

Case-Based Decision Support and Experience Management for Ultrasonography

Ziad El Balaa¹ and Ralph, Traphöner²

¹Université Pierre et Marie Curie
12, Rue Cuvier
F-75005 Paris
elbalaa@ccr.jussieu.fr

²empolis GmbH
Europaallee 10
D-67657 Kaiserslautern
ralph.traphoener@empolis.com

Abstract: We describe the FM-Ultranet approach to provide decision support and experience management for a medical doctor in the course of conducting an ultrasonographical examination of a fetus in the mother's uterus. Based on the medical background and the requirements of the examination we introduce a knowledge representation of fetal malformation and its utilization in a Case-Based Reasoning system to assist the examiner. We conclude with a description of our results from working with domain experts and give directions for future work.

1 Introduction

As compared to other medical imaging techniques, ultrasound imaging is a real non-invasive and cost-effective solution in many diagnostic approaches. In the field of obstetrics (fetal ultrasonography), this technique is used in a different way than in other areas. Scanning a fetus is done mainly to detect abnormalities at a very early stage (e.g. of the head, the heart, abdominal wall, umbilical cord, urinary tract, skeleton, etc.). This is a difficult task done by an ultrasonographer (i.e. a radiologist, an obstetrician, a general practitioner) which requires an average of 1/2 hour of examination. This task is operator dependent and subject to a strong personal interpretation as reference cases are not easily accessible.

Ultrasound scans interpretation and diagnosis can largely be improved through comparison of past existing similar cases and with guidance of an expert. Hence, FM-Ultranet combines Case-Based Reasoning (CBR) and Expert networking to improve ultrasonography through decision support. CBR seems to be best suited to achieve this goal. In the past there have been a number of applications of CBR in medicine. [GBS98]

presents a comprehensive overview. It also shows that the integration of such systems into the medical work process is crucial for the success. Following we present our approach in detail.

2 FM-Ultranet Approach

When an ultrasonographer detects a malformation during a morphological examination of a fetus then he may remember a previous case from his experience and/or he may ask an expert for a second opinion. These are two ways to obtain support for his decision, i.e. the kind of malformation and, in the worst case, the termination of pregnancy.

FM-Ultranet acts as an electronic assistant to its user. It trains the apprentice to do complete examinations and to recognize the relevant symptoms of the diverse malformations. It supports the practitioner by easing his daily work while supporting him in the exceptional case of a malformed fetus. Last but not least it assist the expert in exploring large collections of cases and helps him to share his experience.

3 Knowledge Representation

Technically, FM-Ultranet is a knowledge-based support system. Its kernel is a CBR system that utilizes an object-oriented case model. The similarity assessment applies specific medical measures that were developed with gynecologists. These two knowledge containers, i.e. cases and similarity measures, are augmented with medical background knowledge in the form of rules to express constraints and consistency conditions, among others.

4 Results

The whole system has been implemented with the CBR tool *CBR-Works* from empolis, Germany. We have collected 120 reference cases of the malformations of the urinary tract including the related image data. The knowledge representation fully covers the sane and normal fetus. According to the representation of malformations the urinary tract is fully described, 25% of the heart and 10% of the abdomen are covered. The model consists of 40 classes with 140 attributes. Each class has a rule set to ensure completeness and consistency of the description and to provide guidance for the image interpretation. All discriminant attributes have appropriate medical similarity measures.

The system was deployed and tested in a trial with medical practitioners in Nimes and Liège. Most appreciated by these users was the similarity based retrieval of reference case data to improve their diagnostic quality and the use of the system as a personal experience management system.