EE367 Project proposal
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Motivation

Computational Imaging is applied to many different areas these days. For medical domain, disease diagnosis by MRI or other medical imaging requires a lot of time, labour and professional knowledge. We want to use computational imaging technology to achieve auto-diagnosis, which could better the quality of the images and improve the efficiency of the process in hospitals.

The spinal bone bulges out and presses the cord and nerve, causing pain. The disease is pretty normal currently, everyone sitting in the office all days tend to catch it under the effect of gravity, which gives the reason for why we do it. We hope our algorithm will ease the workload of radiologists and doctors and increase the treatment efficiency significantly.

related work

Non-Local Means (NLM) is analyzed and adapted to reduce this noise in MR magnitude images. NLM is highly dependent on the setting of its parameters. The paper "MRI denoising using non-local means"[1] tries to find the optimal parameter selection for MR magnitude image denoising. Also, the filter has been adapted to fit with specific characteristics of the noise in MR image magnitude images (i.e. Rician noise). From the results over synthetic and real images we can conclude that this filter can be successfully used for automatic MR denoising.

The paper "Adaptive MRI image denoising using total-variation and local noise estimation"[3] presents an automated, adaptive image denoising method for removal of Rician noise from MRI images. The proposed method is based on the discretized total variation (TV) minimization model and the local noise estimation technique. The regularization parameter of the TV-based denoising method is adapted based on the standard deviation of noise in MRI image.

project overview

We are planning to do the slipped disc disease detection based on medical MRI image. As we all know the such bone bulge disease tortures billions of people every day. It is a medical condition affecting the spine in which a tear in the outer, fibrous ring of an intervertebral disc allows the soft, central portion to bulge out beyond the damaged outer rings.

Technical solution: increase image contrast → filter noise → crop central spinal cord area using machine learning → filter to transfer image into binary or frequency domain → detect bulge area or test spinal cord area's symmetry characteristic

Image with disease

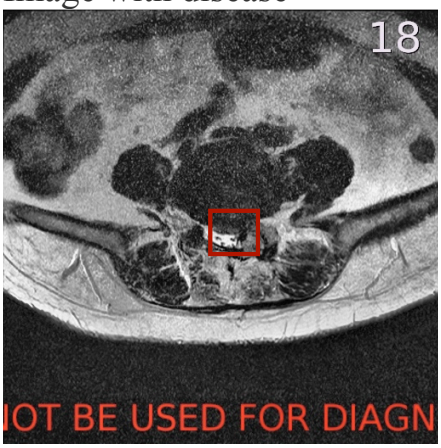
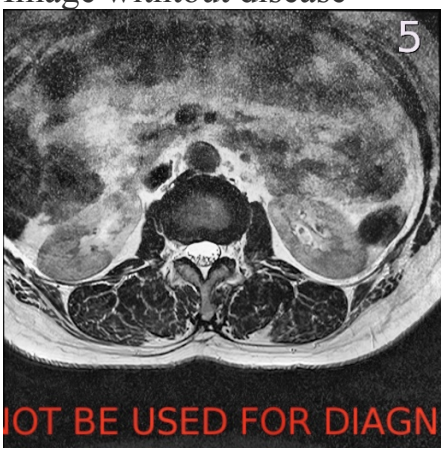


Image withtout disease



Milestones, timeline & goals

During our project, we plan to take 1 week to implement and try out methods to increase image contrast, since most images' contrast is not so high making it even difficult for people to judge whether there's a disease. By properly increasing contrast we could make it more accessible to people first, then computer could have chance to judge it.

Then we need to take days to remove noise, since some more black points could indicate a disease(black bulge) on the fragile spinal cord area, we should suppress types of noise like Gaussian white noise or hot noise caused by MRI machine. This step takes a lot of trials and tuning on different combination of filters in order to a achieve a high average performance(like high PSNR).

Next step should be cropping out the spinal cord area within one week, since we have a lot of irrelevant areas in the whole image which are useless, so cropping that spinal cord area could make our image processing scope significantly smaller. In detail we are planning to use RCNN or YOLO to finish this step with some pretrained model, which could help increasing the accuracy.

Then if we are trying to find whether the spinal cord has a disease, we could judge its symmetry characteristic. Because without a disease/bulge, the spinal cord could be almost perfectly symmetric. For this task we are still in discussion, since there will be different ways like in frequency domain or in convolutional deep learning domain. We will figure it out.

Reference

[1] Manjón J V, Carbonell-Caballero J, Lull J J, et al. MRI denoising using non-local means[J]. Medical image analysis, 2008, 12(4): 514-523.
[2] Buades A, Coll B, Morel J M. A non-local algorithm for image denoising[C]//Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on. IEEE, 2005, 2: 60-65.
[3] Varghees V N, Manikandan M S, Gini R. Adaptive MRI image denoising using total-variation and local noise estimation[C]//Advances in Engineering, Science and Management (ICAESM), 2012 International Conference on. IEEE, 2012: 506-511.