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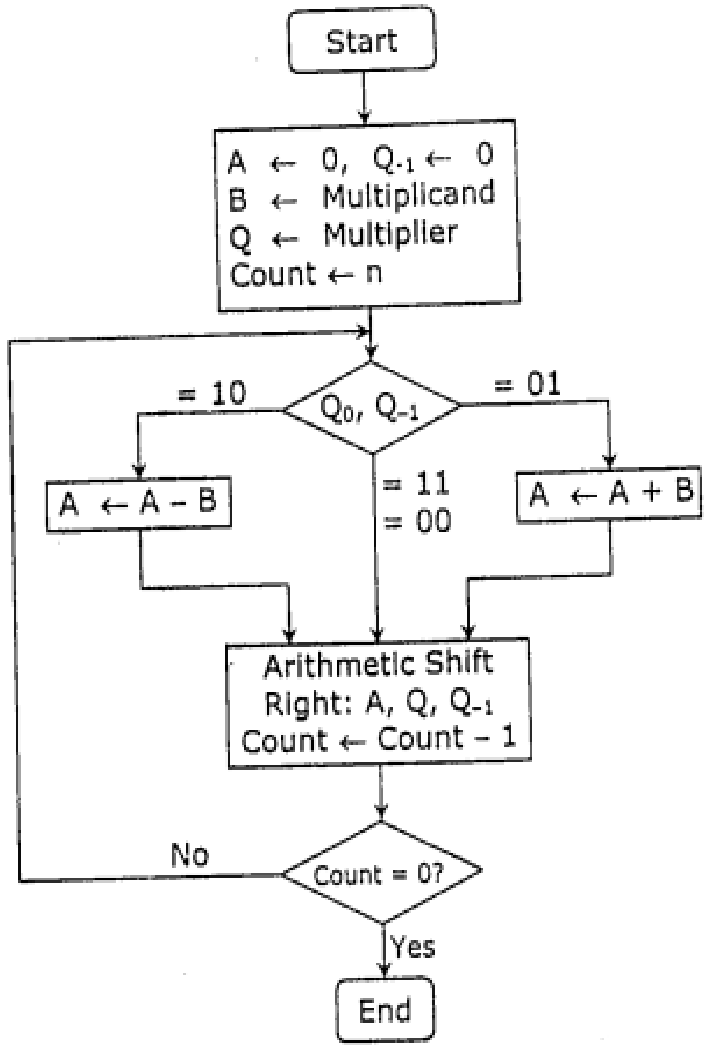
Aim: To implement Booth's algorithm using c-programming.

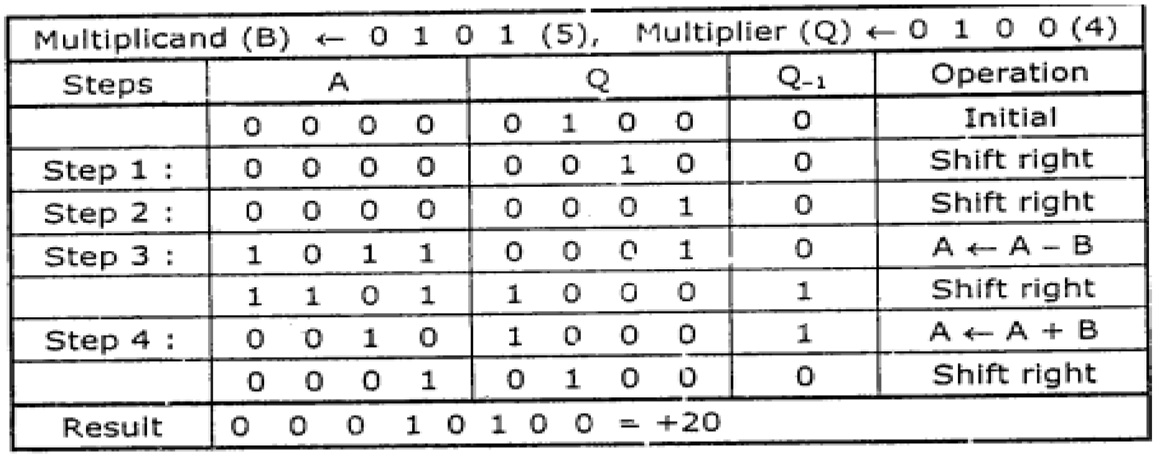
Objective -

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 <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;
        }
    }

  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];
```

```
   }

   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(){
    int temp = pro[4], temp2 = pro[0], i;
    for (i = 1; i < 5  ; i++){
       pro[i-1] = pro[i];
    }
    pro[4] = temp;
    for (i = 1; i < 5  ; i++){
        anumcp[i-1] = anumcp[i];
    }
    anumcp[4] = temp2;
    printf("\nAR-SHIFT: ");
    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){
          printf("\n-->");
          arshift();
          q = anum[i];
       }
       else if(anum[i] == 1 && q == 0){
         printf("\n-->");
         printf("\nSUB B: ");
         add(bcomp);
         arshift();
         q = anum[i];
       }
       else{
         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:

OUTPUT:-

```
BOOTH'S MULTIPLICATION ALGORITHM
Enter two numbers to multiply:
Both must be less than 16
Enter A: 10
Enter B: 2
Expected product = 20

Binary Equivalents are:
A = 01010
B = 00010
B'+ 1 = 11110



-->
AR-SHIFT: 00000:00101
-->
SUB B: 11110:00101
AR-SHIFT: 11111:00010
-->
ADD B: 00001:00010
AR-SHIFT: 00000:10001
-->
SUB B: 11110:10001
AR-SHIFT: 11111:01000
```

```
-->
ADD B: 00001:01000
AR-SHIFT: 00000:10100
Product is = 0000010100
```

Conclusion –
Booth's algorithm, a multiplication algorithm designed to efficiently multiply signed binary numbers, has proven to be a significant advancement in computer arithmetic. Its capacity to perform multiplication using a more streamlined process by reducing the number of additions and operations required showcases its relevance in optimizing computational efficiency. Booth's algorithm stands as a valuable contribution to computer arithmetic, offering an efficient method for multiplying binary numbers.