Preface

Although we might not be aware of this, compression methods are used on a daily basis to store or transmit data. We can find examples of this by looking at our computers (which compress large folders with a simple click of the mouse), our mobile phones (which integrate Codecs), our digital and video cameras (including post-compression recording on flash memory or others), our CD and MP3 players (which are capable of storing hundreds or thousands of songs), our High Definition digital televisions (using the MPEG-2/MPEG-4 compression standards) and our DVD players (which allow us to visualize data in various formats, such as the MPEG-4 format).

Consideration of these can lead us to ask the following question: how does this apply to the medical field?

Although some of the thousands of observations made by physicians are still recorded on paper using radiological film, much of the data acquired (signals, images) are now digital. In order to properly manage the huge amount of medical information, it is essential to exploit all of this digital data efficiently.

It is obvious that most doctors, wherever they are located, would appreciate efficient and fast access to the medical information pertaining to their patient. For instance, suppose that the doctor uses some type of mobile imaging system (for instance, an ultrasound system) for the purpose of analysis. As a consequence, the main clinical observations can be transmitted to a medical center for a preliminary check-up. Of course, in this case, secure data might be transmitted by telephone line or simply through the Internet. In fact, this acquisition/transmission protocol can be established so that the patient could be directed efficiently to the most appropriate clinical service in order to pursue the medical examination further.

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For such changes to take place, data compression will be necessary both for the transmission as well as for the storage of all medical information. In fact, many authors have been interested in the medical compression field, and numerous techniques have been dedicated to this purpose. However, as the title *Compression of Biomedical Images and Signals* suggests, we have aimed to work collectively on this topic while giving detailed consideration to the use of recent technology in medicine, focusing particularly on compression.

This book will address questions such as the following: should bioelectric or physiological signals be compressed as audio signals? Should we compress a medical image as if it had been acquired by a simple camera? What about three-dimensional images? In other words, should we directly apply common compression methods to medical data? Should we compress the images with or without losing any information at all? Is there a compression method specific to medical data? In order to answer questions on such a sensitive and delicate topic, we have gathered the skills of over 20 researchers from all corners of France and from various medical and scientific communities including: the signal and image community and the medical community. Such a topic cannot simply be seen from the perspective of a single community, in the sense that one community cannot provide objective judgment on the topic whilst at the same time being involved in its activity. Moreover, a multi-disciplinary reflection is enriching and produces more fruitful work. We therefore hope that this piece of work will serve as a starting point for all young researchers in scientific and medical communities wishing to engage in this particular field. It should thus be used as additional reading to any specialized course module at a Masters level (in science or in medicine).

This book is organized into 11 chapters and structured in the following way.

Chapter 1 describes how important the role of compression is in the medical field. It is built on the observations and points of view of medical experts in images and signals. Their experiences as doctors working in imaging poles have helped us outline the function of medical information compression. It is important to note however that the views upon which our argument is based are specifically relevant to the current state of technological developments (2006) and that innovations in this field are recognized and significant.

Chapter 2 deals with the state of compression methods, and more generally the different compression norms. Some of them can be used to compress medical data while others cannot. Throughout the following nine chapters we will be making constant references to this particular chapter, most notably when comparing the different methods applied to medical data.

Chapter 3 is an introduction to the subsequent chapters. It outlines important features of medical signals and images that are used throughout the discussion in the rest of the book and in various descriptions of certain specific compression methods.

Chapter 4 describes the role of compression norms applied to medical images. This chapter will introduce standardization committees present in the field of medical information exchange as well as the DICOM standard which encompasses almost all medical images. This standard is undergoing constant improvement and incorporates a variety of different compression methods.

Strong compressions with a high risk of information loss are not used in clinical routine for the simple reason that such possible degradations may thwart the medical diagnosis. Chapter 5 outlines the different approaches commonly used to evaluate the quality of reconstructed medical images following lossy compression.

Chapter 6 specifically concerns the compression of physiological signals. Specific attention will be given to electrocardiogram (ECG) compression.

Chapter 7 reviews the different techniques applied (and often adapted) to medical images. It will look at lossless, lossy and progressive compression methods.

Chapter 8 will look into the compression methods of image sequences, represented as videos (2D+t) or as a non-geometrical volume (3D). The use and popularity of this type of imaging is growing rapidly.

Chapter 9 deals more particularly with geometrical (3D) and (3D+t) compression methods. These techniques are particularly interesting today as they have become the main subjects of various studies and practices on organs such as the heart and lungs. This chapter will conclude with a look at potential prospects and opportunities for the use of such methods.

The security aspects of medical imageries will be looked at in Chapter 10. This chapter will also address encrypting techniques.

The final chapter, Chapter 11, looks at wireless transmission of medical images as well as the potential problems that may arise linked to transmission channels. Various solutions will then be suggested as a possible answer to such problems.

Various medical images used as illustrations throughout this work have been taken from the MeDEISA[1] database *Medical Database for the Evaluation of Image and Signal Processing*, created in 2006. This evolving database can be accessed freely through the Internet and gathers a number of images obtained by different acquisition methods (based on recent acquisition systems). Researchers are encouraged to use this database in order to evaluate their own algorithms.

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1 Accessible at http://www.medeisa.net.