HORIZONTAL VIEW SPINE MRI DENOISE FOR MEDICAL JUDGEMENT

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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 improve auto-diagnosis, which could better the quality of the images and improve the efficiency of the process in hospitals.

PROBLEM STATEMENT

Currently we developed a diagnosis model and line-drawing model for spine MRI images, we fed images directly to the model.

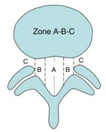
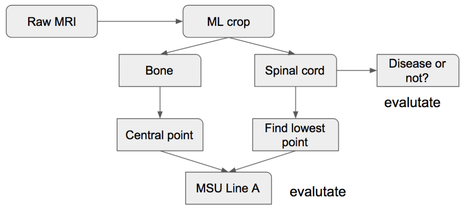


Fig. 2 Zoning the disc for location. Lesions have more impact in tighter zone-B and -C

Now we want to design a MRI preprocessing pipeline to process images before we feed them to ML model to increase the diagnosis accuracy and A-line localization accuracy.

MSU medical standard is shown on right hand, we want A-line.

ORIGINAL PROCESS PIPELINE



In our original system, we directly fed the raw MRI images to the deep learning neural network, but the result was a little fuzzy because different MRI images are from different sources, they are pretty different in brightness, contrast and level of noise. As a result, the MSU A line was drawn pretty unstable, producing a lot of misses or incorrect lines.

Related work

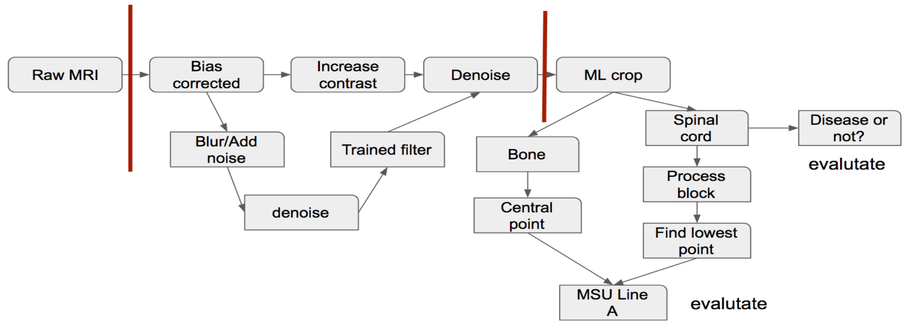
- Median filter and background removal preprocessing method

Disc herniation diagnosis in MRI using a CAD framework and a two-level classifier Jaehan Koh · Vipin Chaudhary · Gurmeet Dhillon

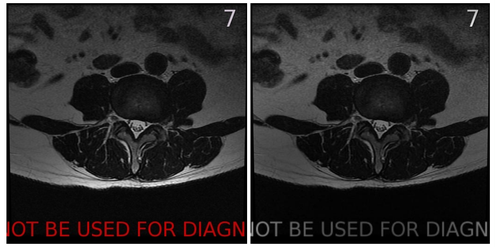
- Image normalization and undefined preprocessing.

M. Mizotin, J. Benois-Pineau, M. Allard, and G. Catheline, "Feature-based brain MRI retrieval for Alzheimer disease diagnosis,"

New Tech—IMAGE PREPROCESSING PIPELINE DESIGN (Between red lines)



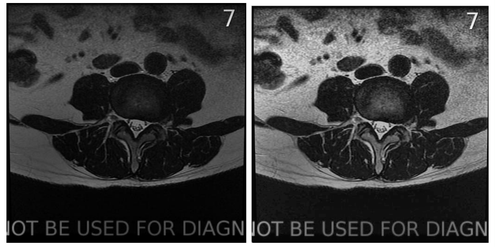
Bias correction:
Because of the inhomogeneities in the magnetic fields of the MRI machine, there is often a bias field. Images are blurred by a bias field and high frequency components such as edges and contours are reduced.So we develop a bias correction function to handles MRI bias and artifact corrections.
The comparison results are shown on the right hand.



Increase contrast:
Here we are using Contrast Limited Adaptive Histogram Equalization(CLAHE) method to increase the contrast.

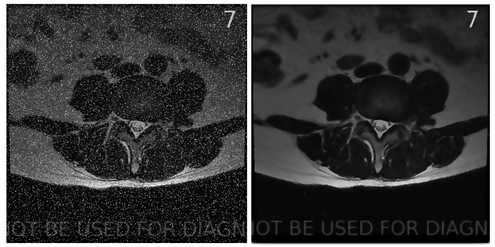
We apply CLAHE in LAB color space, we splits the whole image into L-Lightness, A–color Green to Magenta color component, and B–Blue to Yellow color component.

The comparison results are shown on the right hand.



Simulate noise condition and train filter:
After increasing the contrast, we get lots of Gaussian white noise in the image, so we need to use filters to remove them in order to achieve a relatively high PSNR.

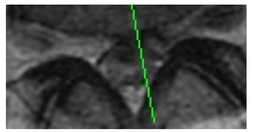
We first added Gaussian white noise to those bias corrected images to "simulate adding noise process" during increasing contrast, and use this to find the filters needed.



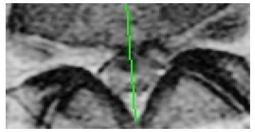
We can't directly use high contrast images to get filters since PSNR between bias corrected images and high contrast images is meaningless. We found the combination of Wiener and bilateral filter performs best.

Continue

Process block:
Originally, we thresholded the cut-out spinal cord section and then applied contour detection to find the lowest tip of cord as end point of A-line.



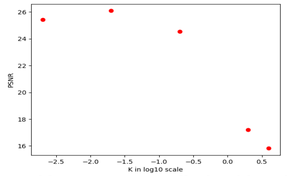
Now we add non-local-means filter to get the right side comparison.
(down image is new)



RESULTS

Filters	PSNR(average on 100 images)
gaussian-2D	23.31
average	24.10
bilateral	14.18
Median+wiene+bilateral	24.36

So we think the combination of filters works best, in order to choose 1/SNR. We list a number of choices and plot the PSNR graph on certain test images. The best value is 0.2.



Finally our processes' impact on prediction/drawing result is compared below on chart.

	Original images	Processed images
Line localization accuracy	90%	96%

	Original images	Processed images
Diagnosis accuracy	82%	84%

CONCLUSIONS

- Compared to original data, the data processed by our pipeline can improve both diagnosis accuracy and localization accuracy.
- shows the best result for denoising so far.

REFERENCES

[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]Juntu, Jaber, et al. "Bias field correction for MRI images." Computer Recognition Systems. Springer, Berlin, Heidelberg, 2005. 543-551.