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An Eliciting Requirements for Automotive Product Development: A Study

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Abstract
Requirements elicitation plays a crucrolethe requirements engineering process as it involves discovering and formalizing the product development. In many cases, stakeholder's collaboration to define the requirements, is one of the most difficult tasks in the automotive product development because of the different perspective and expectation of stakeholders about the future of automotive product development. This paper deliberates about the gaps from the existing approaches, tools, techniques and methods used for eliciting requirements in developing automotive products. Besides that, this paper investigated and analysed the current approaches and tools to elicit the requirements for automotive product. Our findings from the reviewed and analysed of different tools and approaches on requirements elicitation for automotive product development are presented. Next, the strength and weakness of these approaches and tools are also discussed to provide and offer more understanding of the gaps and flaws of each tools. Further, future work recommendation are also presented.

Keywords: Requirements elicitation; automotive product development.

Introduction

Requirements elicitation is the process whereby the product developers such as designer discover, review, articulate and understand the users or potential customer or even stakeholder needs and project limitations on development process. Constraints and conflict may arise in this requirements elicitation phase because of the misunderstanding and miscommunication between stakeholders and designer while gathering, determining, extracting or exposing the requirements and needs from the stakeholders.

Specifically, design teams face a considerable challenge in making effective use of increasing amounts of information that often accumulate and remain in individual information systems [1]. As a result the analysts may not have a clear idea what kind of system they are building and the customer as the end-users are often surprised when they notice that the final product does not fulfil their expectations and solve the problems needed by system at the first place [2].

From the user's perspective, good elicitation results is having a better understanding of their needs and constraints. From this, they will be able to effectively evaluate alternatives solution and understand the implications of their decisions [3]. Therefore, an elicitation strategy is required as it is a set of guidelines for identifying the correct source of requirements and background information and resolving conflicts among them [3].

Besides, requirements elicitation tools, methods, techniques and approaches used for the automotive product development also plays an important roles to ensure the quality of the developed product in the automotive industry. In this paper, a review of existing tools and approaches in eliciting requirements for automotive product development are discussed. The paper is organized as follows: Section 2 describes the survey of literature. Section 3 presents a description of selected tools and approaches for eliciting requirements for automotive product development synchronize with the comparison analysis. Section 4 designates to the discussion of the overall findings and this paper end with a conclusion section.

Related Work

There are various types of elicitation techniques, approaches, methods and tools used to develop automotive products. For instance, M. G. Violante et al [4] propose a user-based strategy that based on the Kano methodology user satisfaction and turned it into a product specification. The Kano model of customer satisfaction is a useful tool to categorize product attributes based on how they are perceived by the customers and their effect on customer satisfaction [5]. Here, customer satisfaction is the ultimate objective of every business: not to supply, not to sell, not to service, but to satisfy the customer needs that drive companies to do business [4]. Yet, this eliciting approach required some knowledge and effective

tools to elicit accurate user requirements and relies on the managements of the requirements.

In addition, X. Liu et al [6] extend the EAST-ADL2 language to build a multiview requirement modeling language for automotive systems using the timed automata and communication signal matrix. However, this approach is only focused on modeling software requirements in the automotive domain but not in eliciting the requirements of product in automotive domain. Meanwhile, Siegl et al [7] proposed a Timed Usage Model (TUM) as a formal representation of requirements specification in development process in automotive domain.TUMs are Markov Chain Usage Models (MCUM) extended by time information, that preserve the semantic of the MCUM and support automated test case generation for embedded systems in test environments as they are established in the automotive industry [7]. Though, this approach focuses on the traceability of formal requirements specification from the requirements documents to the results of the test cases still it does not concern or derive from the characteristic of a requirement specification.

Next, Zhou et al [8] suggested feature-oriented requirements validation for automotive system. To be specific, this approach specifies features by using an informal yet restricted natural language (from scratch) without losing ease of use, and then formalizes a set of executable models based upon the aforementioned intermediate specifications to perform the requirements validation [8]. In the meantime, this approach are lack in the validation of the requirements specification in the wider industrial and also absence of algorithm. Then, Roy et al [9] presents a framework that is based on the ontological to provide a shared conceptualization of the knowledge needed for the specification on a product. An ontology for a product allows the different stakeholders to have a shared conceptualisation of the product requirements in terms of mutually accepted and understood abstractions and associated language [9]. Yet this approach has the difficulties on validation by domain engineers to elicit precise requirements in developing automotive domain.

Tools Survey

Various approaches have been developed to elicit requirements for the needs of developing an automotive products. In this section, we present a descriptive review of six eliciting requirements approaches for automotive products development. The main objective of this descriptive review is to explore and evaluate the effectiveness and practicality of the eliciting requirements approaches for the automotive product developments. For example, Aoyama et al [10] proposed AORE
(Aspect-Oriented Requirements Engineering) methodology. This approach is designed to model the non-functional and functional requirements of automotive software systems of numerous product lines allied on a safety-critical distributed real-time architecture. Furthermore, this approach allows to model and analyse the numerous non-functional requirements under the constraints of reference architecture and produce a set of multiple product-lines using the aspect models as the first class reusable asset. However, this approaches are not applicable on large set of non-functional requirements and this approaches are still yet need to be extends the modeling capability and support complicated interrelations of aspects and features.

Meanwhile, A. Goknil et al [11] present a metamodeling approach that allows reasoning about requirements and their relations on the whole/composed models expressed in different requirements modelling notations. Besides, this approach is based two modeling approaches which is product line requirements models and SysML for system requirements. First, the core metamodel is specialized to model product-line requirements with their relations. New relations among product-line requirements are inferred and the consistency of the relations is checked. Second, the core metamodel is specialized to model the system requirements in SysML. The reasoning is performed for the requirements relations and use the relation types in the core metamodel to relate the product-line and SysML requirements [11]. However, this approach is not goal-oriented requirements models and yet need to be improve. In addition, S. Islam et al [12] developed and validate a new concept to elicit and specify user requirements in automotive. The concept developed are related with the systematic expert interview and after the interviewing phase the text-based use cases generated to represent the requirements. However, this proposed approach are constructed based on the interviews to elicit all the requirements needs to developing automotive products occasionally cause time consuming and inherently misleading requirements. Also Yang et al [13] sets up product requirement expression model by using the semantic network, and creates customer express requirement for the product simply and directly and involve in product design. However, the semantic networks has no standard definition of link names for each nodes.

Meanwhile, X. Liu et al [14] proposed a model-driven development methodology that encouraging approach to develop a complex software-intensive. This work will help software analyzers to decompose complicated requirement documents into separated concerns, and organize essential requirement information as rigorous models, which will both facilitate simulation and verification of requirements and set up the starting point for the model-driven development [14]. However, this models-driven approach framework focuses only to the aspectual models to form a complete requirements specifications. Other than that, P. Nistala et al [15] presented a methodology that has been developed from the synthesis of different systemic models which recognizes the nonlinear behavior of business systems. The key models in this methodology are: defining the System in Focus, Qualitative Cybernetic Model, Stakeholder Analysis Framework, Objective alignment model and Process Requirement Matrix [15]. Yet, this approach only facilitate the holistic comprehension of a system by introducing two key models, namely, qualitative cybernetic model and a stakeholder framework and does not provide any templates for further significant derivations. J. Boulanger et al [16] resumes the model-based development (MBD) approach to improves the specification, design and implementation phase for the automotive software. This approach is based on two standard languages: EAST-ADL and SysML. EAST-ADL is an architecture description language dedicated to automotive

software. It provides a mean to describe the functionality of a vehicle, from high level requirement to implementation details [16]. SysML gives a means to early represent into models the requirements and physical parametric of automotive system [16]. However, this approach are focused on the MeMVaTEx methodology that is not definitive and decisive.

TABLE 1: Comparison of approaches for requirements elicitation in automotive product development

Tools Name						**Requirement Presentation**		
Approach/ Methodology and Techniques	Types of Requirements					Formal	Semi-Formal	Informal
	Architectural	Business	User	Functional	Non-functional			
AORE (Aspect-Oriented Requirements Engineering)				/	/	/		
Reasoning Metamodeling				/		/		
Systematic use case interviews			/				/	
Semantic Network			/			/		
Model-driven development	/						/	
Systemic Model		/				/		
TOTAL	**1**	**1**	**2**	**3**	**2**	**4**	**3**	**0**

Tool Comparison

All the six existing approaches use for eliciting requirements in the developing automotive products are compared based on the method or approach, types of requirements the approaches relates on and also the requirements presentation as shown in the Table 1 above. It shows that most approaches are concern on the functional or non-functional requirements of automotive product development. Less work is focussing on the verbal user requirements and the business requirements as well as the architecture requirements of the system being developed. It is also shown that most are using formal and semi-formal representation to visualize the automotive product requirements. There is none of the tool assist the natural language requirements (informal) which is the source of any system development that is requirements document.

Discussion

Precise and accurate requirements elicitation plays an important role when it comes to the support and provision of the product developments in automotive industry. Various approaches, methodology, tools and techniques has been developed to assist and support the requirements elicitation phase mainly in automotive industry in developing and emerging their products. Therefore, different teams may need to use different requirements modeling approaches to express requirements related to their assigned parts of a given project: informal (interviews, surveys, textual requirements, etc.), semi-formal (Product-line, SysML, etc.) and formal (Deontic logic, B-method, etc.) [11]. However, current works and tools do not offer a proper means to elicit requirements for developing automotive products and the current techniques are tedious, expensive, time consuming and complex. Thus, it is essential to have an effective and competent approach in eliciting requirements in automotive products development.

We have conducted a review on six types of tools developed in eliciting requirements of the automotive products development such as AORE (Aspect-Oriented Requirements Engineering), Reasoning Metamodeling, Systematic use case interviews, Semantic Network, Model-driven development and Systemic Model. Based on our review as shown on Table 1, we have found that there are various approaches or methodologies used by existing eliciting requirements tools for developing automotive products. Aspect-Oriented Requirements Engineering (AORE) is the approaches that involve in eliciting both functional and non-functional requirements. The reasoning modeling are only involve in eliciting functional requirements.

For the systematic use case interviews and semantic network approach, these approaches are based on the user requirements to elicit the requirement of the product development. Nevertheless, the model-driven development developed are used to elicit the architectural requirements and systemic model focuses on eliciting business requirements. Systematic use case interviews and Model-driven development tools used the semi-formal representation of requirements and the rest of the tools used the formal representation of requirements. In contrast, there are very least work in using ontology or any other classification techniques to classify and identify both functional and non-functional requirements of an automotive product to be developed. There is also none taxonomy found to categorise the characteristic of the automotive product.

Conclusion

Requirements elicitation is the crucial phase in developing the accurate and precise products in automotive products developments. We have investigated and analysed the approaches and tools that currently exist to elicit the requirements of an automotive product to be developed.

For future works, we plan to develop an approach and tool that is able to categorise and classify the functionality and non-functionality requirements for develop automotive products.

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