Detection of local motion artifacts and image background in Multi Exposure Laser Speckle Contrast Imaging Affiliations

Johannes Nyhlén^{1,2}, Märta Sund^{1,2}

Examiner: Ingemar Fredriksson^{1,2} Supervisor: Martin Hultman^{1,2}

Background and motivation

For cells to get the oxygen and nutrients needed to stay alive as well as waste products and carbon dioxide to diffuse, a well-functioning microcirculation is vital. The microcirculation consists of arterioles, venules, and capillary blood vessels. The fact that the network of vessels is very complex, together with the microscale of the vessels makes it challenging to measure the function of microcirculation. One way to observe microcirculation is to use Laser Speckle Contrast Imaging (LSCI). LSCI utilizes the speckle pattern that occurs due to doppler shift that appears when light hits moving particles, e.g. circulating blood. However, the LSCI models are based on assumptions and several microcirculation conditions can result in the same exposure contrast. To reduce these effects, Multi-Exposure Laser speckle Contrast Imaging (MELSCI) was proposed by Parthasaralthy et al. leading to an increased amount of information collected. A limitation of the clinical use of LSCI to assess blood perfusion in human tissue is local motion artifacts that contribute to inaccurate data. Moreover, the background of the image contributes to noisy and unnecessary data. [1][2]





Research questions

- 1. How can local motion artifacts be detected in Laser speckle Contrast Imaging(LSCI)?
- 2. How can local motion artifacts be detected in Multi-Exposure Laser speckle Contrast Imaging(MELSCI)?

References

- Engineering OnLine, 17 2018

Method

- Input data: Single exposure perfusion dataset of size 256(height) x 320(width) x number
- Temporal filtering with Hampel filter \rightarrow binary dataset 1=outlier & 0=non-outlier.
- Spatial filtering with moving minimum, moving maximum & Gaussian filter.
- Output data: Binary classification dataset of same size as input.

Part 2: Deep learning using MELSCI Data

Several machine learning models have been trained on datasets consisting of 20 000 patches in sizes 3x3, 7x7, 13x13 and 21x21 pixels. To get a diverse dataset, criteria in regards of ground truth and intensity were established. Visualization of the first results from the machine learning models are shown to the right.

Next step: Train networks with datasets where time dimension is included.

Linköping University, Department of Biomedical Engineerring
Perimed AB, Järfälla Stockholm, Sweden

3. How can the image background be detected to enable reduction of irrelevant background noise?

M. Hultman, "Real-time multi-exposure laser speckle contrast imaging of skin micro-circulatory perfusion," Ph.D. dissertation, Linköping University, 2021 2. Y. An and et.al., "Blood flow characteristics of diabetic patients with complications detected by optical measurement," BioMedical

Prediction image

Ground truth image

LINKÖPING UNIVERSITY **DEPARTMENT OF BIOMEDICAL ENGINEERING**