**The conference of young scientists "Pidstryhach readings - 2021"
May 26-28, 2021, Lviv**

UDC 519.6

FAST MATRIX MULTIPLICATION: DISCUSSION & OPEN RESEARCH ISSUES

Siddhartha Chatterjee, Mauparna Nandan

Department of Computer Science and Engineering, Gargi Memorial Institute of Technology, Kolkata 700144, India,
e-mail: siddhartha.chatterjee31@gmail.com
Department of Computational Science, Brainware University, Kolkata 700125, India,
e-mail: mauparna2011@gmail.com

Multiplication between two square matrices is one of the fundamental computational approach in the domain of mathematics and computer science where it is fully recognized as a fore most technique for several interdisciplinary domain and sub domains like linear algebra, graph theory, multidimensional graphics, cryptographic computation, convolution neural network, deep learning, digital signal processing, medical image processing, steganography, relativity theory, quantum computing and many others. In a high-performance computing environment computational complexity analysis of matrix multiplication algorithm ensures a powerful paradox that takes a massive data processing approach to the world where problem solution feasibility comes down in respect of operation and time. In our paper we have analyze different methods to multiply two square matrices (like 2×2 matrices) and their arithmetic complexity analysis in a asymptotic flavor along with operation collapsing issues through serial processing technique. We have analytically and experimentally explained and shown using MATLAB 9.3 simulator that fast matrix multiplication approach like Strassen and Winograd perform much better than conventional matrix multiplication algorithm especially for large amount of data.

Square matrix multiplication concepts always stands up with fundamental operation from our childhood days to solve a problem in mathematics and now it is more essential in various fields of computational computing with respect of both practical and theoretical aspects. The proof can be determine in different fields of theoretical computer science research, applied mathematics, statistics, physics, bioinformatics, electronics and many other interdisciplinary areas where we have to frequently deal with large amount of data/information. Any type of computational applications in real world always need faster algorithm that can be solved within an optimum time. ThatвЂ™s why computational speed for solving those applications mainly rely on the execution time of

algorithm aside from other instantaneous requirement. So, when we are going to do something in a high-performance computing domain then maximum time apart from memory space, time requirement is one and only valuable resource for any algorithm by which we can get faster result along with effective performance. In this scenario, design, analysis and deep exploration for getting faster square matrix multiplication algorithm is profoundly required and that has already become the main purpose in computational computing research. This paper discusses about different types of matrix multiplication approach, its operation collapsing issues and asymptotic time complexity analysis result using a serial processing system.

Traditional matrix multiplication computation is represented as follows

$$T(n) = 8T(\frac{n}{2}) + \theta n^2 \tag{1}$$

Strassen and Winograd matrix multiplication is represented as follows

$$T(n) = 7T(\frac{n}{2}) + \theta n^2 \tag{2}$$

1. Bodrato M. *A Strassen - like Matrix Multiplication Suited for Squaring and Higher Power Computation.* In: Proc. of the Intern. Conf. "35th International Symposium on Symbolic and Algebric Computation (ISSAC)", Munich, Germany, July 25 – 28, 2010.

2. Cohn H., Kleinberg R., Szegedy B., Umans C. *Group - Theoretic Algorithms for Matrix Multiplication.* In: Proc. of the Intern. Conf. "(FOCS)" , (46), Page 379 – Page 388, 2005.

3. Junjie L., Sanjay R., Sartaj S. *Strassen's Matrix Multiplication on GPUs.* In: Proc. of the Intern. Conf. "IEEE 17th International Conference on Parallel and Distributed Systems" ,Taiwan, Page 157 – Page 164, 2011.