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Article

Bridging Medical Imaging and Web-Based Visualization Technologies via MIPRV Platform

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Abstract: Medical diagnosis has undergone a profound transformation, transitioning from traditional reliance on clinical intuition to modern methodologies incorporating comprehensive body scans for precise assessment. This evolution continues its shift in the analysis of medical scans from traditional 2D representations to advanced 3D reconstructions facilitated by computer software, recently through interactive medical imaging web applications. The article encompasses a thorough exploration of existing literature on DICOM files, similar solutions, and the capabilities of Cornerstone3D technology including a comparison of Cornerstone3D with its predecessor and a standalone DICOM viewing platform named MITK. With the aim of speeding up the diagnostic process, thus providing healthcare professionals with advanced tools for exhaustive analysis and informed decision-making, a web platform for visualizing DICOM images is proposed, to allow users to upload 2D scans in DICOM format and obtain their 3D reconstructions online, eliminating dependence on stand-alone applications, but maintaining the performance expected of this type of application.

Keywords: DICOM Images, Cornerstone, Web Platform, Medical Images Visualization.

1. Introduction

In a hospital, during the patient diagnosis process, a scan of the patient's body or a crucial body part is often taken using X-ray technology. The resulting 2D print is then analyzed by medical professionals. Before the advent of X-ray machines, conditions such as broken bones, tumors, or swallowed objects, required invasive procedures and were mostly diagnosed through physical examination and a doctor's best guess [1]. With continuous innovations and technological advancements, the quality and ease of patient diagnosis have significantly improved. However, in the current era, medical professionals face challenges in acquiring critical information when viewing medical images in a 2D format. A 3D

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counterpart would enable them to navigate through a person's body scan more efficiently. Efforts have been made to develop software capable of processing medical images and reconstructing them into 3D visualizations. Identisoft, an enterprise specializing in information and communication technology solutions for the health sector, uses its expertise in medical imaging data management to innovate. One such solution is a Web platform designed to visualize 2D medical images in the DICOM (Digital Imaging and Communications in Medicine) format, which is a standard that plays a pivotal role in facilitating the seamless exchange and interoperability of medical images and related information [2]. This enterprise collaborates with the Polytechnic Institute of Viana do Castelo to introduce the development of a Web platform for medical image visualization, supported in web browsers. The objective of this Web platform is to incorporate tools like volume rendering and 3D reconstruction, using the Cornerstone3D library, a lightweight JavaScript library for visualizing medical images in modern web browsers. Cornerstone3D, along with its associated libraries, like Cornerstone3DTools, which offers a wide range of imaging tasks [3]. Numerous software solutions for reconstructing and visualizing medical images have been implemented, but this proposal takes a unique approach. It employs newer software (Cornerstone3D) and focuses on developing a web platform rather than a standalone application. The objective is to create a solution that leverages newer software within a web platform, aiming for enhancements outlined in the objectives section below. The subsequent section (Section 2) includes an extensive exploration of research and studies on DICOM files, similar work, and solutions in the field, along with a review of other published works on Cornerstone3D. Section 3 delves into the Cornerstone3D library, examining its uses, including image loading, volume loading, volume rendering, and other functions. Section 4 details the initial development and planning for the web platform, while Section 5 discusses some of the obtained results and Section 6 holds the conclusion.

2. Literature Review

This section reviews previous approaches, solutions, and technologies related to the processing and reconstruction of medical images from a 2D format to a 3D one. The research involves multiple published articles in this area to determine similar solutions to the proposal and to identify the work that has already been conducted. The research follows the Design Science Research (DSR) method, which had its origins in engineering and other applied sciences [4]. DSR is a creative and innovative problem-solving activity whose main product is the creation of new technologies. Vaishnavi and Kuechler refer to it as the "improvement research method" to underline its focus on problem-solving or improving solution performance [5-7]. A picture saved in the DICOM format is known as a DICOM file. It includes an image from a diagnostic scan, such as an MRI or ultrasound and these files may also contain patient identifying information to associate a picture with a specific person. The DICOM format was created by the National Electrical Manufacturers Association (NEMA)

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to facilitate the exchange and analysis of medical images [8]. The initial DICOM standard was established by NEMA in 1982 and underwent several changes in the 1990s and 2000s. The format is still actively maintained by the association. Over the years, numerous software solutions dealt with this format for displaying medical images, including ITK (Insight Toolkit) and VTK (Visualization Toolkit). ITK, developed by the US National Library of Medicine, in 1999, is an open-source software toolkit for image processing and analysis in C++. It often collaborates with VTK, an open-source system for 3D computer graphics and visualization. An example of these collaborations can be seen in the DICOM viewer MITK (Medical Imaging Interaction Toolkit) which integrates algorithms from ITK with visualizations from VTK, creating tailored applications for medical image analysis [9, 10] ITK has two types: single DICOM reading and sequential DICOM. ITK uses the itkGDCMImageIO class to read slices and the itkGDCMSeriesFileNames class to create lists of filenames and determine which slices of a common volumetric dataset belong to the same series [8, 11] while VTK encapsulates a related DICOM reading class: vtkDICOMImageReader. Other solutions such as VTK.js also appear to challenge the web part of the existing viewers, mostly using WebGL on instances per viewport such as Med3Web [12]. This occurs because GPU memory limitations do not scale well for scenarios like PET/CT hanging protocols, which could need more than ten viewports to be displayed at once [3]. Cornerstone rendering engine was built from the ground up for efficient GPU memory usage, as an attempt to have greater performance than their other online counterparts. Cornerstone3D does not deal with loading images; instead, it delegates this work to image and volume loaders registered with Cornerstone3D such as CornerstoneWADOImageLoader [3, 13].

Volume rendering, a key component of 3D medical image visualization, involves rendering isosurfaces in volumetric data using algorithms like Marching Cubes. VTK's vtkMarchingCubes function is used for isosurface rendering. The Ray Casting Algorithm determines if a point is inside a polygon. The integration of Marching Cubes and Ray Casting can be found in "Design of 3D Visualization System Based on VTK Utilizing Marching Cubes and Ray Casting Algorithm" [14]. Each method has its advantages and disadvantages, with Marching Cubes offering flexibility, quick rendering, and lack of memory restrictions, while Ray Casting provides straightforward implementation and high-quality images [15]. The Texture-based Algorithm is another direct volume rendering method. It maps an image onto a geometric object. It runs fast and produces sustainable images but has limitations in texture memory when dealing with a large number of medical data slices.

Clinical trials and medical registries need DICOM viewer software for visualization and interfaces for integration when using imaging biomarkers and image-based surrogate endpoints [16]. Three use cases for DICOM viewer software are Central Viewing, Decentralized Viewing, and Advanced Viewing, each with specific requirements. A survey of 28 tools concluded that no viewer satisfies every requirement, and the choice should consider use-case scenarios. Research on scientific articles related to Cornerstone3D, using

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the Google academic search bar, led to only one result that included the “Cornerstone3D” or “Cornerstone 3D” keywords on 04/01/2024, which is not surprising, given its recent release. The study conducted by Sebastien Jodogne focuses on the use of WebAssembly for Rendering and Segmenting Medical Images [17] refers the Cornerstone3D open-source release, announced on 06/04/2022, with the main goal of creating a renderer with high-performance interactivity without sacrificing memory efficiency in RAM or GPU.

3. The Cornerstone Library

Cornerstone3D is a lightweight JavaScript library designed for visualizing medical images in modern web browsers that support the HTML5 canvas element. Leveraging Cornerstone3D and its associated libraries, such as Cornerstone3DTools, enables the accomplishment of a broad spectrum of imaging tasks [3]. Table 1 is a comparison table between three DICOM viewers namely cornerstone.js, cornerstone3D and MITK, based on previous works [10, 16, 18] which was created using parameters defined in prior research. MITK and Cornerstone were, among the DICOM viewing software covered in these studies, Cornerstone3D however was not. The rationale for choosing MITK and Cornerstone over other options lies in MITK’s extension of VTK and ITK, and Cornerstone’s role as the precursor to Cornerstone3D, providing insight into the advancements introduced by the newer software. The parameters can be divided into Interface, Support, 2D viewing and 3D viewing, including the following sub-parameters selected for the table:

- Web-based: Web applications accessible via modern browsers on client systems.
- Multi-platform: Software developed for use with multiple operating systems.
- DICOM capable: Query-Retrieve (Q/R) for actively requesting and gathering data from other DICOM nodes.
- Documentation: Availability of written software documentation, such as manuals.
- Wiki: Presence of a wiki web page for user reference.
- Forums: Web-based forum for user support.
- Metadata: Viewing DICOM object metadata, including image resolution, study identifiers, and vendor-specific DICOM tags.
- Measurements: Drawing geometric figures (e.g., lines) and analyzing them (e.g., distances, angles) with calibration information from DICOM headers.
- Annotations: Storing results of image viewing for later use through measurements or text annotations.
- Secondary Reconstruction: Functionality for reconstructing a secondary axis based on the primary direction for better visualization of specific structures.
- Slice Cube Volume Slices: Showcasing volumes effectively by independently moving various slice axes (e.g., transversal, sagittal, coronal) with displayed slices in a separate window.

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- Volume Rendering: Direct representation of 3D image data with the ability to scale, translate, and rotate the volume.
- Surface Generation: Calculating surfaces of voxels with the same grey values using algorithms like marching cubes to enhance the visibility of image structures.

Table 1: Comparison between three DICOM viewers

	Parameter	MITK	Cornerstone	Cornerstone3D
Interface	Web	–	+	+
	Multi-Platform	–	+	+
	DICOM Capable	+	+	+
Support	Documentation	+	–	+
	Wiki	+	–	–
	Forums	–	+	+
2D Viewing	Metadata	+	–	–
	Measurements	+	+	+
	Annotations	+	–	–
3D Viewing	Secondary Reconstruction	+	–	+
	Slice Cube Volume slices	+	–	+
	Volume Rendering	+	–	+
	Surface Generation	+	–	+

From analyzing Table 1 it is possible to conclude that cornerstone3D improves on the already existing library, mainly on the 3D Viewing area. These improvements can be found in detail in the next section. It is also important to note that while cornerstone3D is still lacking in the 2D Viewing area, it delegates some of its work to Image Loaders and that while the library isn't capable of "seeing" DICOM metadata, there are separate libraries that allow for this process (Figure 1).

3.1. Image Loaders

Medical images are typically followed by a large amount of non-pixel-wise metadata, such as the pixel spacing of the image, the patient ID, or the scan acquisition date. This data is stored in the file header for some file types (e.g. DICOM) and can be read, parsed, and passed throughout your application. Others (like JPEG and PNG) require that this information be provided separately from the actual pixel data. However, since this can significantly improve performance, it is typical for application developers to provide metadata independently from the transmission of pixel data from the server to the client even for DICOM images [13, 19]. Cornerstone requires that Image Loaders return an Object containing a Promise which Cornerstone will use to receive the Image Object asynchronously, or an error if one has occurred. CornerstoneWADOImageLoader is one such loader, it loads DICOM images from a WADO-compliant server [3]. It can be installed and initialized using the code provided by Cornerstone in their documentation and tutorials. The

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final result can be seen in Figure 1, with the 2D representation on the left and the image metadata on the right.

Internally, CornerstoneWADOImageLoader registers its wado-rs and Wado-uri image loaders to Cornerstone3D and uses DICOMParser to parse the metadata and pixel data. The CornerstoneWadoImageLoader provides a few examples for the uploading of DICOM images that were used with the DICOM images provided by the Identisoft enterprise, for testing purposes.

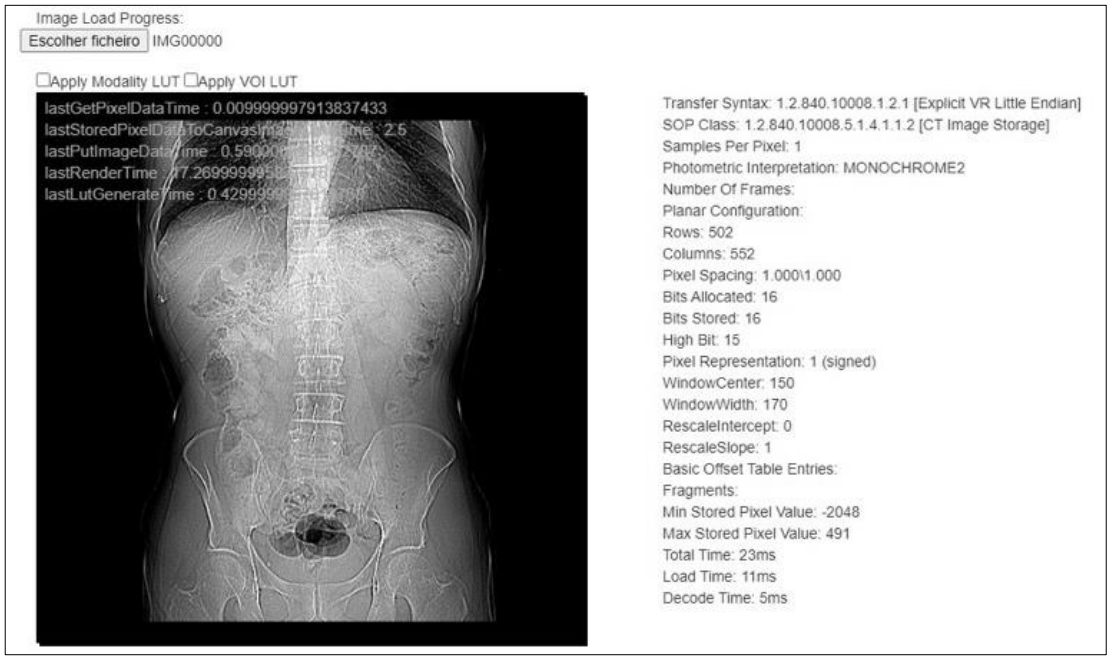


Figure 1. CornerstoneWadoImageLoader (DICOM Loader Example) for a DICOM file upload, provided by Identisoft enterprise.

This image loader, however, has been recently deprecated and Cornerstone3D has moved on to "dicomImageLoader" which, according to its backlog on "13/02/2024" still does not work with the examples provided by the Cornerstone team. However, in order to continue developing the work described here, the CornerstoneWADOImageLoader continued to be used.

3.2. Heading Volume and Volume Loaders

A volume is a 3D data array that has a physical size and orientation in space. It can be built by composing pixel data and metadata of a 3D imaging series or it can be defined from scratch by the application. A volume loader takes a volumeId (the volume identification) and other necessary data, much like image loaders do, and returns a Promise that resolves into a Volume. This Volume may be created from a single 3D array object or from a collection of 2D images (such as imageIds) (such as NIFTI format) [13, 19]. Cornerstone offers a volume loader that enables individual image slices to be streamed in, to fill an entire volumetric array

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(e.g. a portion of an MRI or CT acquisition). Essentially, reconstructing a 3D model from 2D images, as visualized in Figure 2, the user can still adjust the volume, while this slice-by-slice streaming is taking place. This loader was created/designed to accept imageIds and load them into a Volume.

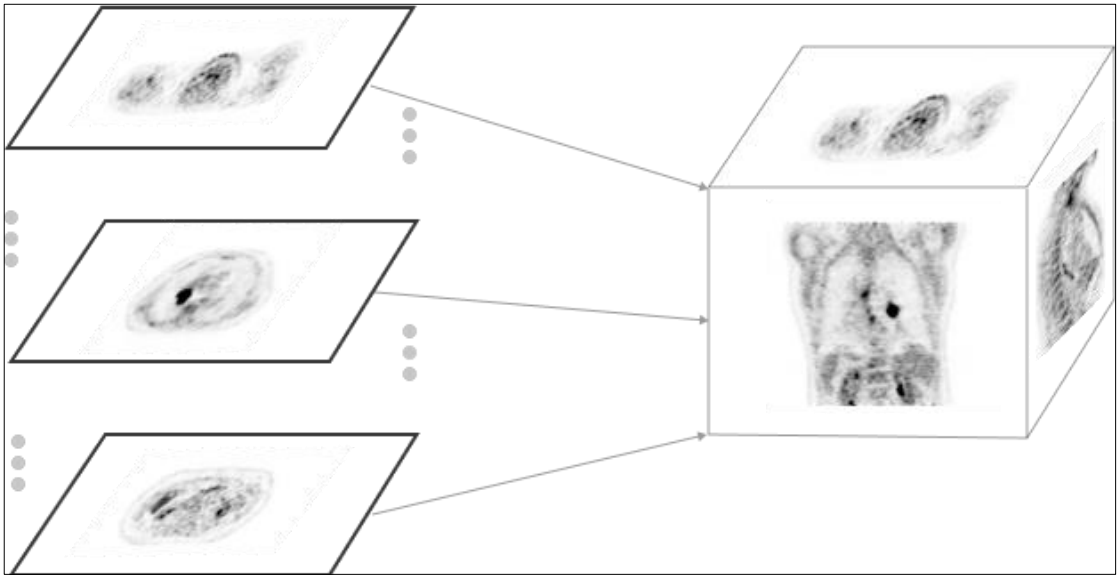


Figure 2. Volume Building - Visual reconstruction from 2D to 3D, picture available in cornerstone web platform [13].

Since a 3D Volume is comprised of 2D images (in StreamingImageVolume), the metadata for the volume is derived from the 2D image metadata. Therefore, this loader needs a first call to fetch image metadata. This allows to render a volume as the 2D images are loaded, in addition to pre-allocating and caching a volume in memory (progressive loading). It is possible to avoid having to create an Image object for each imageId, by pre-fetching the metadata from all images (imageIds). Instead, simply insert the image's pixelData into the volume in the appropriate place. This ensures quickness and memory effectiveness (but comes at minimal cost of pre-fetching the metadata). If the objective is to return from the 3D format to 2D, a volume can implement functions to transform its 3D pixel data to 2D photos, without having to re-request them over the network, thanks to the StreamingImageVolume, which loads a volume based on a series of obtained images (2D). For instance, StreamingImageVolume takes an imageId and its imageId index and uses convertToCornerstoneImage to return a Cornerstone Image object (ImageId Index is required since the goal is to locate the imageId pixelData in the 3D array and copy it over the Cornerstone Image). Figure 3 shows the usage of cornerstoneStreamingImageVolume according to the tutorials provided by Cornerstone, for volume rendering [13].

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Figure 3. Volume Rendering - Result from Cornerstone tutorial for rendering a volume [13].

4. MIPRV Web Platform

This section covers the early development, decision-making process, and technologies used in the development of a web platform, entitled MIPRV (Medical Imagery Processing Reconstruction and Visualization). Several requirements/goals were established with the Identisoft enterprise, to be achieved within the project, they are as follows:

- Research and explore other solutions in the area;
- Work with DICOM P10 anonymized images (from CT studies) provided by Identisoft;
- Stream the slices of a volume and view them in real-time as they are being loaded;
- View the same volume in different orientations such as axial, sagittal, and coronal without having to reload, the entire volume again (minimum memory footprint);
- View oblique slices in a volume;
- Render different blends of the same volume (e.g., MIP (maximum intensity projection) and average intensity projection);
- Implement a Crosshairs tool;
- Fuse and overlay multiple images such as PET/CT fusion;
- Test the developed platform with end-users.

4.1. Web Platform Prototype

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A Web platform prototype was created which contains a landing page where a regular user would initially start, then be sent to a projects page where the user would import their DICOM files into the web platform, which then allows for the viewing of each DICOM file loaded even during their import process. A login system would not be set up and the files and project would be lost upon ending the session, by closing the browser, thus ensuring the file's privacy and increasing ease of use, by not requiring a user account. In Figure 4, the mockup is illustrated specifically showcasing the 2D reconstruction of DICOM files previously imported within the web platform. Users have a range of options for viewing them, including conversion into a 3D state, which unlocks additional unique 3D viewing options and functionalities.

Additionally, the web platform has a documentation/help page to assist users in navigating the various viewing modes and understanding the website's functionality. A contact page is also provided, having information about the developers, in case users have unanswered questions after consulting the help tab.

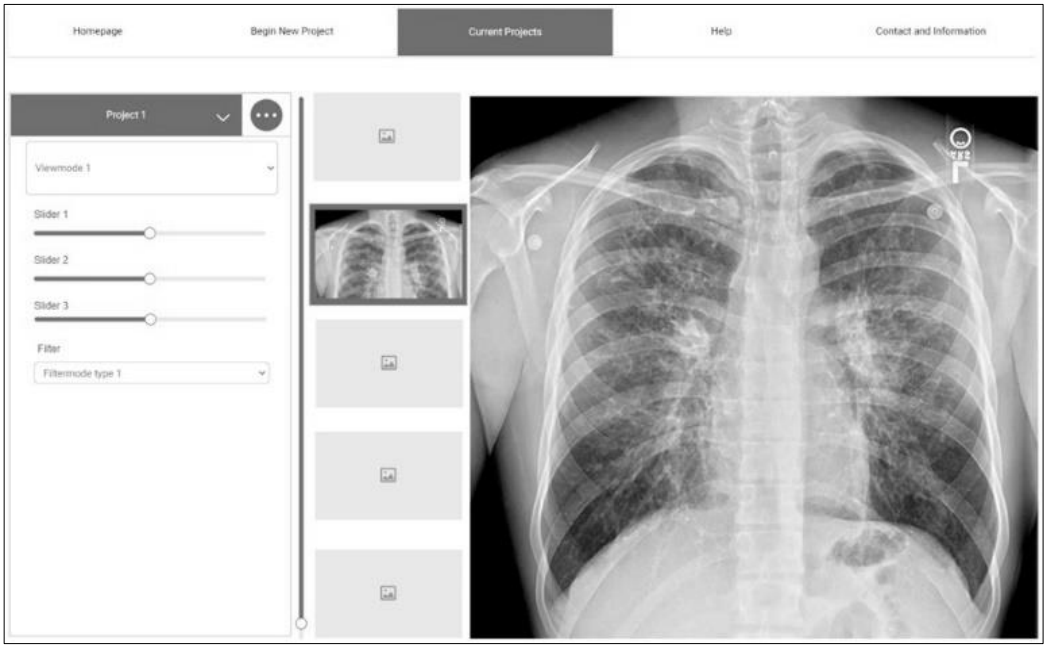


Figure 4. Prototype/mockup developed for the MIPRV web platform.

4.2. Architecture

The Web platform has the architecture shown on Figure 5. Initially, DICOM images are uploaded to the MIPVR platform, which uses an Image loader to load them, namely CornerstoneWadoImageLoader, then these files will be processed and rendered into an interactive 2D visualization, with an option to continue into a 3D visualization. The entire rendering process is powered by Cornersonte3D and HTML (hypertext markup language), JavaScript and CSS (cascading style sheets) are the planned languages that will be used to

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support the website development, along with React technology, in order to make the process become more agile.

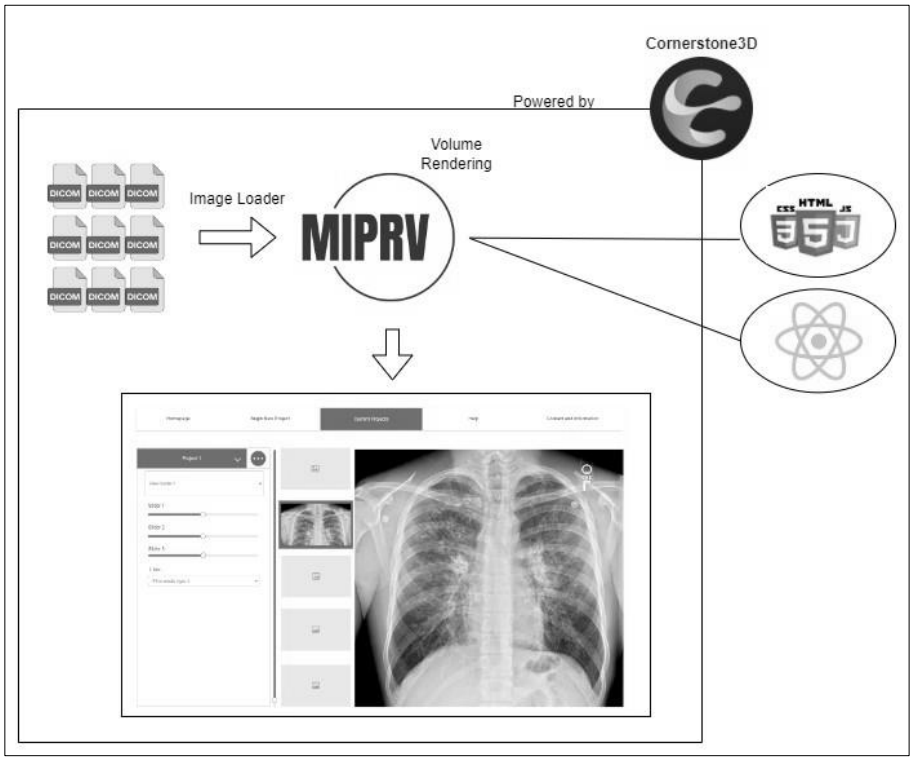


Figure 5. Web platform architecture.

The web platform uses React [20] as the JavaScript framework to build the UI (User interface) and manage UI components of the web platform's Front-End. Using the CornerstoneWadoImageLoader the web platform allows the user to import their own DICOM files directly from the computer and view them in a 2D online format as planned (Figure 6).

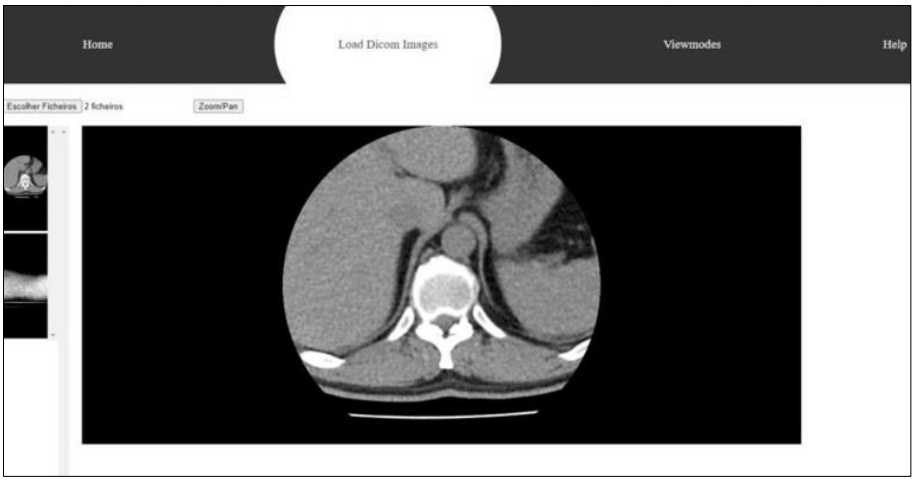


Figure 6. Web platform uploading page.

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Thus, the user may load the contents before continuing to the next page. Once the images have been uploaded, they can be scrolled through and enlarged individually. Upon completion of the Loading process via button press or by directly accessing the Viewing tab the user is sent to the viewing page, which will open showing DICOM files using cornerstone3D. The viewing page employs the functionality of Cornerstone3D viewports to organize the files, enabling seamless navigation through an array of DICOM images by scrolling using the mouse wheel, the user can also zoom through each individual DICOM image being processed with increased clarity and detail upon double clicking and using the mouse scroll button. These viewports are positioned in the center of the screen much like the DICOM files loaded as seen in Figure 6.

5. Results and Discussion

The study here presented provides some valuable insight into Cornerstone3D. The platform, unlike others, does not deal with loading images directly, instead delegating this task to ”Image Loaders” like the one used in the development of MIPRV ”CornerstoneWadoImageLoader”. It does however include image rendering and caching. The platform delves into not only 2D viewing but 3D viewing of DICOM files, while maintaining similar performance to standalone viewers and keeping the convenience of online usage.

The development of the MIPRV web platform, using the Cornerstone3D library, managed to achieve several key milestones. The initial phase involved the exploration of existing software solutions in the field, with a particular emphasis on frameworks like ITK, VTK, and MITK, used to develop standalone platforms. Numerous software programs available can recreate and display medical images, however, the proposal presented here intends to follow a different approach improving on standalone applications on the ease-of-use area via the lack of download and improving on other online applications with performance and a focus on the 3D viewing which is lacking on web-viewers. Cornerstone3D marked a shift towards an online, web-based approach, distinguishing itself by providing both 2D and 3D viewing capabilities while maintaining the speed of standalone applications.

The web platform successfully used the CornerstoneWadoImageLoader for uploading and cornerstone3D for viewing DICOM files directly from the user’s computer. Notably, the process demonstrated impressive speed, handling the loading, and displaying datasets of 500 plus DICOM files in under two seconds. The platform’s ability to display the files in real-time as they are loading individually was intended to enhance user interaction and provide seamless experiences, however the files load so fast that this feature proved inconsequential.

The cornerstone3D library facilitated dynamic 3D reconstructions, allowing users to view the same volume in different orientations, such as axial, sagittal, and coronal, without the need to reload the entire volume, this is a big improvement versus other online viewers

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such as MED3WEB who have small loads when the user seeks to move through the slices. This functionality significantly improves efficiency and makes an analysis of a case seamless.

6. Conclusion

Despite being a relatively recent addition, the Cornerstone3D library emerges as a promising advancement, particularly in enhancing the 3D viewing capabilities of its previous iteration. It sets itself apart from standalone viewers by providing a fully online platform, eliminating the need for application downloads and installation, while striving to maintain the expected performance standards of standalone DICOM viewers.

Through the development of the Web platform, it was concluded that there are benefits of using the cornerstone3D, specifically in the performance areas, such as loading speeds and allowing for the moving through the slices of a 3D render without reloading.

This study provides a written scientific article on the Cornerstone3D library, explaining some of its intricacies while highlighting features and functionalities for future developers as well as display the development of a web-platform using this technology. The platform built used the framework to successfully process DICOM Files and allow for their viewing in a 2D state, using CornerstoneWadoImageLoader and cornerstone3D's viewports for stacking these images, allowing the user to scroll through the DICOM files in order.

The Cornerstone3D library has proved to be an excellent option for the future development of other web platforms for medical imagery processing, reconstruction, and visualization. In the future the MIPRV platform can benefit from swapping the image loader to a more modern version, begin user testing and finally provide an online demo freely available.

Conflicts of Interest: The authors declare no conflict of interest.

References

[1] Lederman, M. (1981). The early history of radiotherapy: 1895-1939. International Journal of Radiation Oncology, Biology, Physics. 639-648

[2] Mildenberger, P., Eichelberg, M., Martin, E. (2002). Introduction to the DICOM standard. European Radiology. pp. 920-927

[3] Ziegler, E., Urban, T., Brown, D., Petts, J., Pieper, S., Lewis, R., Hafey, C. & Harris, G. (2020). Open Health Imaging Foundation Viewer: An Extensible Open-Source Framework for Building Web-Based Imaging Applications to Support Cancer Research. JCO Clin Cancer Inform 4, 336-345. https://doi.org/10.1200/CCI.19.00131

[4] Venable, J. R. (2006). The role of theory and theorising in design science research. First International Conference on Design Science Research in Information Systems and Technology. California. vol. 1, pp. 1-18

[5] Vaishnavi, V. K. (2007). Design Science Research Methods and Patterns. Innovating Information and Communication Technology. Auerbach Publications. https://doi.org/10.1201/9781420059335

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[6] Vaishnavi, V. K. and Kuechler, W. (2015). Design Science Research Methods and Patterns: Innovating Information and Technology (2nd edition). CRS Press. https://doi.org/10.1201/b18448

[7] Cruz, E. F. and Cruz, A. M. R. (2020). Design Science Research for IS/IT Projects: Focus on Digital Transformation. 15th Iberian Conference on Information Systems and Technologies (CISTI), Seville, Spain, 2020, pp. 1-6, doi: 10.23919/CISTI49556.2020.9140972

[8] Bidgood Jr, W. D. and Horii, S. C. (1992). Introduction to the ACR-NEMA DICOM standard. Radiographics: a review publication of the Radiological Society of North America, Inc, 12(2), 345-355. https://doi.org/10.1148/radiographics.12.2.1561424

[9] Ibanez, L. (2003). The ITK Software Guide. ISBN: 9781930934108

[10] Wolf, I., Vetter, M., Wegner, I. Bttger, T., Nolden, M., Schbinger, M., Hastenteufel, M., Kunert, T., Meinzer, H.P. (2005). The Medical Imaging Interaction Toolkit. Medical Image Analysis. Volume 9, Issue 6. Pages 594-604. ISSN 1361-8415. https://doi.org/10.1016/j.media.2005.04.005

[11] Ibanez, L., Schroeder, W., Ng, L., Cates, Josh and Consortium, I. (2005). The ITK Software Guide, Second Edition, Updated for ITK version 2.4. https://itk.org. Last accessed on November 12, 2023.

[12] Liang (2018). Med3Web Dicom 2d/3d web viewer. https://github.com/hongliang666/med3web. Last accessed on November 22, 2023

[13] CornerstoneJS (2023). CornerstoneJS. https://www.cornerstonejs.org/docs/getting-started/overview. Last accessed on December 12, 2023

[14] Tan, J., Chen, J., Wang, Y., Li, L. and Bao, Y. (2016). Design of 3D Visualization System Based on VTK Utilizing Marching Cubes and Ray Casting Algorithm. 8th International Conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC), Hangzhou, China, 2016, pp. 192-197, doi: 10.1109/IHMSC.2016.153

[15] Nguyen, S., Tran, H. and Quang Vu, M. (2016). A Research on 3D Model Construction from 2D DICOM. International Conference on Advanced Computing and Applications (ACOMP). Can Tho, Vietnam, 2016, pp. 158-163, doi: 10.1109/ACOMP.2016.031

[16] Haak, D., Page, C. E. and Deserno, T. M. (2016). A Survey of DICOM Viewer Software to Integrate Clinical Research and Medical Imaging. Journal of digital imaging, 29(2), 206-215. https://doi.org/10.1007/s10278-015-9833-1

[17] Jodogne, S. (2023). On the Use of WebAssembly for Rendering and Segmenting Medical Images. In: Roque, A.C.A., et al. Biomedical Engineering Systems and Technologies. BIOSTEC 2022. Communications in Computer and Information Science, vol 1814. Springer, Cham. https://doi.org/10.1007/978-3-031-38854-5_20

[18] Lo Presti, G., Carbone, M., Ciriaci, D., Aramini, D., Ferrari, M., & Ferrari, V. (2015). Assessment of DICOM Viewers Capable of Loading Patient-specific 3D Models Obtained by Different Segmentation Platforms in the Operating Room. Journal of digital imaging, 28(5), 518-527. https://doi.org/10.1007/s10278-015-9786-4

[19] Cruz, R. (2022). Identisoft Technical Document to Prepare "Visualization and manipulation of medical images in modern web browsers" React (2023). CornerstoneJS. https://react.dev/. Last accessed on December 20, 2023.

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