

Soft Computing Techniques for Disability: A Short Review

Rojano, Rafael^{1,2}

¹Department of Computer Science and Artificial Intelligence
Universidad de Granada
Granada, Spain
rrojano@ugr.es

Rebolledo, Genaro²

²Facultad de Estadística e Informática
Universidad Veracruzana
Xalapa, Mexico
grebolledo@uv.mx

Herrera, Francisco¹

¹Department of Computer Science and Artificial Intelligence
Universidad de Granada
Granada, Spain
herrera@decsai.ugr.es

Abstract—In this article we make a short review about the current trends in Soft Computing which are used to cope with different problems facing the disabled. For this purpose, we address our review taking into consideration as a keystone: Fuzzy Logic (FL), Artificial Neural Networks (ANN) and Genetic Algorithms (GA). As a result of such review we identify several techniques that has been addressed for researchers to tackle three main disabilities, but not limited to: Learning Disability (LD) problems, Motion Disability (MD), and Specific Language Impairment (SLI).

Keywords—soft computing; disability; review; handicap people

I. INTRODUCTION

According to the World Health Organization (WHO) the 15 per cent of world population has some disability [1], such percentage is equivalent to one hundred eight millions of people from the world population in 2013 [2]. In Mexico, the people with some disability is around six million according to INEGI [3], which is approximately the 1 per cent of the global population. Thus, in this sense Information and Communication Technologies (ICTs) can be seen as an opportunity mechanism to support inclusive governance, including services such as education, social security, economy, etc. In the Mexican context the governmental reference is given by the National Digital Strategy [4] that defines the general policies to take into account such sectors.

This article is part of an investigation toward the use of Soft Computing techniques applied to “**closing digital divide in vulnerable population**” by making use of ICT tools, and particularly by integrating such techniques as a natural way to tackle with uncertain in the process. As a part of our research process we will continue describing the application of such

techniques in different context. Hence, in the following sections we describe first briefly the general work of ICT with aspect related to disability, later we particularize the work done with Soft Computing techniques centered in FL, ANN, and GA. We conclude with some interesting statistics about the relationship technique/disability.

II. CURRENT WORK WITH ICT AND DISABILITY

For some time now researchers, scholars as well as institutions has been interested in attending a part of the population which is miscalled “minority”, and that for their circumstances is vulnerable to lack of care, access to services, and in general a full life. In our particular case, talking about technology, we can refer to what Bolt and Crawford (2000) in [5] define as digital divide: as the existing gap between individuals who belong to certain social groups, and the presence or absence of access to technology. Therefore, such kind of groups represent our target population.

As previously stated, Information and Communication Technology (ICT) has an important role as mechanism to improve quality of life, but only if it is encompassed by a set of powerful techniques that can mediate between the digital world and the everyday world, this point of view is explored in the subsequent sections, but first we review the work that has been done to give access to different services to impaired people.

A. Accessibility for

Popularized at the end of 80’s and starting of 90’s [6], the World Wide Web (WWW) has experimented a huge and fast growth due to the introduction of graphical browsers, alike of this, some sectors of the society have found difficult to benefit from it, as a clear example, including but not limited to, visually impaired people [7]. In a conducted study in [8] it was found that

most research is made focusing on effectiveness, freshness and composition of result of the web sites, but less work is made about accessibility on interfaces. As a particular case of this problem are search engines, which prioritize the aesthetic instead of the accessibility, for example through web images which cannot be accessed by screen readers. However it is also possible to find examples about accessibility as in [9].

Another good example about the current applications of ICT is given by the people who suffered some decreasing in their hearing capability. Even though such community can obtain benefit from digital contents and courseware [10], [11], they require access to sign language interpretation service in order to be able to communicate with others [12], nevertheless communicating by means of visual expression is quite difficult even for highly trained [13] for that reason complex and robust systems need to be developed [14].

Although not an extensive revision, it is possible to realize that the current work in ICT depends on the particular problem and target population, as well as the final product (web application, mobile application, and physical application). While so much work has been made in the standardization problem it still remains open the possibilities to contribute from different fields and using a variety of techniques. In our particular context, we describe the approach by Soft Computing techniques in the following sections.

III. CURRENT TRENDS IN SOFT COMPUTING AND DISABILITY

As aforementioned, we present in this section a short and not extensive review about the different techniques currently employed to tackle the topic of disability by means of Soft Computing (SC), in this sense we will explore the typical elements in SC as Fuzzy Logic (FL), Artificial Neural Networks (ANN), and Genetic Algorithms (GA). Therefore, we address our survey by exploring aspects of diagnosis, treatment or support in everyday life with such techniques.

A. Fuzzy systems

Uncertainty is inherent to human being, and to the processes he/she conducts in daily life, for that reason a powerful tool to cope with it is the fuzzy logic because it does not limit to just binary relations such as true/false. Conversely, it defines membership levels between 0 and 1 which constitutes the heart of the fuzzy set theory [15]. Thus, a natural way to cope with imprecise aspects of disability, e.g. IQ scores, successful achievement, etc., is using this approach.

Furthermore, in our research we identify from Scopus database an increasing tendency in the last years to use fuzzy system in problems of disability, see Figure 1. For example in [16]–[22] is used fuzzy logic for a wide variety of problems such as: interaction by haptic interface, identification of human body in motion, identification of learning disability, interaction of people with limited movement, interaction within smart house, specific language impairment, user-centered applications for elders, and vision disturbance.

Hence, from the perspective of diagnosing hard problems such as Specific Language Impairment (SLI), which is one of the most common childhood learning disabilities [23] with unknown causes and also difficult to diagnose by experts, in [19]

Fuzzy Cognitive Maps (Fuzzy logic and Neural Networks) is proposed as technique which can deal even with contradictory or conflicting data from experts because it uses a weighted system to assign credibility instead of a rule-based expert system.

B. Neural networks

In a similar way, diagnosis by means of Artificial Neural Networks (ANN) presents a growing tendency in researching, as well as other techniques. In [24] another approach to diagnosis is presented, where Artificial Neural Networks (ANN) and Adaptive Neuro-Fuzzy Inference Systems (ANFIS) are used to diagnose the problem of Learning Disability (LD) which is a general term to describe different learning problems in reading, writing and math, but it is not used to refer mental retardation [25]. In this study ANN are used for prediction about if the child present LD or not. In the meantime ANFIS is used to assign a percentage of LD and the class. Another approach to diagnose dyslexia, which belongs to the set of common problem in LD, is presented in [26-27] where the authors follow an approach based in Soft Computing Agents, which are agent that, on the one hand, implement a technique as ANN, GA, or FL to obtain an admissible decision, and on the other, an agent that orchestra data transfer in a distributed environment. In [28] the problem of LD is addressed also but by using a technique called Learning Vector Quantization (LVQ) which is a special case of ANN [29].

C. Genetic algorithms

GA has been used generally as an optimization mechanism and search methods as stated in [30]. Departing from the perspective of previous examples, in [31] the authors applied GA as mechanism to optimize the parameters of an ANN whose objective is the diagnosis of students with LD.

As an assistive technology, the implementation of electromyography (EMG) to measure the muscular activity with the purpose of rehabilitate patients as received the support of GA as a mechanism to optimize the estimated model of action in the EMG. It is important to say that this kind of research is very important in order to assist people who has suffered of a stroke. Some other examples can be found as mechanism of optimization of other techniques in SC [32], [33].

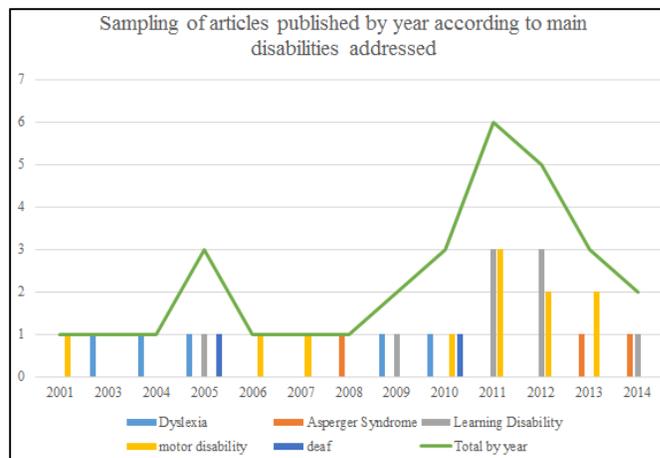


Figure 1. Sampling of papers published by year according to main disabilities addressed.

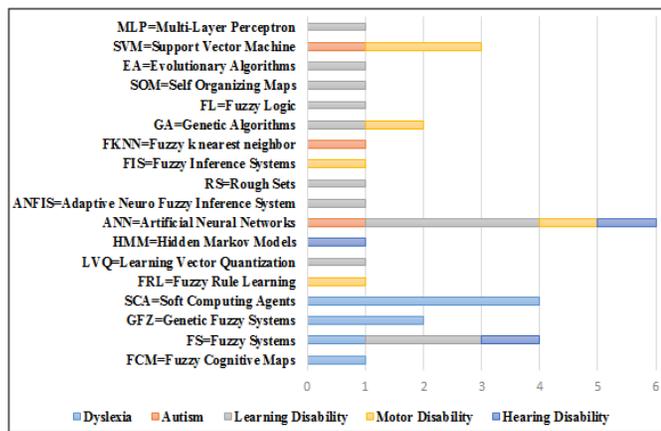


Figure 2 trend disabilities and trend soft computing techniques identified through different articles.

IV. CONCLUSIONS

In essence, Soft Computing techniques are present to solve different problems which imply the existence of uncertainty or present difficulty to take decisions. In this case such tools provide a robust way to cope with difficult problems related to disability. Even though it is not an extensive review, we learn that some of the trend topics related with disability are Learning Disability (LD), Specific Language Impairment (SLI), and Motor Disability (MD), also another variety of disabilities are studied as it is shown in Figure 1, as well we identified that among the main Soft Computing techniques addressed are ANN, Fuzzy Systems, and SVM other techniques are show also in Figure 2.

As previously stated, in Figure 1 there are also some problems related to disability that were previously addressed in last sections and that are equally relevant to support handicap people and which remains open to be addressed for new solutions. For that reason we identify future lines of development to support our project "**closing digital divide in vulnerable population**" by making use of Information and Communication Technologies (ICT) tools, and particularly by applying Soft Computing Techniques.

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