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Regression Model-based VCO Design Optimization Technique

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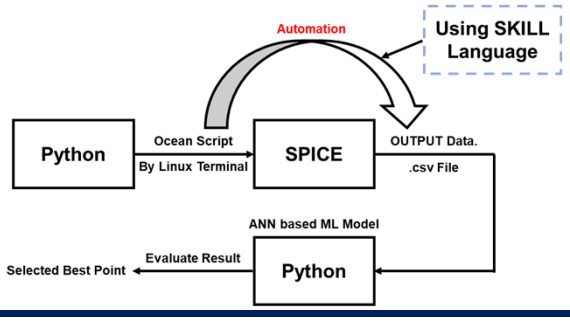
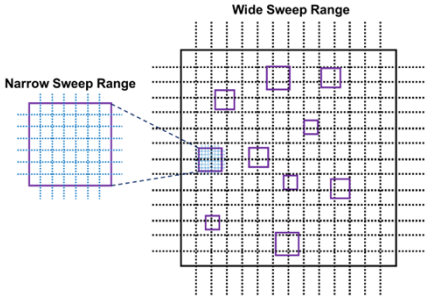
Introduction



- In this work, we implemented design automation of mixed-signal circuit using ANN-based regression model. And divided searching steps that consist of wide sweep range simulation and narrow sweep range step. Also, we considered PVT variation by verification step and high-accuracy regression model. We applied this algorithm in CMOS 65nm tech.
- The goal of this paper is,
  ① Reducing computer processing time
  ② Applying variation by mismatch of transistors

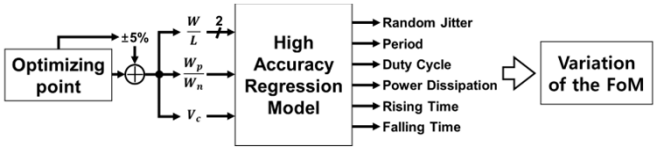
Method

① Zoom-in Algorithm



- The zoom-in algorithm subdivides the search step into two steps(Wide S.R/Narrow S.R) for efficient design.
- The narrow sweep ranges set the range proportional to the error in the verification step.

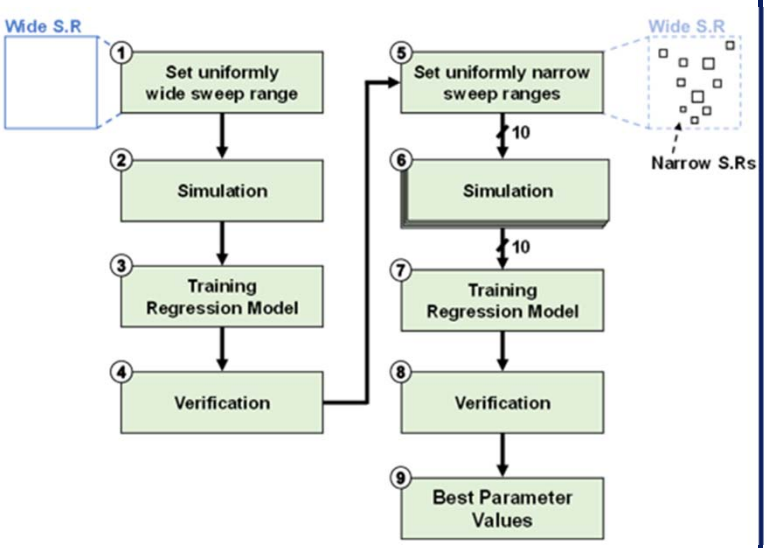
② Reflecting PVT Variation



- In narrow sweep range simulation, the accuracy of the regression model is high.
- Due to the high-accuracy regression model, the variation of the FoM (Figure-of-Merit) is reliable.

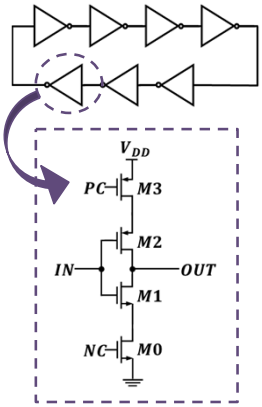
Design Flow

Flowchart of the optimizing algorithm



Design circuit

VCO (voltage-controlled-oscillator)



Device Index	Design Parameter	
	Length	Width
M0	65nm	200nm X N0
M1	65nm	200nm X N1
M2	65nm	200nm X R X N1
M3	65nm	400nm X N0

Simulation Result

Index	Random Jitter [ps]	Average Cycle [ps]	Duty Cycle [%]	Power Dissipation [mW]	Rising Time [ps]	Falling Time [ps]	FoMJ* [dB]
SPICE	1.139	0.888	51.52	0.137	121	177	-257.50
Regression Model	1.138	1.000	51.67	0.125	136	203	-257.91
Error [%]	0.09 %	12.61 %	0.29 %	8.76 %	12.40 %	14.69 %	0.16%

$* \mathrm{FoM_J} = 10\log\left[\left(\frac{\sigma_t}{1s}\right)^2 \cdot \left(\frac{P_{DC}}{1mW}\right)\right]$

Future Work

- By devising an additional verification method, we will be able to compensate for the point where the regression model is mis-trained.
- By merging the genetic algorithm that generates the next range by distinguishing the weights according to the target specifications based on the previous results and the zoom-in algorithm we proposed, an accurate design will be possible while reducing the computer processing time.

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