UNIVERSITI PUTRA MALAYSIA

PARALLEL BLOCK METHODS FOR SOLVING HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS DIRECTLY

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Numerous problems that are encountered in various branches of science and engineering involve ordinary differential equations (ODEs). Some of these problems require lengthy computation and immediate solutions. With the availability of parallel computers nowadays, the demands can be achieved.

However, most of the existing methods for solving ODEs directly, particularly of higher order, are sequential in nature. These methods approximate numerical solution at one point at a time and therefore do not fully exploit the capability of parallel computers. Hence, the development of parallel algorithms to suit these machines becomes essential.

In this thesis, new explicit and implicit parallel block methods for solving a single equation of ODE directly using constant step size and back values are developed. These methods, which calculate the numerical solution at more than one point simultaneously, are parallel in nature. The programs of the methods employed are run on a shared memory Sequent Symmetry S27 parallel computer. The numerical results show that the new methods reduce the total number of steps and execution time. The accuracy of the parallel block and 1-point methods is comparable particularly when finer step sizes are used.

A new parallel algorithm for solving systems of ODEs using variable step size and order is also developed. The strategies used to design this method are based on both the Direct Integration (DI) and parallel block methods. The results demonstrate the superiority of the new method in terms of the total number of steps and execution times especially with finer tolerances.

In conclusion, the new methods developed can be used as viable alternatives for solving higher order ODEs directly.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat untuk ijazah Doktor Falsafah

KAEDAH BLOK SELARI BAGI MENYELESAIKAN PERSAMAAN PEMBEZAAN BIASA PERINGKAT TINGGI SECARA LANGSUNG

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Pelbagai masalah yang melibatkan persamaan pembezaan biasa ditemui dalam bidang sains dan kejuruteraan. Sesetengah masalah tersebut memerlukan pengiraan yang panjang dan penyelesaian segera. Dengan adanya komputer selari pada masa kini, kedua-dua tuntutan tersebut dapat dipenuhi.

Walau bagaimanapun, kebanyakan kaedah yang sedia wujud bagi menyelesaikan persamaan pembezaan biasa secara langsung, terutamanya yang berperingkat tinggi, adalah bersifat jujukan. Kaedah tersebut menggangar penyelesaian pada satu titik pada satu masa dan oleh itu tidak memanfaatkan keupayaan komputer selari dengan sepenuhnya. Oleh yang demikian, pembangunan algoritma selari yang sesuai dengan komputer tersebut amatlah diperlukan.

Dalam tesis ini kaedah baru blok selari tersirat dan juga tak tersirat bagi menyelesaikan pembezaan biasa tunggal dengan menggunakan saiz langkah dan nilai belakang malar dibangunkan. Kaedah ini yang menghitung penyelesaian berangka pada beberapa titik serentak adalah bersifat selari. Semua atur cara dilaksana dengan menggunakan Sequent Simetry S27 iaitu sebuah komputer selari berkongsi ingatan. Keputusan berangka menunjukkan kedua-dua kaedah baru ini dapat mengurangkan bilangan langkah dan masa perlaksanaan. Kejituan kaedah blok selari dan 1-titik adalah boleh banding khususnya bila saiz langkah kecil digunakan.

Satu algoritma baru bagi menyelesai sistem persamaan pembezaan dengan menggunakan saiz langkah dan nilai belakang boleh berubah turut diperkenalkan. Strategi yang digunakan bagi merekabentuk kaedah ini adalah berasas kepada kaedah Pengamiran Langsung dan blok selari. Keputusan berangka membuktikan kelebihan kaedah baru ini dari segi bilangan langkah dan masa perlaksanaan terutamanya bagi toleransi yang kecil.

Kesimpulannya, kaedah baru yang dibangunkan boleh diguna sebagai alternatif dalam penyelesaian persamaan pembezaan biasa peringkat tinggi secara langsung.

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