

【Grant-in-Aid for Scientific Research(S)】

Integrated Science and Innovative Science (Comprehensive fields)



Title of Project : Highly productive software environment based on Ruby for parallel and distributed computing systems

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Research Area : Informatics

Keyword : Computer and network, HPC, High-productivity language, Parallel processing, compiler

【Purpose and Background of the Research】

Realization of high productivity in high-performance computing by high-productivity language is tried in HPCS project of the United States. However, resulted high-productivity languages, that is, X10, Fortress and Chapel, fail to have large number of users. They also lack scalability in massively parallel systems with million parallelisms. In fact, these high-productivity languages have following characteristics: (1) the number of users of them is very limited because only scientific users with parallel machines may use them, (2) These new languages are difficult to use for non-CS scientists. (3) Although object-oriented languages increase productivity of software, object-oriented language is not suitable to describe hierarchical parallelism and managing excessive parallelism.

The objective of the project is to solve issues above mentioned. To do so, we extend Ruby language, which is an object-oriented functional language, to highly parallel language for numerical computations.

【Research Methods】

Our goal is to establish high-productivity language framework for high-performance computing that is based on Ruby language. Furthermore, we will develop unified programming environment of HPC programming and Web environment that is one of key feature of Ruby language.

In order to realize these goals, we will perform research and development of HPC ruby by the following sub-projects: (1) Optimization of Ruby language system for HPC programming, (2) Modeling and description of scientific problems by Ruby, and (3) Evaluation of the developed Ruby system on highly parallel and distributed computing environments.

The goal of each sub-project is as follows: (1) Automatic extraction of parallelism from Ruby program, optimizing algorithm for dynamic

languages, implementation of data-structure and management of excessive parallelism by optimizing compiler, (2) development of simulation code that utilize dynamic feature of Ruby. Here, target scientific problems are astronomical N-body problem for simulation of galaxy and formation of planets. (3) Construction of highly parallel computing system for evaluation of developed Ruby system, then evaluating performance on scientific applications and integration of Web application and scientific applications.

【Expected Research Achievements and Scientific Significance】

The result of this project improves productivity of scientific software by utilizing functional and object-oriented feature of Ruby, as well as dynamic language features and call-back facility to other conventional programming languages. The resulting programming environment has scalability and high productivity for programming highly parallel and distributed supercomputing systems. Thus, results of this project will become important tools to scientists for progress of computational science.

【Publications Relevant to the Project】

- 「MCAMP: Communication Optimization on Massively Parallel Machines with Hierarchical Scratch-pad Memory」: Hiroshige Hayashizaki, Yutaka Sugawara, Mary Inaba, Kei Hiraki, Proc. PACT08, 2008.
- 「A Retargetable Code Generator for the Generic Intermediate Language in COINS」: Seika Abe, Masami Hagiya and Ikuo Nakata, IPSJ Transactions on Programming, Vol.46, No.SIG14(PRO27), pp.12-29, 2005.

【Term of Project】 FY2009-2013

【Budget Allocation】 166,600 Thousand Yen

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