Hybrid Domain Parallel Algorithm for 3d Kirchhoff Prestack Depth Migration

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Abstract

The size of seismic data from a survey area has exceeded 100 TB, and will increase to more than 1 PB in the near future. The size of PC cluster used for seismic data processing has been 256~1000 nodes and GPU cluster has been used to speed up the parallel computation. To support increasing survey sizes and processing complexity, we propose a practical approach that implementing the large-scale parallel processing of 3D Kirchhoff Prestack Depth Migration (KPSDM) on heterogeneous cluster. The parallel algorithm is called "hybrid domain parallel", which is based on three-level decomposition including offset, imaging space, and seismic data. The algorithm eliminates the dependencies among tasks. We design a "dynamic and asynchronous" task allocation policy to make the I/O of waiting tasks and the computation of current tasks asynchronous execution and achieve load balancing on heterogeneous computing system. Because KPSDM, as part of its execution, usually requires repeated access to huge seismic data and a large travel time table data base, the scalability is always limited by the shared storage maximum throughput. To solve the scalability problem, we build a distributed cache system using local storage of all hosts that a KPSDM job spans. The distributed cache system stores the seismic data and travel time table data corresponding to each task on the local storage. According to the load of each node, it can select the spare node to provide a very high aggregate data bandwidth and supply seismic data and travel time table data to a task timely. In order to make the KPSDM more robust, MPI model is substituted for the Geophysical Parallel Programming (GPP) model which can support the task migration in the execution of application program. Furthermore, the "task backup" strategy from MapReduce frame is used for slow nodes to avoid the delay of job running time. The KPSDM implementation can obtain close to linear speedup when it processes real word data on a 256-node cluster.