Curriculum Vitae, Studies, Actions and Published Work

Dr. George N. Apostolopoulos
Electrical and Computer Engineer, Dipl.-Ing

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Contents

Curriculum Vitae

Summary

Dr. George Apostolopoulos received his Dr.-Ing. degree in Electrical and Computer Engineering from the University of Patras (**UP**), Greece in 2010. Since 2004 he has been a research fellow of the Electrical and Computer Technology Department of **UP**. His research interests include medical image analysis, image processing, pattern recognition and 3D information representation. He has publications in international journals and conferences with reviewers, related to these fields. Also he has supervised many diploma theses. He is a member of the Institute of Electrical and Electronics Engineers (**IEEE**), the Technical Chamber of Greece and the Hellenic Association of Mechanical and Electrical Engineers. During 2010 – 2016 collaborated with the Technological Educational Institute (**TEI**) of Western Greece as Adjunct Professor in the Department of Informatics & Mass Media. Lecturing: Computer Graphics, Advanced Issues in Computer Graphics, Digital Image Processing, Digital Signal Processing and Data Bases. From September 2016 until June 2019 he collaborated with the Hellenic Electricity Distribution Network Operator S.A. (**HEDNO**) as a head Engineer of the Network Engineering & Construction Department. Since June 2019 until now he collaborates with the Public Tenders Review Authority of Greece (**PTRA**) as a specialized scientific staff.

Education

- **1997 – 2004**: University of Patras, School of Engineering, Dept. of Electrical Engineering and Computer Technology (Diploma Degree, **7.13** at **10**, **Cum Laude**)
- **2004 – 2010**: Ph.D. at Dept. of Electrical Engineering and Computer Technology, School of Engineering, University of Patras

Academic Experience

- **2010 – 2016**: Adjunct Assistant Professor at Dept. of Informatics and Mass Media, Technological Educational Institute of Western Greece
- **2013 – 2015**: Post-Doctoral Research Fellow at Medical Physics Laboratory, Dept. of School of Medicine, University of Patras
- **2010 – Until Now**: Post-Doctoral Research Fellow at Wireless Communication Laboratory, Dept. of Electrical Engineering and Computer Technology, School of Engineering, University of Patras
- **2020 – Until Now**: Senior Researcher at Signal, Image Processing & Pattern Recognition Group (SIPPRE), Electrical & Computer Engineering Department, University of Peloponnese, Greece

Professional Experience

- **2016 – 2019**: Head of the Network Engineering & Construction Department, Hellenic Electricity Distribution Network Operator SA (HEDNO), Department of Central Greece Region, Livadia Area
- **2019 – until now**: Specialized Scientific Staff, Public Tenders Review Authority of Greece (PTRA), Informatics Department.

Military Service

- **2000 – 2001**: I served in 116 CW of Araxos as a Telecommunications Engineer at the Center Operations of the Combat Wing

Further Expertise and Skills

- Computer Expertise
    - Excellent knowledge of MatLab, Mathematica and MathCad
    - Excellent knowledge in Programming Languages, such as, C, Pascal and Fortran
    - Excellent knowledge of relational Data Base (design the Schema of DB, normalize the DB and MySQL)
    - Computer Vision using the OpenCV library
    - Computer Graphics using the OpenGL library and the GLSL Shading Language
    - Good Knowledge in developing web applications (HTML, PHP and Flash Action Script)
    - Operating Systems (Linux, Unix, Dos, Windows 2000/XP/8.0/10)
    - Excellent knowledge of using the Ms Office
- English Language
    - Advanced Level Certificate in English

Scientific Associations and Institutions

- Full Member of Technical Chamber of Greece
- Full Member of Hellenic Association of Mechanical and Electrical Engineers
- Full Member of the Institute of Electrical and Electronics Engineers (IEEE)
- Full Member of the IEEE Signal Processing Society
- Full Member of the IEEE Computer Society
- Full Member of IEEE Smart Cities
- Full Member of IEEE Transportation Electrification Community
- **2011 – 2013**: Member of the Standing Committee on Education, Science and Technology, Technical Chamber of Greece (Dept. of Western Greece)
- **2014 – 2016**: Member of the Standing Committee on Research, New Technologies and Informatics, Technical Chamber of Greece (Dept. of Western Greece)

Research Work and Activities

My research work and the overall research activity divided in the following areas:

- Participation in research projects
- Participation in the preparation of research proposals
- Writing research papers, including the Ph.D. dissertation
- Lecturing Courses

My Research interests concern:

- Medical image analysis, Image processing, Pattern recognition, information retrieval, information extraction in the field of medicine
- Algorithms development to identify diseases related with human red blood cells
- Algorithms development to identify lesions in mammographic images

My published work is related with the development of algorithms for identifying diseases associated with human red blood cells, algorithm to identify lesions in mammography and as well as the design of non-invasive devices for the estimation of heart rate and the level of glucose in human blood.

In chapter three of this document, there is the list publications of the scientific papers, including the dissertation of the doctoral thesis and maybe other papers that have been sent for publication.

The papers of this list are presented in chapter four of this document ("4. Presentation of Research Papers"). Any additional research papers will be accepted for publication will be included in this document with newer supplementary statement.

Academic Lecturing Experience

Dept. of Informatics and Mass Media, Technological Educational Institute of Western Greece

- **2005 – 2006**
  - Digital Technology (Spring Semester, Lab)
  - Programming (Fall Semester, Lab)
- **2006 – 2007**
  - Digital Technology (Spring Semester, Lab)
  - Programming in C Language (Fall Semester, Lab)
- **2007 – 2008**
  - Digital Technology (Spring Semester, Lab)
- **2008 – 2009**
  - Digital Technology (Spring Semester, Lab)
- **2009 – 2010**
  - Digital Technology (Spring Semester, Lab)
  - Graphics, Motion, Simulation Via Computer (Fall Semester, Lab)
- **2010 – 2011**
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Digital Image Processing (Fall Semester, Lab)
- **2011 – 2012**
  - Computer Graphics (Fall Semester, Theory)
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Data Bases (Spring Semester, Theory)
  - Digital Image Processing (Fall Semester, Lab)
- **2012 – 2013**
  - Computer Graphics (Fall Semester, Theory)
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Digital Image Processing (Fall Semester, Lab)
  - Data Bases (Spring Semester, Theory and Lab)
  - Programming in C Language (Spring Semester, Lab)
- **2013 – 2014**
  - Computer Graphics (Fall Semester, Theory and Lab)
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Digital Image Processing (Fall Semester, Lab)
  - Data Bases (Spring Semester, Theory and Lab)
  - Programming in C Language (Spring Semester, Lab)
- **2014 – 2015**
  - Computer Graphics (Fall Semester, Theory)
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Digital Signal Processing (Spring Semester, Lab)
- **2015 – 2016**
  - Computer Graphics (Fall Semester, Theory)
  - Advanced Issues in Computer Graphics (Fall Semester, Theory and Lab)
  - Digital Image Processing (Fall Semester, Lab)
  - Digital Signal Processing (Spring Semester, Lab)
  - Programming in C Language (Spring Semester, Lab)

Dept. of Management, Economics, Communication of Cultural and Hospitality Units Department, Technological Educational Institute of Western Greece

- **2015 – 2016**
  - Database Management (Fall Semester, Theory)

Dept. of Museology, Museography and Exhibition Design, Technological Educational Institute of Western Greece

- **2007 – 2008**
  - Introductions to Computers (Fall Semester, Theory and Lab)
  - Digital Database in Museology (Spring Semester, Theory)
- **2008 – 2009**
  - Introductions to Computers (Fall Semester, Theory and Lab)

Dept. of Electrical Engineering and Computer Technology, University of Patras

- **2004 – 2009**
  - Programming in Fortran Language (Spring Semester, Lab)
  - Pattern Recognition I (Fall Semester, Lab)

Diploma Thesis Supervision

- **Algorithmic Techniques Solving the Sudoku Problem**, Dept. of Informatics and Mass Media, 2013 (in progress)
- **Digital Image Processing Using the OpenCV Library**, Dept. of Informatics and Mass Media, 2013 (in progress)
- **Composition methods of super resolution images derived by lower resolution images**, Dept. of Informatics and Mass Media, 2013 (in progress)
- **Automatic Detection of tumors in mammography images**, Dept. of Informatics and Mass Media, 2013 (in progress)
- **Detection and Monitoring User through Web-Camera Using Human-Machine Interaction**, Dept. of Informatics and Mass Media, 2013 (in progress)
- **Developing Multimedia Application for the Acropolis of Athens Using 3D Graphics and Animation**, Dept. of Informatics and Mass Media, 2012 (in progress)
- **Three dimensional computer scenes using the OpenGL**, Dept. of Informatics and Mass Media, 2012
- **Automatic face recognition**, Dept. of Informatics and Mass Media, 2011 (in progress)
- **OpenGL's new generation: The GLSL shading language**, Dept. of Informatics and Mass Media, 2014 (in progress)
- **3D computer graphics scenes using fractals**, Dept. of Informatics and Mass Media, 2014 (in progress)

Research Activity

Research Topics

- Developing methods of digital image processing and pattern recognition in the medical field (with particular emphasis on images of scattering electromagnetic radiation)
- Mammography image Analysis
- Information retrieval
- Development of relevant algorithms to address above issues
- Design devices for extracting the biometric and diagnostic information using non-invasive and non-ionizing radiation in living tissue
- Biomedical technology

Project: Content-Based Image Retrieval Services for Breast Cancer Computer-Aided Diagnosis

The goal of the project was the development of CBIR-based CAD approach for breast cancer. This approach relies on comparing the query image to known cases stored in a database, in terms of visual similarity, while the most “similar” cases are retrieved and used to make a decision related to detection or diagnosis, regarding the unknown query case. Based on this approach and to deal with the need of radiologists, services will be built that will address diagnostic decision making in relation to visual material of lesions as appear in multimodal breast images, provided in a ubiquitous accessibility fashion via an independent web-enabled platform

Scientific Activities - International Recognition

Award of Scientific Work

- Award of the 3rd International Mobile Multimedia Communications Conference (MOBIMEDIA) for the third best scientific paper, **G. Apostolopoulos** et al., '*Local Adaptive Contrast Enhancement in Digital Images*', Awards – Grants of MOBIMEDIA, August, 2007

Award of Reviewing Research Papers

- Award of Reviewing Research Papers, Journal of Biomedical Signal Processing And Control, Elsevier, March, 2016
- Award of Reviewing Research Papers, Journal of the International Society for Advancement of Cytometry Part A, Wiley, May, 2017

Reviewer in International Journals

- Biomedical Signal Processing and Control, Elsevier
- Journal of the International Society for Advancement of Cytometry Part A, Wiley
- IEEE Transactions on Systems, Man, and Cybernetics: Systems
- Computers & Electrical Engineering, Elsevier
- Journal of the International Measurement Confederation, Elsevier

Reviewer in International Scientific Conferences

- International Workshop on Mathematical Methods in Scattering Theory and Biomedical Engineering, BIOENG
- IEEE International Conference on Electronics, Circuits, and Systems, ICECS

Research Papers

Ph.D. Dissertation

George N. Apostolopoulos, '*Estimation of geometrical properties of human red blood cells using light scattering images*', Ph.D. Dissertation, Dept. of Electrical Engineering and Computer Technology, School of Engineering, University of Patras, 2010

Supervisor: Associate Professor Evagelos Dermatas

Publications in International Journals

[Jnr-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*A methodology for estimating the shape of biconcave red blood cells using multicolor scattering images*', Journal of Biomedical Signal Processing and Control, Elsevier, 8 (2013) pp. 263-272

[Jnr-2] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Identification of geometrical properties of Red Blood Cells from light scattering images using SVD*', Journal Of Mathematical And Computer Modelling, Elsevier 57 (2013) pp. 1531-1542

[Jnr-3] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Estimation of size and shape of the Human Red Blood Cell using light scattering images*', Journal of Computational Methods in Science and Engineering, IOS press, Volume 9, Number 1-2/2009, pp 19-30

Book Articles

[BA-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Estimation of Human Red Blood Cells size using light scattering images at multiple wavelengths*', Advanced Topics In Scattering Theory And Biomedical Engineering, World Scientific, Vol. 9, pp 161-168, 2009

[BA-2] **G. Apostolopoulos**, M. Vlachos and E. Dermatas, '*Robust Non-Invasive Estimation of Oxygen Saturation in Human Tissue*', Advanced Topics In Scattering Theory And Biomedical Engineering, World Scientific, Vol. 8, pp 218-225, 2007

[BA-3] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Recognition and Identification of Red Blood Cell size using Angular Radial Transform and Neural Networks*', 12th Mediterranean Conference on Medical and Biological Engineering and Computing (MEDICON), IFMBE Proceedings 29, pp 707-710, Springer, 2010

[BA-4] **G. Apostolopoulos**, A. Koutras, I. Christoyianni, E. Dermatas, '*Computer Aided Classification of Mammographic Tissue Using shapelets and Support Vector Machines*', Springer's Lecture Notes in Computer Science, pp. 510–520, 2014

[BA-5] **G. Apostolopoulos**, A. Koutras, I. Christoyianni and E. Dermatas, 'Computer Aided Diagnosis of Mammographic Tissue Using Shapelets in Quaternionic Representation', XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016, IFMBE Proceedings 57, pp. 222 – 227, Springer, 2016

[Cnf-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, *'Identification the Shape of Biconcave Red Blood Cells Using Histogram of Oriented Gradients and Covariance Features*', IEEE 13th International Conference on Bioinformatics & Bioengineering (BIBE), 2013

[Cnf-2] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Recognition and Identification of Red Blood Cell size using Zernike Moments and Multicolor Scattering Images*', IEEE 10th International Workshop on Biomedical Engineering, BioEng 2011

[Cnf-3] **G. Apostolopoulos**, S. Tsinopoulos, M. Vlachos and E. Dermatas, '*Estimation of size and shape of the Human Red Blood Cell using light scattering images*', 6th European Symposium on Biomedical Engineering, 19-21, June, Chania, Greece, 2008

[Cnf-4] **G. Apostolopoulos**, E. Dermatas, '*Local Adaptive Contrast Enhancement in Digital Images*', in Proceedings of the 3rd International Conference on Mobile Multimedia Communications. ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), p.8, [Online], 2007

[Cnf-5] Vlachos Marios, **Apostolopoulos Georgios**, '*Non-invasively estimation of the cardiac pulse using spectroscopy methods*', 1st National Conference of Electrical and Computer Engineering, 25-26 May, Athens, Greece, 2007

[Cnf-6] **G. Apostolopoulos**, V Tzitzilonis, V. Kappatos and E. Dermatas, '*Disguised Face Identification Using Multi-Modal Features in a Quaternionic Form*', 7th International Conference on Imaging for Crime Detection and Prevention (ICDP 2016), 24-25 November 2016 in Madrid, Spain, 2016

[Cnf-7] **G. Apostolopoulos**, A. Koutras, I. Christoyianni and E. Dermatas, '*A New Method for Breast Cancer Identification Using Multi-modal Features in Quaternionic Form*', 25th European Signal Processing Conference (EUSIPCO), pp. 66-70, 28/8 – 2/9, Kos Island, Greece, 2017

[Cnf-8] Vasileios Tzitzilonis, Vassilios Kappatos, Evangelos Dermatas and **George Apostolopoulos**, *'Classification of occluded 2D objects using deep learning of 3D shape surfaces*', Proceedings of the 10th Hellenic Conference on Artificial Intelligence, SETN 2018, Patras, Greece - July 09 - 12, 2018

Presentation of Research Papers

Ph.D. Dissertation

George N. Apostolopoulos, '*Estimation of geometrical properties of human red blood cells using light scattering images*', Ph.D. Dissertation, Dept. of Electrical Engineering and Computer Technology, School of Engineering, University of Patras, 2010

Supervisor: Associate Professor Evagelos Dermatas

The aim of this PhD thesis is the development of digital image processing and pattern recognition methods to estimate biometric and diagnostic parameters using scattering phenomena in the visible and infrared spectrum. More concretely, several reverse scattering problems of EM radiation from a human, healthy and undistorted Red Blood Cell (RBC) is solved. Methods of estimation and recognition of geometrical properties of healthy and undeformable RBCs using simulating images are presented. The information retrieval process includes, features extraction using two-dimensional integral transforms, features normalization, and Neural Networks for estimation of three major RBC geometrical properties. Using the same features set, a recognition system of the geometric characteristics of RBCs was developed and evaluated. The scattering images were created simulating the forward scattering problem of a plane electromagnetic wave using the Boundary Element Method, taking into account both axisymmetric geometry of the scatterer and the non-axisymmetric boundary conditions of the problem. Initially, the problem is solved at 632.8 nm and consequently the same problem was solved at 12 different wavelengths, from 432.8 to 1032.8 nm equally spaced. Also, a new device for acquisition of scattering images from RBCs-flow, consisting of a multi-color light source (Led) was proposed, for RBC size estimation and recognition. Finally, a system for the estimation of different RBCs concentration was developed when scattering images acquired using multiple scattering images acquired from multiple Leds and color filters. The system was evaluated using additive white regular noise.

Publications in International Journals

[Jnr-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*A methodology for estimating the shape of biconcave red blood cells using multicolor scattering images*', Journal of Biomedical Signal Processing and Control, Elsevier, 8 (2013) pp. 263-272

In this paper, a novel methodology for estimating the shape of human biconcave red blood cells (RBCs), using color scattering images, is presented. The information retrieval process includes, image normalization, features extraction using two-dimensional discrete transforms, such as angular radial transform (ART), Zernike moments and Gabor filters bank and features dimension reduction using both independent component analysis (ICA) and principal component analysis (PCA). A radial basis neural network (RBFNN) estimates the RBC geometrical properties. The proposed method is evaluated in both regression and identification tasks by processing images of a simulated device used to acquire scattering phenomena of moving RBCs. The simulated device consists of a tricolor light source (light emitting diode – LED) and moving RBCs in a thin glass. The evaluation database includes 23,625 scattering images, obtained by means of the boundary element method. The regression and identification accuracy of the actual RBC shape is estimated using three feature sets in the presence of additive white Gaussian noise from 60 to 10 dB SNR and systematic distortion, giving a mean error rate less than 1% of the actual RBC shape, and more than 99% mean identification rate.

[Jnr-2] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Identification of geometrical properties of Red Blood Cells from light scattering images using SVD*', Journal Of Mathematical And Computer Modelling, Elsevier 57 (2013) pp. 1531-1542

In this paper an automatic identification method of geometrical properties of Red Blood Cells (RBCs) using light scattering images, is presented. A small number of features are estimated by the pixels' intensity projection into an RBC-space. The basis of the RBC-space is derived using the singular vectors of a set of known RBCs. The nearest neighbor rule is used to classify any image projection to the known RBC coordinates. Since, the dimension ability of the RBC-space is significantly lower than the whole scattering image-space, it is easier to compare projections than original images. Considering the above idea, a Singular Value Decomposition (SVD) approach is implemented in this work. The database includes 1188 simulated scattering images, obtained by means of the Boundary Element Method (BEM). The identification accuracy of the actual RBC shape is estimated using three features sets in the presence of additive white Gaussian noise from 60 to 10 dB SNR, giving a mean error rate less than 1 percent of the actual RBC shape. Moreover, an open-class classification problem was solved using RBC scattering images with new shapes and landscape images.

[Jnr-3] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Estimation of size and shape of the Human Red Blood Cell using light scattering images*', Journal of Computational Methods in Science and Engineering, IOS press, Volume 9, Number 1-2/2009, pp 19-30

In this paper, a novel method for the estimation of the human Red Blood Cell (RBC) size using light scattering images is presented. The information retrieval process includes, image normalization, a two-dimensional Discrete Cosine Transformation (DCT2) or Wavelet transformation (DWT2), and a Radial Basis Neural Network (RBF-NN) estimates the RBC geometrical properties. The proposed method is evaluated in both regression and identification tasks when three important geometrical properties of the human RBC are estimated using a database of 1575 simulated images generated with the boundary element method. The experimental setup consists of a light beam at 632.8 nm and moving RBCs in a thin glass and additive noise distortion is simulated using white Gaussian noise from 60 to 0 dB SNR. The regression and identification accuracy of actual RBC sizes is estimated using three feature sets, giving a mean error rate less than 1 percent of the actual RBC size, in case of noisy image data at 10 dB SNR or better, and more than 97 percent mean identification rate.

Book Articles

[BA-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Estimation of Human Red Blood Cells size using light scattering images at multiple wavelengths*', Advanced Topics In Scattering Theory And Biomedical Engineering, World Scientific, Vol. 9, pp 161-168, 2009

In this paper, a novel method for the estimation of the human Red Blood Cell (RBC) size using light scattering images at multiple wavelengths is presented. The information retrieval process includes, image normalization, a two-dimensional discrete Wavelet transformation (DWT2), and a Radial Basis Neural Network (RBF-NN) is used to estimate the RBC geometrical properties. The proposed method was evaluated in both regression and identification tasks by processing images of simulated device used to acquire scattering phenomena of moving RBCs. The database includes 1575 images of 50x50 pixles, is created with the boundary element method

(BEM) in 9 different wavelengths. The experimental setup consists of nine, equally spaced, light beams from 632.8 to 1032.8 nm moving RBCs in a thin glass. When artificial white Gaussian noise is added to the simulated images at 10 dB SNR, the mean absolute error between the actual geometrical properties and the RBF based estimations is less than 1% of the actual RBC size. In the identification experiments correct classification rate better than 99.8% is obtained.

[BA-2] **G. Apostolopoulos**, M. Vlachos and E. Dermatas, '*Robust Non-Invasive Estimation of Oxygen Saturation in Human Tissue*', Advanced Topics In Scattering Theory And Biomedical Engineering, World Scientific, Vol. 8, pp 218-225, 2007

In this paper a pulse oximeter instrument based on a novel design and implementation, including multiple-LEDs and multiple-phododiodes, is presented and evaluated. Several novel solutions are presented: the light-absorption in tissue is measured in multiple wavelengths (more than two), analog and digital adaptive filtering methods minimize the influence of noise in the final measurement, and strong artifact events are automatically detected. The experimental results show that the acquired signals approximate the corresponding theoretical signals, and the estimated oxygen saturation is almost identical to commercially available instruments. Moreover, the pulse-oximeter is implemented by using the ultra-low power capabilities of the low-cost MSP430F169 microcontroller.

[BA-3] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Recognition and Identification of Red Blood Cell size using Angular Radial Transform and Neural Networks*', 12th Mediterranean Conference on Medical and Biological Engineering and Computing (MEDICON), IFMBE Proceedings 29, pp 707-710, Springer, 2010

In this paper, a novel method for the estimation of the human Red Blood Cell (RBC) size using light scattering images is presented. The information retrieval process includes, image normalization and features extraction using the Angular Radial Transform (ART). A Radial Basis Neural Network (RBF-NN) estimates the RBC geometrical properties. The proposed method is evaluated in both regression and identification tasks when three important geometrical properties of the human RBC are estimated using a database of 1575 simulated images generated with the boundary element method. The experimental setup consists of a light beam at 632.8 nm and moving RBCs in a thin glass and additive noise distortion is simulated using white Gaussian noise from 60 to 10 dB SNR. The regression and identification accuracy of actual RBC sizes is estimated using three feature sets, giving a mean error rate less than 1 percent of the actual RBC size, in case of noisy image data at 10 dB SNR or better, and more than 97 percent mean identification rate.

[BA-4] **G. Apostolopoulos**, A. Koutras, I. Christoyianni, E. Dermatas, '*Computer Aided Classification of Mammographic Tissue Using shapelets and Support Vector Machines*', Springer's Lecture Notes in Computer Science, pp. 510–520, 2014

In this paper a robust regions-of-suspicion (ROS) diagnosis system on mammograms, recognizing all types of abnormalities is presented and evaluated. A new type of descriptors, based on Shapelet decomposition, derive the source images that generate the observed ROS in mammograms. The Shapelet decomposition coefficients can be used efficiently to detect ROS areas using Support-Vector-Machines (SVMs) with radial basis function kernels. Extensive experiments using the Mammographic Image Analysis Society (MIAS) database have shown high recognition accuracy above 86% for all kinds of breast abnormalities that exceeds the performance of similar decomposition methods based on Zernike moments presented in the literature by more than 8%.

[BA-5] **G. Apostolopoulos**, A. Koutras, I. Christoyianni and E. Dermatas, 'Computer Aided Diagnosis of Mammographic Tissue Using Shapelets in Quaternionic

Representation', XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016, IFMBE Proceedings 57, pp. 222 – 227, Springer, 2016

In this paper a robust regions-of-suspicion (ROS) diagnosis system on mammograms, recognizing all types of abnormalities is presented and evaluated. A new type of descriptors, based on Shapelet decomposition, estimate the source images that generate the observed ROS in mammograms. The Shapelet decomposition coefficients can be used to efficiently detect ROS areas using a new classifier base on
quaternionic representation. Extensive experiments using the Mammographic Image Analysis Society (MIAS) database have shown high recognition accuracy over 86% for all kinds of breast, with less computational cost.

Publications in International Conferences with Reviewers

[Cnf-1] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, *'Identification the Shape of Biconcave Red Blood Cells Using Histogram of Oriented Gradients and Covariance Features*', IEEE 13th International Conference on Bioinformatics & Bioengineering (BIBE), 2013

In this paper, a novel methodology for estimating the shape of human biconcave Red Blood Cells (RBCs), using color scattering images, is presented. The information retrieval process includes, image normalization, features extraction using both Histogram of Oriented Gradients (HoG) and region covariance features (RCoV); and features dimensionality reduction using the Independent Component Analysis (ICA). The points of interest (PoIs) are detected using the Harris-corner detector in order to extract the image features. A scheme using adjustable algorithms, i.e. support vectors machine (SVM) is adopted in order to fuse the multimodal features. A Radial Basis Function Neural Network (RBF-NN) estimates the RBC geometrical properties. The proposed method is evaluated in both regression and identification tasks by processing images of a simulated device used to acquire scattering phenomena of moving RBCs. The evaluation database includes 23625 scattering images, obtained by means of the Boundary Element Method. The regression and identification accuracy of the actual RBC shape is estimated using three feature sets in the presence of additive white Gaussian noise from 60 to 10 dB SNR, giving a mean error rate less than 1 percent of the actual RBC shape, and more than 99 percent mean identification rate in a set of valid RBCs size.

[Cnf-2] **G. Apostolopoulos**, S. Tsinopoulos and E. Dermatas, '*Recognition and Identification of Red Blood Cell size using Zernike Moments and Multicolor Scattering Images*', IEEE 10th International Workshop on Biomedical Engineering, BioEng 2011

In this paper, a new apparatus device and a novel method for the estimation of the human Red Blood Cells' (RBC) size and shape in the blood, using color scattering images presented. The information retrieval process includes, image normalization, features extraction using the Zernike moments and features dimension reduction using both Independent Component Analysis (ICA) and Principal Component Analysis (PCA). A Radial Basis Neural Network (RBF-NN) estimates the RBC geometrical properties. The proposed method was evaluated in both regression and identification tasks by processing images of simulated device used to acquire scattering phenomena of moving RBCs. The experimental setup consists of a multicolor polarized light source at 570, 587 and 628 nm and moving RBCs in a thin glass. The evaluation database includes 1575 simulated scattering images of 50 x 50 pixels each obtained by a new scattering acquisition device. The regression and identification accuracy of actual RBC sizes is estimated using three feature sets in the presence of additive white Gaussian noise from 60 to 10 dB SNR, giving a mean error

rate less than 1 percent of the actual RBC size, and more than 99 percent mean identification rate.

[Cnf-3] **G. Apostolopoulos**, S. Tsinopoulos, M. Vlachos and E. Dermatas, '*Estimation of size and shape of the Human Red Blood Cell using light scattering images*', 6th European Symposium on Biomedical Engineering, 19-21, June, Chania, Greece, 2008

In this paper, a novel method for estimation of the size and the shape of human Red Blood Cell using light scattering images is presented. The information retrieval process includes, image normalization, a Discrete Cosine Transform used to derive a normalized feature vector, and a Radial Basis Neural Network is implemented to estimate the geometrical properties of the actual RBC. The proposed method is evaluated in simulation experiments when three important geometrical properties of the human RBC is estimated using a database of 1575 images. The experimental setup consists of a simulated light beam at 632.8 μm and the RBCs are moving in a thin glass. The experimental results include estimation of actual RBC sizes using three feature sets, giving a mean error rate less than 1 per percent of the actual size in case where the image data are distorted using white Gaussian noise at 10 dB SNR

[Cnf-4] **G. Apostolopoulos**, E. Dermatas, '*Local Adaptive Contrast Enhancement in Digital Images*', in Proceedings of the 3rd International Conference on Mobile Multimedia Communications. ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), p.8, [Online], 2007

In this paper an algorithm for optical quality enhancement in low contrast images is proposed. The brightness dynamic region is increased using a non-linear transformation function, which is adapted from the local contrast. In a new approach, the local contrast is defined in every central pixel, using a four direction masking method and a statistical estimation of the local contrast value. Two adaptive thresholds locate the exact pixel positions where the proposed contrast adjustment algorithm is used to improve the image quality. In the evaluation process, several artificially distorted images are enhanced and the mean square error and peak noise ratio between the restored and the original images are estimated. The experimental results show both objective and subjective improvements in the image quality.

[Cnf-5] **G. Apostolopoulos**, V Tzitzilonis, V. Kappatos and E. Dermatas, '*Disguised Face Identification Using Multi-Modal Features in a Quaternionic Form*', 7th International Conference on Imaging for Crime Detection and Prevention (ICDP 2016), 24-25 November 2016 in Madrid, Spain, 2016

Disguised face recognition is considered as very challenging and important problem in the face recognition field. A disguised face recognition algorithm is proposed using quaternionic representation. The feature extraction module is accomplished with a new method, decomposing each face image into a linear decomposition of a set of localized basis functions. The feature sets, related to Shapelets and Gabor filters, are used to encode the image data. The coefficients of the integral transformations are fused and presented in quaternionic representation to the Classification module. This study shows the proposed algorithm can achieve high recognition results under disguised conditions.

[Cnf-6] **G. Apostolopoulos**, A. Koutras, I. Christoyianni and E. Dermatas, '*A New Method for Breast Cancer Identification Using Multi-modal Features in Quaternionic Form*', 25th European Signal Processing Conference (EUSIPCO), pp. 66-70, 28/8 – 2/9, Kos Island, Greece, 2017

Mammography is still the most effective procedure for early diagnosis of the breast cancer. Computer-aided Diagnosis (CAD) systems can be very helpful in this direction for radiologists to recognize abnormal and normal regions of interest in digital mammograms faster than traditional screening program. In this work, we propose a new method for breast cancer identification of all types of lesions in digital mammograms using multimodal features in a quaternionic representation. The proposed method consists of two steps: First, a novel feature extraction module utilizes two dimensional discrete transforms based on ART, Shapelets, Zernike moments and Gabor filters to decompose Regions of Suspicion (ROS) into a set of localized basis functions with different shapes. The extracted features are then fused and presented in quaternionic representation to the classification module in the second step. For the classification task, we propose a new type of classifier (Q-classifier) that successfully, accurately, with low computational cost and higher speed of diagnosis, recognizes normal and abnormal ROS from mammograms. The proposed method is evaluated on the Mini-MIAS database. The methods' performance is evaluated using Receiver Operating Characteristics (ROC) curve. The achieved result AUC = 0.934 shows that the proposed method can be quite effective and can be used as a tool for efficiently diagnosing breast cancer compared to similar techniques presented in the literature that use SVM classifiers and unimodal features.

[Cnf-7] Vasileios Tzitzilonis, Vassilios Kappatos, Evangelos Dermatas and **George Apostolopoulos**, *'Classification of occluded 2D objects using deep learning of 3D shape surfaces*', Proceedings of the 10th Hellenic Conference on Artificial Intelligence, SETN 2018, Patras, Greece - July 09 - 12, 2018

This paper presents a novel deep learning method for partially occluded 2D object classification. A 2D Convolutional Neural Network (CNN) was trained with partial and whole images of the 3D models obtained from different camera views. The efficiency of the proposed method in classifying partial objects in 40 categories is more than 80% in most objects and exceeds 95% in some of them.