



# **Vidyavardhini's College of Engineering and Technology**

## **Department of Artificial Intelligence & Data Science**

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Experiment No. 7
Implement Booth's algorithm using c-programming
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Date of Performance:04/09/24
Date of Submission:



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**Aim:** To implement Booth's algorithm using c-programming.

### Objective -

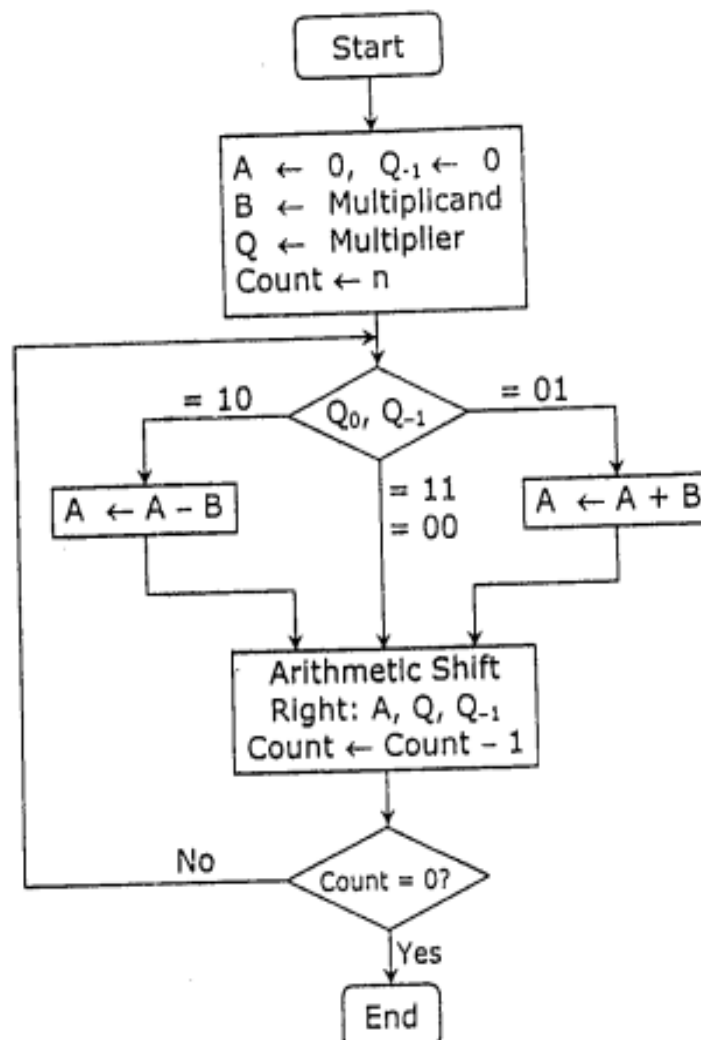
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

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





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Multiplicand (B) ← 0 1 0 1 (5), Multiplier (Q) ← 0 1 0 0 (4)				
Steps	A	Q	Q <sub>-1</sub>	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]);  
    }  
}
```



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```
}  
}  
  
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: ");  
        }  
    }  
}
```



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```
        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]);
}
}
```



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### Output:

```
BOOTH'S MULTIPLICATION ALGORITHM
Enter two numbers to multiply:
Both must be less than 16
Enter A: 5
Enter B: 2

Expected product = 10

Binary Equivalents are:
A = 00101
B = 00010
B'+ 1 = 11110

-->
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
-->
AR-SHIFT: 00000:01010
Product is = 0000001010

...Program finished with exit code 1
Press ENTER to exit console.□
```

### Conclusion -

Implementing Booth's algorithm in C provides an efficient method for multiplying binary numbers using signed integers. This algorithm reduces the complexity of multiplication by transforming the problem into a series of shifts and adds, leveraging the properties of binary arithmetic. By coding Booth's algorithm, you can effectively handle signed multiplication operations, which is particularly useful in low-level programming and digital systems design. The algorithm's systematic approach ensures that multiplication operations are performed accurately and efficiently, even when dealing with negative numbers.