DEM-BASED SLOPE ANALYSIS METHOD USING COMPUTING GRID

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With the establishment of China's multi-scale digital elevation model (DEM), the applications and analysis that based on the DEM play an important role in both scientific research and practical application. The bases of DEM-based spatial analysis is terrain factors such as slope, aspect and others [1-3], and these factors must be calculated by larger resolution dataset. Studies show that in the Loess Plateau Area, slope must be calculated by 1:10'000 or greater scale DEM, which can better reflect the reality [4-6]. Data resolution increase means an increase computing resources in demand, which involves much larger amounts of data and greater computational complexity that need new computing technologies and methods. Grid computing is derived from distributing parallel computing and network high-performance computing, which both depend on specific computer hardware and are both expensive to be used universally, while the idea of grid computing solves the question primely. So the grid technology has important theoretical and practical value on solving the high intensity and intensive computing, heterogeneous distributed spatial data sharing, and GIS system interoperability in spatial analysis [7, 8]. Here we demonstrated the feasibility of DEM analysis tools and implement the prototype of the system based on computational grids and designed system architecture based on Alchemi.

Alchemi developed by Australia's Melbourne University computer science and software engineering based on the Microsoft.NET Framework [9]. The Design objective of Alchemi is simplified the construction and development of grid system on the base of without sacrificing scalability, flexibility and reliability. Based on the Alchemi grid computing platform and the needs of DEM spatial analysis, The DEM analysis tools can be divided into DEM analysis server, computational grids nodes and spatial database server in architecture and implemented in API, grids, spatial analysis and application layers (Fig.1): (1) DEM analysis sever; (2) DEM analysis computing grid; (3) Spatial database server. For the end-users, using spatial analysis computing grid services just need connect to the DEM analysis server. DEM analysis server, which building based on Alchemi SDK, .NET, spatial database API, providing a simple user interface, through this interface, users can use the functions of analysis tool like the general GIS software, users also can use its functions in other program through Web Service API .

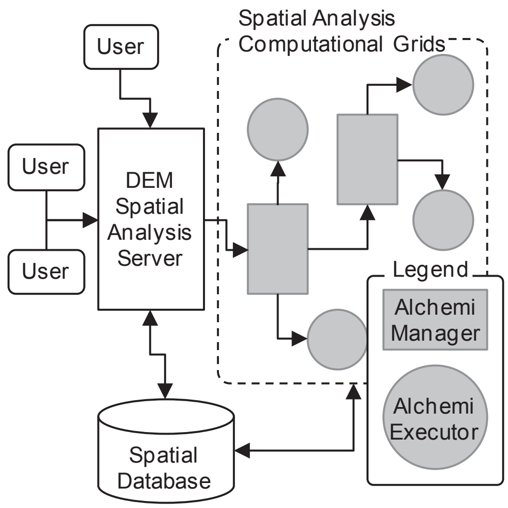

Fig. 1 The Architecture Design of DEM Analysis Tools Based on the Alchemi

Based on the design of Fig.1, we implement the prototype of the system. The Parallel algorithm of tools is based on procedure decomposition, functional decomposition, data decomposition principle. A separate spatial database server is designed as a spatial data server to avoid huge decline in efficiency caused by the mass data transfer in distributed computing grid. It computes the slope and aspect of the 8 triangles defined by the mid-points of the 3x3 window.

Table 1 The Execute Times of Different Dataset in Different Grid Nodes (unit: second)

Dataset Size	**Single Machine**	**Grid Nodes（Executor）Number**					**Efficient** (5Nodes/ Single)
		1	**2**	**3**	**4**	**5**	
400*400	0.64	12.20	7.76	7.18	7.09	6.98	0.09
2000*2000	16.01	94.50	62.46	58.30	55.30	53.47	0.29
10000*10000	1745.74	2162.39	1671.93	1237.47	995.39	907.62	1.92

The efficiency of computational grid is tested by slope factor calculation by different size dataset based on the prototype system of DEM analysis tools. Experiments show that the efficiency of DEM analysis for big dataset can be significantly enhanced by computational grid, but for small dataset, the efficiency is not significant. The results confirm the feasibility of the application of computational grids to DEM spatial analysis for enormous amounts of data.

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