Task 4 Writeup

The following is a writeup of Task4. Yumetech in conjunction with awardee of Task 4 will determine the methods and algorithms required to use DICOM data in an implementation of the VRC. This
description will not be limited to a particular programming language. Instead, it will provide guidance to programmers on how they can use this type of data in their own X3D-based applications. Yumetech will also attend relevant DICOM Working Group meetings to promote the adoption of the X3D standard into the DICOM specification

DICOM Overiew

Digital Imaging and Communications in Medicine (DICOM) is a standard for handling, storing, printing, and transmitting information in medical imaging. It includes a file format definition and a network communications protocol. The communication protocol is an application protocol that uses TCP/IP to communicate between systems. DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format. The National Electrical Manufacturers Association (NEMA) holds the copyright to this standard [1]. It was developed by the DICOM Standards Committee, whose members [2] are also partly members of NEMA [3].

DICOM enables the integration of scanners, servers, workstations, printers, and network hardware from multiple manufacturers into a picture archiving and communication system. The different devices come with DICOM conformance statements which clearly state the DICOM classes they support. DICOM has been widely adopted by hospitals and is making inroads in smaller applications like dentists' and doctors' offices. See reference (1) for a good introduction to DICOM.

DICOM Terms:

IOD - Information Object Definitions
Information objects define the core contents of medical imaging such as images, reports, and patients whose function is to carry information; entities in an E-R model whose descriptive attributes have been listed and defined.

Service Class - A set of functions performed to communicate between layers within a device

SOP classes - Service-object pair

SOP instance - A patient specific of imagery and patent information

Message - Communication version of the SOP class that provides the specified service and the data set made up of the properly encoded information object instance.

See reference (2) for a good technical description of DICOM.

DICOM how things are stored(3.6)

The DICOM standard stores information in a tag value encoded pair. The tag is a unique ID composed of 2 integers that describes the name of an attribute. The attribute describes some feature of the image. Most DICOM libraries provide a mechanism for easily accessing the tag's value in a DICOM file.

Parts most relevant to X3D Implementations:

Two parts are most relavent to X3D implementations looking to use DICOM images. These parts deal with storage of images on a local file system and access to these images from a web service.

3.10 - Media Storage and File Format for Data Interchange
Part 10 - offline file format. See reference(3) for file level details.

3.18 - Web Access to DICOM Persistant Objects(WADO)
Part 18 – Web access. See reference(4) for transmission details.

Toolkits implementing DICOM:

The most likely route for an X3D implementation to use DICOM is to use a toolkit to read the files. The following toolkits for C and Java might be useful.

C/C++:

DCMTK - DICOM Toolkit

David Clunie's Library:

http://www.dclunie.com/dicom3tools.html

Java:

dcm4che - DICOM implementation in Java

http://sourceforge.net/projects/dcm4che/

JDDK(Java DICOM Development Kit)

ImageJ

http://rsb.info.nih.gov/ij/

Use-Cases developed

Working group process at DICOM requires the development of use-cases before a work-item proposal is accepted to modify the standard. A call for use-cases was issued to the DICOM membership from

Working Group 6. The following section is a distillation of the answers to the call. It includes the first round acceptance of use-cases to cover.

Guiding Principal:
  No running application code needed on the receiver
  movement of volumes/geometry fine, but no simulations

1st Round Accepted

Web3D Use Cases
  Diagnosis Access Medical doctors(Downstream Uses)
    wider distribution
    easier to comprehend the stack of images
    faster to find items of interest

  Anatomy Education
    adjunct to dissection
  Consumer - informed consent

Use Case: Custom Prosthesis
  ct model of patent

  3d model matching
    how much of the knee to cutoff

  or custom fit

  end communication
    cut geometry
      2D lines and polygons
      or 3D geometry
    standard knee to use
      or custom model
    surgey instructions?

Allan G Farman(WG 22 Denistry)
  Dental implant planning and surgical navigation come immediately to mind
    communicate location, measurements, surgical path, geometry of implant

  3D cephalometric analyses for orthodontic and orthognathic surgical planning
    communicate to surgeons the results of analyses
    communicate to other surgeons / patents the planned surgery

    cone-beam CT cephalometry with 3D visible light fusion and vector diagrams
      fusing 2D photo with rendered CT volume

Armin Loepfe(17 and 24)

orthopaedic preop planning of implants in 3D on CT or C-Arm 3D (Siemens Iso 3D) nDimensional display
communication of results in a graphic fashion
annotations of measurements on 3D images

WG7 - Better annotations are needed
Curve data is a presentation state standard. How does it apply?
Looks to just be a lineset, no color information?
No text?

Communication of the developed plan is in scope:

Radiation Therapy(WG7) -- Strong use case
Beam Modulation Display
beams eye view of the tumor so you can crop the beam

Cut planes need to be stored
Does data hidden need to be transfered.
for surgical planning, monitoring treatment won't need the stuff outside the cut plane

Steven Plymale(Claron Tech)
Good use case description
mix of resegmentation and presentation state
make some voxels go away(no shader).

Later

Radiation Therapy - Simulation of gantry movement, path planning
radiation cone/dose estimation

Allan G Farman(WG 22 Denistry)
dental implant planning with embedded simulations

Armin Loepfe(17 and 24)
surgical implant navigation and smart tools (minirobotic)we need nDimensional display functions.
how much of the original data(resolution) is needed for navigation?
DICOM images dont have multi-resolution versions of images?
do we need a streaming protocol for multi-resolution images
is jpip useful? allows stopping of stream

surgical simulation in 3D
is this display of the result of simulation?

Geometry

Not enough info

Leif(Pathology, WG 26)

DICOM standards committees

The following standards committees are involved in 3D development at DICOM.

WG 6 - Base Standard
This group is responsible for the general architecture of the standard. They accept work items to change the standard and approve new sop classes.

WG 11 - Display Function Standard
This working group is responsible for how items are presented in DICOM. Any presentation state information is developed here.

The following groups are also interested in 3D topics. They have developed a SOP class to handle 3D geometric mesh(Supplement 112).

WG 12 - Ultrasound
WG 17 - 3D
WG 24 - Surgery

References

1 - http://en.wikipedia.org/wiki/Digital_Imaging_and_Communications_in_Medicine
2 - http://www.rsna.org/Technology/DICOM/intro/elemental.cfm
3- http://medical.nema.org/dicom/2007/07_10pu.pdf
4 - http://medical.nema.org/dicom/2007/07_18pu.pdf