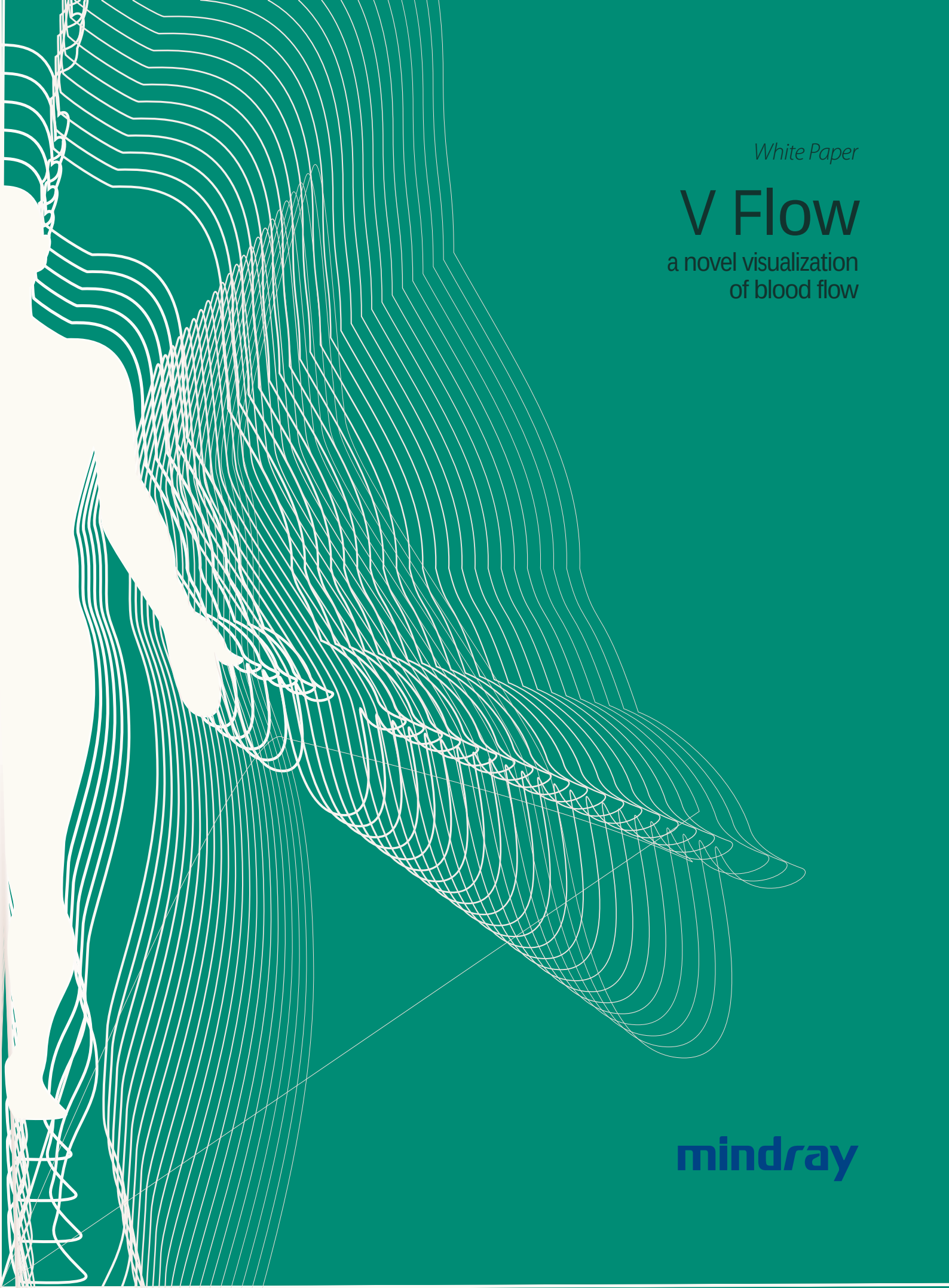

White Paper

V Flow

a novel visualization of blood flow

mindray

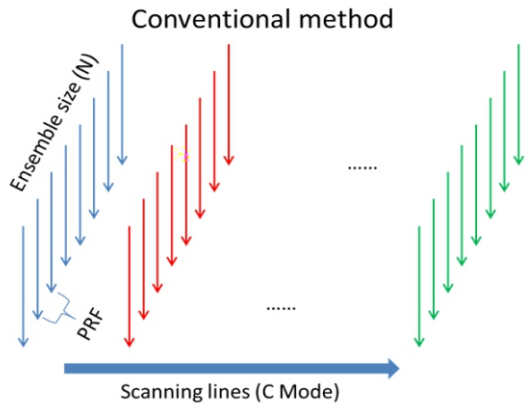

Fig. 1: Scan sequence of conventional CFM

CFM technical limits

By increasing the pulse repetition frequency (PRF), the frame rate of the color Doppler image can be increased. This also increases the maximum detectable velocity and reduces the aliasing problem. However, the PRF is also restricted to the maximum scanning depth as there has to be enough time for a round trip of the wave. For example, examination of a common carotid artery requires an image display with a depth of 4 to 5 cm. The maximum PRF is then around 15KHz, which is calculated by PRF = 1/(Depth

V Flow works differently

In Mindray's new ultrasound system Resona 7, a much more powerful and newly structured platform with an extremely high frequency is used, and is very flexible due to the availability of arbitrary beamforming methods. Therefore, multiple image lines will be generated after a single transmission, and continuous Doppler transmission scanning is applied for the same region of interest, thus continuous clutter filtering can be achieved, to avoid a transient state compared to the conventional color Doppler imaging.

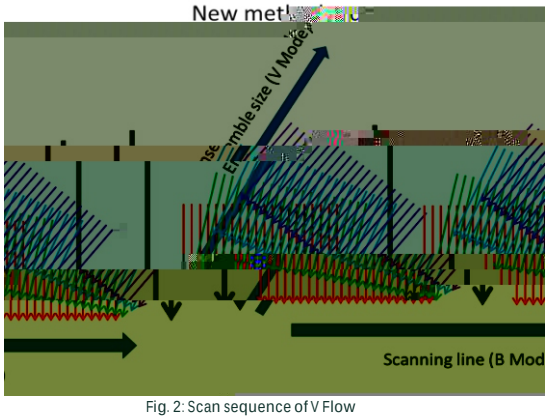

Fig. 2: Scan sequence of V Flow

To derive the direction of velocity of flow at any location, multi-directional transmissions and receptions are employed as shown in Fig. 2, and then a true velocity with accurate direction can be calculated by an angle-compounding technology as shown in Fig. 3, which shows an example where compounding and regression analysis of two angles is applied giving more angles, resulting in an over-determined system [7-9]. The velocities at any location are obtained as long as the area is scanned by the multi-directional beams. Focused beams are also transmitted alternatively and used to generate B-mode image lines. The interleaved transmissions with multi-directional and focused beams, ensure both high-sensitivity vector flow imaging and high-resolution B-mode imaging, respectively [10].

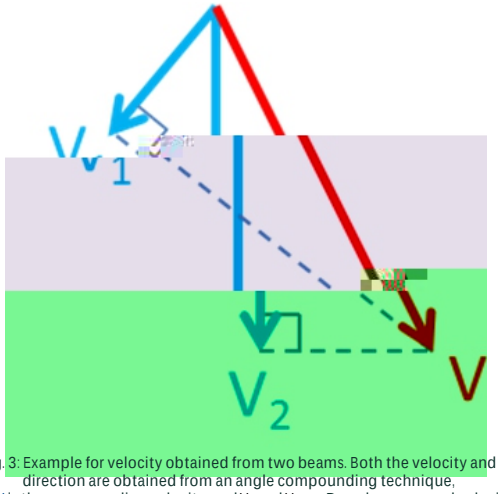

Fig. 3: Example for velocity obtained from two beams. Both the velocity and direction are obtained from an angle compounding technique, where V is the compounding velocity, and V_1 and V_2 are Doppler measured velocities.

Innovative display technology

In order to demonstrate the blood flow more intuitively, an innovative display has been developed [7]. The vector velocities at arbitrary locations within the ROI can be derived at each time instance and thus the fluidity of blood can be achieved by continuously updating the positions of detected red blood cells in the vessel according to the calculated vector velocities as shown in Fig. 4. In this system, colored arrows are used to present both velocity and direction of the flow. The length of the arrow also denotes the velocity. The quantitative values including velocities and their directions can be shown where the cursor is located as presented in Fig. 5 [11]. An adjustable ROI can be manipulated arbitrarily by users, where the maximum and mean velocities are displayed, and the variance of the flow angles inside ROI is calculated, which is a good way to give a quantitative measure for the turbulence.

Measurement of volume flow for carotid artery as shown in Fig. 9.

Quantitative measures provided by V Flow

V Flow can provide unique quantitative measurements, including velocities curves (Fig. 8), volume flow (Fig. 9), and WSS (Fig. 10) for clinical studies.

Three velocity curves along with time are plotted at the bottom of the image as shown in Fig. 8.

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