A Workflow Component for Knowledge Management in the Field of Radiological Examinations

Krechel Dirk, Faber Kerstin, Reidenbach Daniel, Blasinger Klaus*, von Wangenheim Aldo+, Comunello Eros+

Knowledge Based Systems Group, University of Kaiserslautern,
Postfach 3049, 67553 Kaiserslautern, Germany
Email: {krechel,faber,reidenba}@informatik.uni-kl.de
*Radiologische Gemeinschaftspraxis Dr.Buddenbrock, Dr.Blasinger, Dr.Benz,
Rheinstrasse 4 A-C, 55116 Mainz, Germany
Email: krechel@goofy.zdv.uni-mainz.de
+Department of Computer Science, Universidade Federal de Santa Catarina,
88049 Florianopolis, Brazil
Email: {eros,awangenh}@inf.ufsc.br

Abstract In this paper we present a workflow component for the knowledge intensive task of reporting radiological images. Our component integrates the current developments in medical standards. It should act as an organizational memory for private radiological hospitals and help to train young physicians. We have build a computer aided methodology to create standard examination protocols and the physician can use an assistant system during his daily work. Our approach helps to save the organizational knowledge of a private hospital.

Keywords: DICOM, Workflow Management, Radiological Education

1 Introduction

Until now there exists no integrated software solution for the daily work in private radiological hospitals. Many single components are available, but there is no support for the complete workflow in this domain, starting with the registration of the patient and ending with the transfer of the report back to the referring doctor. Such a solution is under development in our German-Brazilian Cooperation project Cyclops. This system will be based on the actual developments, for example the IHE (Integrating the Healthcare Enterprise)[1] of HIMSS (Healthcare Information and Management Systems Society) RSNA (Radiological Society of North America) and the current enhancements of the DICOM (Digital Imaging and Communication in Medicine) Standard [2]. The component for the steps 14-18 of the IHE Basic Process Flow Chart of this system is presented in this abstract. The standard functionality for viewing, interpretation and reporting of radiological images is enhanced with some knowledge management features [3]. This component is integrated in our DICOM software, which is used by our medical partners in Germany and Brazil.

2 Objectives

One of the problems in private radiological hospitals is the lack of knowledge management. Often there are only few experienced radiologists, who spend a lot of time in teaching their younger colleagues. At the moment there exists only a small number of isolated computer based teaching tools, but no tools that could aid a young radiologist during their daily work. The only knowledge resources accessible are medical textbooks. One aim of this work is to create a database with the standard knowledge of the experienced radiologist and typical cases (including the images), which can easily be used during diagnosis. On the diagnosis workstation there are worklists for the examinations with different levels of abstraction available. The top level consists of the list with the standard diagnosis steps. This steps can be refined for unexperienced users so that detailed information and examples are presented. Each user must execute the diagnosis steps at his appropriate abstraction level and the system automatically generates a standard report from the decisions made. The intention of this approach is to make reports more comparable and to define some hospital standards.

3 Methods

The IHE Technical Framework defines a business process model for the hospital domain. A task in such a process consist of the predecessor and successors in the process, the particular activity with tools and resources, and the variables that are accessible from the workflow system and the tools. We added knowledge tasks to the standard model. This representation extends the business-modeling approach. The Knowledge task is characterized by the specification of supporting information that helps the user to achieve the goals of the task. An information need can be fulfilled by actions of varying complexity, for example presenting textual descriptions, retrieving example cases, calculations by some expert system or database queries.

3.1 Worklist Management and Structured Reporting

Our component is included into a workflow system based on the standard model of the workflow coalition and the process definition in the IHE Technical Framework. We have enhanced our existing DICOM software with the implementation of worklist management and structured reporting IODs and services of the DICOM standard.

IHE Technical Framework IHE, a joint initiative of HIMSS and RSNA, was founded to "stimulate integration of information and imaging systems and other software components and resources for healthcare"[1] by encouraging existing standards like DICOM and HL7(Health Level Seven). IHE shows the architecture of an integrated system, which connects several components of a hospital like RIS (Radiology Information System), modalities and PACS (Picture Archieving and Communication System), so that e.g. redundancy of data and function can be reduced and existing processes can be improved. As a result, examination times shall be cut down and so the cost of an examination is reduced.

IHE defines a Basic Process Flow Chart consisting of 18 steps, starting with the registration of a patient, and including steps like the arrival of the patient in the hospital, the acquisition of the images and the report of the results. In the beginning, IHE focuses on the first 13 steps of this workflow, which deal with the patient registration, the schedule of the modalities and the acquiring and storing of the images. For our application, steps 14 to 18 are the most relevant ones (excerpt from [1]):

14-16 The newly acquired images are interpreted (comparison/review of prior relevant information is important for this step, e.g. patient nodes, clinical notes, prior images), and reports, etc.

17-18 Report is generated (voice recognition or dictation)

DICOM Supplement 10: Basic Worklist Management Supplement 10 to the DICOM Standard [4] deals with Basic Worklist Management and has been published in February 1996 by the DICOM commission. It defines the Basic Worklist Management Service Class, which supports the exchange of any type of worklists from one Application Entity to another Application Entity. Currently it includes only one SOP Class (Service Object Pair Class): the "Modality Worklist SOP Class" supports the transfer of worklists from an Information System to a Modality. It is possible to define further SOP Classes in future and combine them all in the Service Class.
A Modality Worklist includes attributes of five Real-World objects:

- Scheduled Procedure Step
- Requested Procedure
- Imaging Service Request
- Service Episode
- Patient

DICOM Supplement 23: Structured Reporting Object This Supplement of the DICOM Standard [5], [6] defines several IODs (Information Object Definition) for a structured and standardized report. So different reports can be compared better and reports can be exchanged between diagnosis stations, archives and workstations easily.

A Report Series consists of the Original Report, which is not allowed to be changed, and several Amendments. The Original Report consists of a set of Findings Groups with unique Findings Group Contexts. Every Finding Group contains one ore more Observations, the smallest piece of information in a Structured Report.

In the Frozen Draft four different IODs for different kinds of reports are defined:

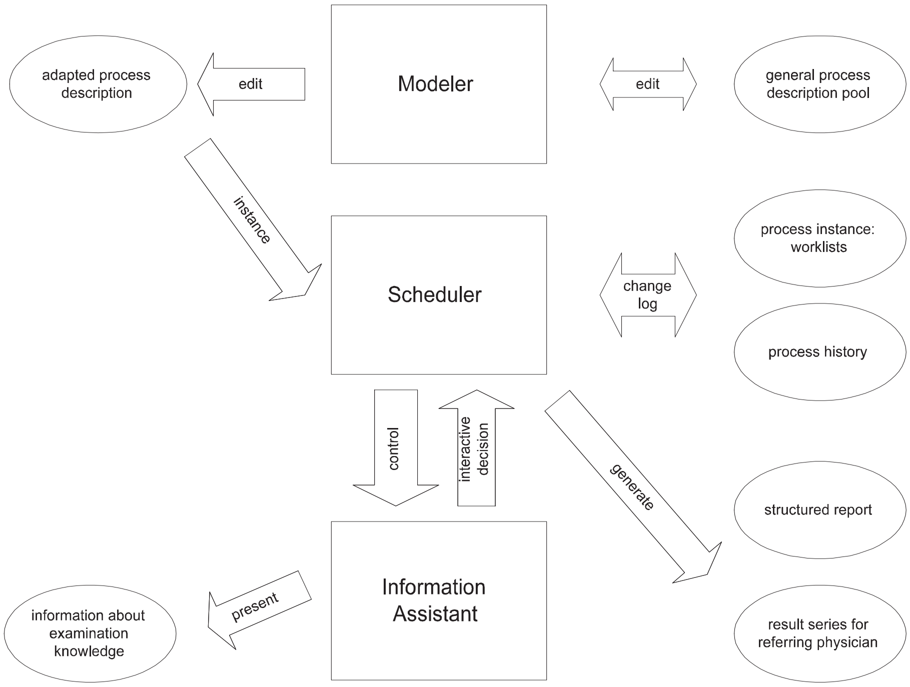

Figure1. knowledge management system architecture

- SR Text IOD
- SR Audio IOD
- SR Detail IOD and SR Comprehensive IOD

3.2 Knowledge Management

The reporting of radiological images is a knowledge intensive task. To support the doctor during his daily work we build an information assistant that presents the knowledge about specific examinations. The knowledge consists of worklists with the standard examination steps, textual descriptions, example cases and specific image processing routines which can help to find suspicious regions in big datasets. Figure 1 shows our system architecture.

One main problem is often the acquisition of the knowledge. We have build a modeling tool to support this task. This tool has three components. The first component is for the acquisition of the examination process models, textual descriptions and the integration of other tools in the process enactment. The second component is for storing and retrieving example cases for a specific examination. The third component is an interactive tool to create and test image processing sequences that help the physician to perform the diagnosis steps. The existing

Cyclops [7] image processing expert system is used to perform or support diagnostic worklist steps, for example to analyze contrast agent curves, to measure findings or to match time series volumes.

The modeled process descriptions are used by a scheduler who changes and logs the execution of the process instance worklists. The scheduler controls the Information Assistant and creates interactive decision tasks if user interaction is needed. The Information Assistant is integrated into our DICOM viewer [8] which has the usual functionalities of commercial products.

4 Results and Future Work

The first group of examinations we use as an example for our concepts are MR knee examinations. We will develop a standard examination protocol (worklist) for this type and will define text components for the structured reports. We hope that this first application can help to train unexperienced radiologists and reduce the costs of this examination

References

1. HIMSS and RSNA Integrating the Healthcare Enterprise: IHE Technical Framework, Revision 3.0, April 26, 1999
2. NEMA Standards Publication PS3.x-1999, Digital Imaging and Communications in Medicine (DICOM), National Electrical Manufacturers Association, 1300 N. 17th Street, Rosslyn, Virginia 22209 USA, 1999
3. D. O'Leary: Enterprise Kowledge Managment Computer, Vol.31, No. 3, Mar. 1998, pp. 54-61
4. Digital Imaging and Communications in Medicine (MEDICOM/DICOM), Supplement 10: Basic Worklist Management, Final Text, February 1, 1996
5. Digital Imaging and Communications in Medicine (DICOM), Supplement 23: Structured Reporting, Frozen Draft, November 20, 1997
6. S. von Gehlen, L. Vorwerk, M. Eichelberg, P. Jensch A multimedia editor for radiological reports based on the DICOM Supplement Structured Reporting, CARS'99 - H.U. Lemke, M.V. Vannier, K. Inamura, A.G. Farman (Editors), Elsevier Science B.V., 1999
7. v. Wangenheim A.: Ein Konfigurationsansatz zur Integration hybrider Systeme am Beispiel der Bildauswertung. Dissertation, Universität Kaiserslautern, 1996
8. Dirk Krechel, Kerstin Faber, Aldo von Wangenheim , Silvio Sampario: Object Oriented Implementation of a DICOM Network Client in Smalltalk, Proceedings of the Twelfth IEEE Symposium on Computer Based Medical Systems Stamford, IEEE Computer Society Press, ISBN 0-7695-0234-2, pages 12-17 1999