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学位論文の概要及び要旨

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題　　目　A Study on Change-Point Software Reliability Modeling and Optimization for Development Management（チェンジポイント・ソフトウェア信頼性モデルと開発管理のための最適化に関する研究）

学位論文の概要及び要旨

Software development managers should conduct development management properly for achieving the quality required from the user. The major factors under the development planning are the quality, cost, and delivery (QCD), and they are needed to be satisfied as much as possible. However, there are several problems for software development management. For example, when the software development managers make a decision by using the existing development management methods, the amount of information for the decision-making is not enough. That is, the existing development management methods are not realistic and applicable because they are not reflected the actual development environment enough. From these backgrounds, this doctoral thesis discusses the software development management methods based on software reliability growth models (SRGMs). Especially, we discuss mathematical methodologies for software development optimization. Concretely, we focus on the following problems: change-point, optimal software release and optimal testing-resource allocation problems.

This thesis is composed of the following chapters: Chapter 2 discusses change-point modeling framework and the detection method. Chapter 3 discusses an analytical optimal software release problem based on a change-point model. Chapters 4 and 5 discuss an optimal software release problem and an optimal testing-resource allocation problem based on a multi-attribute utility theory (MAUT).

In Chapter 2, a change-point modeling framework based on typical NHPP (nonhomogeneous Poisson process) models and the detection method are discussed. The testing-time when the stochastic characteristics of software failure-occurrence time-intervals change due to a change of testing-environment is called change-point. It is known that the occurrence of change-point influences the accuracy of SRGM-based software reliability measurement/assessment. The existing SRGMs are not introduced the concept although change-point is known as a problem in the actual testing-environment. Furthermore, change-point is caused by software development management or technical aspects of software development. In the former case, change-point is determined sensuously by the software development managers. On the other hand, in the latter case, change-

point occurs as the natural phenomenon. Nevertheless, there is not the theoretical method for detecting change-point. Therefore, we improve the accuracy of existing SRGMs by reflecting the actual testing-environment as the aim of this chapter. We develop specific NHPP models with change-point, and confirm that the proposed models have better performance than the existing models. Also, we apply a Laplace trend test for developing our detection method. The Laplace trend test is a method for observing the time when the trend of software reliability growth process changes. Concretely, we confirm the effectiveness as a change-point detection method by comparing the goodness-of-fit for the existing models and our models applied the estimated change-points. Our change-point detection method enables us to evaluate whether the software development managers could determine the change-point properly or not.

In Chapters 3 and 4, the optimal software release problem is discussed. It is an optimization problem on estimating optimal shipping time of the software product. Normally, an SRGM is applied for discussing the optimal software release problem. However, the actual testing-environment is not reflected to this problem because change-point is not considered so far. Therefore, we discuss the optimal software release problem based on the change-point model. We can estimate the optimal release time and the optimal testing-time duration from the change-point to the termination time of testing simultaneously by formulating the cost function based on a change-point model. Furthermore, we discuss a method for estimating optimal release time considering the multiple evaluation criteria simultaneously. Concretely, we apply a multi-attribute utility theory for solving them. MAUT is the utility theory on decision-making with considering multiple constraints. Additionally, the decision-making for the development management is evaluated by using the utility as an evaluation criterion. The optimal release time and optimal testing-time duration from the change-point to the termination time of testing are derived as the optimal solutions by solving the optimization problem.

In Chapter 5, we discuss an optimal testing-resource allocation problem based on MAUT. This problem is an optimization problem for allocating the testing-resource in the module testing. We need to develop a method for the optimal allocation with considering multiple constraints by using MAUT. Additionally, the expected number of remaining faults is estimated by using the optimal testing-resource expenditures.

Each chapter shows numerical examples by using actual data sets. The final chapter summarizes the results obtained in this doctoral thesis, and remark the conclusion.