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Requirements Engineering and Estimation Process

by

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The estimation takes an important role in initial phases of the project in the system engineering. . The role of requirements in the estimation process is discussed. The requirements based estimation approach is introduced in the following chapter.

Keywords

System engineering, requirements, estimation methods

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Introduction

The system engineering is important discipline, which takes key role in the scientific and engineering area. Because of the system are more and more complicated.

The set of the system requirements describes the functionality of a system, its goals and constrains, which are applicable to the future system. The requirements engineering process takes very important role in the system engineering. Many systems are become software centric and in this background appropriate design of the functionality are more than important. The system engineering as a discipline covers a broad number of subject at present time. It can focused on military systems [11], robotics [12,13] or management systems [14].

The aim of this contribution is to introduce and discuses benefits of employing the requirements engineering techniques in the system engineering.

According to [2, 3, and 4] the system design projects have very often important issues. The factors, which are the most problematic, are cost of the project, delays in terms and technical issues. The requirements engineering is the phase, which takes probably the most responsibility of named issues in the projects.

The organization of this contribution is as follows. Chapter 2 describes the requirements classification. Chapter 3 discusses the methods of requirements documentation. Chapter 4 describes the gathering of requirements. In the chapter 5 is the discussion of the generic requirements engineering process. Finally chapter 6 is a conclusion.

Requirements definition

The requirement [1], [15] is a description of the functionality or condition which stakeholders define for the system. The requirements should be classified under the several criteria. Firstly is talked about the raw requirements are list of functionality or condition for the proposed system, which is unanalyzed yet. The most important in this phase is to establish the project goals, which should be achieved.

The next group of the requirements is non-functional requirements. The purpose of these requirements is familiarized system designers with problem domain and conditions in the domain. Well-known examples of these are reliability, performance, safety or security. These non-functional requirements are critical in the system evaluation very often.

The next group is so-called system characteristics. The system characteristics are commonly prepared in negative way. It means, that system design specifies what irrelevant system behavior is.

Constraint requirements are used for set limits upon the design alternatives the systems. No matter how the problem is solved the constraint requirements must be adhered to.

The appropriate requirement is unitary and atomic; it means describes strictly individual part. Secondly the requirement has to be complete and consistent. This is very important in context of requirements contradiction.

The requirements have to be verifiable. The implementation of the requirement can be determined through inspection or in form of some tests cases.

Requirements documentation

The requirements should be documented in form of free text, in form of structured text and in graphical notation.

The form of free text is common, but brings a many of misinterpretation issues [5]. In the free text description the technical jargon or acronyms have to be omitted.

The structured text and graphical form are commonly used together.

For user goals or for overall overview of the user needs, technique which is adopted from the agile methodologies is used. In the extreme programming, which belongs to the agile methodology group, user stories are used. In the extreme programming user takes important role in the software development.

User stories are forms or cards which contains goal of selected task. The tasks are described in free language without any internal structure. When user stories are written, vague subjects, adjectives, prepositions, verbs and subjective phrases are avoided.

A requirement [6] is defined as a stereotype of UML Class subject to a set of constraints. A standard requirement des

properties to specify its unique identifier and text requirement. Additional properties such as verification status can be specified by the user.

Several requirements relationships are specified. These include relationships [6] for defining a requirements hierarchy, deriving requirements, satisfying requirements, verifying requirements, and refining requirements.

A composite requirement can contain sub requirements in terms of a requirements hierarchy. This relationship enables a complex requirement to be decomposed into its containing child requirements. A composite requirement may state that the system shall do A and B and C, which can be decomposed into the child requirements that the system shall do A, the system shall do B, and the system shall do C.

An entire specification can be decomposed into children requirements, which can be further decomposed into their children to define the requirements hierarchy.

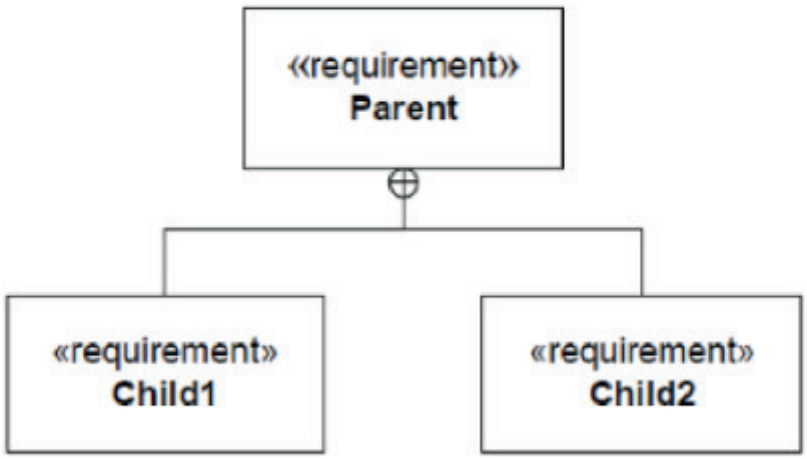

Fig. 1 Containment Relationship

The "derive requirement" relationship relates a derived requirement to its source requirement. This typically involves analysis to determine the multiple derived requirements that support a source requirement. The derived requirements generally correspond to requirements at the next level of the system hierarchy.

The verify relationship defines how a test case or other model element verifies a requirement. In SysML, a test case or other named element can be used as a general mechanism to represent any of the standard verification methods for inspection, analysis, demonstration, or test. There can be tagged values – for example verification status.

Requirements engineering process

The requirements engineering process represents a formal view of all necessary activities to achieve a Complete and balanced system requirements.

The requirements engineering process contains these steps:

1.Application Domain Analysis

2.Stakeholders Identification

3.Users and System Stories

4.Prototype Creation

5.Functional Requirements Elicitation

6.Non-Functional Requirements Elicitation

7.Constrain Requirements Elicitation

8.Requirements Clustering

The application domain analysis is very important phase. During this phase all of the environmental aspects are determined. Understanding of the domain concepts is very important for next steps.

The stakeholders Identification is next logical step, which is based on the domain analysis. In this step is necessary to resolve budget holder and all users of

the modeled system. The list of stakeholder is created and then used for interview or questionnaires.

The domain analysis and stakeholder's analysis are then used for creation of user and system stories.

These basic stories are then reworked in form of prototype. This prototype is used in our proposed methodology for requirements gathering. We expected that prototype is appropriate for functional, non-functional and for constrain requirements elicitation.In the phase No. 5, 6, 7 methodology offers interview in the form of brainstorming, which is moderate by laddering.

The final phase of proposed approach is requirements clustering, in which system modules are designed.

Estimation based on Use Cases

In this article we present a system engineering, which is based on SysML langauge and requirements gathering process.

The clustered requirements are mapped to use cases.

Use Case is used for the system function description. This model is composed of the actors, which are external entity and of the use cases. The use cases represent system functions or algorithms. Each of the use case has to realize one of the requirements as minimum.

The Use Case is description of the activity of the action in the system. The use case model in the system engineering consist of the actors, use case and associations.

An use case is written in form of the scenario. The scenario represents sequence of the steps, which represents using of the system by an actor. The actors and scenarios are the base factor in the estimation methodology, called use case points.

Scenarios provide a brief description of an activity of an actor in a system. Other common definition describes a scenario as internal part of a business process, which is solved by a system itself.

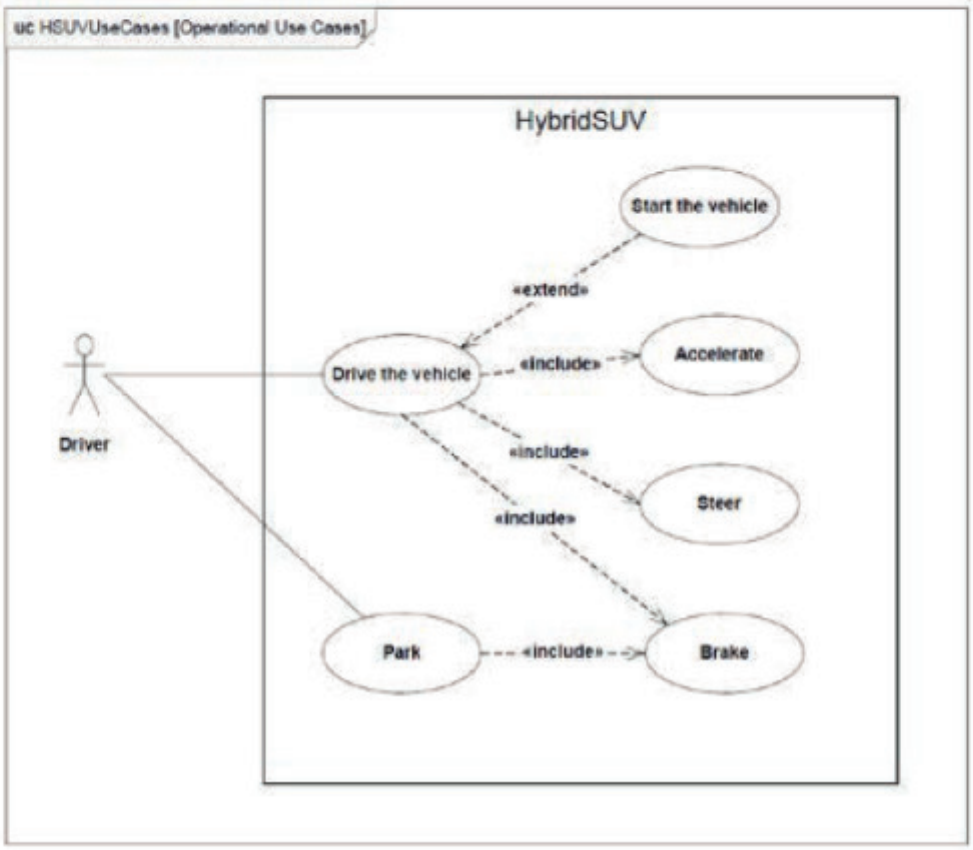

Fig. 2 Use Case Model Sample [6]

For purpose of estimation number [9,10] of steps in the scenario is significant. The number of steps represents the scenario or use case complexity, therefore a system complexity is represents by the number of use cases.

For analyzing the system complexity is necessary to analyze the use cases, which were created based on clustered requirements. The quality of use cases is important for the correct estimation without occurring error.

The technical requirements of the use case such as concurrency, security and performance.

The generic use case point methods [9,10] is described as following steps:

•Technical Complexity Factor.

•Environment Complexity Factor.

•Unadjusted Use Case Points.

•Technical Complexity Factor

Technical Factors

There are standard technical factors exist to estimate [9,10] the impact on

Table 1 Technical factors

Technical Factor	Description	Weight
T1	Distributed system	2
T2	Performance	1
T3	End User Efficiency	1
T4	Complex internal Processing	1
T5	Reusability	1
T6	Easy to install	0,5
T7	Easy to use	0,5
T8	Portable	2
T9	Easy to change	1
T10	Concurrent	1
T11	Special security features	1
T12	Provides direct access for third parties	1
T13	Special user training facilities are required	1
T14	Sociotechnical system	2
T15	Business Critical	2

productivity that various technical issues have on an application. Each factor is weighted according to its relative impact. A weight of 0 indicates the factor is irrelevant and the value 5 means that the factor has the most impact.

Environmental complexity factor

Environmental Complexity estimates the impact on productivity that various environmental factors have on a system.

Each environmental factor is evaluated and weighted according to its perceived impact and assigned a value between 0 and 5. A value of 0 means the environmental factor is irrelevant for this project; 3 is average; 5 means it has strong influence.

Table 2 Environmental Complexity Factor

Environmental Factor	Description	Weight
E1	Familiarity with System Designing	2
E2	Systém Domain Experience	1
E3	SysML Experience	2
E4	Lead analyst capability	2
E5	Motivation	1
E6	Stable Requirements	2
E7	Sub-Contractors	-2
E8	Difficult Integration	2
E9	Ecological Evaluation	-2
E10	Public Importancy	-2

Use case classification

The Use Cases are clustered into three sets. Simple, Average and Complex.

The **simple** set contains use cases, which have software based interface and main path scenario has 4 steps as a maximum and implementation contains of 2 subsystems.. Calculation value is 5.

The **average** set contains use cases, which have user interface, data processing and main path scenario has 8 steps as a maximum and implementation is group of 5 subsystems. Calculation value is 10.

The complex set contains use cases, which involves a technology control, mechanical user interface or very complex data processing. Main path has Over 8 steps; its implementation involves more than 5 subsystems. Calculation value is 15.

System Actor Clasification

Actor are clustered in same sets as use cases. Sets are simple, avarage, complex.

Simple. The Actor represents another system with a defined standardized interconnection. Calculation value is 1.

Average. The Actor represents another system interacting through a protocol, like TCP/IP. Calculation value is 5.

Complex. The Actor is a person interacting via an software or mechanical interface. Calculation value is 10.

Calculation Case Study

The recapitulation of the example in the figure 5, can be found in the table 3.

Table 3 Actor and Use Cases Characteristic

Actors:	Complexity	Weight	Number
Driver	Complex	10	1
Use cases:			
Drive the vehicle	Complex	15	1
Park	Avarage	10	1
Start the vechicle	Simple	5	1
Accelarete	Avarage	10	1
Steer	Avarage	10	1
Brake	Avarage	10	1

Anadjusted Use Case is 60, based on sum of weight and number.

Unadjusted Actors is 10, based on sum of weight and number.

Significance of the technical and environmental factors should set as 0 * 10, where 0 has to effect and 10 represents the most significant factor.

Summary of the technical and environmental factor can be found in the tables 4 and 5.

Table 5 Technical factors for the case study

Technical Factor	Weight	Effect
T1	2	5
T2	1	0
T3	1	5
T4	1	10
T5	1	0
T6	0,5	0
T7	0,5	0
T8	2	10
T9	1	0
T10	1	5
T11	1	5
T12	1	5
T13	1	5
T14	2	5
T15	2	5

Technical Factors are calculated as TTF: 0.6+(0.01*GlobalTechnicalFactor. The global technical factor is calculated as sum of Weight*Effect for each T.

For sample project TTF is 1.45.

Table 4 Environmental factors for the example

Environmental Factor	Weight	Effect
E1	2	5
E2	1	10
E3	2	0
E4	2	10
E5	1	0
E6	2	0
E7	-2	5
E8	2	0
E9	-2	5
E10	-2	5

Environmental Factors are calculated as ETF: 1.4+(-0.03*GlobalEnviromentalFactor. The global environmental factor is calculated as sum of Weight*Effect for each E.

For sample project ETF is 1.1.

Final result of calculation, the number of use case points is calculated as follows:

(Unadjusted Use Case + Unadjusted Actors) * TTF * ETF. In our example, total number of use case points is 111.65.

Final estimation is based on number of working our per 1 use case point. It is usually set approx. 30 hours per 1 point.

Conclusion

The idea of the contribution was to introduce System Modeling Language for modeling system behavior. The system engineering were described and connection between system modeling language diagrams and the system engineering phases were illustrated.

The modeling project support analysis, specification, design, verification and validation of systems. SysML therefore support all phases of the system engineering lifecycle.

The SysML uses number of diagram, which allow to a system designer model the proposed system in many views.

The system behavioral modeling deals with requirements engineering, use cases elicitation and state modeling of the system.

The proposed requirements gathering model leads to clustered requirements, which are used for mapping use cases. The scenarios in use cases are used for system estimation.

Further research in system modeling is focused on the improvement of the appropriate calculation values, which probably the most important in the estimation factors.

Further research will be focused in improving accuracy of technical and environmental factors.

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