VIETNAM NATIONAL UNIVERSITY, HANOI
VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
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INFORMATION ON DOCTORAL THESIS

1. Full name: Bui Huu Phuc 2. Sex: Male

3. Date of birth: September 18th, 1980 4. Place of birth: Hai Duong

5. Admission decision number: 654/QĐ-CTSV Dated: September 15th, 2014

6. Changes in academic process:

7. Official thesis title: ***Some techniques to improve embedded software performance on multi-core processors***

8. Major: Software Engineering 9. Code: 9480103.01

10. Supervisors:

1. Assoc. Prof. Nguyen Ngoc Binh
2. PhD. Le Quang Minh

11. Summary of the **new findings** of the thesis:

The thesis provides an overall model of the performance improvement problem in developing embedded software on multi-core processors. In the overall model, the thesis has presented the embedded software improving problem to improve performance based on task parallelization and data parallelization while focusing on parallelization of functions, parallelization of data as well as selecting source code structure and asynchronous handling of execution flows in software. The findings of the thesis are described as follows:

Firstly, the problem of the performance improvement based on task parallelization:

- The thesis has studied in the direction of task parallelism with the main idea being to divide the overall functionality into parallel tasks, distribute tasks to idle cores, schedule tasks and manage communication exchanges between tasks. The thesis has divided the overall functionality into parallel tasks, however, not all parallel tasks achieve better performance than sequential execution, so we choose the one followed Pareto's law and give a condition that constrains the number of parallelized tasks;

- The thesis proposes a method to find the appropriate parallel configuration for the source code based on the evaluation of the corresponding structure and parameter set and build a general model to implement the idea. The thesis presents the definition of parallel structure, the definition of parallel configuration, and the construction of parallel configuration conditions through the performance evaluation function and supporting formulas to find the appropriate configuration in the method.

Secondly, the problem of the performance improvement based on data parallelization:

- The thesis divides data balance and dynamic allocation to parallelize data for the purpose of improving embedded software performance, the thesis gives the definition of independent datasets, sub-datasets attributes and independent tuples to determine parameters, provide formulas to support threading, and calculate the number of threads and the size of the data to be processed;

- For global data or data that cannot be independently determined, the thesis build a global data division model based on processor core configuration and asynchronous data processing between threads. To improve performance, the thesis built a general model to develop the method. The thesis gives definitions of speed ratio, cache size ratio and aggregate ratio of cores in the processor. Based on these definitions, we determine the division of data to each core according to the choice, the formula is built to support the division of data processing according to the configuration of each core. The thesis also reduces the synchronous limitation about timeout costs by using the shared variable and controlling the computation of the variable after the execution threads have finished executing.

Finally, the thesis has installed the problems from the proposed method to experiment. From the general model, we build an experimental model and implement it experimentally to prove that the proposed theories are correct. The findings have been presented in conferences, seminars and specialized scientific journals.

12. Practical applicability, if any:

The techniques proposed in the thesis can be applied in practice to well-structured problems, performing independent tasks suitable for embedded software. In addition, these techniques are also effective for independent data processing problems, especially in messaging in IoT embedded devices. With the encryption problem is also analyzed and uses data partitioning and asynchronous processing to increase the performance of embedded software.

13. Further research directions:

In the next time, the PhD student will focus on studies which may solve some of the remaining limitations of the thesis. In particular, the author will focus on conducting these following studies:

- Find the function to evaluate the f_j performance to make the choice of the appropriate song configuration;

- Improved the method in several aspects: extending the problem to synchronous data processing; map execution threads to the respective cores; monitor and change the data division by performance at each time when each CPU core is done processing data.

14. Thesis-related publications:

1. B.H. Phúc, P.V. Hưởng và N.N. Bình, 2017, "*Một phương pháp cải thiện hiệu năng các ứng dụng Android trên chip đa nhân*", Kỷ yếu Hội thảo khoa học FAIR 2017

2. B.H. Phuc, P.V. Huong, N.N. Binh and L.Q. Minh, 2017, "*Enhancing the performance of Android applications on multi-core processors by selecting parallel configurations for source codes*", pp. 225-229, 2017 4th NAFOSTED Conference on Information and Computer Science, DOI: 10.1109/NAFOSTED.2017.8108068

3. B.H. Phuc, P.V. Huong, P.V. Quang, N.Q. Linh, 2018, "*Dynamic Threading to Improve Embedded Software Performance in IoT Devices Using MQTT Protocol*", 2018 International Conference on Advanced Technologies for Communications, pp. 321-325, DOI: 10.1109/ATC.2018.8587511

4. B.H. Phuc, H.T. Binh, L.Q. Minh, N.N. Binh, P.V. Huong, 2022, "*Data partitioning and asynchronous processing to improve the embedded software performance on multicore processors*", Informatics and Automation journal (Scopus), Vol. 2, Issue 21, pp. 243–274, ISSN 2713-3192 (print), ISSN 2713-3206 (online), DOI: 10.15622/ia.21.2.2