FOURIER TRANSFORMS USING CONJUGACY CONSTARINTS OVER SUBFIELDS FOR QUASI CYCLIC LDPC CODES

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ABSTRACT: Quasi cyclic low density parity check codes are broadly used in many digital communication and storage systems. The operations of these encoders are done by using generator matrices. We focus on the QC-LDPC code matrices of dimension $(2^r - 1) * (2^r - 1)$ and the entries are elements of GF($2^{P)}$ where p divides r and hence GF(2^P) is the subfield of GF(2^r).To reduce the complexity of the encoder we have used the fourier transforms for the better performance and low complexity but with the use of fourier transforms the storage and time taking is high. We have used fourier transforms for subfields and conjugacy constraints. In this paper we are using inverse fourier transforms for better performance and better accuracy. In this the computations get decreased and complexity also decreases with the help of inverse fourier transforms.

Index terms: Encoder, Quasi cyclic, Low density parity check codes(LDPC).

I.INTRODUCTION

Binary low density parity check codes are broadly used in digital communications and storage elements. Non binary codes are used mostly compared to the binary codes because they have the parity check and generator matrices have i.e., GF(2^P) (P>1) and can achieve high coding gain when the length code is moderate and have the burst error correction performance. Non-binary LDPC codes are developing into the practical systems due to recent work on the decoder complexity reduction.

Quasi cyclic LDPC codes enable efficient partial-parallel processing because of the regularity in their parity check matrix H. The H matrix of CPM in 1's is replaced by the elements of GF(2^P) (P>1).p needs to be small to keep the decoder complexity low.

LDPC codes are designed usually with the H matrix. The encoding is done easily if the H matrix have low triangular structure. The low triangular structure of H matrix have low weights. The general encoding is done by H matrix which has to derive the generator matrix G and then should multiply the message vector with G. We are ending up with the usage of more number of encoders.

To reduce the encoder complexity of QC-LDPC we are using fourier transforms. By applying fourier transforms each dense circulant becomes a diagonal matrix and the number of multipliers used for the transformed generator matrix get decreased. The improved methods in encoders for subfields are implemented directly.

In this paper we are developing the encoders by using conjugacy constraints with the help of inverse fourier transforms. By using the inverse fourier transforms we get the low complexity and errors in data can be detected easily.

II. EXISTED SYSTEM

The fourier transform is a mathematical tool which decomposes any function into sinusoidal basis function.Each of this basis function is a complex exponential of a different frequency.

The fourier transform can be derived as below

$$F\{g(t)\}=G(f)=\int_{-\infty}^{\infty} g(t)e^{-2\pi ift}dt$$

The fourier transforms can be use for encoding the QC-LDPC codes. We already knew that LDPC codes are done by using parity check matrix H with the dimension of $(2^r-1)*(2^r-1)$. We know that p divides r hence, $GF(2^P)$ is subfield of $GF(2^r)$. Assume that dimension of H is (n-k) e * ne. where $e=2^r-1$

The generator matrix is expressed as below

$$G=\begin{pmatrix} I & 0\ldots0 & G(0,0)\ldots\ldots G(0,n-k-1) \\ 0 & I\ldots0 & G(1,0)\ldots\ldots G(1,n-k-1) \\ 0 & 0\ldots I & G(k-1,0)\ldots\ldots G(k-1,n-k-1) \end{pmatrix}$$

In the existed system we are having the subfield elements which is substantially constructed by using chein architecture.The inputs are the elements of $GF(2^r)$ and the outputs are the symbols of the subfield $GF(2^p)$.

The matrix multiplication is done by partial parallel transformed generator matrix. The fig shown below is the process of matrix multiplication.

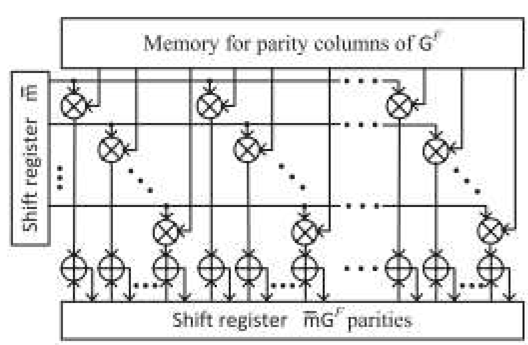

FIG:-Partial-parallel transformed generator matrix multiplication architecture.

The above figure is the intra block architecture for generator matrix. The intra block architecture is used because the operations are done internally which are simplified and the errors can also get detected within itself. In the above figure each clock cycle are simultaneously multiplied with all non zero entries in the corresponding rows of G^F. Since the parity part of G^F consists of n-k block columns of diagonal submatrices, n-k multipliers are needed for each of the leading symbols. The intermediate products of parity columns are stored in shift registers.The registers are shifted by l' positions so the connection between multipliers and registers remain unchanged.For example when l=8 and e=63 it takes [63/8]=8clock cycles to get the message for a block.The matrix multiplication involving in the message block needs to be finished in 8 clock cycles. The simplified fourier transforms have premultipliers which have switches in it. The premultipliers are in the combination of subfields and conjugacy constraints. The fourier transforms are used to calculate the vector matrix for the given simplified architecture. The inputs are in the order of matrix form which is shown below.

$$F(w)=wV=w\begin{pmatrix} 1 & 1 & 1 & \ldots\ldots \\ 0 & \alpha^{-1} & \alpha^{-2} & \ldots\ldots \\ : & : & : & \\ 1 & \alpha^{-(e-1)} & \alpha^{-(e-2)} & . \end{pmatrix}$$

The above equation satisfies the simplified fourier transforms architecture. The simplified fourier transform architecture is shown below.

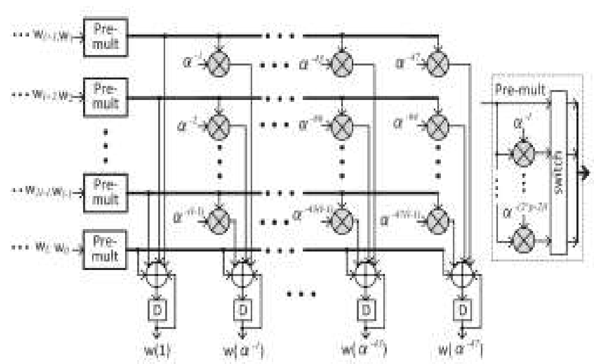

Fig:- Simplified fourier transform architecture

The transform architecture is modified by using a encoder in the simple form. The architecture is shown in a tree like structure and the data is sent in the form of bits which is in the form of serial input serial output.

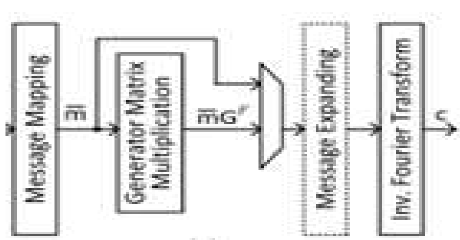

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Fig:-Modified transform architecture

The generator matrix is taken for multiplication. The output of the matrix multiplication block is of parity symbols. The parity of the message mapping is given to the matrix multiplication. The architecture is to be inverse fourier transform to get the original data.

III.PROPOSED SYSTEM

In the proposed system we are using the inverse fourier transforms which leads to the decrease of complexity of architecture.

The inverse fourier transform of a function can be derived as equation below which gives a cosine forms of a signal.

$$F^{-1}\{G(f)\}=\int_{-\alpha}^{\alpha} G(f)e^{2\pi i f t}df=g(t)$$

The inverse fourier transform is only applied to the parity symbols. The encoding can be done easily with the help of encoders. The complexity of encoders is less because of less components. The conjugacy constraints have less complexity when compared to subfields.

The number of fourier transforms needed for encoding is k for existed and n-k for proposed. The number of inverse fourier transforms needed for encoding is n for existed and n-k for proposed

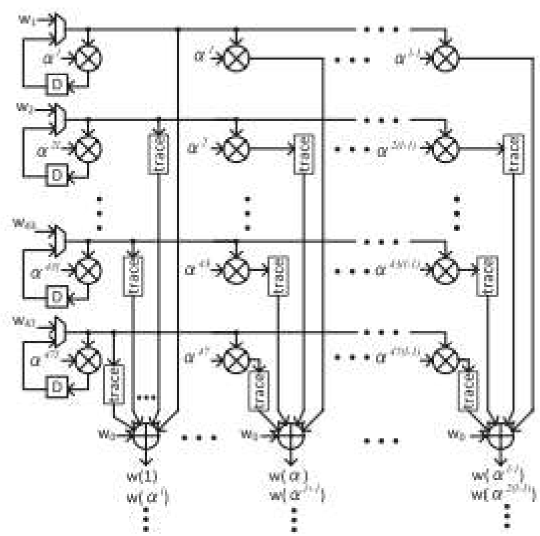

Fig:-Simplified architecture for conjugacy constraints.

The above figure has lower complexity. The trace block in the architecture are eliminated, and each of the constant multipliers except in the first column computes least significant coefficient in the product. The trace matrices in the above are used as transpose matrix. The trace of an element in generator matrix GF((2^p)^t) is always an element of GF(2^p).The trace matrix is taken as Tr(a)=a_{t-1}Tr(x^{t-1})+……..+a_1Tr(x)+a_0Tr(1)

Here Tr(x^{t-1}),….Tr(x),Tr(1) can be pre computed. By this the trace of an element

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can be derived easily by constant multiplications over GF(2^p).

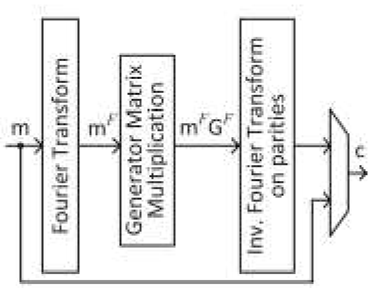

Fig: Architecture for modified inverse fourier transform encoder

The first k blocks of e symbols in codeword generated for above encoder are given below

$$m^F IV^{-1(K)} = mV^{(k)}\ IV^{-1(K)} = m$$

In this encoder fourier transforms and inverse fourier transforms for computing the systemantic codeword are cancelled and message symbol directly become the systematic path.

In this encoder inverse fouriertransform are applied to parity symbols. Here no extra step is needed to decode the LDPC codes.

The above architecture is implemented by the same generator matrix multiplication which is of fourier and inverse fourier transform architectures as in encoder. The area requirements for the existed and proposed are same. The above encoder must get activated in the inverse fourier transform to get the fewer blocks of symbols. The consumption of the above encoder is lower compared to the existed especially for high rate codes.

IV. RESULTS

COMPARISON TABLE FOR LDPC

	LDPC EXISTED	LDPC PROPOSED
TIME	36.58 secs	0.19 secs
MEMORY	249232	149840

Table:-comparison of existed and proposed

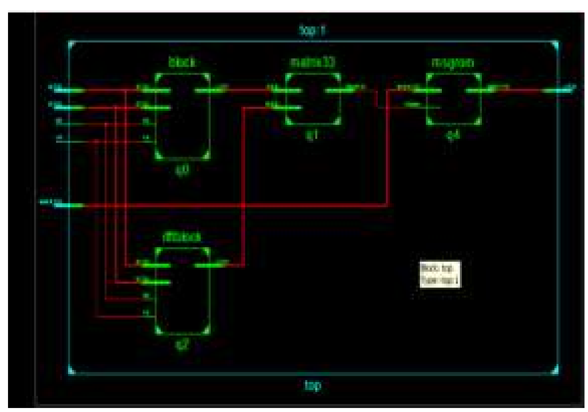

Fig:-RTL schematic

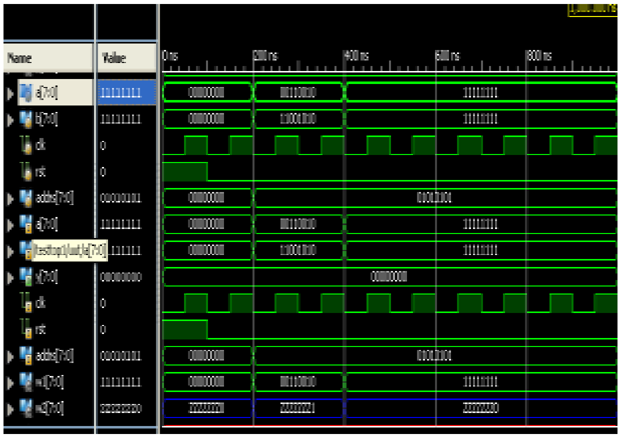

Fig:-Output waveform

VI. CONCLUSION

This paper presented modified transformed encoders for QCNB-LDPC codes of conjugacy constraints over subfields. The proposed designs can also be applied to binary codes, which are a special case of codes over subfields. Compared with the previous Fourier transform encoder, the proposed designs have much simpler data flow and avoided large buffers. In addition, novel architectures are developed to implement the Fourier transform and inverse by exploiting composite field arithmetic and conjugacy constraints. The proposed designs have smaller area requirement than the proposed encoder. The memory used for storing the generator matrix occupies a large part of the encoder. Future work will be directed to reducing this storage requirement.

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