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Efficient method for blood flow measurements

Patent Status

- PCT patent pending

Keywords

Blood flow simulation, Computational fluid dynamics, Medical imaging, MRI, CT, Phase contrast, Doppler ultrasound

Summary

A new blood flow measurement enhancement method has been developed, to obtain accurate and highly resolved patient-specific local blood flow information. The method uses sparse information from medical imaging modalities, without having to perform any computational fluid dynamic simulations. It can be used for e.g. atherosclerotic plaque rupture risk predictions.

Background

Obtaining high quality flow field estimations with secondary flow quantities such as wall shear stress (WSS) and oscillatory shear index (OSI) can be very useful in medical diagnostics (Fig. 1). However, measuring accurate blood flow information with suitable resolution is a very challenging task. Most flow measurement techniques can only resolve sparse information and then have to rely on flow simulations to provide high resolution data. This involves a huge computational effort which is very time consuming and only a limited amount of measured information can be integrated in the final result.

Invention

An entirely new approach is proposed to obtain high-quality blood flow fields from sparse flow measurement data *in vivo*.

The presented method uses a database of pre-computed high quality blood flow data, from which an interpolation is made based on a partial measurement, thus resulting in a high quality flow field (Fig. 1). All the simulation work is done beforehand so as to accumulate knowledge of the blood flow patterns typically occurring in a given vascular location, which is then used to perform an intelligent interpolation based on the measurement data.

This approach simultaneously overcomes both the major drawbacks of flow simulation techniques: as no numerical problems are solved at run time, the flow field can be recovered in a very short time and a maximal amount of measurement information can be used to constrain the reconstruction (Fig. 2).

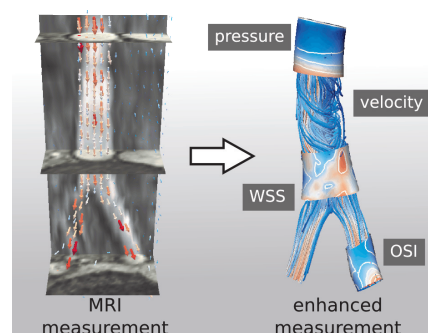


Fig. 1: Based on partial measurements using phase contrast MRI combined with simulation data, high quality patient-specific blood flow fields in the abdominal aortic bifurcation can be obtained.

Features & Benefits

- Highly detailed blood flow field estimation can be recovered in a couple of minutes
- Can be used with MRI, CT or Ultrasound imaging modalities
- Scalable complexity at no added cost
- Increased measurement fidelity
- No computational flow simulations required at run time

Field of Application

Biomedical imaging:

- Patient-specific flow imaging for blood or cerebrospinal fluid for e.g.:
 - estimating aneurysm rupture risk
 - predicting risk of atherosclerotic plaque deposition and rupture
 - predicting medication delivery
- Initial focus will be on the major arteries, with the potential to extend to the entire vascular network

Other applications:

- Fast flow field prediction for internal flows
- Experimental fluid dynamics:
 - wind tunnel measurements
 - visualizing flow in reactors

P.t.o. →

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Efficient method for blood flow measurements (cont.)

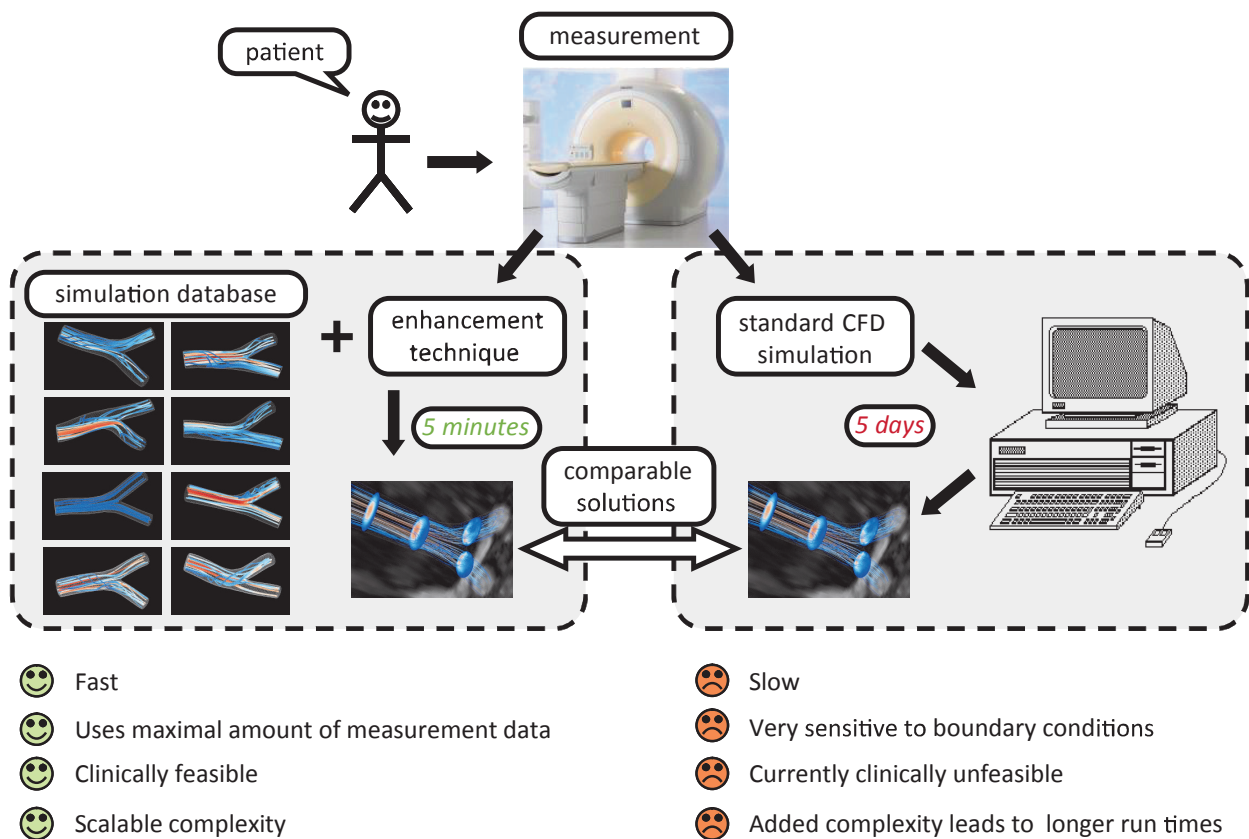


Fig. 2: A comparison of the blood flow measurement enhancement method (left) and the state of the art method (right) for blood flow simulation via computational fluid dynamics (CFD).