Fully Automated Design of Analog Circuits Using Genetic Operation and Simplified Transistor Model

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Abstract

In this talk, an automated design of analog circuits which can extremely reduce the design time is presented. Instead of using complicated transistor models, a simplified model is introduced at the first stage of topology generation. Firstly, the system randomly generates a set of circuits, and then evolves their topologies to fit an environment that is formed by the fitness function translated from the electrical specifications of the circuit. Thus expert knowledge about circuit topologies is not required.

In order to create a circuit topology without help of analog circuit designer's knowledge, genetic algorithm (GA) is used. Together with the elite preservation, reuse of effective genetic operations (GO) is introduced to revise the circuit topologies to achieve higher performances. The reuse of GO together with using simplified transistor model, we can reduce the design time and improve the success rate to almost 100 % to obtain a satisfactory circuits. Though the circuits can be automatically generated by the above method, the designed circuits sometimes are quite complicated and have many strange structures. In addition, it takes a long calculation time. These are resulted from that the method does not utilize any analog circuit design knowledge. In order to include the design knowledge, we restrict the circuit structure that has reasonable current and signal flows.

After obtaining a circuit topology using the simplified transistor model, the model is replaced by transistors and the transistor parameters are optimized to meet the given specifications. This idea follows the design process of skilled analog circuit designers. The analog circuit designers first create a circuit assuming that all transistors are expressed by a simple ideal model such as a voltage controlled current source, and then they replace the ideal elements by practical transistors.

As examples of the design, linear and nonlinear circuits such as a trans-impedance amplifier, a log-linear voltage controlled amplifier, etc. are shown.