Advanced data fusion
in 4-D color doppler volume visualization

Geir Smestad Paolo Angelelli Helwig Hauser
Institute of Informatics, UiB – http://www.ii.uib.no/vis

Introduction

- Modern ultrasound scanners can acquire 4-dimensional interleaved tissue and doppler data in realtime
- Visualizing such combined streams of time-dependent volumetric data requires new compositing strategies to convey both the information and avoid occlusion
- The objective of this project is the development of advanced methods to solve these challenges.

The methods presented here can be classified in 2 different categories

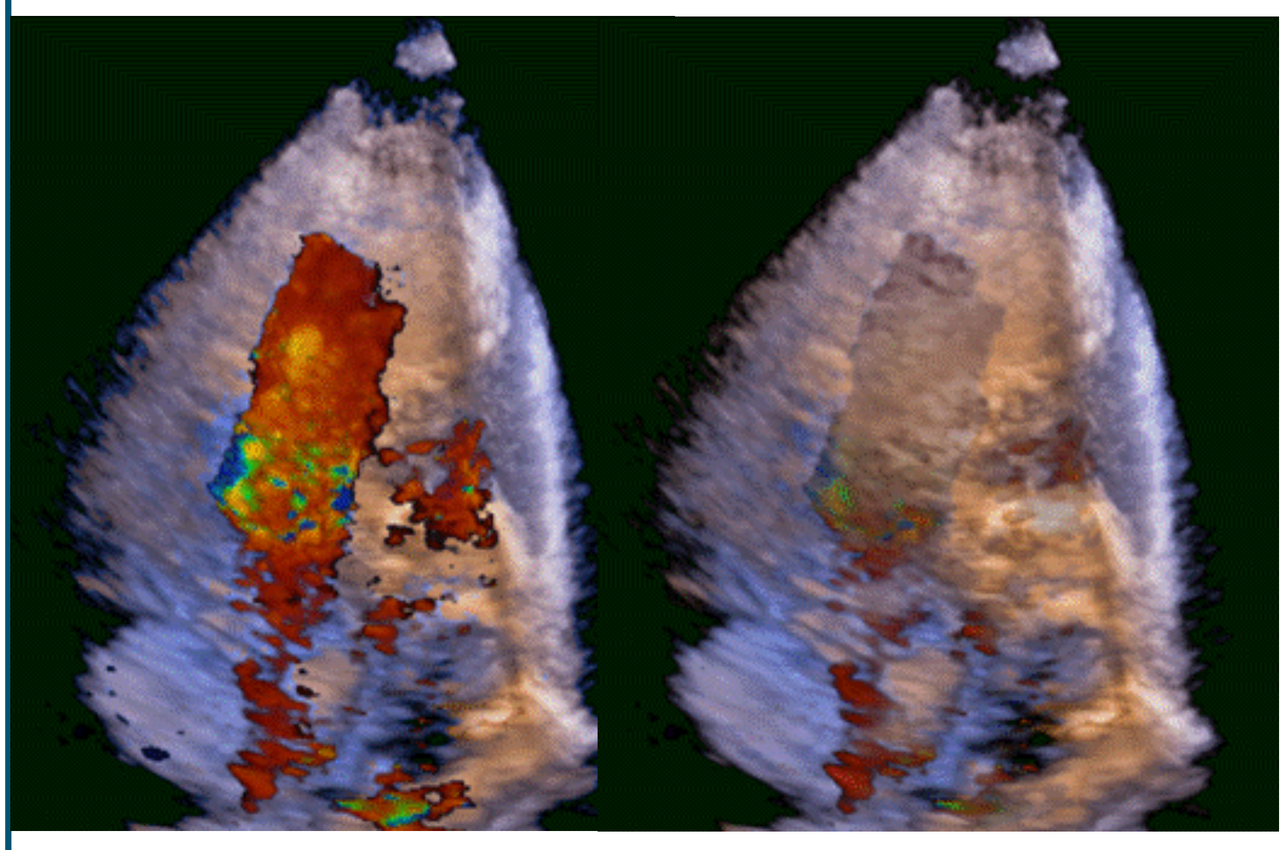
(1.) Information-revealing

(2.) Depth perception enhancement

The methods in the **first** cathegory aim at solving the occlusion and fusion problems in presence of two different information sources in the same physical space.
The methods in the **second** cathegory aim at restoring, and enhancing, the spatial depth perception of the rendered structures. This is especially necessary in a multiple information sources context as it becomes challenging to convey the relative position of the structures coming from the different data sources.

Method

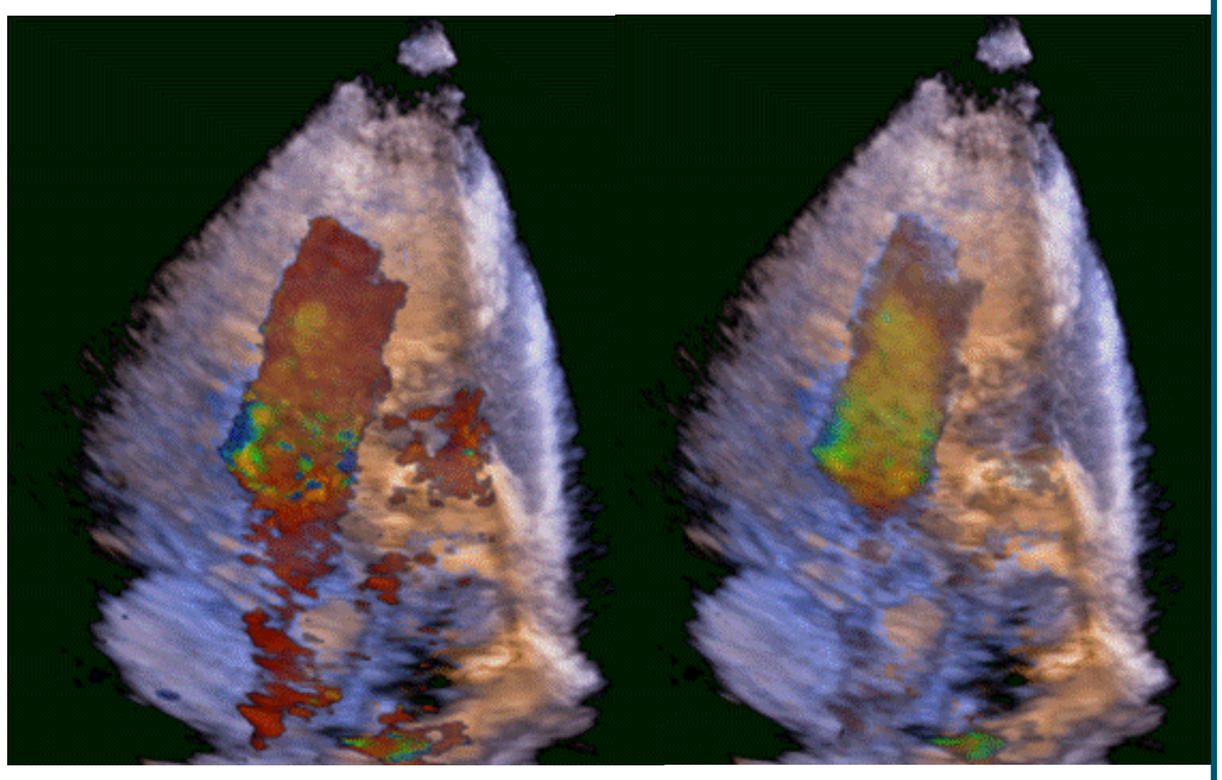
The following techniques have been developed and combined to enahce the multimodal visualization of 4D B-mode and color doppler:



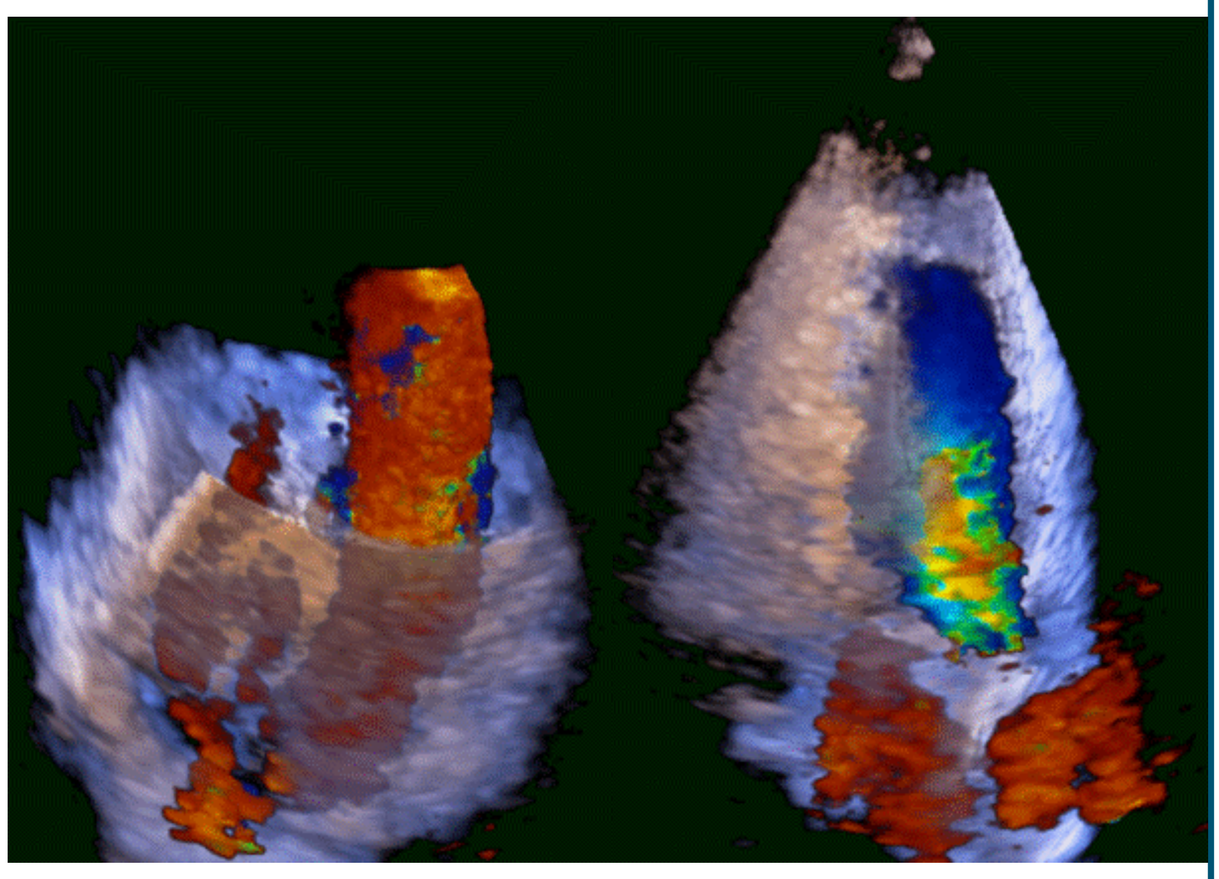
Left: Volumetric cut-away of the tissue occluding the doppler information. Notice the loss in depth perception: the doppler volume appears in front of the tissue. **Right**: opacity modulation of the tissue in the cut-away in front of the doppler volume. The depth perception is now improved, at the expenses of the visibility

Method - continued

(a) Volumetric cut-away of the b-mode data occluding the doppler data (cat. 1)
(b) Direct volume rendering (compositing) of the doppler data to reveal the content of the doppler volume (cat. 1)
(c) Opacity modulation of the volumetric cut-away (cat. 1)
(d) Axis-aligned b-mode crops (cat. 1/2)
(e) Automatic camera small orbiting to exploit motion parallax for depth perception (cat 2)



Left: standard representation of the doppler data combined with volumetric cut-away and opacity modulation. **Right**: the doppler data is rendererd using the volume rendering equation, uncovering the inner part of the flow



Rendering of the b-mode and doppler data with an axis aligned crop applied only to the b-mode data. **Left**: crop along the z-axis. **Right**: crop along the x-axis.

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References

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Contact: Paolo Angelelli <paolo@ii.uib.no>

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