computational processing, the scattered light patterns are analyzed and reconstructed to generate a coherent image of the hidden object. This innovative technology has promising applications in fields such as medical imaging, non-destructive testing, remote sensing, and security, enabling us to visualize and study objects that were previously inaccessible or concealed.

2.4Full-scatter imaging: Full-scatter imaging is a sophisticated imaging technique that encompasses the capture and analysis of scattered light or radiation from an object or specimen from all possible angles, thereby providing a comprehensive and detailed representation of the object's internal structure or surface characteristics. Unlike traditional imaging methods that rely solely on direct or transmitted signals, full-scatter imaging leverages scattered signals, often including diffraction patterns and reflections, to construct a highly informative image. This approach is particularly valuable in various scientific and medical applications, such as X-ray computed tomography (CT) and electron microscopy, where it allows for the generation of three-dimensional reconstructions and the visualization of intricate details that might be otherwise obscured or inaccessible. Full-scatter imaging plays a pivotal role in advancing our understanding of complex materials, biological samples, and various natural phenomena, making it an indispensable tool in research, diagnostics, and non-destructive testing.

2.5CBCT imaging: Cone Beam Computed Tomography (CBCT) is a specialized medical imaging technique that provides detailed three-dimensional views of the internal structures of the human body, particularly the head and neck region. CBCT technology employs a cone-shaped X-ray beam that rotates around the patient, capturing a series of high-resolution images from different angles. These images are then reconstructed using computer algorithms to create a 3D representation of the area of interest, allowing healthcare professionals, particularly dentists and maxillofacial surgeons, to assess and diagnose various conditions with remarkable precision. CBCT is particularly valuable in the field of dentistry for evaluating dental and facial structures, planning dental implants, assessing jaw disorders, and detecting issues like impacted teeth or fractures. Its lower radiation dose compared to traditional CT scans makes it a safer option for certain diagnostic and treatment planning purposes while still providing essential anatomical information.

Method: Using an enhanced method of comparing ambiguity through a weighted average, the evaluation of the TOPSIS ranking technique was conducted. Within the TOPSIS approach, a frequently utilized strategy involves incorporating multiple responses to enhance the resolution of issues, reducing uncertainty regarding the weight assigned to each solution while maintaining manageability. This approach consistently maintains a global standpoint [16]. Employing an effective and advanced ranking mechanism known as TOPSIS, the contemporary methodology of TOPSIS aims to efficiently select alternatives that are both notably close to the optimal solution and significantly distant from the worst-case scenario solution. While an inadequate response from a superior lead to an increase in price, an improved response from a superior extends the criteria for benefits and reduces the criteria for price. The utilization of attribute records is fully accomplished by the TOPSIS method [17]. This method encompasses fundamental features of FMCDM, two activities for fuzzy membership, the TOPSIS technique, and a spreadsheet for data collection. The title delves into the reasons for its use, outstanding concerns, limitations, and suggestions for researchers to enhance the adoption and application of FMCDM [18]. Due to its attributes, TOPSIS serves as an additional measure. It proves to be a more favourable alternative to heuristics due to its reduced factors, increased stability, and a plethora of response values that encompass varying changes in value. The decision to develop TOPSIS was concluded [19]. TOPSIS employs five distinct distance metrics to establish rankings, with a numerical instance involving diverse magnitudes of randomly generated issues for computation. A comprehensive comparative analysis of preference ranking sequences is conducted, considering factors like the consistency ratio, odds ratio of optimal alternatives, and average Pearson correlation coefficients. The association between the two variables constitutes the first link, while the second aims to discern the impact of measurements by contrasting the potential outcomes against the mean count of coefficients. The approach involves regression on rows. The compromise programming system establishes the concept of "Proximity to Ideal," incorporating two criteria: "majority" and "minimum," thereby allocating the highest "group utility" to each individual grievance. The TOPSIS approach, which optimally resolves both short-range and suboptimal issues, employs these distance measures to determine solutions. It's worth noting that these aspects are not considered significant. The TOPSIS method, which stands for Technique for Order of Preference by Similarity to Ideal Solution, offers a multi-criteria approach to identifying optimal choices from a set of options. This technique ranks options based on their proximity to an ideal solution while considering worst-case scenarios where shorter distances indicate poorer performance [20]. Despite its apparent rationality, TOPSIS has been subject to criticism. One critique involves the method's adaptation to tackle multi-objective decision-making (MODM) issues without adequately considering the relative importance of individual criteria or the nature of the problem at hand. PIS denotes the shortest distance, while NIS represents the greatest distance. Subsequently, a "condition of satisfiability" is presented for each criterion, succeeded by a maximum-minimum operator for these criteria. The resolution of overlapping usages is achieved by implementing Harmony, as highlighted in a previous study [21]. Among the efficient methodologies is TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), designed for optimal solution-like regulatory performance. This technique involves analysing, contrasting, and evaluating the available options. Building upon this foundation, the current investigation aims to extend the application of TOPSIS to real-world assignment-focused group decision-making scenarios. A comprehensive and effective selection process is then outlined [22]. The TOPSIS procedure has concluded. Initially, the influence of the Weighted Euclidean (EW) method on decision-making or evaluation processes is investigated. This examination is founded on diverse statistical data and theoretical assessments. Subsequently, the effects of EW on the TOPSIS technique are evaluated in terms of specific and bilateral stage selections in decision-making or assessment. The role of EW in the selection or assessment process is governed by E-TOPSIS, as outlined in reference [23].

3. RESULTS AND DISCUSSION

TABLE 1. High performance parallel computing

	CC1	CC4	CC8	CC12
Scatter-free imaging	25.88	6.38	3.7	2.2
Detector-scatter imaging	657	170.5	83.66	55.7
Object-scatter imaging	720	190.4	88.5	63.2
Full-scatter imaging	436.55	110.3	54.6	36.7
CBCT imaging	493.35	122.1	63.97	42.5

Table 1 shows comparison of High-performance parallel computing In this case, the values are decreasing as the computing capacity increases, indicating that for scatter-free imaging, lower computing capacity (CC12) is sufficient and more efficient. Similar to scatter-free imaging, the values decrease as computing capacity increases. CC12 provides the most efficient computation for detector-scatter imaging. Again, lower computing capacity (CC12) seems to be sufficient for object-scatter imaging, with the values decreasing as capacity increases. For full-scatter imaging, the trend is consistent with the previous cases. Lower computing capacity (CC12) is efficient. Like the others, CBCT imaging also shows a decrease in values as computing capacity increases, indicating that CC12 is sufficient for this type of imaging.

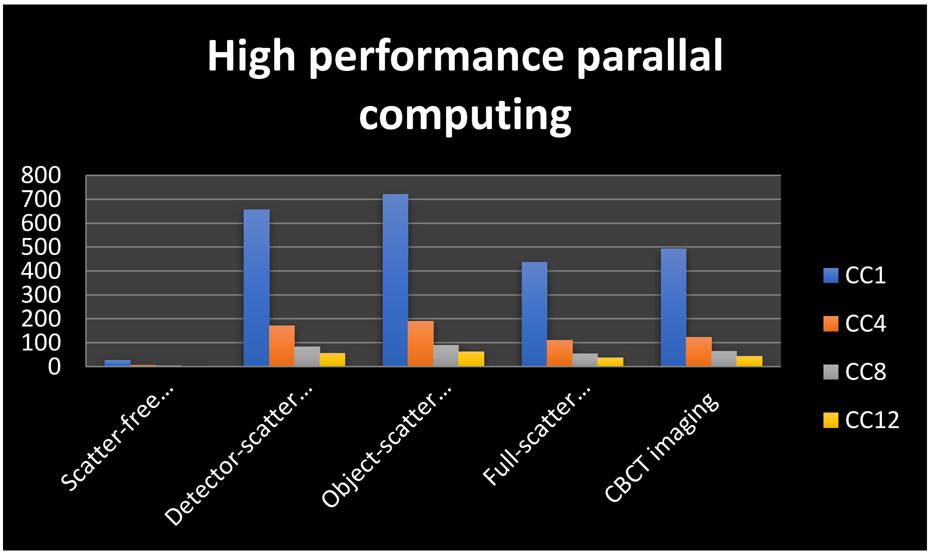

FIGURE 1. High performance parallel computing

Figure 1 illustrate graphical representation of High-performance parallel computing

$$X_{n1} = \frac{X1}{\sqrt{((X1)^2+(X2)^2+(X3)^2\ldots)}} \ldots\ldots\ldots 1$$

TABLE 2. Normalized Data

Normalized Data			
CC1	**CC4**	**CC8**	**CC12**
0.0220	0.0054	0.0250	0.0217
0.5583	0.1449	0.5651	0.5500
0.6119	0.1618	0.5978	0.6241
0.3710	0.0937	0.3688	0.3624
0.4193	0.1038	0.4321	0.4197

Table 2 shows the various values of normalized Data for Scatter-free imaging, Detector-scatter imaging, Object-scatter imaging, Full-scatter imaging, CBCT imaging is obtained by using the formula (1).

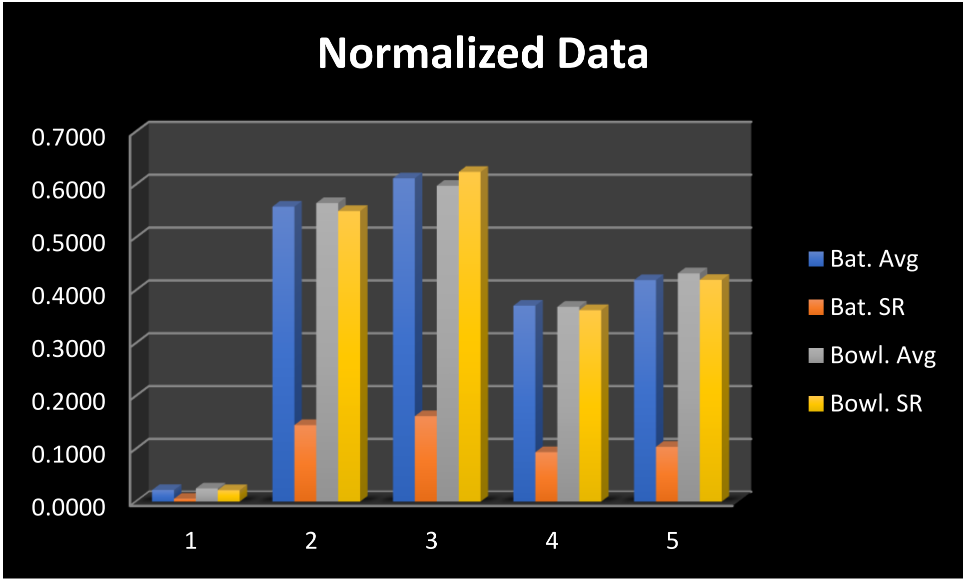

FIGURE 2. Normalized Data

Figure 2 illustrate graphical representation of Normalized data

TABLE 3. Weight ages

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

Table 3 shows Weight ages used for the analysis

$\boldsymbol{X_{wnormal1}} = X_{n1} \times w_1$……..2

TABLE 4. Weighted normalized decision matrix

Weighted normalized decision matrix			
0.0055	0.0014	0.0062	0.0054
0.1396	0.0362	0.1413	0.1375
0.1530	0.0405	0.1494	0.1560
0.0927	0.0234	0.0922	0.0906
0.1048	0.0259	0.1080	0.1049

Table 4 shows weighted normalized decision matrix for Scatter-free imaging, Detector-scatter imaging, Object-scatter imaging, Full-scatter imaging, CBCT imaging to figure out the weighted normalized decision matrix, we used the formula (2).

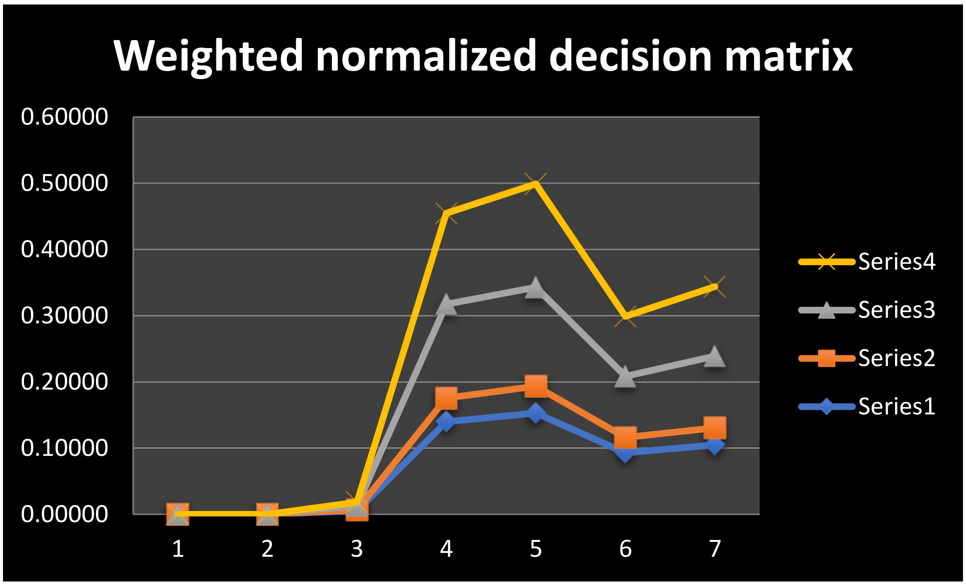

FIGURE 3. Weighted normalized decision matrix

Figure 3 illustrate graphical representation of Weighted normalized decision matrix has done

TABLE 5.Positive and Negative matrix

Positive Matrix				**Negative matrix**			
0.1530	0.0405	0.0062	0.0054	0.0055	0.0014	0.1494	0.1560
0.1530	0.0405	0.0062	0.0054	0.0055	0.0014	0.1494	0.1560
0.1530	0.0405	0.0062	0.0054	0.0055	0.0014	0.1494	0.1560
0.1530	0.0405	0.0062	0.0054	0.0055	0.0014	0.1494	0.1560
0.1530	0.0405	0.0062	0.0054	0.0055	0.0014	0.1494	0.1560

Table 5 shows the positive and negative matrix for final result of TOPSIS for High performance parallel computing Scatter-free imaging, Detector-scatter imaging, Object-scatter imaging, Full-scatter imaging, CBCT imaging .In various positive matrix in maximum value0.1530,0.0405 minimum value 0.0062,0.0054 is taken and Negative matrix maximum value 0.0055,0.0014 and minimum value 0.1494, 0.1560 has taken

$$X_{si+1} = \sqrt{((X_{wn1} - X_{p1})^2 + (Y_{wn1} - Y_{p1})^2 + (Z_{wn1} - Z_{p1})^2)} \text{………3}$$

$$X_{si-1} = \sqrt{((X_{wn1} - X_{n1})^2 + (Y_{wn1} - Y_{n1})^2 + (Z_{wn1} - Z_{n1})^2)} \text{ …….. } (4)$$

$$X_{ci1} = \frac{X_{si-1}}{(X_{si+1}) + \left(X_{s(i-1}\right)} \quad \dots\dots\dots \qquad (5)$$

TABLE 6. Final result of High performance parallel computing

SI Plus	Si Negative	Ci	Rank
0.1526	0.2078	0.5766	1
0.1894	0.1400	0.4250	4
0.2078	0.1526	0.4234	5
0.1362	0.1251	0.4788	2
0.1509	0.1216	0.4462	3

Table 6 shows Final result of TOPSIS for High performance parallel computing si positive is calculated using the formula (3). From figure 4, in si positive, objective-scatter imaging having higher value and full-scatter imaging having lower value si negative is calculated using the formula (4). In si negative, scatter-free imaging is having higher value and CBCT imaging is having lower value. Ci is calculated using the formula (5). In ci, scatter free imaging is having higher value and object- scatter imaging is having lower value

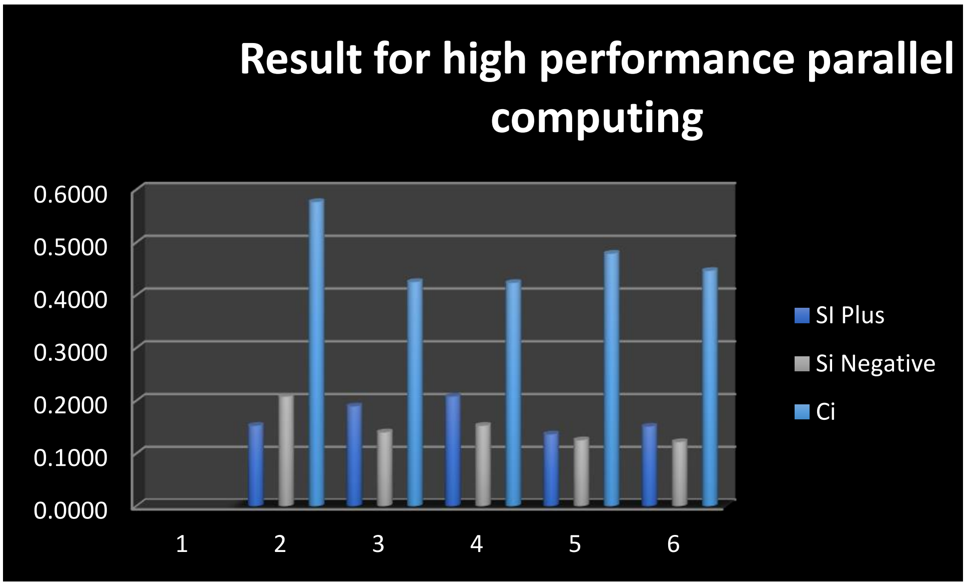

FIGURE 4. Result for High performance parallel computing

Figure 4 illustrate graphical representation of final result for high performance parallel computing si positive, si negative and ci value

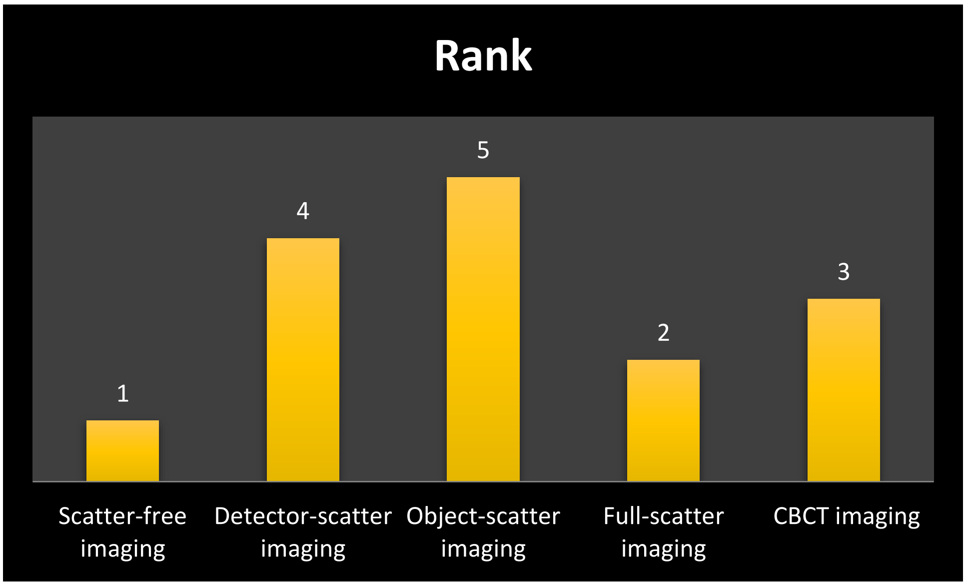

FIGURE 5. Rank

Figure 5 Shows the Rank for High performance parallel computing.Scatter- free imaging is got the first rank and object-scatter imaging is having the lowest rank.

4. CONCLUSION

High-performance parallel computing represents a pivotal and dynamic field in the realm of modern computing. It is an indispensable tool that has revolutionized the way we approach complex computational problems. Through the simultaneous execution of multiple tasks or threads, parallel computing has enabled us to harness the immense power of modern processors and supercomputers, delivering unprecedented speeds and efficiencies. This technology has been instrumental in a wide range of applications, from scientific research and data analysis to artificial intelligence and computer graphics. One of the primary advantages of parallel computing is its ability to tackle computationally intensive tasks in a fraction of the time it would take using traditional sequential methods. This acceleration has opened new frontiers in scientific research, allowing us to simulate complex physical phenomena, model climate change, and unravel the mysteries of the universe with unparalleled precision. Moreover, it has driven advancements in machine learning and artificial intelligence, making it possible to train sophisticated deep learning models on vast datasets, enabling breakthroughs in natural language processing, image recognition, and autonomous systems. Parallel computing has also permeated into the realm of business and industry. In sectors such as finance, healthcare, and logistics, it has enabled real-time data processing, optimization, and decision-making, thereby enhancing productivity and competitiveness. Furthermore, the advent of parallel computing frameworks and libraries has made it more accessible to developers, empowering them to harness its potential without delving into the complexities of parallelism. Nonetheless, high-performance parallel computing is not without its challenges. It demands specialized expertise in parallel programming, as well as careful consideration of issues such as load balancing, data synchronization, and scalability. Efficiently harnessing parallelism also requires access to powerful hardware, which can be costly. Additionally, power consumption and heat dissipation are emerging concerns in the era of exascale computing, necessitating innovative approaches to energy-efficient parallel architectures. High-performance parallel computing stands as a cornerstone of modern computational science and technology. Its contributions to scientific discovery, industrial innovation, and everyday computing tasks are undeniable. As we move forward, the field continues to evolve, promising even more exciting breakthroughs and opportunities, provided we navigate its challenges with ingenuity and collaboration. In this ever-advancing digital age, parallel computing remains an indispensable force driving the boundaries of what is computationally achievable.

REFERENCES

[1]. kanayake, Jaliya, and Geoffrey Fox. "High performance parallel computing with clouds and cloud technologies." In *Cloud Computing: First International Conference, CloudComp 2009 Munich, Germany, October 19–21, 2009 Revised Selected Papers 1*, pp. 20-38. Springer Berlin Heidelberg, 2010.

[2]. Gourdain, N., L. Gicquel, M. Montagnac, O. Vermorel, M. Gazaix, G. Staffelbach, M. Garcia, J. F. Boussuge, and T. Poinsot. "High performance parallel computing of flows in complex geometries: I. methods." *Computational Science & Discovery* 2, no. 1 (2009): 015003.

[3]. Sugie, Takashige, Takanori Akamatsu, Takashi Nishitsuji, Ryuji Hirayama, Nobuyuki Masuda, Hirotaka Nakayama, Yasuyuki Ichihashi et al. "High-performance parallel computing for next-generation holographic imaging." *Nature Electronics* 1, no. 4 (2018): 254-259.

[4]. Chan, Cy, Bin Wang, John Bachan, and Jane Macfarlane. "Mobiliti: Scalable transportation simulation using high-performance parallel computing." In *2018 21st International Conference on Intelligent Transportation Systems (ITSC)*, pp. 634-641. IEEE, 2018.

[5]. Zhang, Xiaoyong, W. U. Ruizhen, Mingming Wang, and Lin Wang. "A high-performance parallel computation hardware architecture in ASIC of SHA-256 hash." In *2019 21st International Conference on Advanced Communication Technology (ICACT)*, pp. 52-55. IEEE, 2019.

[6]. Jin, Haoqiang, Dennis Jespersen, Piyush Mehrotra, Rupak Biswas, Lei Huang, and Barbara Chapman. "High performance computing using MPI and OpenMP on multi-core parallel systems." *Parallel Computing* 37, no. 9 (2011): 562-575.

[7]. Hénon, Pascal, Pierre Ramet, and Jean Roman. "PaStiX: a high-performance parallel direct solver for sparse symmetric positive definite systems." *Parallel Computing* 28, no. 2 (2002): 301-321.

[8]. Kudoh, Tomohiro, Junji Yamamoto, Hiroaki Nishi, Shinji Nishimura, Osamu Tatebe, and Hideharu Amano. "RHINET: a network for high performance parallel computing using locally distributed computers." In *Innovative Architecture for Future Generation High-Performance Processors and Systems (Cat. No. PR00650)*, pp. 69-73. IEEE, 1999.

[9]. Del Rosario, Juan Miguel, and Alok N. Choudhary. "High-performance I/O for massively parallel computers: Problems and prospects." *Computer* 27, no. 3 (1994): 59-68.

[10]. Collier, Nicholson, and Michael North. "Parallel agent-based simulation with repast for high performance computing." *Simulation* 89, no. 10 (2013): 1215-1235.

[11]. Grayson, Brian, and Robert Van De Geijn. "A high performance parallel Strassen implementation." *Parallel Processing Letters* 6, no. 01 (1996): 3-12.

[12]. Hussain, Hameed, Saif Ur Rehman Malik, Abdul Hameed, Samee Ullah Khan, Gage Bickler, Nasro Min-Allah, Muhammad Bilal Qureshi et al. "A survey on resource allocation in high performance distributed computing systems." *Parallel Computing* 39, no. 11 (2013): 709-736.

[13]. Kendall, Ricky A., Edoardo Aprà, David E. Bernholdt, Eric J. Bylaska, Michel Dupuis, George I. Fann, Robert J. Harrison et al. "High performance computational chemistry: An overview of NWChem a distributed parallel application." *Computer Physics Communications* 128, no. 1-2 (2000): 260-283.

[14]. Nagel, Kai, and A. Schleicher. "Microscopic traffic modeling on parallel high performance computers." *Parallel Computing* 20, no. 1 (1994): 125-146.

[15]. Vondrous, Alexander, Michael Selzer, Johannes Hötzer, and Britta Nestler. "Parallel computing for phase-field models." *The International journal of high performance computing applications* 28, no. 1 (2014): 61-72.

[16]. Behzadian, Majid, S. KhanmohammadiOtaghsara, MortezaYazdani, and Joshua Ignatius. "A state-of the-art survey of TOPSIS applications." Expert Systems with applications 39, no. 17 (2012): 13051-13069.https://doi.org/10.1016/j.eswa.2012.05.056

[17]. Salih, Mahmood M., B. B. Zaidan, A. A. Zaidan, and Mohamed A. Ahmed. "Survey on fuzzy TOPSIS state-of-the-art between 2007 and 2017." Computers & Operations Research 104 (2019): 207-227.https://doi.org/10.1016/j.cor.2018.12.019

[18]. Shukla, Atul, Pankaj Agarwal, R. S. Rana, and Rajesh Purohit. "Applications of TOPSIS algorithm on various manufacturing processes: a review." Materials Today: Proceedings 4, no. 4 (2017): 5320-5329.https://doi.org/10.1016/j.matpr.2017.05.042

[19]. Opricovic, Serafim, and Gwo-HshiungTzeng. "Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS." European journal of operational research 156, no. 2 (2004): 445-455.https://doi.org/10.1016/S0377-2217(03)00020-1

[20]. Jahanshahloo, Gholam Reza, F. HosseinzadehLotfi, and Mohammad Izadikhah. "An algorithmic method to extend TOPSIS for decision-making problems with interval data." Applied mathematics and computation 175, no. 2 (2006): 1375-1384.https://doi.org/10.1016/j.amc.2005.08.048

[21]. Kuo, Ting. "A modified TOPSIS with a different ranking index." European journal of operational research 260, no. 1 (2017): 152-160.https://doi.org/10.1016/j.ejor.2016.11.052

[22]. Shih, Hsu-Shih, Huan-JyhShyur, and E. Stanley Lee. "An extension of TOPSIS for group decision making." Mathematical and computer modelling 45, no. 7-8 (2007): 801-813.https://doi.org/10.1016/j.mcm.2006.03.023

[23]. Chen, Pengyu. "Effects of the entropy weight on TOPSIS." Expert Systems with Applications 168 (2021): 114186.https://doi.org/10.1016/j.eswa.2020.114186