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Design and Implementation of Fault Tolerant Parallel Fir Filter Using Hamming Codes

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Abstract: This paper deals with the filters which are predominantly adopted in trading out with signal processing and communication systems. The filters so used are digital filters. In some cases, the reliability of those systems is abusive, and miscue tolerant filter exertion are desired. Over the duration, lots of techniques that make use of the filters structure and properties have been scheduled to enact fault tolerance. As technology scales, it empowers more complex systems that materialize many filters. In those complex systems, it is prevalent that some of the filters operate in parallel, for instance, by administering the same filter to varying input signals. Recently, a simple technique that exploits the presence of parallel filters to enact miscue tolerance has been conferred. In this brief, that idea is generalized to show that error correction codes (ECCs) guard the parallel filters in which each filter is the equivalent of a bit in a traditional ECC. This new scheme grants more dynamic protection when the number of parallel filters is extensive. The proposed scheme coded in HDL and simulated using Xilinx 12.4. This new scheme grants more decisive protection when the number of parallel filters is extensive. The technique is estimated adopting a case study of parallel finite impulse response filters showing the effectiveness in terms of protection and implementation cost. This filter can also be implemented using SPARTAN6.

Index terms: ECC, parallel FIR filter, hamming code, HDL

INTRODUCTION:

The Digital Filters hits a imperative portrayal in the analog and digital communication. The main purpose of utilizing the filters is to provide the better quality signal at the output by eradicating the undesired signal components. The digital filters of engendering the stabilized signal have unique characteristics at the output while compared with the analog filters. So that the digital filters are more preferable than the analog one.. The FIR filter is approved over the IIR filter because of dynamic hardware implementation with fewer precision errors and also giving the stabilized response with the linear phase, also helps to perceive further about parallel processing.

It can also be adopted for miscue detection in the clocked phase. For an potent and computerized implementation, basic cells are advanced for an automated integration, which can be used in the same way as scan elements. A lightweight observation tree, implying which register may be depraved can be incorporated for fault location and if a restart after clock gating is required. Small extensions reusing the scheme for clocked online fault detection and off-line test are allowed. The intension which leads to more effective fault fortitude interprets new protection techniques that are easily combined with normal data processing methods. The error detection structures in the data processing system are developed for detecting and correcting subsystem errors.

Concurrent parity value techniques are very useful in detecting numerical error in the data processing operations, where a single error can inseminate to many output errors. Simple construction, small volume and light weight are the advanced features possessed by Induction motor. In spite of their robustness and reliability they occasionally decline and hence require constant attention. It is well known that faults on induction motor causes interruption of manufacturing process which persuates a momentous loss for the firm. In induction motor ,major faults such as stator winding faults, bearings faults, rotor faults and external faults such as voltage unbalance ,phase failure, single phasing occur.

In case of any short circuit occuirs in stator winding stands for nearly one third of reported faults. Broken rotor bar and end ring faults serve around 10 percent of induction motor faults. Early fault detection grants preventive maintenance to be scheduled for machines during scheduled downtimes and prevent an extended period of downtime caused by extensive motor failure, improving the reliability of motor driven system. With proper system monitoring and fault detection schemes, cost of retaining the motors can be greatly diminished, while the availability of these machines can be significantly upgraded. Many Engineers and Researchers have concentrate their attention on impending fault detection and preventive maintenance in recent years.

Different methodologies have been proposed using FFT and DWT based on current and vibration spectral analysis for induction motor preventive monitoring of specific faults. FFT analysis has been utilized by Habetler all for exposing thermal overload and bearing faults, the motor current signals were analyzed. In detection of broken rotor bar is done by applying Fourier transform, to improve the diagnosis and to consent the detection of incipient rotor bar , analysis is completed by Hilbert transform. Stator currents are analyzed through wavelet packet decomposition to detect bearing defects. Swing angle is a fault indicator which is used for broken rotor bar and in turn fault is investigated.

This fault indicator depends on rotating magnetic field pendulous oscillations concept in faulty squirrel cage induction motor. FFT vibration analysis for detecting cracked rotor bar and inner race and outer race bearing defects have been adopted. For Fault diagnosis of induction motor, Time frequency domain techniques have been used, which includes STFT,FFT, high resolution spectral analysis. Online induction motor diagnosis system utilizing MCSA with signal and data processing algorithm is adopted to scan induction motor faults which includes breakage of rotor bars, bearing defects and air gap eccentricity.

Detection of broken rotor bars and in turn short circuit in stator windings based on analysis of three phase current envelopes of induction motor using reconstructed phase space transform is proposed in Artificial Intelligence play a dominant role in field of conditioning monitoring and varying techniques such as neural network, fuzzy inference systems, expert system, adoptive neural fuzzy inference system and genetic algorithm are being widely utilized for feature extraction and classification purpose.

It can be encapsulated that there are countless techniques for diagnosis and prognosis of specific induction motor faults, most of these techniques are applied offline, which insists a discern technique that allows online multiple fault detection.

The Digital Filters plays a dominant role in the analog and digital communication. The main purpose of using the filters is to afford the better quality signal at the output by eradicating the undesired signal components. The digital filters of provoking the stabilized signal at the output have unique characteristics while compared with the analog filters.

CONCEPT OF FAULT TOLERANCE:

A number of techniques can be used to defend a circuit from errors. Those range from modifications diminish the number of errors in the manufacturing process of the circuits to counting redundancy at the logic or system level to insure that errors do not alter the system functionality. Several techniques have been proposed to safeguard them from errors and digital Filters are one of the most commonly used signal processing circuits. There are number of methods endorsed to pinpoint faults and the actions necessary to correct the faults within circuit.

HAMMING CODES:

In telecommunication, Hamming codes are a clan of linear error-correcting codes that generalize the Hamming(7,4)-code, and were fuctioned by Richard Hamming. Hamming codes can recognize up to two-bit errors or correct one-bit errors without detection of uncorrected errors.

EXISTING METHOD:

Electronic circuits are progressively present in automotive, medical, and space applications where reliability is critical. In those applications, the circuits have to subsidize some grade of liability tolerance. This need is further improved by the intrinsic reliability challenges of advanced CMOS technologies that encompass, e.g., manufacturing variations and soft errors. A number of techniques can be used to cushion a circuit from errors. Those range from modifications in the manufacturing process of the circuits to reduce the number of errors by adding redundancy at the logic or system level to ensure that errors do not affect the system functionality. A general technique known as triple modular redundancy (TMR) can be utilized to add redundancy. The TMR is commonly used to triplicate the design and to add voting logic to correct errors. However in some applications, it triples more than the area and power of the circuit, sometimes it may not be acceptable. When the circuit to be protected has algorithmic or structural properties, a better option can be to accomplished those properties to implement fault tolerance.

PROPOSED METHOD:

Digital filters are one of the most commonly used signal processing circuits and several techniques have been scheduled to safeguard them from errors. Most of them have fixated on finite-impulse response (FIR) filters. For example, the use of minimized precision replicas was proposed to reduce the cost of implementing modular redundancy in FIR filters. An accord between the memory elements of an FIR filter and the input sequence was used to detect errors. Other schemes have abused the FIR properties at a word level to accomplish miscue tolerance. The use of residue number systems and arithmetic codes has also been recommended to secured filters. In this brief, a general scheme to protect parallel filters is displayed. Parallel filters are considered with the same response that process varying input signals. The new access is based on the application of error correction codes (ECCs) using each of the filter outputs as the identical of a bit in and ECC codeword. This is a generalization of the scheme presented and empowers more efficient implementations when the number of parallel filters is large. The scheme can also be adopted to afford more powerful protection utilizing advanced ECCs that can correct failures in multiple modules.

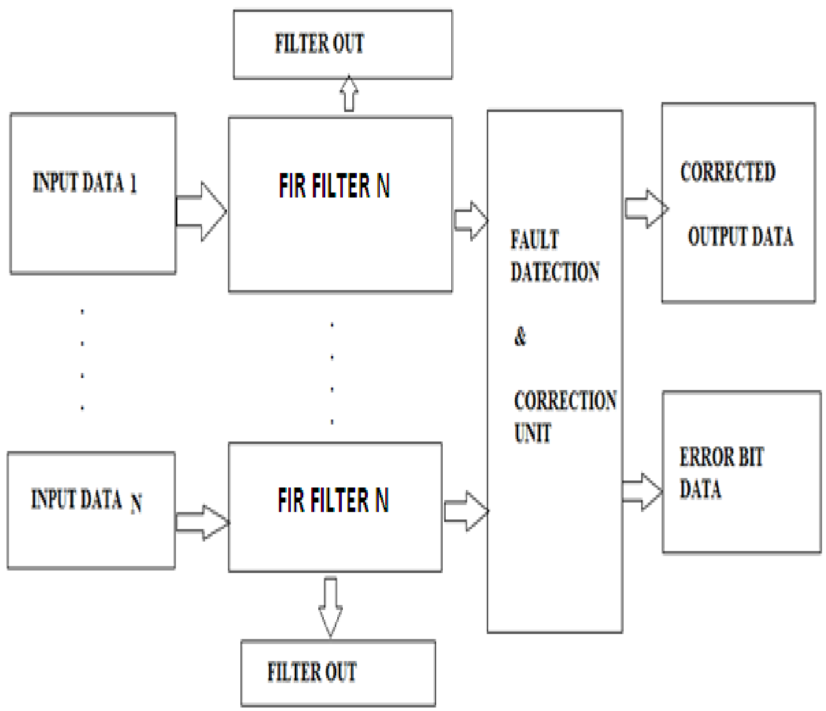
PARALLEL FILTER BASED ERROR-CORRECTING CODE:

1. Hamming codes:
   - Hamming(7,4): a Hamming code that encodes 4 bits of data into 7 bits by summing 3 parity bits
   - **Single error detection and correction.**
2. Hamming codes:
   - Hamming(7,4): a Hamming code that encodes 4 bits of data into 7 bits by summing 3 parity bits
   - **Single error detection and correction.**
   - **Double bit error detection.**

ERROR DETECTION AND CORRECTION TECHNIQUES:

The following are the error detecting and correcting schemes.

ERROR-CORRECTING AND DETECTING FOR FIR FILTER:



ERROR DETECTING SCHEMES:

1. Repetition codes.

2. Parity bits

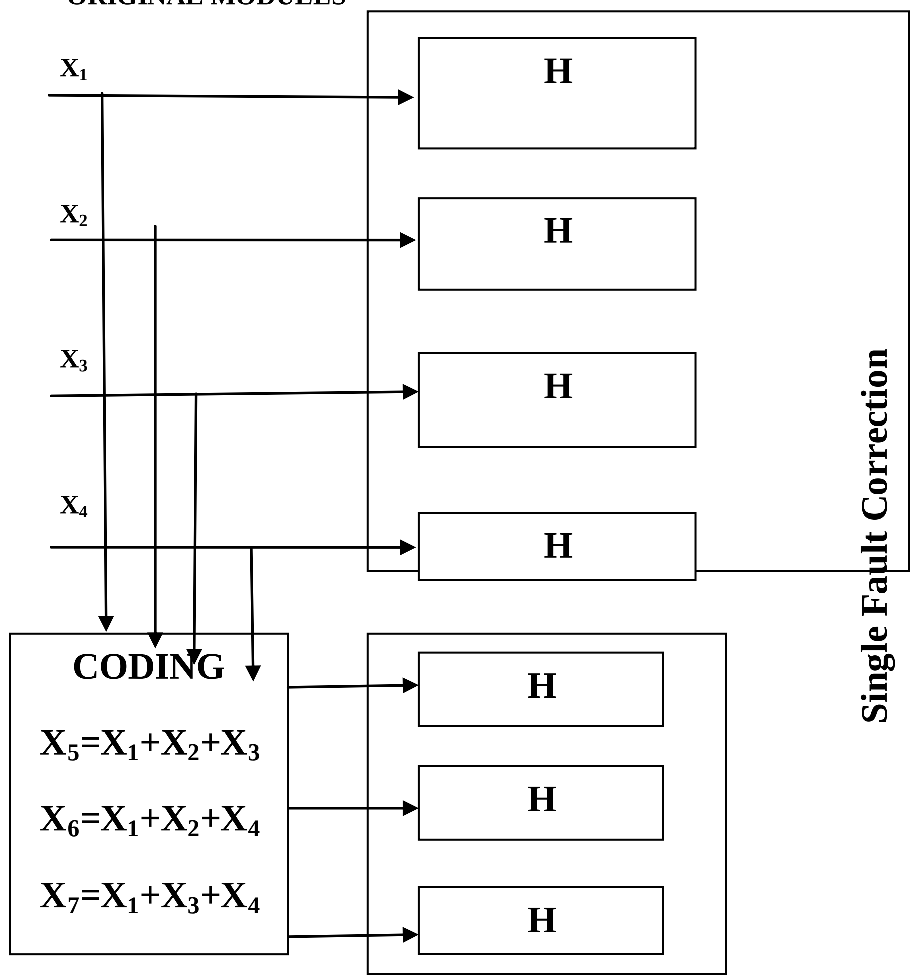
3. Checksums

4. Cyclic redundancy checks (CRCs)

5. Cryptographic hash functions

BLOCK DIAGRAM:

ORIGINAL MODULES



Redunant modules

ERROR CORRECTING SCHEMES:

1. Automatic repeat request

2. Error-correcting code

3. Hybrid schemes

The input signals are encoded using a matrix with arbitrary coefficients to give the signals that penetrate the four original and two redundant filters. In its more general form, this coding matrix A can be forged as: Therefore the error check will insure error detection when the sum of the columns in each of the matrixes are different and non-zero. Since the coding matrix A is known, matrix C can be resolved in advance, and stored for error detection.

The complexity of the error detection and correction reveal on the design of A. In order to avoid additional calculations to reconstruct those outputs. The execution will greatly streamlined. In case of emphasizing the use of the proposed coding scheme in a practical application, the next section presents two case studies that are figured out both in terms of implementation cost and protection strength.

CODES PREDATING HAMMING:

A number of simple error-detecting codes were used before hamming codes. But Hamming codes were as effective as in the same skyward of space.

TABLE I
ERROR LOCATION IN THE HAMMING CODE

$s_1\, s_2\, s_3$	Error Bit Position	Action
0 0 0	No error	None
1 1 1	d_1	correct d_1
1 1 0	d_2	correct d_2
1 0 1	d_3	correct d_3
0 1 1	d_4	correct d_4
1 0 0	p_1	correct p_1
0 1 0	p_2	correct p_2
0 0 1	p_3	correct p_3

APPLICATIONS:

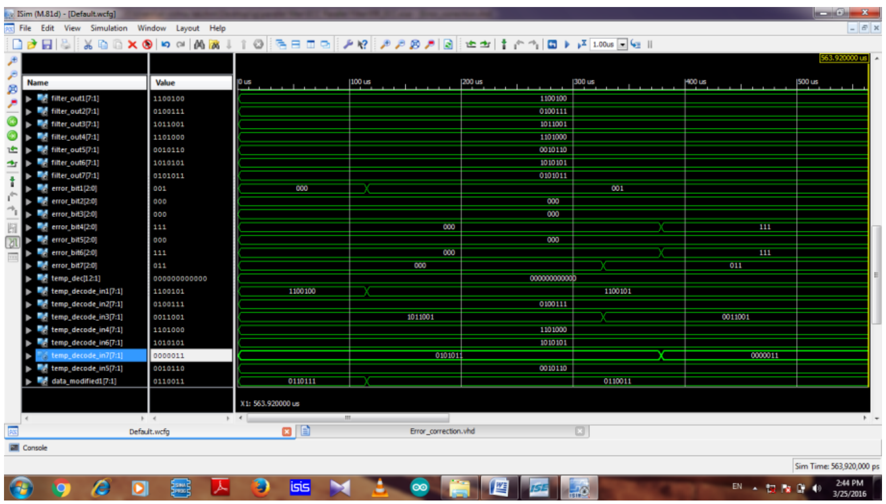
- Error correction.
- Digital signal processing.
- Automotive.
- Medical.
- Space applications.

ADVANTAGES:

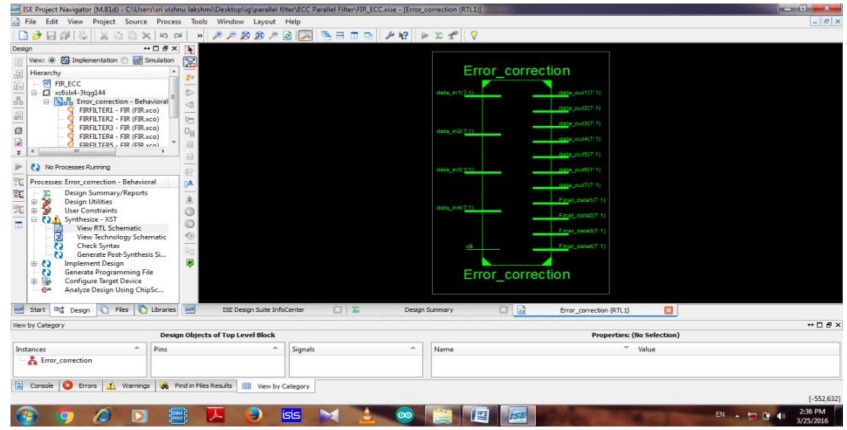
- Error correction is more compared with other codes.

SIMULATION RESULT:

Here, the four 8-bit inputs are encoded and transmitted in a channel. If there is any fault occurring in any position of the channel, Hamming code in FIR filter will automatically correct it and the corrected output will be displayed.



RTL DIAGRAM:



This diagram shows Register transfer level of FIR filter which represents the corrected output of the given four 8-bit data input.

AREA:

DEVICE UTILIZATION SUMMARY(ESTIMATED VALUES)			
Logic utilization	**Used**	**Available**	**Utilization**
Number of slice registers	616	4000	12%

Number of slice LUTs	336	2400	14%
Number of fully used LUT-FF pairs	323	629	51%
Number of bonded IOBs	106	102	100%
Number of BUFG/BUFGCTRLs	1	16	6%
Number of DSP48A1s	14	8	175%

CONCLUSION:

This proposed paper presents a new blueprint to secure parallel filters. These filters are commonly found in modern signal processing circuits. The access is based on administer ECCs to the parallel filters outputs to recognize and precise errors. In this scheme process, different input signals can be used for parallel filters that have the same response. An aspiration has also been debated to show the effectiveness of the scheme in terms of error correction and problem definition shows the overheads. The proposed scheme makes the cost of the system lesser. Recommended work using parallel FIR filters will result in more efficient miscue tolerant system based on ECCs.This will also exasperate the target to accomplish low power consumption, increase area of application and high speed. In future, there may be the possibility of using GOLAY code techniques for error detection and correction.

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