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Error Detection and Correction Using a Genetic Algorithm

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Abstract

In this paper, we proposed method combines errors detection and correction through the use of the genetic algorithm. Its processes that provided and supported by this algorithm so that the sender and receiver party generate a total of population. Then using crossover and mutation process, as we will be explained in detail later in which we were able to discover and correct error. Also, we reduced the steps compared with error detection code (checksum,etc.) that required to detect and correct errors moreover to ensuring the reliability and security issues when the code word is passing through the channel.

Keywords: Error Detection, Error Correction, Genetic Algorithm, Crossover, Mutation.

Introduction

The error happens when the receiver's message does not match with the dispatcher's message. While transmission, digital signals hurt from a noise that can make errors in the binary bits moving from dispatcher to receiver. That means a bit 1 perhaps arrives as 0 and bits 0 perhaps arrives as 1 [1].In networking, error detection is techniques used to discover noise or other impairments introduced into data while it is transmitted from source to destination. Error detection ensures you deliver reliable data through networks [2].

The aim of error signalling is to alleviate the probability of conveying incorrect information to the designated place, named as the undiscovered mistake possibility. The oldest method that was used for mistakes rectification involves utilizing parity. The core of its work lies in adding an additional bit for each character work transferred the kind of parity; the amount of logic bits in the data character considers as agents that impact on such bit condition.

A recurrence code considers from other procedures that are utilized for signalling errors. In fact, it defines as a coding designer that reproduce bits via manifestation. The mechanisms that are employed for underlying any error are varied and Checksum considers one of them. Indeed, it perceives as modular arithmetic that contains the whole of message code of a stable length of words. In respect of its schemes, they involve things that have the same purpose, i.e. detecting the errors, such as linear redundancy checks, parity bits, and check digits.

The codes that are specialized for identifying errors are executed on one of the two layers either information link or transport of OSI model. Each time the message is passed, it may get crowded by fuss or information that may have been malfunctioned. In order to curb such case from occurring, we can employ the codes that are specialized for signalling errors that are defined as a wide range of information that is inserted to such digital message; it is functioning for signalling any error that might arouse during the transition of the message.

Error definition can be defined as the process that is specialized for signalling the mistakes that arouse in transferred messages as well as restoring the basic information that is devoid from any mistake. The purpose of error amendment is deduced in guaranteeing both that such information does not contain any mistake and that rectified messages are reached to the receptor side.

Systems are able to ask for resending the incorrect messages responding to mistakes rectifying involve in their communication software package. Following things: an automatic repeat request (ARQ) processing, or automatic request for retransmission. However, ARQ considers one of the techniques that utilize mistakes signalling codes; its operating mechanism is embodied in managing the mistakes by employing positive and negative statements. Indeed, its mode of operation lies in its transmitter that transfers the message for the second time, whenever such transmitter gets a negative statement or when a time limit occurs before obtaining the statement. In case of emerging any mistake either by sending or by storing. In such case, the receptor has two tasks the first one is to verify while the second is to rectify the mistakes that might occur. In general, it does not request the sender to transmit for another time whether the frame or the content.

The main purpose for a hybrid method that is employed for connecting both ARQ and FEC lies in rectifying the mistakes. The only case that demands the receptor to call for resending, when the parity information is insufficient to perform error signalling and to rectify as needed. The purpose of Genetic Algorithms evolves around copying a group of processes monitors in normal evolution. The fossil record pointed out that many people in general and biologists, in particular, are stunned that at the degree of sophistication that we manage may have improved in the comparatively short period. The principle of GA lies in utilizing such power of development to resolve the utmost issues. In the early 1970s, John Holland was the first person who created the original Genetic Algorithm.

Genetic Algorithms (GAs) considers adjustable guidance search algorithm; it depends on developed thoughts concerning the normal picking and genetics since they perform brilliant utilization of a casual search that employed for solving the utmost issues.

In spite of the fact that GAs are haphazard, but they are in no way indiscriminate. Rather, they adopt earlier data to draw the inspection toward the spot of improved functioning during the inspection place.

The main mechanisms of the GAs are intended to mimic normal systems' processes that are essential for development. Particularly, such processes that are implementing the basics that are designed by Charles Darwin "survival of the fittest." Which denotes that the normal competition between people for minimal sources leading to the dominance of strongest people over the weakest people.

Related work

The paper [3] indicates the emerging of a new effective implementing regarding the seeking for fixed weight codes. The aim of algorithm embodied in producing codes that contain the maximum amount of codeword for a specific length, fixed weight, and lower hamming space. A new scaling for the value function emerges as a result of differentiating the simulated annealing mechanism with the algorithm. However, such new scaling manifested that it is more efficient than another scaling that is utilized in the literature scaling regarding the value function that manifested.

The paper [4] suggests a technique that decreases power consummation in single-error rectifying double error-detecting checker circuits that execute memory mistake rectifying code. The purpose of the genetic algorithm lies in solving the problem concerning nonlinear power optimization. However, the technique is performed on both frequently used codes, namely standard Hamming and odd column weight Hsiao codes. Indeed, the experiments were conducted to manifest the functioning of the suggested technique. The [1] findings manifest that the genetic algorithm provided in such work performed fully and its arithmetic effort compared to simulated annealing it somehow means obtaining the required codes. The main benefit of it lies in its simplicity. From the other side, the manner is solid and could be easily executed by using an identical computer.

The paper [2] they increase the H-matrix of the memory ECC inspector by utilizing GA with decreasing the power consummation. Immediately after selecting the H-matrix circuity. For executing the code that might be synthesized. Power reduction considers the designed standard that turned into fundamental in immediate times. Since the reduction enhancing of devices, the design standards of first-place power have prompted the investigators to search for ways that are seeking to reduce power consummation in the whole of system design elements. Since the suggested technique maintains the absolute posture of the materials in the parent chromosome, and such technique involves of the better performance. The experimental findings manifest the competency of the suggested technique.

A genetic algorithm is a technique that is used for resolving both types of problems whether limited or unlimited optimization that is based on choosing. Such phase may be conducive to biological development. The genetic algorithm is adjusted frequently a group of personal solutions. At every phase, the genetic algorithms randomly pick people out of the present society to constitute parents and utilize them to create a new generation. The community through the subsequent generations improves toward gaining the ideal solution. We can follow the genetic algorithm to resolve several of utmost problems that do not fit the standard optimization algorithms, involving the matters in which the aim function is ceased, indistinguishable, indiscriminate, or extremely nonlinear.

The genetic algorithm can refer to issues of different integer programming, where some elements are limited to be integer-valued. The genetic algorithms adopt three basic schemes of principles in every stage to generate the subsequent generation out of the current population.

1. The principles of picking embodied in selecting people, given parents, until they reach the next age society.
2. Crossover controls children for the future generation that considers as an integration
3. The principles of transformation lie on making alterations randomly to parents in order to constitue kids.

Genetic algorithm

Genetic algorithms defined as numeral utmost algorithms and derived from picking and normal genetics. The manners have been executed on a large group of problems. The GAs usually preserves a population of people which constitutes a group of solution candidates for solving the greatest problem [5].
Each nominee is subjected to the estimation that depends on its fitness value the percentage of GAs increases due to a group of genetic factors. However, the basic genetic factors are classified as follows: picking, crossover, and transformation. With regard to picking process, in such phase, certain individuals are chosen to be reproduced into the future temporal percentage. It considers better than traditional AI. Moreover, it is more firm.
It differs from other previous AI systems because they do not break instantly, even though the inputs altered a bit, or by the existence of reasonable disturbance. In addition, in looking for huge state-space, various models of state-space, or n -dimensional surface. Indeed, the genetic algorithm might somehow provide various facilities, such as guiding, depth-first, expansion-first, and practical work, over the ideal search of optimization ways.

A genetic algorithm for discovering and correcting mistakes

The term mistake was included in either inputs or corresponding outputs within the explanation of any digital or system analogy. However, such term “mistake” considers as ominous. In a similar manner, the primary reason for mistakes in the set-up of either a digital computer or digital connection when the disturbance moves towards the bit path during the sending from the transferor to the receptor.

The results that are emerged from neither discovering nor rectifying the mistakes are devastating because the digital system is very affected by the mistakes. Therefore, it will breakdown because of such little mistake that manifests in transferred codes [6]. In this section, we apply the genetic algorithm with error detection and correction and we will discuss it as following

1. Error detection:We propose a method to detect the error and determine the position of the error.
2. Error correction:We propose a method to correct error since the position of the error was determined by the previous way.

METHODOLOGY

The fudemental importance in the connection system is good code. Data that has to be conveyed is exemplified by code word like the ASCII code, binary code, and so forth. Such code words that resulted from the Genetic algorithm like the population by choosing process initially we select the codewod theninserting it in a set with index. After that, implementing XOR operation on the parent.After that, we transfer it as excessive information plus codeword above a channel, for instance a phone line, and so forth. Firstly, the receptor obtained the codeword. Secondly, dividing the codeword from the excessive information. Thirdly, contrasting it with a population that he reached when such codwords corresponds with its group.

The receptor employs the intersection process to shape two categories of children. The first category, children adopt (XOR) operation. The second category, children who then adopt (XOR) operation in addition to excessive information that we employ to guarantee that such obtained information is devoid of mistakes. Zeroes there is no error otherwise an error found since the received codeword does not match with the codeword that the receiver has.So we had to correct it from error detection process we know the index that has error bit just apply mutation process we fix the error to ensure that the error is correct to call the detection process again we get zeros so no mistake and we sure that the error has been corrected. this method provides useful feature we can detect the failure from the begging since the codeword is compeered so if any error is found we can note it and determine the index that has the error bit, so the detection and correction easier and more flexible.
The figure below shows the steps, concepts that we proceeded in our work and it will summarize the idea and discus it in details.

1. Error detection

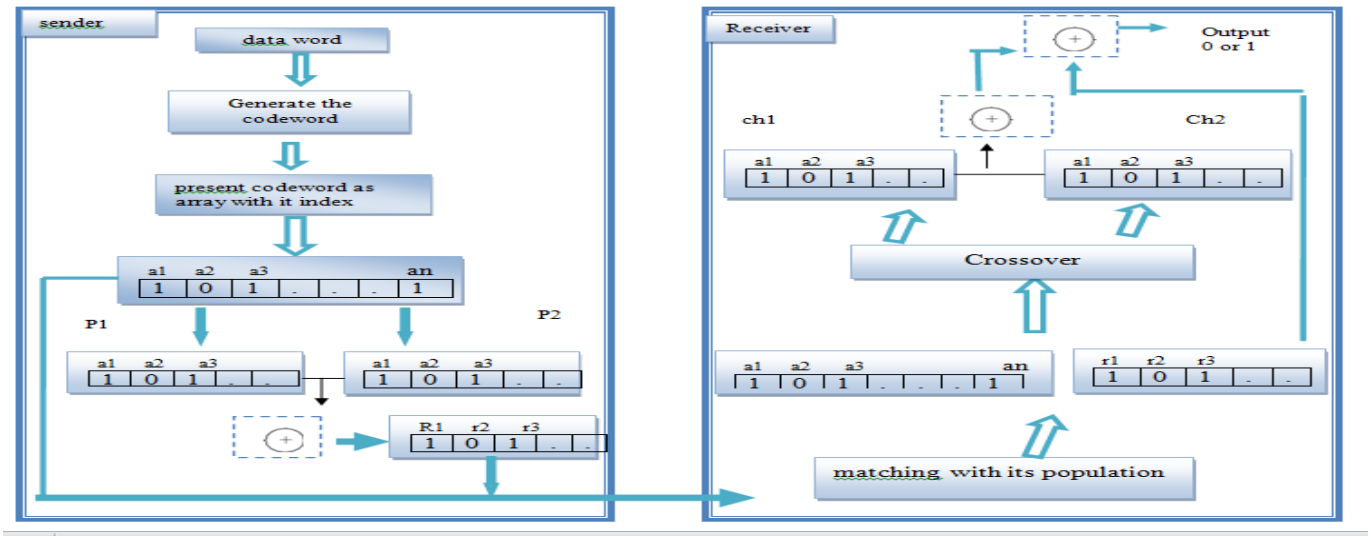

Fig.1. Methodology (error detection)

2. Error correction

The figure below shows the implementation

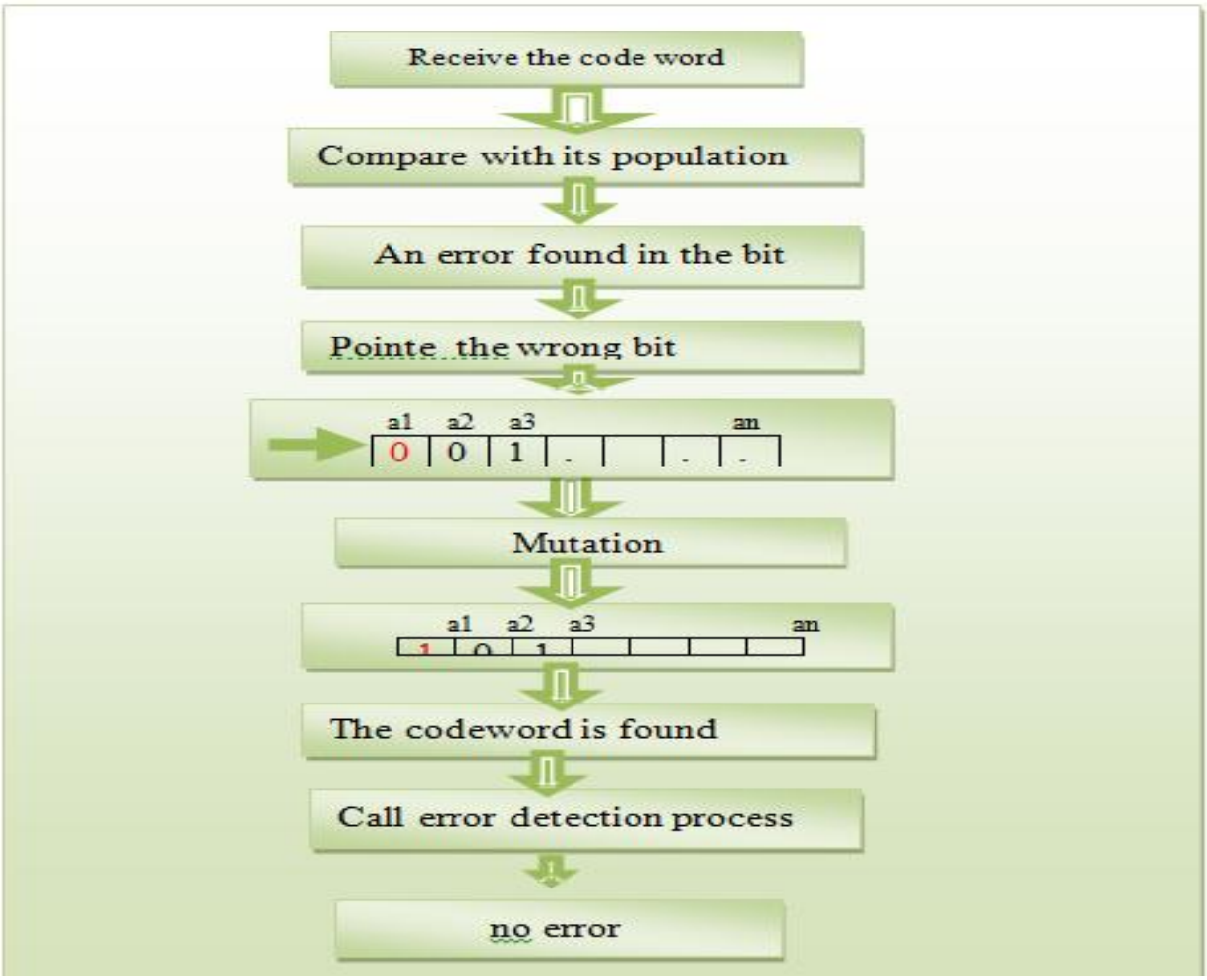

Fig.2.Methodology (error correction)

Evaluation

There are many different algorithm evaluations and they are considered fundamental in measuring the quality of an algorithm [7]. In this step, we evaluate the algorithm. In sender side we use (1010100100111001) as a codeword, and from this codeword we get two parent P_1 is (10101001), and P_2 is (00111001) and apply XOR operation between p_1 and p_2 the result will be added to as redundant data (the redundant data has the same length of P_1 and P_2) to the codeword.The next step in the receiverhas divided the codeword to P_1 and P_2 and find out the redundant data, then, apply crossover by using XOR operation between P_1 and P_2. Then, XOR operation applies again between the result from the previous step and redundant data. We get 0's that means no error.

Errordetection

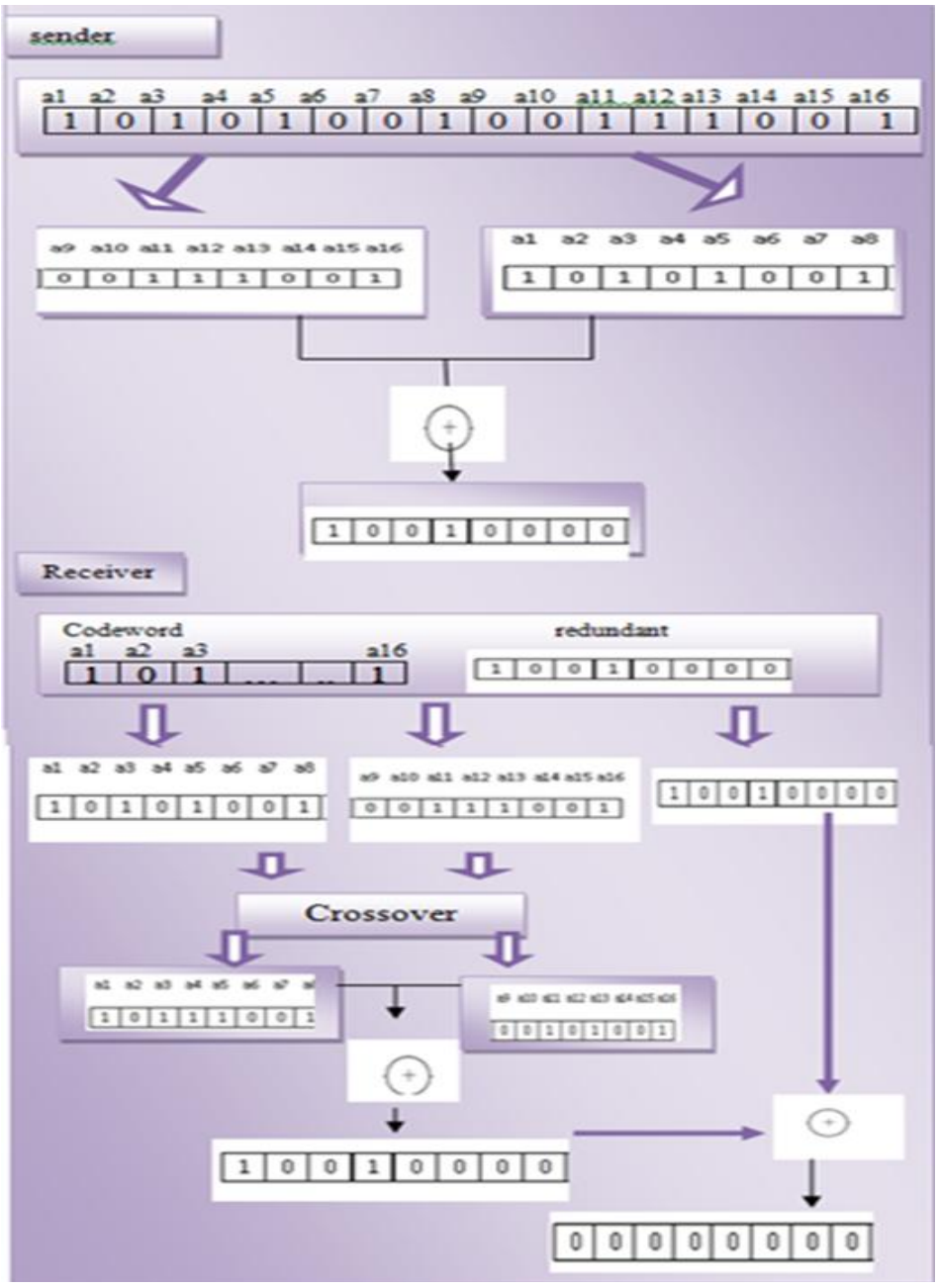

Fig.3. Evaluation (error detection)

Error correction

In another case, if the codeworddoes not match that means there is an error. Therefore, error correction process from array gets the index of the error bit to apply mutation process make 1-bit 0 and 0 bit 1 repeat mutation process until match the generated codeword. The figure bellow shows the steps:

Fig. 4. Evaluation (error correction)

Fitness function

Error detection Apply (XOR) function at the begging on parents(P1,P2) and make the crossover to form the children As following:

Table1: Apply (XOR) function on parents

P1	P2	P1(XOR)P2
0	0	0
0	1	1
1	0	1
1	1	0

Then apply crossover on children then (XOR) operation

Table 2: (XOR) operation on children

Ch1	Ch2	ch1(XOR)ch2
0	0	0
0	1	1
1	0	1
1	1	0

Apply (XOR) operation again as following:

Table 3. (XOR) operation again

P1(XOR)p2	ch1(XOR)ch2	Output
0	0	0
1	1	0
1	1	0
0	0	0

Since the output is zeros that mean no error otherwise, there is an error occur

B. error correction:Since we have an error, we already know the position of the wrong bit just we had to apply the mutation process.

Table 4: Mutation

Index value	Index value(XOR) one
0	1
1	0

So this action correct the error

Conclusion:

In this paper, we proposed an algorithm for error detection and correction by using the genetic algorithm and we show the steps of the algorithm by using it, we find that it represents the optimal solution. As we discuss it above, we can detect the error from the beginning, and with an extra feature, we can detect the error and determine the position of the error bit. Therefore, it makes the correction of the error more flexible, and we will be sure that there is no error is found.

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