UNIVERSITY OF DAR ES SALAAM

COLLEGE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

IS335 / CS498: Final Year Project Report – End of Semester two

Project Title:	**AI DIAGNOSTIC TOOL FOR MEDICAL IMAGE ANALYSIS.**		
Student Name:	**GIBURE, ADELPHINA PASCAL**	**2021-04-02030**	**B.Sc. in BIT**

Supervisor Name: **HONEST KIMARO**

Supervisor Signature

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CERTIFICATION

I declare that this report and the work described in it are my own work, with any contributions from others expressly acknowledged and / or cited.
I declare that the work in this report was carried out in accordance with the regulations of the University of Dar es Salaam and has not been presented to any other University for examination either in Tanzania or overseas.
Any views expressed in the report are those of the author and in no way represents those of the University of Dar es Salaam.

Signature: …………………………… Date: ....

This report may proceed for submission for assessment for the award of BSc. in Business Information Technology at the University of Dar es Salaam.

Supervisor's Signature: ………………………... Date: ....

DECLARATION

I, GIBURE, ADELPHINA PASCAL hereby declare that this project report entitled AI DIAGNOSIS TOOL FOR MEDICAL IMAGE PROCESSING is the record of the work done by me under the supervision Dr. Honest Kimaro in partial fulfilment for the award of bachelor degree of science in Business Information Technology at University of Dar es salaam.
The information and data given in the report is authentic to the best of my knowledge.

Signature ---

ACKNOWLEDGEMENT

In coming to accomplishment of any great project, we normally come across various difficulties which in one way or another shapes our dreams. There a lot of people to thank and appreciate for all they have done to make this task easier but the following have to come first for they have special purpose in my life.

GOD is universal, no words can explain his all-time goodness and favors in all areas of my life.

My supervisor Dr. Honest Kimaro for his better and tirelessly efforts to make me reach the milestones of this project and lots of advice and encouragement, I salute you.

Also, I am thankful to DHIS2 team especially Mr. Vicent Minde and Mr. Gasper Giddson for their supports, advices, encourages and helps that they were provide to us, we are so grateful.

Never will I forget my family since they have been special to my life for, they have never forsaken me in everything that I plan to do. They are always there to comfort me.

Last but not least, special thanks go to my colleague who worked with me hand in hand to accomplish this project.

ABSTRACT

Medical image analysis plays a crucial role in modern healthcare for diagnosis, treatment planning, and disease monitoring. However, noises and complex anatomical structure in images can significantly challenges radiologists during image interpretation, potentially impacting diagnosis and treatment planning accuracy.

This project explored the capability of MONAI open-source deep-learning framework, to develop a medical image analysis assistance. We focused on x-rays and ultrasounds as recommended by University of Dar es salaam Health Centre to address noise reduction and segmentation of anatomical structure.

The workflow incorporated with pre-processing steps utilizing techniques such as sobel operators, median and gaussian operators to reduce noises and improve image quality.

Also, this project help doctors with template to write a remark of a specific patient's image interpretated, then send back to doctor for clinical workflow.

By automating these tasks, our project aimed streamline the workflow for radiologists, potentially leading to faster and more accurate diagnoses. In turn could contribute to improved patient outcomes.

LIST OF ABBREVIATIONS

UDSM	University Of Dar es salaam
COICT	College Of Information and Communication Technology
AI	Artificial Intelligence
MIA	Medical Image Analysis
ECG	Electrocardiogram
CT scans	Computed Tomography Scans
MRI	Magnetic Resonance Imaging
MONAI	Medical Optimal Network for Artificial Intelligence
SDLC	System Development Life Cycle

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1.0CHAPTER ONE

1.1INTRODUCTION

Medical image analysis (MIA) is a field of study that focuses on developing techniques and algorithm to interpret and extract meaningful information from medical images.
This information can be used for a variety of purposes including diagnosis that is MIA detects and diagnoses diseases such as cancer, heart disease, and Alzheimer's disease, treatment planning to plan and monitor treatment for various diseases. Also, in surgery MIA can be used to guide surgeons during surgery and in medical research, MIA can be used to study the progression of diseases and develop new treatments.

There are several images from modalities like X-rays, Computed Tomography scans (CT scans), Magnetic Resonance Imaging (MRI scans) and Ultrasound scans
Before the introduction of MIA, the technologies used where physical examination, laboratory tests, radiography, endoscopy and Electrocardiogram (ECG). These technologies had limitations such as limited accuracy, time consuming, dependence on experts to read the complex images and human interpretation of medical images is inherently subjective hence variation in outcomes.

MIA has revolutionized the way that diseases are diagnosed and treated, it allows doctors to see inside the body in a way that were never before possible. This has led to earlier diagnose of diseases, more accurate diagnoses of diseases and more effective treatment of diseases. The field of medical imaging has undergone a dramatic transformation in recent years with the advent of artificial intelligence (AI). AI-powered diagnosis for medical image analysis has emerged as a powerful tool, overcoming numerous limitations of traditional technologies and significantly impacting healthcare delivery. AI diagnosis medical image analysis can help radiologists to read image accurately by reducing noises making it easier to analyze and segment the images accurately and by highlighting edges within medical images which can help in identifying boundaries of structures such as tumors, organs and other anatomical features.

1.2 STATEMENT OF THE PROBLEM

The current approach to image analysis suffers from variation in diagnoses results due to various types of noises in medical images which require enhancement to highlight important anatomical structures.

1.3 OBJECTIVES

1.0 MAIN OBJECTIVE

To design a User-friendly Interface that links to an API, utilizing MONAI to empower health care professionals in efficient Medical Image Analysis.

1.1 SPECIFIC OBJECTIVES

i. Learning how to use MONAI effectively for medical image analysis.
ii. Develop a secure, user-friendly API, defining how it will work with MONAI.
iii. Integrating MONAI algorithm into API to implement efficient data handling and fast inference for real time diagnostic support.
iv. Test for reliability of API to make sure it gives accurate results with different medicalimage scenario.
v. Designing user-friendly interface (UI/UX)
vi. Establish a smooth integration between the user interface and API to ensure quick data flow.

1.4 SIGNIFICANCE OF THE PROJECT

This project aims to show the introduction of Artificial Intelligence (AI) for medical image analysis, holding the potential to significantly impact the field of medicine. Its significance lies in its ability to revolutionize several crucial aspects of healthcare:

i. Improving Diagnostic Accuracy:

Reduced misdiagnoses hence minimizing human error and missed diagnoses, leading to better patient outcomes. Early Disease Detection by developing image processing model to pre-process medical image to enhance edge detection, reduce noises and improve quality of images for better visualization and analysis.

ii. Enhancing Efficiency

By automating routine image processing tasks such as noise reduction and edge detection, the project significantly reduce workload for radiologists. This allows them to focus on interpreting results and handling more complex cases, thereby improving workflow and enabling radiologists to dedicate more time to patient interaction and care.

iii. Advancing Medical Research and Development:

The processed images produced by the model facilitate better analysis and interpretation, aiding researchers in identifying patterns and relationships within medical data. This contributes to a deeper understanding of diseases mechanism and progression, supporting advances in medical research and development of new diagnostic and treatment approaches.

1.5 PROJECT SCOPE AND LIMITATIONS:

1.5.1 PROJECT SCOPE

1.5.1.1 SCOPE OF THE PROJECT

The projects aim at dealing with the following;

i. Integration of MONAI into API for advanced medical image analysis.
ii. Design and develop API that communicates with MONAI for real-time medical image analysis.
iii. Create user-friendly web-based UI to facilitate interaction between radiologists and the API.
iv. Enable real-time analysis of medical images through the API, providing instant feedback to physicians during image reading.
v. Utilize MONAI to enhance diagnostic accuracy by providing additional insights and highlighting potential abnormalities.
vi. Design the API and UI to be scalable, supporting a large number of concurrent users and handling varying workloads efficiently.

1.5.1.2 DELIVERABLES

i. Fully functional API integrated with MONAI for medical image analysis.
ii. User-friendly web-based UI for medical image analysis.
iii. Documentation for API and UI usage.
iv. Testing for quality assurances.

1.5.1.3 BUDGET

The budget of the project will be estimated covering development, testing, documentation and ongoing maintenance costs.

1.5.2 LIMITATIONS

i. There is a need of internet access so as to enable access anywhere.
ii. High computation power and specialize hardware (NVIDIA GPU) are required for efficient image processing, which may limit accessibility in resource- constrained environment
iii. Storing large volumes of high-resolution medical images and processed data can require significance storage capacity, potentially straining existing infrastructure.

1.6 ORGANIZATION OF THE PROJECT

Chapter One consists of the general introduction of the project, statement of the problem, objectives (i.e., general objectives and specific objectives), the project's significance, and the project scope and limitations.

Chapter Two covers the Literature Review, which consists of current AI tools landscape, its key advantages, challenges and considerations, future trends, recommendations and conclusion.

Chapter Three explains the methodology used to obtain Information about the problem (research and surveys) and the techniques used to get those details

Chapter Four explains the system analysis, requirement gathering and specification, and system designing of the proposed system.

Chapter five explains implementation of assistance tool for medical image analysis, application programming interface and its user interface in icare.

Chapter six explains conclusion and recommendation for the project.

2.0 CHAPTER TWO

2.1 LITERATURE REVIEW

i. Current Landscape

AI is rapidly reshaping the field of medical imaging, showing its potential across areas such as X-ray, CT, MRI, and ultrasound. The integration of open-source software and frameworks, such as MONAI, Opensource Imaging Initiative, and MITK, is aiding collaboration and accessibility in the development of AI solutions for medical imaging.

ii. Key Advantages

The application of AI in diagnostic medical image analysis brings forth several key advantages. Improved accuracy is evident as AI algorithms excel in analyzing huge datasets. Moreover, the automation of routine tasks, including image segmentation and registration, leads to a faster workflow, enabling radiologists to dedicate more time to critical cases.

iii. Challenges and Considerations

However, this technology comes with challenges and considerations. The dependence of AI models on large datasets raises concerns about data quality and bias, particularly affecting underrepresented populations. Regulatory and ethical issues, such as data privacy, cybersecurity, and ethical AI use in healthcare, bring forth need for careful consideration.

iv. Future Trends

Looking ahead, integration of AI tools into existing clinical workflows is essential for widespread adoption and impact. Advanced AI techniques, including research into explainable AI and deep learning with smaller datasets, hold promise for overcoming current challenges. Continued collaboration among researchers, clinicians, and industry players is vital for advancing AI in medical imaging and ensuring access to its benefits.

v. Recommendations

To advance the field responsibly, several recommendations are proposed. Encouraging and contributing to open-source initiatives for AI in medical imaging can accelerate development, emphasize on data quality and promoting the development and implementation of transparent AI models which addresses the need for explainability and trust among clinicians. Furthermore, establishing clear regulations and ethical guidelines is crucial for the responsible and ethical use of AI in healthcare.

vi. Conclusion

In conclusion, AI-powered diagnostic medical image analysis holds immense potential for revolutionizing healthcare. By addressing the challenges and ensuring responsible development and implementation, the technology can significantly contribute to improving patient care delivery.

3.0 CHAPTER THREE

3.1 PROJECT METHODOLOGIES

3..1.1 INTRODUCTION

As it is indicated in the title, this chapter includes the project methodology of the project. In more details, it outlines stepwise the methodology used to achieve the project's goal.

3.1.2 PROTOTYPING MODEL SDLC phases

The prototyping model is a software development model in which a prototype is built, tested, and reworked until an acceptable prototype is achieved. It also creates a base to produce the final product, (Martin, 2021).

Prototyping model for the AI-Assisted Medical Diagnosis API prioritizes collaboration, rapid development, and continuous feedback. From project initiation to user evaluation and refinement, it embraces iterative cycles, emphasizing flexibility and responsiveness. Implementation and maintenance ensuring adaptability of the system.

Figure 1: prototype methodology

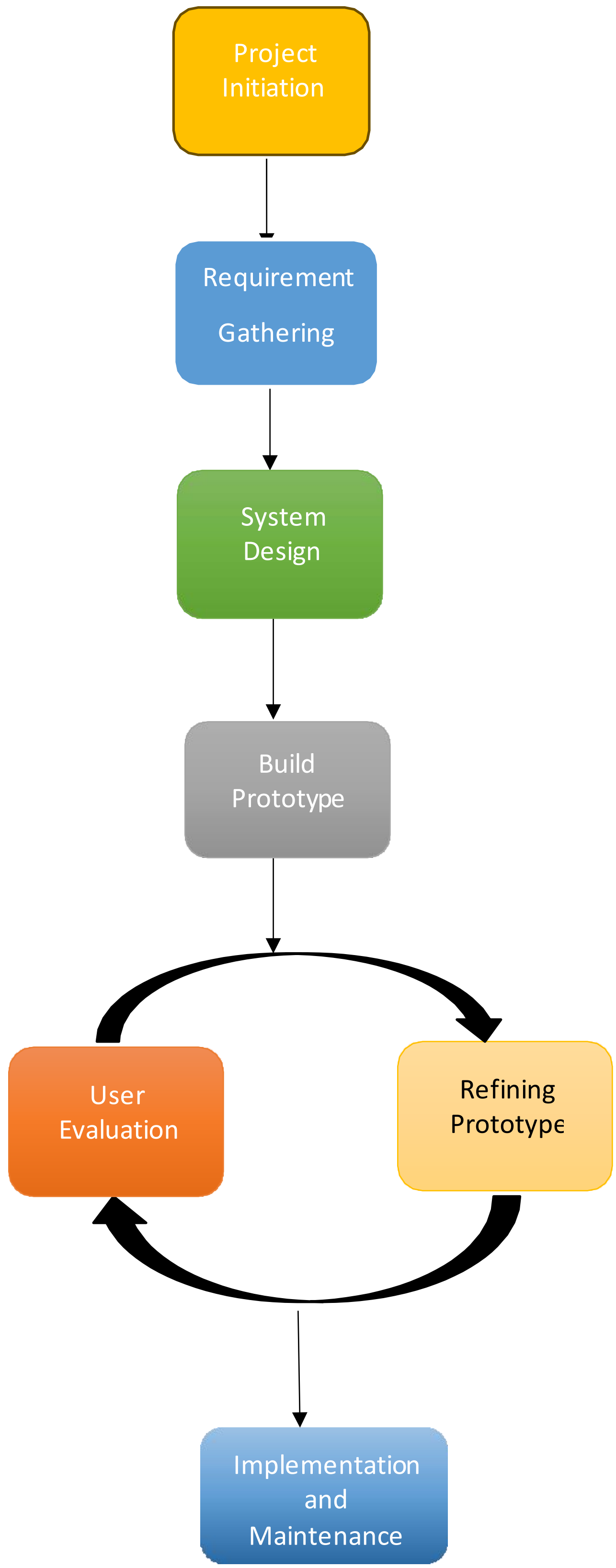


Figure 1: prototype methodology

3.1.3 PROJECT INITIATION

i. Conducting a meeting to align the team with project objectives.
ii. Defining the scope, limitations and success criteria.
iii. Identifying stakeholders such as healthcare professionals.

3.1.4 REQUIRMENTS GATHERING

1. **Research methods**

i. **Qualitative research**.
The main characteristic of qualitative research is that it is most appropriate for small samples, while its outcomes are not measurable and quantifiable and offer a complete description and analysis of a research subject, without limiting the scope of the research and the nature of the participant's responses (Collis & Hussey, 2003).

2. **Data collection and tools**

Activities

i. **In-depth Interviews**

Conducted with physicians / radiologists and radiographers to understand pain points and recommendations. It involved open-ended questions to explore challenges in medical image analysis and reporting.

ii. **Semi-structured Questionnaires**
  - Administered to a small sample of healthcare professionals for broader insights. It involved closed-ended questions with responses to quantify pain points and recommendations.
  - Sections focusing on image quality, report writing time, abnormality highlighting, template-based reporting, and user training needs.

3. **Data analysis**

Content analysis was used to analyze the data which was gathered from personal interviews. According to Moore & McCabe (2005), this is the type of research whereby data gathered is categorized into themes and insights to be able to be comparable. Themes include:

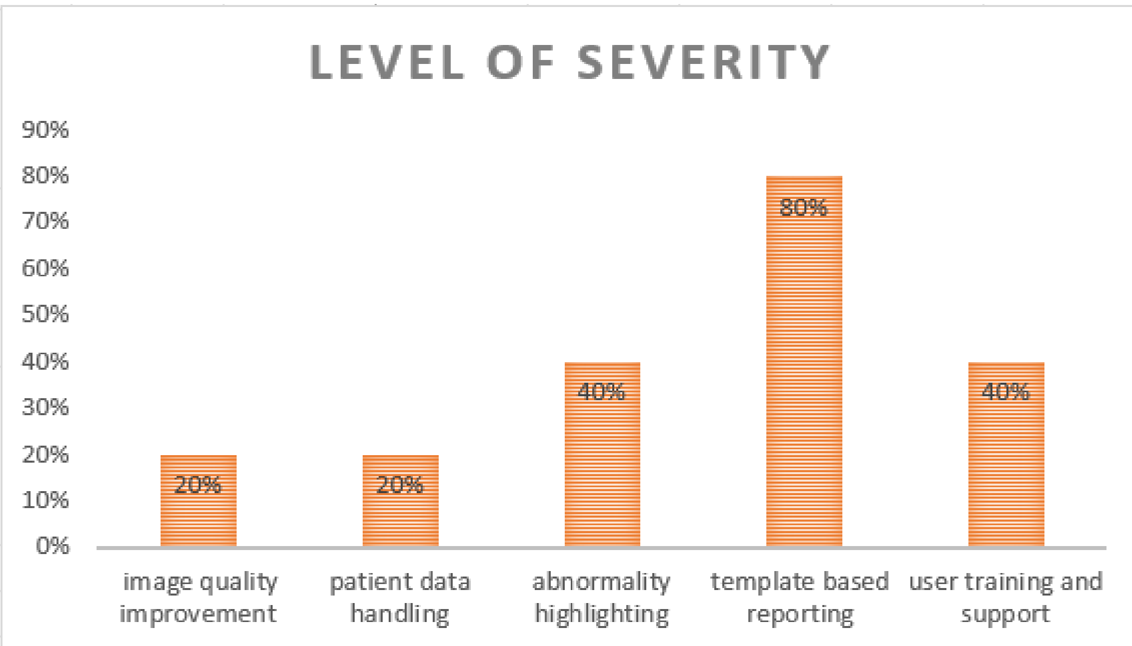


Figure 2: Data collected

i. **Image Quality Improvement**

Pain Point: Blurriness of medical images impacts accurate diagnosis.

Conclusion: Implement image preprocessing techniques, such as denoising and sharpening algorithms, to enhance image clarity and quality before analysis.

ii. **Patient Data Handling**

Pain Point: Dealing with large-sized patient data leads to inefficiencies.
Conclusion: Develop strategies for efficient storage, retrieval, and processing of large medical image datasets. Consider implementing compression techniques or distributed storage solutions to handle data more effectively.

iii. **Abnormality Highlighting**

Pain Point: Difficulty in identifying and highlighting abnormality sections in medical images.
Conclusion: Incorporate image annotation tools into the user interface, allowing physicians to annotate and highlight abnormal regions directly on the images.

iv. **Template-based Reporting**

Pain Point: Lack of standardized reporting formats.

Conclusion: Develop predefined report templates tailored to different medical imaging modalities and anatomical regions. Allow physicians to select relevant templates and customize them as needed, ensuring consistency and efficiency in report writing.

v. **User Training and Support**

Pain Point: Lack of training and support resources for using the system effectively.

Conclusion: Develop comprehensive training materials, including user guides, video tutorials, and interactive demos, to onboard physicians and administrators onto the platform. Offer ongoing technical support and training sessions to address any questions or issues that arise during system usage.

4. **Research conclusion**

Based on the insights gathered from the research with health care professionals, several key conclusions have been drawn. These include the need for improved image quality through preprocessing techniques, efficient handling of large patient database, streamlined report writing processes through automation, enhance abnormality highlights tools, template-based reporting for standardized documentation and robust user training and support resources.

These conclusions provide valuable guidance for addressing pain points and implementing solutions to enhance efficiency and effectiveness of medical image analysis in healthcare delivery.

3.2 SYSTEM DESIGN

I. Outlining the key components of the API architecture, incorporating MONAI for image analysis.
II. Developing preliminary API endpoints and data flow, considering initial user authentication and authorization needs.
III. Create basic user interface to provide an early visualization.

3.2.1 BUILD PROTOTYPE

I. Developing the core functionalities of the API using a suitable programming language and framework.
II. Integrating existing tools for medical image analysis, ensuring initial compatibility with API endpoints.
III. Building a basic user interface focusing on usability and alignment with healthcare professionals' needs.

3.2.3 USER EVALUATION

I. Conduction of testing for individual components of the API and UI to collect feedback from healthcare professionals.
II. Performing initial integration testing to ensure communication between the API and MONAI for medical image analysis.

3.2.4 REFINING PROTOTYPE

I. Collection of feedback from healthcare professionals and users through usability testing and surveys.
II. Iteration of the design and functionality based on feedback, considering both API and UI aspects.
III. Conducting additional testing to validate improvements and refinements.

3.2.5 IMPLEMENTATION AND MAINTENANCE

I. Preparation for deployment by configuring servers and ensuring necessary resources.
II. Deploy the refined prototype.
III. Establish a maintenance plan for updates, bug fixes, and continuous improvements based on user feedback and evolving healthcare needs.

4.0 CHAPTER FOUR

4.1 REQUIRMENTS AND SYSTEM DESIGN

4.2 REQUIREMENT ANALYSIS

The requirement was obtained from the interview; hence, the overall system requirements were summarized and stated below.

4.2.1 Functional Requirements

Functional requirements state what the system must/should do. They are aspects of the system the client is most likely to recognize. Table 2 shows the functional requirements

Ref No	Functional Description	Category
F1	The system should support secure user authentication for physicians and authorized healthcare professionals.	
F2	The system should provide efficient storage and retrieval of medical images.	
F3	The system should utilize MONAI functionalities for interpreting segmented regions and abnormality detection.	
F4	The system should allow users to view detected abnormalities along with relevant details.	
F5	The system should display segmented regions on the UI for better visualization.	
F6	The system should integrate reference materials or guidelines to aid in clinical decision-making.	
F7	The system should expose image upload functionalities.	
F8	The system should provide interactive tools for zooming, panning, and examining specific regions of interest.	

Table 1:Functional requirement

4.2.2 Non-functional Requirements

Non-functional requirements are constraints/restrictions imposed on the system. They define how the system is supposed to behave and are often called qualities of the system. Table 3 shows the non-functional requirements.

Attribute	**Constraint**
Security	The system must ensure data security and compliance with healthcare data privacy regulations (e.g.; HIPAA).
Scalability	The system must handle a scalable number of users and medical image data.
Performance	The system should provide low-latency responses, especially during image processing.
Reliability	Ensure high system reliability and availability for continuous healthcare delivery.
Compatibility	Ensure compatibility with different web browsers and devices.
Documentation	Provide comprehensive documentation for API usage, system architecture, and deployment instructions.
Usability	Conduct usability testing to ensure that the UI is intuitive and easy for physicians to use.
Regulatory compliance	Ensure compliance with relevant medical device regulations and standards.
Training and support	Provide training materials and support for users to effectively use the system.
Interoperability	Ensure interoperability with existing healthcare information systems and Electronic Health Records (EHR) systems.

Table 2: Non-Functional requirement

4.2.3 Hardware Requirements

1. **High-performance Computing (HPC) Cluster or Server**:
   This could include a high-performance computing cluster or server with multi-core processors such as Intel Core i7 CPUs are recommended.

2. **Graphics Processing Unit (GPU):**
   Having a GPU with CUDA support can significantly speed up computation for tasks like abnormality detection and segmentation. NVIDIA GPUs with CUDA support, like the GeForce RTX or NVIDA Quadro series, are recommended for accelerated deep learning tasks. GPUs with a minimum of 8GB VRAM are suitable.

3. **Storage Solution**
   This could involve high-capacity hard drives or SSDs for fast access, as well as network-attached storage (NAS) or storage area networks (SAN) for scalability and reliability. A storage solution with at least 1TB capacity is recommended.

4. **Network Infrastructure**:
   A reliable network infrastructure is crucial for transferring medical images between the user interface, backend processing modules, and database. High-speed networking technologies such as Ethernet or InfiniBand may be required to minimize data transfer latency.

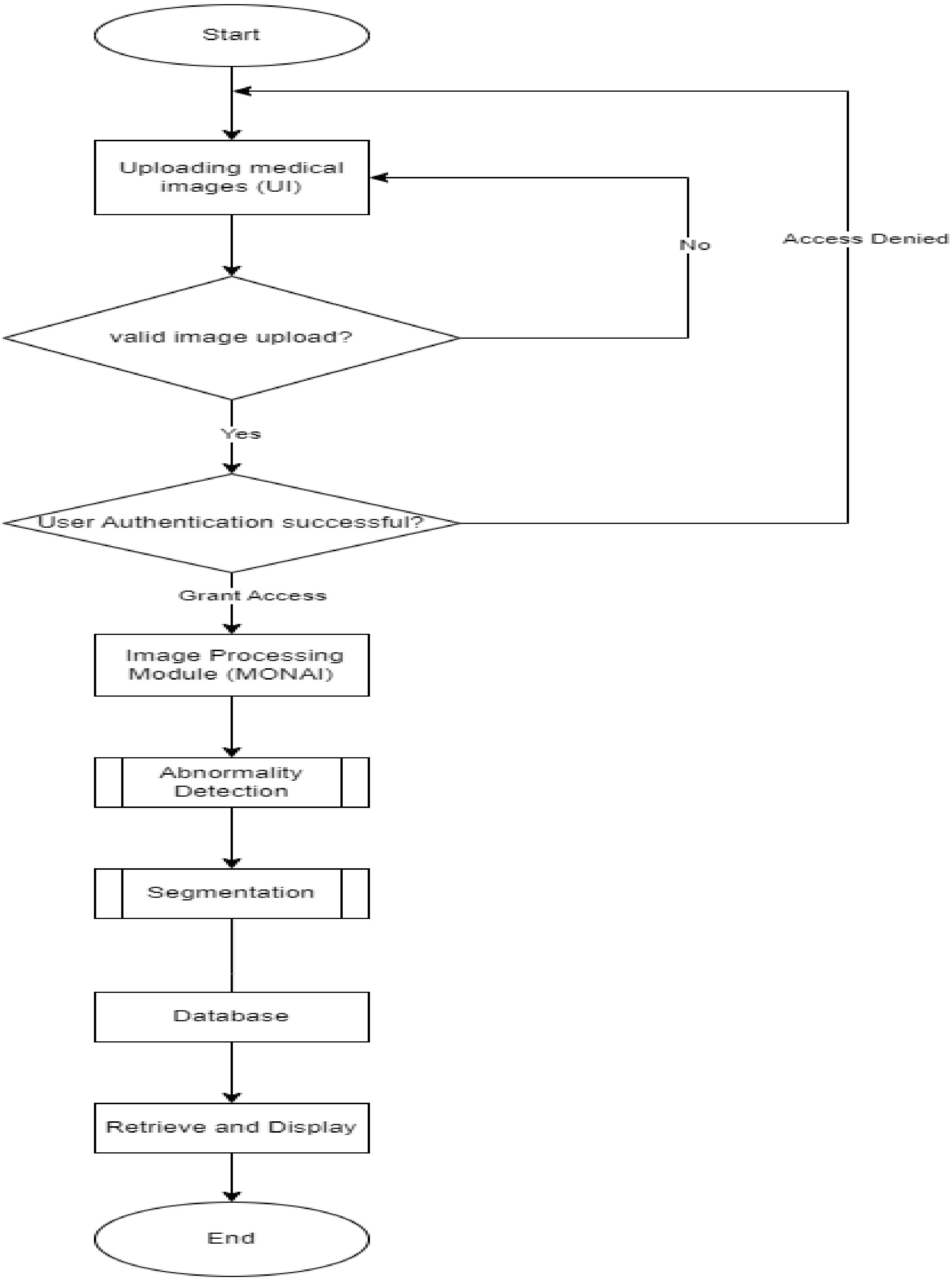
4.3 SYSTEM DESIGN

System design is planning a new system or replacing an existing one by defining its components or modules to satisfy specific requirements.

4.3.1Flow Chart

In the proposed system workflow, a user initiates the process by uploading medical images through the user interface (UI). The uploaded images are then received by the API module, which first performs authentication to ensure secure access. Subsequently, the API module forwards the images to the Image Processing module, where the advanced capabilities of the MONAI framework come into play. This module engages in preprocessing, abnormality detection, and segmentation of the medical images, leveraging MONAI's specialized functionalities. The analysis results, encompassing potential diagnoses and relevant information, are systematically stored in the database for future reference. The UI, acting as the user-facing component, retrieves these results from the database and seamlessly presents them to healthcare professionals. This intuitive interface empowers professionals to visually explore, interpret, and interact with the obtained diagnoses, facilitating an efficient and informed decision-making process in the realm of medical image analysis.

Figure 3: System flow chart



4.4 SYSTEM ARCHITECTURE

1. Frontend (User Interface):

The user interface provides a platform for healthcare professionals to interact with the system.

Components:

- ❖ Upload interface for medical images.
- ❖ Visualization tools for viewing images, anomalies, and segmented regions.
- ❖ Interactive controls for zooming, panning, and navigating through saved images.

2. Backend (Server-side):

Handles data processing, MONAI integration, and communication with the frontend.

Components:

API Module:

- ❖ Defines endpoints for image upload, abnormality detection, and segmentation.
- ❖ Handles authentication and authorization.

Image Processing Module:

- ❖ Utilizes MONAI for preprocessing, feature extraction, abnormality detection, andsegmentation.

Database Module:

- ❖ Stores securely uploaded medical images and resulting processed files.
- ❖ Logs diagnosis results from radiologists.

3. MONAI Integration:

Integrates with the MONAI framework for advanced medical image analysis.

Components:

- ❖ Leverages MONAI functions for preprocessing and feature extraction.
- ❖ Incorporates pre-trained models for abnormality detection and segmentation.
- ❖ Customizes MONAI modules as needed for specific medical imaging tasks.

4. Security Layer:

Ensures the confidentiality, integrity, and availability of sensitive healthcare data.

Components:

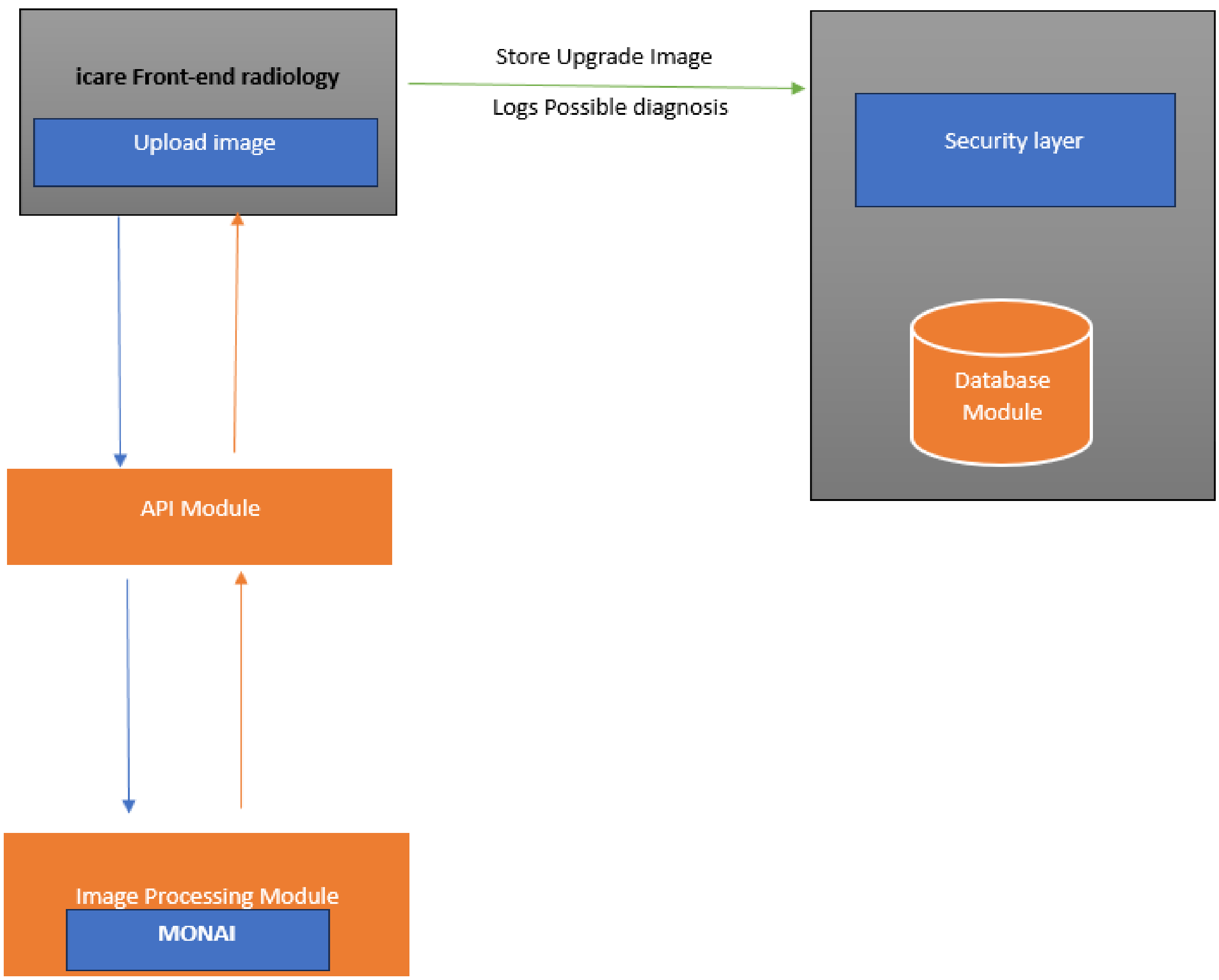
- ❖ Encryption for data transmission and storage.
- ❖ Access controls and user authentication.
- ❖ Regular security audits and compliance checks.

5. External Integrations:

Enables interoperability with icare.

Components:

- ❖ Adapters or connectors to interface with external systems.
- ❖ Compliance with standards for data exchange in healthcare.



4.4.1SOFTWARE DESIGN

4.4.2Actors of the System

Actors are external entities that interact with the system by triggering a request while expecting a response from the system

Actors	Description
Radiologist	Primary user who uploads medical images for analysis and interpretation, aiming to assist in diagnosing medical conditions.
Administrator	Responsible for managing user accounts, system configuration and overall system maintenance to ensure smooth operation and compliance.
Physician	Requests for image analysis and gains report of diagnosis from radiologist.

Table 3:Actors of the system

4.3.3 Use case and Use case Description

A Use Case refers to a written description of how users will perform tasks in a system. A use case outlines, from a user's point of view, a system's behavior as it responds to a request.

A use case diagram addresses the static use case view of a system. It shows a set of use cases and their actors, and their relationships. Use case diagrams are used to model the behavior of asystem.

Figure 4:Use case diagram

Use case description can be used to provide additional information to support the use case definition. It simply a description of a use case as a story.

Use case	**Description**	**Actors**
Upload Medical Images	Radiologists upload medical images through the UI to initiate the analysis process.	Radiologists
Visualize Analysis Results	Radiologists retrieve and visualize the analysis results displayed by the UI, allowing them to interpret and interact with possible diagnoses.	Radiologists
Analysis report	Physician obtains the report on the diagnosis results done by the radiologist.	Physician

Manage User Accounts	Administrators manage user accounts, including creating new accounts, assigning roles and permissions, and handling account-related tasks.	Administrators
Monitor System Health	Administrators monitor the health and performance of the system, ensuring smooth operation and addressing any issues that arise.	Administrators

Table 4:Use case and use case description

4.4.4 System Sequence Diagram

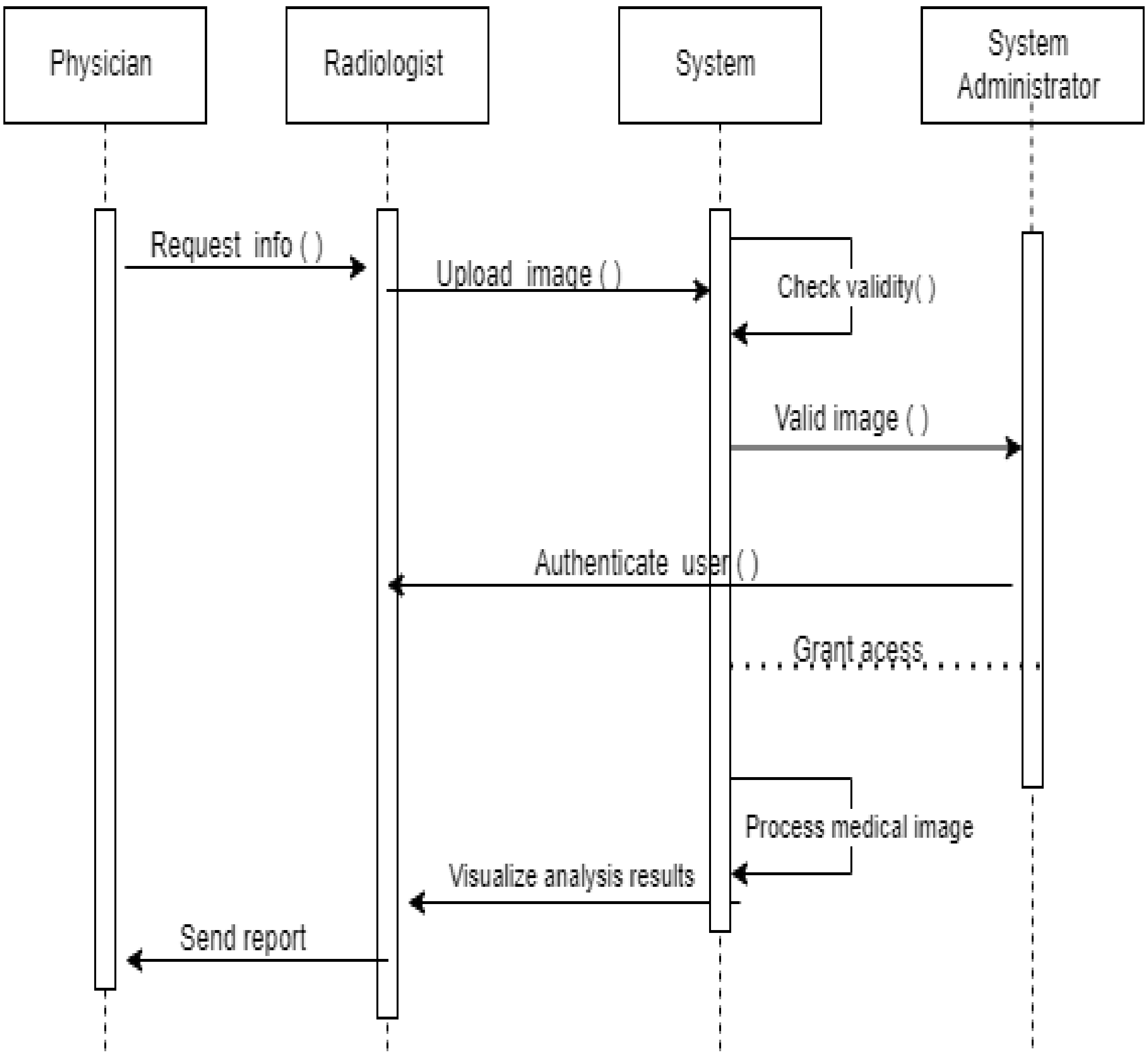


Figure 5: System Sequence diagram

5.0 CHAPTER FIVE

5.1 IMPLEMENTATION

5.1.1 Introduction

In this project, we implemented a medical image analysis workflow using MONAI opensource AI framework. This addresses the challenge of noise in medical images by incorporating pre-processing designing to remove those artifacts and improve images quality, also integrating the model to icare user interface for radiologists to upload image to the model and get back the result the doctor can type the remark on specific patient image.

Project consists of icare user interface includes choose patient, upload image and output of processed image.

Then we have Application Programming Interface (API) and MONAI pre-processing model.

5.1.2 Icare user interface (UI/UX)

From icare frontpage after login radiologist will choose radiology section, then will see patients with radiology issues uploaded from clinic, radiologists should choose a specific patient to upload image. In this user interface development, we used angular framework using programming languages HTML, typescript and CSS languages.

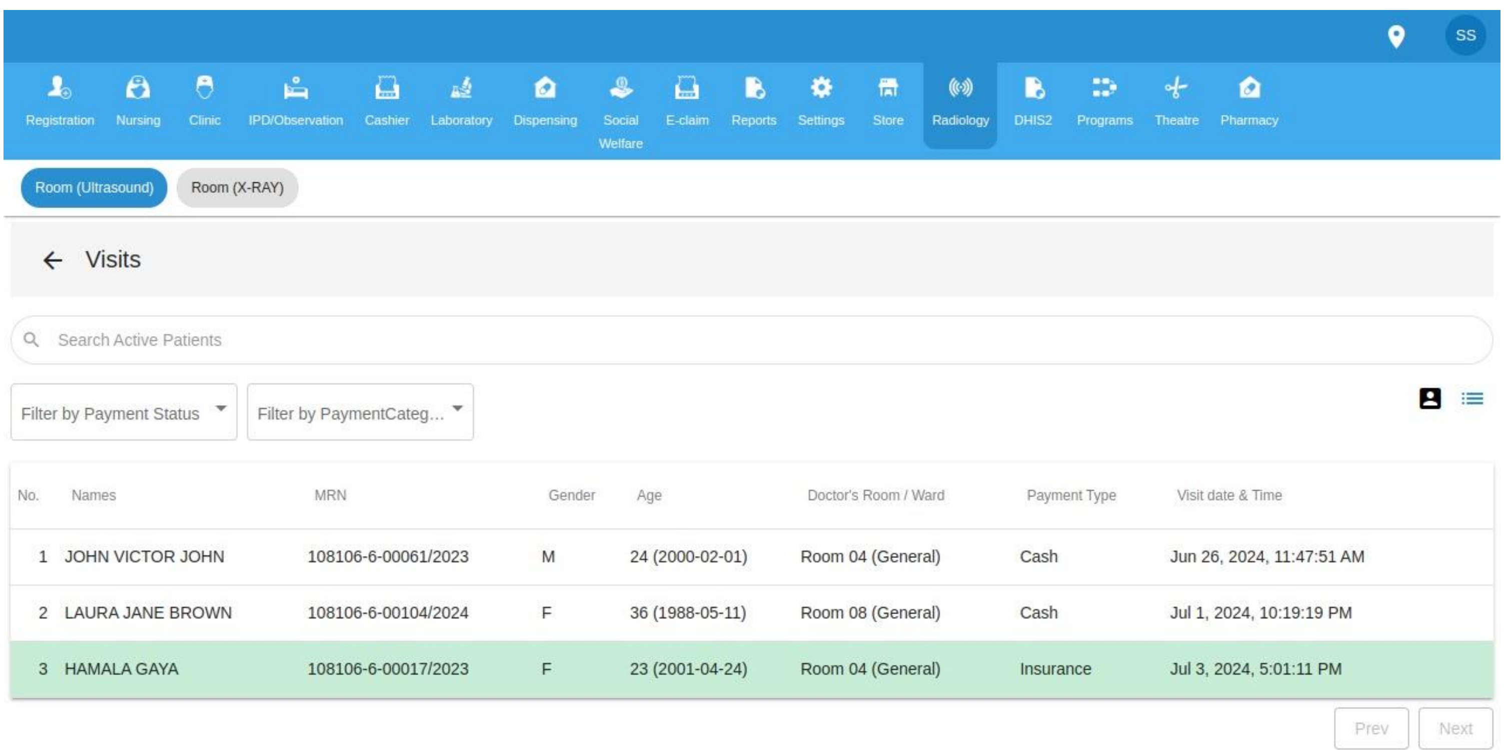


Figure 6:Choose patient

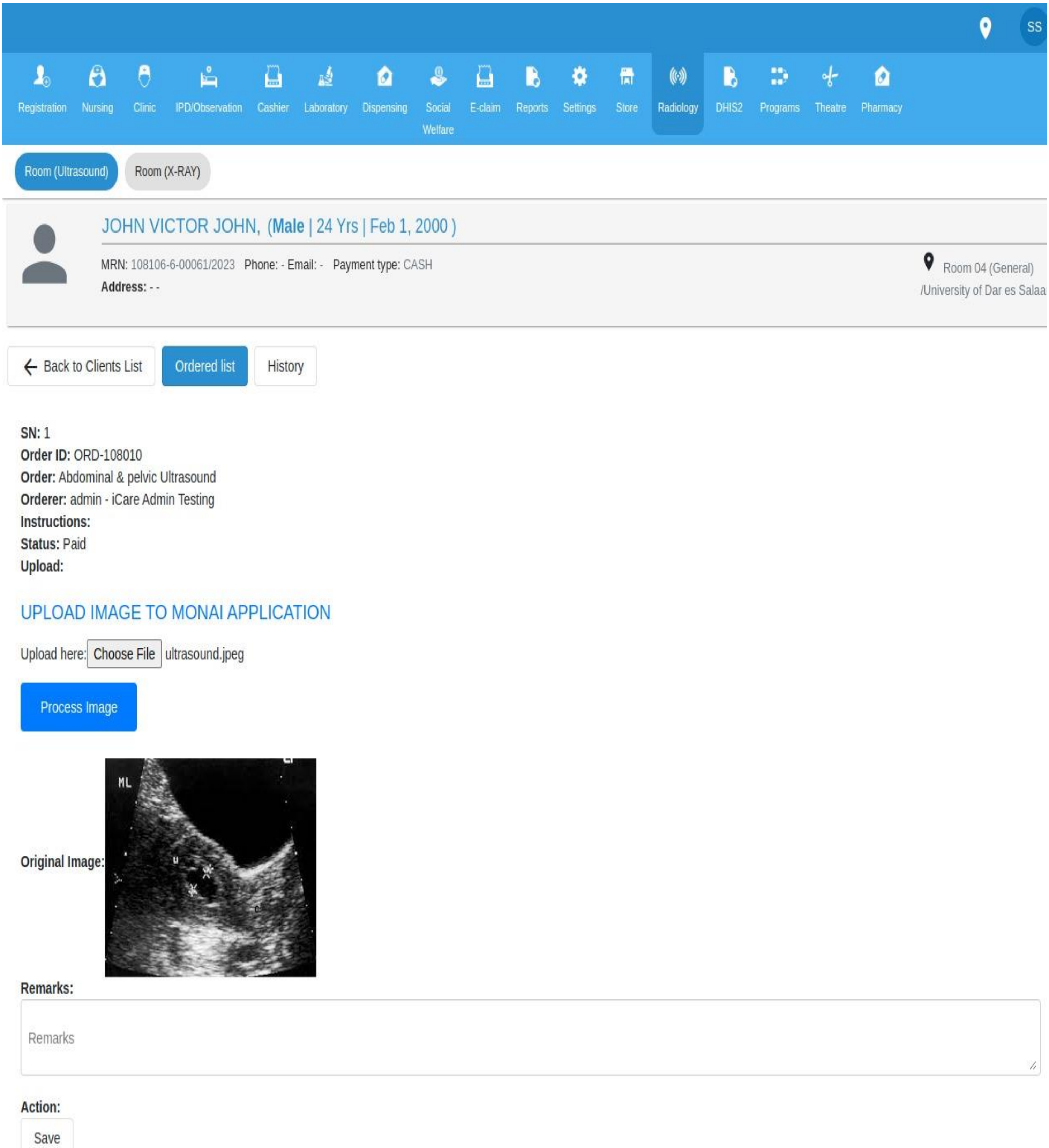


Figure 7:Upload image

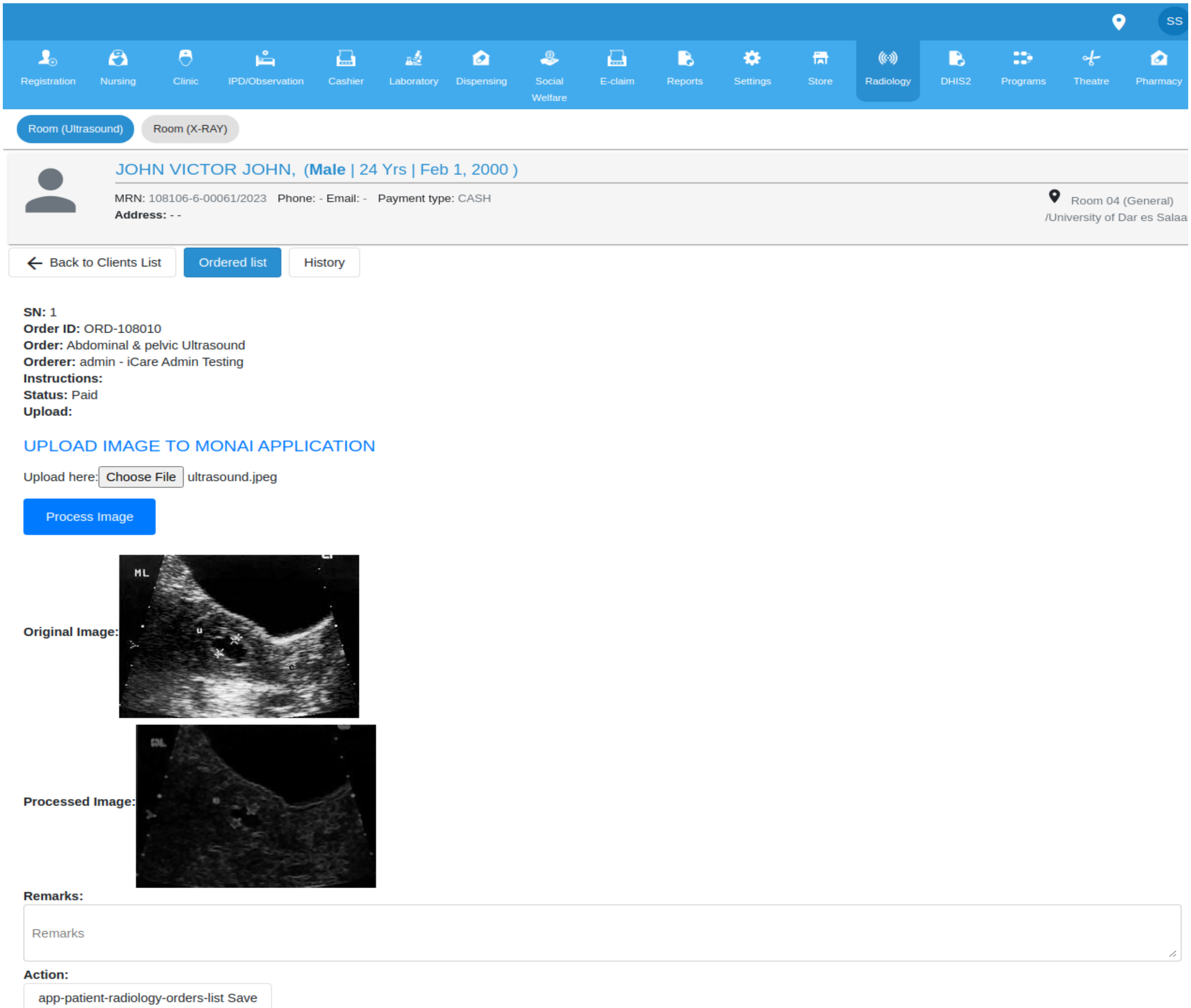


Figure 8: Processed Image

5.2.3 API

We developed a fast API to integrate the pre-processing model and icare user interface, to help doctors and radiologists to upload images from icare to MONAI model and retrieve the results. We used python to develop the fast API for the model.

Below are the figures showing POST method to upload image from icare to API and GET method to retrieve the processed image back to icare.

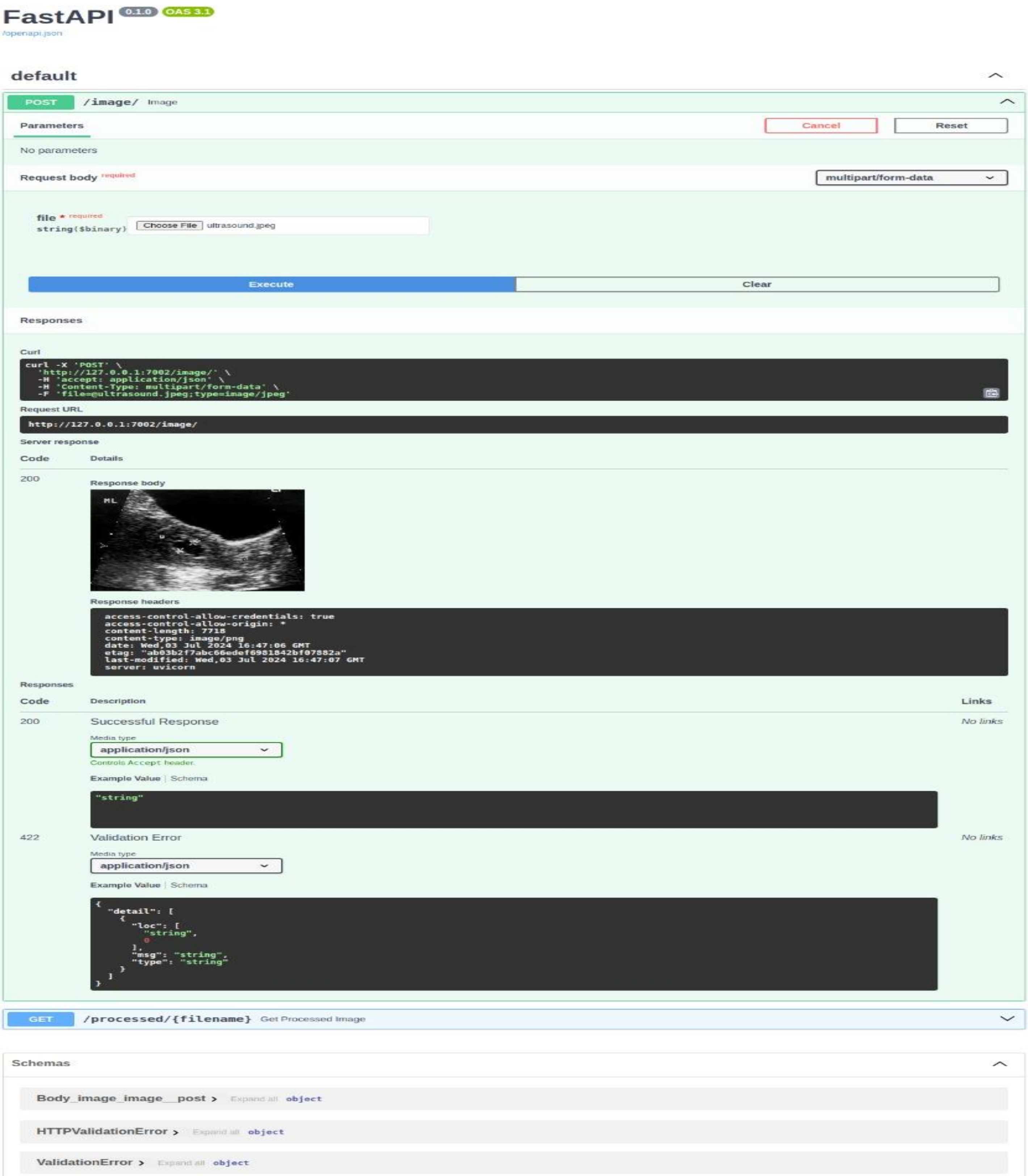


Figure 9: POST method API implementation

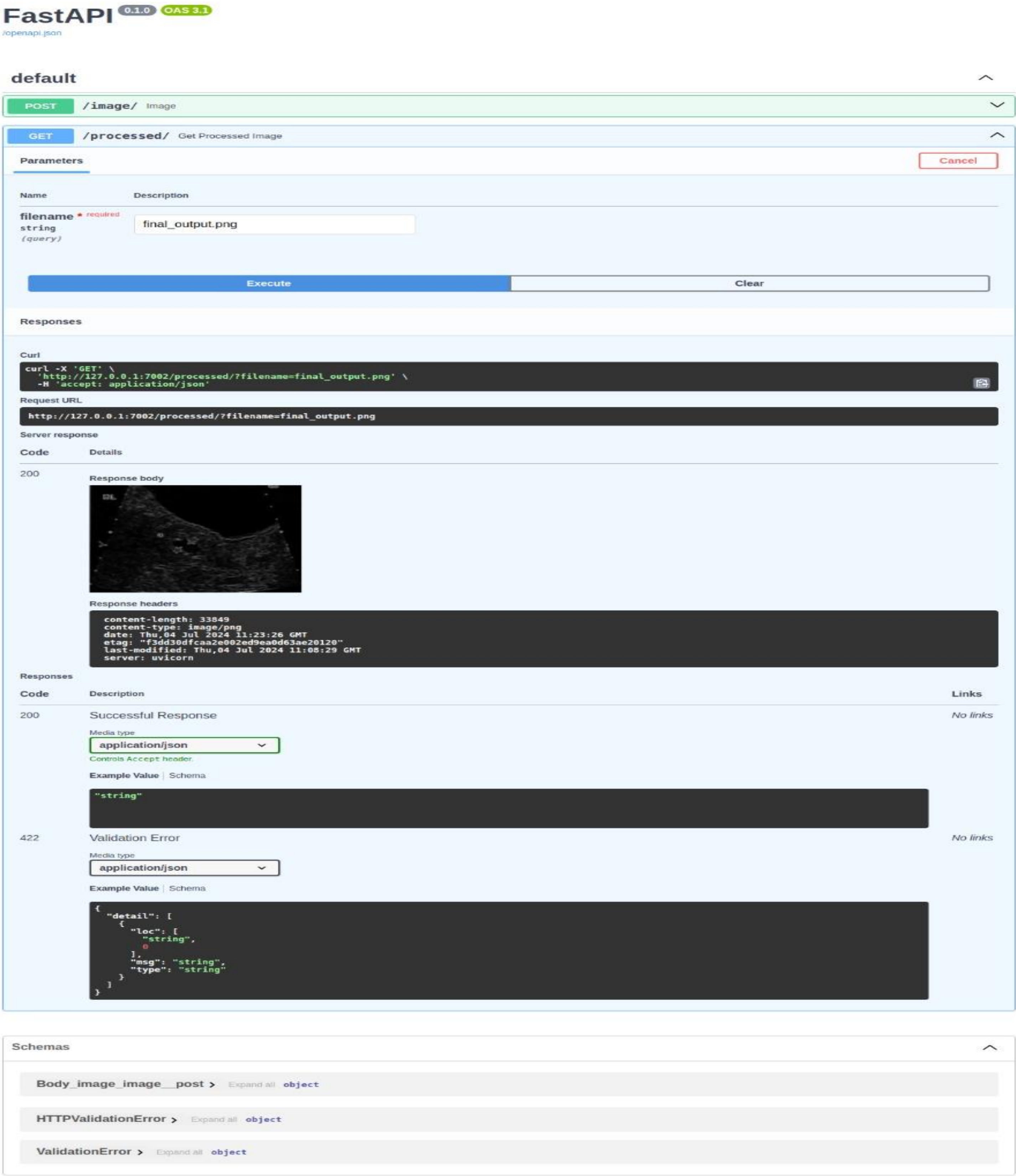


Figure 10: GET method API implementation

5.1.4 MONAI PRE-PROCESSING MODEL

MONAI has several functionalities and models; preprocessing model is for noise reduction to improve image quality for radiologists' interpretation. This model has three operators that functioning to improve image quality and reduction of noises medical images.

Sobel operator act as an edge detector, it analyzes the image and identifies area with high intensity change, highlighting the boundary between different structure such as organs and tissues.

Median operator functions as noises reduction filter, this helps to remove isolated noises points while minimizing the blurring effect that can occur with gaussian filtering.

Gaussian operator act as smoothing filter, it blurs the image slightly, which helps to reduce noises and artifacts. Noises can appear more intensive that can hide some important details, so by gaussian operator helps to remove those noises while preserving image structure.

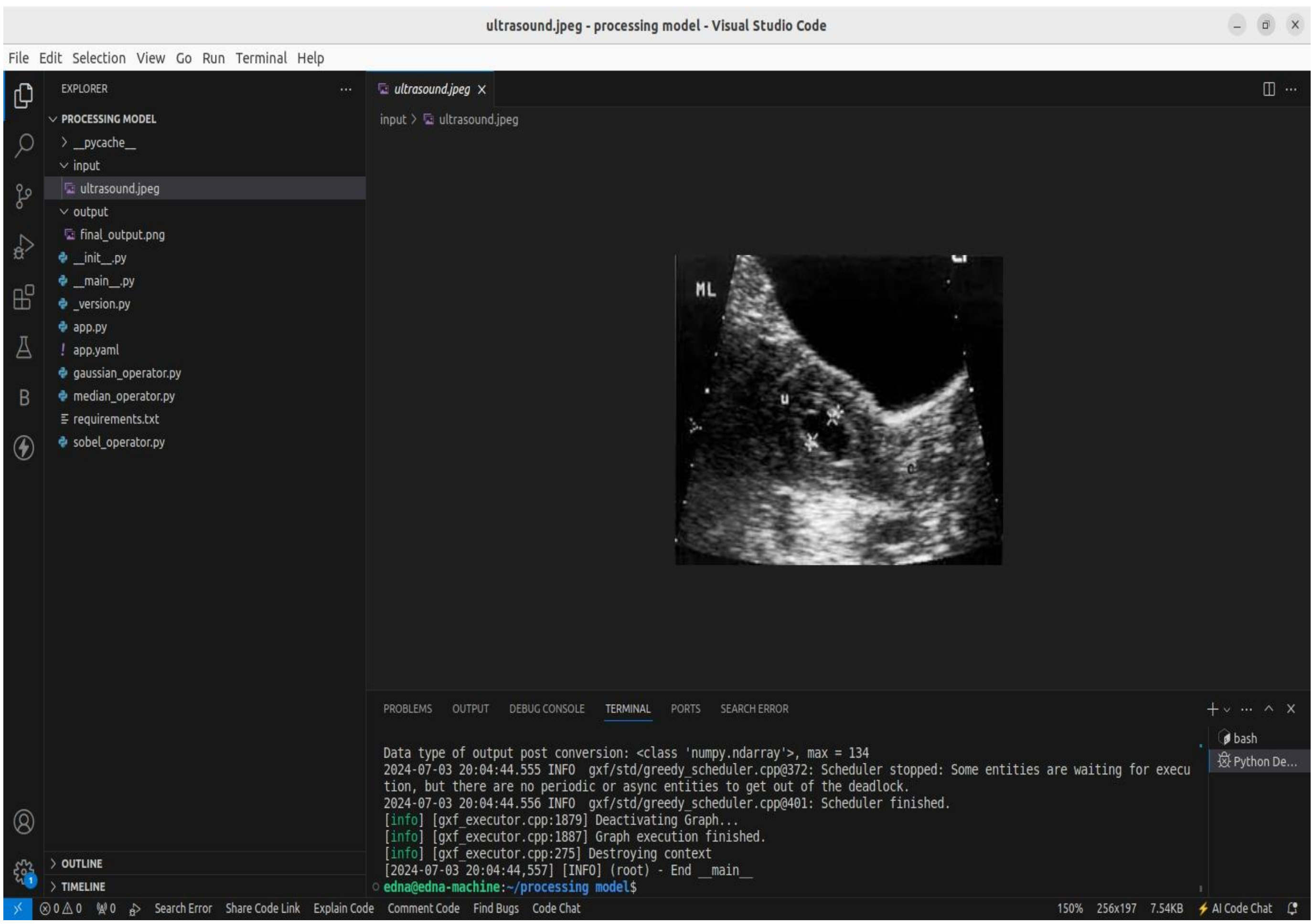


Figure 11: Input file in MONAI model

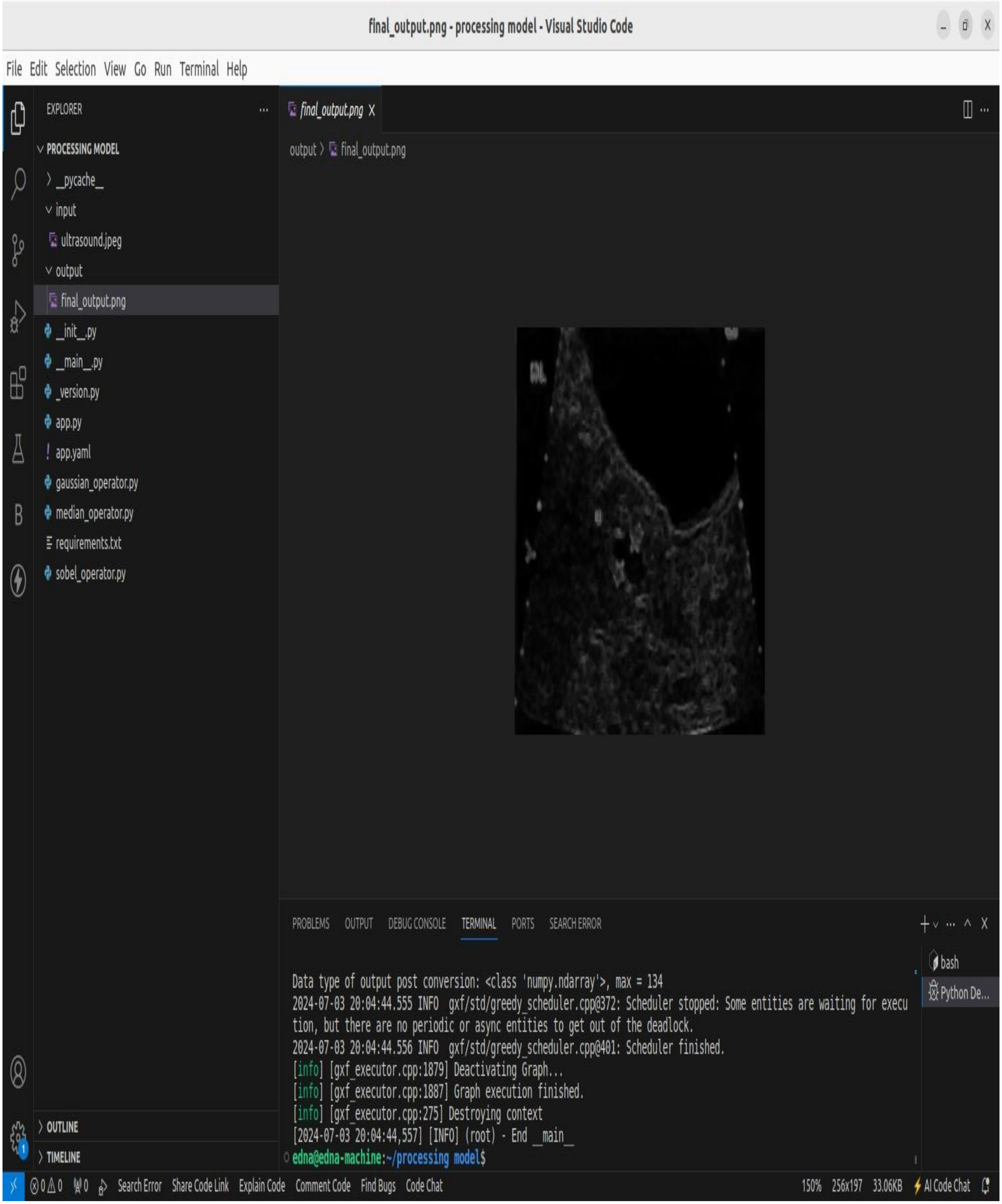


Figure 12:Output file in MONAI model

5.1.5 MONAI SEGMENTATION MODEL

This model is trained in MONAI framework to identify and delineating atomical structures, also it indicates the likelihood of a specific anatomical structure such as bones, muscles and tumors, then used to generate segmentation mark for improved visualization. Segmentation model needs DICOM file to run.

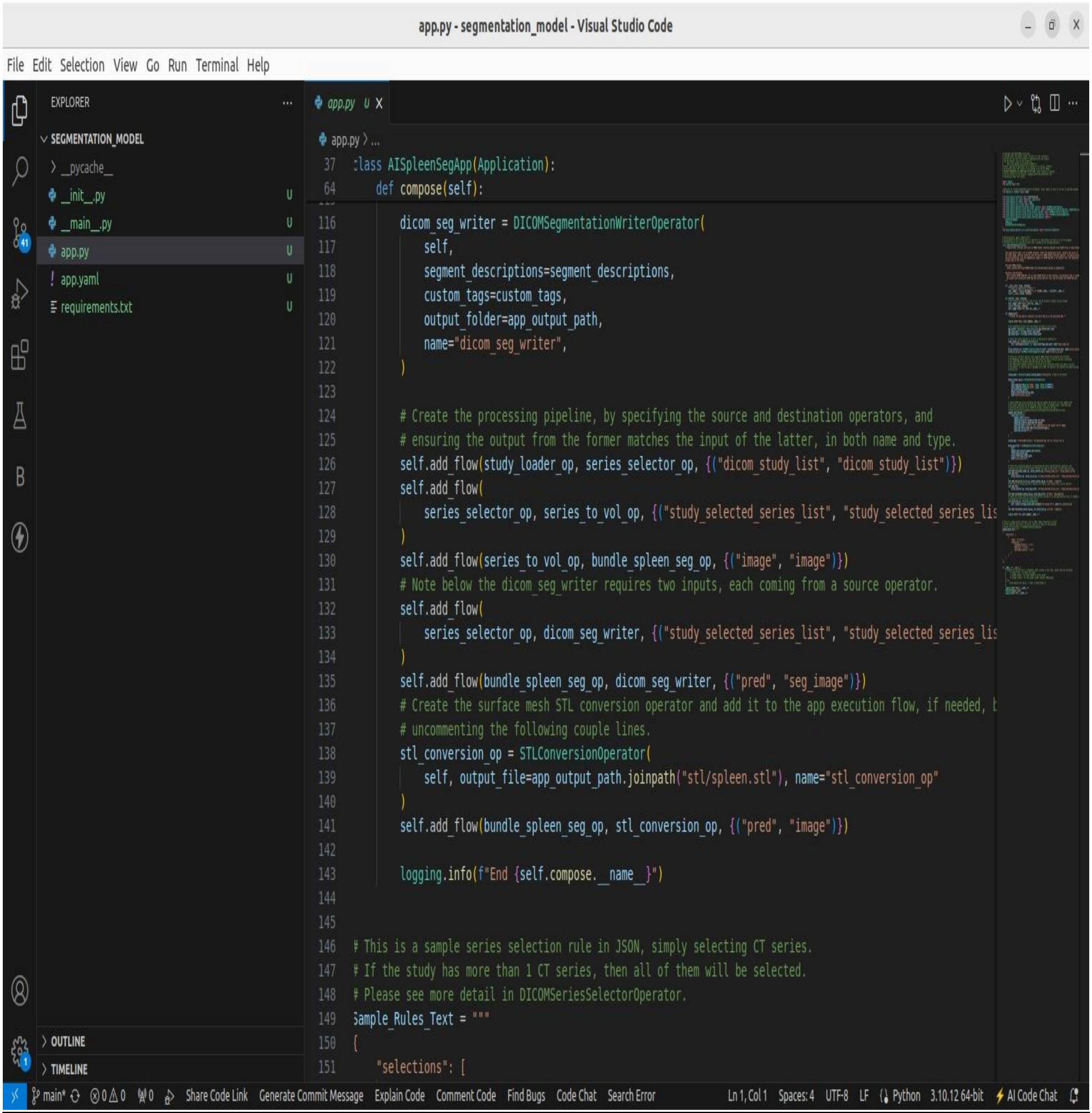


Figure 13:Segmentation Model

6.0 CHAPTER SIX: CONCLUSION AND RECOMMENDATION
6.1 CONCLUSION

In this project, I had investigated the capabilities of MONAI, open source frame work for developing a medical image analysis assistance. This addressed the key challenges in medical imaging as provided by radiologists. In MONAI we incorporated with pre-processing model to reduce noises in images and improving quality of images especially in x-rays and ultrasounds.

By automating the clearance of images and reducing the noises interference, radiologists can potentially focus on critical aspects of image interpretation, leading to faster and more accurate diagnoses.

Furthermore, this project integrated the MONAI model for pre-processing to icare that help doctor for easier upload the images and retrieve the results. Then after radiologist fills the template for specific patient results for clinic practices.

6.2 RECOMMENDATION

Having necessary knowledge to accomplish the project is crucial and so I recommend for the upcoming students or developers willing to create strong and standard software systems to ensure that they have at least the core basics of the technology they would wish to apply into their systems as this will help them to save time during development. Failure to do so a lot of time will be consumed for learning instead of the development process which delays the accomplishment of the project, also student should have a strong and powerful machine to accomplish the project such as having NVIDIA GPU machine for accelerating the process.

To explore more on MONAI model to addition functionalities in segmentation models like land mark detection, depending on the anatomical structures interested in.

To the university, I would like to recommend and insist that the students should be given more time for practical sessions on developing real world applications and some basics of using relevant software frameworks which in one way or another saves time to accomplish projects.

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APPENDIX
APPENDIX A: INTERVIEW QUESTIONS

The interview was done to radiologists

1. What is your role in the healthcare delivery process?
2. What are your primary responsibilities when dealing with medical images?
3. How frequently do you interact with medical images in your daily tasks?
4. Can you describe the typical workflow when reviewing medical images?
5. What are the current challenges or pain points in your workflow when reviewingmedical images?
6. Are there specific issues you face in detecting abnormalities or interpretingsegmented regions?
7. Are you currently using any software tools for medical image analysis? Yes or NoIf yes, what features do you find lacking in the existing tools you use?
   If no, are you comfortable with using a web-based interface for medical imageanalysis?
8. What key features would you like to see in a tool for medical image analysis andabnormality detection?
9. Are there specific functionalities you believe would enhance your efficiency indiagnosing medical images?
10. Are there specific visualization tools or features you would find helpful?11.Would
you require training on using a new medical image analysis tool?

If yes, what format of training materials do you find most effective?

- Videos
- Documentation
- live sessions

APPENDIX B: BUDGET TABLE

ITEM	COST (TShs)
Transport Service	20,000/=
Internet services	100,000/=
Stationary services	30,000/=
Emergencies	50,000/=
TOTAL	200,000/=

Table 5:Budget table