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Standard Based Multiclient Medical Data Visualization

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Abstract. An efficient interaction between a doctor and an electronic health record (EHR) depends also on the visual layer of an EHR. As users with various backgrounds and needs have different perspectives on the same data visualization methods must be flexible to provide the optimal interface. The ISO 13606 community is interested in developing requirements on a generic visualization method that can supplement the archetype model. Our research aims at specifying the requirements on a medical data visualization method based on the ISO13606 data model. XML allows a clear structuring and validation of the data due to the built-in standard features. The proposed visual medical concept allows separating the medical knowledge from the visualization knowledge. The research is focused on defining the optimal XML schema for a visual medical concept to allow multi-client generic data presentation.

Keywords. Visualization, ISO 13606, archetypes, EHR

Introduction

In order to achieve semantic interoperability between healthcare institutes data must be transmitted in a standardized format [1]. The archetype model of ISO 13606 provides a means for modeling medical content and for defining knowledge for the electronic exchange of health records. Semantic interoperability does, however, not stop when the data has been successfully exchanged between the systems [2]. Once transferred the data has to be presented in the most efficient way to ensure it is clear understood and interpreted. A standard based user interface [3, 4] can provide interoperability on the visual level. Several studies were conducted [5-7] to advance this, but a specification of the requirements on a standard based visualization is still missing.

The visualization layer completes the archetype layer and helps to organize the data according to different user requirements and different presentation media. The ISO 13606 community considers data visualization an important aspect [8]. We support this work and develop a visualization method that will be implemented and evaluated within ByMedConnect project [9]. The project itself aims at developing a data exchange solution based on the ISO 13606 data model. It will integrate legacy data and provide the data to the users. One of the project's requirements is the development of a

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standard based visualization method to provide access to the data for the doctors and patients of a healthcare network.

1. Methods

The proposed approach is based on the idea that a visualization layer will complete the archetype layer that represents the medical concept as well as the template layer that acts as a localization concept. The visual concepts are stored as XML files separate from the related archetypes. They define platform independent visual blocks to specify a layout for each archetype data field and group different archetype elements into visual groups. Each visual group contains a specification of visual tools that can be used to build a user interface. The archetype structure is taken into account (e.g. compositions, entries). One of the research aspects is the design of the users' requirements on the EHR interface and the development and implementation of a predefined visual concept for different user groups. This allows building a visual layer based on the ISO 13606 archetype model that will take into account the different perspectives on the medical data of doctors and patients.

2. Results

Previous studies [5, 6] show that the ISO 13606 data model can serve as a basis for a generic visualization method. To make such a method generic and most efficient the knowledge concerning the presentation should be kept separate from the medical concept [6]. We introduce a visual medical concept (VMC) that will complement the archetype layer with a presentation layer, separating medical knowledge from visualization knowledge. As shown in figure 1, a visual medical concept contains the data regarding the presentation layer for different users and different devices.

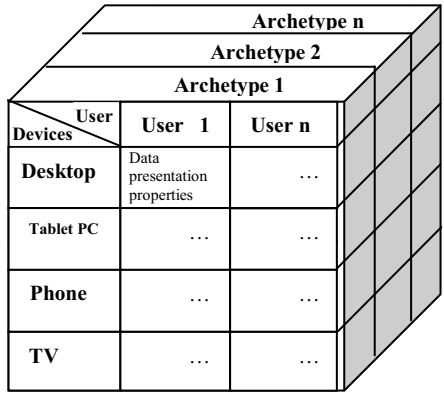

Figure 1. Multi-client medical data visualization structure

The visual medical concept has to meet the following requirements. It has to:

- confirm the requirements and constraints of a ISO 13606 reference model;

- provide multiple device support;
- support different views on the same data;
- be stored separately from the visualized data;
- be platform independent.

An XML scheme for a visual medical concept was developed conforming to the above mentioned requirements and providing validation facilities for visual medical concepts. A visual medical concept is logically divided into three main sections.

The metadata section specifies the properties of the VMC itself. The visual content section defines the data fields that are included in the VMC. The data fields are derived from different archetypes and combined into visual groups. The visual layout section specifies the presentation properties of GUI elements. The VMC allows specifying for each element the user groups and media this element is applicable to.

Presentation layer

The visualization module that we develop within our project uses the visual medical concept. This allows meeting the above mentioned requirements. The visualization module works in parallel to all EHR systems that are already being operated in the practices and consists of two main logical parts. The first part is a designer that generates an archetype based visual medical concept in XML format allowing the re-use and sharing of visual concepts. The designer enables the user to add customization data to the visual concept. The generated view definitions are stored separately as XSL templates allowing multiple views on the same data. The second part creates a presentation layer and displays the data to the user based on the visual structure and on the data from the EHR. Users with different needs will have the possibility to visualize different perspectives on the medical record. The presentation layer for a doctor will provide a user-friendly data presentation using summary views and graphical charts. The process of presentation layer building is shown in figure 2. To define visualization properties such as different users' views and layout properties a VMC is generated based on the predefined XML schema [10] and a set of ISO 13606 archetypes represented in the XML format. A "wizard" style of generator allows specifying the required parameters step by step and finally to generate a VMC. Each VMC can combine data from different archetypes to provide medical data aggregation facilities e.g. to form a summary of the most relevant patient's data. A layout is built by XSL templates that can automatically parse medical visual concepts to form a user interface.

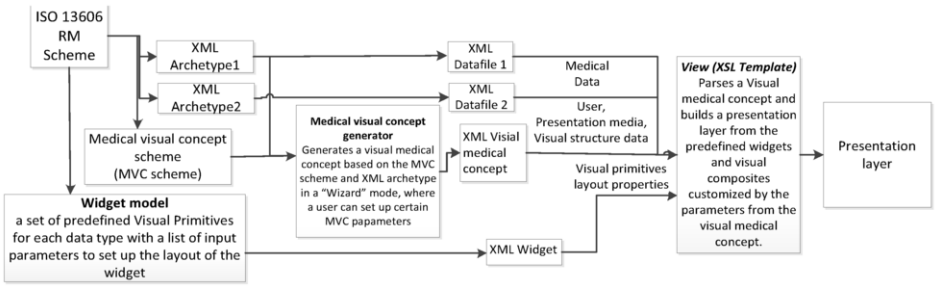

Figure 2. Medical data visualization definition scheme

Now we are working on reducing the number of parameters that are required to be specified manually. The ISO 13606 specification does not allow developing a generic method while keeping the optimal layout. The layout example is presented in figure 3.

Layout properties are logically divided into several groups. One group specifies properties of visual primitives (widgets) that are ISO 13606 data types. Widget properties specify the appearance of the widgets in different visual composites. And visual composites' properties specify the appearance of the graphics.

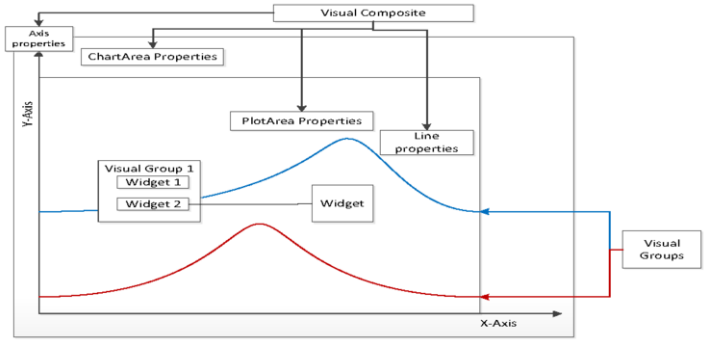

Figure 3. Presentation layer properties.

To define a set of medical data views we need to study the users' requirements regarding the medical data presentation level. Therefore, one of the research aspects is to study the way the different user groups perceive medical data based on the archetyped dataset of our project. The main focus of this survey will be on the doctors, but patients will also be involved in the research. It will allow us to study their requirements on data visualization and to develop multiple views on the same data. The research work constitutes the following steps:

The **first step** is to define a dataset to be exchanged between the doctors. The dataset that is based on the adapted Continuity of Care Record [11] specification was defined in cooperation with the doctors of the regional health network. It was modelled as a set of ISO 13606 archetypes. We also would like to understand the data the patients are interested in and to study their comprehension of the EHR data. Therefore patients will be interviewed to analyse their perception of the medical records.

The **second step** is to specify the content that users require to be visualized. The presentation content will be a subset of the dataset archetypes as the preliminary talks with the doctors showed that they are interested in the visualization of only specific data items from the dataset. The patients' requirements will also be studied.

The **third step** will be to define the best layout of the medical data. The users will be demonstrated different visual samples and the perception parameters will be measured in order to specify the optimal layout and customization possibilities [12,13].

3. Discussion

The proposed approach is based on the idea that a visual layer can complete the archetype layer, which represents the medical concept. The visual medical concepts define platform independent visual blocks and the layout for each archetype data field, respecting also the archetype structure. They will be stored as XML files separate from the related archetypes to make visual medical concepts re-usable. In our work we develop a medical data visualization method that will allow building user interfaces for

different groups of users. The research also includes a study of the patients' requirements on the electronic medical data interface and on how to support different views on the same EHR data. To test the possibility to automatically generate interfaces we performed several experiments using methods based on XML and SVG. The results indicate the high potential for static and dynamic graphical data presentation. This, however, requires further research.

4. Conclusion

The standards such as ISO/EN 13606 and openEHR provide medical concepts with a clear structure that can be used to form a data presentation level. However, visualization methods that are based only on the structure of the data are not supposed to provide optimal presentation layer due to the limitations of the archetype model. The introduced visual medical concept allows separating medical knowledge and presentation knowledge on the model level. Presentation layer model contains also standard data fields associations, which are at the moment static, but a research is planned to allow a dynamic definition of the associations. Due to the limitations of the archetype model a method that generates visual medical concept derives only the structure of archetypes: composition, element, entry and a data type. Other presentation options are to be defined manually in a specially developed designer. The presentation layer will enrich the GUI flexibility and will allow an optimal presentation of medical data considering the different users' perspective and different media used for the data presentation. The wide implementation of the standard based solutions will help to make a step towards standardized data visualization concepts.

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