What is EDA for Wearable Flexible Healthcare Devices?

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Flexible and stretchable electronics represent integrated circuits (IC) implemented on bendable, rollable, conformable, or elastic substrates [1]. They are lighter and thinner, hence, more amenable to wearable healthcare. Due to these advantages and low cost, flexible and stretchable patches and health monitoring devices have attracted increasing interest lately. They can transform healthcare applications by enabling bendable and stretchable wearable systems.

Flexible electronics still suffer from low performance and larger parameter variations than silicon CMOS circuits [2]. For example, state-of-the-art silicon technology offers more than GHz frequency with feature sizes as small as a few nm, whereas the frequency of thin-film transistors (TFT) hardly reaches 10 MHz with feature sizes of µm [1]. Flexible hybrid electronics (FHE) technology by integrating rigid silicon integrated circuits and printed electronics addresses this problem. FHE aims at combining rigid, flexible, and stretchable resources to reduce the gap between the performance of flexible devices and conventional silicon technology while preserving the form factor advantages of flexible electronics. To enhance the productivity of FHE circuit design, ideally, FHE should use the same design environment or Electronic Design Automation (EDA) tools with silicon chips for the co-design capability [2]. Outstanding design and EDA challenges include finding the optimal set of components based on these technologies, interfacing them with each other, optimal integration, and test and validation under different physical conditions.

Health applications using Internet-of-Things (IoT) have drawn significant attention recently with the rapid development of machine learning. Data-intensive computing using machine learning enables pattern recognition for healthcare applications, including health monitoring, sleep monitoring, activity recognition, pose estimation, and patient rehabilitation. User studies show that comfort, maintenance (e.g., charging) requirements are among the leading reasons for abandoning wearable devices [3]. Hence, physically flexible and self-powered devices can drive the next leap forward in healthcare applications. To realize this vision, these devices must provide values, such as collecting clinically relevant data and analyzing them locally, under tight energy budgets. Hence, there is a critical need for killer applications, energy-efficient edge AI algorithms, as well as optimal energy harvesting and management. Finally, these devices must protect user privacy and ensure a secure operation since they handle sensitive information [4].

In summary, FHE has the potential to enable a breakthrough in healthcare applications due to its form factor benefits and sensing technology. Potential high-impact applications include health monitoring, sleep monitoring, activity recognition, pose estimation, and patient rehabilitation [4]. However, it is critical to address the fundamental challenges that hinder co-design capability between mainstream silicon chips and FHE.

References

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