International Journal of Embedded and Real-Time Communication Systems
Volume 13 • Issue 1

ESQuMo:
An Embedded Software Quality Model

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ABSTRACT

Embedded systems are increasingly used in our daily life due to their importance. They are computer platforms consisting of hardware and software. They run specific tasks to realize functional and non-functional requirements. Several specific quality attributes were identified as relevant to the embedded system domain. However, the existent general quality models do not address clearly these specific quality attributes. Hence, the proposition of quality models which address the relevant quality attributes of embedded systems needs more attention and investigation. The major goal of this paper is to propose a new quality model (called ESQuMo for embedded software quality model) which provides a better understanding of quality in the context of embedded software. In addition, it focuses the light on the relevant attributes of the embedded software and addresses clearly the importance of these attributes. In fact, ESQuMo is based on the well-established ISO/IEC 25010 standard quality model.

KEYWORDS

Embedded Software, Embedded Systems, ISO/IEC 25010, Non-Functional Requirements, Product Quality, Quality Attributes, Quality Models, Software Quality

1. INTRODUCTION

Embedded systems are computer platforms consisting of hardware and software. They run specific tasks to achieve certain purposes they were developed for, either in telecommunication, computing, controlling, assistance, etc (Barr, 2007; Kumar, et al., 1996). These tasks are expressed through functional and non functional requirements. On the one hand, functional requirements represent the functional properties of the system like making calls for phones. On the other hand, non functional requirements represent how these tasks were achieved by the system like the phone camera should take a picture in less than 100 milliseconds while pressing the shooting key. The non functional requirements are also known by quality attributes (Guessi et al., 2012).

DOI: 10.4018/IJERTCS.289201 *Corresponding Author

Embedded systems are gaining more attention due to their importance in our daily life. In addition, embedded systems are becoming complex more than ever before since they run under stringent constraints such as time, limited resources, severe environments and critical operations (Jamont, 2005; Pries, et al. 2008; Lee, et al., 2016). The growth in complexity of these systems and the criticality uses of them require sophisticated development process in order to guarantee their quality. Thus, quality assurance is a systematic process which includes all the techniques and tools that should be followed to develop secure, safe, functional and reliable systems. Of course, developing quality models is the basic stone in any quality assurance process because it makes the quality concept commonly specified by using its relevant attributes (Garcés et al., 2017). In this context, most of works proposed in this field are limited to proposing quality attributes of embedded systems without proposing these attributes in a quality model. In fact, a quality model relates the different quality attributes to specify their relationships in order to represent a coherent view of the quality concept. Moreover, the quality of embedded systems is specified using domain-specific terminologies (like dependability) which are not commonly used to specify the software quality models. Consequently, we think that using well-known quality models is more beneficial than using domain-specific attributes.

In this paper, we propose ESQuMo, a specific quality model for embedded software, which based on the well-established ISO/IEC 25010 quality model (ISO, 2011). Of course, proposing this quality model passes through the identification of specific quality attributes of the embedded software. Furthermore, we ignored the attributes of quality considered unnecessary according to the specific characteristics of embedded systems. Also, these attributes are related to the specific quality concepts of embedded systems in order to provide a unique framework that specify the quality of such systems for both software engineer and embedded systems developers. It is important to note that the main purpose of this version of ESQuMo is to define the quality of embedded systems. Measuring or predicting quality of such systems require using other models.

The remainder of this paper is organized as follows: Section 2 introduces some related works to our topic. Section 3 presents a background on embedded systems, quality management and quality assurance. In addition, it gives a detailed overview of quality models with more concentration on the ISO/IEC 25010 standard quality model. In Section 4, we identified the relevant quality characteristics of embedded software used to develop the ESQuMo quality model. Section 5 provides a comparative study between our proposed quality model ESQuMo with other similar works. Conclusion and future works are provided in section 6.

2. RELATED WORKS

A growing number of works are concerned with quality models and quality attributes of software products. However, only few have targeted the embedded software products. The proposition of new quality models that address the specific properties of embedded software is due to the lack of a standard quality model that unifies and covers these properties, as well as the common characteristics of the ordinary software.

Many quality models have been emerged such as the one proposed by Ahrens et al. (2013), a quality model for driver assistance systems. Nevertheless, it is very limited and restricted for driver assistance products.

Jeong & Kim (2012) proposed a quality model for embedded systems based on DeLone and McLean success model. The lack of this work is the absence of a clear meta-model that facilitate the interpretation of the proposed model.

Choi et al. (2008) proposed SCQM (Samsung Component Quality Model) an evaluation quality model for embedded systems based on the ISO/IEC 9126 quality model. The main deficiency in this work is the absence of a clear criterion according to which quality characteristics are divided into main characteristics and sub-characteristics