Introduction to the Visualization Service Based on Web Services

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Scientific visualization evolved up to the stage where collaborative work of computer engineers and physicians becomes unavoidable to identify interesting visualization process routines on specific medical or other cases**.**

Vendor adoption of the web service's concepts over the Internet, with new enhancements in security and the fast computer networks presents a reasonable base for the development of the system which will give ability to collaborative work on a visualization case from distant locations over the Internet. To make this process simple we have specified and developed a system based on interfaces to well used network communication standards as integration points to a network based visualization service.

Data visualization and the routine distribution with ability to process requests on distant places, we call Visualization Over the Internet (VOI). The concept of the visualization over the network is not new, but the central data and visualization routine repository with ability to collaborative work on visualization process routines (finally mapped to program sub-parts) is new presented in our project. Some similar pioneer concepts are presented as server-based visualization approaches developed for the specific visualization needs like brain mapping [1] or building anatomical 3D scenes [2]. Our approach follows the server based visualization where a script processing routine [3] is used to define the processing routine.

The development of distributed visualization systems for medical use can avoid the need for new desktop applications that are very expensive. This can be done using a central medical visualization unit over network communication channels. New visualization patterns, from different areas of science, have to be simply adopted in the system without changing the base architecture and the communication concept giving a chance to develop a standard system and encourage developers to get into the visualization over the Internet. We share the opinion that unique usage and a unified interface, with no need to additional software, can simplify daily work routine of the physicians and engineers from different human working areas.

Each visualization project is defined by the processing routine as XML document (e**X**tensible **M**arkup **L**anguage) that can be performed on the volume data generated by the acquisition modality (e.g. computer tomography or magnetic resonance). Client and visualization services are the components of the system. The visualization service is then granulated to the interface, the unified interface and the visualization processing unit (Fig. 1). The client and the visualization service are the main parts of the system that we present. Client's responsibility is sending a data volume or other specific data, which must be accepted, processed and returned from the visualization service.

The client or the interface for direct connection to standards e.g. DICOM (**D**igital **I**maging and **CO**mmunications in **M**edicine) or HL7 CDA (**H**ealth **L**evel **7** **C**linical **D**ocument **A**rchitecture) should provide a way to define the processing routine for a given data to manage the visualization process. The client is responsible for the presentation of the visualized data. This can be provided by integration of the new rendering software or by integrating software applications to render specific responses from the visualization service (3D viewer, 3D printer). At first**,** the client sends data to the visualization service. Collaboration of scientists from different areas is evident in the process routine creation for visualization that will be performed by the visualization service. More users can be members of the visualization project. The processing routine can be changed without resending data to the visualization service. Visualization services are responsible to process data according to the created processing routine.

The interface should communicate to clients using standard communication protocols such HTTP (**H**yper**T**ext **T**ransfer **P**rotocol), HL7 or DICOM. All requests should be mapped to the unified interface. Unification of all requests enables a standardized way to communicate with the visualization processing unit. All tasks requested by the

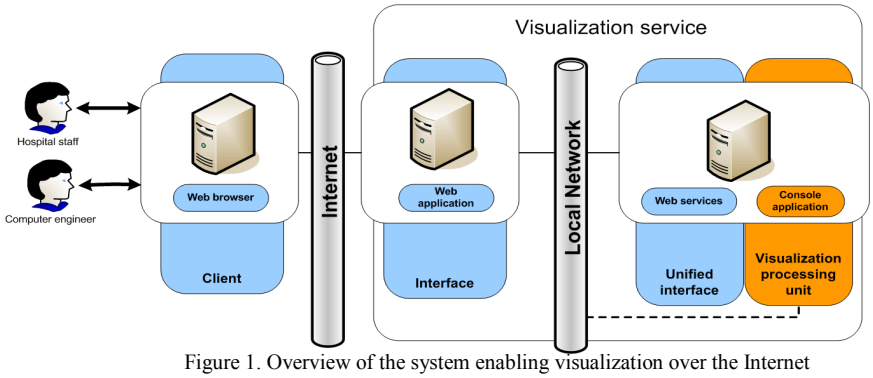

Figure 1. Overview of the system enabling visualization over the Internet

processing routine are scheduled by the unified interface and then processed by the Visualization processing unit. The interface is responsible to accept requests according to the implemented protocol (Fig. 2).

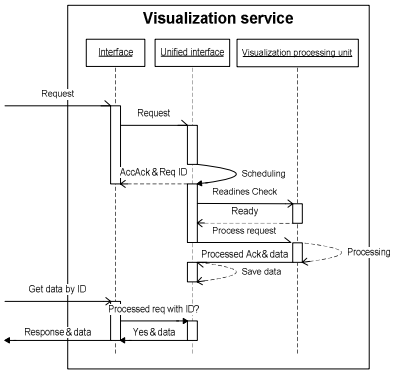

Figure 2. Client communication with the interface according to a selected protocol. Requests are unified and sent to the unified interface.

Today's medical communication infrastructure consists of computer networks and other direct communication links. In all of them, DICOM [4] is widely used and an accepted norm for storing medical data and transferring them through the computer network. DICOM's usage focused on radiology is overridden by new communication concepts, such as HL7 [5]. HL7 [6] can transfer all type of medical data through CDA [7]. Future system should implement DICOM or HL7 interfaces in the VMI (**V**isualization of the **M**edical data over the **I**nternet) system. In the approach described this paper, we have chosen and developed a web portal called VMI for sending DICOM files through HTTP interface (web application) to unified interface.

X3D [8] is an open XML standard for exchanging 3D objects, scenes and for real time collaboration through network applications in a 3D environment. XML is the best standard to define the processing routine. The strict scheme for the XML processing routine defines allowed processing routine functionalities. The scheme gives ability to validate the lexical and semantic meaning of the processing routine and also it demands strict implementation of supported functionalities.

The VMI XSD (**X**ML **S**chema **D**efinition) scheme follows an object oriented design. All objects and methods are defined in XML elements. Attributes of these elements are parameters of the object's constructor or parameters of the method that invokes.

Displaying of 2D join histogram (Two dimensional histogram of the volume dataset: X axis - gray level, Y axis - magnitude of first derivation, area presents cross occurrences N(x, y) in logarithmic scale) is very important to identify parameters for segmentation and visualization. A selected area in the field of 2D join histogram defines the segmentation parameter for volume datasets. The X3D shape writer creates an X3D object as result of the Isosurface rendering on the segmented volume data. The object writer creates .obj file as a simpler representation without specific appearance definition.

Each LOD object defines two volume data object instances for volume data processing. The original volume data is decreased by the factor 2 in each direction to produce lower detailed objects. Part of the sample VMI project definition is shown in Fig. 3**.** The sample generated X3D scene presented in higher level of details consists of 1 825 394 polygons (Fig. 4).

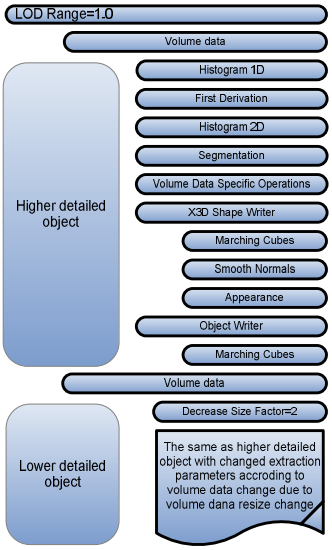

Figure 3. Sinuses extraction from sample data according to the VMI XSD scheme in two LOD levels.

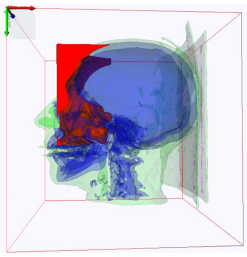

Figure 4. X3D scene generated from sample processing routine defined in VMI XSD Schema. Red represents sinuses & air, blue represents bones and green represents soft tissue.

We have found that the proposed architecture and the given concepts of the communication are acceptable according to the concept of VOI. Strict definition of communication based on the presented architecture and the XSD scheme processing routine definition should encourage research of the separated parts of the system to find out the most effective way of implementation and functionality enrichment. Our VMI can simply adopt new interfaces such HL7 or direct DICOM connectors.

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