Lect. 13. Case Study:
Ultrasound Image Processing for Quantitative Analysis of Fetal Movement

1. Fetus movement parameter estimation task
2. Characterization of US system. B-mode sector scanner.

The main sources of noise interferences that may cause the target tracking failures are:

- Periodic noise due to imperfections of the VCR system;
- Speckle noise generated by the US imaging system.

3. Characterization of organ tracking task

The main obstacles for the reliable organ tracking are:

- The target organ is camouflaged by other organs in the field of view;
- Images are spatially very inhomogeneous;
- The target image changes considerably in the video sequence.

Tracking and measuring the movement of fetal organs in ultrasound images requires solving the following problems:

- Image perfection and noise suppression;
- Target object localization and tracking in cluttered background;
- Fast and accurate image geometrical transformation to allow for image variations that may occur in the process of movement and imaging.

4. Image perfection and noise suppression

4.1 Filtering frame grabber periodic noise:

- Detecting peaks of noise spectrum in averaged power spectrum of image rows
- Filtering out noise spectral components by Empirical Wiener filters

4.2 Filtering speckle noise by local adaptive filters

- Local recursive DCT spectrum analysis
- Local adaptive filter design and application

5. Organ tracking technology

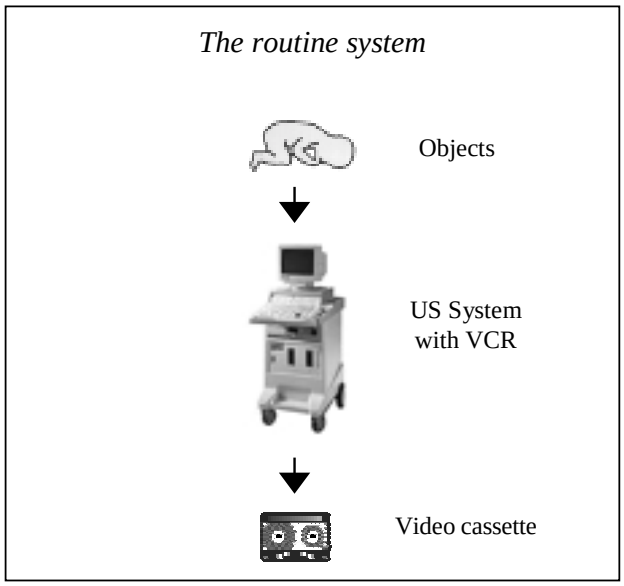
- Target signal formation and refining
- Image homogenization
- Target geometrical transformations by means of fast algorithms of discrete sinc-interpolation
- Optimal adaptive correlator for reliable tracking

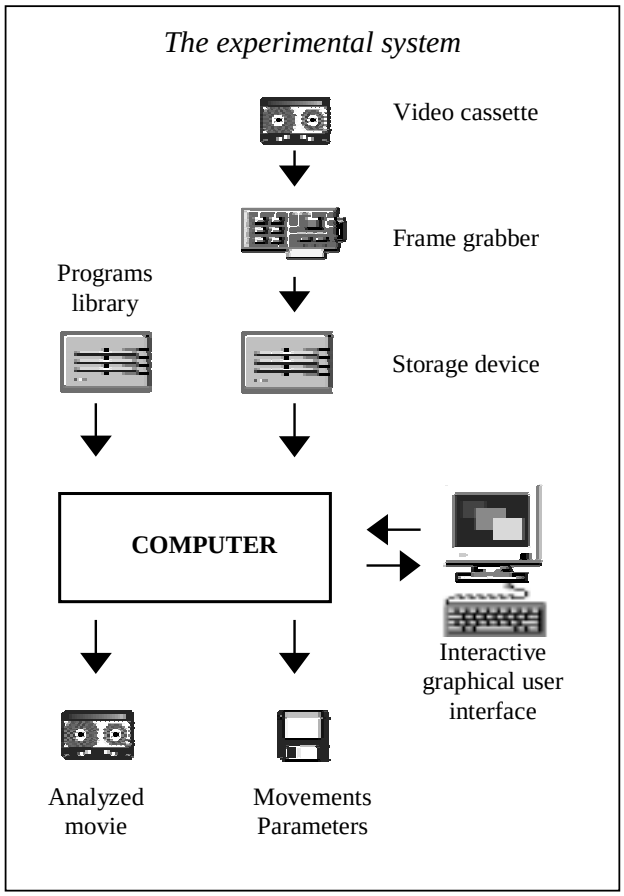
6. Experimental system user interface
7. Other possible applications of the technology

- video tracking
- face detection

References

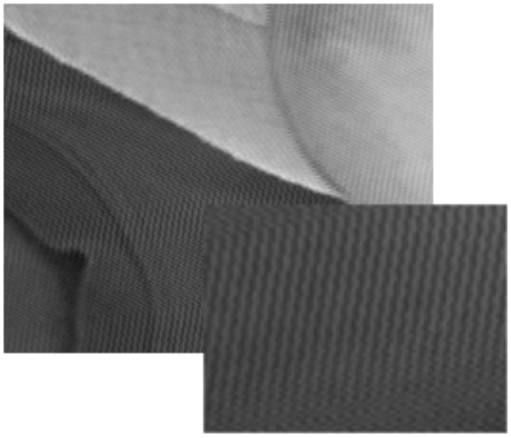
1. L. Yaroslavsky, Biomedical signal and image digital processing. Lecture notes. http://www.eng.tau.ac.il/~yaro/
2. L. Yaroslavsky. Digital Image Processing: Applications. Lecture notes. http://www.eng.tau.ac.il/~yaro/
3. Ben-Zion Shaick, Ultrasound Image Procesing for Quantitative Analysis of Fetal Movement. MS Thesis. Tel Aviv University, 1997
4. B.-Z. Shaick, L. Yaroslavsky, Transform Oriented Image Processing Technology for Quantitative Analysis of Fetal Movements in Ultrasound Image Sequences. In: Signal Processing IX. Theories and Applications, Proceedings of Eusipco-98, Rhodes, Greece, 8-11 Sept., 1998, ed. By S. Theodorisdis, I. Pitas, A. Stouraitis, N. Kalouptsidis, Typorama Editions, 1998, p. 1745-1748


The routine system
Objects
US System
with VCR
Video cassette

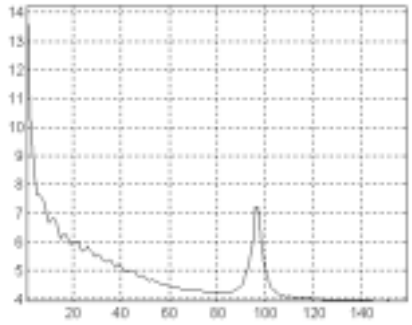

The experimental system
Video cassette
Frame grabber
Programs
library
Storage device
COMPUTER
Interactive
graphical user
interface
Analyzed
movie
Movements
Parameters

Filtering frame grabber periodic noise

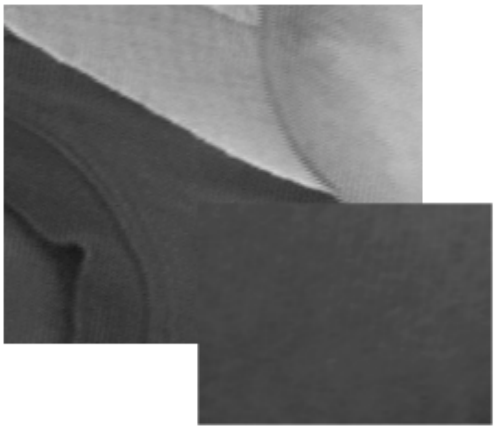
Original image



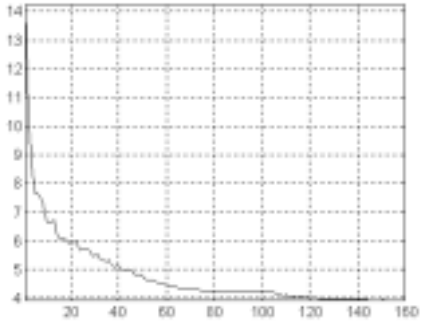
Av. power spectrum along rows



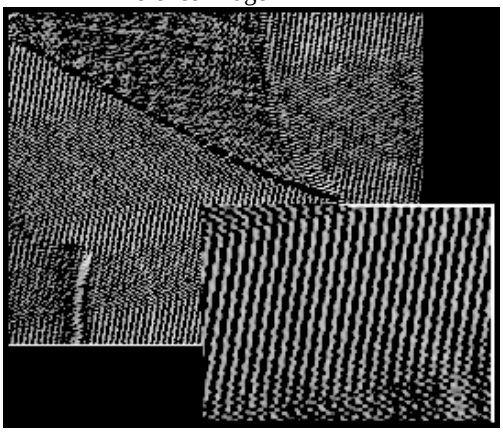
Filtered image



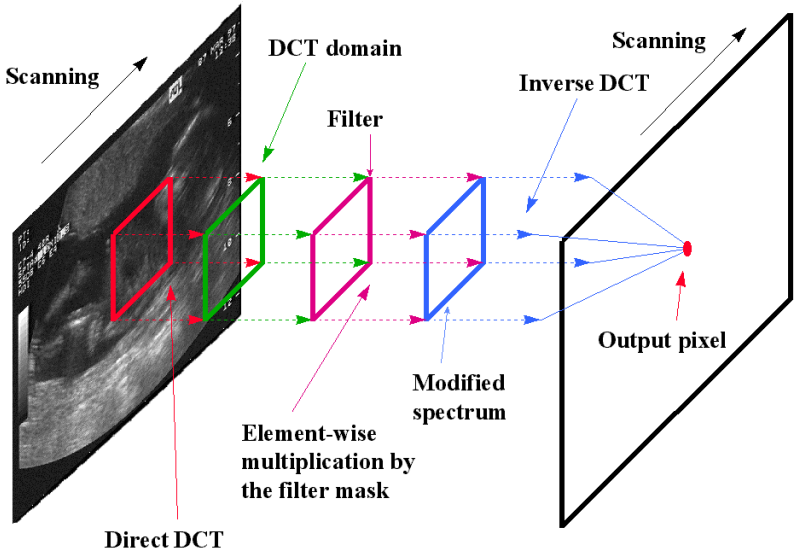
"Filtered" power spectrum

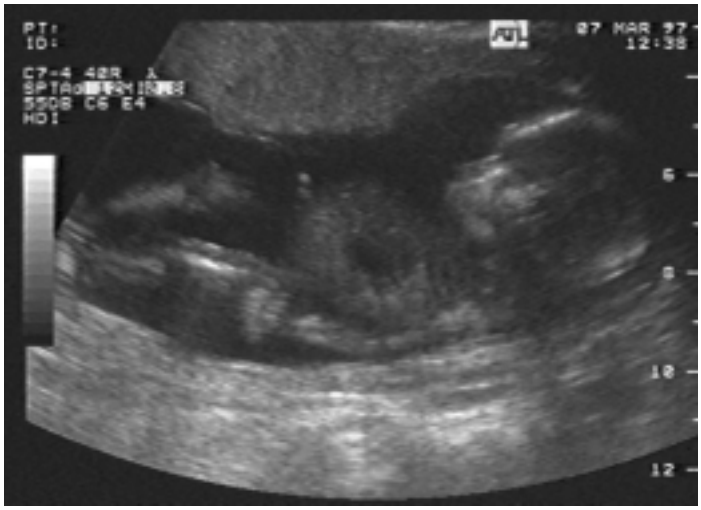


Difference image

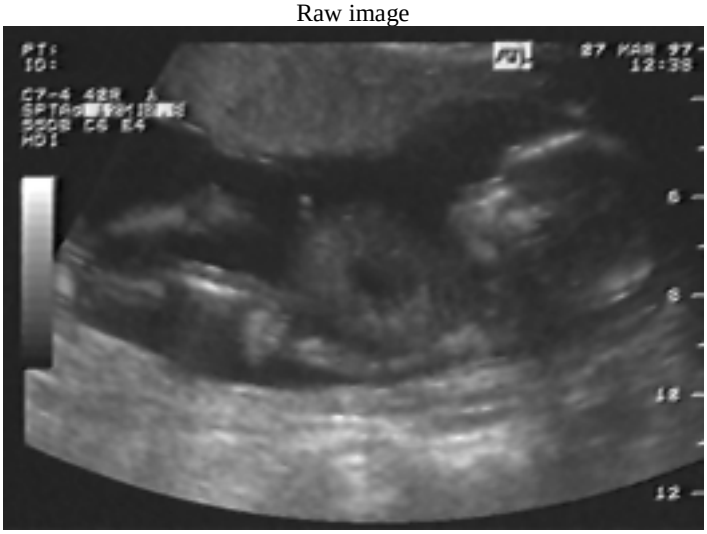


Local adaptive moving window filtering for suppression of speckle noise





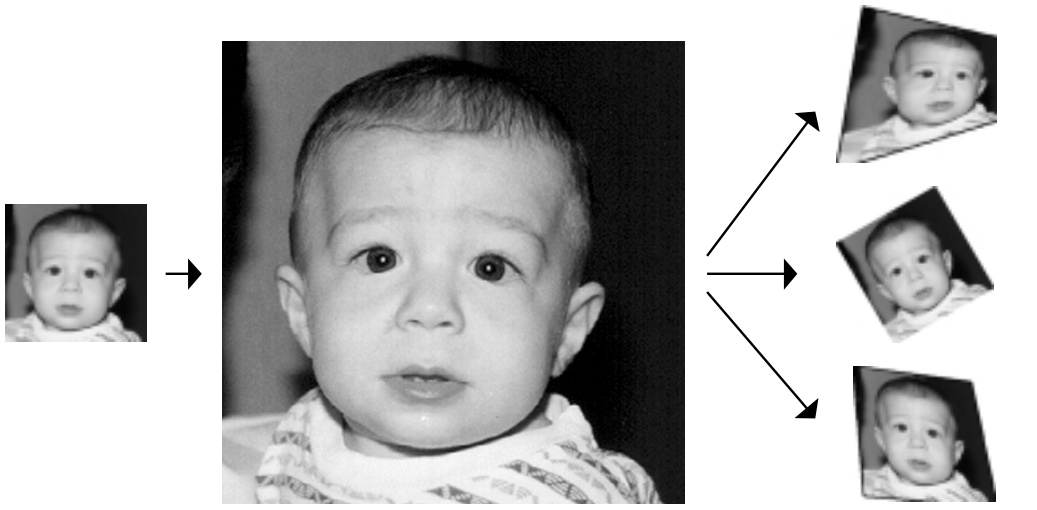
Raw image



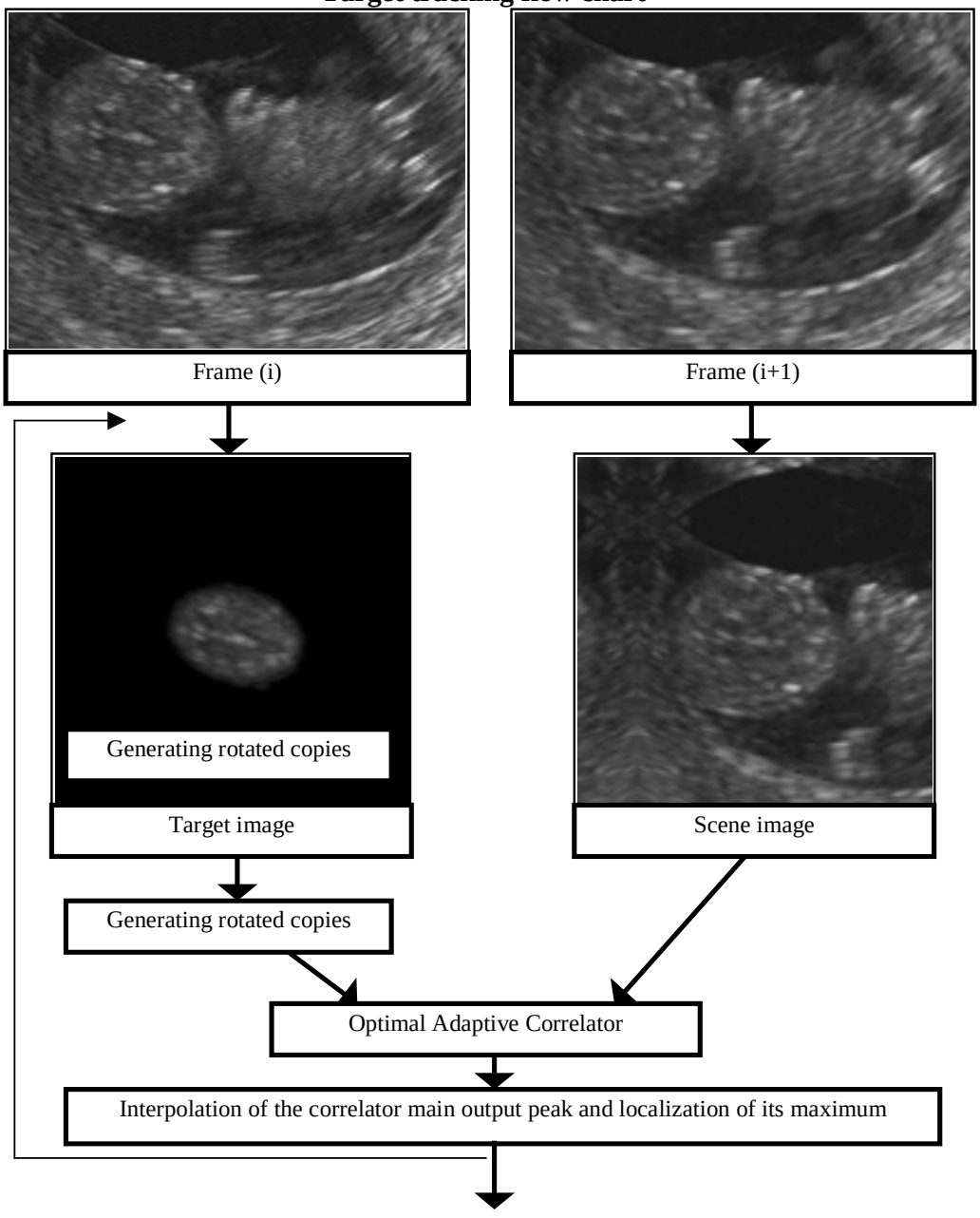
Filtered image

Image homogenization

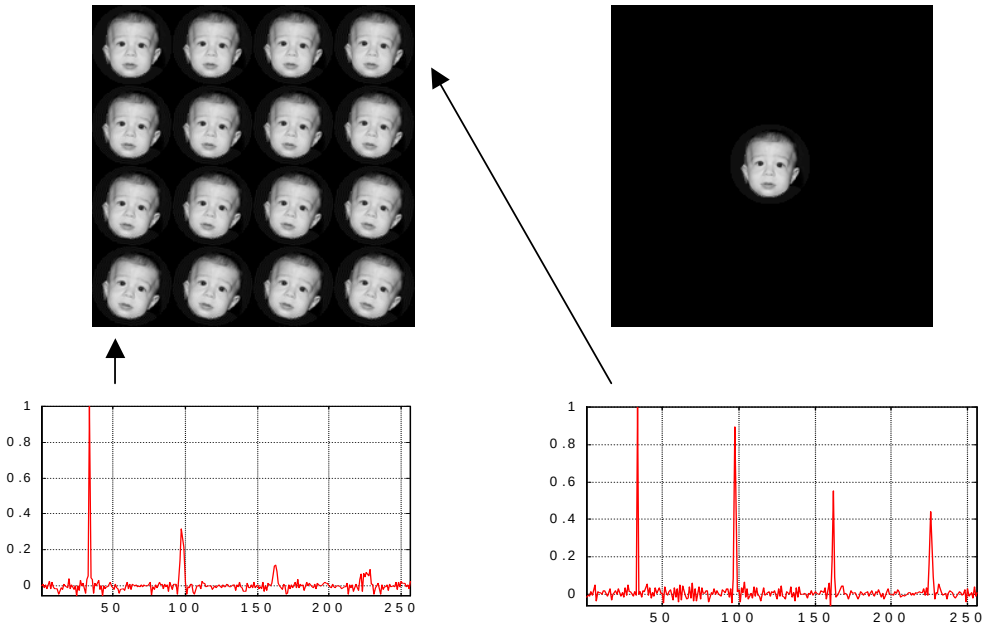
Image Geometrical Transformations



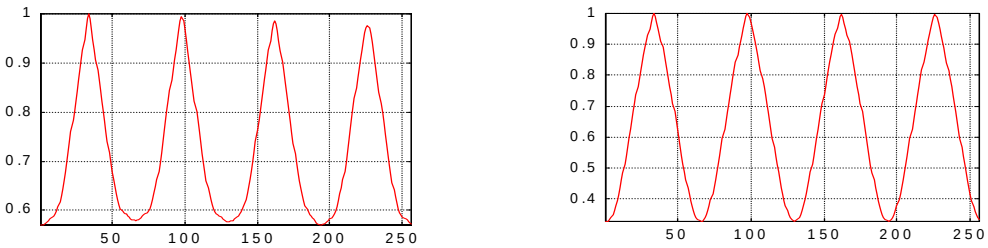
Target tracking flow chart



Rotation sensitive Adaptive matched filter (correlator)



Adaptive matched filter output to rotated target



Conventional matched filter (correlator)

Movies:

1. **Fetus tracking**
2. **Video tracking**