This book contains invited lecturers and full papers presented at VIPIMAGE 2011 - III ECCOMAS Thematic Conference on Computational Vision and Medical Image Processing (Olhão, Algarve, Portugal, 12-14 October 2011). International contributions from 16 countries provide a comprehensive coverage of the current state-of-the-art in:

- Image Processing and Analysis;
- Tracking and Analyze Objects in Images;
- Segmentation of Objects in Images;
- 3D Vision;
- Signal Processing;
- Data Interpolation, Registration, Acquisition and Compression;
- Objects Simulation;
- Medical Imaging;
- Virtual Reality;
- Software Development for Image Processing and Analysis;
- Computer Aided Diagnosis, Surgery, Therapy and Treatment;
- Computational Bioimaging and Visualization;
- Telemedicine Systems and their Applications.

Related techniques also covered in this book include the level set method, finite element method, modal analyses, stochastic methods, principal and independent components analyses and distribution models. 

Computational Vision and Medical Image Processing - VIPIMAGE 2011 will be useful to academics, researchers and professionals in Computational Vision (Image Processing and Analysis), Computer Sciences, Computational Mechanics and Medicine.
Computational Vision and Medical Image Processing

VipIMAGE 2011

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Table of contents

Preface x
Acknowledgements xiii
Invited lectures xiv
Thematic sessions xv
Scientific committee xvii

Invited lecturers
Towards human-stance evaluation 3
C. Fernandez, J. Gonzalez & X. Roca
Finite-context models for image compression 9
A.J. Pinho
Learning classifier families for object detection and parameter estimation 15
S. Sclaroff, A. Thangali, Q. Yuan & V. Ablavsky

Contributed papers
Generation of planar radiographs from 3D anatomical models using the GPU 19
A.S. Cardoso, D.C. Moura & J.G. Barbosa
An on-line system for medical and biological image sharing 23
G.M. Fereidoon, L.A.P. Neves, L.C.M. de Aquino & G.A. Giraldi
Steps replacement-different ways to replace its function 27
F. Gerstl, C. Garbe, M. Parente, P. Martin, R.N. Jorge & J. Paço
Vision-based hand segmentation techniques for human-robot interaction for real-time applications 31
P. Trigueiros, F. Ribeiro & G. Lopes
Database implementation for clinical and computer assisted diagnosis of dermoscopic images 37
The finite element analysis of skull deformation after correction of scaphocephaly 43
W. Wolinski, M. Gzik, E. Kawlewska, D. Larysz & P. Larysz
Modeling and simulation of trigonocephaly correction with use of Finite Elements Method 47
M. Gzik, W. Wolinski, E. Kawlewska, K. Kawlewska & D. Larysz
Computer-aided diagnosis of dementia using medical imaging processing and artificial neural networks 51
G. Gavidia, R. López & E. Soundah
Automated extraction of the Femoral Shaft Axis and its distal entry point from full and reduced 3D models 57
S. Van Caaster, M. De Beule, A. Van Herre, P. Venholt & B. Verhegge
Facial expression recognition using MPEG-4 FAP-based 3D MMM 63
H. Uije & M. Svoor
Flow visualization of trace particles and Red Blood Cells in a microchannel with a diverging and converging bifurcation

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ABSTRACT: This paper aims to investigate the effect of both diverging and converging bifurcations on the flow behaviour of Pure Water (PW) and Red Blood Cells (RBCs). A confocal micro-PTV system is used to visualize and measure the flow characteristics of the working fluids. The results show no formation of a Cell-Free Layer (CFL) around the apex of the bifurcation. In contrast, there is a clear formation of a triangular CFL just downstream of the confluence apex. As a result, this triangular CFL seems to play an important role on the in vitro blood flow characteristics at this region.

1 INTRODUCTION

Blood flow behaviour in both in vivo and in vitro environments has been investigated for several years [1-4]. However, studies performed by Suzuki et al. [3] and Pries, et al. [4] have found conflicting results between in vivo and in vitro experiments with respect to the blood rheological properties. Potential causes for the observed in vivo/in vitro discrepancies are the effect of the endothelial surface layer, the presence of white blood cells and the complex microvascular networks composed by diverging and converging bifurcations [2]. In order to better understand the observed discrepancies we need to investigate in more detail the effect of both diverging and converging bifurcations on the rheological properties of blood. Therefore, the aims of the present paper is to visualize and measure the flow characteristics of both trace particles suspended in pure water and in vitro blood in a diverging and converging bifurcation. The experimental flow visualizations and measurements will be performed by means of a confocal system combined by image analysis techniques from ImageJ.

2 MATERIALS AND METHODS

2.1 Working fluids and microchannel geometry

Two working fluids were used in this study: pure water (PW) with fluorescent trace particles of 1 µm and Dextran 40 (Dx-40) containing about 14% (14Hct) of human RBCs. The washed RBCs were fluorescently labelled with a lipophilic carbocyanine derivative dye, chloromethylbenzamido (CM-Dil, Molecular Probes), using a previously described procedure [5].

The polydimethylsiloxane (PDMS) microchannels used in this study were fabricated using a soft lithography technique [6] and consist of a diverging bifurcation and converging bifurcation (also known as confluence). Fig. 1 shows the dimensions of both diverging and converging bifurcations used in the present study.

2.2 Experimental set-up

The confocal micro-PTV system used consists of an inverted microscope combined with a confocal scanning and a diode-pumped solid state (DPSS)
Figure 1. Dimensions of the a) diverging and b) converging bifurcation used in this study. The channel dimensions are in μm.

Figure 2. Trajectories in a diverging bifurcation of a) fluorescent particles in PW and b) labelled RBCs in D × 40.
and as a result they tend to flow in the centre of the microchannel, just downstream of the confluence apex. However, for the case of labelled RBCs we could not measure any trajectory passing in this centre region (see Fig. 3b). This is due to the existence of a cell-free layer (CFL) in both inner walls and a consequent formation of a triangular CFL in the region of the confluence apex (see Fig. 4). As this triangular CFL seems to play an important role on the in vitro blood flow characteristics, a detailed quantitative study, to clarify the CFL effect in the velocity profiles, is currently under way.

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