FALL 2025 – COS 397 COMPUTER SCIENCE CAPSTONE PROJECT PROPOSALS

Project Title:

Enabling 3D Printing of a Medical CT-Scan: A Web App for Patients and Practitioners

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Brief Description (approximately 500 words)

I am seeking assistance developing a piece of research software. This project will be the development of a client-side web app that will accept a medical x-ray CT scan (in the industry-standard DICOM file format) and output two different file types for 3D printing: (1) a polygonal file in .stl format suitable for sending to a 3D slicer to generate a 3D shape (skull, skin, muscle) or (2) gcode to send to a 3D printer to mimic the x-ray properties of the tissue from the CT scan (see Fig. 1)

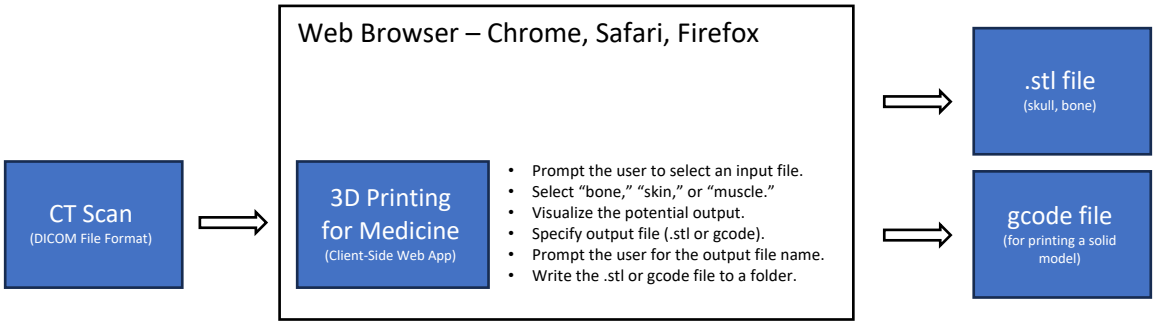

Figure 1: Basic data flow for this proposed project, Enabling 3D Printing of a Medical CT Scan. The concept is for the medical data to remain on the client machine, for the software to run as a web app on the client browser, and the resulting printable files to be produced on the client machine.

The project will require the following:

1. The creation (or adaptation of existing open source software) of a DICOM file reader.
2. The adaptation of existing open source software using a Marching Cubes algorithm to generate polygonal shapes of the patient's anatomy from the CT scan.
3. The generation of new implementation of algorithms and software to generate the g-code files for printing solid models of the anatomy in the CT scan.
4. The creation (or adaptation of existing open source software) of a g-code and a .stl file writer.

5. (OPTIONAL) The creation (or adaptation of existing open source software) of STL slicer software to run within the web app to generate gcode from the generated .stl file.
6. The design and development of a web user interface (for an example interface, see Fig. 2). This user interfaces shall:
    a. prompt the user to select an input file.
    b. Select “bone,” “skin,” or “muscle.”
    c. Visualize the potential output.
    d. Specify output file (.stl or gcode).
    e. Prompt the user for the output file name.
    f. Write the .stl or gcode file to a folder.
7. The design and implementation of an automated test suite to exercise the code on at least three browsers (Safari, Chrome, and Firefox) and three operating systems (MacOSX, Linux, and Windows).

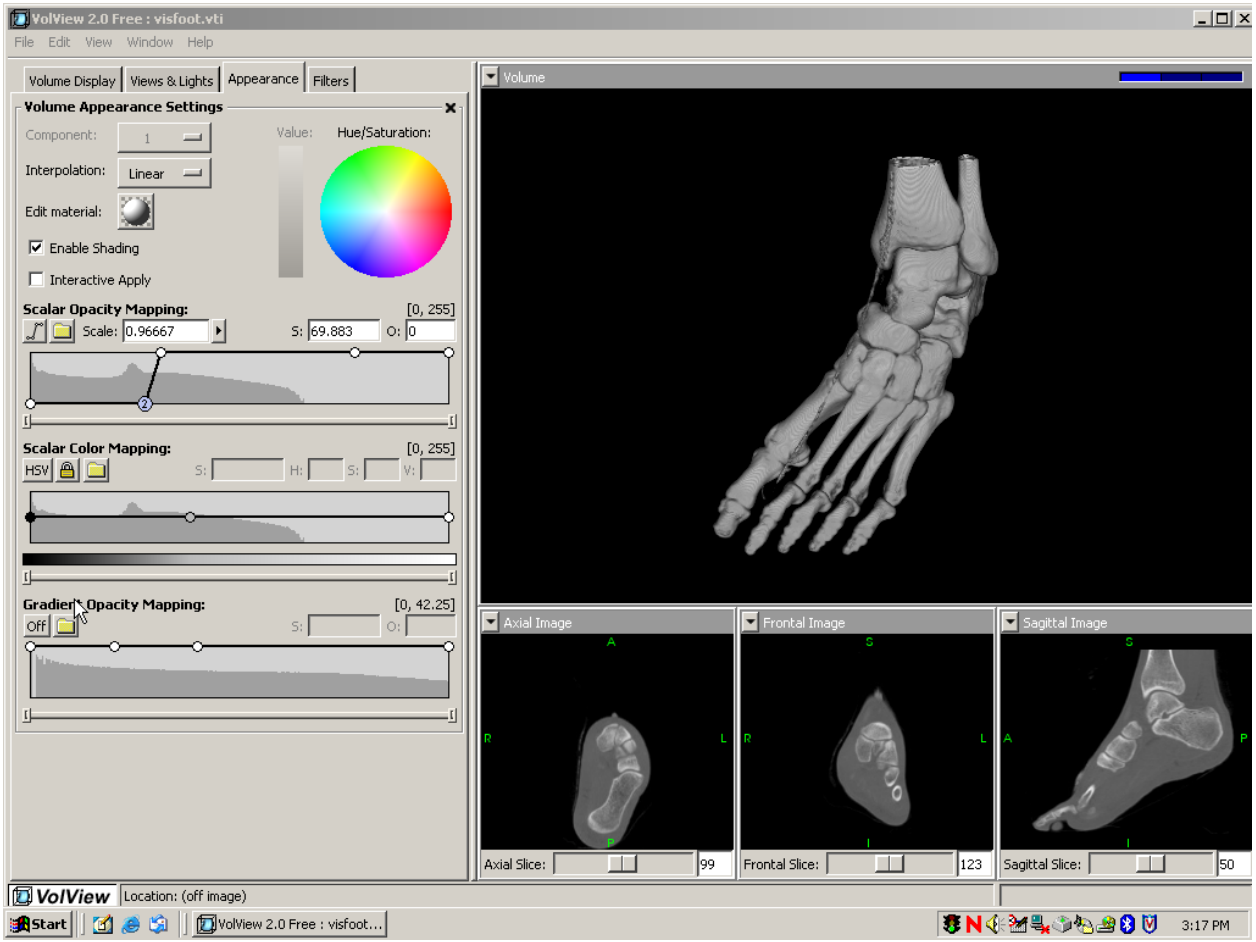

Figure 2: Example user interface for an application similar to the proposed web app. This application , VolView, is a stand-alone app, but it is available as open source.

Goals for the project (approximately 50 words)

The target is research software, a *client*-side web-app capable of taking a CT scan of a patient and producing both a STL file of the bony anatomy suitable for 3D printing and a G-code file that when printed, mimics the x-ray characteristics of the tissue and a conference manuscript.

Total Duration / Elapsed Time [in weeks]: 23 weeks

External Schedules / Deadlines (conferences paper deadline? Meetings?) [if any]:

I hope to generate a publishable manuscript describing the work of the team in time for the 2026 Medical Image Computing Computer Assisted Intervention (2026 MICCAI) conference, to be held 4-8 October 2026. The deadline for this paper is expected to be in mid-February, 2026.

If the conference deadline cannot be met, I propose to instead submit the research to the Journal of Computer Assisted Tomography.

Learning Objectives for student teams:

Expected Project Experiences (select from the list, check all that apply):

☑	Problem definition
☑	Project scope definition
☑	Design and implementation of research methodology
☐	Use of applied statistics
☑	Data analysis
☐	Workflow analysis
☑	Development of functional specifications
☐	Identification of and negotiation for needed project resources
☑	Examination of an unfamiliar technical area
☐	Identification of others' technical expertise
☑	Identification and evaluation of alternatives
☑	Development and presentation of recommendations
☑	Responsibility and accountability for a discrete product
☑	Role definition in a task group and participation in group dynamics
☐	Observation of supervisory activities (*e.g.*, personnel assignment, training, development of procedural guidelines)
☐	Observation of management styles

☐	Observation of organizational politics
☑	Preparation of a manuscript for publication

Recommended experience (What operating system is required? What programming language? Other skills?):

The intention is to create a client-side web-app for processing medical data. The code should work on Windows, MacOSX, and Linux. However, the operating system is far less important than browser compatibility. The target code should run on Safari, Chrome, and Firefox.

The programming language will be up to the development team; however, there are a number of available medical image analysis and 3D computer graphics libraries that should be considered as part of the development. These libraries may dictate the use of Javascript.

Expected Outputs/Products and likely requirements (specific programming language, programming framework, operating system, integration with existing software, web-based requirements, *etc.*):

See above.

Past experiences by the client (If software already exists, what is wrong? What has worked in previous versions, and what has not?):

We have been working in the area of 3D printing for medicine for a number of years. At UMaine, the Laboratory for Convergent Science successfully conducted an undergraduate research project that resulted in an oral presentation and publication of a manuscript at the SPIE Medical Imaging Conference in San Diego, CA, February 2023.

We are presently advising a UMaine CUGR research effort to generate the required G-code. The research is promising, but the software for G-code generation is early in its development.

Proposed Testing Plan (How will the team test their product? Do you have recommended/required testing strategies? What resources are available (test platform, stand-alone network, *etc.*)? Is test data available?):

The client will provide a set of medical CT scans in the industry-standard DICOM file/folder format. The development team will need to create a test environment to automatically successfully generate identical STL files and G-code files for 3D printing using different browsers. The development team should use an open source web-testing-system such as Selenium.

Since the target software is a client-side web-app, we do not need to reproduce a client environment; we will not need to simulate a network, a database, or extensive user

environment.

Benefits to U Maine:

The University of Maine has a considerable reputation for advancing 3D printing for large scale manufacturing; however, UMaine has not had a substantial footprint in medical imaging research. This tool, if available and maintainable, will demonstrate our combined capabilities in 3D printing for medical imaging research. The accompanying conference paper, if published, will secure our contribution in the archival literature.

Project Sponsor(s):

This project is part of the research of the Laboratory for Convergent Science, Terry Yoo, Director.

Other Resource People:

Software/server access required:

No specific server access is required. No software licenses are required. All software used in this project are expected to be available as open source.