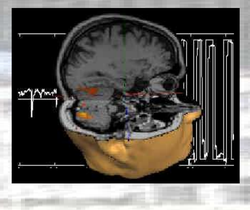
Detecting Stripe Artefacts in Ultrasound Parametric Images



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Introduction

- Visualisation of brain perfusion is necessary for the diagnosis of acute ischemic stroke.
- Currently used techniques (CT, MRI, PET) are expensive, time-consuming and intolerable to critically ill patients.
- Ultrasound perfusion imaging promises to be a fast and inexpensive bedside diagnostic help or alternative.
- Bolus harmonic imaging (BHI) allows insight into a patient's brain.

Parametric images

- US image sequence (ca. 45 sec.) is acquired through skull with contrast agent bolus to assess blood flow.
- Currently four perfusion-related parameters calculated from sequence and displayed as colour-coded images.
- Goal is to have one overall image displaying pathological areas.
- Parametric images suffer from stripe artefacts leading to false conclusions.

Stripe artefacts

- Darker image regions parallel to the US beam due to inhomogenities in the cranial bone or the dura mater.
- Appear intensified in parametric images, because underlying model of parameter calculation is not met.
- Since pathological tissue corresponds to dark areas as well, stripes prevent automatic identification.

Preprocessing

- Convert RGB image to greyscale.
- Artefacts are parallel to radii of US beam circle segment.
- Intensify vertical structures with horizontal derivative filter.

- Threshold image to obtain a binary result image.

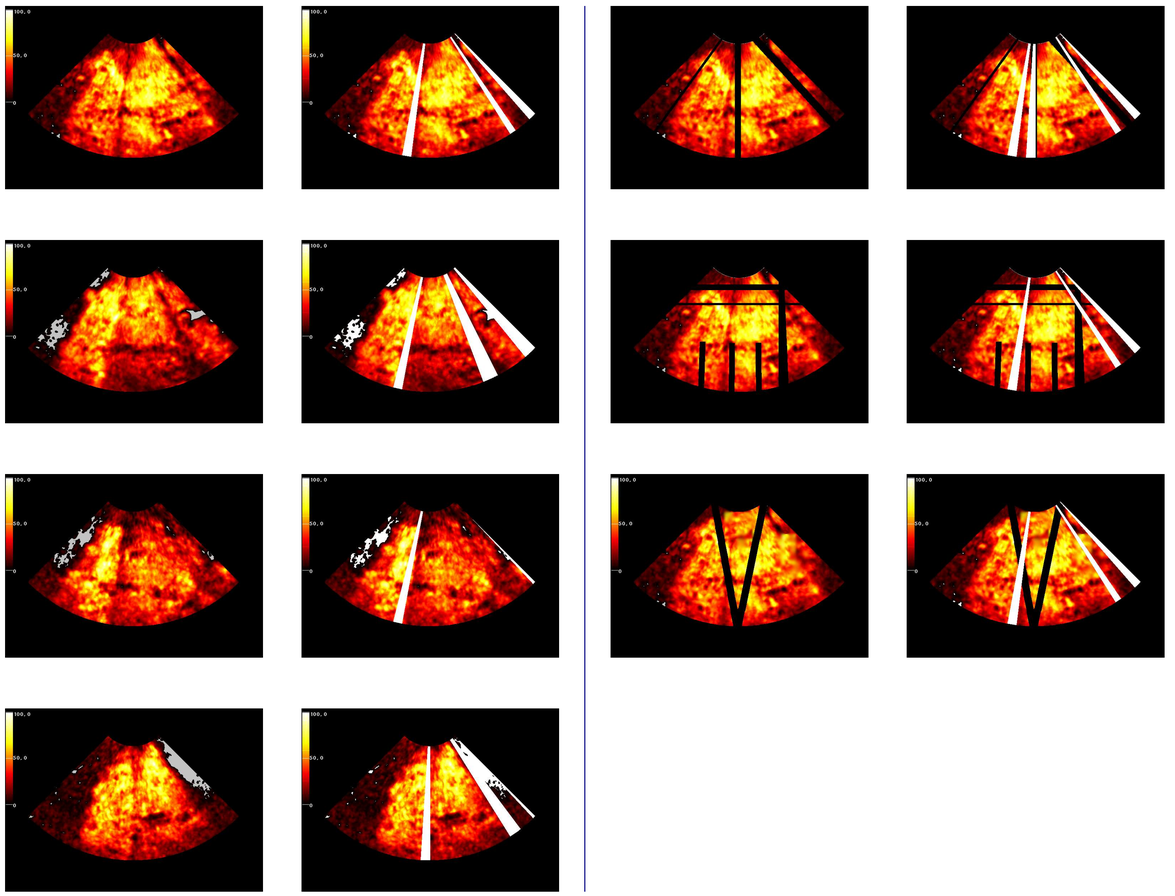
Stripe detection

- Process circle segments individually by masking possible stripe artefacts.
- Divide segments into five parts of equal length to avoid false positives originating from pathological areas crossed by the current segment.
- Examine mean grey values in parts.
- When all five mean grey values are below a threshold, the segment is marked as a stripe artefact.

Sample parametric images and detection results

normal stripe artefacts

artificial stripe artefacts



Results

- Algorithm performance assessed on three classes of images: without, normal, and artificial artefacts.
- Artefacts marked by a clinical expert and compared to algorithm results.

Artefacts	none	normal	artificial
false positives	0-3%	5-7%	0-1%
false negatives	n/a	4-6%	n/a

Conclusions

- Algorithm overcomes inherent shortcomings of BHI method and improves presentation of parametric images.
- Results show very good accuracy and robustness of algorithm.
- Important step towards the goal to obtain the same information about poorly perfused areas from BHI as it is possible with e.g. CT and integrate it to form an expert application.

References:

[1] G. Seidel, K. Meyer-Wiethe, G. Berdien, D. Hollstein, D. Toth, and T. Aach: Ultrasound perfusion imaging in acute middle cerebral artery infarction predicts outcome. Stroke, 35(5), 2004.

[2] K. Meyer, M. Wiesmann, T. Albers, and G. Seidel: Harmonic imaging in acute stroke: Detection of a cerebral perfusion deficit with ultrasound and perfusion MRI. J Neuroimg, 13, 2003.

[3] V. Metzler, G. Seidel, M. Wiesmann, K. Meyer, and T. Aach: Perfusion harmonic imaging of the human brain. In Ultrasonic Imaging, vol. 5035 of Proceedings of SPIE, 2003.

[4] C. Kier, D. Toth, K. Meyer-Wiethe, A. Schindler, H. Cangür, G. Seidel, and T. Aach: Cerebral perfusion imaging with bolus harmonic imaging. In Ultrasonic Imaging, vol. 5750 of Proceedings of SPIE, 2005.

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