International Journal of Future Generation Communication and Networking
Vol. 13, No. 1, (2020), pp. 365-375

MULTIBIT ERROR DETECTION AND CORRECTION USING GOLAY CODES WITHFPGA IMPLEMENTATION

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Abstract

Error detection and correction techniques are very important and widely used in communications anddata base management systems. While performing data communication there may be occurrence of error during transmission of data. To detect and correct errors some algorithms areused. An error-correcting code is one of the methods wherein the message is expressed in the form of numbers where theerrorsmaybedetectedandcorrected which is totally based on the pattern of the remaining numbers. In the existing systemsitdescribesaboutatypeoferror correctingcodecalledasHammingcode. It is a linear error correct code which facilitates to identify and accurate single bit errors occurred during transmission of data. In the proposed system it will overcome the demerits of the existing systems by using Golay codes. It is the only code which can correct up to three errors.

Keywords: *Error correction, Error detection, Golay codes, HammingCode*

I. Introduction

In electronics, a binary code is sort of linear Error-correcting code used in virtualinteractions.ThebinaryGolaycode, relation with the ternary Golay code, has a specially deep and thrilling association with the theory of finite irregular groups in arithmetic. These codes are named following Marcel J.E. Golay. As Golaycode has the potential of correcting up to a few errors it is able to be used in areas wherethepossibilityofmistakesismore.It is the best codes which can accurate up to threeerrors.

1.1 Different Golaycodes:

There are different types of Golay codes.

Some of them are

- Binary Golaycode
- Extended Binary Golaycode
- Ternary Golaycode

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II. ExistingSystem

Data communique achieved at any time does not always move well, it also happens blunders during transmission statistics.The unique algorithms are needed for detecting and correcting the errors during the transmission.Heretakesalookattheusage of the algorithm Hamming Code, because there will be an ease in the detection and correction of bit which is damaged. Hamming codes will find up to 2-bit errors oraccurate1-bitmistakeswithoutdetecting theuncorrectedmistakes.Incontrasttothis, the simple parity code can't accurately mistakes, and it might detect a bizarre number of bits which are in mistakes. Hamming code is used for correction of mistakes. In this coding method, there will be encoding of the message with the aid of inserting redundant bits inside themessage. These redundant bits are extra bits which may be generated and inserted at special positions within the message to allow detection andcorrection.

2.1 Methodology

The supply is a device which generates the information and it can be transmitted. Transmitter converts the data into an analog signal which is to be transmitted. The statistics generated from the source is not always transmitted in its exact shape. Transmission system, will be in the form of a single transmission line or a complex community that connects the supply to the destination. Receiver transforms the analog signal which gets in the form of digital records.

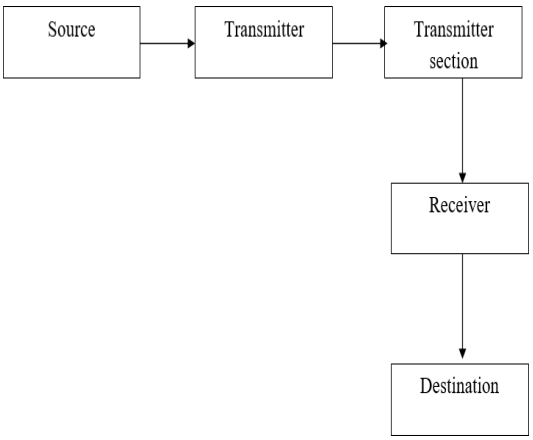

Fig. 1 Block Diagram of Transmission of Data

Transmission gadget alerts the receiver and includes it into a specific form that canbecapturedbymeansofthegoal.For example,amodemwillacquireananalog signalcomingfromthecommunityorthe transmission line direction and changing the analog sign into a digital bit stream. Destination captures the information from the receiver. Receiver side and Destination side are part of the Destinationsystem.

2.2 ErrorCorrection

During the time of transmission, there may be the possibility of corrupted statistics. The receiver will correct the data

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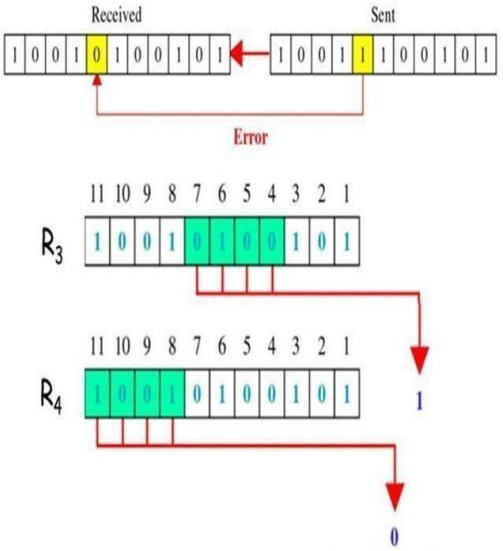
Fig.2 Hamming Code Correction



errors thru a process of blunders detection and correction of mistakes. Error detection method done by transmitter, by means of adding a few greater bits into statistics which is to be transmitted. Error detection and correction technique frequently usedin Compact Disc Players, High-pacemodems, and cellularphones.

2.3 HammingCode

Hamming Code is one of the strategies of mistakes detection and errors correction. This technique uses common sense XOR (Exclusive-OR) operation inside the system where the detection and correction of blunders takes place. whilst input and output information are in the shape of binary numbers. Hamming code approach was invented by Richard W. Hamming in 1940s. It is one among the methods of mistake detection which can found out some errors, however it's miles able to correcting simplest one error. This error detection approach is appropriate in conditions where there is a random happening of errors. Hamming code method inserts a couple of test bits in facts. The count of take a look at bits inserted depends on the period of these statistics. The variety of check bits inserted into the records can be calculated by using the formula such as follows: for 2n bits of evidence of the quality of test bits, c=(n+1) bits.

III. ProposedSystem

3.1 GeneratorMatrix

In coding theory, the rows of a generator matrix form a foundation for the linear code. The linear combos of the rows ofthismatrixarethecodewords,thatis,the row area of the generator matrix is the codeword. The generator polynomial of C is represented as ax^n.

$$G=\begin{bmatrix} g_0 & g_1 & \cdots & g_r & 0 & \cdots & 0 & 0 \\ 0 & g_0 & g_1 & \cdots & g_r & 0 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & 0 & g_0 & g_1 & \cdots & g_r & 0 \\ 0 & 0 & \cdots & 0 & g_0 & g_1 & \cdots & g_r \end{bmatrix}$$

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Fig. 3 Generator Polynomial Represented in Matrix form

The g(x) of (23, 12, 7) code is given by,

$g(x)=x11+x9+x7+x6+x5+x+1$,

12 × 23 generator matrix **G** is:

------ (2)

$$G=\begin{bmatrix}
1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0&0&0&0\\
0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0&0&0\\
0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0&0\\
0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0\\
0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0\\
0&0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0&0\\
0&0&0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0&0\\
0&0&0&0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0&0\\
0&0&0&0&0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1&0\\
0&0&0&0&0&0&0&0&0&0&0&1&1&0&0&0&1&1&1&0&1&0&1
\end{bmatrix}$$

Fig.412x23 Generator Matrix When there is a usage row operation in generator matrix, the systematic G for this code is shown as follows:

$$G_S=\begin{bmatrix}
1&0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0\\
1&1&1&1&1&0&0&1&0&0&1&0&1&0&0&0&0&0&0&0&0&0&0\\
1&1&0&1&0&0&1&0&1&0&1&0&0&1&0&0&0&0&0&0&0&0&0\\
1&1&0&0&0&1&1&1&0&1&1&0&0&0&1&0&0&0&0&0&0&0&0\\
1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0&0\\
0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0\\
0&0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0\\
1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0&0\\
0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0\\
1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1&0\\
0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1
\end{bmatrix}$$

$$= [P \mid I_k]$$

Fig.5 Generator Matrix

ParitycheckbitsmatrixisdenotedasP,and Identity matrix can be expressed as I(k) with k=12.This generator matrix is used in the calculation ofcodeword.

3.2 Parity CheckMatrix

The parity check matrix describes the codeword relation. It is one among the concept of coding theory.

Matrix H is

$$H=\begin{bmatrix}
h_k & \cdots & h_1 & h_0 & 0 & \cdots & 0 & 0\\
0 & h_k & \cdots & h_1 & h_0 & 0 & \cdots & 0\\
\cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots\\
0 & \cdots & 0 & h_k & \cdots & h_1 & h_0 & 0\\
0 & \cdots & 0 & 0 & h_k & \cdots & h_1 & h_0
\end{bmatrix}$$

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Fig. 6 Parity Check Polynomial

Represented in Matrix form

11×23 parity check matrix **H** is:

$$H=\begin{bmatrix}
1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0&0&0&0&0&0\\
0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0&0&0&0&0\\
0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0&0&0&0\\
0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0&0&0\\
0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0&0\\
0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0&0\\
0&0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0&0\\
0&0&0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0&0\\
0&0&0&0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0&0\\
0&0&0&0&0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1&0\\
0&0&0&0&0&0&0&0&0&0&1&0&1&0&0&1&0&0&1&1&1&1&1
\end{bmatrix}$$

Fig. 7 Parity Check Matrix

The row operation which is performed in H,ortransform[P|Ik]into[Ik|PT]from (4), where PT is expressed as a transpose matrix of P, and the systematic parity check matrix for this code is shown as follows: The parity check bits matrix is expressed as P, and Identity matrix can be expressed as I(k) with k=12.This Parity check matrix is used in the calculation of syndrome which determines the errors in receivedcodeword.

3.3 GolayEncoder

An (n, k) code **C** for every codeword is given as

$c=(c0,c1,\ldots,cn-2,cn-1)\in C$ --- (3)

it can also be given as

$c'=(cn-1,c1,c2,\ldots cn-2)\in C$ --------- (4)

Polynomial form of c is,

$(x)=c0+c1x+\cdots+cn-1xn-1$-----(5)

Every code polynomial in **C**, here is a minimal degree r < n for unique monic generator. Every code polynomial c(x) in **C** where it

$(x)=g0+g1x+\cdots+ gr-1x^{r-1}$----(6)

It can be expressed as $c(x) = m(x)g(x)$,

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Hence

$$(x)=m0+m1x^{1}+\cdots+mk-1x^{k-1}$$

----(7)

(x) denotes messagepolynomial.

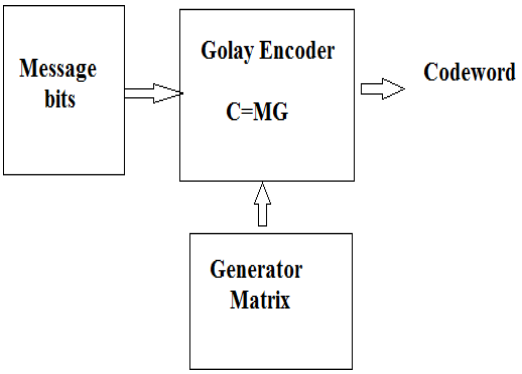

Fig.8 Block Diagram of Golay Encoder

From this, it is identified that the significance bits will constantly occupy the lowest 12 coordinates of all the codeword. In this case, codeword can be generated by using XOR gates. Depending on the generator matrix equations, the 12 message bits are encoded in to 23bits.

3.4 GolayDecoder

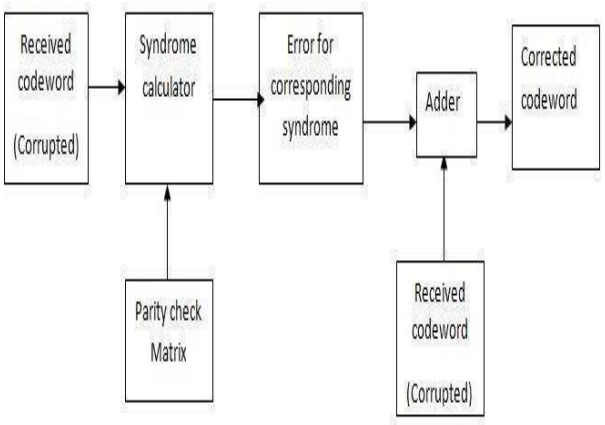

Fig.9 Block Diagram of Golay Decoder

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IV. Stimulation Results

The result of the encoder and the decoder with the hamming code
Message bit 1111
Encoded data 1111111
Decoded data 1111

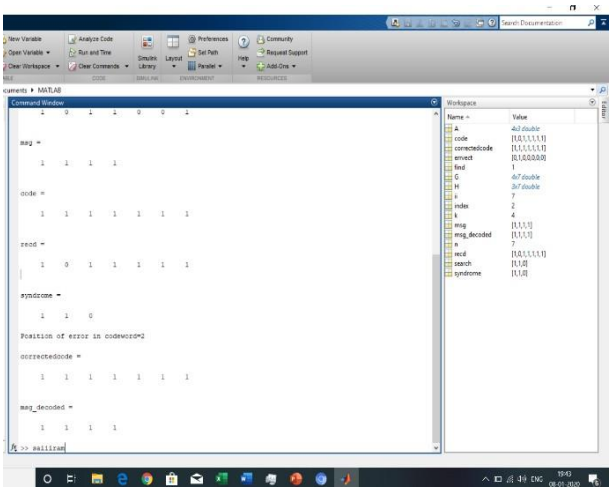

Fig.10 Result of encoder and decoder of hammingcode

Results of Encoder Using Matlab: Message bits are 100000000000, Encoded data is 101011100011000000000000

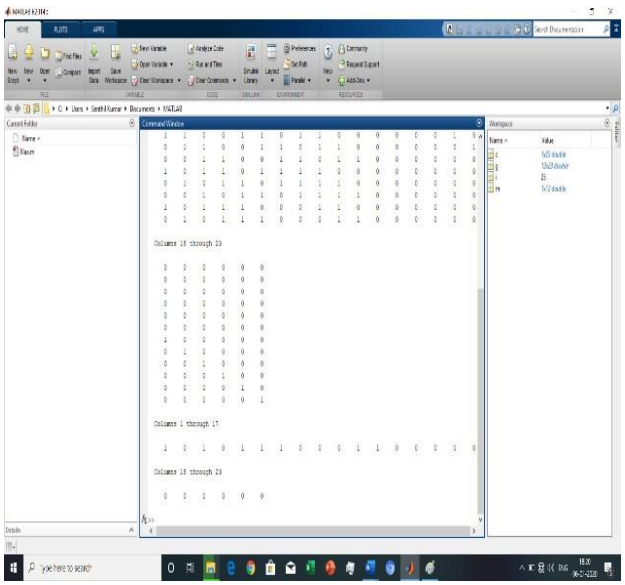

Fig.11 Result of GolayEncoder **Results of Decoder using Matlab: Received code word is 010000000110000000000001**

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Corrected Code word is 010111000110000000000001

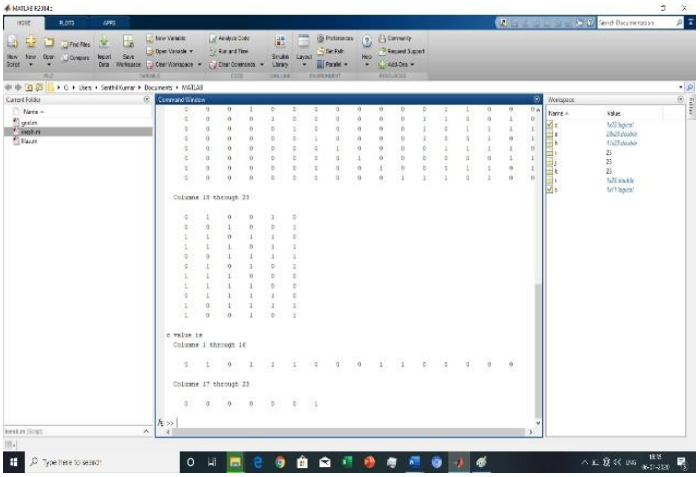

Fig.12. Result of Golay Decoder

V. Conclusion and FutureWork

During the transmission of data there will be an occurrence of errors. Hamming code is one of the methods of error correcting code which is used to correct single bit error. In order to correct up to three errors Golay code is preferred. In this we have corrected up to 3 errors. Coding packages have grown rapidly inthe past several years. The part of applied mathematics that includes various coding schemeswhichareusedtofindthemistakes that are introduced during the transmission of data. This Golay code is applied in NASA deep area project due to the reality transmission of shade picture requireslarge bandwidth.Aslargerecordsaretransmitted Golay code will be effective for encoding and interpreting the facts. This may be further synthesized and may be set up at precise places where in the transmission or reception of big data is carriedout.

References

[1] Bhoyar, P. (2016) “Design of encoder and decoder for Golay code”,2016 International Conference on Communication and Signal Processing(ICCSP).

[2] Jose, A., &Sujith Amol, S. (2017) “FPGA implementation of encoder and decoder for Golay code”, 2017 International Conference on Trends in Electronics and Informatics (ICEI). [3]Ma,J.F.(1997)“DecodingoftheGolaycode”, ElectronicsLetters,33(17),1451.

[3] Nguyen, G. D. (2005) “Error-detection codes: algorithms and fast implementation”, IEEE Transactions on Computers, 54(1), 1–11.

[4] M. Paranthaman, "T-shape polarization reconfigurable patch antenna for cognitive radio," 2017 Third International Conference on Science Technology Engineering & Management (ICONSTEM), Chennai, 2017, pp. 927-929. doi: 10.1109/ICONSTEM.2017.8261338

[5] S.Palanivel Rajan, “A Significant and Vital Glance on “Stress and Fitness Monitoring Embedded on a Modern Telematics Platform”, Telemedicine and e-Health Journal, Vol.20, Issue 8, pp.757-758, 2014.

ISSN: 2233-7857 IJFGCN
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[6] S.Palanivel Rajan, T.Dinesh, “Systematic Review on Wearable Driver Vigilance System with Future Research Directions”, International Journal of Applied Engineering Research, Vol. 2, Issue 2, pp.627-632, 2015.

[7] S.Palanivel Rajan, S.Vijayprasath, “Performance Investigation of an Implicit Instrumentation Tool for Deadened Patients Using Common Eye Developments as a Paradigm”, International Journal of Applied Engineering Research, Vol.10, Issue 1, pp.925-929, 2015.

[8] M.Manikandan,N.V.Andrews, V.Kavitha, “Investigation On Micro Calification Of Breast Cancer From Mammogram Image Sequence” International Journal of Pure and Applied Mathematics, Online ISSN No.: 1314-3395, Print ISSN No.: 1311-8080, Vol. No.: 118, Issue No.: 20, pp. 645-649,2018.

[9] Sivaranjani S, Kaarthik K, MEDICAL IMAGING TECHNIQUE TO DETECT TUMOR CELLS, International Journal of Pure and Applied Mathematics, Vol. 118, Issue 11, pp.399 – 404 , 2018.

[10] S.Palanivel Rajan, T.Dinesh, “Statistical Investigation of EEG Based Abnormal Fatigue Detection using LabVIEW”, ”, International Journal of Applied Engineering Research, Vol. 10, Issue 43, pp. 30426-30431, 2015.

[11] L. RAMESH, T.ABIRAMI, “Segmentation of Liver Images Based on Optimization Method”, International Journal of Pure and Applied Mathematics, Online ISSN No.: 1314-3395, Print ISSN No.: 1311-8080, Vol. No.: 118, Issue No.: 8, pp. 401-405, 2018.

[12] S.Palanivel Rajan, K.Sheik Davood, “Performance Evaluation on Automatic Follicles Detection in the Ovary”, International Journal of Applied Engineering Research, Vol.10, Issue 55, pp.1-5, 2015.

[13] S.Palanivel Rajan, V.Kavitha, “Diagnosis of Cardiovascular Diseases using Retinal Images through Vessel Segmentation Graph”, Online ISSN No.: 1875-6603, Print ISSN No.: 1573-4056, Vol. No.: 13, Issue : 4, pp. 454-459, DOI : 10.2174/1573405613666170111153207, 2017.

[14] K Kaarthik, C Vivek, "Hybrid Han Carlson Adder Architecture for Reducing Power and Delay", Middle-East Journal of Scientific Research, Vol. 24, Special Issue, pp. 308-313,2016.

[15] Dr.S.Palanivel Rajan, Dr.C.Vivek, “Performance Analysis of Human Brain Stroke Detection System Using Ultra Wide Band Pentagon Antenna”, Sylwan Journal, ISSN No.: 0039-7660, Vol. No.: 164, Issue : 1, pp. 333–339, 2020.

[16] Dr.S.Palanivel Rajan, Dr.C.Vivek, “Analysis and Design of Microstrip Patch Antenna for Radar Communication”, Journal of Electrical Engineering & Technology, Online ISSN No.: 2093-7423, Print ISSN No.: 1975-0102, Vol. No.: 14, Issue : 2, DOI: 10.1007/s42835-018-00072-y, pp. 923–929, 2019.

[17] Dr.S.Palanivel Rajan, M.Paranthaman, “Characterization of Compact and Efficient Patch Antenna with single inset feeding technique for Wireless Applications”, Journal of Applied Research and Technology, ISSN: 1665–6423, Vol. 17, Issue 4, pp. 297-301, 2019.

[18] Dr.S.Palanivel Rajan, L.Kavitha, “Automated retinal imaging system for detecting cardiac abnormalities using cup to disc ratio”, Indian Journal of Public Health Research & Development, Print ISSN: 0976-0245, Online ISSN: 0976-5506, Vol. No.: 10, Issue : 2, pp.1019-1024, DOI : 10.5958/0976-5506.2019.00430.3, 2019.

[19] Dr.S.Palanivel Rajan, M.Paranthaman, “Novel Method for the Segregation of Heart Sounds from Lung Sounds to Extrapolate the Breathing Syndrome”, Bioscience Biotechnology Research Communications, ISSN: 0974-6455, Vol. 12, Issue : 4, pp. 245-253, DOI: 10.21786/bbrc/12.4/1, 2019.

ISSN: 2233-7857 IJFGCN
Copyright ⓒ 2020 SERSC

[20] Dr.S.Palanivel Rajan, “Design of Microstrip Patch Antenna for Wireless Application using High Performance FR4 Substrate”, Advances and Applications in Mathematical Sciences, ISSN No.: 0974-6803, Vol. No.: 18, Issue : 9, pp. 819-837, 2019.
[21] M.Paranthaman, S.Palanivel Rajan, “Design of H Shaped Patch Antenna for Biomedical Devices”, International Journal of Recent Technology and Engineering, ISSN : 2277-3878, Vol. No. 7, Issue:6S4, pp. 540-542, Retrieval No.: F11120476S4/19©BEIESP, 2019.
[22] T.Abirami, Dr.S.Palanivel Rajan, “ Detection of poly cystic ovarian syndrome (PCOS) using follicle recognition techniques”, Bioscience Biotechnology Research Communications, ISSN: 0974-6455, Vol. 12, Issue : 01, pp. 1-4, DOI: 10.21786/bbrc/12.1/19, 2019.
[23] M.Paranthaman, S.Palanivel Rajan, “Design of Implantable Antenna for Biomedical Applications”, International Journal of Advanced Science and Technology, P-ISSN: 2005-4238, E-ISSN: 2207-6360, Vol. No.: 28, Issue No. 17, pp. 85-90, 2019.
[24] T.Abirami, S.Palanivel Rajan, “Cataloguing and Diagnosis of WBC’S in Microscopic Blood SMEAR”, International Journal of Advanced Science and Technology, P-ISSN: 2005-4238, E-ISSN: 2207-6360, Vol. 28, Issue No. 17, pp. 69-76, 2019..
[25] M. Anitha, K. Kaarthik, "Analysis of nutrient requirement of crops using its leaf", Journal of Chemical and Pharmaceutical Sciences, Special Issue, pp. 99-103, 2016.
[26] Dr.S.Palanivel Rajan, “Enrichment of ECG Quality using Independent Component Analysis for Dynamic Scenario by Eliminating EMG Artifacts”, Advances and Applications in Mathematical Sciences, ISSN No.: 0974-6803, Vol. No.: 18, Issue : 2, pp. 219-237, 2018.
[27] K Kaarthik, A Sridevi, C Vivek, "Image processing based intelligent parking system", IEEE International Conference on Electrical, Instrumentation and Communication Engineering, 2017, pp. 1-4.
[28] Dr.S.Palanivel Rajan, S.Suganya, “Design of Loop Antenna for the Human Brain Signal Analysis”, Indian Journal of Science and Technology, Online ISSN No.: 0974-5645, Print ISSN No.: 0974-6846, Vol. No.: 11, Issue: 10, pp. 1-6, DOI: 10.17485/ijst/2018/v11i10/120829, 2018.
[29] K Kaarthik, C Vivek, "Hybrid Han Carlson Adder Architecture for Reducing Power and Delay", Middle-East Journal of Scientific Research, Vol. 24, Special Issue, pp. 308-313, 2016.
[30] M.Paranthaman, Dr.S.Palanivel Rajan, “Design of E and U Shaped Slot for ISM Band Application”, Indian Journal of Science and Technology, Online ISSN No.: 0974-5645, Print ISSN No.: 0974-6846, Vol.: 11, Issue: 18, pp. 1-3, DOI: 10.17485/ijst/2018/v11i18/123042 2018.
[31] C.Vivek, S.Palanivel Rajan, “Z-TCAM : An Efficient Memory Architecture Based TCAM”, Asian Journal of Information Technology, ISSN No.: 1682-3915, Vol. No.: 15, Issue : 3, pp. 448-454, DOI: 10.3923/ajit.2016.448.454, 2016.
[32] K Kaarthik, C Vivek, “Weed Remover In Agricultural Field Through Image Processing”, International Journal of Pure and Applied Mathematics, Vol. 118, Issue 8, pp. 393-399, 2018.
[33] S.Vijayprasath, R.Sukanesh, S.Palanivel Rajan, “Assessment of relationship between heart rate variability and drowsiness of post operative patients in driving conditions”, JoKULL Journal, ISSN No.: 0449-0576, Vol. 63, Issue 11, pp. 107 – 121, 2013.
[34] K. Kaarthik, P. Yuvarani , "Implementation of Distributed Operating System for industrial process automation using embedded technology", Journal of Chemical and Pharmaceutical Sciences, Special Issue, pp. 14-17, 2016.

ISSN: 2233-7857 IJFGCN
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[35] S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, “Design and Development of Mobile Based Smart Tele-Health Care System for Remote Patients”, European Journal of Scientific Research, ISSN No.: 1450-216X/1450-202X, Vol. No. 70, Issue 1, pp. 148-158, 2012.

[36] S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, “Analysis and Effective Implementation of Mobile Based Tele-Alert System for Enhancing Remote Health-Care Scenario”, HealthMED Journal, ISSN No. : 1840-2291, Vol. No. 6, Issue No. 7, pp. 2370–2377, 2012.

[37] K. Kaarthik, S. Pradeep, S. Selvi, "An Efficient Architecture Implemented to Reduce Area in VLSI Adders", Imperial Journal of Interdisciplinary Research, Vol.3, Issue 2, pp. 326-330, 2017

[38] M Paranthaman, G.Shanmugavadivel “Design of Frequency Reconfigurable E-Shaped Patch Antenna for Cognitive Radio” International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.20 (2015) pp.16546-16548

[39] S.Palanivel Rajan, “Review and Investigations on Future Research Directions of Mobile Based Tele care System for Cardiac Surveillance”, Journal of Applied Research and Technology, Vol.13, Issue 4, pp.454-460, 2015.

[40] S.Palanivel Rajan, R.Sukanesh, “Experimental Studies on Intelligent, Wearable and Automated Wireless Mobile Tele-Alert System for Continuous Cardiac Surveillance”, Journal of Applied Research and Technology, ISSN No.: 1665–6423, Vol. No. 11, Issue No.: 1, pp.133-143, 2013

[41] S.Palanivel Rajan, R.Sukanesh, “Viable Investigations and Real Time Recitation of Enhanced ECG Based Cardiac Tele-Monitoring System for Home-Care Applications: A Systematic Evaluation”, Telemedicine and e-Health Journal, ISSN: 1530-5627, Online ISSN: 1556-3669, Vol. No.: 19, Issue No.: 4, pp. 278-286, 2013.

[42] K Kaarthik, C Vivek, “Variable Latency Approach in VLSI Adder Implemented to Reduce Area and Power”, Indian Journal of Science and Technology, Vol. 11, Issue 18, pp.1-7, 2018.

[43] K. Kaarthik, S. Pradeep, S. Selvi, "An Efficient Architecture Implemented to Reduce Area in VLSI Adders", Imperial Journal of Interdisciplinary Research (IJIR), Vol.3, Issue 2, pp. 326-330, 2017

[44] S.Palanivel Rajan, et.al., “Intelligent Wireless Mobile Patient Monitoring System”, IEEE Digital Library Xplore, ISBN No. 978-1-4244-7769-2, INSPEC Accession Number: 11745297, IEEE Catalog Number: CFP1044K-ART, pp. 540-543, 2010.

[45] S.Palanivel Rajan, et.al., “Cellular Phone based Biomedical System for Health Care”, IEEE Digital Library Xplore, ISBN No. 978-1-4244-7769-2, INSPEC Accession Number: 11745436, IEEE Catalog Number: CFP1044K-ART, pp.550-553, 2010.

[46] S.Palanivel Rajan, et.al., “Performance Evaluation of Mobile Phone Radiation Minimization through Characteristic Impedance Measurement for Health-Care Applications”, IEEE Digital Library Xplore, ISBN : 978-1-4673-2047-4, IEEE Catalog Number: CFP1221T-CDR, 2012.

[47] S.Palanivel Rajan, et.al., “Experimental Explorations on EOG Signal Processing for Real Time Applications in LabVIEW”, IEEE Digital Library Xplore, ISBN : 978-1-4673-2047-4, IEEE Catalog Number: CFP1221T-CDR, 2012.

[48] Riedel,S.,&Weiss,C.(1999)“TheGolay convolutional code- some application aspects”, IEEE Transactions on Information Theory, 45(6),2191–2199.

[49] Satyabarta Sarangi and Swapna Banerjee, (2015) “Efficient Hardware Implementation of Encoder and Decoder for Golay Code,” IEEE Transactions on Very Large-Scale Integration (VLSI) Systems, September2015.

ISSN: 2233-7857 IJFGCN
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