

Habilitation Thesis Summary

Advanced imaging and data processing techniques with monitoring applications

Assoc. Prof. Loretta ICHIM, Ph.D.

The thesis “Advanced imaging and data processing techniques with monitoring applications” presents, first of all, a review of the most important activities carried out and of the results obtained after supporting the PhD thesis. Secondly, it presents the current scientific research concerns as well as the planned research program in the future. The activity referred to is mainly based on books and chapters (written as author or co-author) published in recognized publishers, on articles published in specialized journals in the field of expertise and on papers published in volumes of conferences prestige in the country and abroad, all listed in important international databases. The thesis is based mainly on books and chapters written as author or co-author, published in recognized publishing houses and on articles published in internationally rated journals and on papers presented at prestigious conferences in the country and abroad.

The thesis itself consists of three sections.

The first section refers to professional and academic achievements and is developed over three chapters. Details of professional experience, publications, areas of interest in research, and visibility at national and international level are given. Concerns in interest directions have led to the development of specialized books in recognized publishers (three books and two chapters), articles published in ISI journals with impact factor (8), articles published in volumes of ISI indexed scientific events (58), patents (2) and award-winning works (4). In order to increase international visibility, she organized special or invited sessions on the subject of the thesis, at prestigious international conferences (12), being also a chair / member of the scientific or program committee. It is presented the evolution in didactic and academic career: courses, projects and laboratories, the activity of guiding students and doctoral students, as well as the capacities and didactic performances. In addition, relevant collaborations (international, with researchers from other departments, universities and industry specialists) are given on scientific and technical lines and research projects won by competitions in which was project manager (4) and those to which was a member of the project team (12). This section ends with the main scientific and technical achievements obtained with the full list of important categories.

The second section of the thesis is detailed in three chapters, two of which are larger, presenting the main original scientific results and a chapter of conclusions. The first two chapters are represented by the two research directions approached, namely: 1. Advanced image data processing, and 2. Advanced processing of multi sensor data. It is worth mentioning that most subjects, grouped in both directions, have been developed within national research grants / projects

in which they participated as a director or team member. It is worth mentioning that most of the subjects, grouped in the two directions, were developed within national research / research projects in which they participated as a project manager or team member.

In the first research section there are presented both simple and complex, modern methods of classifying and segmentation of images. Based on these, effective algorithms have been developed and tested in various fields such as medicine (ophthalmology, haematology and dermatology) and environmental monitoring by remote sensing (segmentation of some regions of interest). The image sharing algorithms, the types of classifiers used, and the types of regions of interest that are the subject of the analysis are provided. In retinal images, regions of interest were optic disc, macula and blood vessels (normal characteristics) and exudates and haemorrhages (abnormal characteristics). In the aerial images, the regions of interest were represented by water areas (floods), crops, constructions, roads, etc. For each of these applications, the author's contributions to the methodology used in conjunction with important publications are widely presented in addition to the current state of the art. Relevant contributions are focused on established methods, mainly used in classification and segmentation of images based on chromatic statistical analysis (such as colour space fractal analysis, texture analysis based on histograms LBP, HOG etc.), on new methods of classification (voting methods, convolutional neural network - CNN, on generative adversarial network - GAN) and as well as on combined methods that have proven their usefulness and performance in their proposed applications.

In the second research direction (Advanced processing of multisensory data), the features and challenges of sensor networks followed by major application areas, especially those related to outdoor or indoor monitoring, are presented first. Modern aspects of data processing have been considered, such as the use of hybrid networks of ground-to-air sensors to extend the scope of monitoring, data aggregation and fusion, and the communication of only relevant data (as a way of energy efficiency). We also briefly outline some of the requirements and needs for communication across a sensor network, with recent technological advances as well as general architectures used. Further, emphasis was placed on developing a sensor network based on differentiated network nodes based on the function they perform. Concerns continued with outdoor monitoring based on complex sensor networks, focusing on multi-level sensor networks, integrating sensor networks into IoT and using the Fog and Cloud Computing methods. The application part was the acquisition and processing of data from large-scale wireless sensor networks, where numerous contributions have been made, such as expanding the monitoring area by integrating multiple WSN-UAVs, distributed network processing at soil by using intelligent sensors etc. which have been materialized in numerous publications. Also, the indoor monitoring part has been approached and contributions have been made on the use of Fog and Cloud Computing algorithms. The last chapter in this section refers to the general conclusions to the scientific research directions proposed in the thesis.

The third (last) section presents the research directions expected to be continued and addressed in the future to achieve a higher level of knowledge. The section ends with a bibliographic reference list illustrating the volume and quality of theoretical documentation used in research and, in particular, the drafting of the paper.

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