High Performance Scientific Computing

NAVIGATION

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Project Title and Abstract

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Project Title	Abstract
Parallel Deep Neural Network Framework	Neural Networks dominate most of the Machin today. Applications ranging from classification manipulation to reinforcement learning and ma Neural Networks of one kind or another. Deepe to train and slower to iterate upon. Moreover, F sequential updates and CNNs with their million even slower to train. Thus, in our project, we pl parallel neural network framework right from sc tasks. We plan to implement the following layer Layers - Simple Activation Layers - 2D and 3D 2D and 3D Pooling Layers If time permits, we v RNNs, which are relatively hard to parallelize. V and benchmark the performance of our normal the parallel implementation and solve simple m learning tasks using the networks formed by th layers and come up with the results.
Hand gesture recognition using	Gestures are widely used by people who can't people who can hear but can't speak. There ar

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	parallel processing	American Sign Language alphabets for A to Z u These alphabets help in facilitating the commu deaf and hearing persons. The objective is to c recognition for the detected hand pos usi 2 6 Shivasubramanian Gopalakrishnan recognition also known as Eigen hand gesture idea is to find the components or the dimensio collection of all possible images is expected to distributed. In addition to implementing PCA ba using OpenCV library, we will be parallelising th OpenMP/Cuda to improve the speed.
	Parallel Sudoku Solver	Sudoku is a highly popular logic-based game. A serial algorithms to solve the game, their execu quite large, often of the order of several tens of attempt to use the various tools taught in the c the backtracking algorithm for solving Sudoku.
	Parallelising Eigenface based face recognition	The task of face recognition is to identify a give specific image out of a set of input images feed Even though there is noise in the image but the pattern using which we can differentiate the sp the set of input images. We analyze these patte given image. Patterns are facial features which distance between eyes, mouth & nose etc. The unique to every human being and are used to r person's face from a set of input faces. These features are known as eigen faces or principal generally. We will be implementing PCA based OpenCV library, our aim is to study the feasibili speed-up over a single-core computation i.e. to parallelism in certain regions of code.
	Distributed Branch and Bound	Integer programming refers to the class of matl optimization problems in which all/some variab be integers. Integer programming is NP-compl Bound is a fairly efficient algorithm used (in cor optimization algorithms like simplex) to solve su it is slower than greedy approaches, it succeed find the optima. The basic idea of Branch and I the given feasible set into two sets and finding bounds for these sets and continuing this parti reasonably accurate solution. While good paral for this algorithm, there is still room for using di We plan to analyze the state of the art parallel i Branch and Bound and to implement distributi
	Parallelisation of Image Segmentation	Image segmentation is the process of partitioni regions. It is useful in simplification of informati in higher level understanding of the image. It is

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Algorithm	medical image processing, face recognition pe etc. The current image segmentation technique based segmentation, edge detection segmenta based on clustering, segmentation based on w learning in CNN, etc. We aim to parallelize som and see the differences in performances with re version.
Hand Gesture Recognition using Parallel Processing	Gestures are widely used by people who can't people who can hear but can't speak. There ar American Sign Language alphabets for A to Z u These alphabets help in facilitating the commu deaf and hearing persons. The objective is to c recognition for the detected hand postures usir recognition also known as Eigen hand gesture idea is to find the components or the dimensio collection of all possible images is expected to distributed. In addition to implementing PCA ba using OpenCV library, we will be parallelising th OpenMP/Cuda to improve the speed.
Multi-level parallelization of Machine Learning Algorithms.	Machine learning is one of the most highly acti sought after topic in recent times. As many lea a large number of mathematical computations, parallel computations can be used to optimize running times for different algorithms. This is w achieve through this project. In this project, the achieved at two levels. Level 1- In k-fold cross- dataset is divided into k parts. Then k models a time taking one of the k data subsets for valida training steps can be parallelized by using diffe training step. This will, in turn, reduce the comp Most of the learning models use algorithms like and backpropagation for obtaining an optimal parameters for the model. This algorithm requir derivative of the respective model error. This st can be parallelized and better performance car intend to do the following two level of paralleliz nonlinear regression and logistic regression. Th obtained will be compared with those obtained A combination of the two levels will also be use performance. After doing after primary task we possibilities of achieving back-propagation par perceptron neural-network. Reference Link- https://www.kdnuggets.com/2016/11/parallelis gpu-cuda-threading.html/2
Landmark based localisation using	Particle filters(PFs) is an algorithm used to solv arising in signal processing and Bayesian statis

	Particle Filter	filtering problem consists of estimating the inte dynamical systems and random noise and dist the sensors and the dynamical system respect application of PF is landmark based localizatio and orientation of a mobile vehicle are estimate measurements based on the observed distanc This project aims to parallelise the particle filte parallelising the calculation of estimate of each purpose open MP / CUDA will be used.
	Using MPI and open mpi in molecular dynamics	It is planned to use open mpi and mpi with vec molecular dynamics codes and compare advar serial code .
	Parallelize Tree Search Algorithms	Parallelizing happens at each level as we desc help to speed up the process up to logarithmic number of nodes. If the tree is very large then t can be limited to a certain fixed threshold.
	Landmark based localisation using Particle Filter	Particle filters(PFs) is an algorithm used to solv arising in signal processing and Bayesian statis filtering problem consists of estimating the inte dynamical systems and random noise and dist the sensors and the dynamical system respect application of PF is landmark based localizatio and orientation of a mobile vehicle are estimate measurements based on the observed distanc This project aims to parallelise the particle filte parallelising the calculation of estimate of each purpose open MP / CUDA will be used.
	Matrix Decomposition	We plan to parallelize LU decomposition using analyze the speedup obtained from the parallel figure out the proper reasons. We will initially st Algorithm. We will parallelize it. Then perform s bottleneck analysis, variation with the number the matrix. We will also look into pivoting (to in how it affects speed. Depending on the availab try to implement an MPI version and make com OpenMP and MPI, such as shared memory vs all of these have been finished, we plan to look algorithms for decomposition of sparse matrice parallelizability as many real-world cases involv References: 1)https://en.wikipedia.org/wiki/LU_ 2)https://courses.engr.illinois.edu/cs554/fa201
	Parallelisation of Image	Image segmentation is the process of partitioni regions. It is useful in simplification of informati

Segmentation Algorithm	in higher level understanding of the image. It is medical image processing, face recognition pe etc. The current image segmentation technique based segmentation, edge detection segmenta based on clustering, segmentation based on w learning in CNN, etc. We aim to parallelize som and see the differences in performances with re version.
Parallelising Optical Flow algorithms	Shape from Motion(SfM) has been a highly rese Computer Vision community. Robust Optical Fl apparent motion in a video and thus aids in SfM Compression and Motion Estimation technique classical optical flow algorithm Lucas-Kanade a algorithms if time permits. We will study the lat by implementing OpenMP, MPI and CUDA cod
Conway's Game of Life in Open-CL	Game of life is a cellular automaton devised by evolution is determined by the initial state and r required it evolves itself and depends only on t the initial state to interact with the game. The in constitutes the seed of the system. s Game of infinite 2D grid made of square cells. Each cell alive state at a time. Each cell interacts with its The following transitions occur in the Game of with fewer than two live neighbours dies, as if b b)Any live cell with two or three live neighbours generation. c)Any live cell with more than three as if by overpopulation. d)Any dead cell with ex neighbours becomes a live cell, as if by reprodu course, as many variations to these rules as the combinations of numbers to use for determinin die. Conway tried many of these different variat these specific rules. Some of these variations c to quickly die out, and others expand without li universe, or some large portion thereof. We are between a serial implementation of Game of Li algorithm and a parallel one using OpenCL. We simple Game of Life using the rules above men other rules to implement another simulation if t
Landmark based localisation using Particle Filter	Particle filters(PFs) is an algorithm used to solv arising in signal processing and Bayesian statis filtering problem consists of estimating the inte dynamical systems and random noise and distu the sensors and the dynamical system respecti application of PF is landmark based localizatio and orientation of a mobile vehicle are estimate measurements based on the observed distanc

		This project aims to parallelise the particle filter parallelising the calculation of estimate of each purpose open MP / CUDA will be used.
	Parallelizing Fast Fourier Transform using MPI	Fourier analysis converts a signal from its origi or space) to a representation in the frequency d versa. We will implement fast fourier transform library functions, and compare its performance Fourier Transform implementation in C++ and a FFT function. If time permits, we will also write compare the performance against MPI implem
	Iterative Closest Point Algorithm	`Iterative Closest Point` (ICP) is one of the wide aligning three dimensional models given an init body transformation required. In this algorithm, reference, is kept fixed, while the other one, the transformed to best match the reference. The a revises the transformation (combination of tran needed to minimize an error metric, usually a d source to the reference point cloud, such as th differences between the coordinates of the ma step various parts of the algorithm can be para performance. At first, we plan to use OpenMP algorithm. If time permits, we will try to write C GPU to improve the performance further.
	Parallelize neural networks	The artificial neural network is an inherently par any decent dataset and architecture, it's critica computing to train/test them in practical amou to start with parallelizing fully connected layers backpropagation framework which will later all be added without a lot of changes. We will do i and GPU using OpenMP and CUDA respective one of the recent lectures, we will do profiling t speedup we should be able to achieve theoreti we can actually get. A detailed analysis and tim done on simple tasks like classification on MNI
	Parallelization of Image Segmentation Algorithm	Image segmentation is the process of partitioni regions. It is useful in simplification of informati in higher level understanding of the image. It is medical image processing, face recognition pe etc. The current image segmentation technique based segmentation, edge detection segmenta based on clustering, segmentation based on w learning in CNN, etc. We aim to parallelize som and see the differences in performances with re version.

Simulation of Jupiter's Trojan asteroids	Our aim is to analyze the Trojan asteroids at the points of the Sun-Jupiter system by parallelizin implementation of a 2D n-body simulation unde interaction only. We intend to use the Barnes-H by storing the n-bodies in a quad tree to reduc effective n-body interactions that are to be con
Dynamic Analysis of Structures Using Lanczos Coordinates	In this project, we aim to implement the metho Bahram Nour-Omid and Ray W. Clough in their Analysis Of Structures using Lanczos Co-ordin Engineering and Structural Dynamics, Vol. 12, discretizing a continuous system, its dynamic r studied using various methods such as the mo method. These methods depend on solving an for the system which is computationally intensi for large systems. Here, an alternative to this us has been presented in the paper which transfo into a tridiagonal form as opposed to decouplir the complete system. This incurs significantly l costs as the eigenvalues and eigenvectors do r computed. The system will be reduced using L the resulting equation will be solved using New We aim to parallelize this code using MPI, Ope combination of which should result in a reducti Reference: https://onlinelibrary.wiley.com/doi/epdf/10.100
Solving Navier Stokes equation using Parallel Programming	Navier Stokes Equation describe the motion of substances.The solution of the equations is a fl field, since it is defined at every point in a regio interval of time. We are planning to write the co navier stokes equation for a general fluid using (Semi Implicit Method for Pressure Linked Equa use parallelisation which will be done using MF Depending on the time we have, we will also m using CUDA. The increase in efficiency and spe after performing the timing and scaling analysis understanding the Navier Stokes parallel progr http://www.netlib.org/utk/people/JackDongarra fluid-flow.pdf http://www.scielo.br/scielo.php? script=sci_arttext&pid=S1807-03022005000300 http://cse.mathe.uni-jena.de/pub/diplom/fritzsc Members: 150010004 - Athul Nambolan 15D10 15D070027 - Akansh Vijay 150040010 - Tanya
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		the sensors and the dynamical system respect application of PF is landmark based localizatio and orientation of a mobile vehicle are estimate measurements based on the observed distanc This project aims to parallelise the particle filte parallelising the calculation of estimate of each purpose open MP / CUDA will be used.
	Parallelisation of algorithms for counting 3-cliques in an undirected-graph.	Number of triangles in a graph is a useful metri It is particularly useful in analysis of social netw social networks is increasing day by day, such need to be computed quickly and efficiently to properly. We want to implement popular serial a and try to find an optimal variations suitable fo we will then try to implement in CUDA and com optimizations achieved. Even though distribute suitable for this we try to explore in this using M notable breakdowns can be achieved. We will u database for our project (Tentatively from https://snap.stanford.edu/data/index.html).
	Parallelizing image processing using CUDA	Image processing tasks are inherently paralleliz applications in photo-editing applications, med processing, satellite imagery, video processing attempt to implement some of the famous imag algorithms, including mean-shift segmentation, used to generate “cartoony” images, bilateral fi preserving noise removal, and the popular JPE compressing images with minimal loss of quali fairly non-trivial and have lots of free parameter implement these algorithms for NVIDIA GPUs u perform benchmarking studies for speed ups fr code. We also aim to perform ablation studies different components of the algorithms and per studies. If time permits, we also plan to implem Convolution operators for edge and blob detec notch removal using fast fourier transform
	Parallelizing DFT	Fourier transform is a very useful concept in sig digital image processing and voice recognition. function of time (a signal) into its constituent fre implementation takes O(n^2) time to compute t fourier transform (FFT) is a divide and conquer down the complexity to O(n log n). We aim to p algorithm using CUDA.
	Parallelization of a Navier Stokes equation solver	Parallelization of a Navier Stokes equation solv function vorticity method over a lid driven cavit various methods such as OpenMP, Open MPI,

based on Stream function vorticity method	OpenACC. Analysing the serial code to identify parallelization. Parallelizing the various segmer parallelizing techniques followed by a compreh the difference in time taken by each method. C depth study by finding the optimal parameters threads, kernels, blocks etc) in each technique. deeper insight of effects of parallelization in ea
Parallelizable collision free trajectory generation for swarm robots	As the capabilities of robots and their control s see an increasing number of use-cases where operation of robots within a space is advantage trajectories for individual robots can be compu existing methods, when robots operate simulta proximity, the requirement for collision avoidan coupling between robot trajectories and makes generation problem difficult to solve quickly. He for developing a parallelizable algorithm which through GPUs. We aim to address the problem feasible, collision-free trajectories for robots op simultaneously and in close proximity. We initia trajectory independently without considering in and we model constraints on the trajectories (e constraints) as soft constraints and include the function. We then employ momentum-based g iteratively improve robot trajectories until all co Given the non-convexity of the problem and th descent, we expect to find non-optimal, feasib neighbourhood. We assume that the reference trajectories generated by our method are track controller. The algorithm will be tested in a maz with a swarm of robots. CUDA architecture will parallelizing and timing analysis will be perform Geforce MX940 graphics card.
Development of parallel Euler equation solver using OpenMP, MPI and CUDA.	Parallel codes for solving two-dimensional Eule uniform rectangular grid will be developed. The based on first order reconstruction using the S vector splitting and explicit Euler time integrati achieved through OpenMP, MPI and CUDA. An gained versus amount of parallelisation for diffe will be presented for each of these three metho
Solving Navier Stokes equation using parallel programming	Navier Stokes Equation describe the motion of substances.The solution of the equations is a f field, since it is defined at every point in a regio interval of time. We are planning to write the co navier stokes equation for a general fluid using (Semi Implicit Method for Pressure Linked Equa use parallelisation which will be done using MF

		Depending on the time we have, we will also m using CUDA. The increase in efficiency and spe after performing the timing and scaling analysis understanding the Navier Stokes parallel progr http://www.netlib.org/utk/people/JackDongarra fluid-flow.pdf http://www.scielo.br/scielo.php? script=sci_arttext&pid=S1807-03022005000300 http://cse.mathe.uni-jena.de/pub/diplom/fritzsc Members: 150010004 - Athul Nambolan 15D10 15D070027 - Akansh Vijay 150040010 - Tanya
	Hand gesture recognition using parallel processing	Gestures are widely used by people who can't people who can hear but can't speak. There ar American Sign Language alphabets for A to Z u These alphabets help in facilitating the commu deaf and hearing persons. The objective is to c recognition for the detected hand postures usir recognition also known as Eigen hand gesture idea is to find the components or the dimensio collection of all possible images is expected to distributed. In addition to implementing PCA ba using OpenCV library, we will be parallelising th OpenMP/Cuda to improve the speed.
	Parallelizing Neural Network Back-propagation.	The artificial neural network is an inherently par any decent dataset and architecture, it's critica computing to train/test them in practical amou to start with parallelizing fully connected layers backpropagation framework which will later all be added without a lot of changes. We will do i and GPU using OpenMP and CUDA respective one of the recent lectures, we will do profiling t speedup we should be able to achieve theoreti we can actually get. A detailed analysis and tim done on simple tasks like classification on MNI
	Parallelizing PageRank Algorithm	Background/Objectives: PageRank is an algori Search to rank web pages in their search engin is a way of measuring the importance of web p parallelize the algorithm. Statistical Analysis: W the algorithm on NVIDIA GTX 960M GPU Maxv CUDA programming language. Group member Verma 150050033 Kshitij Garg 150050028 Bha
	Parallelisation of Image Segmentation Algorithm	Image segmentation is the process of partitioni regions. It is useful in simplification of informati in higher level understanding of the image. It is medical image processing, face recognition pe etc. The current image segmentation technique

		based segmentation, edge detection segmenta based on clustering, segmentation based on w learning in CNN, etc. We aim to parallelize som and see the differences in performances with re version.
	Parallelize cfd codes and study the impact	We are planning to parallelise a computational code which solves the lid driven cavity problem be done using MPI, OpenMP and NVIDIA GPU impact of parallelisation on the computation tin methods and different number of processes/th
	Parallelizing a Neural Network	Intro Neural networks can be used to solve pro difficult to solve using rule-based systems. A n typically consists of a layerwise forward pass a These operations can be quite parallelized. For basic neural nets is a fully connected network v operations are basically matrix multiplications. implement a simple fully connected neural netv the task of handwritten digit recognition. We sh dataset for training and testing. After reaching a accuracy we shall try to reproduce the same re forward and backward passes. We plan to supp connected layers with activation. As we are tryi results despite neural nets having intrinsic rand (weights initialization) we shall have to control t controlling the random seed. Why? Neural netv recent achievements in deep learning. While th on neural nets and its concepts. Building one fi parallelizing its inner working would give a mor perspective. How? We shall first profile the seri functions are taking the most amount of execu parallelize them in that priority. We plan to use compare the theoretical speedup with the prac about discrepancies (if any). We shall also try a correctness using valgrind tool suite.
	Hand gesture recognition using parallel processing	Gestures are widely used by people who can't people who can hear but can't speak. There ar American Sign Language alphabets for A to Z u These alphabets help in facilitating the commu deaf and hearing persons. The objective is to c recognition for the detected hand postures usir recognition also known as Eigen hand gesture idea is to find the components or the dimensio collection of all possible images is expected to distributed. In addition to implementing PCA ba using OpenCV library, we will be parallelising th OpenMP/Cuda to improve the speed.

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	k-SAT Solver	Abstract:- We plan to implement k-SAT solver. problem, whose instance is a CNF formula hav each clause. Given the expression, is there son TRUE and FALSE values to the variables that w expression true? SAT was the first known NP-c There is no known algorithm that efficiently solv SAT. We will implement it in Cuda and also test serial implementation. For analysis, we will con different values of k for serial and parallel imple planning to use the DPLL algorithm for solving
	PARALLELIZING AN IN-HOUSE 2D COMPRESSIBLE EULER CODE	A 2D compressible Euler code is generated and benchmark problem. The initial code is serial in studied to identify the sections of code apt for identified, various parallelising paradigms such are implemented to increase the accuracy and original serial code. At first, the new transforme consistent. Then they are being checked for the general speed up. This study will also suggest parallelising that is theoritcally and practically a be also tested for platform-dependency. by Mr Mahato(183014001) Prakalp Shandilya(183010 Dewalia(183010004) Lotti Rushi(183010011)
	Parallelizing Fast Fourier Transform using MPI	Fourier analysis converts a signal from its origi or space) to a representation in the frequency d versa. We will implement fast Fourier transform library functions, and compare its performance Fourier Transform implementation in C++ and a FFT function. If time permits, we will also write

compare the performance against MPI implem

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