University Booth – Demonstration

SWARM: Self-organized Wiring and Arrangement of Responsive Modules

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About this Demonstration

This demonstration presents a new automation methodology for layout design of analog integrated circuits: *Self-organized Wiring and Arrangement of Responsive Modules* (SWARM). Based on the idea of decentralization, this interdisciplinary approach tackles the task with an innovative *multi-agent system*.

The SWARM Methodology

Its basic principle, similar to the roundup of a sheep herd, is to let *responsive* layout modules (implemented as procedural generators) interact with each other in a user-defined layout zone. Each module is allowed to autonomously move, rotate and deform itself, while a supervising control organ successively tightens the layout zone to steer the interaction towards increasingly compact layout arrangements.

Bottom-up Meets Top-down

The procedural layout modules can consider their respective design requirements *implicitly*, while the control organ functions in an optimizing way and may impose superordinate design requirements *explicitly*. With this *bottom-up-meets-top-down* concept, conflicts are resolved via the module interaction.

Self-organization and Emergence

Considering various principles of self-organization, SWARM is able to evoke the phenomenon of *emergence*: although each module only has a limited viewpoint and selfishly pursues its personal objectives, remarkable overall solutions can emerge on the global scale. Emergence can be observed in nature, such as in a flock of birds: although each bird acts autonomously, this leads to collective *swarm behavior*.

Examples and Results

Several examples also illustrate this emergent behavior in SWARM. For instance, an artificial placement problem (where the modules are allowed to move, but not to rotate or deform themselves) demonstrates, that even *optimal* solutions can arise from the module interaction. Other examples apply SWARM to practical place-and-route problems. Fig. 1, displaying two layout results for an Operational Transconductance Amplifier (OTA) circuit, shows that the layout modules manage to satisfy their local design requirements (e.g., the interdigitated positioning of their devices) as well as global design requirements (such as the explicitly imposed contour and the positions of the layout modules relative to each other).

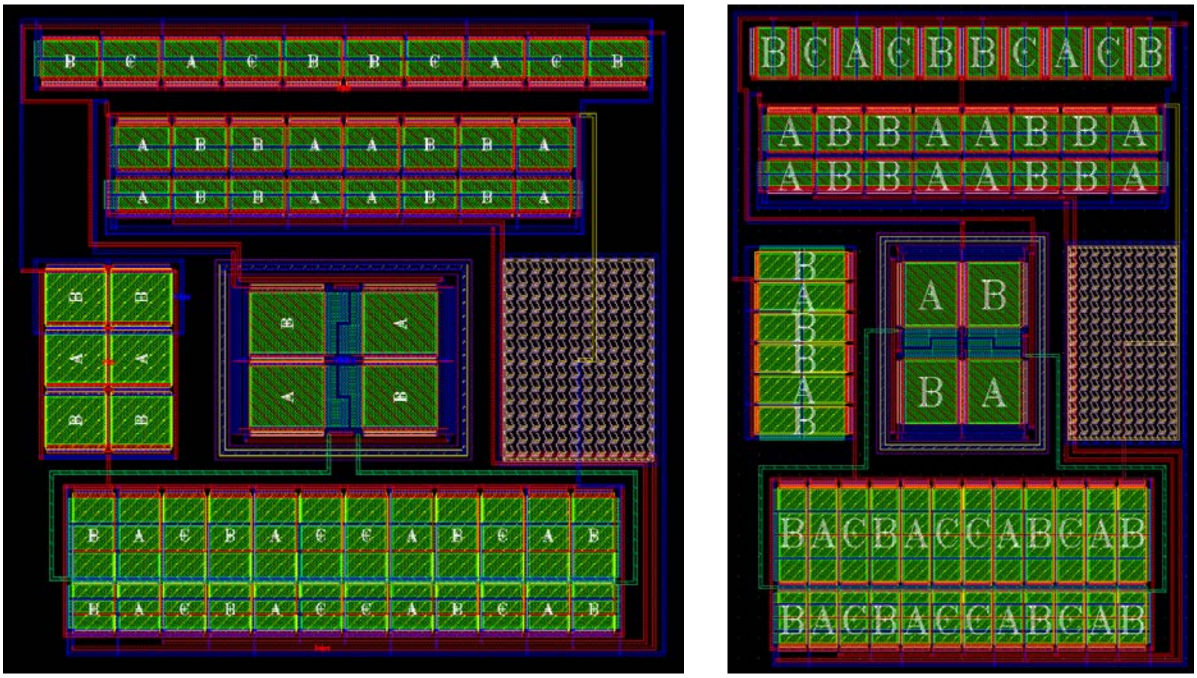

Fig. 1: Layouts achieved by SWARM for an OTA circuit, considering aspect ratios of 1:1 (left) and 2:3 (right).