MEDINFO 2013
C.U. Lehmann et al. (Eds.)

doi:10.3233/978-1-61499-289-9-972

Making Knowledge on Healthcare Technologies Understandable: An Ontology for Lab-on-a-Chip Systems

Gunnar Nussbeck[a], Nazli Soltani[a], Kerstin Denecke[a]

[a]*Department of Medical Informatics, University Medical Center Göttingen, Germany*

Abstract

Technology for supporting diagnosis and treatment is becoming more complex. New developments are coming up and need to be evaluated from various perspectives. Researchers from other disciplines are seldom experts in healthcare technology. The relevant terminology needs to be settled to be able to communicate interdisciplinary. In this paper, we introduce an approach on how to make complex knowledge related to technological developments in healthcare accessible and understandable for experts from other domains. In particular, we consider the field of lab-on-a-chip systems [1]. For this field, we develop an ontology that enables researchers to get insights into the domain and to study the related ethical, sociological, and legal aspects.

Keywords: Knowledge Management, Lab-on-a-Chip Devices, Ontology Engineering

Introduction

The field of Lab-on-a-Chip systems (LOC) is growing fast since a few years. A LOC integrates a number of laboratory operations on one chip [1]. LOC systems have evolved in recent years to an extent where they seem to be fit for direct-to-consumer marketing. The market and research in the LOC domain is already very complex, making it difficult for researchers from other fields such as ethics and social sciences to be aware of the various facets of existing solutions. How can we enable researchers to have a common understanding of the "LOC domain" and to use the same vocabulary? To address this question, we developed an ontology that describes the application field of Lab-on-a-chip systems. An ontology can provide a mean for a consistent, structured description of a domain [2]. Our LOC ontology intends to serve as a tool to categorize and semantically annotate lab-on-a-chip systems, i.e. it intends to support communication in an interdisciplinary research team. It allows to get an overview on the field of LOC systems, their characteristics and application domains.

Material and Methods

The main goal of the ontology is to support researchers in getting a better, mutual understanding of the LOC domain. The target users of the ontology are researchers with a background in medicine, psychology, social sciences, and law. As application scenarios, we identified questions to be answered by the ontology among others related to the characteristics of a specific LOC. The primary use case of the ontology is a manual assessment, i.e. knowledge has to be presented in a human-readable manner. Therefore, we selected the Web Ontology Language (OWL) for knowledge representation of the LOC ontology. In order to identify concepts and relations to be included into the ontology, a structured literature review using the PubMed library was performed. The search with the search terms : 'Lab on a chip', 'Lab-on-a-chip', 'LOC', 'mTAS', 'microTAS', 'micro Total Analysis Systems', 'POC-Testing', 'MEMS', 'Micro electromechanical systems' was conducted on Mai 12, 2010. The results were limited to items with abstracts, meta-analysis, or reviews written in either English or German were published within the last 10 years.

Results

The literature search led to 305 hits and a total of 72 papers from which the terms describing the LOC domain were collected manually and corresponding concepts were created in OWL. An underpinning taxonomy was generated, and relations between concepts were specified and modeled. We identified 202 classes and 42 relationships (object properties and data type properties). The main classes are: *Application, Application Domains, Enabling Technology, Feature, Lab Process, Parameter, Place, Principle, Reagent, Stakeholder, Technology, Unit Operation*, and *Value Partition*. All main classes are further divided into subclasses which differentiate more specific characteristics of the superclass members. For example, the *Application* class classifies the LOC based on the purpose that the LOC was designed for or the way the LOC is applied (*Application Purpose* and *Way Of Application*), where *Drug Efficacy Testing Application* and *Point Of Care Testing Application* are respectively examples of the subclasses of the two *Application* classes. As a first usability validation for the ontology, 45 real-world LOC systems were integrated into the ontology. The resulting ontology has been presented to ontology and LOC experts who confirmed the usefulness of having such an ontology and suggested to introduce some additional relationships between concepts.

Conclusion

The benefit of the developed ontology is a formal, but understandable description of the LOC domain for non-LOC experts. One future use case of the ontology is its use for document retrieval: The terms describing the classes in our ontology could be used as labels for documents in a database. For future research it remains open to connect our LOC ontology to existing (clinical) ontologies which would lead to additional possibilities of future use.

References

[1] Mark D, Haeberle S, Roth G, von Stetten F, and Zengerle R, Microfluidic lab-on-a-chip platforms: requirements, characteristics and applications. *Chemical Society Reviews*, vol. 39, no. 3, pp. 1153-1182, Mar. 2010.

[2] Staab S, Studer R (Eds.). Handbook on Ontologies. Springer 2004.