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

Objective -

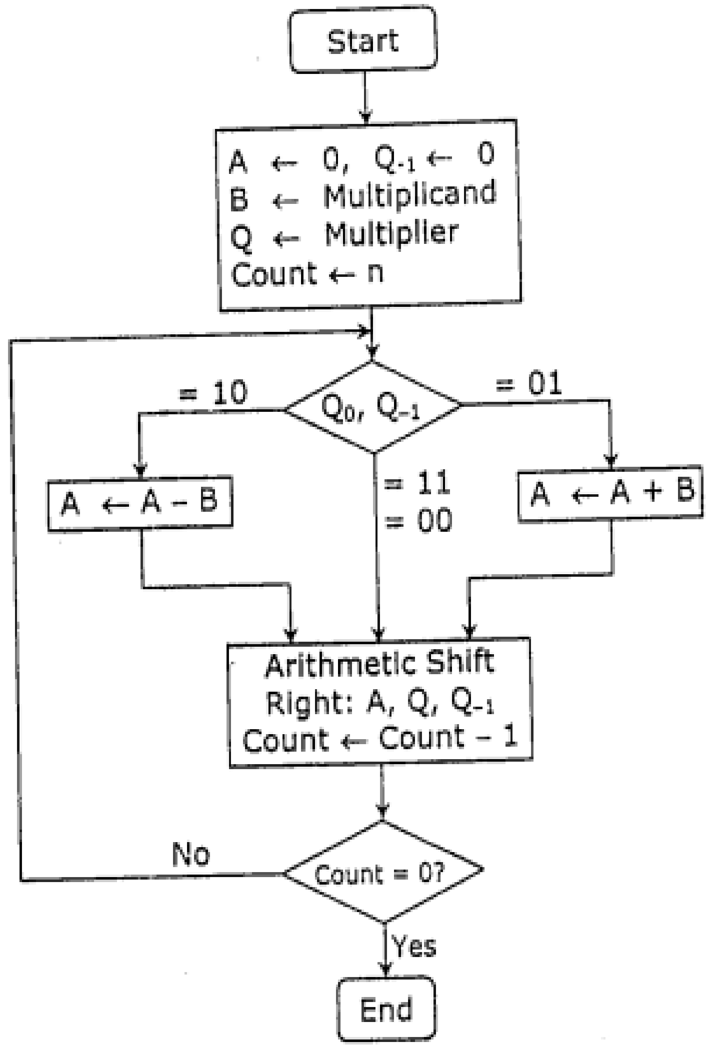
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

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 -

Our exploration into Booth's algorithm has underscored its crucial role in enhancing the efficiency of binary multiplication. Booth's algorithm adeptly cuts down on the quantity of partial products, leading to a marked reduction in the overall number of necessary operations for multiplication. This not only accelerates computation but also simplifies hardware requirements. Booth's algorithm stands as a potent instrument for fine-tuning multiplication procedures and stands as a fundamental concept within the realm of digital arithmetic. Our experiment has effectively showcased its pragmatic utility in computer architecture and the design of digital circuits.