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FACULTY OF SCIENCE AND NATURAL RESOURCES,

SEMESTER 1 SESSION 2023/2024

SC40103 SCIENTIFIC DATA VISUALIZATION

ASSIGNMENT 2

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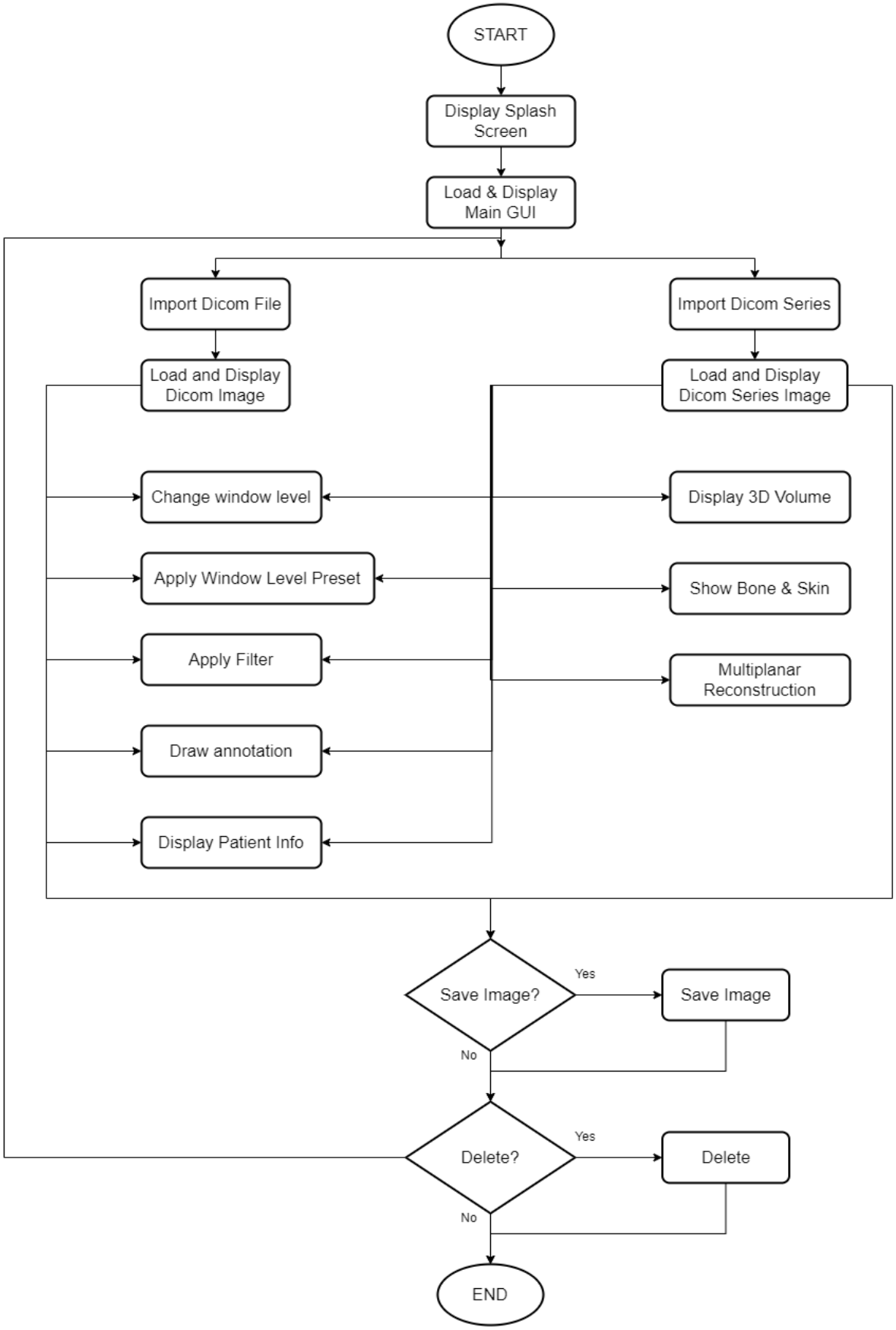
Introduction

In the realm of scientific computing and data analysis, visualization plays a crucial role in transforming complex numerical data into comprehensible and insightful visual representations. The Visualization Toolkit (VTK) emerges as a powerful tool in this domain, providing a comprehensive suite of open-source libraries and tools for creating interactive 3D graphics and visualizations.

Medical imaging offers invaluable insights into the human body, but traditional viewers often lack the power to fully unlock this potential. This assignment explores the use of VTK, a powerful visualization toolkit, to build a custom DICOM medical data visualizer. By leveraging VTK's advanced rendering techniques and user interaction capabilities, we aim to create a tool that empowers healthcare professionals to gain deeper understanding from medical data, leading to improved diagnosis and treatment. This report will delve into the design, implementation, and evaluation of this visualizer, showcasing its potential to revolutionize medical data exploration and analysis. This assignment delves into the foundations of VTK, exploring its capabilities through medical data visualizer. This visualizer showcases VTK's ability to load, visualize, and manipulate DICOM.

Through this assignment, we embark on a journey to uncover the depths of VTK's capabilities and harness its power to transform scientific data into meaningful visualizations.

Flow Chart


START
Display Splash Screen
Load & Display Main GUI
Import Dicom File
Load and Display Dicom Image
Import Dicom Series
Load and Display Dicom Series Image
Change window level
Apply Window Level Preset
Apply Filter
Draw annotation
Display Patient Info
Display 3D Volume
Show Bone & Skin
Multiplanar Reconstruction
Save Image?
Yes
Save Image
No
Delete?
Yes
Delete
No
END

System Architecture

The DICOM medical data visualizer utilizes the VTK library for rendering and the PyQt5 library for its user interface. It can load, render, and interact with DICOM image viewer, 3D volume using VTK readers.

1. DICOM Image Reader
   This visualizer allows users to load Digital Imaging and Communications in Medicine (DICOM). Users can load these models by clicking the button provided in the user interface and select the file or folder they want to import.

2. Patient Information
   Once the DICOM is loaded, the patient details such as name, ID, birthday, and gender will be read and show.

3. View Slices
   Every single dcm file in the data set folder is viewable by vtkImageViewer2 in the visualizer.

4. Length Measurement
   User can use the mouse move event and left button pressed event to get position to draw line on DICOM image and measure the length based on the distance between two points of the line.

5. Show 3D Volume
   Get the vtkImageData output from the reader using GetOutput. A 3D model of representative for the DICOM image data set will be shown.

6. Edge Enhancement
   Set the gradient magnitude input connection from the reader using GetOutputPort. A edge enhance version of image viewer will be shown.

7. Show Bone
   VtkFlyingEdges3D is used for the bone extraction of the 3D volume of DICOM data.

8. Show Skin

VtkFlyingEdges3D is used for the skin extraction of the 3D volume of DICOM data.

9. Save Model

   Users can save the modified image viewer.

10. Multiplanar Reconstruction

    Users able to view the Dicom series in sagittal, coronal and axial directions.

11. Window Level Preset

    User able to choose the typical window width and window level.

Algorithm Used

DICOM Image Reader

1. Open file dialog to get open file/folder name.
2. DICOM file type
    2.1 reader= vtkDICOMImageReader
3. Get output port from reader
4. Set input connection to image viewer
5. Assign interactor style to image viewer
6. Add image viewer to renderer

Dicom Image Details

1. Get PatientName from dicom_file
2. Get PatientID from dicom_file
3. Get PatientBirthDate from dicom_file
4. Get PatientBirthTime from dicom_file
5. Get StudyDescription from dicom_file
6. Get PatientSex from dicom_file
7. Get Modality from dicom_file
8. Get AccessionNumber from dicom_file
9. Get InstitutionName from dicom_file
10. Get SeriesDescription from dicom_file
11. Print at patient detail

Load 3D Volume

1. Reader= DICOMImageReader
2. imageData.ShallowCopy(self.reader.GetOutput())
3. set input data to volumeMapper from image data
4. set up volume property
5. set mapper to volume
6. set property to volume
7. Add volume to renderer

Edge Enhancement

1. The dicom data set is loaded

2. Gradient magnitude =vtkImageGradientMagnitude
3. Set input connection to gradient magnitude from reader output port
4. Set input connection to image viewer from gradient magnitude output port
5. Render image viewer

Show Bone

1. Bone_extractor = vtkFlyingEdge3D
2. Set input connection to bone_extractor by reader output port
3. Set value to bone_extractor
4. Bone_stripper=vtkStripper
5. Set bone_stripper to mapper
6. Apply mapper on bone actor
7. Add actor to renderer

Show Skin

1. Skin_extractor = vtkFlyingEdge3D
2. Set input connection to skin_extractor by reader output port
3. Set value to skin_extractor
4. Skin_mapper=vtkPolyDataMapper
5. Set skin_mapper to mapper
6. Apply mapper on skin actor
7. Add actor to renderer

Draw Line

1. Set length measure= True
2. If left mouse button is pressed
    2.1 Get mouse position
    2.2 Set line point1 to position 1
3. Mouse move event
4. Get position of mouse move
    4.1 Set line point2 to position 2
5. Add line to renderer

Save Image

1. Get output for the image for save

2. Normalized image in array
3. Transpose image
4. Save image in png

Multiplanar Reconstruction

1. Reader= DICOMImageReader
2. ImageViewer = VTKImageViewer2
3. SetSliceOrientation()
4. SetInputconnection()

Window Level Preset

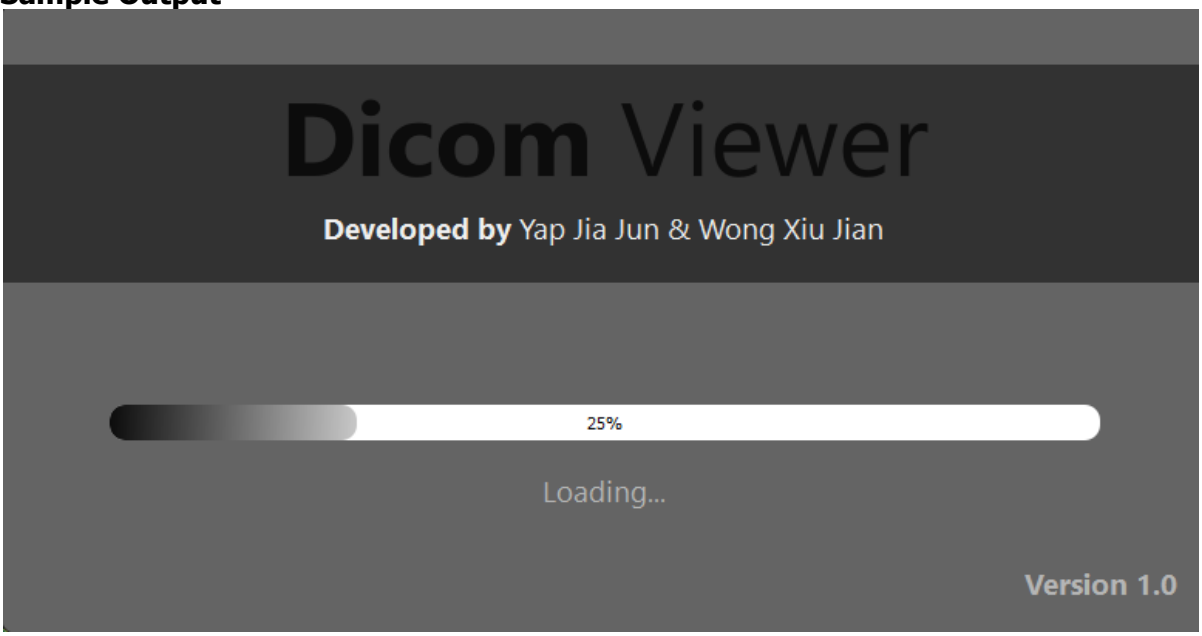
1. ImageViewer = VTKImageViewer2
2. SetColorWindow()
3. SetColorLevel()

Strength and Uniqueness

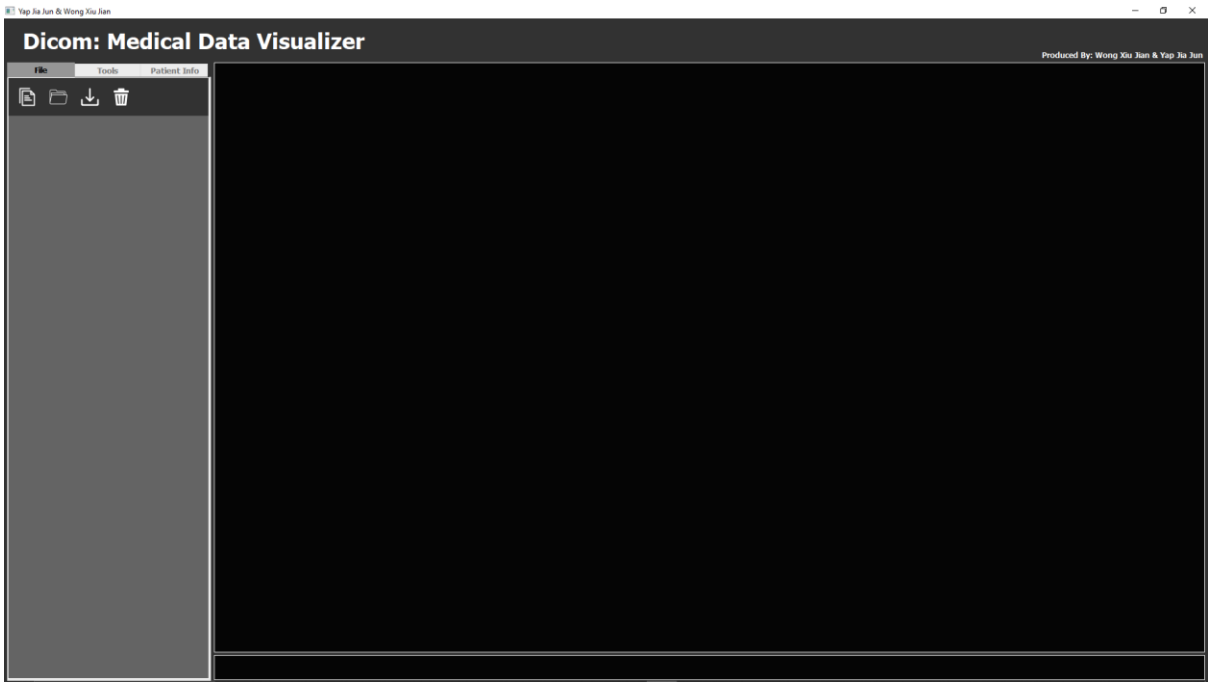
This DICOM Medical Data Visualizer has the following strength and uniqueness.

1. It can import single dcm file or folder for dicom data sets.
2. It can display DICOM file in image viewer and show slice by slice.
3. Able to do edge enhancements on DICOM image.
4. Able to display 3D volume of DICOM data.
5. Show bone of 3D volume.
6. Show skin of 3D volume.
7. Able to show DICOM image in multiplanar reconstruction images.
8. Able to draw line and measure length.
9. Read DICOM file to get patient information.
10. Able to save DICOM images and png file format.

Sample Output



Splash Screen



Main GUI

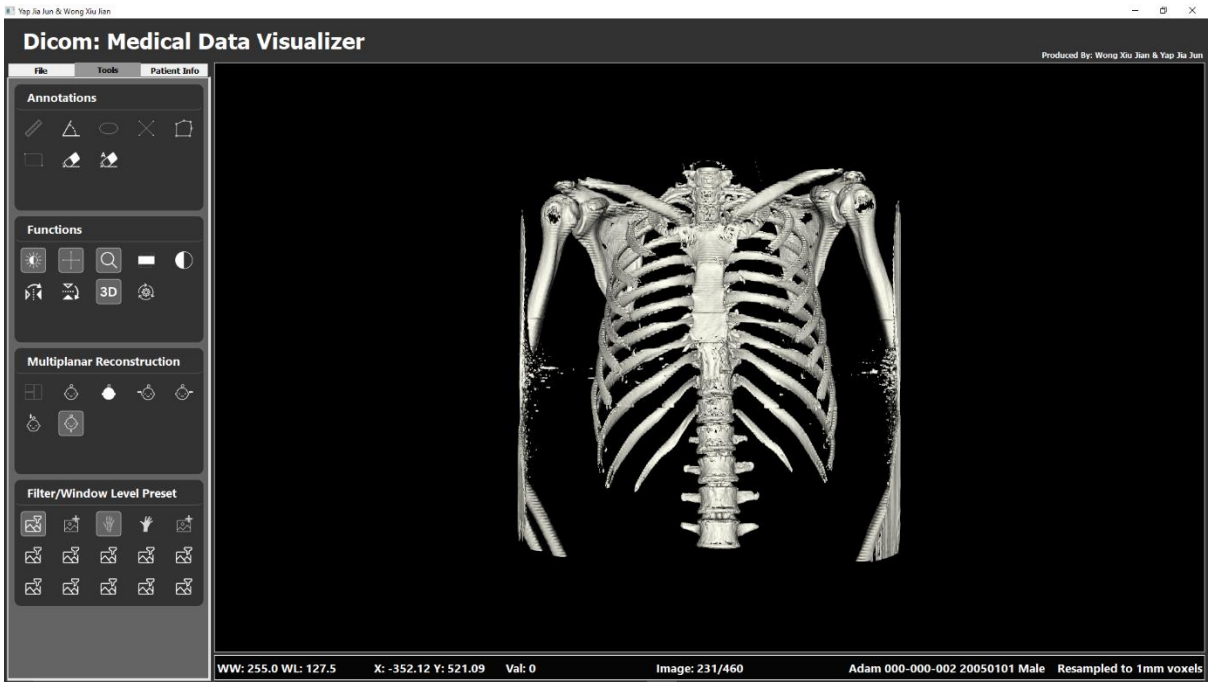
Import Dicom Series

Tools Bar

Patient Info

Multiplanar Reconstruction

3D Volume



3D Bone

Annotations