Cryptography & Network Security

PRN - 2019BTECS00026
Name - Niraja Vasudev Kulkarni
Batch - B1

Assignment - 3

Playfair Cipher

- **Objective -**

  To implement Playfair Cipher in C

- **Theory -**

The Playfair cipher was the first practical digraph substitution cipher. The scheme was invented in 1854 by Charles Wheatstone but was named after Lord Playfair who promoted the use of the cipher. In Playfair cipher unlike traditional cipher we encrypt a pair of alphabets(digraphs) instead of a single alphabet.
Procedure -

1. Take the plaintext & the key as input

2. Arrange the key in 5*5 matrix without repetition of characters. Fill rest of the matrix with remaining alphabets serially (Skip I/J)

3. Prepare chunks of size 2 in plaintext. If 2 characters in the chunk are same , put a dummy character.

4. Make sure the plaintext length is even otherwise put a dummy character in the end

5. For each chunk , encrypt the text by using playfair matrix with the help of following rules :

A) If both of them are in same row , take the next characters in the same row (consider wraparound)

B) If both of them are in same column , take the next characters in the same column (consider wraparound)

C) Otherwise take their intersection

Code –

```
#include <bits/stdc++.h>
using namespace std;
```

```
int RemoveSpaces(char arr[], int len)
{
    int i, count = 0;
    for (i = 0; i < len; i++)
        if (arr[i] != ' ')
            arr[count++] = arr[i];
    arr[count] = '\0';
    return count;
}

void GenerateKeyTable(char keyarr[5], int keylen, char keyTable[5][5])
{
    int i, j, k, flag = 0;
    int map[26] = {0};
    for (i = 0; i < keylen; i++)
    {
        if (keyarr[i] != 'J')
            map[keyarr[i] - 65] = 2;
    }
    map['J' - 65] = 1;
    i = 0;
    j = 0;
    for (k = 0; k < keylen; k++)
    {
        if (map[keyarr[k] - 65] == 2)
        {
            map[keyarr[k] - 65] -= 1;
            keyTable[i][j] = keyarr[k];
            j++;
            if (j == 5)
            {
                i++;
                j = 0;
            }
        }
    }
    for (k = 0; k < 26; k++)
    {
        if (map[k] == 0)
        {
            keyTable[i][j] = (char)(k + 65);
            j++;
            if (j == 5)
            {
                i++;
                j = 0;
            }
        }
```

```
    }
}

void search(char keyTable[5][5], char a, char b, int arr[])
{
    int i, j;
    if (a == 'J')
        a = 'I';
    else if (b == 'J')
        b = 'I';
    for (i = 0; i < 5; i++)
    {
        for (j = 0; j < 5; j++)
        {
            if (keyTable[i][j] == a)
            {
                arr[0] = i;
                arr[1] = j;
            }
            else if (keyTable[i][j] == b)
            {
                arr[2] = i;
                arr[3] = j;
            }
        }
    }
}

int mod5(int a)
{
    if (a < 0)
        a += 5;
    return (a % 5);
}

int Prepare(char arr[], int len)
{
    string res;
    int i = 0;
    while (i < len - 1)
    {
        res.push_back(arr[i]);
        if (arr[i] == arr[i + 1])
        {
            res.push_back('X');
            i++;
        }
        else
```

```
        {
            res.push_back(arr[i + 1]);
            i += 2;
        }
    }
    len = res.size();
    strcpy(arr, res.c_str());
    if (len % 2 != 0)
    {
        arr[len++] = 'X';
        arr[len] = '\0';
    }
    return len;
}

void Encrypt(char textarr[], char keyTable[5][5], int textlen)
{
    int i, arr[4];
    for (i = 0; i < textlen; i += 2)
    {
        search(keyTable, textarr[i], textarr[i + 1], arr);
        if (arr[0] == arr[2])
        {
            textarr[i] = keyTable[arr[0]][mod5(arr[1] + 1)];
            textarr[i + 1] = keyTable[arr[0]][mod5(arr[3] + 1)];
        }
        else if (arr[1] == arr[3])
        {
            textarr[i] = keyTable[mod5(arr[0] + 1)][arr[1]];
            textarr[i + 1] = keyTable[mod5(arr[2] + 1)][arr[1]];
        }
        else
        {
            textarr[i] = keyTable[arr[0]][arr[3]];
            textarr[i + 1] = keyTable[arr[2]][arr[1]];
        }
    }
}

void Decrypt(char textarr[], char keyTable[5][5], int textlen)
{
    string res;
    int i, arr[4];
    for (i = 0; i < textlen; i += 2)
    {
        search(keyTable, textarr[i], textarr[i + 1], arr);
        if (arr[0] == arr[2])
        {
```

```
            textarr[i] = keyTable[arr[0]][mod5(arr[1] - 1)];
            textarr[i + 1] = keyTable[arr[0]][mod5(arr[3] - 1)];
        }
        else if (arr[1] == arr[3])
        {
            textarr[i] = keyTable[mod5(arr[0] - 1)][arr[1]];
            textarr[i + 1] = keyTable[mod5(arr[2] - 1)][arr[1]];
        }
        else
        {
            textarr[i] = keyTable[arr[0]][arr[3]];
            textarr[i + 1] = keyTable[arr[2]][arr[1]];
        }
    }
    for (i = 0; i < textlen; i++)
    {
        if(textarr[i]!='X') res.push_back(textarr[i]);
    }
    strcpy(textarr, res.c_str());
}

string PlayfairEncrypt(char textarr[], char keyarr[],int flg)
{
    char keyTable[5][5];
    int i,j;
    string result;
    int keylen = RemoveSpaces(keyarr, strlen(keyarr));
    int textlen = RemoveSpaces(textarr, strlen(textarr));
    textlen = Prepare(textarr, textlen);
    GenerateKeyTable(keyarr, keylen, keyTable);
    if(flg==1) {
        for(i = 0; i < 5; i++) {
            for(j = 0; j < 5; j++) {
                cout<<keyTable[ i ] [ j ]<<" ";
            }
            cout<<"\n";
        }
    }
    Encrypt(textarr, keyTable, textlen);
    result = textarr;
    return result;
}

string PlayfairDecrypt(char textarr[], char keyarr[])
{
    char keyTable[5][5];
    string result;
    int keylen = strlen(keyarr);
```

```
    int textlen = strlen(textarr);
    GenerateKeyTable(keyarr, keylen, keyTable);
    Decrypt(textarr, keyTable, textlen);
    result = textarr;
    return result;
}

int main()
{
    int option,flg=0;
    string key, text, cipherText;
    char keyarr[30], textarr[30], cipher[30];
    cout << "\nGive input through:\n1)Console\n2)File\n-->";
    cin >> option;
    cin.ignore();
    cout << "Enter key: ";
    getline(cin, key);
    strcpy(keyarr, key.c_str());
    switch (option)
    {
        case 1:
            cout << "Enter text: ";
            flg=1;
            break;
        case 2:
            freopen("input.txt", "r", stdin);
            freopen("output.txt", "w", stdout);
            flg=2;
            break;
    }
    getline(cin, text);
    strcpy(textarr, text.c_str());
    cipherText = PlayfairEncrypt(textarr, keyarr,flg);
    cout << "Cipher Text: " << cipherText << endl;
    strcpy(cipher, cipherText.c_str());
    cout << "Deciphered Text: " << PlayfairDecrypt(cipher, keyarr);
    return 0;
}
```

Output –

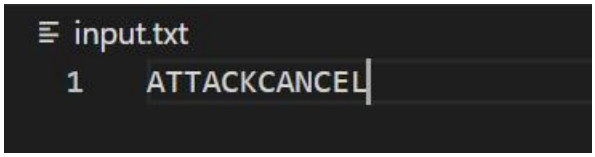
Sample output 1 –

```
D:\BTECH\CNS_LAB\Assg>cd "d:\BTECH\CNS_LAB\Assg\" && g++ PlayfairCipher.cpp -o PlayfairCipher && "d:\BTECH\CNS_LAB\Assg\"Playf
airCipher
How do you want to give input?:
1) Through terminal
2) Through File
1
Enter key: MONARCHY
Enter text: MEETMEAFTERTHEPARTY

Playfair Matrix:
M O N A R
C H Y B D
E F G I K
L P Q S T
U V W X Z
Cipher Text: CLKLCLOILKDZCFSODZ
```

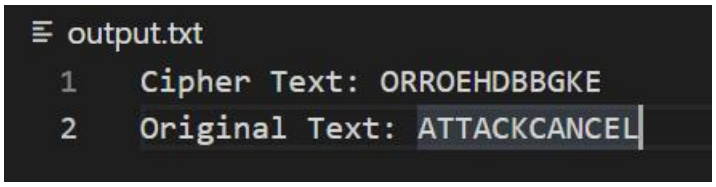
Sample output 2 -

```
D:\BTECH\CNS_LAB\Assg>cd "d:\BTECH\CNS_LAB\Assg\" && g++ PlayfairCipher.cpp -o PlayfairCipher && "d:\BTECH\CNS_LAB\Assg\"Playf
airCipher
How do you want to give input?:
1) Through terminal
2) Through File
2
Enter key: BALLOON

D:\BTECH\CNS_LAB\Assg>
```

Input file



Output file



Conclusion –

Playfair cipher is a polyalphabetic substitution cipher . Due to its easy decrption , it is not used in the modern encryption.