NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES
(KARACHI CAMPUS)
FAST School of Computing
Fall 2023

Project Title

Convex Hull algorithms - Graham's scan and Jarvis March: utilizing OpenMP and MPI

Course: Parallel Distributed Computing (CS3006)

Course Instructor: Dr. Nousheen Shoaib

Section: 5E

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Introduction:

In this project, we aim to explore the application of convex hull algorithms, specifically Graham Scan and Jarvis March, for efficient path planning of a robot. Path planning is a crucial aspect of robotics, as it involves determining the optimal path for a robot to navigate from a starting point to a goal while avoiding obstacles. Convex hull algorithms can help in identifying the outer boundary of obstacles or waypoints, enabling the robot to plan its path efficiently.

Problem Statement:

The main objective of this project is to develop an efficient parallel path planning algorithm for a robot using convex hull algorithms, specifically Graham Scan and Jarvis March, with the use of MPI (Message Passing Interface) and OpenMP (Open Multi-Processing). The algorithm should be able to handle complex environments with obstacles and provide the robot with a collision-free path from the starting point to the goal.

Methodology:

1. Data Collection: Collect the necessary data for the project, including the coordinates of the obstacles and the starting point and goal for the robot.

2. Implement Graham Scan Algorithm: Implement the Graham Scan algorithm to compute the convex hull of the obstacle points. This algorithm involves sorting the points based on their polar angles and constructing the convex hull in a counterclockwise manner. Modify the algorithm to distribute the workload across multiple processes using MPI.

3. Implement Jarvis March Algorithm: Implement the Jarvis March algorithm, also known as the gift wrapping algorithm, to compute the convex hull. This algorithm iteratively selects the point with the smallest polar angle and adds it to the convex hull. Modify the algorithm to utilize parallel processing using OpenMP.

4. Parallel Path Planning Algorithm: Develop a parallel path planning algorithm that utilizes the computed convex hull to generate an efficient path for the robot. This algorithm should take into account the starting point, goal, and obstacle locations to find a collision-free path. Distribute the workload across multiple processes using MPI and utilize parallel processing within each process using OpenMP.

Efficiency Analysis:

Evaluate the efficiency of the parallel path planning algorithm by considering factors such as computational complexity, execution time, and speedup achieved through parallelization. Compare the performance of the parallelized Graham Scan and Jarvis March algorithms with their sequential counterparts in terms of their efficiency and effectiveness in generating optimal paths for the robot.

Impact:

This project's successful execution will provide valuable insights into leveraging convex hull algorithms for parallel path planning, potentially enhancing autonomous systems' navigation capabilities. The optimized paths generated using parallelized Graham Scan and Jarvis March can contribute to safer, more efficient navigation in challenging and cluttered environments, ultimately advancing the field of autonomous robotics and transportation. The project will demonstrate the effectiveness of parallel convex hull algorithms in path planning tasks, highlighting the benefits of parallel programming paradigms such as MPI and OpenMP in robotics applications.