Chapter 15

Functional and QoS Semantics-Driven SOA-Based Biomedical Multimedia Processing

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ABSTRACT

Although there have existed a wide range of techniques of biomedical multimedia processing, none of them could be generally satisfied by various domains. The main reason for such deficiency is due to the correlative nature between biomedical multimedia data and the techniques applied to them. This book chapter introduces an SOA-based biomedical multimedia infrastructure with a pre-processing component. Such an infrastructure adapts the concepts of requirements elicitation of Software Engineering as well as a training set of Machine Learning to analyze functional and QoS properties of biomedical multimedia data in advance. Such properties will be constructed as ontology and used for selecting the most appropriate services to perform data analysis, transmission, or retrieval. Two medical education projects are introduced as case studies to illustrate the usage of functional and QoS semantics extracted from a feature extraction service to improve the performance of subsequent classification service and searching service, respectively.

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INTRODUCTION

In the area of biomedical multimedia processing, there are many existing techniques for different applications. Each of these techniques has their own advantages as well as limitations. A common scenario is that a highly successful technique for a particular problem domain may not work properly for another. Even in the same domain, due to a wide variety of biomedical multimedia data under different conditions (e.g., different capturing devices, different decoding/encoding methods, different illuminations, scales, and viewing angles), a wide range of techniques may be utilized together or separately to achieve the best performance of processing such heterogeneous data. However, how to best leverage the composition/decomposition, rearrangement, or improvement of these techniques to tackle tight correlation between multimedia processing techniques and its data is an open problem. Most of the existing approaches perform preliminary analysis of the problem domain and manually inspection of the raw biomedical multimedia data in order to determine the best practice for later multimedia processing. Unfortunately, such manual trial-and-error procedures to analyze and inspect raw data are tedious and error-prone. The common nature of huge-volume in multimedia data also increases difficulties of the preliminary procedures as well as multimedia processing. Besides, software systems composed by existing or new techniques for biomedical multimedia processing usually have very specific and stringent yet sundry functional and Quality of Service (QoS) requirements. For example, OpenEHR (OpenEHR Foundation, 2010) and HL7 (Health Level 7 International, 2010) standards, HIPAA policies (U.S. Department of Health and Human Services, 2010), and FDA regulations (U.S. Food and Drug Administration, 2010) are mandatory privacy and security requirements that biomedical systems should guarantee. All such problems (i.e., tight correlation, huge-volume data, and stringent functional and QoS requirements) make the determination of the best practice of multimedia processing a challenging task.

Service-Oriented Architecture (SOA) (Erl, 2005; Papazoglou et al., 2007) is a software engineering paradigm that creates, composes and interoperates homogeneous/heterogeneous services (i.e., individual units of logic autonomously perform specific functionalities conforming industry standards and principles (Erl, 2005)) in loosely coupled manners. Such a paradigm may also enable service rearrangements in accordance to specific functional or QoS needs (Papazoglou et al., 2007). This book chapter reviews the semantics-driven and data-driven SOA infrastructure for biomedical multimedia software development introduced in (Liu et al., 2008). The book chapter specifically concentrates on how the proposed SOA-based infrastructure, relying on the multimedia data, stringent multimedia software requirements, and communication protocols as functional and/or QoS contracts with services (Barreto et al., 2007), solves the abovementioned multimedia processing problem (i.e., the correlation problem).

Our infrastructure comprises five main aspects: (i) Services development for biomedical multimedia software. These services include, but not limit to, data analysis, transmission, and retrieval. Data pattern discovery, reliable and secure data transmissions, and efficient data access are the objectives of the three respective services; (ii) Multimedia data annotations, comprising both automatic and manual annotations, are introduced. Content analysis such as edge detection or corner detection may be performed when automatic annotations are invoked. Such an analysis is lightweight and executed before the actual data processing stage. A few insights of the characteristics of the data sets could be revealed to guide on how to choose the most appropriate services/service combinations later. For example, QoS annotations (e.g., bone measures of a skull image) may be elicited by content analysis algorithms; (iii)