

Fuzzy Logic Estimator for Variant SNR Environments

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INTRODUCTION

The acquisition system is one of the most sensitive stages in a Direct Sequence Spread Spectrum (DS-SS) receiver (Peterson, Ziemer & Borth, 1995), due to its critical position in order to demodulate the received information. There are several schemes to deal with this problem, such as serial search and parallel algorithms (Proakis, 1995). Serial search algorithms have slow convergence time but their computational load is very low; on the other hand, parallel systems converge very quickly but their computational load is very high. In our system, the acquisition scheme used is the multiresolutive structure presented in (Moran, Socoró, Jové, Pijoan & Tarrés, 2001), which combines quick convergence and low computational load.

The decisional system that evaluates the acquisition stage is a key process in the overall system performance, being a drawback of the structure. This becomes more important when dealing with time-varying channels, where signal to noise ratio (called SNR) is not a constant parameter. Several factors contribute to the performance of the acquisition system (Glisic & Vucetic, 1997): channel distortion and variations, noise and interference, uncertainty about the code phase, and data randomness. The existence of all these variables led us to think about the possibility of using fuzzy logic to solve this complex acquisition estimation (Zadeh, 1973). A fuzzy logic acquisition estimator had already been tested and used in our research group to control a serial search algorithm (Alsina, Morán & Socoró, 2005) with encouraging results, and afterwards in the multiresolutive scheme (Alsina, Mateo & Socoró, 2007), and other applications to this field can be found in bibliography as (Bas, Pérez & Lagunas, 2001) or (Jang,

Ha, Seo, Lee & Lee, 1998). Several previous works have been focused in the development of acquisition systems for non frequency selective channels with fast SNR variations (Moran, Socoró, Jové, Pijoan & Tarrés, 2001) (Mateo & Alsina, 2004).

BACKGROUND

In 1964, Dr. Lofti Zadeh came out with the term *fuzzy logic* (Zadeh, 1965). The reason was that traditional logic could not answer to some questions with a simple *yes* or *no*. So, it handles the concept of partial truth. Fuzzy logic is one of the possibilities to imitate the working of a human brain, and so to try to turn artificial intelligence into real intelligence. Zadeh devised the technique as a method to solve problems for soft sciences, in particular those that involve human interaction.

Fuzzy logic has been proved to be a good option for control in very complex processes, when it is not possible to produce a mathematical model. Also fuzzy logic is recommendable for highly non-linear processes, and overall, when expert knowledge is desirable to be performed. But it is not a good idea to apply if traditional control or estimators give out satisfying results, or for problems that can be modelled in a mathematical way.

The most recent works in control and estimation using fuzzy logic applied to direct sequence spread spectrum communication systems are classified into three types. The first group uses fuzzy logic to improve the detection stage of the DS-CDMA¹ receiver, and they are presented by Bas et al and Jang et al (Bas, Pérez, & Lagunas, 2001)(Jang, Ha, Seo, Lee, & Lee, 1998). The second group uses fuzzy logic to improve interference

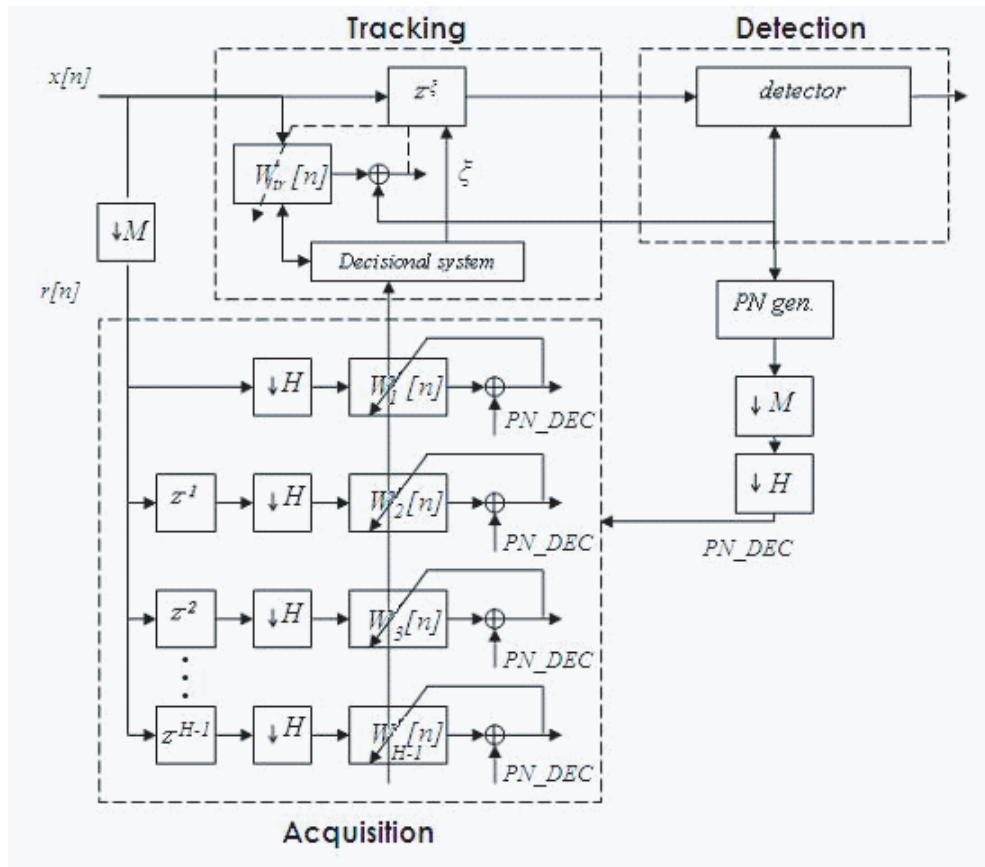
rejection, with works presented by Bas et al and by Chia-Chang et al (Bas, & Neira, 2003) (Chia-Chang, Hsuan-Yu, Yu-Fan, & Jyh-Horng, 2005). Finally, fuzzy logic techniques are also improving estimation and control in the acquisition stage of the DS-CDMA receiver, in works by Alsina et al (Alsina, Moran, & Socoró, 2005) (Alsina, Mateo, & Socoró, 2007).

ACQUISITION ESTIMATION IN DS-CDMA ENVIRONMENTS

One of the most important problems to be solved in direct sequence spread spectrum systems is to achieve a robust and precise acquisition of the pseudonoise

sequence; this is to obtain an accurate estimation of its exact phase or timing position (Proakis, 1995). In time-varying environments this fact becomes even more important because acquisition and tracking performance can heavily degrade communication demodulation reliability. In this work a new multiresolutive acquisition system with a fuzzy logic estimator is proposed (Alsina, Mateo, & Socoró, 2007). The fuzzy logic estimation improves the accuracy of the acquisition stage compared to the results for the stability controller, through the estimation of the probability of being acquired, and the signal to noise ratio in the channel, improving the results obtained for the first fuzzy logic estimator for the multiresolutive structure in (Alsina, Mateo & Socoró, 2007).

Figure 1. Multiresolutive adaptive structure for acquisition and tracking



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