Topic: Security Tools - Error detection codes

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Brief Information about the Tool:
The two error detection methods that we will be implementing are Parity Bit method and Checksum. The Parity Bit Method is a basic error detection technique used in digital communication systems, involving the addition of an extra bit to binary data to ensure either even or odd parity. This allows the receiver to detect single-bit errors during transmission, making it suitable for applications where simplicity and minimal overhead are prioritized. Conversely, Checksums provide a more robust error detection mechanism, generating a checksum value based on mathematical operations applied to data blocks. Widely employed in network protocols, file transfers, and storage systems, checksums offer enhanced error detection capabilities, capable of identifying not only single-bit errors but also burst errors, making them essential for ensuring data integrity in diverse digital communication scenarios.

List of features / functionalities proposed to be implemented:

Parity Bit Method:

- Simple Implementation: The Parity Bit Method is straightforward to implement, involving the addition of a single bit to binary data.
- Even/Odd Parity Selection: Allow users to choose between even parity and odd parity based on their specific error detection requirements.
- Single-Bit Error Detection: It is primarily designed to detect single-bit errors in transmitted data, making it suitable for applications where error detection requirements are minimal.

Checksum:

- Robust Error Detection: Checksums provide robust error detection capabilities, capable of detecting not only single-bit errors but also burst errors and other common transmission errors.
- Block-Level Verification: Checksums operate on blocks of data rather than individual bits, ensuring integrity across larger data units.

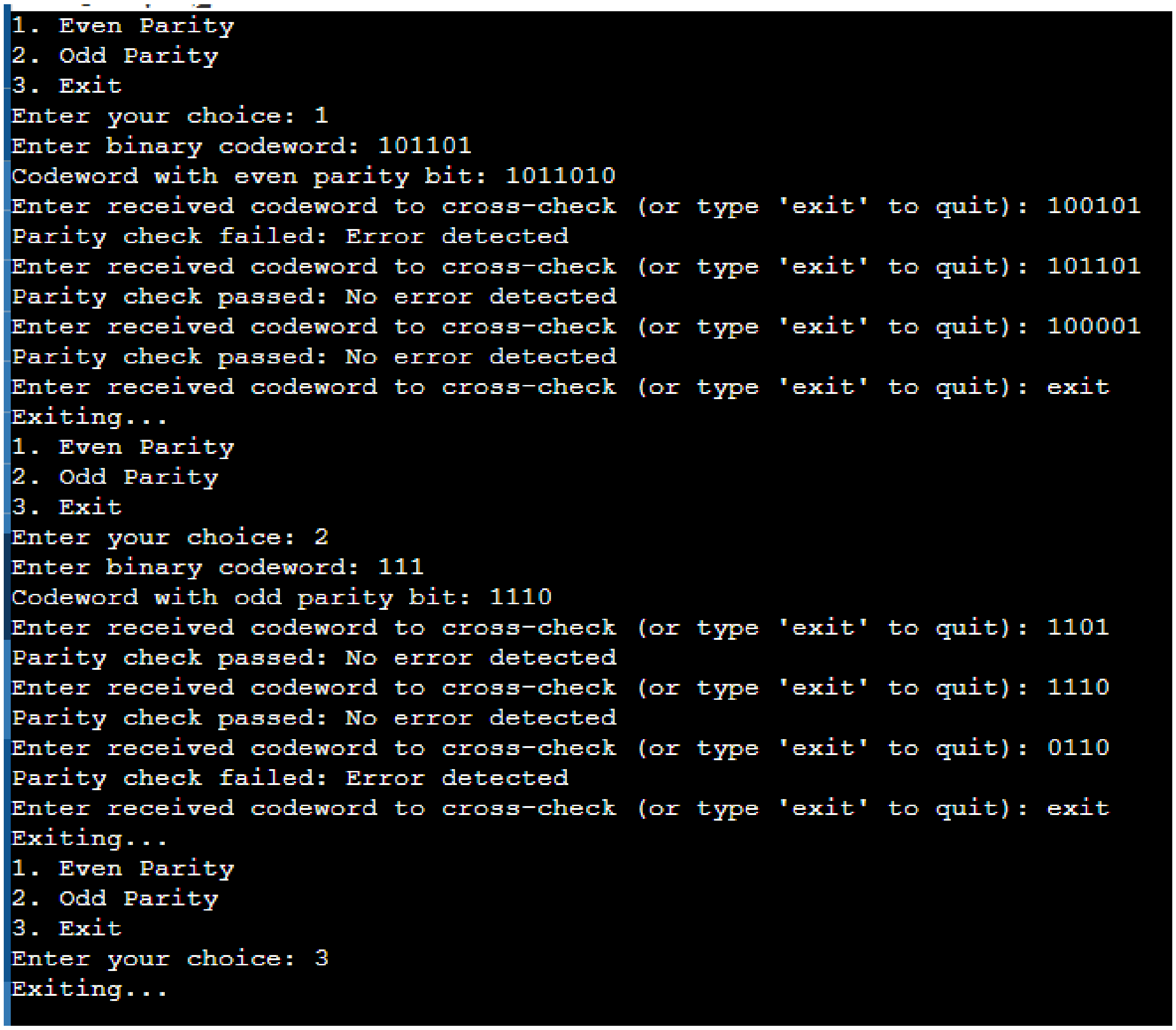
Snapshots:

Parity-bit Method

Code:

```python
def calculate_parity(data, parity_type='even'):
    ones_count = sum(int(bit) for bit in data)
    if parity_type == 'even':
        if ones_count % 2 == 0:
            return '0'
        else:
            return '1'
    elif parity_type == 'odd':
        if ones_count % 2 == 0:
            return '1'
        else:
            return '0'

def add_parity_bit(data, parity_type='even'):
    parity_bit = calculate_parity(data, parity_type)
    return data + parity_bit

def check_parity(data, parity_type='even'):
    received_parity_bit = data[-1]
    calculated_parity_bit = calculate_parity(data[:-1], parity_type)
    if received_parity_bit == calculated_parity_bit:
        return "Parity check passed: No error detected"
    else:
        return "Parity check failed: Error detected"

def menu():
    print("1. Even Parity")
    print("2. Odd Parity")
    print("3. Exit")

while True:
    menu()
    choice = input("Enter your choice: ")

    if choice == '1':
        binary_data = input("Enter binary codeword: ")
        codeword = add_parity_bit(binary_data, 'even')
        print("Codeword with even parity bit:", codeword)

        while True:
            received_data = input("Enter received codeword to cross-check
(or type 'exit' to quit): ")
            if received_data.lower() == 'exit':
                print("Exiting...")
                break
            result = check_parity(received_data, 'even')
            print(result)

    elif choice == '2':
        binary_data = input("Enter binary codeword: ")
        codeword = add_parity_bit(binary_data, 'odd')
        print("Codeword with odd parity bit:", codeword)

        while True:
            received_data = input("Enter received codeword to cross-check
(or type 'exit' to quit): ")
            if received_data.lower() == 'exit':
                print("Exiting...")
                break
            result = check_parity(received_data, 'odd')
            print(result)

    elif choice == '3':
        print("Exiting...")
        break

    else:
        print("Invalid choice. Please enter a valid option.")
```

Output:



```
1. Even Parity
2. Odd Parity
3. Exit
Enter your choice: 1
Enter binary codeword: 101101
Codeword with even parity bit: 1011010
Enter received codeword to cross-check (or type 'exit' to quit): 100101
Parity check failed: Error detected
Enter received codeword to cross-check (or type 'exit' to quit): 101101
Parity check passed: No error detected
Enter received codeword to cross-check (or type 'exit' to quit): 100001
Parity check passed: No error detected
Enter received codeword to cross-check (or type 'exit' to quit): exit
Exiting...
1. Even Parity
2. Odd Parity
3. Exit
Enter your choice: 2
Enter binary codeword: 111
Codeword with odd parity bit: 1110
Enter received codeword to cross-check (or type 'exit' to quit): 1101
Parity check passed: No error detected
Enter received codeword to cross-check (or type 'exit' to quit): 1110
Parity check passed: No error detected
Enter received codeword to cross-check (or type 'exit' to quit): 0110
Parity check failed: Error detected
Enter received codeword to cross-check (or type 'exit' to quit): exit
Exiting...
1. Even Parity
2. Odd Parity
3. Exit
Enter your choice: 3
Exiting...
```

Checksum

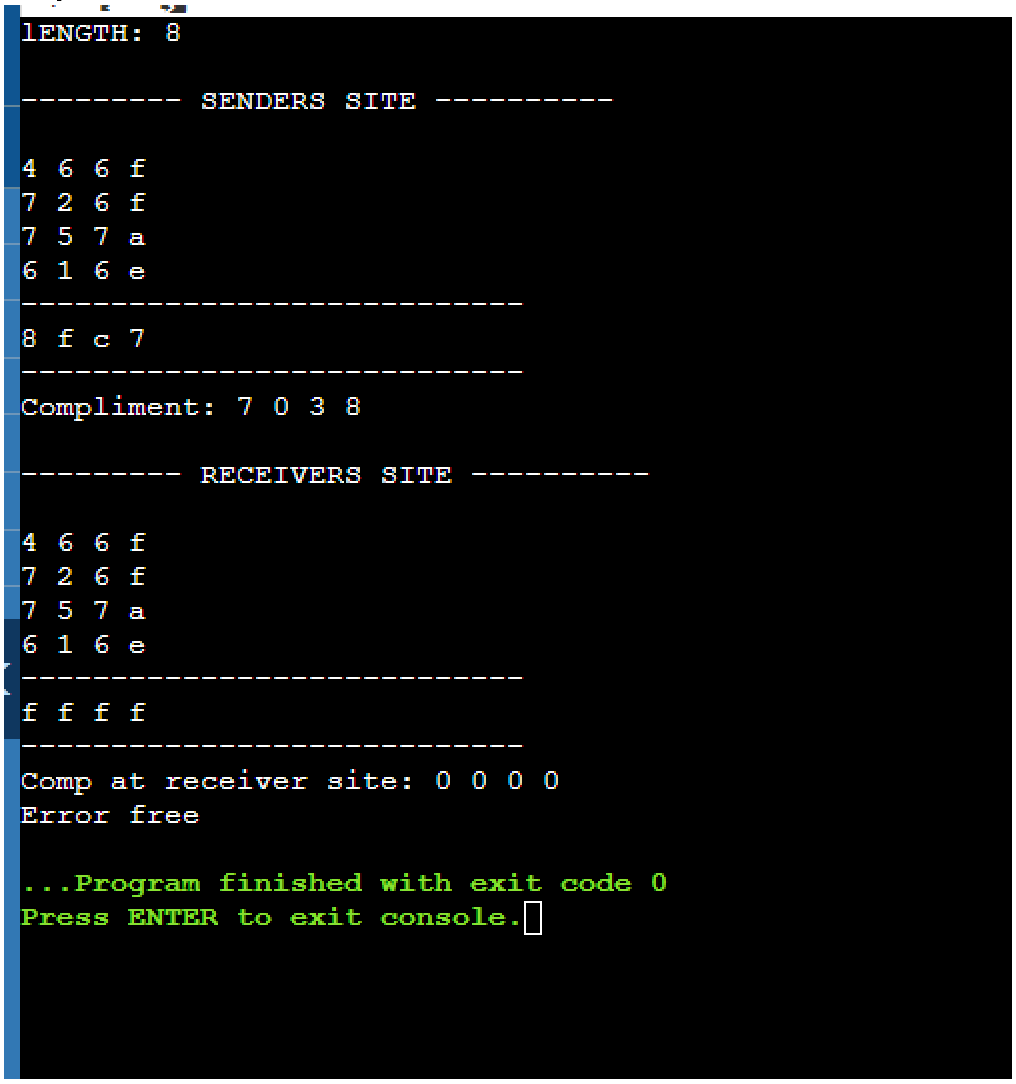
Code:

```
#include<stdio.h>
#include<string.h>
int main(){
    char ch[8]="Forouzan";
    int n=strlen(ch);
    printf("lENGTH: %d", n);
    printf("\n\n--------- SENDERS SITE ----------\n");
    int sum[4];
    for(int i=0;i<n;i=i+2)
    {
        int n1=ch[i];
        int n2=ch[i+1];

        int q1=n1/16;
        int q2=n2/16;
        int r1=n1%16;
        int r2=n2%16;
        sum[0]+=q1;
        sum[1]+=r1;
        sum[2]+=q2;
        sum[3]+=r2;
        printf("\n%x %x %x %x",q1,r1,q2,r2);
    }

    for(int i=3;i>=0;i--)
    {
        int q=sum[i]/16;
        int r=sum[i]%16;

        if(i>0) sum[i-1]+=q;
        else sum[3]+=q;
        sum[i]=r;
    }
    printf("\n----------------------------");
        printf("\n%x %x %x %x",sum[0],sum[1],sum[2],sum[3]);

    for(int i=3;i>=0;i--)
        sum[i]=15-sum[i];
```

```
printf("\n----------------------------");
printf("\nCompliment: %x %x %x %x",sum[0],sum[1],sum[2],sum[3]);

        printf("\n\n--------- RECEIVERS SITE ----------\n");

    int sum2[4];
for(int i=0;i<n;i=i+2)
{
    int n1=ch[i];
    int n2=ch[i+1];

    int q1=n1/16;
    int q2=n2/16;
    int r1=n1%16;
    int r2=n2%16;
    sum2[0]+=q1;
    sum2[1]+=r1;
    sum2[2]+=q2;
    sum2[3]+=r2;
    printf("\n%x %x %x %x",q1,r1,q2,r2);
}
sum2[0]+=sum[0];
sum2[1]+=sum[1];
sum2[2]+=sum[2];
sum2[3]+=sum[3];



for(int i=3;i>=0;i--)
{
    int q=sum2[i]/16;
    int r=sum2[i]%16;

    if(i>0) sum2[i-1]+=q;
    else sum2[3]+=q;
    sum2[i]=r;
}
printf("\n----------------------------");
printf("\n%x %x %x %x",sum2[0],sum2[1],sum2[2],sum2[3]);
for(int i=3;i>=0;i--)
```

```
        sum2[i]=15-sum2[i];
    printf("\n----------------------------");
                printf("\nComp    at    receiver    site:    %x    %x    %x
%x",sum2[0],sum2[1],sum2[2],sum2[3]);
    if(sum2[2]==0 && sum2[1]==0 && sum2[0]==0 && sum2[3]==0){
        printf("\nError free");
    }
    else {
        printf("\nError detected");
    }
}
```

Output:



```
lENGTH: 8

--------- SENDERS SITE ----------

4 6 6 f
7 2 6 f
7 5 7 a
6 1 6 e
----------------------------
8 f c 7
----------------------------
Compliment: 7 0 3 8

--------- RECEIVERS SITE ----------

4 6 6 f
7 2 6 f
7 5 7 a
6 1 6 e
----------------------------
f f f f
----------------------------
Comp at receiver site: 0 0 0 0
Error free

...Program finished with exit code 0
Press ENTER to exit console.
```