

A Memory Efficient Vlsi Implementation Of Golay Codes

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ABSTRACT: *In today's world storing numerous data or information efficiently is a significant issue because of limited storage. Every moment we need to transfer large volume of information soundly and correctly. A storage space/memory storage required to store this information. The way of communication which is also constricted with confined communication lines. The proposed system consists of a cyclic redundancy check-based encoding scheme and implemented an efficient encoding algorithm for both the Golay Codes. Golay Code is a type of Error Correction Code and its performance is very nearer to Shannon's limit. Good error correcting performance enables reliable communication. The binary Golay Code (G23) is represented as (23, 12, 7) while the extended binary Golay Code (G24) as (24, 12, 8). High speed with low-latency architecture has been designed and implemented for Golay encoder without incorporating linear feedback shift register. Our proposed Golay code technique is much more efficient than most of the other existing techniques. The results obtained significant improvements over previous/existing work.*

Index Terms— Huffman decoding, GolayCode, Decoder, Encoder.

I.INTRODUCTION

Human world is now undergoing the most intense technological revolution. We are still living in the era of information. Every instance of time we have to maintain a large volume of data or information and store them as well. But still storage space is considered to be limited for solving our

purpose. To work out in storing data or information in an efficient manner is an important factor/issue. For this reason, a technique, namely compression, is used to act perfectly using the limited storage space. Compression is accomplished by using algorithms or formulas which describes the shrinking procedure of the size of data. The prime performance metric of data compression is compression ratio. Data compression can be lossless or loss. Lossless compression occupies the restitution of a file to its exact status, without having loss of a single bit of data when the file is uncompressed. For example- text compression, spreadsheet files etc. are lossless technique as because loss of a single character, numbers, or words may convert a message into completely different meaning. The key objective is to invent a technique for compressing the tree size of Huffman compression by a memory efficient representation of Huffman tree. The significant development of tree compression ratio will enhance the data compression ratio. Then design of encoding and decoding algorithm for a new technique is accomplished with minimal effort.

In this paper, we proposed a new encoding-decoding technique for compressing the Huffman tree size in an efficient manner and compared the performances (with respect to

compression ratio, savings bits etc.). We also have investigated the limitations of some previous works. The proposed method is also a bit representation technique.

II.EXISTED METHOD

Lots of applications of Huffman encoding method rely on ASCII codes. ASCII is 8-bit character coding scheme. But it is defined only for 0-127 codes which means it can be fit into 7-bits. The leftmost bit of an ASCII coded character is always set to zero i.e. the MSB is guaranteed to be 0. We have taken advantage of that bit.

In proposed method, the Huffman tree is traversed in a depth first fashion. When a leaf containing a character is to be saved, we save 7 bits of that character omitting the MSB. When returning back to the parent from a child node the relative position of the child is saved this takes one bit for each edge of the tree.

If there are n number of different characters to be encoded, total number of edges in Huffman tree would be $(2*n - 2)$. In our existed method every edge is denoted by either 0 or 1 depending

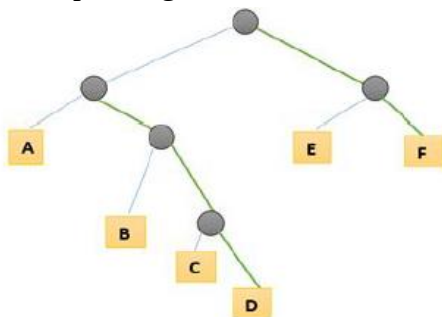


Fig1: Example Tree For Encoding

A	0	B	0	C	0	D	1	1	1	0	E	0	F	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Fig 2: Encoded Bit Stream For Tree Of Figure 1 on their relative position i.e. 1 bit per edge. So number of bits to encode the edges will remain same i.e. $(2*n - 2)$ for every case. Besides, every ASCII coded character comprises of 8 bits where the MSB is 0 for each character. We are ignoring this bit while encoding so that we will require 7 bits for representing each character in our generated encoded bit sequence.

III. PROPOSED BINARY GOLAY CODE

Block codes are referred to as (n, k) codes. A block of k information bits are coded to become a block of n bits. $n=k + r$, where r is the number of parity bits and k is the number of information bits. Marcel Golay was born in Neuchatel, Switzerland in 1902. He was a successful mathematician and information theorist who was better known for his contribution to real world applications of mathematics than any theoretical work he may have done. Golay sought the perfect code. They play an important role in coding theory for theoretical and practical reasons.

There are two closely related binary Golay Codes. The G24 is the extended binary Golay Code which encodes data of 12 bits in a 24-bit word in such a way that any 3-bit errors can be corrected or any 7-bit errors can be detected. The G23 is perfect binary Golay Code which has codeword of length 23 and is obtained from the extended binary Golay Code by deleting one co-ordinate position. The codes have parameters $[24, 12, 8]$ and $[23, 12, 7]$ in standard code notation corresponding to the length of the

Codewords, the dimension of the code and the minimum Hamming distance between two codewords respectively.

The extended binary Golay Code, G24 contains a 12-dimensional subspace W of the space $V = \mathbb{F}_2^{24}$ of 24-bit words such that any two distinct elements of W varied in at least eight coordinates. All code words have the Hamming weights of 0, 8, 12, 16 or 24 in the extended binary Golay Code. Up to relabeling coordinates, W is unique. The perfect binary Golay Code, G23 is a perfect code. That is the spheres of radius three around Code words form a partition of the vector space.

Code word Structure: A codeword is formed by taking 12 information bits and appending 11 check bits which are derived from a modulo-2 division, as with the Cyclic Redundancy Check (CRC) Golay [23,12] Codeword as shown in Fig 3. The common notation is Golay [23,12], which indicates that the code has 23 total bits, 12 information bits and $23-12=11$ check bits. Since each Codeword is 23 bits long, 2^{23} or 8,388,608 possible binary values are presented.

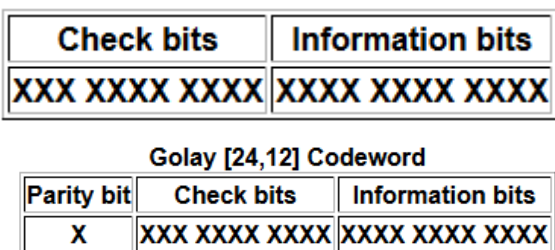


Fig 3 : Notation of Check Bits and Information bits for Golay Code word

However, each of the 12-bit information fields has only one set of 11 check bits, so

there are only 212 or 4096 valid Golay Codewords.

The Properties of the extended binary Golay Code are as follows:

- The length of G24 is 24 and its dimension is 12.
- A parity-check matrix for G24 is the 12×24 matrix $H = [A \mid I_{12}]$.
- The code G24 is self-dual, i.e., $G \perp_{24} = G_{24}$.
- Another parity-check matrix for G24 is the 12×24 matrix $H = [I_{12} \mid A]$ ($= G$).
- Another generator matrix for G24 is the 12×24 matrix $G_0 = [A \mid I_{12}]$ ($= H$).
- In G24 the weight of every Code word is a multiple of 4.
- The code G24 has no Code word of weight 4, so the minimum distance of G24 is $d = 8$.
- The code G24 is an exactly three-error-correcting code.

IV. RESULTS

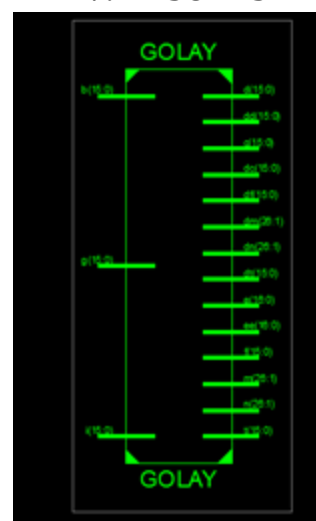


Fig 4:RTL Schematic

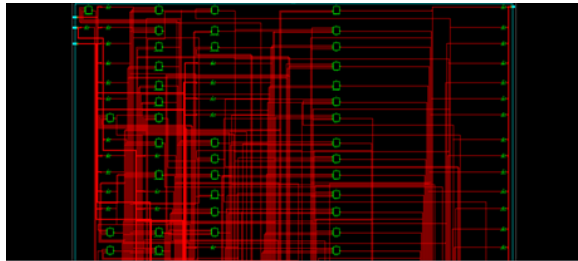


Fig 5:Technology Schematic

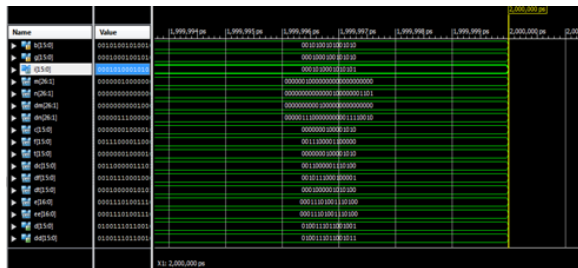


Fig 6: Output Waveform

GOLAY Project Status				
Project File:	W:\ANGLPRACTICE\GOLAY	Parser Errors:	4 (8 Errors)	
Module Name:	GOLAY	Implementation State:	Synthesized	
Target Device:	AC32000-5-q100	Errors:	No Errors	
Product Version:	ISE 14.7	Warnings:	1 (Warning, 0 new)	
Design Goal:	Speed	Routing Results:		
Design Strategy:	Virtex Default (unlocked)	Timing Constraints:		
Environment:	System Settings	Final Timing Score:		

Device Utilization Summary (estimated values)			
Logic Utilization	Used	Available	Utilization
Number of Slices	114	960	11%
Number of 4 input LUTs	200	1920	10%
Number of bonded IOBs	314	66	475%

Detailed Reports				
Report Name	Status	Generated	Errors	Warnings
Synthesis Report	Current	Fri 23 Mar 12:57:49 2018	0	1 (Warning, 0 new)
Translation Report				
Map Report				

Fig 7: Report

V.CONCLUSION

In this paper, the Golay Code and operation for various encoder and decoder is discussed. This encoding and decoding algorithm have been successfully applied to short block codes such as Golay Code. Decoding algorithm consists of syndrome measurement unit, weight measurement unit and weight constraint. We can reduce the

area, Maximum Combinational Path Delay (MCPD) of decoding algorithm of Golay Code.

VI.REFERENCES

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