Experiment No. 7
Implement Booth's algorithm using c-programming
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Date of Performance:
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Aim: To implement Booth's algorithm using c-programming.

Objective -

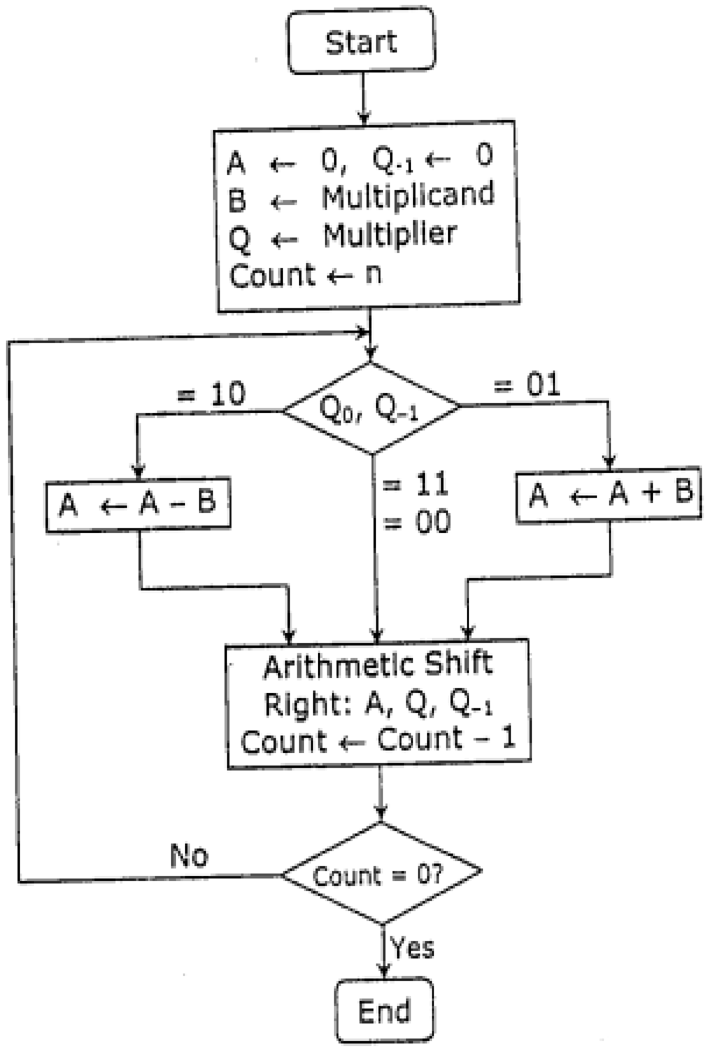
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

Theory:

Booth's algorithm is a multiplication algorithm that multiplies two signed binary numbers in 2's complement notation. Booth used desk calculators that were faster at shifting than adding and created the algorithm to increase their speed.

The algorithm works as per the following conditions :

1. If Qn and Q_{-1} are same i.e. 00 or 11 perform arithmetic shift by 1 bit.
2. If Qn Q_{-1} = 10 do A= A - B and perform arithmetic shift by 1 bit.
3. If Qn Q_{-1} = 01 do A= A + B and perform arithmetic shift by 1 bit.



Multiplicand (B) ← 0 1 0 1 (5), Multiplier (Q) ← 0 1 0 0 (4)				
Steps	A	Q	Q_{-1}	Operation
	0 0 0 0	0 1 0 0	0	Initial
Step 1 :	0 0 0 0	0 0 1 0	0	Shift right
Step 2 :	0 0 0 0	0 0 0 1	0	Shift right
Step 3 :	1 0 1 1	0 0 0 1	0	A ← A − B
	1 1 0 1	1 0 0 0	1	Shift right
Step 4 :	0 0 1 0	1 0 0 0	1	A ← A + B
	0 0 0 1	0 1 0 0	0	Shift right
Result	0 0 0 1 0 1 0 0 = +20			

Program:

```
#include <stdio.h>
#include <math.h>

int a = 0,b = 0, c = 0, a1 = 0, b1 = 0, com[5] = { 1, 0, 0, 0, 0};
int anum[5] = {0}, anumcp[5] = {0}, bnum[5] = {0};
int acomp[5] = {0}, bcomp[5] = {0}, pro[5] = {0}, res[5] = {0};

void binary(){
        a1 = fabs(a);
        b1 = fabs(b);
        int r, r2, i, temp;
        for (i = 0; i < 5; i++){
        r = a1 % 2;
        a1 = a1 / 2;
        r2 = b1 % 2;
        b1 = b1 / 2;
       anum[i] = r;
       anumcp[i] = r;
          bnum[i] = r2;
        if(r2 == 0){
           bcomp[i] = 1;
```

```
        }
        if(r == 0){
            acomp[i] =1;
        }
        }
//part for two's complementing
c = 0;
for ( i = 0; i < 5; i++){
        res[i] = com[i]+ bcomp[i] + c;
        if(res[i] >= 2){
            c = 1;
        }
        else
            c = 0;
        res[i] = res[i] % 2;
        }
for (i = 4; i >= 0; i--){
        bcomp[i] = res[i];
}
//in case of negative inputs
if (a < 0){
        c = 0;
        for (i = 4; i >= 0; i--){
```

```
        res[i] = 0;
         }
         for ( i = 0; i < 5; i++){
        res[i] = com[i] + acomp[i] + c;
         if (res[i] >= 2){
            c = 1;
         }
         else
            c = 0;
        res[i] = res[i]%2;
         }
         for (i = 4; i >= 0; i--){
        anum[i] = res[i];
        anumcp[i] = res[i];
         }

  }
  if(b < 0){
         for (i = 0; i < 5; i++){
         temp = bnum[i];
        bnum[i] = bcomp[i];
        bcomp[i] = temp;
         }
```

```
  }
}
void add(int num[]){
        int i;
        c = 0;
        for ( i = 0; i < 5; i++){
       res[i] = pro[i] + num[i] + c;
        if (res[i] >= 2){
          c = 1;
        }
        else{
           c = 0;
        }
       res[i] = res[i]%2;
        }
        for (i = 4; i >= 0; i--){
        pro[i] = res[i];
      printf("%d",pro[i]);
        }
  printf(":");
  for (i = 4; i >= 0; i--){
       printf("%d", anumcp[i]);
        }
```

```
}
void arshift(){//for arithmetic shift right
        int temp = pro[4], temp2 = pro[0], i;
        for (i = 1; i < 5  ; i++){//shift the MSB of product
        pro[i-1] = pro[i];
        }
        pro[4] = temp;
        for (i = 1; i < 5  ; i++){//shift the LSB of product
      anumcp[i-1] = anumcp[i];
        }
        anumcp[4] = temp2;
   printf("\nAR-SHIFT: ");//display together
        for (i = 4; i >= 0; i--){
      printf("%d",pro[i]);
        }
   printf(":");
        for(i = 4; i >= 0; i--){
      printf("%d", anumcp[i]);
        }
}

void main(){
  int i, q = 0;
```

```
printf("\t\tBOOTH'S MULTIPLICATION ALGORITHM");

printf("\nEnter two numbers to multiply: ");

printf("\nBoth must be less than 16");

//simulating for two numbers each below 16

do{

    printf("\nEnter A: ");

    scanf("%d",&a);

    printf("Enter B: ");

    scanf("%d", &b);

        }while(a >=16 || b >=16);


 printf("\nExpected product = %d", a * b);

        binary();

 printf("\n\nBinary Equivalents are: ");

 printf("\nA = ");

        for (i = 4; i >= 0; i--){

    printf("%d", anum[i]);

        }

 printf("\nB = ");

        for (i = 4; i >= 0; i--){

    printf("%d", bnum[i]);

        }

        printf("\nB'+ 1 = ");
```

```
        for (i = 4; i >= 0; i--){
      printf("%d", bcomp[i]);
        }
   printf("\n\n");
        for (i = 0;i < 5; i++){
        if (anum[i] == q){//just shift for 00 or 11
          printf("\n-->");
          arshift();
        q = anum[i];
        }
        else if(anum[i] == 1 && q == 0){//subtract and shift for 10
          printf("\n-->");
          printf("\nSUB B: ");
          add(bcomp);//add two's complement to implement subtraction
              arshift();
        q = anum[i];
        }
       else{//add ans shift for 01
          printf("\n-->");
          printf("\nADD B: ");
          add(bnum);
          arshift();
        q = anum[i];
```

```
        }
        }

    printf("\nProduct is = ");
        for (i = 4; i >= 0; i--){
       printf("%d", pro[i]);
        }
        for (i = 4; i >= 0; i--){
       printf("%d", anumcp[i]);
        }
}
```

Output:

Terminal

```
BOOTH'S MULTIPLICATION ALGORITHM
Enter two numbers to multiply:
Both must be less than 16
Enter A: 10
Enter B: 05
Expected product = 50

Binary Equivalents are:
A = 01010
B = 00101
B'+ 1 = 11011



-->
AR-SHIFT: 00000:00101
-->
SUB B: 11011:00101
AR-SHIFT: 11101:10010
-->
ADD B: 00010:10010
AR-SHIFT: 00001:01001
-->
SUB B: 11100:01001
AR-SHIFT: 11110:00100
-->
ADD B: 00011:00100
AR-SHIFT: 00001:10010
Product is = 0000110010
```

Conclusion -

Our experiment on Booth's algorithm has underscored its crucial role in optimizing binary multiplication. This efficient algorithm effectively reduces the number of partial products and minimizes the overall multiplication operations, thereby enhancing computational speed and reducing hardware complexity. Booth's algorithm stands as a powerful tool for optimizing multiplication processes and is a fundamental concept in digital arithmetic. Our experiment has effectively showcased its practical applicability in computer architecture and digital circuit design.