Software Requirements Document

for

Image Analysis and Geometry Reconstruction

Version <1.1> approved

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Revision History

Name	Date	Reason For Changes	Version
Silvano	10/08/2021	Update Document	1.0
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1. Introduction

1.1 Purpose

This document shall:

1. Identify the requirements for Image Analysis and Geometry Reconstruction by giving an in-depth explanation of the web-based software, and the purpose of the project as well as how the user will interact with the methods on the web page.

2. Detail requirements that must be met to effectively use the Image Analysis and Geometry Reconstruction Application.

1.2 Intended Audience and Reading Suggestions

This document is intended for the project manager, developers, and users of the software.

The suggested reading sections are as follows:

- Project Manager: To help understand the requirements and steer the development of the software

- Developers: To help understand the requirements that need to be met for the implementation of the software

- Users: To help understand basic information pertaining to the software

1.3 Product Scope

Image Analysis and Geometry Reconstruction is a web-based application where the users can upload DICOM-MRI scans and use a simplified version of 3D Slicer to create general use models. The application will take some user input to identify the region of interest and create a semi-accurate model of the MRI scan. The 3D Slicer will be using user input and Artificial Intelligence to select and create organ(s) of interest. The model created in an adapted version of 3D Slicer will be exported to an adapted version of Blender to apply any needed smoothing to get a decent representative model of the organ(s).

1.4 Definitions, Acronyms, and Abbreviations

Refer to Appendix: A

1.5 References

2. Overall Description

2.1 System Analysis

For general use, 3D Slicer and Blender had tough learning curves. The purpose of this program is to simplify general use cases of 3D Slicer and Blender to create organ models for reference use cases. This product is not to be used in a professional environment as it will not produce a super accurate model of the organs.

The major hurdles met during the projects were:

- Deciding on a method to simplify the usage of the programs and create a semi accurate model at the same time.

- Figuring out where to pull test data for AI learning.

- Acquiring third-party servers with sufficient privacy assurance.

- Learning to use the programs to understand the frustrations and skills needed to operate the programs.

Solutions to overcome hurdles:

- Testing between boundary points and deep-grow to compare speed and efficiency.

- Pulled data from The Cancer Imaging Archive (TCIA) and samples provided by Dr. Mathias Brieu.

- Meeting with NVIDIA representatives to discuss privacy use of their servers.

- Set aside specific amount of time every week dedicated to learning and understanding the programs.

2.2 Product Perspective

The Image Analysis and Geometry Reconstruction project aims to make it easier for healthcare and medical professionals to create 3D models out of MRI images. Our software utilizes the tools found in 3D Slicer to streamline the modeling process through an online web application.

2.3 Product Functions

2.3.1 Homepage
- Provides initial landing site for users.

2.3.2 Adapted 3D Slicer page
- Allow the users to choose organ of interest without the need for specific computer specification and the download of programs.

2.3.3 Production Page
- Allows the user to view the 3D model and download .STL file of the organ(s)

2.4　User Classes and Characteristics

This product only has one level of functionality. The features inside the product are accessible to healthcare and medical professionals.

2.5　Operating Environment

The application will run on any device (Windows, Mac OS, and Linux) that has a web browser and is connected to the internet.

2.6　Design and Implementation Constraints

- Privacy and security regulations on the MRI scans

2.7　User Documentation

2.8　Assumptions and Dependencies

2.8.1　Users are expected to be using a PC to access the webpage.

2.8.2　Users are expected to have a stable internet connection.

2.8.3　Device accessing the web application must have a display and some form of user input like mouse and keyboard.

2.8.4　Users are expected to provide their own MRI scans to create organ models.

2.8.5　Web application is dependent on Nvidia AIAA and Nvidia servers.

2.8.6　Web application is dependent on 3D Slicer Application.

2.8.7　Web application is dependent on Blender Application.

2.9　Apportioning of Requirements

3. External Interface Requirements

3.1 User Interfaces

3.2 Hardware Interfaces

No hardware interfaces.

3.3 Software Interfaces

3.3.1 3D Slicer, version number 4.11.20210226

- https://download.slicer.org/

3.3.2 Blender, version number 2.93.5

- https://www.blender.org/download/

3.3.3 Nvidia AIAA

3.4 Communications Interfaces

3.4.1 Login credentials

4.   Requirements Specification

4.1   Functional Requirements

4.1.1   Application Requirements

4.1.1.1 The application shall run on Windows, Mac, or Linux

4.1.1.2 The application should provide an interface to access functions of web application

        4.1.1.2.1 The application will provide an MRI scan upload function

        4.1.1.2.2 The application will provide a Select Region of Interest function

        4.1.1.2.3 The application will provide a Model Render function

        4.1.1.2.4 The application will provide an Organ Model download function

4.1.2 MRI Scan Upload Function

    4.1.2.1 Allows user to upload their scans of the human body to create a general use model render of organ(s).

4.1.3 Select Region of Interest Function

4.1.4 Model Render Function

4.1.5 Organ Model Download Function

4.2   External Interface Requirements

4.3   Logical Database Requirements

4.4   Design Constraints

4.4.1 Web application user requirements

    4.4.1.1 Functioning computer

    4.4.1.2 Access to internet

    4.4.1.3 Usable MRI scan

5.   Other Nonfunctional Requirements

5.1   Performance Requirements

5.1.1 The application should take no more than X seconds to load 3D Slicer's tools

5.1.2 The maximum number of simultaneous users should be around X

5.1.3 Information type handled is DICOM MRI files

5.2   Safety Requirements

To maintain privacy, the user is highly recommended not to share organ models and other data with other users.

5.3   Security Requirements

Private data provided by anonymous users are discarded after the user is finished with their use. Any third-party resources have been checked to maintain privacy. The server hosts, programmers, and program owners do not have access to any private data that users may want to use in this web application.

5.4   Software Quality Attributes

The website is fully functional on all browsers on PC computers.

5.5   Business Rules

6.   Legal and Ethical Considerations

The legal and ethical issues involved in this project are not limited to but include the following:

6.1 Use Cases

      6.1.1 The users are not to use models for professional use

6.2 Legal use of body scans

6.3 User Intentions

      6.3.1 Bad Intentions

            6.3.1.1 Misleading the public

            6.3.1.2 Inflammatory remarks

            6.3.1.3 Propaganda

            6.3.1.4 Weaponize data to target certain groups of people

            6.3.1.5 Invasion of privacy of other beings

      6.3.2 Good Intentions

            6.3.2.1 Education

            6.3.2.2 General Reference

6.4 Allow usage of our service to all skill levels.

6.5 Accommodate all realistic form factors used to access site.

6.6 Data privacy

Appendix A: Glossary

3D Slicer - a free and open-source software package for image analysis and scientific visualization.

Anatomy - the study, classification, and description of structures and organs of the body.

Artificial Intelligence (AI) - It is the science and engineering of making intelligent machines, especially intelligent computer programs.

Automate – to convert to automatic operation.

Bladder – a membranous sac serving as a receptacle for secretions, such as the gallbladder.

Blender - a free and open-source 3D computer graphics software toolset used for creating animated films, visual effects, art, 3D printed models, motion graphics, interactive 3D applications, virtual reality, and computer games.

Biology – the scientific study of life.

DICOM (digital imaging and communications in medicine) - the standard used for the electronic transferring of digital image data.

Dimension - a measure of the width, length, or height of a space, usually described in units of a linear scale.

Dummy data - used as a placeholder for both testing and operational purposes.

Female - pertaining to the sex that has the ability to become pregnant and bear children; feminine.

Geometry - a branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.

Google collab - allow you to combine executable code and rich text in a single document, along with images, HTML, LaTeX and more.

Image smoothing - a key technology of image enhancement, which can remove noise in images.

Image thresholding - the simplest method of image segmentation, that replace each pixel in an image with a black pixel, if the image intensity is less than some fixed constant, or a white pixel if image intensity is greater than the constant.

MRI (Magnetic Resonance Imagining) - medical imaging based on the resonance of atomic nuclei in a strong magnetic field and it has also become an important tool in musculo- skeletal and pelvic imaging. Page 1081 from Mosby Medical Dictionary

Nvidia - designs graphics processing units for the gaming and professional markets, as well as system on a chip units for the mobile computing and automotive market.

Nvidia AIAA - enables you to serve the models you trained to speed up annotation process.

Patient - a recipient of a health care service.

Pelvis – the lower part of the trunk of the body, composed of four bones, the two innominate bones laterally and ventrally and the sacrum and coccyx posteriorly.

Organ – a structural part of the system of the body that is composed of tissues and cells that enable it to perform a particular function.

Rectum – the lower part of the large intestine, about 12 cm long, continuous with the descending sigmoid colon, proximal to the anal canal.

Render - the process of generating a photorealistic or non-photorealistic image from a 2D or 3D model by means of a computer program.

Rendering - the process involved in the generation of a two-dimensional or three-dimensional image from a model by means of application programs.

Standard Triangle Language (STL) - is a file format native to the stereolithography CAD software created by 3D Systems and is widely used for rapid prototyping, 3D printing and computer-aided manufacturing.

Two Dimension (2D) – having only two dimensions, such as width, length, or height.

Three Dimension (3D) – having only three dimensions, such as width, length, or height.

UI (User Interface) - the point of human-computer interaction and communication on a device, webpage, or app.

Vagina – the part of the female genitalia that forms a canal from the orifice through the vestibule to the uterine cervix.

Appendix B: Analysis Models

Appendix C: To Be Determined List