Correction to "Estimating Two-Dimensional Frequencies by Matrix Enhancement and Matrix Pencil"

Y. Hua and F. Baqai

We wish to make an amendment to the tables shown in [1] where a numerical error was caused by a bug in the noise generation subprogram. Fortunately, the error was not major enough to alter any conclusion drawn in [1]. Specifically, the patterns shown in Figs. 1–8 are actually the same as the correct ones, but the biases and deviations shown in Tables I and II should be replaced by those shown below.

TABLE I
BIASES AND DEVIATIONS OF 200 INDEPENDENT ESTIMATES OF THREE 2-D FREQUENCIES (THE CRB'S SHOWN HERE ARE THE CRB'S ON DEVIATIONS (*not variances*); $K = L = 6$, SNR = 20 dB)

f_1	bias $\times 10^{-3}$	dev $\times 10^{-3}$	CRB $\times 10^{-3}$	f_2	bias $\times 10^{-3}$	dev $\times 10^{-3}$	CRB $\times 10^{-3}$
0.26	−0.14	1.21	0.40	0.24	0.03	0.48	0.32
0.24	−0.08	0.61	0.31	0.24	0.04	0.72	0.31
0.24	0.10	0.70	0.32	0.26	0.19	1.34	0.40

TABLE II
BIASES AND DEVIATIONS OF 200 INDEPENDENT ESTIMATES OF THREE 2-D FREQUENCIES (THE CRB'S SHOWN HERE ARE THE CRB'S ON DEVIATIONS (*not variances*); $K = L = 7$, SNR = 10 dB)

f_1	bias $\times 10^{-3}$	dev $\times 10^{-2}$	CRB $\times 10^{-2}$	f_2	bias $\times 10^{-3}$	dev $\times 10^{-2}$	CRB $\times 10^{-2}$
0.26	0.19	0.46	0.13	0.24	0.19	0.18	0.10
0.24	−0.30	0.23	0.10	0.24	−0.46	0.29	0.10
0.24	0.27	0.25	0.10	0.26	0.74	0.49	0.13

REFERENCES

[1] Y. Hua, "Estimating two-dimensional frequencies by matrix enhancement and matrix pencil," *IEEE Trans. Signal Processing,* vol. 40, no. 9, pp. 2267–2280, Sept. 1992.

Manuscript received December 11, 1992; revised June 12, 1993. The associate editor coordinating the review of this paper and approving it for publication was Prof. Georgios B. Giannakis.

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IEEE Log Number 9216697.

Fully Static Multiprocessor Array Realizability Criteria for Real-Time Recurrent DSP Applications

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***Abstract*—This paper considers real time implementation of recurrent digital signal processing algorithms on an application-specific multiprocessor system. The objective is to devise a periodic, fully static task assignment for a DSP algorithm under the constraint of data sampling period by assuming interprocessor communication delay is negligible. Toward this goal, we propose a novel algorithm unfolding technique called the generalized perfect rate graph (GPRG). We prove that a recurrent algorithm will admit a fully static multiprocessor implementation for a given initiation interval if and only if the corresponding iterative computational dependence graph of this algorithm is a GPRG. Compared with previous results, GPRG often leads to a smaller unfolding factor α_{GPRG}.**

I. INTRODUCTION

Recurrent digital signal processing algorithms are formulated as infinite DO loops [3]. The loop body corresponds to the operations needed to process a new data sample. For example,

Program 1:

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        DO 10 i = 1 to ∞
O1      B[i] = f1(A[i − 1])
O2      C[i] = f2(B[i − 1])
O3      A[i] = f3(A[i − 1], B[i], C[i])
     10 CONTINUE
```

A program can be represented by an *iterative computational dependence graph,* ($ICDG$), as depicted in Fig. 1 which is an ICDG which corresponds to Program 1. Each statement i corresponds to a node in the ICDG. Data dependency are represented by arcs. If a statement i of x^{th} iteration depends on the results from statement j of y^{th} iteration, the dependence arc is labelled with a dependence distance $\delta_{i,j} = x - y$. For example, in Fig. 1 $\delta_{O_2,O_1} = 1$ for arc (O_2, O_1). The dependence distance label is omitted when $\delta_{i,j} = 0$. For each cycle C in the ICDG, we denote *cycle computing time* $\mathcal{T}_C = \sum_{i \in C} \tau_i$, where τ_i is the computing time at node i. Also, we denote $\Delta_C = \sum_{(i,j) \in C} \delta_{i,j}$ to be the total dependence distance in cycle C.

In a recursive algorithm, current output depends on the outputs of previous iterations. Hence a new iteration can *not* be initiated without the completion of some prior iterations. The theoretical minimum initiation interval between two successive iterations is found as [1]

$$I_{\min}(G) = \max_{\forall C \in G} \frac{\mathcal{T}_C}{\Delta_C}. \quad (1)$$

We define real-time processing as the condition that the number of data samples which can be processed per clock period is greater than or equal to the number of incoming data samples per clock period. If m_s data samples can be processed in one iteration of an algorithm

Manuscript received December 23, 1991; revised June 17, 1993. The associate editor coordinating the review of this paper and approving it for publication was K. Wojtek Przytula.

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IEEE Log Number 9216671.

1053-587X/94$04.00