# Image Analysis and Processing with Applications in Proteomics and Medicine

Duration:1/9/2010 - 31/8/2013

Total Budget: €45.000

Eleftheria Mylona was funded by the aforementioned program as a PhD candidate.

This research introduces novel methods for proteomics image analysis and processing. The main challenges in such images are the inhomogeneity of the background, the complex regions containing overlapping spots as well as the dynamic range of proteins concentration resulting to saturated and faint spots. State-of-the-art software packages are dominant in proteome analysis. Nonetheless, they are highly parametric and demonstrate a notable output variance. The proposed methods exploit the attractive properties of active contours and mathematical morphology.

[Review](Review)

## Recent Image Analysis methods in Proteomics

Duration:14/12/2009 - 31/7/2013

Estimated Budget: €16.000

## Design and Implementation on FPGAs of a Ray-Tracing Engine Accelerator for 3D Display Devices.

Duration: 1/9/2005-31/8/2008

In the present project, the acceleration of a rendering method for three-dimensional data based on Ray Tracing is studied. A detailed evaluation procedure for the additional overhead that is introduced by including a lens array containing a large number of lens objects in a computer-generated Integral Imaging  scene for Ray Tracing rendering is described. Also, the acceleration of time-consuming algorithms that are used for the compression, reconstruction and display of Integral Photography images is addressed. The acceleration is realized by proposing novel digital architectures that confront the problem of processing large volumes of data. A number of optimization techniques like data reutilization and implementation of a large number of processing elements used for parallel operation are adopted in this context. The performance increase that is obtained compared to the software approaches renders them capable or real-time performance.

## Computer aided processing and analysis of ultrasound images for the detection and characterization of thyroid nodules.

Duration: 1/11/2005-31/10/2008
Funded by General Secretariat for Research and Technology under Measure 8.3 Research and Technology Human Resources, Action 8.3.1 Reinforcement Programme of Human Research Manpower "PENED".
Total Budget: €134.842 (75% EU funding - 25% national funding)
Grand No. 03-ED-662.
Michalis Savelonas and Keramidas Eystratios were funded by the aforementioned program as PhD candidates

The topic of this program is the development of novel methods for processing and analysis of ultrasound images for the detection and characterization of nodules of the thyroid gland. On those grounds a variety of methods for nodule delineation in thyroid ultrasound (US) images have been developed, including VBAC ( variable background active contour), JET (Joint Echogenicity-Texture, v-LAC (vector-Local binary pattern Active Contour), and s-LAC (scalar-Local binary pattern Active Contour). Moreover, a novel approach has been proposed for the discrimination of nodules of high malignancy risk, from normal thyroid parenchyma, which encodes both texture and echogenicity of ultrasound images using noise-resistant image features. Additionally an uncertainty-aware texture representation approach called FLBP (Fuzzy Local Binary Patterns) has been proposed for the computation of noise resilient texture features from ultrasound images. Finally an original, efficient and robust scheme has been proposed and implemented as a prototype software system, named TND (Thyroid Nodule Detector) for the detection of nodular tissue in ultrasound images and videos of the thyroid gland.

## Detection and genotyping of pathogenic respiratory viruses and enteroviruses using novel computational techniques on DNA microarray data

Duration: 1/1/2006-31/12/2008
Funded by General Secretariat for Research and Technology under Measure 8.3 Research and Technology Human Resources, Action 8.3.1 Reinforcement Programme of Human Research Manpower "PENED".
Total Budget: €207.000 (75% EU funding - 25% national funding)
Grand No. 03-ED-324.
Dimitris Bariamis was funded by the aforementioned program as a PhD candidate

The topic of this program is the development of novel methods of biomedical data analysis in

software and hardware. The logarithm function is widely used in microarray data normalization. A novel FPGA-based architecture for the calculation of the logarithm function has been developed, which achieves fast operation, high accuracy and low resource utilization. Additionally, a novel method for automatic microarray image gridding has been developed, based on the maximization of the margin between consecutive rows or columns of microarray spots. The achieved results of this method show that it achieves perfect gridding for more than 98% of the spots, significantly surpassing the established methods.

## Study-Analysis of the gene expression of children leukemia using cDNA microarrays, and discovery of therapy clone-markers based on original methodologies of machine learning.

Duration: 1/1/2006-31/12/2008
Funded by General Secretariat for Research and Technology under Measure 8.3 Research and Technology Human Resources, Action 8.3.1 Reinforcement Programme of Human Research Manpower "PENED".
Total Budget: €207.657 (75% EU funding - 25% national funding) Grand No. 03-ED-332.
Eleni Zacharia was funded by the aforementioned program as a PhD candidate

In the present project, original methods of computational analysis are put forward, which focus on image analysis and processing. The proposed methods are applied in biomedical images, such as cDNA microarray images as well as 2D gels images that are obtained from two-dimensional electrophoresis of proteins. They exploit the intensity information of the images and convert basic problems of analysis and processing, such as the determination of grid structure (gridding) and spot segmentation, to optimization problems which are subsequently solved using the methodology of genetic algorithms. The proposed methods of gridding and spot-segmentation have been applied to synthetic images as well as to real ones. Their application results have showed that the proposed methods achieve higher accuracy in comparison to various well-known and broadly used techniques.

## Medical Decision Support System for Cancer Diagnosis using Clinical and Genomic Data

Duration: 1/5/2004-31/8/2006
This work was realized under the framework of the Operational Program for Education and Vocational Training Project "Pythagoras" co-funded by European Union and the Ministry of National Education and Religious Affairs of Greece.
Total Budget: 59.500 Euros
Dimitris K. Iakovidis was funded by the aforementioned program as post-doc researcher.

[Project web page](#)

This research project aimed to the development of a novel medical decision support system for cancer diagnosis, using clinical and DNA patient data. The proposed system consists of two autonomous subsystems. Their outputs may be combined for the final diagnosis. The first subsystem uses endoscopic video as input. It provides information regarding the existence and the location of lesions. The research was focusing to the development of novel methods for video analysis, real-time feature extraction, selection and classification. The second subsystem uses DNA microarray data as input. Microarray data processing determine the genes of which the expression is differentiated in the presence of cancer. The research was focusing in data preprocessing, feature selection and cancer identification and/or prediction methods. Time consuming data processing algorithms have been implemented in Field Programmable Gate Arrays (FPGA), to achieve realtime performance. Medical and biological evaluation of the system results has been realized. The results of this research could be proved valuable for disease diagnosis and prediction and could be used for the determination of new pharmaceutical targets in the future.

## Implementation of a system for the classification of image regions using special parallel architectures

This work was funded by the Special Account of Research Grants of the University of Athens

Total Budget: 2.900 €

## Development of a system for the detection of abnormal regions in

## endoscopic video

This work was funded by the Special Account of Research Grants of the University of Athens

Total Budget: 1.500 €

## A biomedical image recognition system using digital image processing techniques and neural networks for cancer detection

This work was funded by the Special Account of Research Grants of the University of Athens

Total Budget: 750.000 GRD

## Development of a system for cancer detection and identification in endoscopic video

This work was funded by the Special Account of Research Grants of the University of Athens

Total Budget: 3.000.000 GRD

## MEDEA - Microscanning Endoscope with Diagnostic and Enhanced Resolution Attributes

Duration: 1/1/1998 - 1/1/2001

Total  Project Budget: 1.500.000 ECUs = 480.000.000 GRD

Total Budget for the University of Athens: 320.000 ECUs = 100.000.000 GRD

Greek sientific group: Prof. Nik. Theofanous, Asst. Profs: A.Arapoyanni, M.Gregoriadou, D.Maroulis , Drs. P.Papageorgas,  S.Karkanis,  G.Magoulas,
Other sientists:  G.Anagnostopoulos,H.Panagi,D.Mitropoulos, N. Mathios,J.Ioannovitch D.Iakovidis,K.Galoussi.

The major objective at this project refers to the use of fiber-coupled solid state lasers with blue, red and green emissions, in a new (electronically controlled) microscanner. This structure consists of two independent mirrors, for vertical and horizontal scanning, and the fiber-coupled light guide to the avalanche diode detector at the proximal end of an endoscope outside the body. A second objective is the achievement of  miniaturized  compact optics and detection units along with the implementation of advanced image and signal processing techniques, which are the prerequisite for a compact field monitor without moving parts that could wear out or become disgusted by shocks. The total sum of the enhancement of the yield of all components will bring down the expected costs and increase the MTF value of the diagnostic system.

## Multichannel Raman gas Sensor for Quantitative air Pollution Monitoring

Duration: 29/6/1994 - 29/6/1997

Total  Project Budget: 991.900 ECUs = 317.408.000 GRD

Total Budget for the University of Athens: 241.750 ECUs = 77.360.000 GRD

Greek scientific group: Prof. Nik. Theofanous, Asst. Profs:A.Arapoyanni and D.Maroulis, Dr. P.Papageorgas, Dr. S.Karkanis, Dr. G.Agapiou, G.Poulakis.

A multichannel Raman sensor for quantitative air pollution monitoring, on a portable basis, has been realized  and evaluated in several steps, as follows:

  -  Evaluation of the method with a three-channel lab set-up to specify all components in detail of the proposed functional prototype for field tests,
  -  Development and production of the improved components of a six-channel multigas sensor by using of new technologies and assembly of the prototypes with increased overall efficiency,
  -  Laboratory and field tests, evaluation of the efficiency and practicability for environmental monitoring, evaluation of further optimization potentials, test of compliance with directives and standards, evaluation of modifications needed for emission and immission measurements, comparison with reference methods.
  -  The obtained system and results proved to be quite satisfactory.

## ARTEMIS MARK-IV, The New Greek-French Digital Radio Spectrograpf at Thermopyles, Greece

Duration: 1990 - 1996

Total Budget: 80.000.000 GRD

Greek sientific group: Prof. C.Caroubalos, Profs: C.Allisandrakis, X.Moussas, Ass.Profs D.Maroulis , P.Prekka.

This new digital solar radio spectrograph located at the Thermopyles station, Greece, was developed and constructed by the Informatics Department of the University of Athens with collaboration of the Space Research Department (DESPA) of Paris–Meudon Observatory and it is operated by the University of Athens. Observations cover the range from 110 to 600 MHz, using a 7m parabolic antenna. The reception system uses two techniques in parallel: sweep frequency and multi–channel, the latter being based on the Acousto-Optical technique. The data acquisition system is based on two subsystems, a Sun Sparc-5 workstation and a front end based on a VME Motorola system. The two subsystems are connected through the Ethernet and are operated using the VxWorks real-time package. The daily operation is completely automated: pointing of the antenna to the sun, starting and stopping the observations at pre-set times, acquiring data, compressing data by silence suppression in real-time, and archiving the data on a routine manner on DAT tapes. Apart from its usual function, this instrument will be used in conjunction with other instruments, including the Nancay decameter array and the law frequency radio receivers on the Wind spacecraft

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## The Digital System ARTEMIS of the Space Research Department of Paris

## Observatory at the Nancay Radioastronomy Station

Duration: 1987-1989

Total Budget: 90.000.000 GRD

Greek sientific group: Prof. C.Caroubalos, Ass.Prof. D.Maroulis

This system was developed and constructed by the Space Research Department (DESPA) of Paris/Meudon Observatory with collaboration of the Informatics Department of the University of Athens, to digitize, calibrate, format, date, process, compress, and archive in real time signals form multichannel receivers. It is controlled by a multiprocessor computer based on Motorola MC 68010/68020 processors; it permits the automatic, routine recording of 128 parallel channels at a rate up to 300 samples per second and per channel with a 12-bit accuracy (4096 levels of intensity); it is used to process and record the 120 channels of a multichannel solar radiospectrograph in the frequency range 110-469 MHz. The large quantity of raw data is reduced in real time from about 1.3 Gbytes to about 75 Mbytes per day by the use of an original algorithm for real time data compression.