Assignment 1

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Topic title: Design and implement an error detection module.

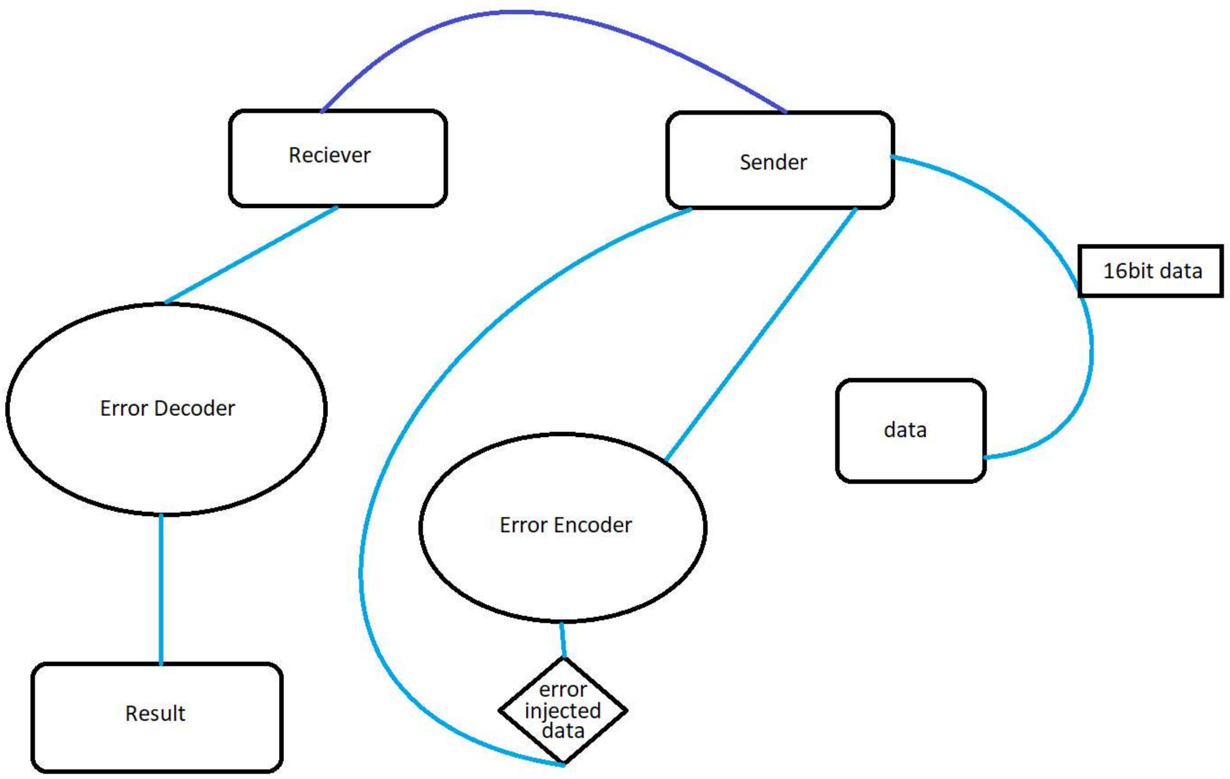
Design:

The complete project was implemented using Java 16. The key elements to the program is the Client-Socket module. The client and socket are made to run on the same system connected through a given port number.

The elaborate component list is listed below:

- Encode Data module
- Detect Error module
- Client (sender)
- Server (receiver)
- File(containing the data to be tested)

The diagrammatic representation of the complete setup is provided below:



Implementation:

The data is read from the file data.txt and stored in an array of String of size 100000. Substrings of size 16bits (2 bytes) are created and encoded using the Encode Data module. The encoded message is then send through the Client and received by the Server the data is then analysed using the Error Detection module

Individual methods

VRC: The given data of 16 bits is divided into 8bit substrings and the parity of the sliced strings are calculated and made to catenate with the 8bit substring.

Sent data : data/2 + VRC(bit) + data/2 + VRC(bit)

LRC: The given data of 16 bits is divided into 8bit substrings and the parity of each 8 columns and the new parity substring is catenated to the end of the data.

Sent data: data + LRC(bits)

Checksum: The given 16 bit data is complemented and we find the xor between the complemented with the binary of 2^n – 1 where n is the number of bits of the data. The sum of the complemented data is then catenated with the original 16 bit data.

Sent data: data + Checksum(bits)

CRC: We implement the CRC-10 and catenate the remainder to the 16bit data

Sent data: data + CRC(bits)

Test cases:

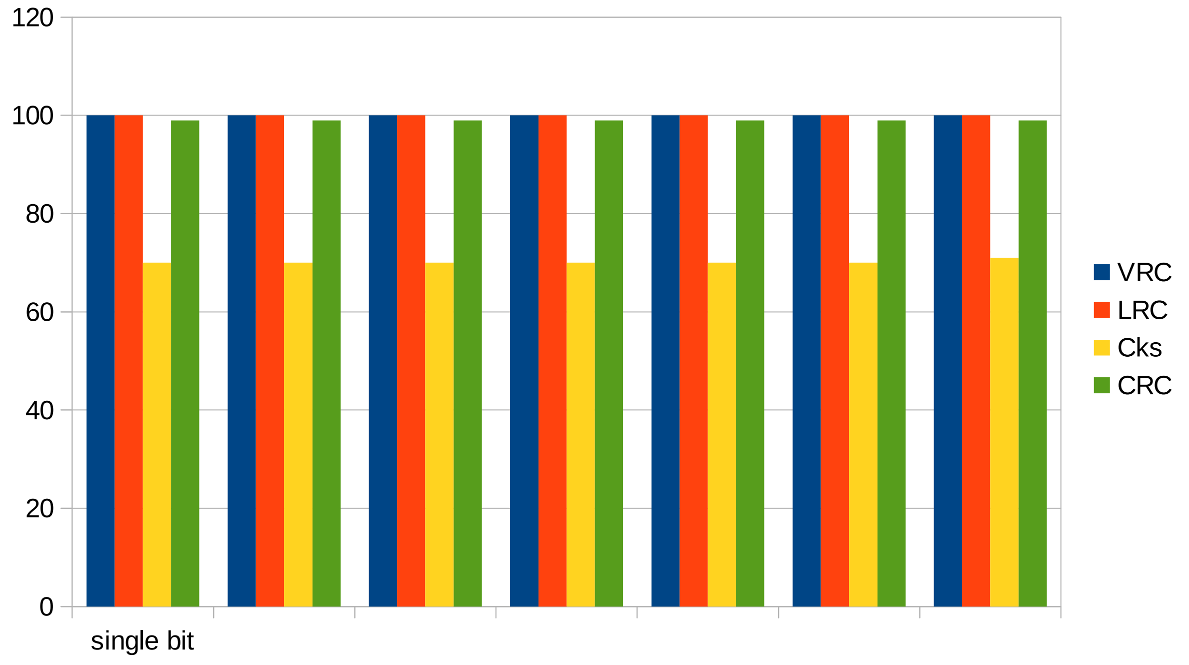
test cases have been generated by a random testcase generating program.

the code for the test case generating program is provided below

```
// *** java 16.0.1
import java.io.FileWriter;
import java.io.IOException;

public class GenerateDataWord {
    public static void main(String[] args) {
        // File dataFile = new File("data.txt");
        try {
            FileWriter fileWriter = new FileWriter("data.txt");

            for (int i = 0; i < 1000; i++) {
                String dat = "";
                for (int j = 0; j < 16; j++) {
                    long z = Math.round((Math.random() * 10));
                    if (z % 2 == 0) {
                        dat += "0";
                    } else {
                        dat += "1";
                    }
                }
                dat += "\n";
                fileWriter.write(dat);
            }

            fileWriter.close();
        } catch (IOException e) {
            e.printStackTrace();
        }

    }
}
```

Result:

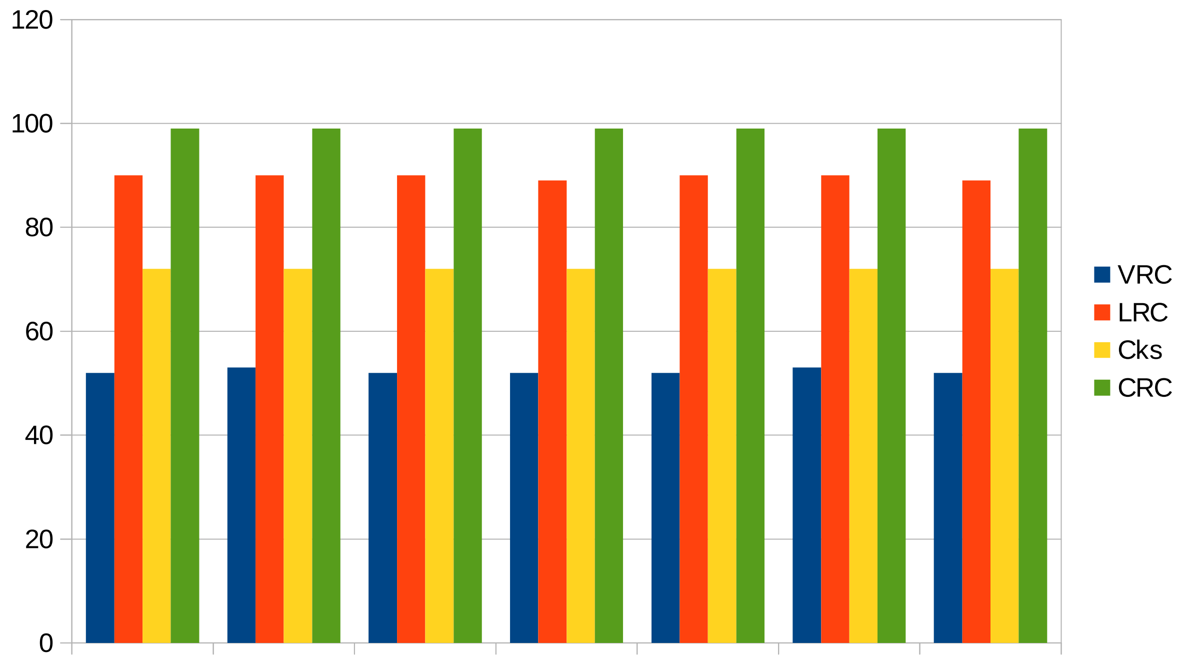
Error detection after ***single bit error*** injection



average:

VRC:	100.00000000
LRC:	100.00000000
Checksum:	70.14285714
CRC:	99.00000000

Error detection after ***burst error*** injection:



average:

VRC:	52.28571428
LRC:	89.71428571
Checksum:	72.00000000
CRC:	99.00000000

Analysis:

From various iterations over 10^5 data fragments we come to the conclusion that LRC and VRC are equally reliable at complete efficiency in detecting single bit error, but VRC fails detect almost 48% of the burst error injected data. LRC on the other hand drops about 10% efficiency in detecting burst error detection. Checksum has just a slight improvement of 2% on detecting burst error as compared to single bit error.

Among all the error detection methods, CRC has the most reliable and stable error correction rate standing at about 99% for both single bit error and burst error.

Comment :

If a practical system is to be designed for the given setup, the most logical implementation is to CRC modulation because of its overall consistency. If hybrid modulation is possible with more than one modulation on the same data, a combination of CRC + VRC might improve the range of CRC over single bit error but no significant improvement on burst error detection VRC detection rate being aroung 52%, thus a combination of LRC(100%, ~90%) and CRC(99%) is the most plausible.