A FRAMEWORK FOR FAULT TOLERANCE TECHNIQUES IN THE ANALYSIS AND EVALUATION OF COMPUTING SYSTEMS

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Received May 2011; revised October 2011

ABSTRACT. The Algorithm Based Fault Tolerance (ABFT) approach transforms a system that does not tolerate a specific type of faults, called the fault-intolerant system, to a system that provides a specific level of fault tolerance, namely safety and/or recovery. ABFT techniques are most effective when employing a systematic form. The error detection is employed based on a high-rate real convolution code. This paper addresses new methods for performing error correction when real number codes are involved. The parity values are determined according to a systematic real convolution code. Detection relies on two sets of parity values which are computed in two different ways, one set from the input data but with a simplified combined processing subsystem, and the other set directly from the output processed data, employing the parity definitions directly. The ABFT philosophy leads directly to a model from which error correction can be developed. By employing an ABFT scheme with effective real convolution code, the design allows high throughput as well as high fault coverage. The simulations show that the great difference between the round-off error and the computer-induced error is large enough to be distinguished.

Keywords: Algorithm based fault tolerance (ABFT), Convolution code, Parity values, Round-off error, Redundancy

1. Introduction. In the case of fault tolerance, real convolution codes are primarily used for error detection, providing the vector space separations, and detected abnormal behavior leads to recomputation of the corrupted results. While the theory of real number coding is similar to codes over finite fields, the decoding for error-correcting purposes is more complicated. Algorithm based fault tolerance, proposed by Huang and Abraham [1], is a fault tolerance scheme that uses Concurrent Error Detection (techniques at a functional level). ABFT techniques are most effective when applied in a systematic form. The redundancy necessary for the ABFT method is commonly defined by real number codes, generally of the block type [2-8]. It has been used to reduce redundant hardware. ABFT methodologies used in [9,10] present parity values dictated by a real convolution code for protecting linear processing systems. A class of convolution codes called burst-correcting convolution codes is introduced in [10,11]. These codes provide error detection in a continuous mode using the same computational resources as the algorithm progresses.

The motivational model underlying ABFT as applied to linear processing of blocks of real data is shown in Figure 1. The ABFT error detection technique relies on the comparison of parity values computed in two ways. Number data processing errors are detected by comparing parity values associated with a convolution code. This article proposes a new computing paradigm in order to provide fault tolerance for numerical algorithms. The data processing system is protected through parity values defined by a