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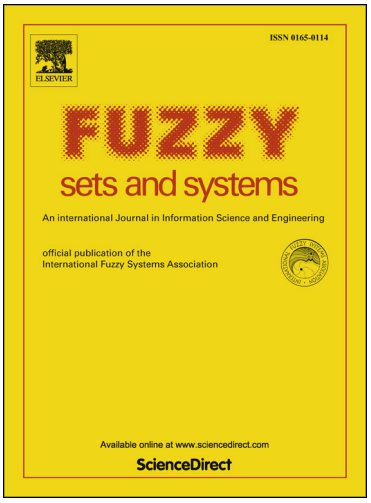

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A Low-Power, Fully Programmable Membership Function Generator Using Both Transconductance and Current Modes

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Abstract

In this paper, a membership function generator (MFG) is presented which can produce triangular, trapezoidal, S-shaped or Z-shaped membership functions. The presented structure can operate in both trans-conductance (voltage-current) and current mode (current-current) with high programmability. The slope (keeping the height or width of the membership function constant), height (keeping the width constant) and width (keeping the height constant) of the membership function are independently programmable. Moreover, the width of the trapezoid can be varied without changing slope or height and all the generated shapes can be positioned horizontally. The topology, primarily, is presented in transconductance mode which can be converted to current mode with a little change in the input section of the circuit. Simulation results for the proposed circuit are presented in two operation modes. The most remarkable feature of the proposed MFG is its capability of generating outputs while consumes a very low amount of power. The analytical analysis of the proposed circuits is also given in HSPICE using TSMC 0.18μm CMOS technology.

Keywords: Fuzzy System, Fuzzifier, Transconductance Mode, Current Mode

1. Introduction

Over the past few years, modelling some human reasoning aspects in modern technologies has attracted increasing interests [1]. Among different methods of modelling, fuzzy theory has been highly considered, especially in the matter of emulating human decision making process [2, 3]. Over recent years, the applications of fuzzy controllers have been significantly grown in many areas such as antilock-braking system (ABS) of vehicles, robotics and home applications [4- 6].

Many hardware implementations of fuzzy systems as well as theoretical studies confirm the efficiency of fuzzy models in decision making. Owing to the design specification, three basic approaches using digital, analogue or mixed-mode circuit design techniques are available to design fuzzy controller chips [7-10]. Digital fuzzy chips offer significant potential for general applications but they have limited speed [11, 12]. In addition, the use of analogue-to-digital and digital-to-analogue converters in digital and mixed-mode fuzzy chips decreases the speed further and increases the complexity of hardware and power consumption [13]. Thus, considering elements such as speed, power consumption, small die size and accuracy, the analogue circuit design stands out remarkably among other possible approaches [14]. Taking into account that the building blocks of fuzzy