International Workshop on Depth Image Analysis
November 11, 2012
Tsukuba Science City, Japan

Extraction and Visualization of Cardiac Beat by Grid based Active Stereo

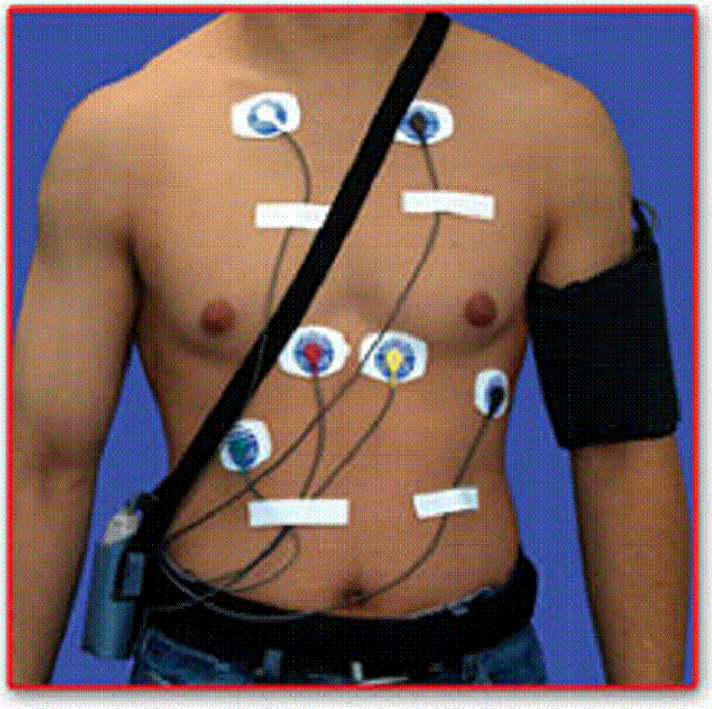
Hirooki Aoki[1], Ryo Furukawa[1], Masahito Aoyama[1], Shinsaku Hiura[1],
Ryusuke Sagawa[2] and Hiroshi Kawasaki[3]

[1] Hiroshima City University, Japan
[2] National Institute of Advanced Industrial Science and Technology, Japan
[3] Kagoshima University, Japan

Cardiac Beat Measurement

- Electrogram (ECG):

Conventional method of cardiac beat measurement



Plobrems:

- Detachment of electrodes
- Uncomfortable

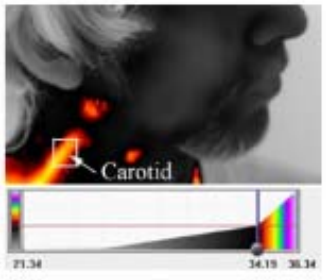
Easy and convenient cardiac beat measurement for improvement of examinee's QOL is desired.

Non-contact Cardiac Beat Measurement

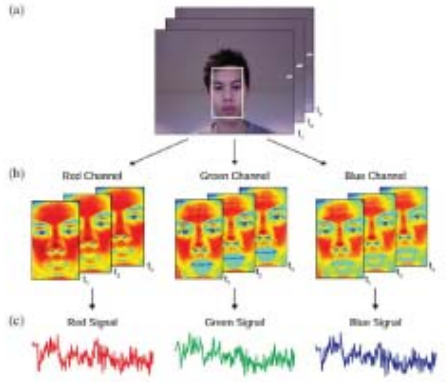
Some non-contact measurements are proposed…

1. By microwave reflectometry (Nagae et al., 2009)
2. By thermal Imagery (Garbey et al.. 2007)
3. By web camera (Poh et al., 2011)

In 1&2, expensive measurement devices are required.
3 can't properly measure cardiac beat waveform.



Garbey(2007)



Poh(2011)

Motivation

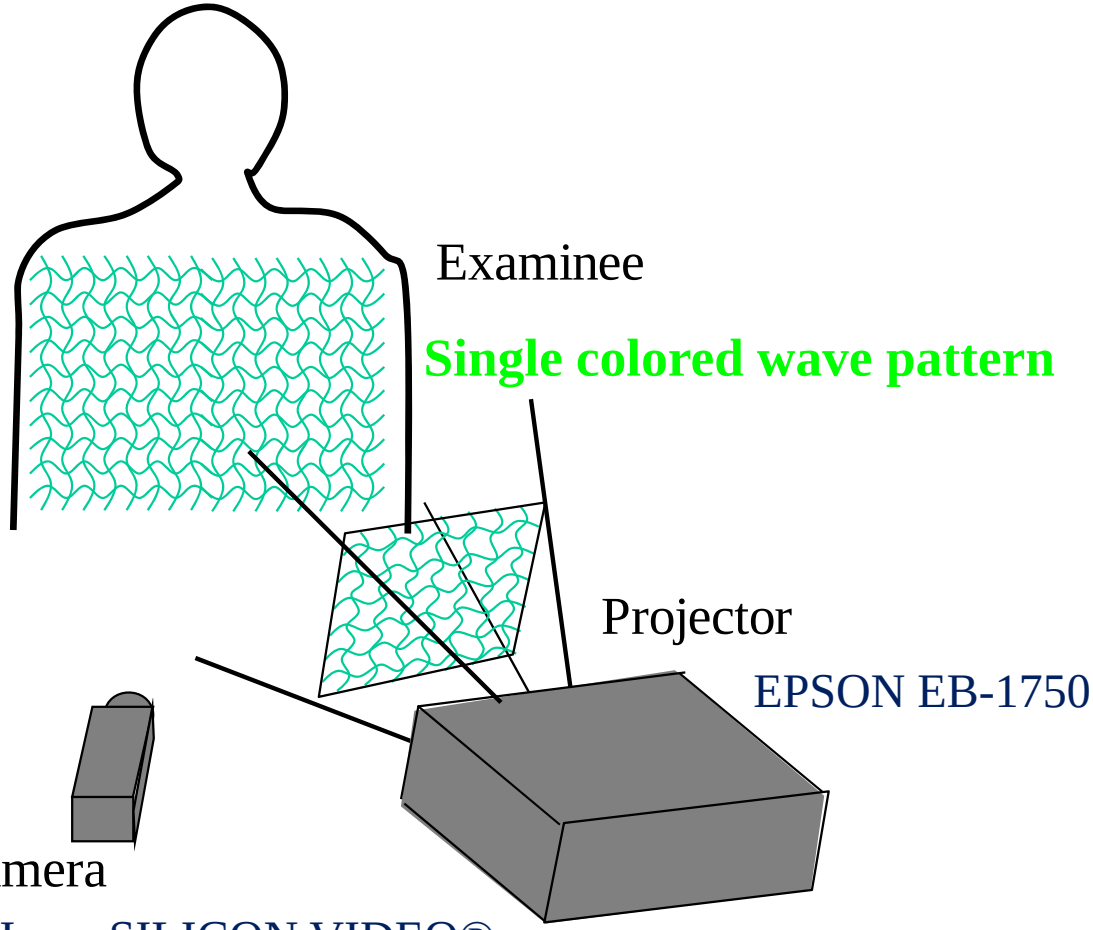
Some applications of non-contact cardiac beat measurement is expected.

- Screening for cardiac disease
- Monitoring of postoperative patient
- Autonomic function testing

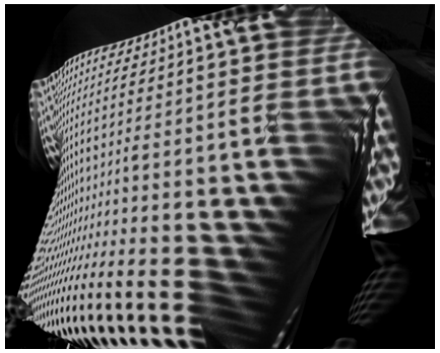
We propose non-contact cardiac beat measurement by using grid-based active stereo.

In our method, minute 3D shape change of chest surface due to cardiac pulsation is measured.

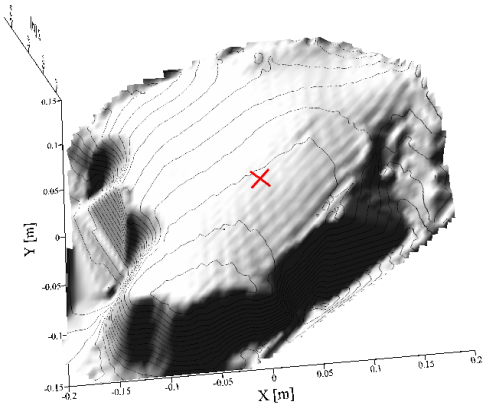
System configuration



EPIX, Inc. SILICON VIDEO®
monochrome 643M (102FPS)

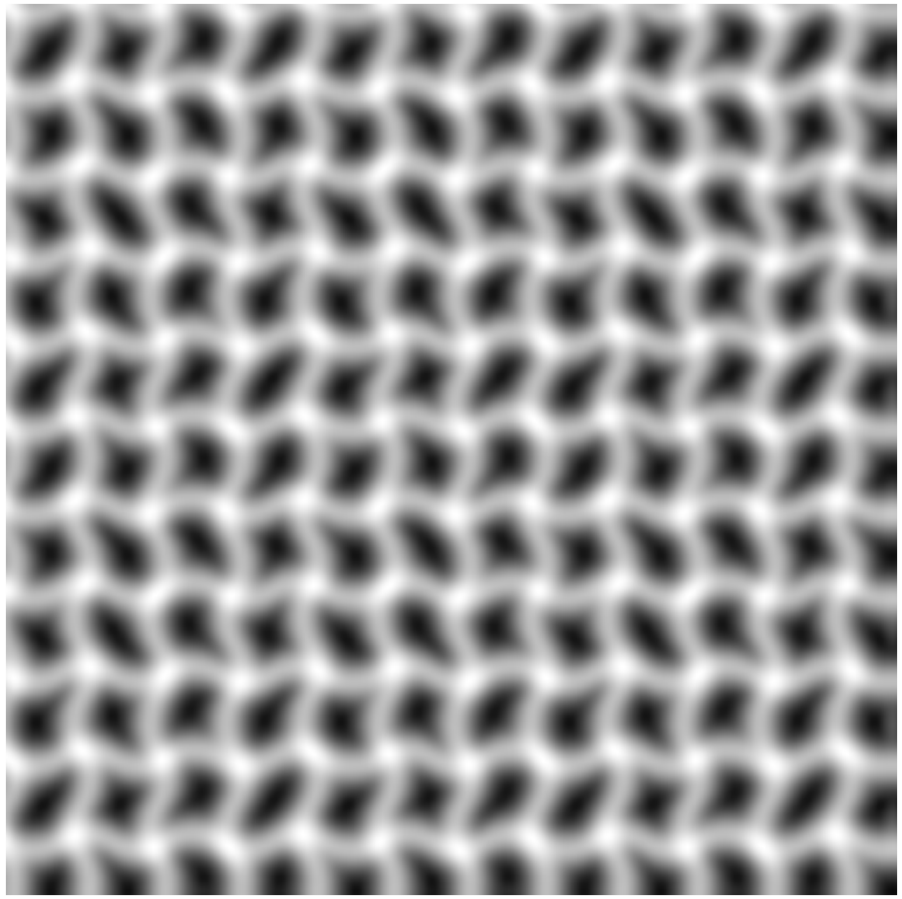


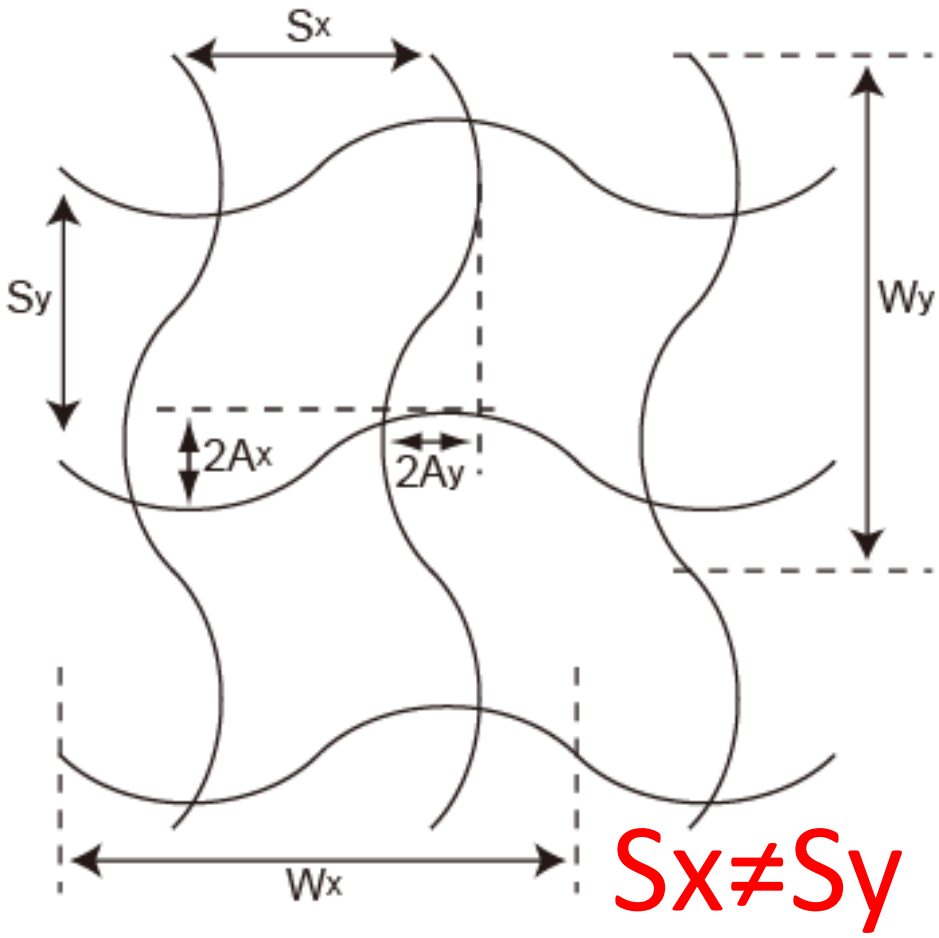
Captured image



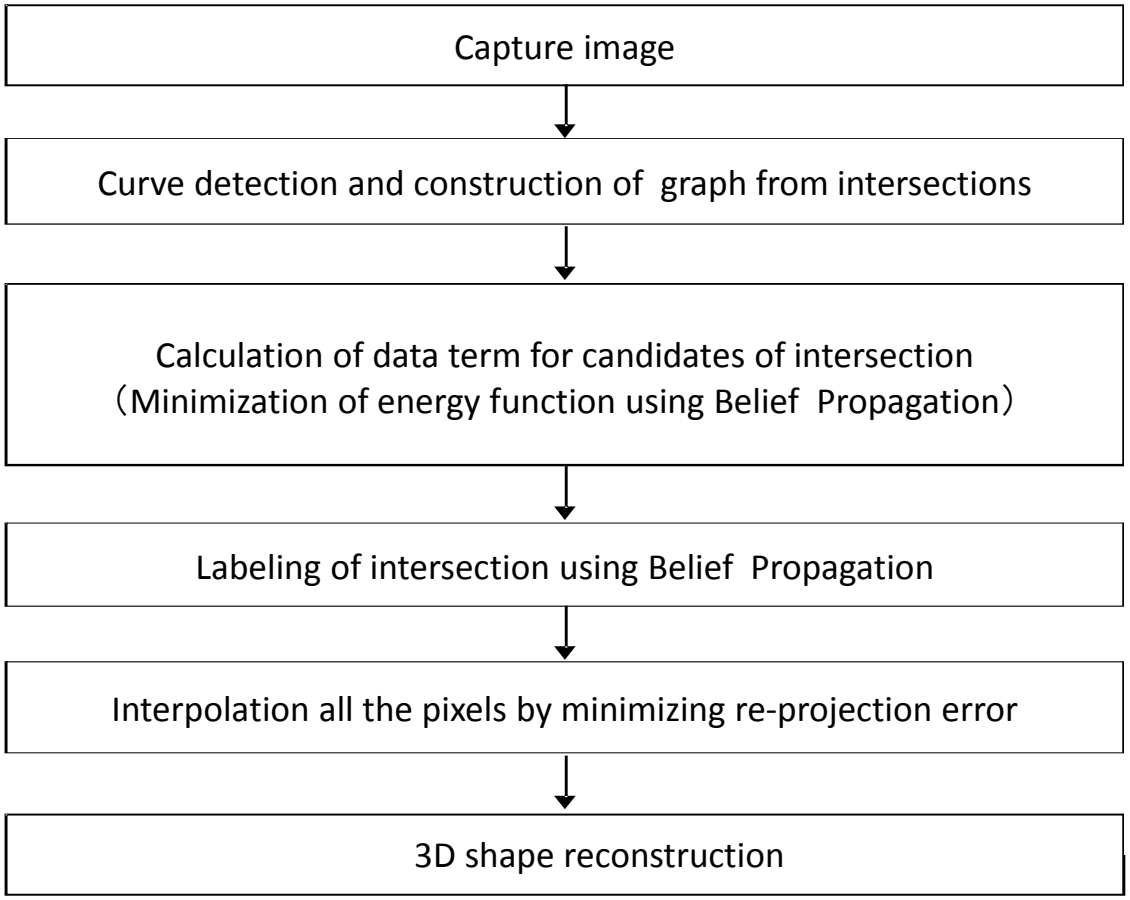
Reconstructed 3D chest shape

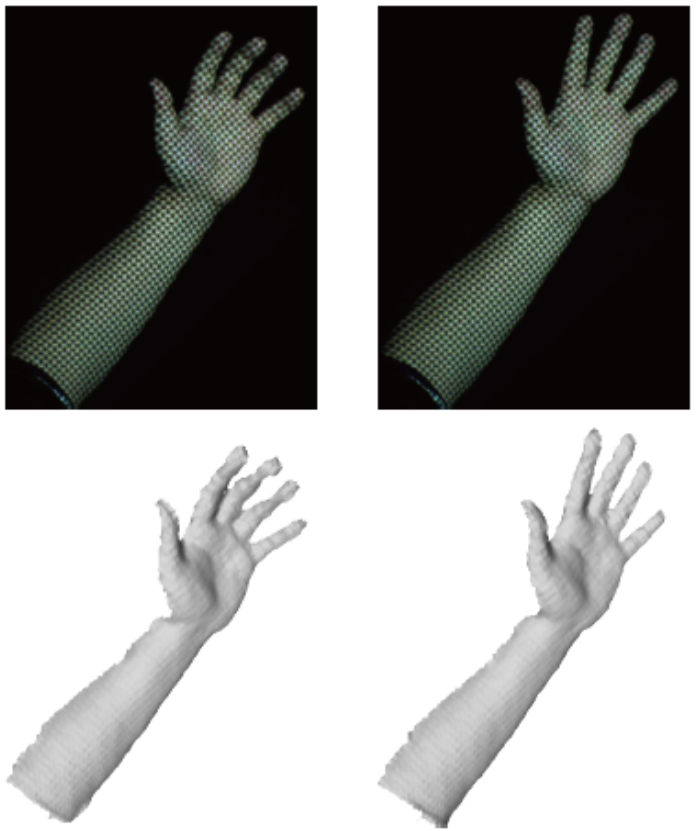
Wave pattern





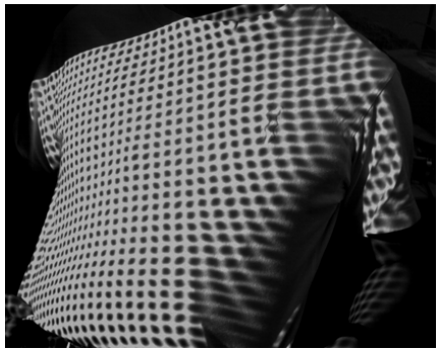
Algorithm for 3D reconstruction





R. Sagawa et al.: ” Grid based Active Stereo with Single-colored Wave Pattern for Dense One-shot 3D Scan,” 3DIMPVT2012

Extraction of cardiac beat



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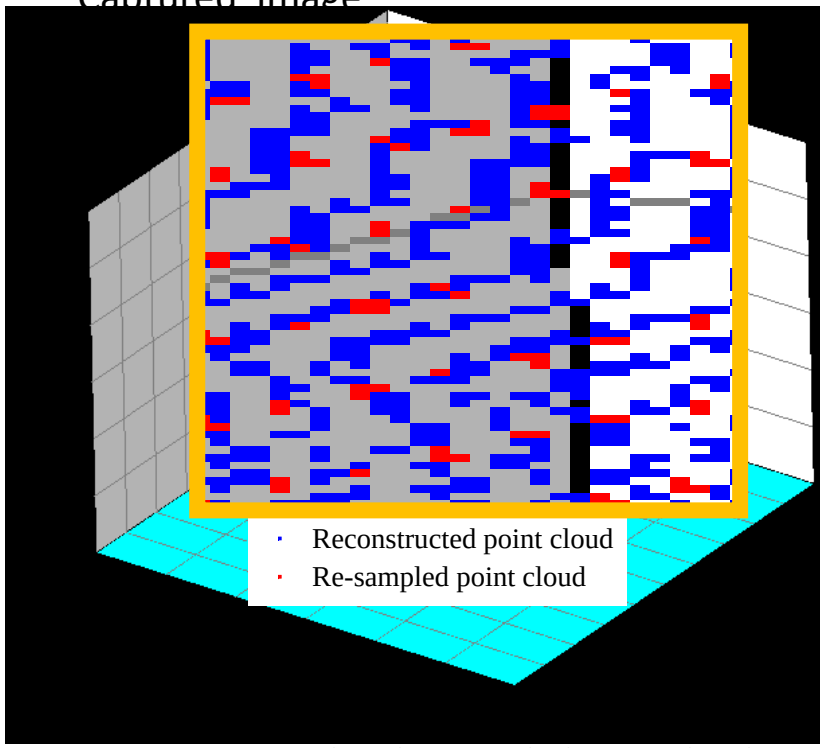


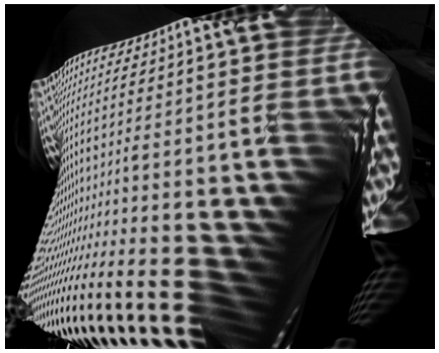
Reconstructed and resampled point cloud

Resampling reconstructed point cloud

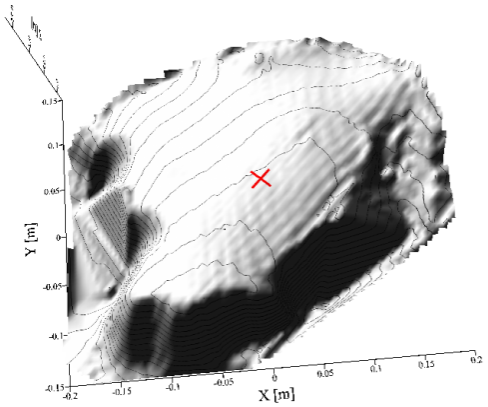
Calculation of inter-frame depth change

Extraction of cardiac beat by FFT filter

Extracted waveform

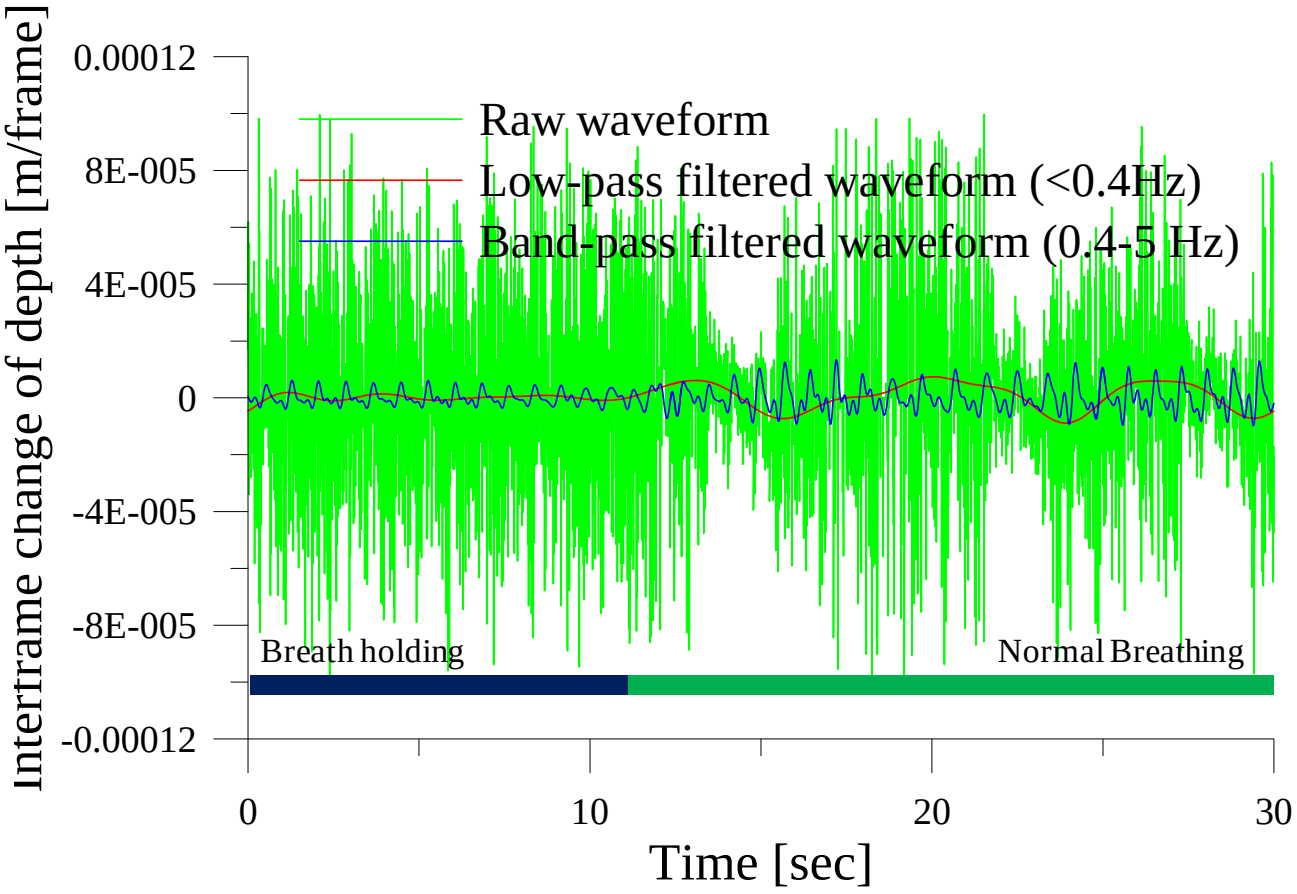


Captured image

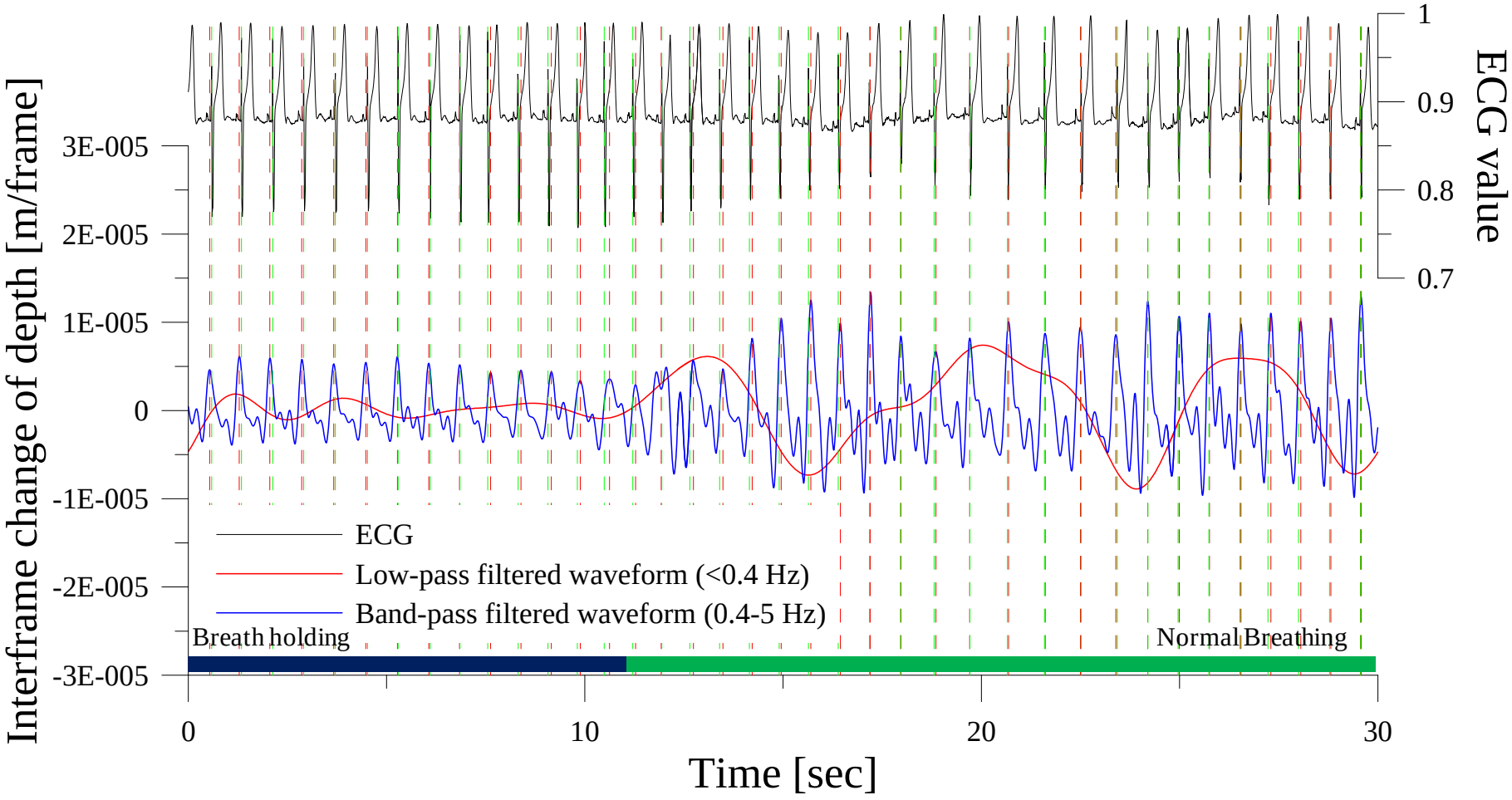


Reconstructed 3D chest shape

Measurement waveform (at X-point)



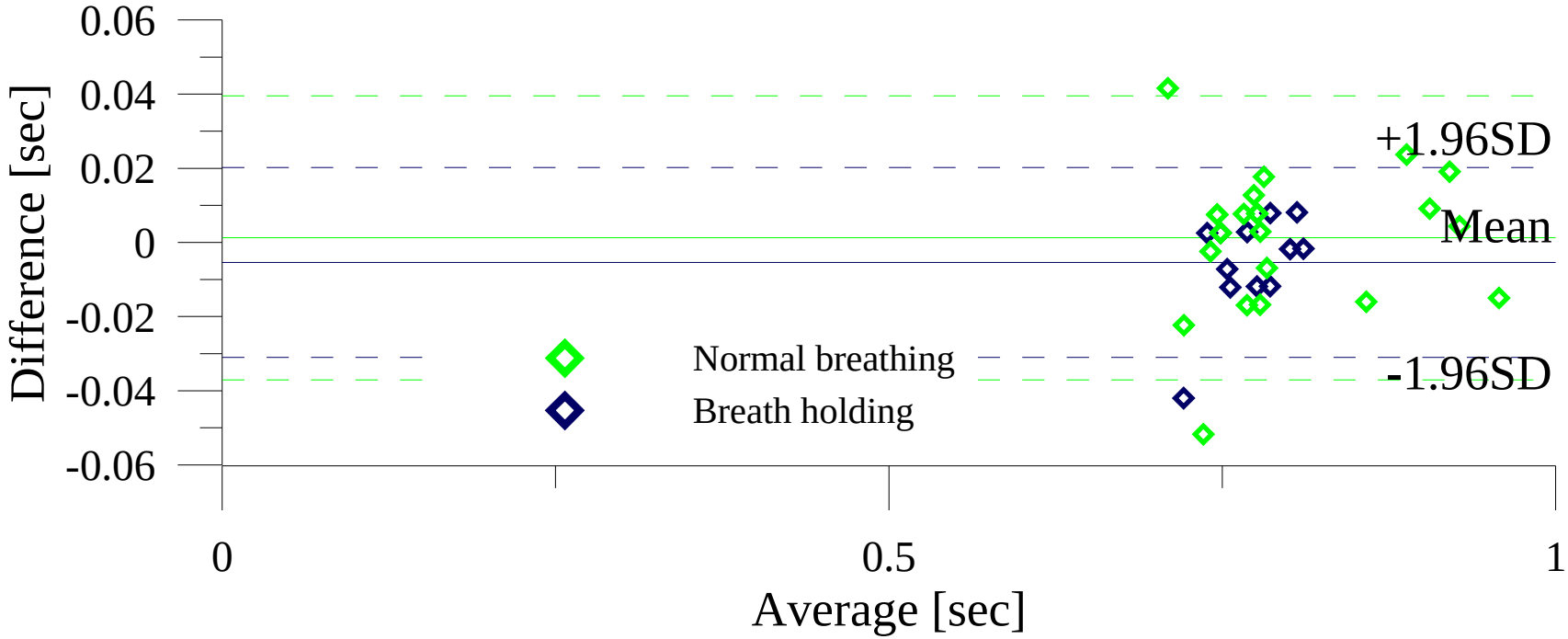
Comparison to ECG



Correspondence on peak interval

Comparison on peak intervals

Bland-Altman plot

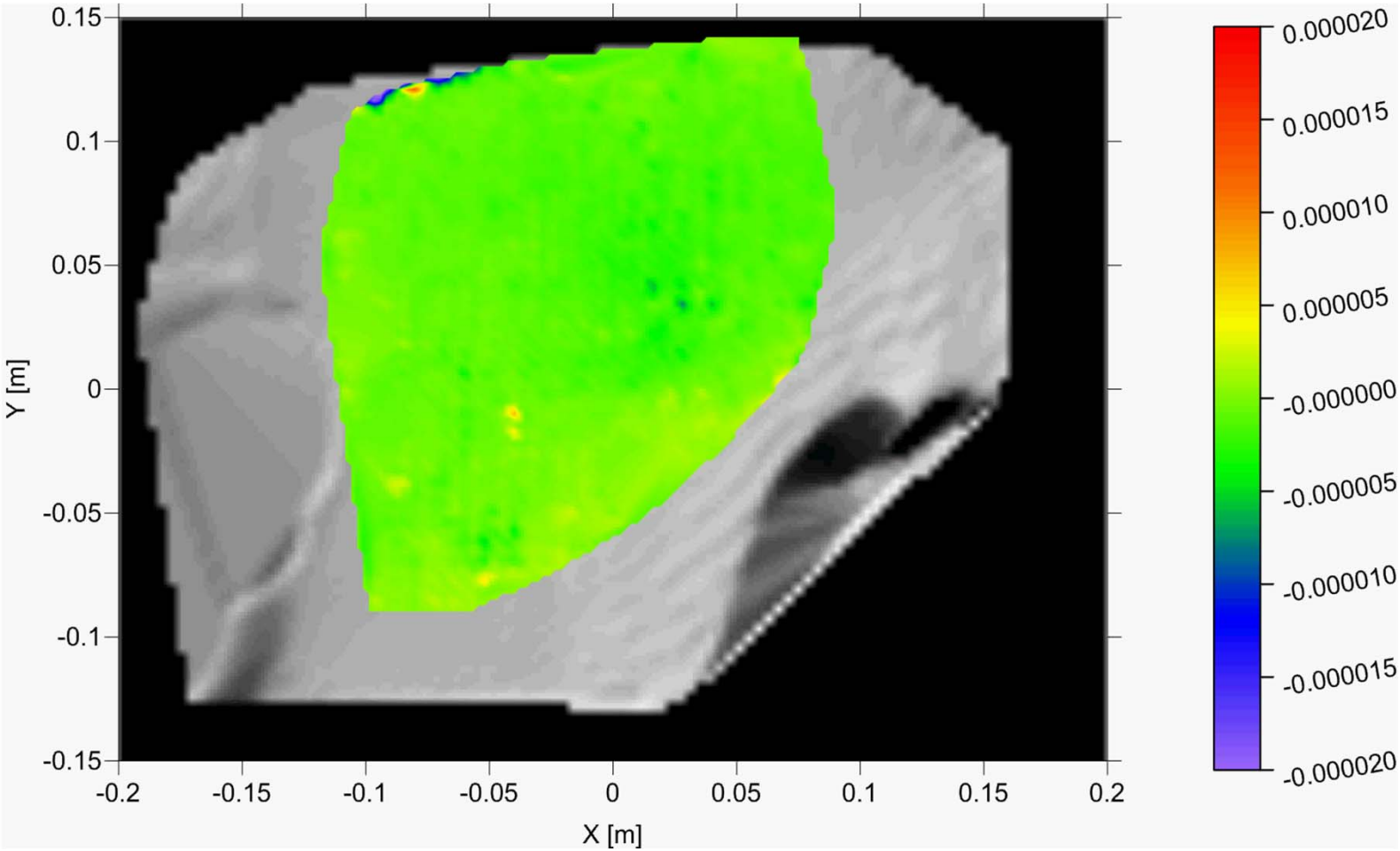


95% Confidence interval

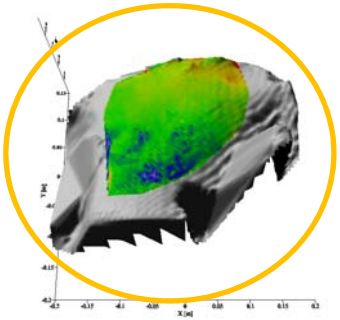
Breath holding : -0.005383 ± 0.02561 [sec]

Normal breathing : 0.001236 ± 0.03830 [sec]

Visualization of cardiac beat



Visualization of cardiac beat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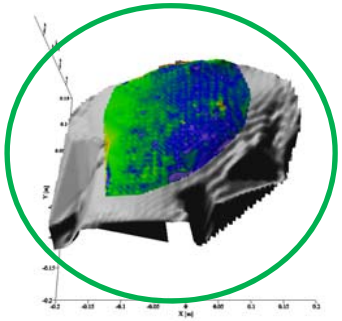
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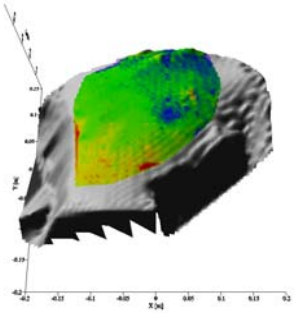
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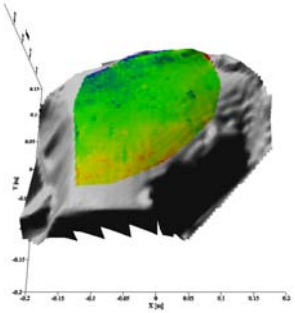
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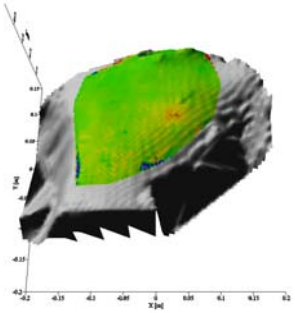
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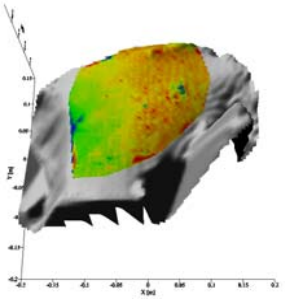
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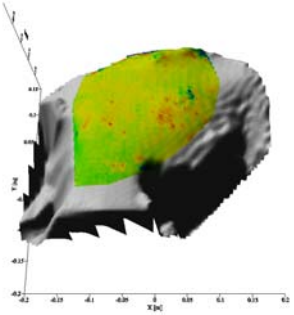
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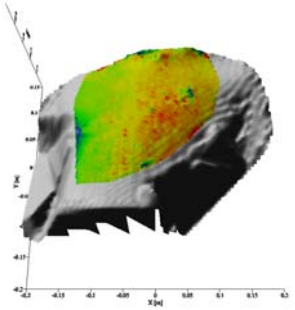
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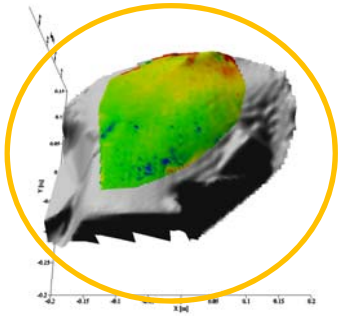
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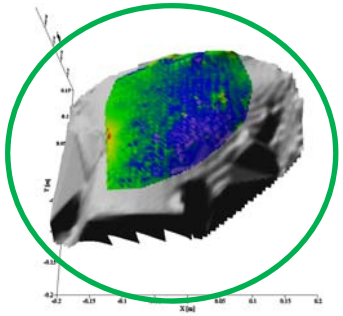
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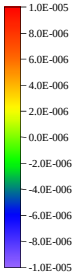

[m/frame]

Conclusion

We propose the extraction of cardiac beat from 3D shape information of body surface by using grid-based active stereo, and basically examine the validity of proposed method.

By simultaneous measurement ECG, there are correspondence between peak intervals in measurement waveform.

This result suggests that non-contact measurement of cardiac beat is realized by the active stereo.

We tried the visualization of the spatial distribution of inter-frame depth change plotted on the 3D shape of chest region.

And, periodically depth change by cardiac beat is found on.

Thank you for your attention.