Panoramic ultrasonic imaging

Presented by Vera Degtiareva

Supervisor: Michael N. Rychagov, Prof., Dr.Sc.

MB-JASS 2011
General information

Problem: As a result of the limited aperture, only the limited view can be obtained with a fixed transducer position.

Task: In many applications it is desirable to get a more comprehensive overview of the region of investigation.

Solution: Recover in-plane transducer motions and combine the information into a single panoramic image.

Method: Numerical modeling using Matlab.
Main steps

1. Find features
2. Initial matching
3. RANSAC matching
4. Homography computing
5. Image transformation
6. Image stitching
Find features

\[ L(x, y, \sigma) = G(x, y, \sigma) \ast I(x, y), \]

where \( L \) — value of Gaussian in a point with coordinates \( (x, y) \),
\( \sigma \) — radius of blurring,
\( G \) — Gaussian core,
\( I \) — input image,
\( \ast \) — convolution operation.

\[ D(x, y, \sigma) = (G(x, y, k\sigma) - G(x, y, \sigma)) \ast I(x, y) = L(x, y, k\sigma) - L(x, y, \sigma). \]

***Image1 - Image2***
Finding keypoints 1...
260 keypoints are found.
Finding keypoints 2...
148 keypoints are found.
Image matching

Initial match found: 28 matches.
RANSAC match found: 26 matches.

2 false matches were removed by RANSAC algorithm
Image transformation

\[ H_1 = H_{1\_0} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \]

\[ H_2 = H_{1\_0} \cdot H_{2\_1} \]

\[ H_2 = \begin{bmatrix} 0.9867 & 0.0032 & 147.9864 \\ -0.0068 & 1.0006 & 0.1231 \\ -0.0001 & 0.0000 & 1.0000 \end{bmatrix} \]
PSNR based image quality estimation

Original modeling image

Final panoramic image

PSNR – Peak Signal-to-Noise Ratio

\[ PSNR = 20 \log_{10} \left( \frac{1}{\text{rms}} \right) , \]

where \( \text{rms} \) – root mean square difference between two images

PSNR = +44.46dB

This value indicates that the stitching is of high quality
Conclusion

• Panoramic images were generated from two and several ultrasonic images received by linear array

• Developed program module has good runtime performance and stability

• Final panoramic image is of high quality

• At present, modeling data for phased array are obtained
Thank you for your attention!