High Performance Continuous Variable Bandwidth Digital Filter Design for Hearing Aid Application

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High Performance Continuous Variable Bandwidth Digital Filter Design for Hearing Aid Application

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Abstract

A low complexity, low delay reconfigurable digital filter structure for hearing aids is proposed in this paper. The main objective is to match a given human audiogram, with minimum error. The high computational complexity in the conventional uniform and non-uniform filter bank techniques, probes to shift the design paradigm towards variable filter structure. In this paper, Farrow structure based design is used to realize an arbitrary sample rate converter, making use of a differentiator based model, by which the bandwidth can be continuously varied. The proposed design also considers the importance of the power, area, and delay in such a critical scenario. Exhaustive comparisons are performed with the existing literature on audiogram matching, and our design is very competitive when compared to the designs in the literature, not only with respect to the matching error but also with respect to area, power dissipation, and hardware complexity.

Keywords: Audiogram Matching, Hearing Aid, Farrow structure, Variable bandwidth filter

1. Introduction

According to the World health organization (WHO) 2017 statistics, 360 million people worldwide (5% of the worlds population) have disabling hearing loss and 32 million of them are children. The sheer number makes the hearing loss a relevant problem, as it affects the quality of the people. It impacts the functional, socio-economic and emotional domains of the affected individual. Majority of the people with disabled hearing loss, live in low- and middle-income countries [1]. In India, the prevalence of Hearing Loss is 2.4% in children, 9.5% in adults below 65 years and 48% in adults above 65 years. As per National Institute on Deafness and other communication disorders (2015), 15% of Hearing Loss is due to noise-work, leisure activity or use of mobile phone [2]. Use of hearing aids and other assistive devices benefits a large section of the impaired population having a sensorineural hearing loss which is caused by damage to the sensitive hair cells inside the inner ear or damage to the auditory nerve. The WHO study also indicates the insufficiency in global hearing aid production, fitting services and lack of batteries in low-income settings. Hence, a method