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Design and Implementation of RS(450, 406) Decoder:

Forward Error Correction by Reed Solomon Decoding

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ABSTRACT

Nowadays, in the field of data transmission between receiver and transmitter, the Reed Solomon code is used very frequently. FEC codes have two foremost and influential operations: (1) calculating parity symbols at the encoder side and (2) transmitting message symbols with parity symbols and decoding the received codeword at the second side by using the decoding algorithms. Gigabit automotive ethernet is used in the automotive car to provide better bandwidth for every kind of applications to connect functional components of the vehicles. This error correction technique is used in the gigabit automotive ethernet to reduce the channel noise during data transmission. RS (450, 406) is a powerful error correction techniques used in automotive ethernet. This paper focused only on the analysis of Reed Solomon decoding. Reed Solomon decoding is more efficient decoding techniques for correcting both burst and random errors. The critical steps of the Reed Solomon decoding are to solve the error evaluator and error calculator polynomial, which is also known as KES solver.

KEYWORDS

Cadence ncSim, Cadence Simvision, Chien-Search, Error Corrector, Forney Algorithm, Forward Error Correction, Galois Field (GF), Gigabit Ethernet, Inversionless Berlekamp Massey (iBM), Reed Solomon

1. INTRODUCTION

With the development of advanced vehicle technology, electronic systems are increasing in vehicle to refine their interpretation and new features. Considering the features of a car, its electronics system is divided into many functional elements, and every element has self-dependent control. Various complex controls and sensors are used in cars to maximize their efficiency and power. To conserve vehicles in normal operation, components in different domain or same domain need to communicate properly to each other. Therefore, to complete this communication inside vehicles different vehicle networks technology has been developed, like as Flex Ray, MOST (Media Oriented System Transport),

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LIN (Local Interconnect Network), LVDS (Low-Voltage Differential Signaling) and Controller Area Network (CAN) etc. These networks are developed for specific applications or domains. Initially CAN BUS is used in vehicle network but due to some limitations (like restriction on cable length, bit rate and module synchronization etc.), Automotive Ethernet (AE) is replacing CAN network technology. Automotive Ethernet (AE) is used for providing connection in between electronic systems.

AE is designed to meet bandwidth requirements, synchronization requirements, latency requirements and network management requirements. It has wide range of applications including: Diagnostics, Infotainment, Advance Driver Assistance Systems (ADAS) and in vehicle connectivity. In Ethernet data is transferred in the form of packets between nodes, it provides bidirectional communication. AE is a wired hierarchical homogeneous network. Gigabit or 1000BASE-T1 Ethernet is a next generation Automotive Ethernet, can serve as a backbone of the Autonomous car. The Automotive Ethernet (Sana Ullah et al., 2013, pp. 1-12) is used in cars to connect the different electronic systems for providing better and fast communication between them. AE is the physical network used to connect different electronic components used in the vehicles by a wired network. It provides better bandwidth, latency and management requirements.

The Physical Coding Sublayer (PCS) service interface allows the 1000BASE-T1 PCS to transfer information to and from a PCS client. In PCS transmission code is used for improving the transmission characteristic of any type of information to be transferred. In PCS Forward Error Correction (FEC) technique is used for error detection and correction. FEC is a powerful transmission code, it correct limited number of error without the need of retransmission. Several Error Correction Codes (ECC) available for FEC are:

1. Block codes
2. Convolutional codes
3. Hamming Codes
4. Binary Convolution code
5. Low – Density Parity check code
6. Cyclic Code
7. BCH (Bose Chaudhari and Hocquenghen) code
8. Reed Solomon Code

Except Reed Solomon (RS) Code, other error correction codes are not used in Physical layer (or PCS) due to their limitations such as: less error correction capability, less data rate and poor bandwidth. Moreover, these all EC codes are independent of Galois Field (GF) and primitive polynomial except RS code. They can correct error up to several bits. Hamming codes can detect two-bit error, or they can fix only one-bit error without detection of uncorrected errors. The most significant difference between BCH code and Reed Solomon are:

- BCH codes correct bits, while Reed Solomon code corrects symbols.
- BCH codes correct t bit error errors, while RS code corrects t symbols.

BCH codes can correct only random error, while RS code can correct both random and burst error during data transmission. Hence, due to the error correction capability RS codes are preferred over other BCH codes.

In physical layer of AE, RS encoder and decoder are used. They work simultaneously to provide full duplex communication. RS code is a powerful FEC code. RS encoding and decoding is used in the Gigabit Ethernet for better bandwidth and for reducing channel noise during the data transmission. RS code (E. R. Berlekamp, 1984; R. E. Blahut, 1983) is one of the most popular FEC (M. Kaur & V. Sharma, 2010) code. It adds the parity symbol in the message symbol and makes the receiver

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