VIETNAM NATIONAL UNIVERSITY
HO CHI MINH CITY
UNIVERSITY OF SCIENCE

3-DAY
Workshop on Medical Imaging

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1 Day 1: Preparation, Orientation, and Introduction to KIT

The first day of the 3-day Medical Imaging Workshop began with an introductory session aimed at preparing participants and orienting them to the tools and concepts that would be explored throughout the event. The session was held under the guidance of Professor Masayuki Fukuzawa, who provided an engaging overview of medical imaging and its applications. This report summarizes the key activities and content covered during the day.

1.1 Welcome and Introductions

The workshop kicked off with a warm welcome, followed by self-introductions from three Japanese students participating in the program. Each student briefly shared their background and interest in medical imaging, setting a collaborative tone for the workshop. This was followed by an orientation to the KIT (presumably the "Kyoto Institute of Technology" or a specific imaging toolkit), which served as the foundation for subsequent technical discussions.

1.2 Team Formation

Following the introductions, participants were organized into small groups to facilitate teamwork throughout the workshop. This step encouraged interaction among attendees, allowing them to leverage diverse skills and perspectives for upcoming practical exercises and discussions.

1.3 Overview of Medical Imaging Applications by Prof. Masayuki Fukuzawa

Professor Masayuki Fukuzawa delivered an insightful lecture on the role of image processing in medicine, emphasizing its practical applications and foundational techniques. The following topics were covered:

1.3.1 Fourier Transform in Medical Imaging

The session introduced the Fourier Transform, a mathematical tool used to decompose images into their frequency components. Prof. Fukuzawa explained how this technique is essential in medical imaging for tasks such as noise reduction, image reconstruction, and enhancing diagnostic features in modalities like CT and MRI.

1.3.2 Understanding DICOM

Next, the professor introduced DICOM (Digital Imaging and Communications in Medicine), the standard format for storing and transmitting medical images. He highlighted its importance in ensuring interoperability between imaging devices and hospital systems, allowing seamless access to patient data across platforms.

1.3.3 Imaging Modalities: CT, MRI, X-Ray, and Ultrasound

Prof. Fukuzawa provided an in-depth exploration of four key imaging modalities, each with distinct principles and applications in image processing:

- **X-Ray**: A technique using ionizing radiation to visualize dense structures like bones. Image processing enhances contrast and reduces noise for better diagnosis of fractures or abnormalities.

- **CT (Computed Tomography)**: Utilizes multiple X-ray projections to create detailed 3D images of internal structures. Image processing reconstructs these projections into cross-sectional slices, aiding in the detection of tumors or internal injuries.
- **MRI (Magnetic Resonance Imaging)**: Relies on magnetic fields and radio waves to image soft tissues with high resolution. Image processing improves tissue differentiation, critical for diagnosing brain or muscle conditions.
- **Ultrasound (US)**: Employs sound waves to visualize soft tissues, often used in prenatal imaging. Image processing enhances edge detection and reduces speckle noise for clearer images.

A comparison between CT and MRI was also presented. CT excels in imaging dense structures and is faster, making it ideal for emergency diagnostics, while MRI offers superior soft-tissue contrast, essential for detailed neurological or musculoskeletal assessments. Hospitals require both machines to address diverse diagnostic needs effectively.

1.3.4 Introduction to MRML

The session briefly touched on MRML (Medical Reality Markup Language), a data format used to represent 3D medical models and scenes. Prof. Fukuzawa noted its role in integrating imaging data with visualization tools like 3D Slicer for surgical planning and analysis.

1.3.5 Basic Usage of 3D Slicer

Participants were introduced to 3D Slicer, an open-source software for visualizing and analyzing medical images. Using a dataset of the upper torso (excluding the head), Prof. Fukuzawa demonstrated basic functionalities, such as loading DICOM files, adjusting window levels, and exploring anatomical sections. The session concluded with a Q&A segment addressing the following questions:

1. **Q1: What organ is easy to be found in the sagittal section?** The sagittal section, a vertical plane dividing the body into left and right parts, clearly reveals the spinal column, making it an easily identifiable structure in this view.
2. **Q2: What organ becomes good contrast when you select 'CT-abdomen' in Window Level editor presets?** When selecting the 'CT-abdomen' preset, the liver exhibits excellent contrast due to its density and vascularity, aiding in the identification of lesions or abnormalities.
3. **Q3: What is the major difference in T2W and STIR modes?** In MRI, T2-weighted (T2W) imaging highlights fluid-rich tissues (appearing bright), while STIR (Short Tau Inversion Recovery) suppresses fat signals, enhancing the visibility of edema or inflammation. The key difference lies in fat suppression, which STIR uniquely provides.

1.4 Conclusion

Day 1 laid a solid foundation for the workshop, blending theoretical insights with hands-on exploration. Participants left the session with a clearer understanding of medical imaging principles and tools, eager to delve deeper in the days ahead.

1.5 Conclusion

Day 1 provided a strong foundation, blending theory with practical exposure, and preparing participants for deeper exploration.

2 Day 2: VR Applications and Surface Model Visualization

The second day shifted focus to advanced visualization techniques, with an emphasis on virtual reality (VR) and 3D modeling in medical imaging. The session featured contributions from students and an expert presentation, culminating in a hands-on VR experience.

2.1 Student Introductions from HCMUS

The day began with introductions from students of Ho Chi Minh City University of Science (HCMUS). Each student shared their personal information, interests, academic major, and individual research projects. This segment highlighted the diversity of expertise among participants, ranging from computer science to biomedical engineering, enriching the workshop's collaborative environment.

2.2 VR Applications in Medicine by Panote Siriaraya

Panote Siriaraya delivered a compelling presentation on the applications of virtual reality in healthcare. He discussed how VR enhances medical training, surgical planning, and patient rehabilitation by providing immersive, interactive 3D environments. Examples included VR simulations for anatomy education and preoperative visualization of complex structures.

2.3 Visualizing Surface Models in 3D Slicer

Participants then explored surface model visualization in 3D Slicer using a Brain MRI dataset. The hands-on activity focused on generating and analyzing 3D models, followed by a discussion addressing the following questions:

1. **Q1: What are the pros and cons of Volume Rendering?** *Pros:* Provides a full 3D view of internal structures with realistic depth, ideal for complex anatomy. *Cons:* Requires significant computational power and can obscure details due to overlapping tissues.

2. **Q2: What are the pros and cons of Surface Rendering?** *Pros:* Offers clear, defined surfaces for specific structures, with faster rendering speeds. *Cons:* Lacks internal detail and may oversimplify complex volumes.

3. **Q3: Why is automatic generation of surface models still an ongoing research topic?** Automatic surface model generation remains challenging due to variability in tissue boundaries, noise in imaging data, and the need for precise segmentation algorithms, all of which require ongoing advancements in machine learning and image processing.

2.4 VR Observation with Headsets

The session concluded with participants using VR headsets to observe the 3D models created in Slicer. This immersive experience allowed them to interact with brain structures in a virtual space, reinforcing the practical applications of VR in medical visualization and providing a memorable highlight of the day.

2.5 Conclusion

Day 2 successfully bridged theoretical insights with cutting-edge technology, offering participants a deeper appreciation of VR's potential in medicine and hands-on skills in 3D visualization.

3 Day 3: Image Segmentation and Group Presentations

The final day focused on practical image segmentation techniques, guided by Professor Masayuki Fukuzawa, and concluded with group presentations and awards, celebrating the participants' efforts.

3.1 Student Introductions from HCMUS

Day 3 opened with additional introductions from HCMUS students, who shared their backgrounds, academic pursuits, and research interests, further strengthening the collaborative spirit of the workshop.

3.2 Practical Image Segmentation by Prof. Masayuki Fukuzawa

Professor Fukuzawa led a session on image segmentation, aiming to teach practical techniques and highlight the challenges of full automation. Using the CTACardio sample dataset in 3D Slicer, participants worked in groups through the following steps:

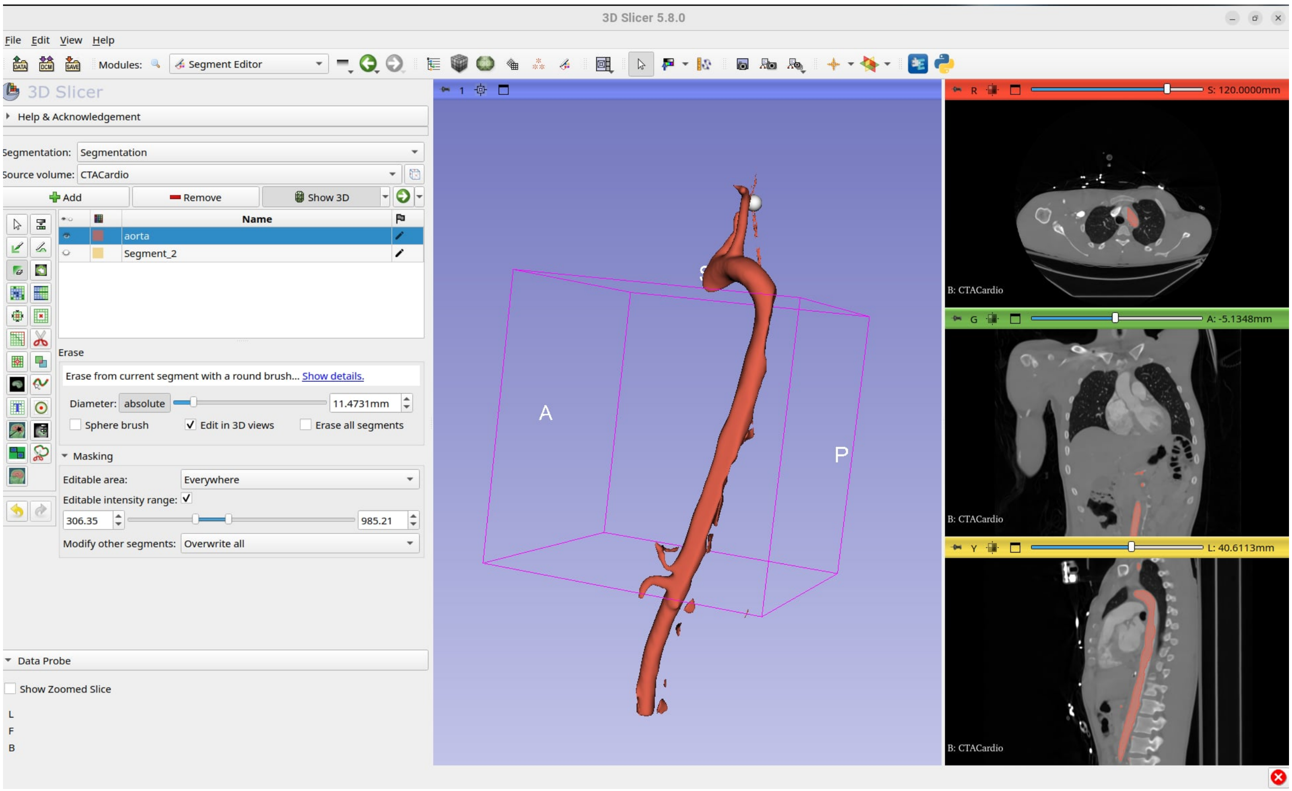
1. **Aorta Segmentation with 'Fast Marching' Technique**: This method uses a wavefront propagation approach to segment the aorta, relying on intensity gradients to define boundaries.
2. **Aorta Segmentation with 'Grow from Seeds' Technique**: Participants placed seed points manually, allowing the algorithm to expand and segment the aorta based on intensity thresholds.
3. **Optimization of Segmentation Parameters**: Groups adjusted parameters like thresholds and seed placement to refine their models, exploring the balance between accuracy and efficiency.

The exercise underscored the difficulties in automating segmentation, such as distinguishing the aorta from adjacent structures and handling dataset variability.

3.3 Group Presentations

Groups prepared slides to present their findings, addressing three questions:

1. **Q1: Show us the best aorta model of your group using 'Grow from Seeds' technique.**



2. **Q2: Which parameter was dominant in the 'Grow from Seeds' technique to determine model quality?**
   The *seed point* placement was often dominant, as it dictates the starting region for growth. However, the *threshold* value was equally critical, controlling the boundary expansion and preventing over-segmentation into adjacent tissues.

3. **Q3: What is the biggest challenge in automating aorta segmentation? Is it possible with modern AI techniques?**
   The primary challenge is accurately identifying the aorta amidst similar-intensity structures, often leading to errors like segmenting the wrong organ. Modern AI, such as deep learning, shows promise by learning complex patterns, but full automation remains limited by dataset quality and generalization across patients.

3.4 Awards and Closing

The workshop concluded with a small awards ceremony recognizing outstanding group presentations. Group 2, my team, received commendation for our commendable effort, reflecting our dedication despite challenges. The ceremony celebrated the collective achievements of all participants, marking a rewarding end to the 3-day event.

3.5 Conclusion

Day 3 provided hands-on experience in segmentation, deepened understanding of its challenges, and fostered teamwork through presentations, leaving participants with practical skills and insights into medical imaging advancements.