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**EUROCAST 2017**

# **Computer Aided Systems Theory**

**EXTENDED ABSTRACTS**

**16th International Conference on Computer Aided Systems Theory  
Las Palmas de Gran Canaria, Spain, February 2017**



**Sixteenth International Conference on  
COMPUTER AIDED SYSTEMS THEORY**

**EUROCAST 2017**

Edited by

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# eurocast 2017

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## Preface

The concept of CAST as Computer Aided Systems Theory was introduced by Franz Pichler of Linz in the late 80's to name computer theoretical and practical tools for problems in System Science. It was thought as the third component (the other two being CAD and CAM) that will provide for a complete picture of the path from Computer and Systems Sciences to practical developments in Science and Engineering.

Franz Pichler organized in the University of Linz the first CAST workshop in April 1988, which demonstrated the acceptance of the concepts by the scientific and technical community. Next, Roberto Moreno-Díaz, of the University of Las Palmas de Gran Canaria joined Franz Pichler, motivated and encouraged by Werner Schimanovich, of the University of Vienna (present Honorary Chairman of Eurocast), and they organized the first international meeting on CAST, (Las Palmas February 1989), under the name EUROCAST'89 that again proved to be a very successful gathering of systems theorists, computer scientists and engineers from most of European countries, North America and Japan. It was agreed that EUROCAST international conferences would be organized every two years, alternating between Las Palmas de Gran Canaria and a continental Europe location, being later decided to celebrate them in Las Palmas. Thus, successive EUROCAST meetings took place in Krems (1991), Las Palmas (1993), Innsbruck (1995), Las Palmas (1997), Vienna (1999), Las Palmas (2001), (2003), (2005), (2007), (2009), (2011), (2013) and (2015) in addition to an extra-European CAST Conference in Ottawa in 1994. Selected papers from those meetings were published by Springer-Verlag Lecture Notes in Computer Science nos. 410, 585, 763,1030, 1333, 1798, 2178, 2809, 3643, 4739, 5717, 6927, 6928, 8111- 8112, 9520 and in several special issues of "Cybernetics and Systems: an International Journal". EUROCAST and CAST meetings are definitely consolidated, as it is shown by the number and quality of the contributions over the years.

EUROCAST 2017, to be held in the Elder Museum of Science and Technology of Las Palmas, February 19-24, continues with the approach tested in last Conferences as an International computer related Conference with a true interdisciplinary character. The participants profile is presently extended to include fields which are in the frontiers of Science and Engineering of Computers, of Information and Communication Technologies and the fields of Social and Human Sciences. The best paradigm is the Web, with its associate systems engineering, CAD-CAST tools and professional application products (Apps) for services in the social, public and private domains.

There are different specialized Workshops which, in this occasion, are devoted to: **1.-** Systems Theory and Applications, chaired by Pichler (Linz) and Moreno-Díaz (Las Palmas); **2.-** Pioneers and Landmarks in the Development of Information and Communication Technologies, chaired by Pichler (Linz), Stankovic (Nis), Kreuzer, F. and J. (USA); **3.-** Stochastic Models and Applications to Natural, Social and Technological Systems, chaired by Nobile and Di Crescenzo (Salerno); **5.-** Theory and Applications of Metaheuristic Algorithms, chaired by Affenzeller and Jacak

(Hagenberg) and Raidl (Vienna); **6.-** Embedded Systems Security, chaired by Mayrhofer and Schmitzberger (Linz); **7.-** Model-Based System Design, Verification and Simulation, chaired by Nikodem (Wroclaw), Češka (Brno), Ito (Utsunomiya); **10.-** Systems in Industrial Robotics, Automation and IoT, chaired by Stetter (Munich), Markl (Vienna), Jacob (Kempten); **11.-** Applications of Signal Processing Technology, chaired by Huemer (Linz), Zagar (Linz), Lunglmayr (Linz), Haselmayr (Linz); **12.-** Algebraic and Combinatorial Methods in Signal and Pattern Analysis, chaired by Astola (Tampere), Moraga (Dortmund), Stankovic (Nis); **13.-** Computer Vision, Deep Learning and Applications, chaired by Penedo (A Coruña), Radeva (Barcelona); **14.-** Computer and Systems Based Methods and Electronic Technologies in Medicine, chaired by Rozenblit (Tucson), Hagelauer (Linz), Maynar (Las Palmas), Klempous (Wroclaw); **15.-** CyberMedical Systems, chaired by Rudas (Budapest), Kovács (Budapest), Fujita (Iwate); **16.-** Socio-economic and Biological Systems: Formal Models and Computer tools, chaired by Schwaninger (St. Gallen), Schoenenberger (Basel), Tretter (Munich), Cull (Corvallis US), Suárez-Araújo (Las Palmas) and **17.-** Intelligent Transportation Systems and Smart Mobility, chaired by Sánchez-Medina (Las Palmas), Celikoglu (Istanbul), Olaverri-Monreal (Wien), García-Fernández (Madrid), Acosta-Sánchez (La Laguna).

In this Conference, as in prior ones, most of the credits of success are due to the chairpersons of the workshops. They, with the counselling of the International Advisory Committee, selected near 154 extended abstracts for oral presentation at the meeting, which are included in this volume. Specific instructions will be given for the preparation of the Post-Conference Publication, which will contain full papers selected, as in prior EUROCAST's, after the oral presentations. The present volume is divided in Chapters corresponding to the Workshops.

The event has been possible thanks to the efforts of the chairpersons of the Workshops in the diffusion and promotion of the Conference, as well as the selection and organization of all the material. The organizers must express their acknowledgement to all contributors and participants and to the invited speakers, Prof. Christian Müller-Scholer from Hamburg, Prof. Manuel Maynar, from Las Palmas and Prof. Jaakko Astola from Tampere, for their readiness to collaborate. Also to the Director of the Elder Museum of Science and Technology, D. José Gilberto Moreno, to the members of the Museum, and finally, to the Collaborator Institutions and to all those which contribute to the success of the Conference as a pleasant and useful scientific, technical and human event.

Las Palmas de Gran Canaria, February 2017.  
The Editors.

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# Interactive Three-Dimensional Visualization System of the Vascular Structure in OCT Retinal Images

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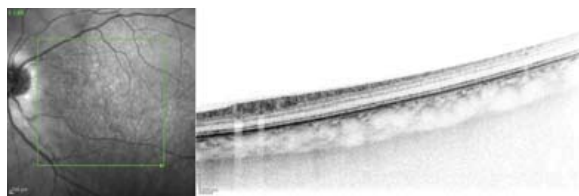
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**Abstract.** This paper proposes an automated tool for the 3D visualization of the retinal arterio-venular tree using Optical Coherence Tomography (OCT) images. The system provides useful information to the doctors that can be of a great utility to obtain accurate diagnosis in a large variability of pathologies.

**Keywords:** computer-aided diagnosis, retinal imaging, OCT, vessel tree

## 1 Introduction

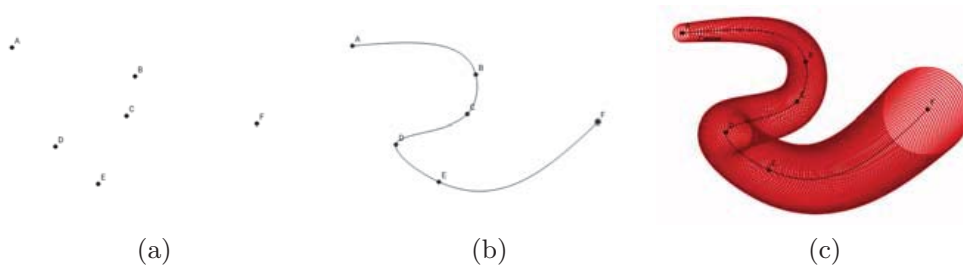
Computer-aided diagnosis (CAD) has become one of the major research subjects in medical imaging. OCT is a standard imaging technique in the ophthalmologic field because can provide non-invasive diagnostic images. This tomograph provides two types of images: a near infrared reflectance retinography and histological sections image of ocular tissues, as shown in Figure 1. Ophthalmologists use OCT retinal images for the analysis of the vascular tree and produce a diagnosis in different diseases. Therefore, the use of an automatic system for the 3D visualization of the vessel tree is relevant to facilitate the specialists work, increasing their productivity and helping to establish preventive and therapeutic strategies.



**Fig. 1.** Near infrared reflectance retinography and histological section example.

## 2 Methodology

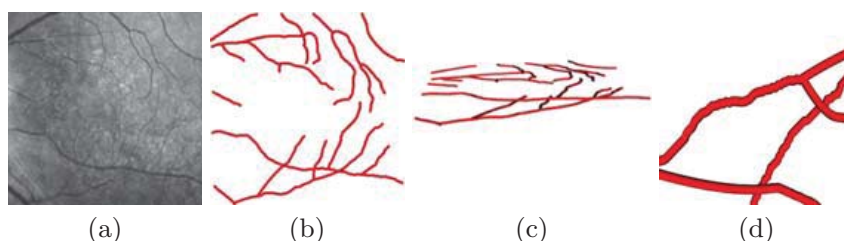
The methodology takes advantage of different image analysis techniques to initially segment the vessel tree and estimate its calibers along it [1]. Then, the corresponding depth for the entire vessel tree is obtained [2]. Finally, with all this information, the 3D reconstruction of the vessel tree is achieved, interpolating with splines all the segments to obtain a smoother representation. Figures 2 (a), (b) and (c) illustrates this 3D representation process over a curve. This model allows the visualization and manipulation of the 3D vessel tree by means of graphical transformations including translation, scaling and rotation.



**Fig. 2.** Example of 3D representation process. (a) Set of points  $(x, y, z)$  of the plane. (b) Interpolation with splines between points. (c) 3D tube along a spline.

### 3 Results and Conclusions

This automated tool for 3D visualization of the retinal arterio-venular tree has been evaluated by an expert who has validated the functionality of the system. The methodology showed promising results, providing a coherent 3D vessel tree visualization that can be posteriorly used in different medical diagnostic processes of many diseases as, for example, hypertension or diabetes. Figure 3 illustrates with an example the result of the methodology.



**Fig. 3.** Example of interactive 3D visualization of the vessel tree. (a) Input Near infrared reflectance retinography. (b) 3D Visualization of the vessel tree. (c) Rotation of the vessel tree. (d) Scaling of the vessel tree.

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