Mindray Vascular Symposium, March 2021

Synthetic Aperture Imaging

Robert Gill, PhD

Conventional ultrasound imaging

- The standard for 50 years or more.
- An ultrasound pulse is transmitted into the patient
  - travels along a focussed *transmit beam*.
- The machine detects echoes returning from within a *receive beam*.
- The echoes are processed and displayed in the image along a line.
- The beam steps to a series of different positions to build an image.

Limitations

- Image resolution (lateral) determined by beamwidth
  - the user sets the depth at which the beam is focussed.
- Multiple focus operation is possible but it reduces frame rate significantly.
- The frame rate (images per second) is limited by depth.
- Additional modes (colour Doppler, harmonics, compound imaging) slow the frame rate further.
- So the classical approach can only focus at one depth (or several depths when using multiple focus) and it has limited frame rate.

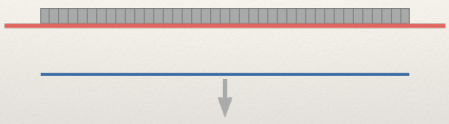
Synthetic Aperture Imaging

- A totally different way of making the image
  - has a number of advantages.
- Used for many years in other types of imaging.
- Originally not feasible for ultrasound due to technological limitations, but technology has caught up.

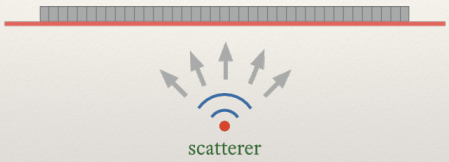
Concept

- Transmit ultrasound with a broad beam.
- Receive and digitise echoes for each of the active transducer elements.
- The digitised echoes are stored in the machine's memory.
- The image is computed point by point from the echo data
  - no receive beam, optimally focussed at every point
- Fast!

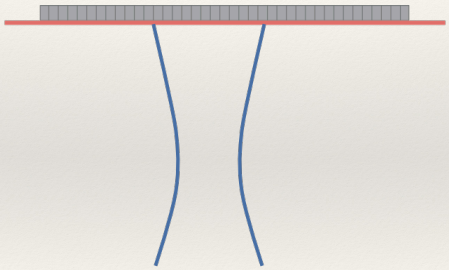
Plane wave imaging



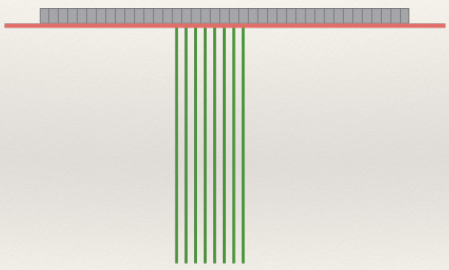
Plane wave imaging



More practical



More practical



Advantages

- Optimally focussed at all depths.
- Fast. A significant part of the image can be made with one transmit pulse.
- High speed imaging allows extra modes of operation and image enhancement.
- Also great for tracking blood and tissue motion
  - strain imaging, elastography, vector blood flow imaging.
- We may see the old “conventional” paradigm disappear in time.