Abstract

My habilitation thesis presents my main achievements in my scientific and professional field, after 2003 when I obtained the PhD in "electronics and telecommunications", with "Magna Cum Laudae" distinction, at the Politehnica University from Bucharest. In 2003 I also obtained the PhD in "images and systems" at the National Institute of Applied Sciences from Lyon, France. My PhD was co-directed (co-tutelage) by prof. Vasile Buzuloiu and DR (Research Director) Isabelle Magnin and the thesis was defended both at the Politehnica University from Bucharest and at the National Institute of Applied Sciences from Lyon, France.

Since I obtained the PhD, I participated to 5 research grants, at 3 of them being director or local responsible. In this period I was author or co-author of 5 books and 2 practical guides, a book chapter at an international publishing house and 2 supports for practical activities, available on my personal website and on the website of the University of Oradea. I also was author or co-author of 19 papers indexed in the ISI-Web of Science database, 5 of them being articles in journals, with impact factor, as well as 17 papers indexed in international databases. In this period I participated as invited professor at research or didactic periods (others than Erasmus) at:

- Laboratory of Signals, Images, Communications XLIM-SIC from the University of Poitiers, http://www.sic.sp2mi.univ-poitiers.fr/, France (May-June 2006);
- Laboratory of Sciences and Materials for Electronics and Automatics (ancient LASMEA), presently included in Pascal Institute of Engineering Sciences and Systems from the Blaise-Pascal University from Clermont-Ferrand, http://ip.univ-bpclermont.fr/, France, July-September 2006;
- Laboratory of de Electronics-Telecommunications-Informatics, from the Superior School of Chemistry-Physics-Electronics (CPE) from Lyon, http://cpe.fr/-Les-laboratoires-electronique-.html, France, January 2008 and January 2009.

In this period I also was reviewer at several prestigious journals and conferences (as Journal of Visual Communication and Image Representation or ICIP 2014-2017).

The PhD thesis is structured on 10 chapters, divided in 3 main parts namely: the first part has 8 chapters and is dedicated to scientific achievements; the second part is dedicated to professional and academic achievements and plans of carrier evolution and development, after the habilitation attainment; the final part represents a references list, including the personal scientific achievements.

In chapter 2 and 3 the principles used in my main scientific fields of interest are shortly presented. Thus, in chapter 2 the hypothesis (as brightness conservation along the motion trajectory) and the problems (as opening problem) in motion estimation and compensation are presented. In this chapter are also described the principles of motion estimation and compensation, being described the motion constrain (or optical flow) equation and the main motion estimation methods.

In chapter 3 the principles of cellular neural networks and their utility in image processing are presented. The structure of cellular neural networks is presented, as well as their input, state and output equations, information' circulation and the cells' interconnection and the implication of these principles in image processing.

In chapter 4 an application of cellular neural networks in motion estimation and compensation is presented, namely an original implementation of the Horn and Schunck method using cellular neural networks. A cost (energy) function that has to be minimized is presented, as well as the templates resulting from this minimization and also the advantages of parallel computation allowed by the cellular neural networks. The testing of the obtained templates was done using both synthetic and real images.

In chapter 5 an extension in 3D volumes interpolations of the principle of motion estimation using cellular neural networks, is presented. Thus, as in the case of motion estimation in sequences of 2D images we can see the time as a third dimension and the motion compensation as a method of time interpolation of the sequence, the principle of motion compensation could be applied in the interpolation of 3D volumes, formed by 2D slices. The proposed method is illustrated for the case of 3D interpolation of volumes of 2D images acquired with a computer tomograph (CT) and with magnetic resonance imaging (MRI) equipment.

Chapter 6 presents an original method of medical image enhancement using cellular neural networks with applications in assisted diagnosis using medical imaging. The variational method is detailed, being described a cost (energy) function proposed to approximate the problem of image enhancement and the templates obtained after the minimization of this function. The utility of the proposed method in medical image enhancement is illustrated for synthetic images as well as for real CT and MRI images.

Chapter 7 presents an original method of noise removal using cellular neural networks. This method combines the properties of mean filter and the properties of median filter, in the sense that has the effect of a mean filtering but preserves the image contours. The effects of the proposed method are illustrated in the case of synthetic images as well as for real CT and MRI images.

In chapter 8 several applications of motion estimation in sequences of echographic images are presented. In the first sub-chapter an application of the block matching method is presented, to create an elasticity map from a sequence of endo-echographic images. In the second sub-chapter a sub-pixel motion estimation method is presented, that uses the phase plane matching, being presented a direct and an iterative method. In the third sub-chapter a sub-pixel motion estimation method is presented that uses the phase matching of complex signals, with applications in echographic elastography. In the last sub-chapter of the chapter 8 and original method for the diagnosis of the thyroid tumors is detailed described. A method of motion estimation between two images is presented and also an extension of this method to estimate global motion in longer echographic sequences. The performances of the proposed method are illustrated in the case of synthetic images as well as in the case of real B-mode echographic images.

In chapter 9 the main professional and academic achievements are presented, as well as the evolution and development plan taken into account after the habilitation. In chapter 10 a list of bibliographic references is presented, including the personal scientific achievements.