Contribution ID: **71** Type: **not specified**

Analog CMOS Circuits for Convex Quadratic Programming

Monday, 27 May 2024 16:15 (10 minutes)

Analog circuit design for nonlinear programming has been widely studied in the literature (Dennis, 1959; Kennedy and Chua, 1988; Tank and Hopfield, 1986; Wilson, 1986). However, recent advances in edge computing and in model predictive control have led to a resurgence of interest in analog programming circuits (Vichik and Borrelli, 2014; Vichik et al., 2016; Bena et al., 2023). We develop electronic circuit analogs for emulating the solution of convex Quadratic Programming (QP) problems. Quadratic programs are prevalent in engineering and are often encountered in applications where solutions must be determined in real time using minimal computational resources. Such applications include among others model predictive control (MPC) problems, economic dispatch of power, and optimal routing in large-scale integration (VLSI) to mention a few.
We model the optimality conditions associated with such convex QP problems using energy-conservative laws governing the flow of current and voltage distribution within a piecewise linear resistive-diode network. The quiescent operating point for the ensuing circuit characterizes the optimal solution of the source QP problem.
The proposed work entails taking advantage of the inherent parallelism in analog circuits to emulate the behaviour of the programming circuit on a high-speed analog circuit processor known as a Field Programmable Analog Array (FPAA) board. This provides a high-level simulation-based mechanism for accessing the feasibility of the programming circuit and for functional verification. Then the programming circuit is realized using a very large-scale integration technology. An analog CMOS application-specific integrated circuit (ASIC) is developed to realize the programming circuit in a 180nm process technology (Skibik and Adegbege, 2018; Araújo et al., 2024). Finally, we show, using tools from mathematical programming and circuit theory, that the circuit solution coincides with the solution of the original QP program. We demonstrate the viability of the proposed programming circuit using a real-life example of an economic dispatch problem.

Primary authors: Mr INNOCENT, Emmanuel (Obafemi Awolowo University); Mr EGWU, Emmanuel (Obafemi Awolowo University); Mr OLULETI, Victor (Obafemi Awolowo University); Dr JUBRIL, Abimbola (Obafemi Awolowo University); Prof. ADEGBEGE, Ambrose (Obafemi Awolowo University)

Presenters: Mr INNOCENT, Emmanuel (Obafemi Awolowo University); Mr EGWU, Emmanuel (Obafemi Awolowo University); Mr OLULETI, Victor (Obafemi Awolowo University)

Session Classification: Technical session 1

Track Classification: Engineering: Computer Engineering