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Review Article

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Post-Processing Techniques in Radiology to Enhance Medical Imaging Interpretation: Radiographers vs. Radiologists

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ABSTRACT
The aim of this paper is to review post-processing techniques to show radiological anatomy and enhance radiological interpretation. After reviewing these techniques and what they can do, a conclusion can be drawn about who fit best to do this task, radiographers or radiologists?

Keywords: Multi-Planer Reformate, Maximum Intensity Project, Minimum Intensity Project, Image Reconstruction, Noise Reduction, Contrast Enhancement, Volume Rendering Techniques, 3D Work Station

Introduction

There are many techniques like Multi-Planer Reformate (MPR), Maximum Intensity Project (MIP), Minimum Intensity Project (MinIP), Image Reconstruction, Noise Reduction, Contrast Enhancement, and Volume Rendering Techniques (VRT). These techniques are used to enhance the generated image. The raw image is generated with thicker slices then reduced to thin slices on the axial section. The reconstructed axial image is used to generate sagittal and coronal sections. Not following these steps and reconstructed the raw image it will generate coronal and sagittal images with haziness. These generated images could be MPR, MIP, or MinIP. Then based on which technique is used from the previous three, other techniques can be generated like Shaded Surface Display (SSD). Also, VRT requires having sagittal and coronal to generates high quality VRT. Usually, MPR is used to make the VRT. The following techniques must be made by the radiographer; MPR, MIP, MinIP, and image reconstruction. The VRT is generated automatically by the work station for the radiologist. The radiologist can adjust the brightness and contrast of the image only. The noise reduction techniques in radiology are done as well by the radiographer. The radiologist can reduce the noise of a metallic foreign body like a bullet in the skull for example by using different window like the bone window.

Some of the post-processing in X-ray images are similar to the pre-processing techniques without any difference. Adjusting brightness, sharpness, histogram curves adjustment, flipping the X-ray image direction, increase or decrease the value of pixels, etc. All these techniques and others are based on many technical factors that the radiologists or physicians in general have no idea what are the technical factors behind doing the processing of any radiograph. It is not part of the radiologist job to know these technical things or even be aware that they exist. Since radiologists do not study these technical topics and issues, they are not qualified to do pre-processing or post-processing. They can ask for help from radiographers or describe the wanted result and the radiographer can help in achieving that goal. Asking radiologists to do this task will result in doing post-processing without knowing the technicality behind this processing. Digital artifacts can be made by the radiologists when they do the radiographer job. Windowing can be done on the PACS instantly which can be done by the radiologist. When radiologist is asked to do the job from receiving the patient, doing for example ultrasound scan, then interpret the scan it will lead to generating poor image quality, poor documentation of the patient, and it might lead to wrong diagnosis. When a sonographer is in charge

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of the job, the data is accurate, the generated images are perfect, and for sure the diagnosis accuracy will increase. Based on my work experience for 7 years in different hospitals, radiologists produce the worst ultrasound images for their low knowledge of the technical things to improve the image quality to the maximum. Even the simplest task can't be done accurately by radiologists like filling the patient's name, age, ID number, sex, and other information are not filled completely due to being focused on the case or other reason. Not to mention the poor image quality and documentation of the scan on the PACS for medicolegal purposes since ultrasound is a real time image. The result is poor documentation on the PACS with poor ultrasound images.

Radiographers do process of images on portable X-ray, C-arm, Fluro, US, NM, CT, MRI, etc. This shows that radiographers know how to handle any radiology images in all settings, unlike radiologists. This proof that radiologists should not do the job of image processing. Pre- and post-processing are essential for interpretation. The processing is needed due to the fact that information is not apparent in the raw data so processing is needed to show this hidden information, improve appearance of abnormality, and better visualization of anatomy. Enhancement and manipulation could make some details to appear or disappear.

Techniques involved in pre-processing and post-processing in CT/MRI

The techniques that are used in CT and MRI images are; 1- Image reconstruction using different algorithms and filters to improve the spatial resolution and contrast, 2- Noise reduction by using filters, 3- Contrast enhancement by adjusting contrast and brightness levels, 4- Multi-Planer Reconstruction (MPR) to reconstruct 3D images from 2D images, 5- Maximum Intensity Project (MIP) and Minimum Intensity Project (MinIP) are used to show different things based on the intensity that is selected like skull snapshot using MIP to show a one view of the skull, 6- Volume Rendering Technique (VRT) to show 3D image of the structure which can be picked based on the system like osteo, colonoscopy, lung, etc. On VRT we can cut structure that hides another structure behind it like we can remove the mandible to see the styloid processes, 7- Windowing which is selecting the accurate window for the scan, but these windows can be done automatically on the PACS, but many windows are not available at the regular PACS at the emergency room like the internal auditory canal window which can be done on the CT machine only or seen automatically at the radiologist work station, 8- Curved-Planar Reformatted image, etc.

Techniques involved in pre-processing and post-processing in ultrasound

Pre-processing techniques are; 1- Noise reduction like speckle reduction filter, median filter, wavelet de-nosing, 2- Contrast enhancement using the gain button, the right prop, preparation of the patient like fasting, 3- Geomatric correction, 4- Artifact removal, 5- ROI selection which is picked on the machine and select the correct prop (note today there are available one prop for all purposes), etc.

Post-processing techniques are; 1- Image fusion like combination of CT with US or MRI with US, 2- 3D/4D reconstruction, 3-Quantitive analysis like; blood flow, velocity, tissue elasticity, and organ dimension, 4- Contrast enhancement, 5- Color Doppler image, 6- Compression of DICOM file, etc.

Impact of processing on interpretation

Without having processing many details are missing and it requires someone to show these details. Pre-processing is done by radiographers as well as post-processing. When the radiographer miss doing some of the processing the radiologist can ask for more post-processing. As the radiographer gets more experience at work as the pre-processing and post-processing task is understood by the radiographer in which case this type of processing is required without being asked to do it, but the radiographer will do it automatically. Some of the post-processing are done automatically on the work station by radiologist like windowing or 3D VRT.

Radiographers vs. radiologists

In Mezrich's statement he/she claims three things: 1-radiographers do not know the human anatomy, 2- The 3D work station does automatic reconstruction including; axial, sagittal, coronal, oblique, linear, and curved, and 3- Radiologist are better in doing so than radiographers and the automatic work station [1].

This position is wrong for many reason; 1- He/she speaks about anatomy like it is rocket science and it is like nobody studied anatomy except Mezrich, 2- Anatomy is the oldest science since human came to Earth, and 3- Unqualified radiologic technologist in the united states are the exception not the rule since they have only a diploma and they go to a community college (were plumbers and electricians get their diploma) then they can't be compared to radiographer in the UK who spent 3 years studying a B.Sc. or radiographers in the Arab world who spent 5 years studying a B.Sc. in radiology, 4- The low level of education of Mezrich made him/her think that post-processing means taking sections which proof that he/she did not even study a subject about image processing and analysis at school, the residency, or fellowship program, 5- According to Juluru co-author in Mezrich et al. (2011), who replied to Mezrich statement, she mentioned that radiographers at Massachusetts General Hospital lab, it take them 6 months of experience at the post-processing lab until they feel familiar with technologies like segmentation, 3D volume measurements, vascular view, etc., 6- According to Juluru, it takes a team of dedicate radiographers to do the processing of huge number of cases, 7- These different technologies and tools when they are given to some radiologist who is not even aware how to use them it could be "meaningless at best and dangerous at worst" according to her, 8- It is highly specialized field in its own, 9- the quality of the post-processing needs expertise in image processing and being familiar with the software, 10- It keeps radiologist away from their work which is interpreting scan to master a new skill which is image processing, 11- It is highly technical and most radiologists are not trained with these system except few who have a passion with no formal education in image processing, 12- Creating vascular views of CTA can take 45-60 min by untrained hand and it could be done automatically but it will not be perfect like the one done by processing lab radiographers, 13- A 3D work station provides only an artistic image that can't help in operation mapping and planning, 14- In large group and large volume settings, it needs a team of radiographer, 15- Quality of post-processing will be

damaged and one high standard among all patient can't be done by radiologists, but a professional team of radiographers, and 16- Each medical imaging company have their own software to do the job which requires practice with their system.

Conclusion

Radiologists are not familiar with technical parts of processing a radiology image. Some radiologists can pick up some information from here and there, but they did not study it formally; therefore; they should not be in charge of doing this job. All radiographers are aware of processing of images, but some junior radiographer might not aware when to use it and with which case? With more training and supervision of senior radiographer, this issue will be solved.

Reference

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