UH6461002 MATHEMATICS WITH COMPUTER GRAPHICS

FACULTY OF SCIENCE AND NATURAL RESOURCES,

SEMESTER 2 SESSION 2022/2023

SC40103

VISUALISASI DATA SAINTIFIK

ASSIGNMENT 2

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1. INTRODUCTION

Medical imaging plays a pivotal role in modern healthcare, providing clinicians with invaluable insights into the human body's intricate structures. As part of our second assignment, we dive into the realm of Digital Imaging and Communications in Medicine (DICOM) to develop a sophisticated GUI for visualising medical datasets. DICOM, a standard format universally accepted in the medical field, enables the seamless exchange and retrieval of medical images across diverse platforms.

DICOM images are not just visual representations; they encapsulate crucial patient-specific data and serve as the foundation for diagnostic decision-making. These images are typically stored in Picture Archiving and Communication Systems (PACS), forming a comprehensive database accessible to medical professionals worldwide. Our task is to create a DICOM application capable of interfacing with PACS, retrieving images, and providing a user-friendly platform for viewing, interpreting, and potentially modifying these critical medical assets.

To accomplish this, we leverage the power of the Visualisation Toolkit (VTK), a versatile and robust library renowned for its capabilities in three-dimensional (3D) visualisation. The potential of VTK offers us the opportunity to craft a cutting-edge DICOM visualiser that not only showcases the library's prowess but also enhances the user experience for medical professionals.

This assignment provides an opportunity to explore the intersection of medical imaging, data visualisation, and software development, creating a DICOM Image Visualiser that displays the DICOM image series and its diagnostics along with make modifications to the 3D volume reconstructed from the images.

2. ABOUT APPLICATION

GeoGrafiX is an innovative DICOM visualizer designed to revolutionize the landscape of medical imaging. Leveraging the capabilities of PyQt5 for an intuitive graphical user interface (GUI), *pydicom* for streamlined access to patient data, VTK for 3D volume visualization, and OpenCV for image editing, *GeoGrafiX* emerges as a feature-rich application offering a multitude of tools for in-depth exploration of medical datasets.

The user journey begins with *GeoGrafiX* providing a detailed display of patient information and dataset particulars. The application's versatility is immediately apparent as it presents axial, sagittal, and coronal plane slices, allowing users to explore datasets from diverse perspectives. The interactive manipulation of horizontal and vertical sliders ensures a user-friendly experience.

GeoGrafiX introduces advanced features such as customizable color mapping for slices, providing users with the flexibility to visualize data according to their diagnostic preferences. The application goes beyond standard DICOM viewers by enabling the export of selected slices for further analysis, catering to the needs of both research and diagnostic users.

Another feature of *GeoGrafiX* is its precise distance measurement capability. Users can measure the distance between two points on a slice through mouse input, enhancing anatomical assessments and contributing to the accuracy of clinical analyses. The application also allows users to manipulate color window and level values through mouse input, providing control over the opacity of the reconstructed 3D volume. This unique functionality enables users to focus on specific layers of interest within the volumetric data.

GeoGrafiX extends its capabilities to the modification of volume properties, allowing users to apply basic transformations and adjust colors.

GeoGrafiX also facilitates the exportation of modified 3D models alongside the extracted DICOM information. This cohesive output serves as a valuable resource for further research, collaboration, or detailed patient documentation.

ALGORITHM

1. **Initialisation**:
    1.1. Load splashscreen
    1.2. Initialise the GeoGrafiX application.
    1.3. Load *PyQt5, pydicom, vtk, Numpy* and *cv2* libraries.

2. **Loading DICOM Data**:
    2.1. Retrieve DICOM data for visualization.
    2.2. Store *reader*.

3. **Display Patient and Dataset Information**:
    3.1. Display patient information obtained from *reader*.

4. **Slice Visualization**:
    4.1. Reslice *reader* to obtain axial, sagittal, and coronal plane slices
    4.2. Display.

5. **User Interaction Loop**:
    5.1. Enter main application loop.

6. **Action Execution**:
    6.1. Get slice axis:
    6.2. If user adjusts slice slider:
        6.2.1. Get new slider value.
    6.3. Reslice reader using slider value.
    6.4. Convert resliced image from vtkImageData to Numpy Array.
    6.5. Convert image intensity values from Int16 type to UInt8.
    6.6. If user changes colour map selection:
        6.6.1. Update colour map type.
    6.7. Get current colour map.
    6.8. Apply colour map to image numpy array.
    6.9. If user chooses to measure distance:
        6.9.1. Get first point.
        6.9.2. Get second point.
        6.9.3. Calculate distance.

6.9.4. Display points and total distance on the image.

6.10. Convert image intensity values from UInt8 type to Int16.

6.11. Convert to vtkImageData.

6.12. Set data into image viewer.

6.13. Render.

6.14. If user left clicks and drags on image viewer:

6.14.1. Get mouse coordinate input as colour window and colour level values.

6.14.2. Set new image viewer's colour window and colour level values.

6.15. If user chooses to export slice:

6.15.1. Repeat steps 6.1 to 6.8.

6.15.2. Access *cv2* library to save image as PNG.

6.16. If user adjusts colour window or colour level slider:

6.16.1. Get colour window slider value.

6.16.2. Get colour level slider value.

6.16.3. Create opacity map.

6.16.4. $scalar1 = 6(1.5cl - 0.5cw)$

6.16.5. Add $scalar1$ representing transparent scalar point to opacity map

6.16.6. $scalar2 = 6(1.5cl + 0.5cw)$

6.16.7. Add $scalar2$ representing transparent scalar point to opacity map.

6.16.8. Add the opacity map to the reconstructed 3D volume.

6.16.9. Render.

6.17. If user chooses to extract data:

6.17.1. Extract DICOM information in *.txt* format file.

6.17.2. Export both modified model and default reconstructed model as PLY format.

6.18. If user chooses to import new DICOM dataset:

6.18.1. Repeat steps 2-6.

6.19. If user clicks exit:

6.19.1. Call cleanup function to terminate program.

7. **Cleanup and Termination**:

7.1. Perform necessary cleanup activities and resource management.

7.2. Close the GeoGrafiX application.

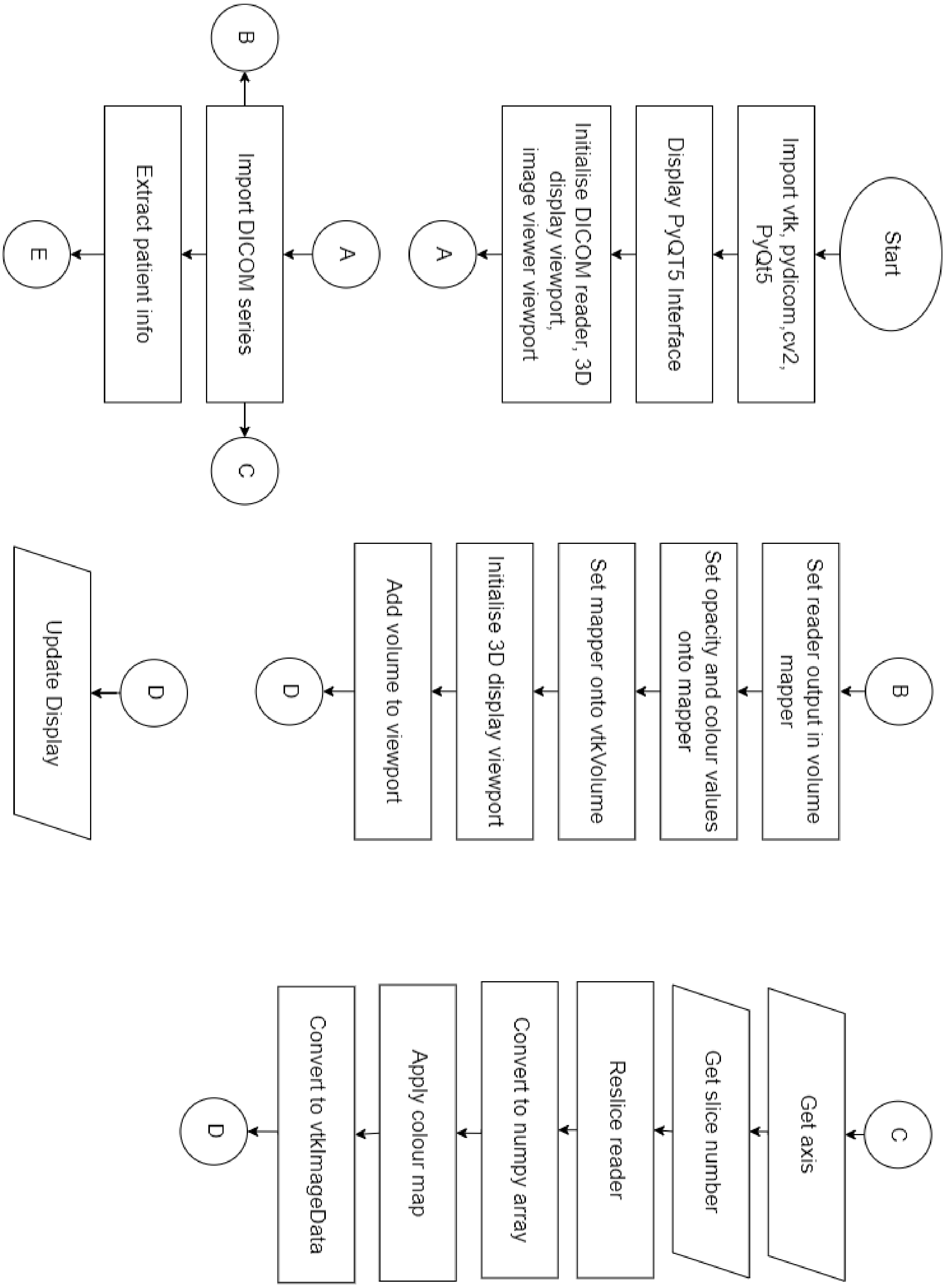

Figure 1 Flow diagram of *GeoGrafiX* visualiser.

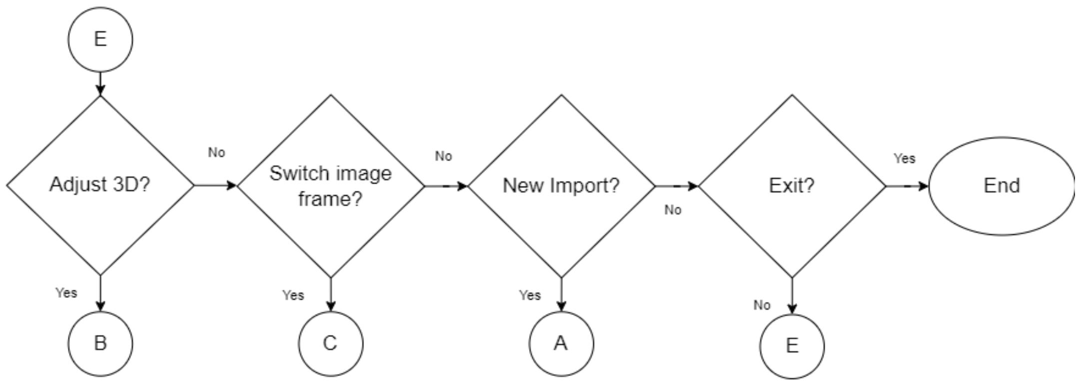

Figure 2 Flow diagram of *GeoGrafiX* user interaction loop.

3. STRENGTHS AND UNIQUENESS

At the core of *GeoGrafiX* lies an intuitively crafted, user-friendly interface. Designed for ease of use, the interface seamlessly maintains simplicity while ensuring the coherent presentation of details and features within a singular GUI window. Users navigate a fluid and efficient workflow without the distraction of constant frame switching, fostering a focused and streamlined user experience.

Adapting to the distinctive demands of the medical imaging realm, *GeoGrafiX* adopts a dark theme to optimize visual contrast. Beyond alleviating eye strain during extended usage, this design choice ensures that the bright features often inherent in imported models and datasets are displayed with unparalleled clarity and visibility.

GeoGrafiX allows users to apply personalised colour maps onto binary images based on specific diagnostic requirements. This feature provides medical professionals with flexibility in image analysis.

Accuracy in measurements is paramount in medical imaging, and *GeoGrafiX* facilitates precise analysis by providing correct scaled pixel to actual distance values on image slices.

GeoGrafiX enables users to extract detailed patient information alongside both the original and modified 3D models.

In conclusion, *GeoGrafiX* emerges as a beacon of innovation in the DICOM visualization domain. Its focus towards user-centric design, advanced visualization techniques, and holistic feature integration positions it at the forefront of medical imaging software.

4. SAMPLE OUTPUT

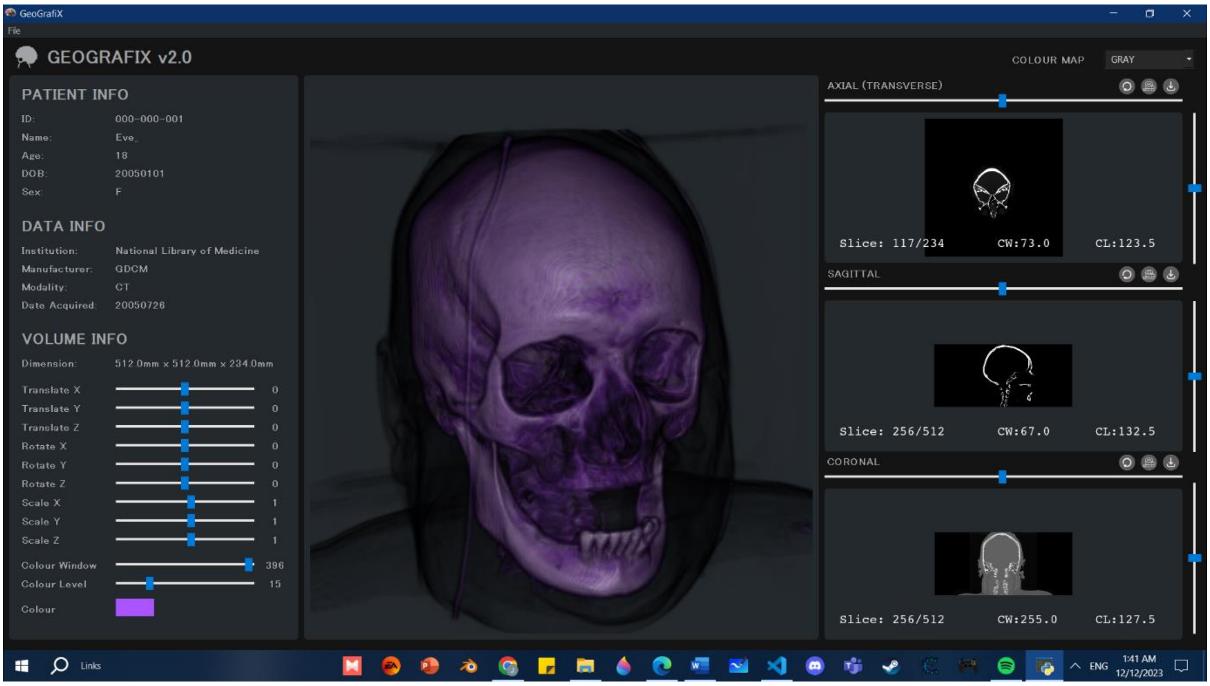

Figure 3 Overview of GeoGrafiX interface.

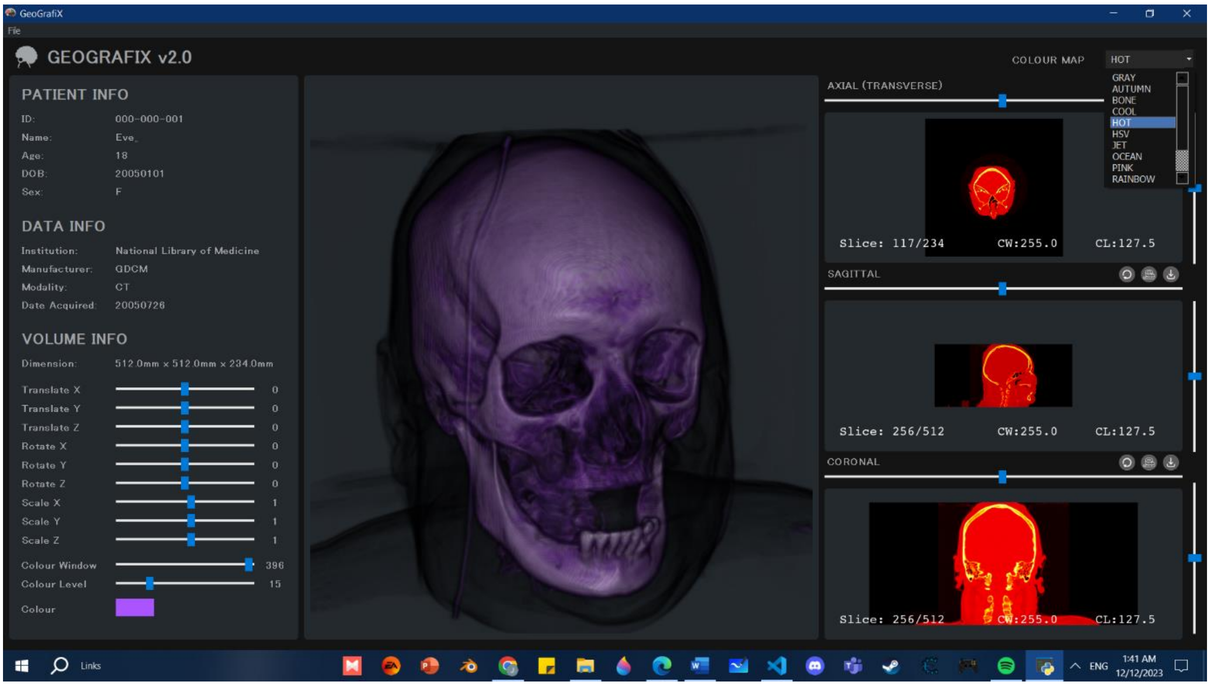

Figure 4 User can apply colour maps to view different layers within the image better.

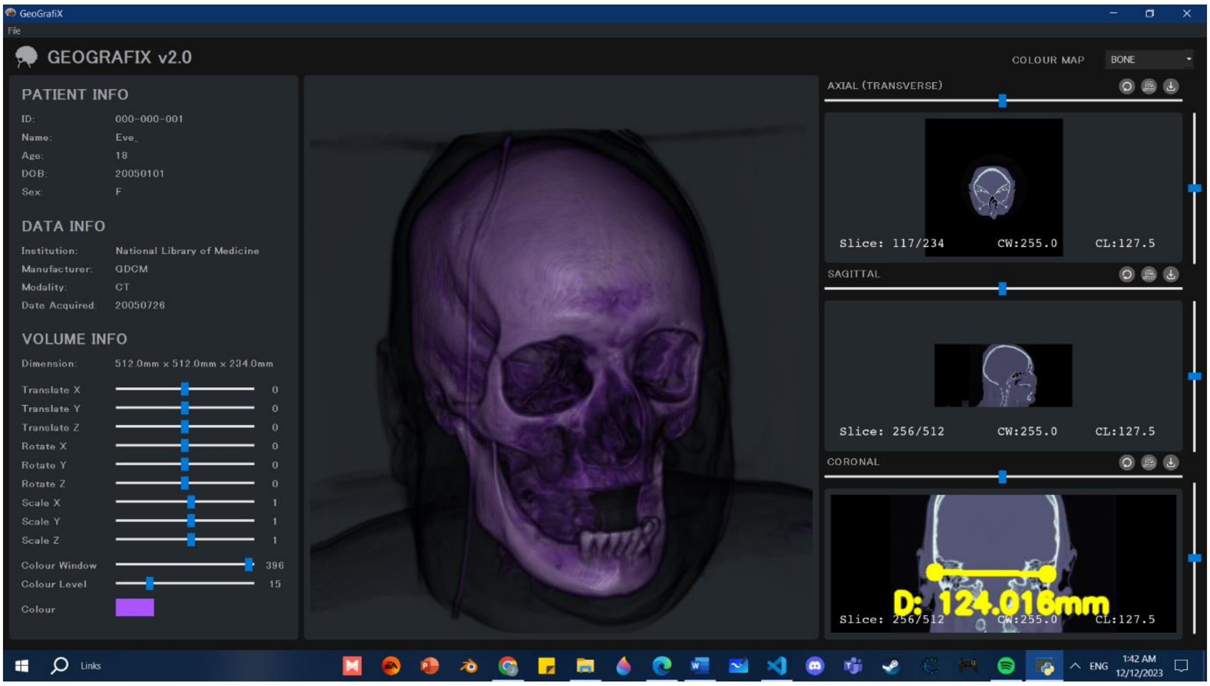

Figure 5 User can get the distance between two points on the image.

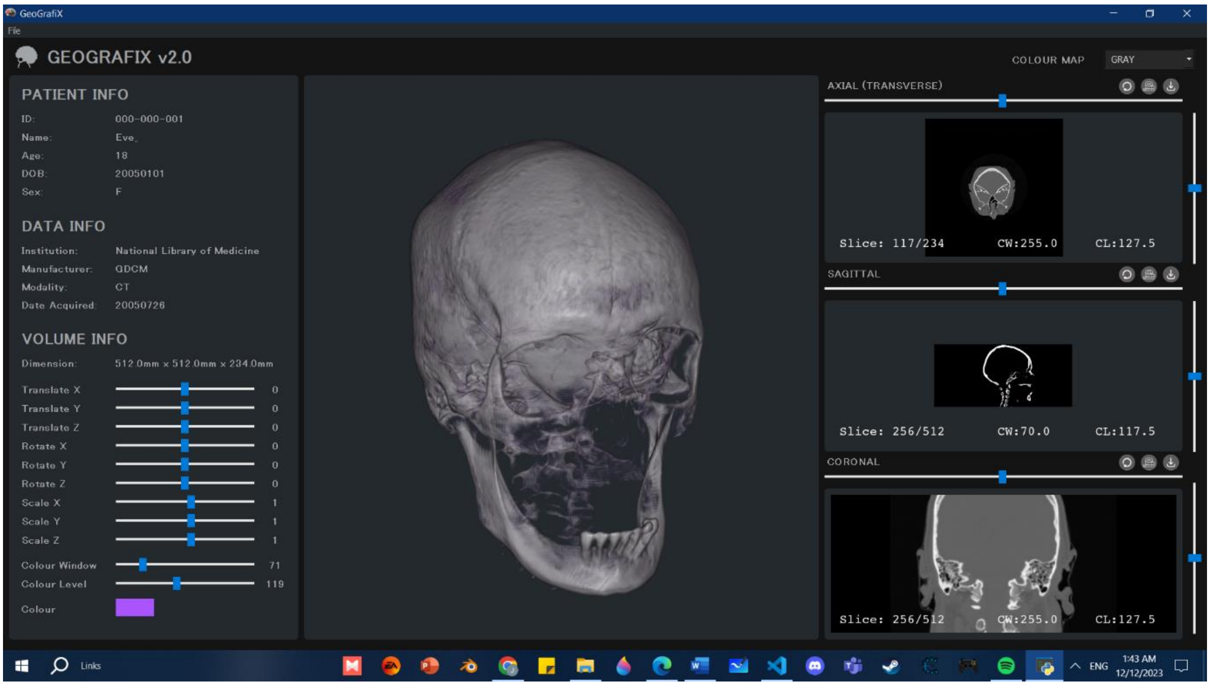

Figure 6 User can manipulate colour window and level for both 3D and 2D models.