VIETNAM NATIONAL UNIVERSITY, HANOI
VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

INFORMATION ON DOCTORAL THESIS

1. Full name: Bui Anh Tu, 2. Sex: Male

3. Date of birth: 10th August 1984, 4. Place of birth: Thai Nguyen City

5. Admission decision number: 1276/QĐ-ĐT, Dated 31th December 2015 by the Principal VNU University Engineering and Technology of Vietnam National University, Ha Noi.

6. Changes in academic process:

- Extend the study for another two academic years (2018 - 2019, 2019 - 2020) according to the Decision No. 1260/QĐ-ĐT by the Principal of VNU - University of Engineering and Technology, dated December 13, 2018.

7. Official thesis title: **Approaches to optimize power consumption for mobile devices based on source code analysis**

8. Major: Software Engineering, 9. Code: 9480103.01

10. Supervisors: Assoc. Prof. Dr. Truong Ninh Thuan

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

The main contributions of the thesis include:

The thesis proposes a model of energy consumption on mobile devices based on source code analysis. The thesis has analyzed a large number of source code fragments, determined the influence of software source code on the level of energy consumption. The thesis builds energy consumption models for each hardware component and for mobile devices. The model uses state transition automats to represent changes in power consumption under the control of the program source code. By the method of static program analysis, the thesis proposes a method to automatically generate models from software source code, build a tool (named PSA) that allows visualization of the energy state to support users. Programmatically observe the power consumption directly on the source code.

The thesis proposes a method to estimate the energy consumption level based on the model. The thesis continues to propose algorithms to estimate the level of energy consumption over time based on the model, the algorithm allows to estimate the level of

energy consumption with each specific use case. The thesis builds a tool to estimate energy consumption directly on the source code. This tool allows installation on programmers such as Android Studio and IntelliJ as a programming plug-in software.

The thesis proposes a method to generate test data for automatic energy consumption. Based on the proposed model and control flow testing techniques, the thesis proposes to improve the CFG graphs to test the energy properties of the software. By adding time factors and energy consumption to the CFG graph, two improved graphs from the CFG are introduced to overcome the weaknesses of the CFG graph in the energy problem. The thesis introduces algorithms to remove useless paths, retain useful paths on graphs that generate test data for the application's energy consumption.

The thesis proposes a method to reduce energy consumption for mobile devices. Optimizing the processing of tasks in the mobile cloud computing model will help reduce energy consumption for mobile devices. By applying the proposed power consumption estimation approach for each task in mobile and cloud execution, combined with real-time constraint analysis to excute tasks, the thesis proposes an objective function and algorithms for decision making to reduce the load on tasks on mobile devices by executing tasks in the cloud to optimize energy consumption and time.

12. Practical applicability: The results of the thesis have the potential to be applied in software development stages, such as aiding in error detection in programming, optimizing the execution of test cases, and reducing energy consumption for mobile devices based on source code improvements.

13. Further research directions: Subsequent research of the thesis could focus on enhancing solutions to improve the effectiveness of the proposed method.

14. Thesis-related publications:

Research projects directly related to the thesis:

1. Anh-Tu Bui, Hong-Anh Le, and Ninh-Thuan Truong, Generation of power state machine for android devices, ICCASA 2017/ICTCC 2017, Springer, LNICST 217, (2018).

2. Hong-Anh Le, Anh-Tu Bui, and Ninh-Thuan Truong, An approach to modeling and estimating power consumption of mobile applications, Mobile networks and Applications, pp. 124-133, (2019)

3. Anh-Tu Bui, Van-Viet Nguyen, and Ninh-Thuan Truong, Generating test data for energy property in mobile applications, 2020 7th NAFOSTED Conference on Information and Computer Science (NICS), IEEE, pp. 96-101, (2020).

4. Anh-Tu Bui, Van-Viet Nguyen and Ninh-Thuan Truong, Time-and-Energy consumption offloading for mobile devices in Mobile Cloud Computing, International Journal of Future Computer and Communication vol. 12, no. 3, pp. 63-69, (2023).

Date: 15th November 2023   Date: 15th November 2023

Signature: …………………   Signature: …………………

Full name: Assoc. Prof. Dr. Truong Ninh Thuan   Full name: Bui Anh Tu