Whole Slide Imaging in Pathology

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Short description: DICOM currently defines Image IODs by storing the rows and columns as unsigned short integer. This means that an image can only be at most of size 2^16 * 2^16 pixels. This is a limitation for Microscopy Images as, for example, WSI can go up to Terabytes in extreme conditions.In addition to these “hard” restrictions, another consideration is due to large amount of information in these images rapid panning and zooming should also be supported.

Basic Information

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Project

DICOM currently defines Image IODs by storing the rows and columns as unsigned short integer. This means that an image can only be at most of size 2^16 * 2^16 pixels. This is a limitation for eg. Microscopy Images as, for example, typical Whole Slice Images can be 80,000 * 60,000 pixels. Since images are generally stored with 24-bit color pixels, this means WSI can go up to 15 Gb and for multiple Z planes it will go more than this. In addition to these “hard” restrictions, another consideration is that entire WSI objects are not accessed all at once. Typically for viewing applications a client requests image data incrementally from a server, at random, supporting rapid panning and zooming without first transmitting and storing the entire WSI object to the client.

To solve the above problems, we need some solutions which are listed below:

1. Provide a way to store large size images (WSI).

2. Support rapid panning and zooming.

These tasks can be divided in three parts.

WSI Storage: We can come over the limitation of rapid panning by Storing images with a tiled organization and for rapid zooming the WSI consists of multiple images at different resolutions.

To come over the 32 bit limitation we can **store the individual "tiles" of a WSI pyramid as individual frames in a DICOM multi-frame image object**. Multiple resolution images are needed or desired for the WSI, each "level" is stored separately in the series. After storing each tile in image object we store location of the tile in multi frame image object, its level in the pyramid, color, Z plane and other informations so that we can easily access them.

Each image in the pyramid stored as a series of tiles, to facilitate rapid retrieval or arbitrary subregions of the image. WSI consists of multiple images at different resolutions (the "altitude" of the pyramid corresponds to the "zoom level").

The WSI Information object Definition(IOD):

It is necessary to provide a description of the "mapping" from images in the DICOM series to the tiles in the conceptual WSI pyramid. There are also metadata(optical path, frame of reference) useful for pathology applications which should be stored for the overall image object, each pyramid level, and [possibly] each tile. The role of the WSI IOD is to provide a repository for these data, consisting primarily of the tile map and image or tile metadata.

To implement the above we need to extend GDCM library and **new DICOM IOD will be created** to describe the sequence of images within the series, indicating which images and tiles are present. This IOD will be known as the WSI IOD, and will contain a "data map" describing which data are present and how they are stored within the DICOM series.

WSI image data access:

For accessing WSI image data client connects to a server encapsulating the WSI image, retrieves the WSI IOD ("data map"), and then accesses individual images from within the WSI series as needed. To facilitate navigation across the WSI data set (series) WSI IOD proposes a LOCALIZER "image flavor" as a visual guide to the various resolution levels and tiles/frames within those levels, Although DICOM does not specify display application behavior, the Multi-Resolution Navigation Module in the localizer image provides sufficient information for an application to navigate through all frames of images in the series. It identifies the corresponding location in the localizer image of all frames, and provides their salient characteristics (resolution, color, Z-plane).

Proposal Timeline

"*Before April 25:*

To familiarize myself with GDCM Library.

April 25–May 23 (Before the official coding time):

1) To be familiar with the compilation and usage of GDCM.

2)To familiarize myself with the source code structure, IOD Part and Image compression(JPEG 2000) part.

May 23–June 25:

1) Read the existing codes of Single Image storage and IOD.

2) Implement the code for dividing the image into the "tiles/Frames".

3) Implementing the Pyramidization (Multi-resolution) of WSI Image up to a level which preserves the basic characteristics of an object.

4) Integrating tiling and Multi-resolution on an WSI Image.

June 26 - July 10:

1) Storing individual tile of single WSI as individual frame in DICOM multi-frame image object.

2) Storing the data of each frame, about its location,color,level and Z-plane in LUT.

July 10–July 15:

1) Preparing the mid-term evaluations.

2) Finishing any of the tasks that have not been finished.

July 15 – July 31:

1) Implementing the WSI IOD.

2) Adding multi-frame object with WSI IOD.

August 1 – August 14:
Implementing the Multi-Resolution Navigation Module and add it to WSI IOD.

August 11 – August 22:

Writing documentation. The other time is kept for any unpredictable delay.

MY Qualifications

I am an Undergrduate student pusuing my B.Tech degree from L.N.M. IIT Jaipur. I have been using C/C++ from last three years. From the past two years i am learning and working in field of video/Image compression and Image processing. I got International publications in these fields. I am familiar with medical images and i am also interested in computer and graphics.

Currently, I am working working on my B.Tech thesis on parametric video coding. It incorporates a standard for video compression. I have a experience of working with medical Images. I have worked in the field of medical image enhancement and got two publications in this area. In one of these research paper i have used wavelet transformation which is main algorithm of JPEG -2000. I think that I will succeed in providing enhancements to the whole project.