Complementary Synthesis for Pipelined Encoder

Abstract— Complementary synthesis automatically generates an encoder's decoder that recovers the encoder's inputs variables from its output variables. However, the Boolean function of the decoder are characterized by Craig interpolant, and thus include lots of random logic gates that make it unnecessarily large and difficult to be understood by human. By studying the structure of many encoders from real industrial projects, we found that most of them have a pipeline structure that can be exploited to overcome these two problems.

Thus, we propose a novel algorithm to first find out the encoder's pipeline registers in each pipeline stage, and then characterize the Boolean function of these pipeline registers and the encoder's input variables with support set from the next pipeline stage.

Experimental results on several complex encoders indicate that this algorithm can always correctly infer the encoder's pipeline structure, and generate the Boolean functions for the pipeline registers and input variables. Furthermore, the circuit area are significantly reduced, and the generated decoder's structure are much more easier to be understood.

I. Introduction

One of the most difficult jobs in designing communication and multimedia chips is to design and verify complex encoder and decoder pairs. The encoder maps its input variables $\vec{i}$ to its output variables $\vec{o}$, while the decoder recovers $\vec{i}$ from $\vec{o}$. Complementary synthesis [8, 6, 7, 5, 3, 4, 9] eases this job by automatically generating a decoder from an encoder, with the assumption that $\vec{i}$ can always be uniquely determined by a bounded sequence of $\vec{o}$. Thus, the decoder's Boolean function can be characterized with the algorithm proposed by Jiang et al. [2] based on Craig interpolant [1].

However, the decoders generated in this way have two major shortcomings:

1. Its circuit area is unnecessarily large because some common logic for two different input variables $i_1, i_2 \in \vec{i}$ are hidden deeply in the two Boolean function computed by Craig interpolants.

2. The decoder's circuit structure are lost, which make it very difficult to be understood by human engineers.

TABLE I
Fonts for Initial-Submission and Camera-Ready Papers

Font Size	Style	Text
14pt	bold	Paper title
12pt		Authors' names
10pt		Authors' affiliations, main text, equations, first letters in section titles[a]
10pt	italic	Subheddings
9pt	bold	Abstract
8pt		Section titles[a], table names[a], first letters in table captions[a], tables, figure captions, references, footnotes, text subscripts and superscripts
6pt		Table captions[a], table superscripts

[a]Uppercase

II. How to Format the Page

A. Full-Size Camera-Ready Copy

Prepare Initial-Submission paper in full size format, on A4 size or 8 1/2" × 11"(21.5cm × 27.9 cm) paper.

B. Fonts

The best results will be obtained if your computer word-processor has several font sizes. Try to follow the font sizes specified in Table I as best as you can. As an aid to gauging font size, 1 point is about 0.35mm. Use a proportional, serif font such as Times of Dutch Roman.

C. Formats

In formatting your A4-size paper, set top margin to 29mm (1.14 inches), bottom margin to 30mm (1.18 inches), left and right margins to 15mm (0.59 inches) If you are using paper 8 1/2" × 11", set top margin to 17mm (0.67 inches), bottom margin to 24mm (0.94 inches), left margin to 18mm (0.71 inches) and right margins to 17mm (0.67 inches). The column width is 88mm (3.46 inches) with 5mm (0.2 inches) space between the two columns.

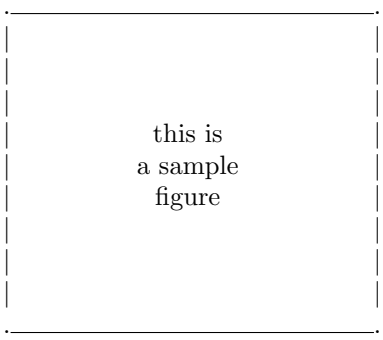

Fig. 1. This is a sample figure. Captions exceeding one line are arranged like this.

You should left- and right-justify your columns. On the last page of your paper, try to adjust the lengths of the two columns so that they are the same. Use automatic hyphenation if you have it and check spelling. Either digitize or paste down your figures.

III. Figures and Tables

Position figures and tables at the tops and bottoms of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table captions should be above the tables. Avoid placing figures and tables before their first mention in the text. Use the abbreviation "Fig.1", even at the beginning of a sentence.

The paper's graphics should have resolutions of 600dpi for monochrome, 300 dpi for grayscale, and 300 dpi for color. But, please do not include too much high-resolution images or photos in your paper.

IV. Helpful Hints

A. References

List and number all references at the end of the paper. When reffering to them in the text, type the corresponding reference number in the the citations consecutively. The sentence punctuation follows the parentheses. Do not use "Ref. [**?**]" or "reference [**?**]" except at the beginning of a sentence.

B. Footnotes

Number the footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it is cited. Do not put footnotes in the reference list.

C. Authors names

Give all authors' names; do not use "et al" unless there are six authors or more. Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [**?**]. Papers that have been accepted for publication should be cited as "in press" [**?**]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign language citations [**?**].

D. Notice for LaTeX users

If you use LaTeX to create your initial-submission paper, we recommend you to use `dvipdfm` to produce PDF files from dvi files. If you cannot use it, please use Type1 fonts instead of ugly Type3 fonts!

V. Summary and Conclusions

This template can be downloaded through the ASP-DAC 2016 web site (http://www.aspdac.com/). If you have any problem, please contact ASP-DAC 2016 publication chair.

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This article was written by referring to *"Author's guide – Preparation of Papers in Two-Column Format for VLSI Symposia on Technology and Circuits"*, the *"Preparation of Papers in Two-Column Format for the Proceedings of the 32nd ACM/IEEE Design Automation Conference"* written by Ann Burgmeyer, IEEE and *"the template for producing IEEE-format articles using LaTeX"*, written by Matthew Ward, Worcester Polytechnic Institute.

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