Regularized level-set-based inverse lithography algorithm for IC mask synthesis

用于集成电路掩模综合的基于水平集的正则化反向光刻算法

Citation: Zhen Geng, Zheng Shi, Xiao-lang Yan, Kai-sheng Luo, 2013. Regularized level-set-based inverse lithography algorithm for IC mask synthesis. *Journal of Zhejiang University-Science C (Computers & Electronics)*, 14(10):799-807. [doi:10.1631/jzus.C1300050]

- Optical proximity correction optimization methods can be divided into two classes: rule-based approaches and model-based approaches. In advanced technology nodes, rule-based approaches do not work well; in contrast, inverse lithography technology (ILT), as a special case of model-based approaches, produces a much better result

- The level-set-based inverse lithography technology (LSB-ILT) represents the mask as a 2D level-set function and the representation allows contours to merge, break, appear, or disappear, in a consistent, mathematical representation

- The manufacturability of the optimized mask is one of the critical issues in ILT. Considering that few studies were concerned about enhancing the manufacturability of the mask generated by LSB-ILT, it is necessary to reduce the complexity of the mask in the LSB-ILT optimization process

- This paper presents a regularized level-set-based inverse lithography algorithm with high pattern fidelity in partially coherent illumination, which has the advantage of reducing mask complexity in the optimization process

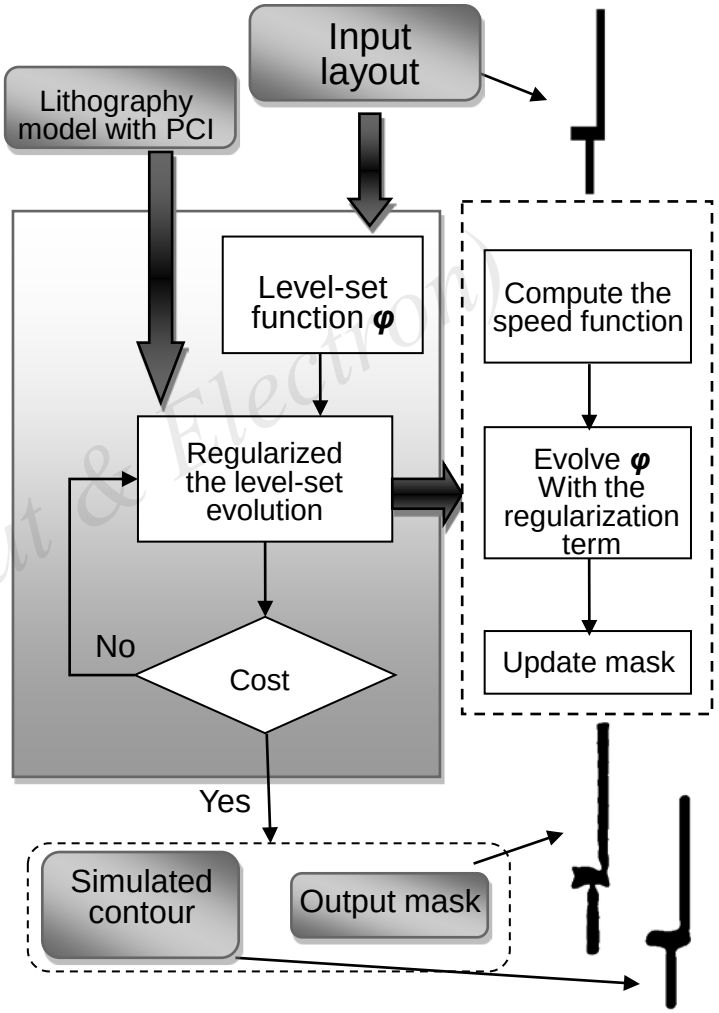

Fig. 4 Overall flow of regularized level-set based ILT

Table 1 Performance comparison between the ordinary LSB-ILT algorithm and the RLSB-ILT algorithm with the Laplacian term or TV term

Group	Test target	Initial cost	Final cost	ε metric[a]	ε metric[b]	ε metric[c]	Rate η^b (%)	Rate η^c (%)
SLP	SGL1*	6648	2598±5	252	138	170	45.24	32.54
	SGL2*	5891	3088±5	292	142	161	51.40	44.86
	NOR2*	9596	3799±5	298	216	238	27.51	20.13
	OR1	7039	4229±5	186	122	145	34.41	22.04
	INV0	6675	3519±5	168	93	101	44.64	39.88
MLP	AND2V	11 978	4596±5	588	323	350	45.07	40.48
	NAND2H	16 091	5994±5	527	378	418	28.27	20.68
	NOR3	11 881	5199±5	794	410	451	48.36	43.20
	OR2H	10 670	5249±5	496	340	372	31.45	25.00
	OR2V	10 776	5399±5	658	360	400	45.29	39.21
LLP	NOR4H	39 740	13 397±5	3733	1885	2317	49.50	37.93
	AND4H	42 839	14 494±5	4233	2737	2918	35.34	31.07
	DQ4V	37 882	12 779±5	2599	1620	1806	37.67	30.51
	NAND4V	39 823	13 417±5	3385	1951	2099	42.36	37.99
	OR4H	42 473	14 318±5	3645	1835	2039	49.66	44.06

The first three patterns with '*' are the 36 nm layout pattern. [a] Using the ordinary LSB-ILT algorithm; [b] using the RLSB-ILT algorithm with the Laplacian regularization function; [c] using the RLSB-ILT algorithm with the TV regularization function

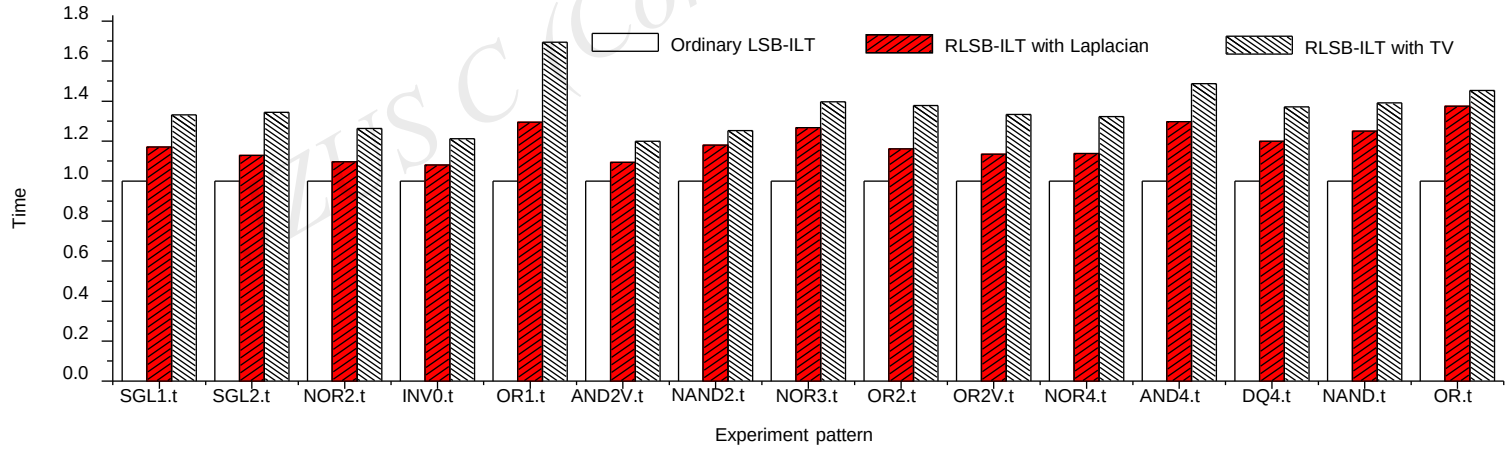

Fig. 7 Comparison of the simulation time of 15 test patterns between the ordinary LSB-ILT algorithm and the RLSB-ILT algorithm with the Laplacian term or TV term