FRAME TO FRAME FILTERING OF REAL TIME STRAIN IMAGES

A contribution of Kompetenzzentrum Medizintechnik Ruhr

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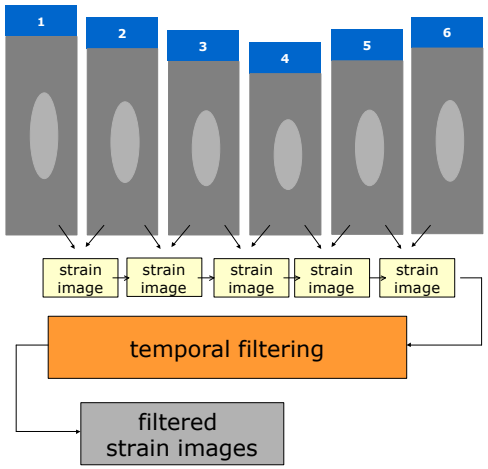
INTRODUCTION

- Frame rates in a Real-time Strain Imaging System have to be high (>20 Hz) to reduce motion artifacts
- The strain signal in a high-frame-rate system is small, it can be increased by the combination of several successive strain images similar to multicompression approaches
- In a Real-time Strain Imaging System this corresponds to a temporal filtering of the strain images which improves the SNR
- In this paper several possible filters are compared



STATISTICS AND FILTERS

- Covariance of successive strain images:

$$c(k) \approx \sigma_s^2 \begin{cases} 1 & k = 0 \\ -0.5 & |k| = 1 \\ 0 & |k| > 1 \end{cases}$$

Filter 1: Weighted Summation:

$$\bar{s}_k = \bar{s}_{k-1} + p s_k$$

$$0 < p < 1 : \text{persitence}$$

Filter 2: Vibrography:

$$\bar{s}_k = k(s_k - p_c s_{k-1}) - p_c^* \bar{s}_{k-1}$$

$$p_c = e^{-j\omega_{vibration}}$$

constraint: compression is replaced by a low frequency vibration (no manual compression)

$$\omega_{vibration} = 1/4 \frac{1}{2\pi Framerate}$$

Filter 3: Adaptive Filter

$$\bar{s}_k = \bar{s}_{k-1} + p_{adaptive} s_k$$

$p_{adaptive} = +1$ or -1 based on estimated compression direction

COMPARISON

Basis:

- Theoretical comparison of SNR based on covariance of strain images $c(k)$
- Phantom studies with sponge phantoms
- In vitro study for the use of strain images in neurosurgery (pig brains)
- In vivo study for the use of Real-time Strain Imaging for the early detection of prostate cancer

	Amount of necessary compression (7,5 MHz)	SNR	+/-
Weighted summation (WS)	3-5 mm	Best possible SNR for constant compression	+standard hardware - instable image or high compressions
Vibro-graphy (VG)	<1 mm	SNR proportional to frame-rate	+long time stable images - vibration source necessary
Adaptive weighted summation (AWS)	1-2 mm	for constant compression, identical to WS, for vibration worse than VG	+standard hardware

CONCLUSIONS

- AWS-Filter best suitable for manual compression in Real-time Strain Imaging
- Vibrography necessary for Neurosurgey and applications where only low strains can be used