ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

A Gray Code Based Clock

Monika Kumar Jethani
Dept. of CSE, Pranveer Singh Institute of Technology, Kanpur, Uttar Pradesh, India

Abstract
Digital electronics forms an integral part of our life since the appliances which we witness in our day-to-day life are an application of this field. A clock is an instrument used to indicate, keep and co-ordinate time.There can be many ways to generate a clock.In this paper,we are going to focus on an innovative way to design a clock,that is,how Gray Code,commonly known as Reflected Code can be used in designing a clock.

Index Terms
Gray Code.

I. Introduction

Digital electronics provides an understanding to the design and working of a wide range of applications,from consumer to industrial electronics to communications;from embedded systems and computers to security equipment [3]. A clock is a mere application of digital electronics that not only indicates, keeps and co-ordinates time [5] but also drives our life.

The Gray code, also known as Reflected binary code, named after Frank Gray, is a binary numeral system where two successive values differ in only one bit (binary digit) [2][4].Gray Code belongs to the class of minimum change code.

Two bit Gray Code can be generated as follows

0-00
1-01
2-11
3-10

So Two-bit Gray Code has four combinations.A 2-bit Gray Code will have first two Gray codes written in order preceeded by a 0.The last two gray codes will be written in reverse order(assuming a mirror placed between first two and last two) and a 1 appended [1]. Gray Code is an unweighted code. We all witness 24-hour clocks or 12-hours clocks in our day-to-day life that possess 3 hands,popularly known as “hours hand” denoting number of hours,”minutes hand” denoting number of minutes and “seconds hand” denoting number of seconds.

We are going to design a Clock based on Gray Code discussed above. A clock has 60 divisions and when these 60 divisions are traversed by the seconds hand it is equivalent to a minute and when these 60 divisions are traversed by the minute hand it is equivalent to an hour.

Now we would use gray codes for the 60divisions.Use the 2-bit gray code for first 4 integers(divisions) and then iterate it 15 times as 15*4=60,so that makes complete 60 divisions.It is elaborated using the code below :-

```
for(i=1;i<=15;i++){
        new clock().gengraycode();
System.out.println(hours+":"+minutes+":"+seconds);
        seconds+=4;
            }
```

Here, gengraycode() generates 2-bit Gray Code that is stated above for 4 decimal numbers and this process is repeated 15 times therefore a for loop is used for iterating 15 times.i is a variable that is used as a loop counter.The System.out.println(+":"+minutes+":"+seconds) statement is used for displaying the number of hours,minutes and seconds.

So we require 2-bits for representing the 60 divisions. So the entire implementation can be represented as follows

```
    int hours=0,minutes=0,seconds=0,i,j,k;
        System.out.println(hours+":"+minutes+":"+seconds);

                for(k=1;k<=24;k++)
{
                        minutes=0;
                for(j=1;j<=59;j++)
{
                        seconds=0;
                for(i=1;i<=15;i++)
{
                        new clock().gengraycode();
        System.out.println(hours+":"+minutes+":"+seconds);
                        seconds+=4;
                }
        System.out.println(hours+":"+minutes+":"+seconds);
                minutes+=1;
        }


                System.out.println(hours+":"+minutes+":"+se
conds);
                hours+=1;
}
```

We have used Integer variables hours,minutes,seconds for indicating the number of hours,minutes and seconds respectively,each of which is initially set to zero at the start of the code segment.Then the outer for loop for k is used for the number of hours.The for loop with loop counter j is used for the number of minutes.System.out.println(+":"+minutes+":"+seconds) is used for displaying the number of hours,minutes and seconds.

In the code segment,

```
for(i=1;i<=15;i++){
                        new clock().gengraycode();
System.out.println(hours+":"+minutes+":"+seconds);
                        seconds+=4;
                    }
```

A 2-bit gray code is being generated for the first 4 divisions and this process is repeated four times using a for loop with i as the loop variable. Each time the Gray Code is generated for 4 integers the seconds counter increments.When the number of seconds equals 60 then the Minutes counter gets incremented.When the number of minutes equals 60 then the Hours counter gets incremented.

The detailed implementation of gengraycode() is as follows:-

```
public void gengraycode(){
                int a[]={0,0},k,j;
                for(k=0;k<2;k++)
                {
                        System.out.print(a[k]);
                }
                System.out.println();

                for(k=1;k>=0;k--)
                {
                if(a[k]==0)
                        a[k]=1;
                for(j=0;j<2;j++){

                System.out.print(a[j]);
                        }
                System.out.println();


                }
                if(a[1]==1)
                        a[1]=0;
                for(j=0;j<2;j++){
                System.out.print(a[j]);
                        }
                System.out.println();
        }
```

Here array a is used for the 2-bit gray code generation which initially has values 0,0.This value is then printed in the first for loop.The next for loop performs gray code computation and then displays 01 and 11.The last for loop produces output 10.
The output of gengraycode() is

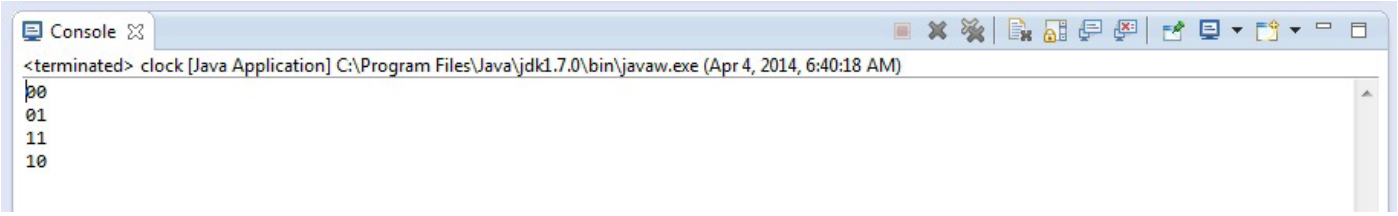

Fig. 1: Output of gengraycode().

The snapshot of entire implementation of Gray Code based Clock is as follows

```
package graycode;
public class clock {
public static void main(String[] args) {
        int hours=0,minutes=0,seconds=0,i,j,k;
        System.out.println(hours+":"+minutes+":"+seconds);
        for(k=1;k<=24;k++){
            minutes=0;
        for(j=1;j<=59;j++){
            seconds=0;
        for(i=1;i<=15;i++){
            new clock().gengraycode();
            System.out.println(hours+":"+minutes+":"+seconds);
            seconds+=4;}
        System.out.println(hours+":"+minutes+":"+seconds);
        minutes+=1;}
        System.out.println(hours+":"+minutes+":"+seconds);
        hours+=1;}
    }
    public void gengraycode(){
        int a[]={0,0},k,j;
        for(k=0;k<2;k++){
        System.out.print(a[k]);}
        System.out.println();
        for(k=1;k>=0;k--){
        if(a[k]==0)
            a[k]=1;
        for(j=0;j<2;j++){
            System.out.print(a[j]);}
        System.out.println(); }
        if(a[1]==1)
            a[1]=0;
        for(j=0;j<2;j++){
        System.out.print(a[j]);}
        System.out.println();
    }
        }
```

Fig. 2: Implementation of Gray Code Based Clock.

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

It contains a class named clock with two methods,main() and gengraycode().gengraycode() is used to display the gray code.The main() is used to for generation of clock,that is computation of hours,minutes and seconds and these values are displayed using the System.out.println(+":"+minutes+":"+seconds) statement. The output of entire implementation of Gray Code based Clock is as follows

II. Conclusion

This paper has proved that there exists an innovative technique for clock generation, hence Gray Codes find application in clock generation too.This concept can be used for appliances and real time applications.

III. Future Scope

Similar to Gray Code, other codes such as Excess-3, 8-4-2-1,Binary Coded Decimal may also be useful for implementations of various applications.

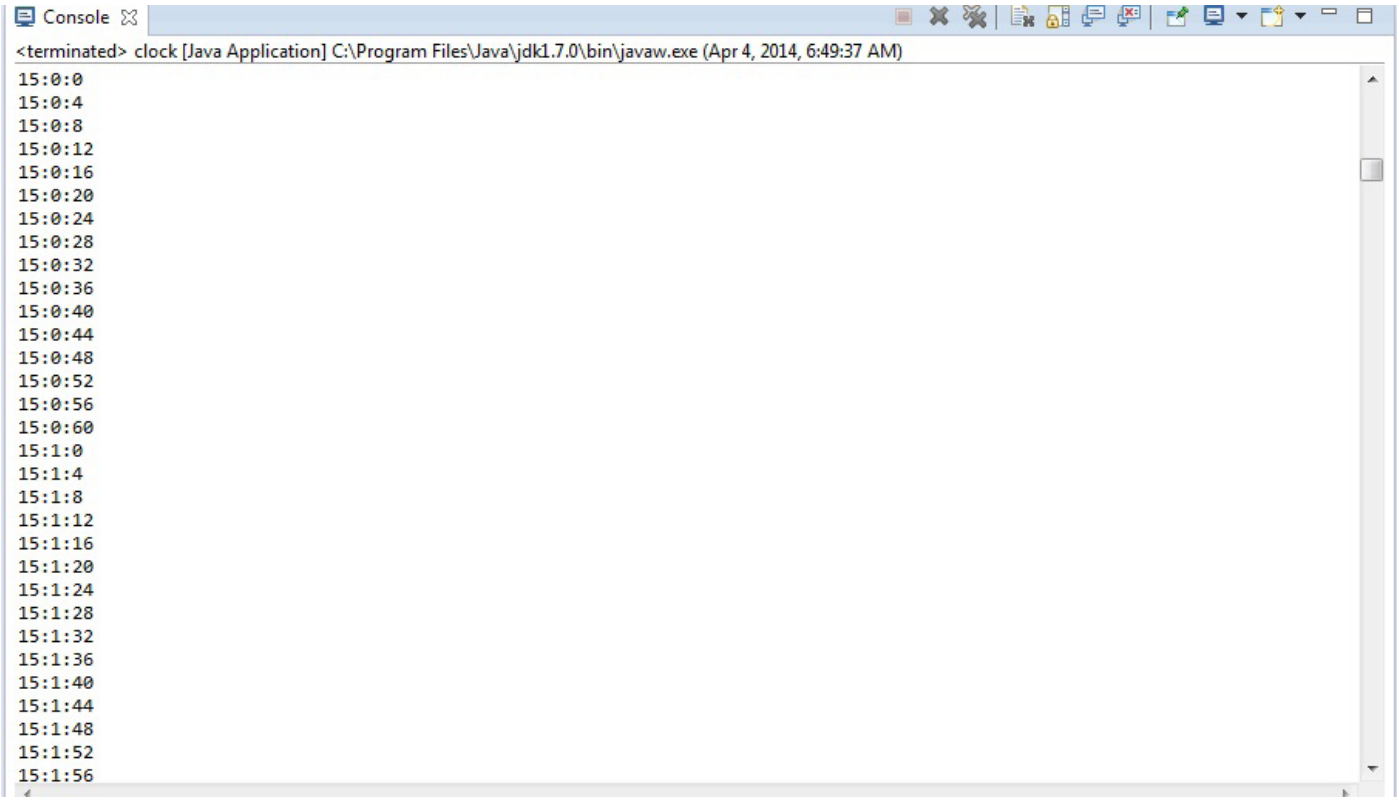

Fig. 3: Output of Implementation of Gray Code Based Clock.

References

[1] *R. Jain, "Modern Digital Electronics 4E," Tata McGraw Hill, vol. 4.*
[2] S.P. Bali,"2000 Solved Problems in Digital Electronics", Tata McGraw Hill, vol. 1, 2006.
[3] Anil K. Maini ,"Digital Electronics: Principles ,Devices and Applications",WILEY,2007.
[4] En.wikipedia.org/wiki/Gray-code.
[5] En.wikipedia.org/wiki/Clock.