Innovative Formalism for Biological Data Analysis

Calin Ciufudean
Stefan cel Mare University, Romania

INTRODUCTION

Modern medical devices involves information technology (IT) based on electronic structures for data and signals sensing and gathering, data and signals transmission as well as data and signals processing in order to assist and help the medical staff to diagnose, cure and to monitors the evolution of patients. By focusing on biological signals processing we may notice that numerical processing of information delivered by sensors has a significant importance for a fair and optimum design and manufacture of modern medical devices. We consider for this approach fuzzy set as a formalism of analysis of biological signals processing and we propose to be accomplished this goal by developing fuzzy operators for filtering the noise of biological signals measurement. We exemplify this approach on neurological measurements performed with an Electro-Encephalograph (EEG).

We mention that automatic diagnosis based on fuzzy approach becomes more and more used in artificial intelligence framework of proposing new methods and tools for developing automatic medical diagnosis. Fuzzy techniques of analysis and diagnosis have a significant advantage compared to classical techniques, respectively the ability to deal with typical uncertainty and estimation that characterizes any physical system, including the human body.

This chapter is focused on reasoning with fuzzy logic for designing new type of filters capable to reject noises which overload the biological signals taken by invasive ad/or non-invasive medical tools. We will exemplify our approach on EEG measurements. This goal will be accomplished by using a new structure and inference mechanism of fuzzy operators which will implement a new design of filters against impulsive and uniform distributed noise. This approach is inspired by the class 1-D (signals) and 2-D (images) of fuzzy filters proposed in (Zadeh, 1988; Russo & Ramponi, 1994; Russo, 1994). Building our approach we were guided by Professor Lofthi Zadeh`s statement (Zadeh, 1988): "Fuzzy logic is a precise conceptual system of reasoning, deduction and computation in which the objects of discourse and analysis are, or are allowed to be, associated with imperfect information. Imperfect information is information which in one or more respects is imprecise, uncertain, incomplete, unreliable, vague or partially true". We assume that the reader is familiarized with fuzzy logic systems, or we address the reader to (Kumar, s.a., 2001; Adlassnig, 2007; Chin, 1991; Fathi-Torbaghan & Meyer, 1994; Nguyen & Kreinovich, 2001; Bounds, 1999). We notice that literature treat intensively the subject of applying fuzzy logic to biological data acquisition and processing for medical diagnosis (John & Innocent, 2005; Perner, 2002); therefore we try to add a piece in this puzzle hoping to speed up the process of having a clear picture. Automatic processing of sensory information is an actual research area, and fuzzy techniques are well framed in this content, and represents a useful and widely applicable technique with long run perspective. This chapter is focused on implementing rule-based fuzzy systems for processing, e.g. filtering, measured biologic data in order to determine the availability of the most important ones for the final diagnosis. We appreciate that our approach will framework the

DOI: 10.4018/978-1-5225-2255-3.ch158

computer systems for medical diagnosis. An example will emphasize our approach.

This chapter is organized as follows: section 2 briefly discuss the chapter`s position on the topic of biological data processing and analysis, section 3 presents our fuzzy filter approach, section 4 deals with fuzzy inference mechanism for filtering electric signals, section 5 illustrates our approach by an example and section 6 concludes the present work and gives a few directions for future research in the area.

BACKGROUND

As modern world evolves, so does the technique, economy, the life style, and unfortunately, the diseases; therefore, nowadays mainly due to stress, pollution and rush life style we confront with a new medical problem: the diagnosis of multiple diseases and the diagnosis of mutant diseases. Therefore, nowadays mainly due to stress, low infrastructure facilities and rush life style we confront with a new problem: the diagnosis of multiple informational news and data releases of mutant informational transmission infrastructure. Failure diagnosis in complex information systems, such as medical ones, is a critical task due to respect the safe development of these systems and patient care. In an optimistic scenario, doctors are confronted with patients who suffer from one disease and the diagnosis tries to find the cause and the most adequate treatment (Cacioppo & Tassinary, 1990; Lyons, Budynek, & Akamatsu, 1999). This approach give birth to classic diagnosis, e.g. to ordered tables or lists well known in medicine as well as in medical informatics that make a correspondence between symptoms and disease (Ekman, Levenson, & Friesen, 1983; Ekman, Friesen, & Ellsworth, 1972; Posner, Russell, & Peterson, 2005). In our view this is only the starting point for developing a new way for applying computational modeling techniques in medical diagnosis procedure. This is explained by the fact that while in the above mentioned rule-based systems deterministic models are considered (e.g. there are facts determined by certain factors), our approach deals with dependent probabilities of medical symptoms, signs and tests, and therefore we model the diagnosis procedure with artificial intelligence formalisms, such as fuzzy sets.

We assume that diagnosis of patients implies some risks and also some possible human errors or lack of an adequate logistics such as materials, equipment, medical devices, etc. (Pearl, 1988; Perner, 2006, 2008).

Basically, the doctors` expertise based on clinical symptoms, physical examination and laboratory results are the foundation for a correct diagnosis and treatment procedure for the patients. In order to optimize this complex process and to help performing correct computational modeling diagnosis our paper focuses on fuzzy built-in diagnosis procedure (Picard, Vyzas, & Healy, 2001; Groshan, 2012). An advantage of our model is that the use of large fuzzy models is not required. Another advantage is that it allows performing sensitivity analysis of an entire flexible system, as well as of its components. The novelty of this approach is that it incorporates the availability of the human factor, as fuzzy approach usually does, and in order to deal with this issue we built a fuzzy filter capable to reject both human and machine errors in medical data transmission and processing, e.g. capable to reject errors of patient diagnosis.

We consider for this approach fuzzy set as a formalism of analysis of biological signals processing and we propose to be accomplished this goal by developing fuzzy operators for filtering the noise of biological signals measurement. These fillers are capable to reject impulsive noise as well as the uniform noise in a very large proportion. The design of such filters is simple, starting by choosing the number of neighbors used for the correction, and obtaining an, easy to implement inference approach (Gadoras & Mihailkov, 2009; Sharifalundian, 2009).